

2017

School of Roots

Tallgrass Prairie Center

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SCHOOL OF ROOTS

BACKGROUND

Ecosystem services

Many people are familiar with the parts of ecosystems – predators, prey, plants and the non-living resources they depend on. However, ecosystems are not just collections of pieces. They are active entities; they DO things – for the living populations within them and for us. They provide products – wild foods, medicines, fibers and biofuels. They also provide less obvious services such as purifying water, building soil, reducing pollution, controlling pests and storing carbon that could otherwise contribute to climate change. The roots of prairie plants perform key roles that contribute to many of these ecosystem services.

Prairie roots and soil communities

All roots anchor plants in the soil, take in water and nutrients, store the products of photosynthesis and serve as habitat for other soil organisms. Perennial roots, like those of most prairie plants, provide more and better services than annual roots for two main reasons: their persistence over time and their diversity. Unlike annual crop roots, perennial prairie roots remain living in the soil for years. This prevents soil loss, builds organic matter in the soil and slows the runoff of nutrients into waterways. Farmers who hope to keep soil and nutrients in place plant prairie or other perennials in certain parts of their fields

The School Community as an Analogy

Schools and the people who work in them also provide many services – both obvious and subtle – to their communities. Thus, a school system can provide an analogy for prairie roots and the services they provide. Analogies help people to make connections between their pre-existing knowledge and new, unfamiliar information. This is especially important when presenting abstract concepts such as ecosystem services to young audiences at various stages of cognitive development. The use of the school as an analogy can help diverse learners find ways of relating to new information about the ecosystem services provided by prairie roots.

Overview

Students learn about the ecosystem services provided by prairie roots by matching them to services provided by various components of a school.

Objectives:

Students will be able to:

- List several services provided by prairie roots.
- Explain how prairie root services compare to the services provided by the parts of a school.
- Evaluate the importance of ecosystem services provided by prairie roots.

Subjects Covered:

Science: Life Science

Grades: 7-8 (and higher)

Group size:

20-30 for whole-class activity

Any size for small-group activity

Activity Time: 30-45 min.,

depending on the length of discussion and use of assessments

Season/Location:

Any season/Indoors

Materials:

- Printed Analogy Cards
- Large paper or portable whiteboards
- Markers
- Prairie roots specimen and/or images showing diversity of prairie roots and the soil community

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VOCABULARY

Analogy: A comparison for the purpose of explanation made between things that are alike in important ways.

Ecosystem services: Beneficial functions provided by diverse organisms interacting with each other and the environment in which they live.

Perennial: Living for many years.

Diversity: Having many different kinds or types.

TEACHER PREPARATION

- Decide whether you want to do the activity with the whole group or small groups. Gather materials and make copies of the Analogy Cards in Appendix A (pages a through f). Cards are printed front-to-back – a to b, c to d, e to f – then cut into a total of 30 two-sided cards.
- If you do not have a prairie root specimen, print images of prairie roots (see Resources, below) or prepare to project them.
- If you are not familiar with the concept of ecosystem services, visit the resource links and read through Appendix B: Prairie Roots – Ecosystem Services.
- Work with the Analogy Cards on your own to make sure that you are able to make matching sets and explain them.

ACTIVITY

Introducing the activity

This activity follows the Teaching-With-Analogies Model, a systematic approach to using analogies effectively as a teaching strategy. (See Resources for more information.)

1. If you have access to a prairie root specimen, have students to look at it carefully and think about what the roots do. (If you do not have a root specimen, display an image – see Resources.) Have students think of the “jobs” roots do for the plant, sharing their thoughts with a partner, then the whole class. Guide the discussion to the following root functions: anchoring plants in the soil, taking up water and nutrients and storing food for plants.
2. Ask what roots do for other living things, including us. Point out that the “jobs” prairie ecosystems do for us are called *ecosystem services*. Tell students the point of this activity is to think about all the jobs or services of prairie roots -- many of which we’re hardly aware.
3. Ask students to define an analogy and think of examples. Why do we use analogies?
4. Tell students we are going to use a school community as an analogy for the prairie root community. What services does the school community provide for us? How does it provide those services?

