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# K-12 Partnership Lesson Plan

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# *Connecting Landscapes in a Changing World*

## Overview

## Changes to landscapes as a result of human activities often result in habitat fragmentation. Habitat fragmentation not only results in smaller habitat patches and greater distance between those patches, but can also affect movement of organisms between the remaining fragments. Decreasing the ability of organisms to move between patches can have negative effects on the population, as well as potentially threatening the long-term persistence of a given species. Designing reserves and connecting existing habitat patches are a couple ways to mitigate the negative effects of habitat fragmentation. One means that is used to connect habitat fragments is the establishment of landscape corridors. Landscape corridors are areas of land between habitat fragments that are used to promote the movement of organisms between patches. Corridors can take on a number of shapes and forms, which depend on the movement requirements of the organisms that land managers are trying to promote or restore the movement of. In this lesson, we will discuss why habitat area and reserve design are important. Beginning with preservation of habitat patches, we will discuss how the area of a habitat patch is an important consideration when deciding whether or not to invest resources (e.g., money) in a particular patch to preserve it. We will then discuss the importance of movement between habitat patches and provide examples of the creative ways that scientists and land managers establish or preserve corridors for movement. The lesson concludes with an activity where students are challenged to engineer the best disperser for given environment types, specifically an artificial wind-dispersed seed in windy and calm environments.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Explain why habitat area is important for survival of organisms
* Interpret graphs relating to habitat area, species richness, and extinction rates
* Understand that habitat fragmentation affects movement of organisms
* Provide examples of ways that humans can establish corridors to promote movement between fragments
* Explain the ways that different organisms have different requirements for moving through landscapes

Students will be able to answer the following questions:

* How do humans change natural landscapes?
* How does the area of habitat available affect different species?
* How does habitat fragmentation affect movement of organisms?
* How can we connect landscapes to promote movement?

**Length of Lesson**

This lesson can be carried out in 1 – 2 class periods (of 1 hour each) depending on if you choose to use only one activity or both the “Area Effects” worksheet and “Design the Best Disperser!” activity. Choosing only one activity to complete after the introductory PowerPoint can be accomplished in a single, efficient class period.

**Grade Levels**

Middle school, high school

**Standards covered (NGSS)**

Disciplinary Core Ideas:

 *Middle School*

* **MS-LS1-4**: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
* **MS-LS2-4**: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
* **MS-LS2-5**: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
* **MS**-**ETS1-2**: evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem

*High School*

* **HS-LS4-6:** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
* **HS-LS4-5**: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Cross Cutting Concepts:

* Patterns
* Structure and function

Science and Engineering Practices

* Developing and using models
* Planning and carrying out investigations
* Analyzing and interpreting data
* Constructing explanations and designing solutions
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **L.EC.06.32**: identify the factors in an ecosystem that influence changes in population size
* **L**.**EC.06.41**: describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems
* **B3**.**4C**: examine the negative impact of human activities

**Materials**

* “Connecting landscapes in a changing world” powerpoint (online on “Connecting landscapes” lesson page on the KBS GK-12 website)
* Graphing worksheet (“Area Effects”, online)
* “Design the Best Disperser” activity materials (online)
	+ Seed-constructing materials (suggestions)
		- Beads (1-3 sizes, all fairly small)
		- Yarn and/or string
		- Glue
		- Scissors
		- Tissue paper or substitute (e.g., coffee filters)
		- Note cards or paper board
		- Copy paper
		- Other lightweight craft materials if desired. Some other materials that work well are cotton balls, lightweight fabric, Velcro dots, small foam balls, etc..
	+ Measuring tape
	+ You will also need 1-3 different “habitats” surrounding the schoolyard. One of these should be a windy area. The other(s) should be an area with lower wind speeds and/or gusts, such as a wooded area, an area downwind of the school (lower wind), or others…

**Background**

Around the world, habitat destruction and degradation resulting in habitat fragmentation are occurring at alarming rates. Human activities, such as road construction or development, and changes to landscapes (e.g., conversion of forest to post-agricultural fields) are often to blame for habitat fragmentation. Across the globe, the resulting pattern is one of patches of habitat surrounded by a “matrix” of varying land use and type. This matrix is often unsuitable habitat for the species that occurred there prior to human disturbance. Habitat fragmentation is considered to be the greatest driver behind biodiversity loss across the globe. In an effort to combat the negative effects of habitat fragmentation (e.g., extinction of a species), land managers seek to strategically conserve what remaining habitat patches exist.

