The Role of Spatial Planning in Conserving Biodiversity

Half-Earth Activity Series – Table of Contents

The Role of Spatial Planning in Conserving Biodiversity

Half-Earth Activity Series – Series A Framing

Series A includes 3 activities, labeled as A.1, A.2, and A.3 in the following materials.

- A.1 "Saving a Coral Reef: Introduction to Spatial Planning Approaches"
- A.2 "Landscape Features and Conservation: Mapping Species with Grids and Units"
- A.3 "Testing the Effectiveness of Conservation Decisions: The Interactive Marxan Simulator"

Spatial Conservation Planning is a process that integrates math, science, and geographic information systems (GIS) to analyze a portion of earth's surface especially the species residing there, to prioritize conservation decisions. Spatial planning is a way to look at the land we use and inhabit, collect information about the species within that land area, and analyze information on both the species and the human usage. The species, abiotic factors, and human impacts are all called features. Asking questions and collecting information on a feature helps us to make more informed conservation decisions. Digital maps are versatile tools for storing and displaying many layers of information, such as where people live and farm, compared to where species live. The integration of mapping, mathematics and GIS are just the beginning. As Jen McGowan says, "algorithms give us solutions but people make decisions; algorithms start the dialogue and frame the problem."

Activity A.1 introduces students to the concepts of efficient conservation planning by challenging them to find solutions that save the most species in the smallest marine reserve network. In the next two activities, students will continue exploring efficient spatial planning through grid analysis and gain a deeper understanding of the thinking involved in spatial planning for conservation decision making. Activities A.2 and A.3 are best used after completing A.1. The sequence of these activities guides students through the principles of spatial planning for the conservation of species.

Activity A.2 features a video with Half-Earth Project and Map of Life spatial planning scientist Scott Rinnan, Ph.D. Students will view the video, respond to questions, and design solutions using a simple printable map matrix. Estimated time is one class period.

Activity A.3 can stand alone but is intended to follow A.1 and A.2 even if in separate class periods. Student worksheets and instructions guide students through the use of a free online tool called the Marxan Simulator, that allows students to test their own conservation plans. Estimated time is one class period, or 30 minutes as homework.

The Role of Spatial Planning in Conserving Biodiversity

Half-Earth Activity Series Activity A.1

Saving a Coral Reef: Introduction to Spatial Planning Approaches

Instructor Background: Jennifer McGowan, a Spatial Planning Technical Coordinator for the Nature Conservancy and Half-Earth Project Spatial Scientist, uses species data for spatial prioritization and conservation decision-making. Her work involves creating tools that help support this spatial mapping and conservation planning. The animation featured in this activity was created by Jen to provide an introduction to spatial planning and how it works in considering how to choose a marine reserve.

How to Choose Marine Reserves Animation:
Have students watch the animation and pause at 3:50. Students can answer the following questions while watching the animation or discuss them after viewing.

1. What is a planning unit and why is it important in spatial planning?

2. Jennifer mentioned the acronym C.A.R.E. What does each letter stand for and what does it mean in terms of conservation prioritization and planning?