This activity itself will allow students to match features of the target concept (ecosystem services provided by the root community) to the analog concept (services provided by parts of the school community).

Instructions for whole-group activity

1. Pass out the Analogy Cards. Each student should receive a different card. You may need to adjust the set for the group size. If there is an odd number, a teacher or other adult leader could join in.
2. Students go around the room and talk to other students about their cards. They try to form matching pairs of cards. Each pair should include:
 - a. A service performed by the prairie root community.
 - b. An analogous service performed by a component of the school.
3. Once all students have formed pairs, instruct them to develop an explanation for why their match makes sense. They should summarize their match and explanation on the whiteboard or large paper.
4. Each group will share their match and explanations with the class. Set up the whiteboards or papers so that they remain visible to the class.
5. Ask other class members to politely critique each set: 1) In what ways is it an effective match? 2) In what ways does the match not work so well?
6. Ask the class to evaluate which service is the most important. How would removing any one component or its functions affect the whole system (school or ecosystem)? Are there any functions or services that the system could live without?
7. Address misconceptions by providing additional information or asking guiding questions.

Instructions for small-group activity

1. Each group of 3-4 students receives a complete set of Analogy Cards.
2. Instruct them to form matching pairs of cards. Each pair should include:
 - a. A service performed by the prairie root community.
 - b. An analogous service performed by a component of the school.
3. Once all groups have created matching pairs for all (or most) of their cards, tell them that each group will explain one of their matches to the class. Draw cards from a hat to decide which set a group will share. The group should use the whiteboard or large paper to summarize their match and explain why it makes sense. Call on groups one at a time to present their matches.
4. Ask other class members to politely critique each set: 1) In what ways is it an effective match? 2) In what ways does the match not work so well?
5. Ask the class to evaluate which service is the most important. How would removing any one component or its functions affect the whole system (school or ecosystem)? Are there any functions or services that the system could live without?
6. Address misconceptions by providing additional information or asking guiding questions.

ASSESSMENTS

- a. Students match services provided by different parts of the school community to ecosystem services provided by prairie roots. At the end of the activity, they present the reasons for their matches to the class.
- b. Students work in small groups to evaluate the school community as an analogy for root ecosystem services. They create a graphic showing the ways in which the analogy works well and the parts where it breaks down.
- c. Individual students write a list, from memory, of the ecosystem services provided by prairie roots. They compare their lists in small groups and add any services that they missed.
- d. Students create their own analogy for the ecosystem services that roots provide. They may choose any system that they find interesting, as long as it has multiple, interdependent parts that provide services to each other.

EXTENSIONS

1. Students develop their own analogies for the ecosystem services provided by diverse, perennial root communities. They create posters to illustrate their analogies. If technology is available, they could create infographics or videos and share them online.
2. Students research a local environmental issue that could be addressed by restoring diverse, perennial vegetation to an area. They present an action plan to the City Council or County Conservation Board. Their presentation should use analogies to illustrate the ecosystem services that diverse, perennial roots would provide and how that would improve the situation.

ADAPTATIONS

To support learners with reading challenges or English language learners, use visual materials to help introduce vocabulary and concepts. Make sure that these students receive the cards describing the components of the school community, since the vocabulary and ideas will be more familiar.

To increase the level of challenge, have students develop the descriptions of each of the school services, rather than providing them. (This would require a longer time than the estimate of 30 minutes.)

