



**MODULE 1, LESSON 2 Inhabitable: Species-Area Relationship and Creating More Hospitable Spaces**

**GRADES:** 9-12

**DURATION:** 1 class period (45-50 minutes)

**MATERIALS:**

Per pair: computer, pencil/pen, paper; optionally for graphing by hand: graph paper, 2 colored pencils

**STANDARDS:**

*Living Environments Performance Indicator 1.1f*

*Every population is linked, directly or indirectly, with many others in an ecosystem. Disruptions in the numbers and types of species and environmental changes can upset ecosystem stability.*

*Living Environments Performance Indicator 7.2b*

*When humans alter ecosystems either by adding or removing specific organisms, serious consequences may result. For example, planting large expanses of one crop reduces the biodiversity of the area.*

*Living Environments Performance Indicator 7.2a*

*Human activities that degrade ecosystems result in a loss of diversity of the living and nonliving environment. For example, the influence of humans on other organisms occurs through land use and pollution. Land use decreases the space and resources available to other species, and pollution changes the chemical composition of air, soil, and water.*

Students compare how land cover/habitat changes affect number of species in Welikia (1609) vs. New York City (2014).

*NYS MST Standard 1: Students will use mathematical analysis, scientific inquiry and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.*

*NYS MST Standard 2: Students will access, generate, process, and transfer information using appropriate technologies.*

Students use Visionmaker to record the estimated number of species found in a given area. They create scatter plots using graphing software to display the species-area relationship curve.

Students test the mathematical probability of using green roofs to improve habitat for the taxa covered by Visionmaker.

*Living Environments Performance Indicator 1.1c*

*In all environments, organisms compete for vital resources. The linked and changing interactions of populations and the environment compose the total ecosystem.*

Students test the species-area relationship by recording and graphing area to number of species using the Visionmaker vision extent tool and spreadsheets.

Students see how different ecosystems are able to support different amounts of biodiversity.

*NYS MST Standard 4: Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.*

Students use some tools of landscape ecologists to look at models of the environment.

Students understand that metrics (EPs) serve as proxy for other variables happening in the landscape and are just a few ways to measure environmental performance.

**PREPARATION:**

If the school using this site is not in New York City, use City Hall as the starting block for Activity 1. Alternately, choose a location in New York City that might have some significance to the class, perhaps some place where the school has gone on a field trip. It is a good idea for the teacher to test the chosen starting block before class.

**ACTIVITY 1**

**Building Blocks: Exploring Species-area Relationship (30 minutes)**

The relationship between area and species diversity is one of the most important concepts in ecology. It is called the

species-area relationship and commonly abbreviated SAR. It describes how many species can be expected in a given sized area. If the class went through Module 1, Lesson 1, summarize the number of species each team discovered. Would doubling the space probably equal about double the amount of species? How about quadrupling? Would the curve increase along a line or would the line curve? Now have them look at some data from New York City:

Upon entering the site, click on LOGIN TO CREATE VISION. Enter username and password.

Have students or student pairs zoom into the block where their school is (City Hall or alternative location) by typing the address (only need street address) in the MAP POSITION field. When they press return, the map should zoom into the block.

They will need to find the vision for their block. Scroll over VISIONS on the bottom of the screen. Choose ANY in the SHOWING pull down tab. Click on the SEARCH button in the Visions carousel. Enter the name of the street in the field VISION NAME. Probably more than one vision will appear. Students will need to either know another cross street (or look on Google maps because Visionmaker does not display street names on satellite view) or be able to recognize the block shape to choose the correct block. Students can choose either the 2014 or 1609 block for this exercise.

Have them find and record the number of species on their block in 1609 and the present. Look for the total ecosystem area located by clicking the SHOW DETAILS button under the ENVIRONMENTAL PERFORMANCE drop down menu. The ecosystem area is in the VISION INFORMATION or DATA SUMMARY tabs.

Click on COPY AND EDIT THIS VISION

The student/ student pairs will add one block at a time (5 blocks total) to their starting block by clicking on an adjacent block.

Click SAVE. Press RECALCULATE. Record the ecosystem area, 1609 number of species, and 2014 number of species (Figure 1).

| Area in meters <sup>2</sup> | 1609 # of species | 2014 # of species |
|-----------------------------|-------------------|-------------------|
| 10075                       | 23                | 10                |
| 25500                       | 30                | 14                |
| 36066                       | 36                | 18                |
| 45626                       | 39                | 18                |
| 54614                       | 42                | 18                |

Figure 1. Sample Table

They will create a chart using a spreadsheet program (Excel or Google Docs) or drawing their scatter plots on graph paper, using different colors for 1609 and 2014 (Figure 2).

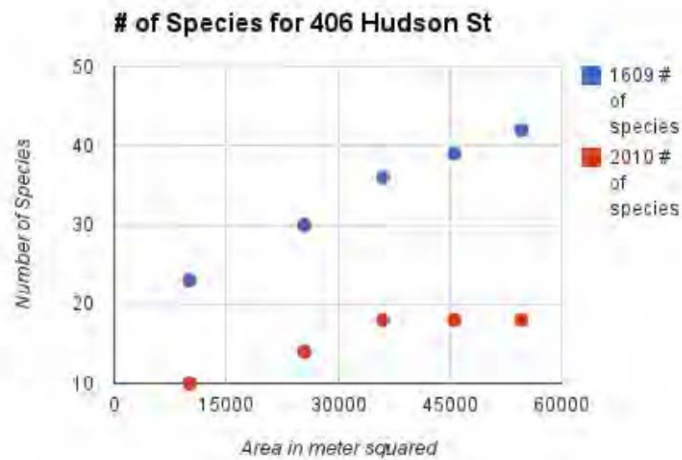


Figure 2. Sample data points

Use area for the x-axis and species number on they-axis. Alternately, if there is no printer, have students plot these points on graph paper using different colors for 1609 and 2014.