3. What is your understanding of spatial planning after watching this animation?

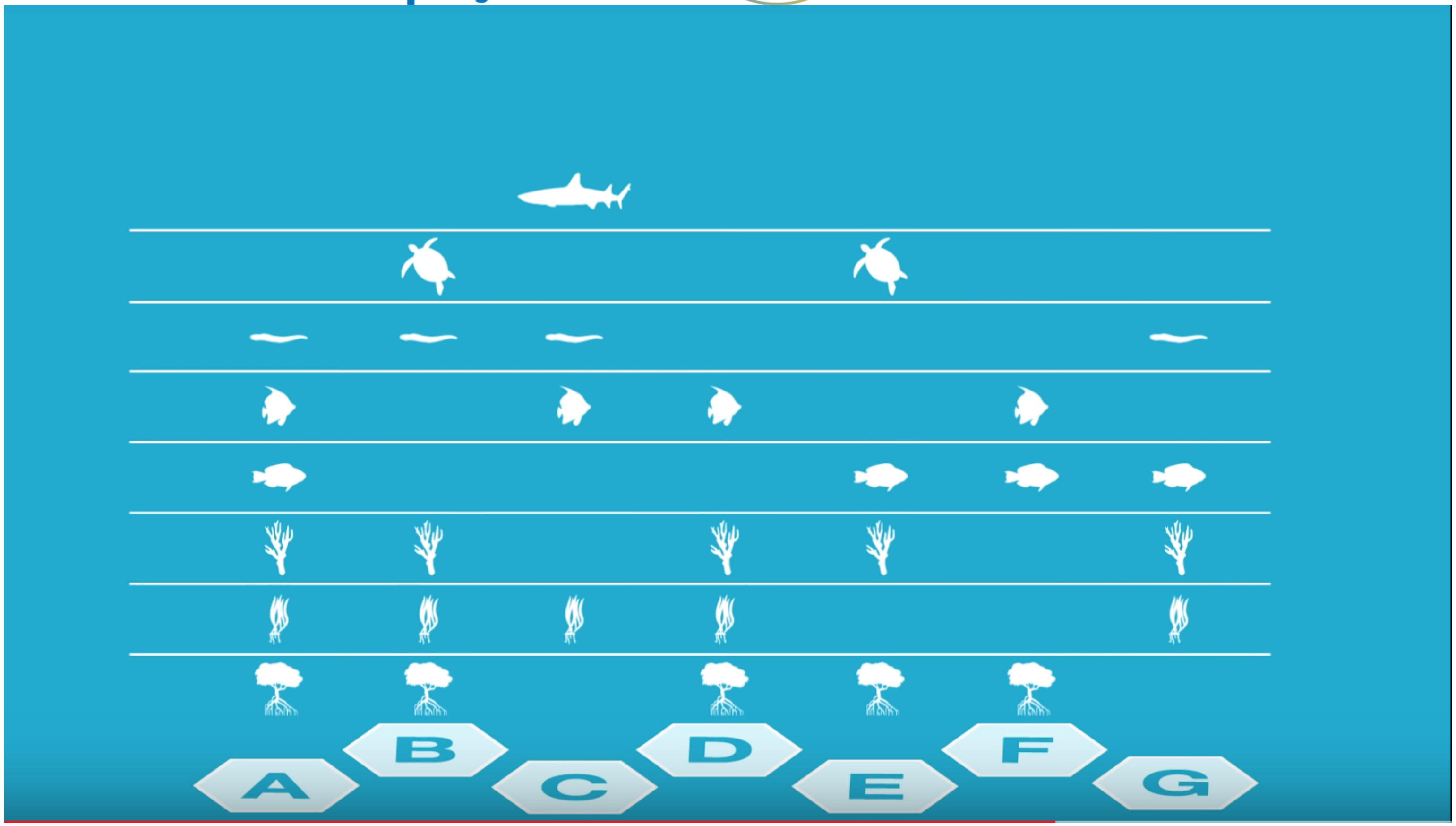
Choosing a Marine Reserve Activity:
Students will work in pairs or small groups to determine which sites or “planning units” could be conserved in order to provide a habitat for all species in the marine reserve. Students should try to be efficient with their decision-making which means finding the smallest number of sites that would conserve all the features. Allow students time to discuss their decisions in groups and share their conservation decisions with evidence and reasoning from the video (CARE) and the map itself. Ask students to consider the following: Is your groups choice efficient? Why or why not? After all groups have shared and discuss with the whole class, play the rest of the video 3:50-5:37. Have students reflect on the following:

1. Now that you have more information, was your groups choice the most efficient? Why or why not?

2. How does your groups choices compare to the experts?

3. Why is the most obvious choice not always the most efficient choice?

4. Maps are an important part of spatial planning and conservation decision-making. Putting species on the map is even more important. Based on your experience with this activity, why is this true?



Summary Graphic: The species present in 7 different units of a potential marine reserve network. (Frame from Jenn McGowan's animation.)

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Half-Earth Activity Series Activity A.1

Saving a Coral Reef: Introduction to Spatial Planning Approaches – Student Worksheet

How to Choose Marine Reserves Animation:

Watch the animation and pause at 3:50. Students can answer the following questions while watching the animation or discuss them after viewing.