RESOURCES

- Prairie Roots images
http://www.tallgrassprairiecenter.org/curriculum_images
- Prairie Roots presentation by Dr. Laura Jackson, Tallgrass Prairie Center
<https://www.youtube.com/watch?v=X2uFS4DbuVU>
- The Teaching-With-Analogies Model. NSTA WebNews Digest. <http://www.nsta.org/publications/news/story.aspx?id=53640>
- Glynn, Shawn M. 1994. Teaching Science With Analogy: A Strategy for Teachers and Textbook Authors. <http://files.eric.ed.gov/fulltext/ED373306.pdf>
- Ecosystem Services Fact Sheet. Ecological Society of America. <http://www.esa.org/ecoservices/body.comm.fact.ecos.html>
- Ecosystem Services. TEEB – The Economics of Ecosystems and Biodiversity. <http://www.teebweb.org/resources/ecosystem-services/>

STANDARDS

MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

APPENDICES

A: Printable Analogy Cards

B: Prairie Roots - Ecosystem Services

Prairie Roots lesson plans created by the Tallgrass Prairie Center
with funding from the Iowa Living Roadway Trust Fund.

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Appendix A. Printable Analogy Cards

Teachers and Associates	Support diverse soil food web
Sports Teams	Control invasive weeds
Arts and Music Programs	Promote other ecosystem services such as pollination
Cafeteria Workers	Provide nutrients to the soil food web
Janitors	Process wastes and cycle nutrients

<p>Prairie roots survive in the soil for many years and provide for the needs of a diverse web of soil life including mammals, insects, worms, fungi, and bacteria.</p>	<p>Work at school for many years, with new groups of students each year. Plan activities that will meet the needs of students with different learning styles and needs.</p>
<p>Roots of diverse prairie plants occupy different spaces in the soil, gather nutrients more efficiently than one species could by itself, and outcompete weeds.</p>	<p>Help students learn skills and teamwork. Need “depth on the bench” - many members with diverse talents to help teams compete and win games.</p>
<p>Prairie roots are part of a diverse plant community. Diverse plants produce flowers, leaves, stems, and fruits that attract diverse animals, including pollinators, to the ecosystem.</p>	<p>Allow students to develop their creativity and create exhibits and performances that attract community members to the school.</p>
<p>Prairie roots receive food from the above-ground parts that do photosynthesis; provide plants with water and nutrients; and nourish the other living things in the soil food web.</p>	<p>Prepare food from materials delivered to the school. Provide food and drinks that students need to keep working and learning.</p>
<p>Prairie roots take up, use, and store nutrients from animal wastes, fertilizers, and decomposition that could otherwise run off and pollute our waterways.</p>	<p>Keep the school clean by containing and getting rid of dirt, trash, and recyclable materials that are produced by students and teachers.</p>

Lockers	Anchor soil and improve soil structure
Plumbing systems	Improve infiltration
Computers and Internet	Use nutrients efficiently by connecting to a network
Construction and Maintenance	Build soil organic matter and store carbon
Restrooms	Phytoremediation of pollution

<p>Prairie roots act as year-round soil anchors and help give soil structure by gluing soil particles into crumbs called aggregates. This keeps soil in place and out of the air and water.</p>	<p>Store and organize lots of things - books, papers, folders, snacks - so that they do not get lost or make a mess of the school.</p>
<p>Prairie roots provide deep, long-lived channels and pores that help water soak into soil and support the needs of soil organisms instead of running off. This helps prevent pollution and flooding.</p>	<p>Provide paths for water to move around the building so that students and teachers can access and use it safely.</p>
<p>Roots of different prairie plant species get and share nutrients through an underground network with helpful partner fungi.</p>	<p>Connect students to the wider world of information. Allow students share their work and collaborate with others online.</p>
<p>Prairie roots are long-lived and add organic matter that builds up and improves soil health over time. This also stores carbon in the soil that would otherwise go into the atmosphere and contribute to global warming.</p>	<p>Keep the school in good working order over the years, so that students and teachers have a healthy environment for learning. Build new additions to the school building as the school community grows and its needs change.</p>
<p>Prairie roots take up and break down some forms of pollution and thereby help to clean up the environment. The more diverse the root community, the more types of pollutants can be remediated.</p>	<p>Take in and contain wastes that would otherwise pollute the school and send them to a wastewater treatment plant where the water is purified before returning it to the environment.</p>