However, not all remaining habitat patches are “equal” and land managers must take this into consideration when deciding which habitat patches to preserve in order to meet their conservation goals. Often times, these decisions involve consideration of how much habitat they can feasibly conserve and whether the habitat that they can conserve is fragmented into multiple smaller patches or if it is one large, continuous habitat patch. These considerations are at the center of the classic “SLOSS” (Single Large or Several Small) debate. Either option, one large patch or multiple small patches equivalent in size to one another, comes with its own pros and cons, however one predominant belief is that preserving a large, continuous habitat patch is more beneficial than multiple small patches, all else being equal. “Single Large” supporters argue that larger patches 1) support species with wider ranges, 2) possess greater habitat heterogeneity (or a variety of habitat types within the large patch) which can contribute to higher rates of speciation and diversity, and 3) that large habitat patches can support larger populations, which are less prone to extinction.

Establishing a single large reserve of habitat area isn’t always possible in human-changed landscapes. Often, landscapes today are a mosaic of developed land, agricultural land, and have pockets of remaining habitat (fragments) scattered throughout. Working to conserve and restore the remaining habitat patches is important for persistence of populations in the long-term. Examples of measures that are being taken to conserve and restore these species include establishment of nature reserves, parks, and preserves. Other conservation tools include breeding programs (e.g., in zoos) to augment natural population sizes, assisted migration between habitat patches (highly debated), and establishment of landscape corridors between patches to promote movement of individuals between habitat patches.

Landscape corridors are strips of land between habitat patches that are used to promote the movement of organisms between patches. They can take on many shapes and forms. The major types of landscape corridors include natural corridors, experimental corridors (both large-scale and small), and applied corridors for conservation, which can include elements of both man-made and natural corridors.

* Natural corridors are landscapes that are pre-existing and are frequently used for movement by organisms. They typically follow geographic features such as mountain ranges, rivers, and wind currents.
* Experimental corridors are often established for scientific purposes to study the effectiveness of corridors. They can range in size from prairie or forest plots (on the scale of meters to hundreds of square meters) to the size of vials or petri dishes with moss or other smaller organisms.
* Man-made corridors are created by humans to connect natural habitat patches for conservation or restoration purposes. Often, these corridors are created over or under roads as wildlife overpasses or underpasses. These corridors can mitigate the occurrence of negative human-animals conflicts (e.g., road accidents involving wildlife) and promote movement of individuals between patches. This particular type of corridor is important considering the occurrence of a common human change to landscapes: roads or highways.
* Large-scale corridors are established or protected to connect habitats regionally or at broader scales (e.g., internationally). These corridors usually connect large areas of habitat, such as national parks or preserves

*Examples of each of the corridor types mentioned above are provided in the supporting Powerpoint presentation that is available online.*

The ways that corridors are designed depends on how the organisms and/or populations that land managers are working to connect move. Organisms move in different ways, ranging from the migration of caribou on foot, to birds flying from patch to patch, fish using streams and water ways, to plants traveling on animal fur or by wind, amongst others. As an example, designing a corridor to promote movement of grizzly bears would differ drastically from designing a corridor to promote movement of a small plant species. Knowing how animals and plants move, what their behavior is, how far they move, and what their habitat requirements entail are important considerations.

As an example (graphics and further information provided in Powerpoint), plants alone can move in a variety of ways. One of the primary means that plants move across landscapes is by seed dispersal. Seed dispersal can be completed by movement through wind, by animals, by water, by ballistics (or bursting), and by humans. Seeds have dispersal structures, such as wings (also known as a samara, which maple seeds use), a pappus (like dandelions), a “tasty” fruit body that animals will eat, velcro-like structures that stick to animals, or a fatty-body called an elaiosome that ants will move in the process of capitalizing on that lipid resource.