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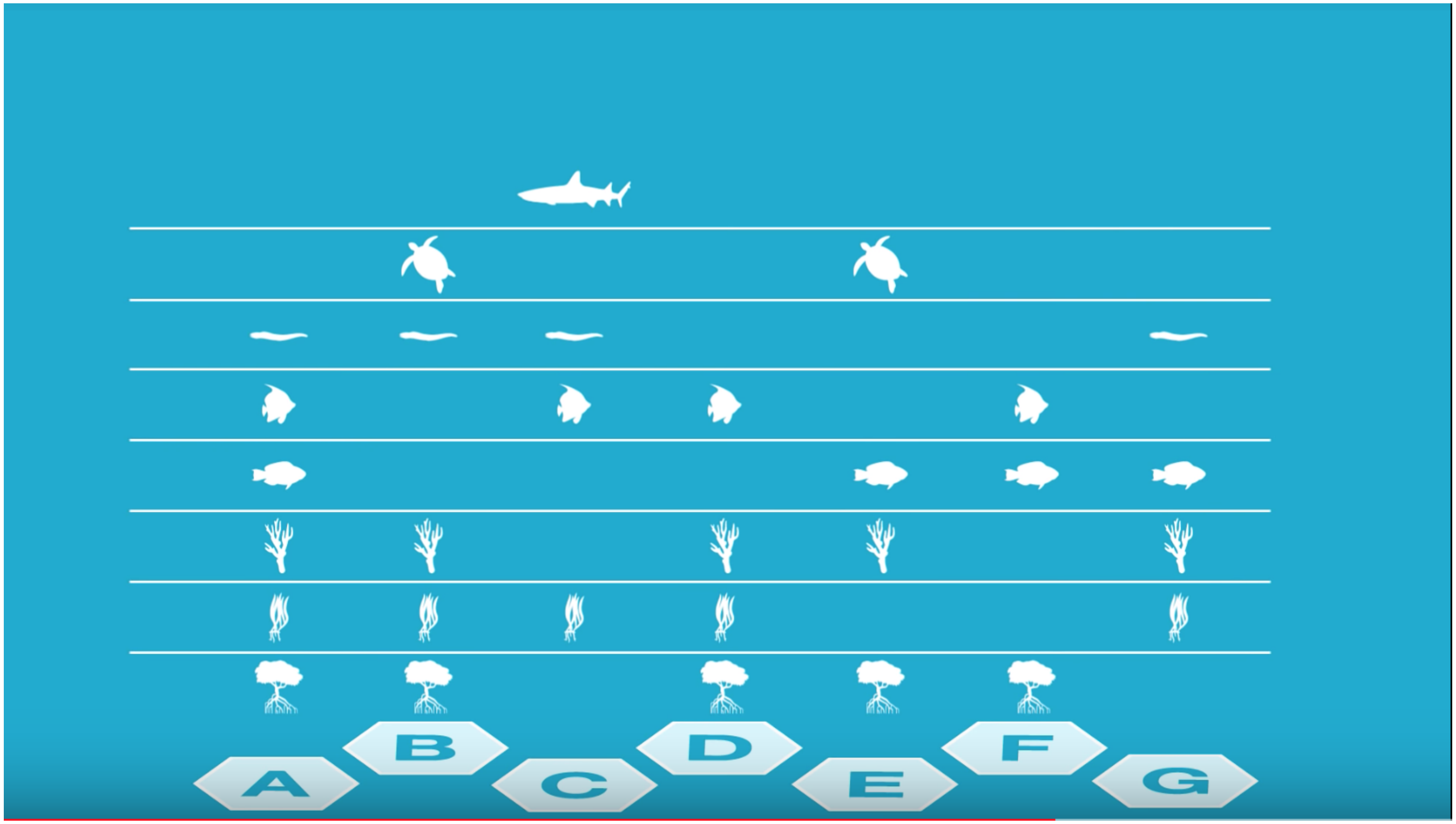

Summary Graphic: The species present in 7 different units of a potential marine reserve network. (Frame from Jenn McGowan's animation.)