Ventilation Systems	Aerate soil
Roof and Walls of School Building	Provide protection and niches for soil animals
Library and Media Center	Store genetic information
Citizens of the Community	Maintain a healthy ecosystem
School Administration	Maintain diverse plant community

<p>Prairie roots create long-lasting channels and pore spaces that allow air movement through the soil, providing a healthy environment for the soil community.</p>	<p>Includes fans and ductwork that move air throughout the school, helping to provide a healthy environment for teachers and students.</p>
<p>Prairie roots provide diverse microhabitats that shelter and provide for the needs of various kinds of soil animals.</p>	<p>The school building, with its roof and walls, provides protection from the weather and spaces for various activities.</p>
<p>Past evolution has made prairie roots well-adapted to their local environment. The diversity of prairie plants stores genetic information to allow adaptation to future environmental changes.</p>	<p>The library and media center store information that can help students learn from the past, function in the present, and plan for the future.</p>
<p>Diverse prairie roots help maintain a healthy ecosystem for humans and other inhabitants by stabilizing soil, retaining nutrients that could pollute water, and storing carbon.</p>	<p>Good schools help a community be a great place for all of its citizens to live by helping to develop young citizens and providing events and entertainment for the whole community.</p>
<p>Prairie roots release substances that attract and support diverse communities of helpful bacteria that maintain ecosystem stability by keeping disease-causing germs from spreading.</p>	<p>School administrators hire and manage teachers and other school employees, enforce school rules, and ensure safety and security.</p>

PRAIRIE ROOTS – ECOSYSTEM SERVICES

Superior erosion control

The dense network of roots under prairie vegetation is exceptionally efficient at holding soil in place. These perennial roots are year-round soil “anchors.” This is particularly notable in a state dominated by annual row crops, where topsoil lacks adequate protection much of year, and has almost no protection during the rainy, spring season.

Soil loss from agricultural fields, urban sites and other settings can be reduced by strategically placing prairie in the landscape.

Increased rainfall and runoff infiltration

Healthy, diverse root communities improve soil structure, adding underground air spaces and absorbent organic matter. This makes the soil under prairies act like a sponge. As a result, water more easily soaks *into the soil* rather than flowing across the landscape. This reduces flooding and keeps sediment out of waterways.

Between rainfall events, the absorbent soil slowly releases water to the large prairie roots.

Reduced nutrient pollution

Nutrient pollution refers to the contamination of surface water by excess fertilizer, particularly nitrogen and phosphorus. Nitrogen makes it way to rivers and lakes in water leaching though the soil; phosphorus enters water bodies attached to soil particles. Crop fields are especially prone to nutrient loss in the spring because annual crops are not yet growing.

Perennial prairie roots begin growing in early spring and are able to take up excess nitrogen leaching through the soil from crop fields higher on the landscape. Prairie roots reduce phosphorus pollution by helping to control soil erosion.

Invasive weed control

The soil underneath a mature prairie is filled with a tangle of prairie roots. The “architecture” of these roots is diverse, including fibrous and tap roots; course and fine roots; deep and shallow roots; bulbs, corms, stolons and rhizomes. A dense and diverse prairie root system leaves little space and few niches for invading weeds to establish.

Carbon sequestration

The removal and long-term storage of carbon – usually CO₂ – from the atmosphere is known as carbon sequestration. Through photosynthesis, plants convert atmospheric CO₂ into food. Some is released through respiration and decay, but much more is stored.

Prairie plants are especially adept at storing carbon, locking up large amounts in their roots. When the roots die, microorganisms move some of the carbon to the soil where it stabilizes, remaining below ground for hundreds of years.