A common means by which seeds move is by wind. Wind-dispersed plants are a key component of grassland and savanna ecosystems around the world and are often of conservation interest. Many rare and threatened species move by wind. Wind-dispersed plants have traits that can be studied that are very relevant for wind-dispersal. These include a low falling velocity, which allows them to catch a ride on the wind because they fall slowly, and varying seed release heights, with high seed release heights promoting further movement. Wind-dispersed seeds move best in habitats that are open and have high wind speeds and gusts. Designing a corridor to promote the movement of wind-dispersed plant species would thus require consideration of the wind patterns in the corridor and ways to promote windiness (such as by thinning of the trees and vegetation in the area).

A competitive activity (it’s no-contact ☺ ) has been designed and provided online, in which students are challenged to engineer a seed that would disperse the furthest in a given environment type. Environment types such as a “still” or “calm” area versus a “gusty” or “windy” area are suggested because it is likely that all schools would be able to find a place in their schoolyard that matched each of those environment type descriptions. However, you’re encouraged to tailor this activity to your interests and don’t necessarily have to look at wind-dispersal! As an alternative to making this a partially-outdoor activity, fans in varying configurations in a classroom can act as a surrogate for a windy, gusty, or turbulent environment. In this activity, students can use information discussed in the introductory PowerPoint about seed dispersal structures and important traits for wind-dispersed species to aid in the design of their seeds. Additionally, students can view images of seed dispersal structures found in nature (e.g., in the provided PowerPoint, online, etc…) or examine actual, collected seed specimens for inspiration in building their own seed dispersal structures that aid in movement by wind.

Upon conclusion of this activity, our goal is that students will better understand that animals, plants, and other organisms move in different ways and have different habitat and movement requirements. Because of these variations in the ways that organisms move and what their requirements for survival are, design of habitat reserves and landscape corridors must take into consideration these biological requirements if they are to be effective in promoting the movement of individuals between habitat patches and for conserving focal species over long timeframes.

### Activities of the session

Typical use of the following three activities may be to use the introductory PowerPoint at the beginning of a class period followed by one of the student activities during a single class period, with the option of completing the other activity the following class period. The two student activities can be used completely independently of one another.

1. “Connecting Landscapes in a Changing World” PowerPoint (provided online) which introduces the following topics with examples and visuals:
* Human changes to landscapes that contribute to habitat fragmentation
* Importance of size of habitat patches for populations
* Decision-making during Habitat Reserve design and selection
* Impeded movement of organisms between habitat patches as a result of habitat fragmentation
* Using landscape corridors to facilitate movement between patches and the various types of landscape corridors
* Applied corridor design considerations (movement of organisms through corridors)
* Various means by which different organisms move
* Dispersal structures that plants have that aid in movement
1. Graphing activity using “Area Effects” worksheet (provided online)
2. “Design the Best Disperser!” competition activity (simple instructions can be found in stand-alone handout provided online and/or at the end of the provided PowerPoint).
* Students are challenged to design the best disperser (by means of constructing fake seeds with dispersal structures made from simple craft materials) for two or more given environment types
* Provides an opportunity to get outside and use the various “environment types” in your schoolyard for the competition
* Uses materials you might already have in your classroom!
* This activity lends itself well to a follow-up graphing activity using pooled classroom data

**Resources**

* Provided on KBS GK-12 website for this lesson:
	+ “Connecting Landscapes in a Changing World” introductory PowerPoint
	+ “Area Effects” graphing worksheet
	+ “Design the Best Disperser!” activity instructions handout (also found at end of the above-mentioned PowerPoint)
* For further exploration or extensions (and your enjoyment):
	+ Yellowstone To Yukon (Y2Y) website: [www.y2y.net](http://www.y2y.net)
	+ Google Earth: <https://www.google.com/earth/>
	+ Conservation Corridor website: <http://conservationcorridor.org/mission/>

**Extensions and Modifications**

“Area Effects” worksheet can be followed up with a discussion of how reserve design decision-making could change with predicted range shifts of species due to climate change. The Y2Y example works well for this given the potential for range shifts both in latitude and altitude.

“Design the Best Disperser!” activity can be followed by a graphing activity or simple data analysis activity using pooled classroom data collected during the competition.

**Assessment**

 Evaluation of worksheet

 Evaluation or explanation of why students designed seeds the way they did