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Half-Earth Activity Series Activity A.2

Landscape Features and Conservation: Mapping Species with Grids and Units

Instructor Background: An interview with Half-Earth Project Scientist Scott Rinnan along with the questions and a map graphic are designed to help students understand how spatial scientists use mapping data to make species conservation decisions. The goal of the activity is to expose students to the concept of spatial planning, what an efficient plan is, and how mapping assists in the process of spatial planning. By the end of the activity, students should understand that each letter represents a species and certain species live in certain parts of the landscape. The landscape is divided into squares (also called cells) that are planning units. You can cue students to think that this grid is being laid on top of a piece of land to organize it in order to notice patterns and use the data within the grid to make decisions. You might tell them to think of a local park for example that has grassy and tree-covered areas. The goal is to conserve, or save, as many species as possible using the fewest units as possible; this is called an efficient solution.

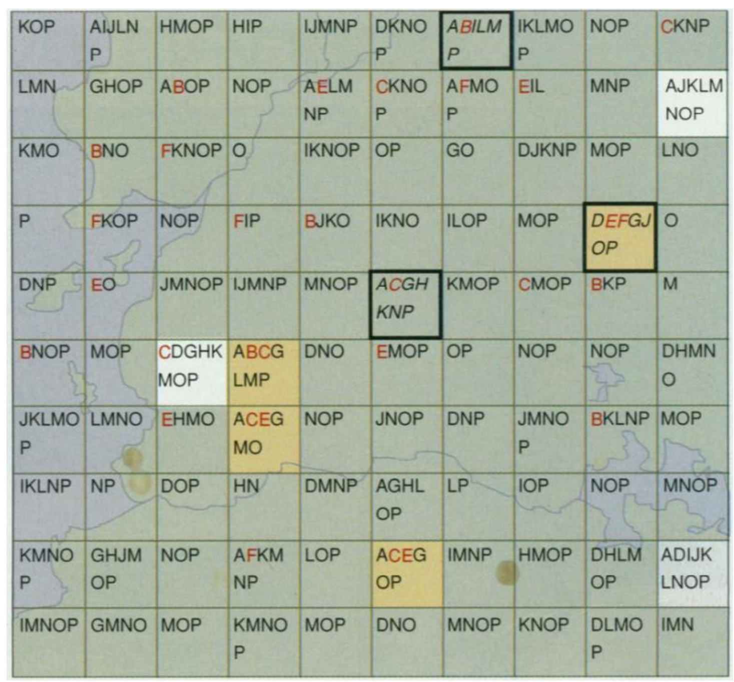
Student Activity: Use this video (30:49-36:00) to answer the following questions about the 10x10 grid Scott is presenting.

Answer these questions while you watch the video. Your instructor will replay the video more than once to help you understand the basics of how to think through a Spatial Planning problem.

1. What do these different letters represent? How many are represented? (Instructor Note: Before moving on, make sure that students understand each letter represents a different species, organism, animal, plant, etc.)

2. What do the different colors of letters represent? Be explicit.

3. What do the white, yellow, and black outlined boxes represent?



Pimm, S.L., & Lawton, J.H. (1998). Planning for biodiversity. *Science,* 279(5359), 2068-2069. https://science.sciencemag.org/content/279/5359/2068.summary

After watching the video, work with a partner or small group according to your instructor's directions, to answer the following discussion questions. Be prepared to share your answers with the class.

4. For the boxes in yellow, how many species are conserved with this conservation plan? Which ones?

5. For the boxes in white, how many species are conserved with this conservation plan? Which ones?

6. For the boxes outlined in black, how many species are conserved with this conservation plan? Which ones?

7. There is a solution represented by yellow boxes, a solution represented by white boxes, and a solution represented by dark outlines. Which solution is the most efficient conservation decision and why? (Instructor Note: Students should indicate which of those three solutions - yellow boxes, white boxes, or darkly outlined boxes - is the most efficient solution and then explain why it is the most efficient solution using information from the video and the grid.)

8. What is considered in the conservation decision?

After discussing the above questions with your classmates, consider the following. After answering independently, discuss your thoughts with a partner, small group, or be prepared to share with the whole class.

