Oregon State University
Precollege Programs

**Envision, Believe, Succeed**

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# Biodiversity makes ecosystems Stable

## DIVE4Ag Agroecology Activity Guide

**HOW DO SEEMINGLY SMALL CHANGES IN BIODIVERSITY MAKE A DIFFERENCE IN AN ECOSYSTEM?**

## Learning Objectives

1. The decisions that humans make can either improve or degrade the environment.
2. Biodiversity in an ecosystem is key to maintaining functional and sustainable systems.

## Background

The **Rivet Hypothesis** uses the analogy of rivets in an airplane wing to compare the increasingly critical effect that the loss of biodiversity will have on the function of an ecosystem. An ecosystem includes all of the living and non-living elements that live in the same environment. Living elements of an ecosystem can include plants, insects, and other animals. Non-living elements of an ecosystem can include soil or water. Farms are a type of ecosystem, just like oceans, rivers, forests, and grasslands. An agricultural ecosystem is known as an agroecosystem.

**NGSS ALIGNMENT:**

**LS2.A:** Interdependent Relationships in Ecosystems
Organisms, and populations of organisms are dependent on their environmental interactions both with other living things, and with nonliving factors. (MS-LS2-1)

**LS2.C:** Ecosystem Dynamics, Functioning, and Resilience
Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

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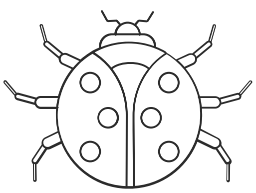
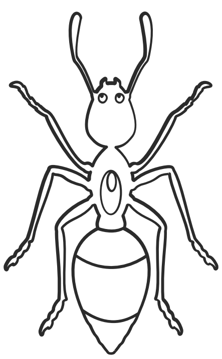
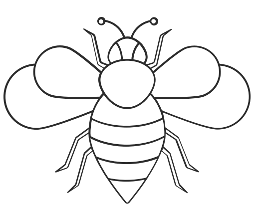
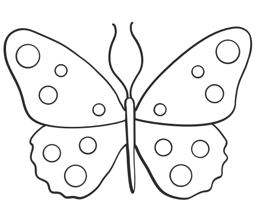
## Materials

- **Jenga Game**
- **Sharpie markers**
- **Concept Map Template**
- **Internet for online research**









## Background

**Ecosystem functions** include those things that an ecosystem does that ultimately provide human beings with goods or services that we need. Ecosystem functions are due to natural processes such as the conversion of sunlight into energy by plants. Ecosystem functions are also due to the species such as trees in a forest or fish in a river that live within an ecosystem. Ecosystem functions ultimately lead to ecosystem services, which are the goods and services that humans use and need. The services an ecosystem provides include nutrient recycling in soils or photosynthesis in plants. Ecosystem goods are categorized as things like food, fuel, fiber, or timber. For example, ocean ecosystems provide us with food. Agroecosystems provide us with food, but also fuel (e.g. corn ethanol) and fiber (e.g. cotton). Forest ecosystems provide us with wood that we use for building materials and also generate the oxygen that we breathe.

**The rivet hypothesis** suggests that as more and more species are lost from an ecosystem, it will be more and more difficult for that ecosystem to properly function. For example, if bees disappear from agroecosystems, farmers would no longer be able to grow crops that depend upon pollinators. Crops that depend upon bees include apples, watermelon, berries, cucumbers, and squash. Crops such as lettuce, broccoli, kale, and basil don't need bee pollination, per se. But, these crops depend upon bee pollination to make seed that is used to plant the next season's crop.

**Scientists have debated** how the loss of species will affect ecosystem function. Is the relationship linear, so that for each loss of a species, there is a comparable loss of ecosystem function? Or, is the effect more curvilinear, and subject to a critical threshold, so that an ecosystem can tolerate the loss of species ~ up to a critical point? If that critical threshold is surpassed, the function of an ecosystem will be altered, and humans may no longer be able to depend upon that ecosystem for food, fuel, fiber, or timber.

**Insects are important** components of almost all ecosystems, except for oceans. In fact, insects make up about 57% of all life on earth. Thus, it should not be surprising that we depend upon insects for many ecosystem goods and services. Bees help to pollinate our crops. Many wasps, beetles, and bugs provide natural pest control that limit the need for chemical insecticides. Beetles and earwigs help to break down organic matter and recycle nutrients back into the soil. Caterpillars and other insects are important sources of food for birds.