Have students draw a line through the data points representing the relationship (Figure 2).

What is the relationship between number of ecosystems and biodiversity? How is the relationship they found similar to or different from their expectations at the beginning of the activity? How are the relationships different in Welikia (1609) vs. New York (2014)? What explains those differences?

For a related math lesson, point out that the species area relationship appears to follow a power-law distribution, where the number of species is related to area by some exponent. If you plot the power-law distribution on a log-log scale, it forms a linear relationship. See the help under the SPECIES metric for a more expansive description. Wikipedia also has a concise and useful description: [http://en.wikipedia.org/wiki/Species-area\\_curve](http://en.wikipedia.org/wiki/Species-area_curve)

## Activity 2

### Roof Hopping: learning to Use Modifier Tools (15 minutes)

The students likely discovered that logarithmic growth in number of species was probably a lot slower in 2014 than 1609. That's because area in contemporary New York is generally less hospitable to a diversity of species. One strategy to help create ecosystems more hospitable to non-human species is by adding green roofs. Ask if any of the students have heard of or seen a green roof. It's a roof that is partially or entirely covered with vegetation. While the practice is centuries old, green roofs are becoming increasingly popular in urban-areas. Green roofs are one way that certain animals can find suitable habitat. Some of the other benefits of green roofs include that they provide insulation in the winter, cooling in the summer, and reduce storm water runoff. Green roofs are one type of modifier tool on the website.

Use the green roof tool (in the "modifier" toolset with the solar panel icon) to add green roofs on all the buildings of their vision. Note that you can't paint green roofs on top of streets or courtyards or parks or water. How did adding green roofs change the number of species in their visions?

The students will have likely found that covering all the buildings did not make a big impact on their number of species. Click on SHOW DETAILS. Open the VISION DATA SUMMARY tab and scroll down to BIODIVERSITY (green). Have students click on the drop down area next to SPECIES. Visionmaker records species by taxa, groups of animals, and does not cover all taxa. For example, green roofs attract mostly insects and birds, animals that can somehow get to a roof.

**Extension Activity: Making a Block a Home (45-50 minutes)**

The Welikia Project researchers estimate that before the city, in 1609, that plant species on Manhattan numbered 1195 and vertebrate species numbered around 658. Surprisingly, no one really knows how many exist today across the entire city. Some species have become locally extinct (also called extirpated) in the city like black bears, wolves, and mountain lions, but those species still live in other places, typically far from the city; some species are globally extinct (meaning that species no longer lives on Earth) like the passenger pigeon or the heath hen. However there are lots of new species living in the city. These introduced species have been brought from elsewhere by people, intentionally or unintentionally. Some of our most common wildlife species are introduced like the pigeon (originally the "rock dove" from Gibraltar) and the English sparrow (originally from England.)

People obviously have an important influence on the numbers of species that live in the city with us. For example, beavers used to be important and abundant animals on Mannahatta. They were important to native Americans, who hunted them for their furs and the fat in their tails. They were really important to the Dutch who liked to make them into hats. (So important that beavers are to this day shown on the New York City seal.) As a result of hunting, beavers disappeared from New York City more than 250 years ago. As it turns out, the beaver has finally come back to New York City, though not to Manhattan. After having been gone for over 200 years, in 2007, a beaver made a home in the Bronx River. To allow some species to return, the students will need to alter landscapes aggressively.

Have the students decide what animal they would bring back to future New York City. Alternately, the instructor can have a few species already chosen and assign those species to groups. Have students research the needs of that animal focusing on finding answers to these three questions: home range, habitat, and diet. Beavers, for example, have a home range radius of about 0.5 mile from their lodge. Building a habitat with a few trees would not be enough to sustain the beaver, however. Students will then choose an area they think is appropriate to reintroduce their animal and need to fill that minimum area with suitable ecosystems. They will need to look at the 1609 map slider to see where historical habitat would have been.

As students are creating habitat, they will have to continue to SAVE and RECALCULATE to see the size of their vision. Make sure they know to do the conversion from miles to meters, which is what Visionmaker uses. They should pay attention to the shape of their vision. Will the visions be long or square or spread out? Students should consider how these shapes might affect the success of their ecosystem revisions for their species.

After creating their vision, students will look at the change in biodiversity in number of species. How many species were gained in creating habitat for their species? A species chosen to protect broad swaths of habitat is called an umbrella species. Visionmaker will not tell the students if their species will

survive in their newly created Vision, but it will tell them how creating the habitat amenable to the umbrella species affects the biodiversity EPI.

#### **GLOSSARY**

*Extinct* (of a species, family, or other larger group) having no living members.<sup>1</sup>

*Green Roof* is the top of a building partially or entirely covered with living vegetative material.<sup>1</sup>

*Local extinction/extirpation* when a species no longer exists in a discrete geographic area.<sup>1</sup>

*Umbrella species* is a species selected for making conservation related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.<sup>2</sup>

1. [www.oxforddictionary.com](http://www.oxforddictionary.com)

2. Roberge, J. and P. Angelstam. (2004). "Usefulness of the Umbrella Species Concept as a Conservation Tool." *Conservation Biology* 18(1): 76-85.