9. How does mapping and spatial planning inform conservation decision-making?

10. This example used a 10x10 grid. If we expanded the grid to even 100x100, what problems would you face and what resources or technology could you use to help you make an efficient conservation decision? (Instructor Note: This activity is already showing how complicated conservation decisions can be with 16 species and a 10x10 grid of "land." The gist of this question is to get students thinking about how mathematical tools such as algorithms and computer programs help make the analysis easier as the problem gets more complex.)

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The Role of Spatial Planning in Conserving Biodiversity

Half-Earth Activity Series Activity A.2

Grids, Units (cells), and Features – Student Worksheet

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Answer these questions while you watch the video. Your instructor will replay the video more than once to help you understand the basics of how to think through a Spatial Planning problem.

1. What do these different letters represent? How many are represented?

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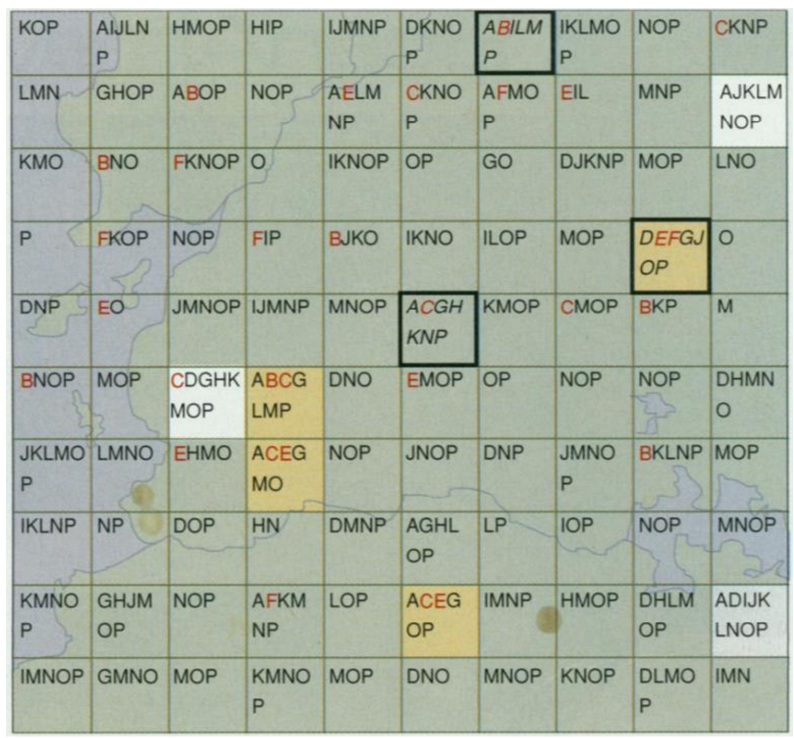

Pimm, S.L., & Lawton, J.H. (1998). Planning for biodiversity. *Science,* 279(5359), 2068-2069. https://science.sciencemag.org/content/279/5359/2068.summary

After watching the video, work with a partner or small group as directed by your instructor, to answer the following discussion questions. Be prepared to share your answers with your class.

4. For the boxes in yellow, how many species are conserved with this conservation plan? Which ones?

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Half-Earth Activity Series Activity A.3

Testing the Effectiveness of Conservation Decisions: The Interactive Marxan Simulator

Instructor Background: Marxan is a software tool developed by The Nature Conservancy to help decision-makers and conservation managers consider options for biodiversity conservation in the landscapes and water areas they are interested in. The Marxan simulator in this activity gives students an interactive way to see how the tool works and to test their own proposed conservation plans.

Activity A.3 builds on concepts students encountered in Activities A.1 and A.2 with the important variable of cost added in. The simulator uses dollars, and literal cost in dollars is an important factor, but you can also think of it as a stand-in for a variety of human interests and impacts like competing uses of the land for forestry, agriculture, human living space, mining, fishing, hunting, and recreation.

In this activity students apply the concept of efficient conservation using specific realistic but fictitious species as a case study. Using the simulator students will explore the many options for conservation with the goal of finding the most efficient solution.