**Given our dependence upon insects,** and their importance to ecosystem function and services, many scientists have become concerned by what has been called the 'insect apocalypse'. For example, a long-term study in Germany found that insect biomass has declined by 76% over the past three decades. A review of several studies found that 41% of all insects are in decline, and suggested that insect species are going extinct at a rate of 1% per year.

**Most scientists think** that ecosystems are subject to the threshold model of species loss. If this is the case, ecosystems can tolerate the loss of some species. But, if too many species are lost, the ecosystem will collapse. In this way, Jenga can serve as a good proxy to demonstrate the rivet hypothesis.

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## ACTIVITY PART 1

**1) Ask students** to talk with a partner about what they know about ecosystems- what are ecosystems? What are the different components that make up an ecosystem? Have students share their ideas and record them using a concept map they can build individually or in a group. Discuss the map with students after they are done, reminding them that an ecosystem is all of the living and nonliving parts that make up a given area. Ecosystems can be very big like the ocean or a forest, or smaller like a farm, tree, or even much smaller like a patch of grass. Build discussion from what they write in the concept maps.

**2) Tell students** that they are going to work in small teams and choose an ecosystem that they are interested in learning more about. Break students into groups (3-4 students) and have them spend some time investigating the types of animals and plants that can be found in their selected ecosystem. Tell them that they need 45 blocks (set 4 aside) and they must include plants (21 blocks), herbivores (12 blocks), and predators (12 blocks). Have each student choose which group they will be in charge of researching and recording.

**3) Once they have identified species** within each group, tell them that they are going to record them onto JENGA blocks (1 block = 1 species). Have students color the ends to represent the species group as well to more easily see them when playing (e.g. green for plants, orange for herbivores, red for carnivores, etc.) Hand out one set of JENGA per group.

**4) Talk with students** about some of the different ways that they benefit from the ecosystem they live in. Ask: what "services" do the trees provide for you? Shade, food, lumber, clean air. Share that ecosystem services and functions include those things that an ecosystem provides that human beings use and need. For example, ocean ecosystems provide us with food. So do agroecosystems. Forest systems provide us with wood, but also generate the oxygen that we breathe.

**5) Once students have a solid understanding** of what is meant by ecosystem services and functions, have them research the types of services people get from the ecosystem they selected. Tell them that once they have identified 4 ecosystem services, they should record them onto their remaining JENGA blocks.

## ACTIVITY PART 2

**6) Invite students** to build their JENGA tower using food web concepts: plants at the bottom, herbivores in the middle, predators near the top, and ecosystem functions at the very top.

**7) Direct students to** only remove species (and not services) from their JENGA tower and to record how many blocks can be removed before the tower collapses.

**8) Have students replay** their JENGA game, removing only plants (at the bottom of the tower), only herbivores (near the middle), or only predators (near the top).

**You may choose to have students read this article on Ecosystem Services before they brainstorm. Or suggest that students do this activity first to better understand what ecosystem services are.**

https://www.nationalgeographic.org/activity/ecosystems-help-everyoneeven-humans/

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## Concept Map Template for Students (Attachment 1)

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## Debrief- Guiding Discussion


What did you observe in each version of the game?

How quickly did the JENGA tower fall with each variation that you played? Why do you think that was?

How did the small changes impact the larger ecosystem? Were they so small after all?

What surprised you? What are you still wondering?

**Explain that this game is a representation of how seemingly small changes can impact the stability of a whole system.**

## Suggested Readings

Jarvis, Brooke (2018). **The insect apocalypse is here.** What does it mean for the rest of life on earth. New York Times Magazine. November 27, 2018. https://www.nytimes.com/2018/11/27/magazine/insect-apocalypse.html?smid=url-sha

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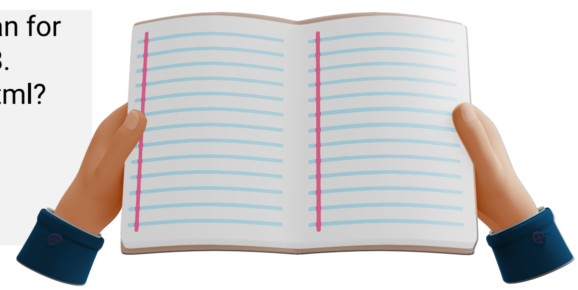

## Referenced Materials

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Sánchez-Bayoa, F. and Wyckhuys, K. A. G. (2019). Worldwide decline of the entomofauna: A review of its drivers. Biological Conservation 232: 8-27.
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