Student Activity: Consider that each letter - A, B, C - are different species that are endangered or at risk of being endangered on this 10x10 plot of land. Your challenge is to reach the conservation goal outlined in the simulator for each species while also considering the cost of the land. The target for Species A, a road-crossing chicken, is to conserve 267.4 individuals. The target for Species B, a slow toad, is to conserve 251.2 individuals. The target for Species C, a silly goose, is to conserve 243 individuals. This information is organized in the chart below.

Species	Features	Target
Road-crossing chicken	A	267.4
Slow toad	B	251.2
Silly goose	C	243

Your Task: Which cells would you protect to reach the goal of meeting all of the species conservation targets while also spending the least amount of money on land?

- Look at the cells and the amount of species conserved in each cell.
- Look at the cells and the cost of each parcel of land.

Click on the cells that you want to conserve and see how you begin to reach your conservation goal for each species.

Analysis questions:

1. After meeting your targets, count how many cells you chose and record.

2. After meeting the targets, what is your "Unclumped" total cost? What is your "Clumped" total cost?

3. Why do you think these costs are different?

4. Compare your results with a partner or small group. How do they compare? Who had the most efficient solution?

5. Click "show solution" for the "Unclumped" and "Clumped" arrangements. Compare the cost, number of squares and visual arrangement.
    1. Which arrangement is the most cost efficient? Why?

    2. Which arrangement resembles a wildlife corridor and why is this beneficial to species conversation?

6. How would you make these results seem more real to you? Would it help to put the grid in a real place and add some real species? Suggest a place and some species.

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Half-Earth Activity Series Activity A.3

The Interactive Marxan Simulator for Testing the Effectiveness of Conservation Decisions

Student Worksheet

Student Activity: Consider that each letter - A, B, C - are different species that are endangered or at risk of being endangered on this 10x10 plot of land. Your challenge is to reach the conservation goal outlined in the simulator for each species while also considering the cost of the land. The target for Species A, a road-crossing chicken, is to conserve 267.4 individuals. The target for Species B, a slow toad, is to conserve 251.2 individuals. The target for Species C, a silly goose, is to conserve 243 individuals. This information is organized in the chart below.

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Appendix: The Role of Spatial Planning in Conserving Biodiversity

Half-Earth Activity Series – Instructor Background

To support students and educators to explore the science of spatial conservation planning, the Half-Earth Project education team has produced a series of activities of varying length and complexity to bring you and your students progressively deeper into the important science of spatial planning for conservation, an exciting multidisciplinary effort. Conservation needs all kinds of experts AND students!

The Conservation of Biodiversity is not a single action, or one effort. Conservation involves research and application of that research in the real world to plan, communicate, and negotiate to take specific conservation actions. A single species can be the focus of conservation actions, or a particular place. For example, planting native plants in your own yard, or volunteering to remove invasive species from public lands near where you live are conservation actions.

Spatial planning is a tool that is useful to conservation efforts at almost any scale from a town, national park, state, or entire country. Spatial planning helps people to analyze and guide decisions on the best things to do, and when the very best thing cannot be done for biodiversity, to consider next-best options. The goal of the Half-Earth Project is to save the vast majority of species worldwide to reverse the current extinction crisis and bring the biosphere we depend on into the safe zone. Scientific evidence points to half of the land and seas on a global basis to be the right target. But life is not evenly distributed on the planet and so a random half will not get us there. To identify the most important lands and portions of the oceans to protect, the project turns to the science of spatial planning.

The data for spatial planning comes from the collected efforts of governments, organizations, and individual researchers from around the world, working in the field to study where species live and what they need to thrive, as well as from satellite data that tells us about human impacts such as urbanization and deforestation. Data from many different sources can be shown on powerful digital mapping tools like the Half-Earth Map available online for use by conservation planners, educators, and students. The Half-Earth Map features layers showing biodiversity, protected areas, and human impacts, as well as analytical tools for understanding how effective our conservation efforts are toward progressing to the safe zone for our planet. We hope that the activities we have developed will help you and your students dig deeper into the science behind the Half-Earth Map and conserving our planet's precious biodiversity.