

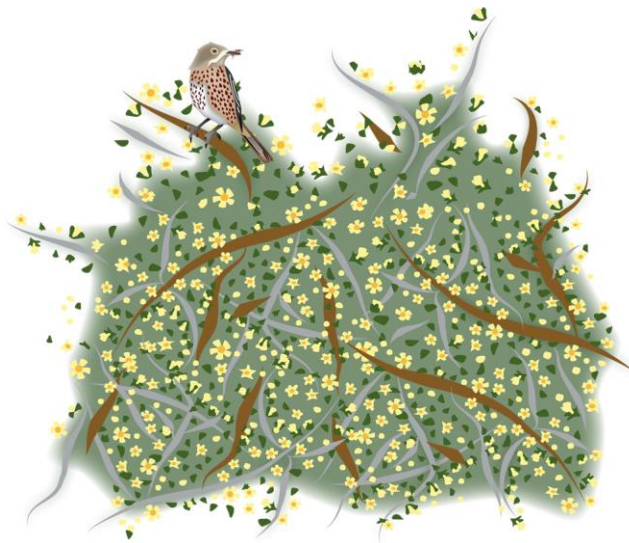
Inquiry, Exploration & Service Learning in the

Sagebrush Ecosystem



Teacher's Guide
Grades 4-12

Inquiry, Exploration & Service Learning in the Sagebrush Ecosystem



Teacher's Guide Grades 4-12

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Engaging Every Student, engagingeverystudent.com

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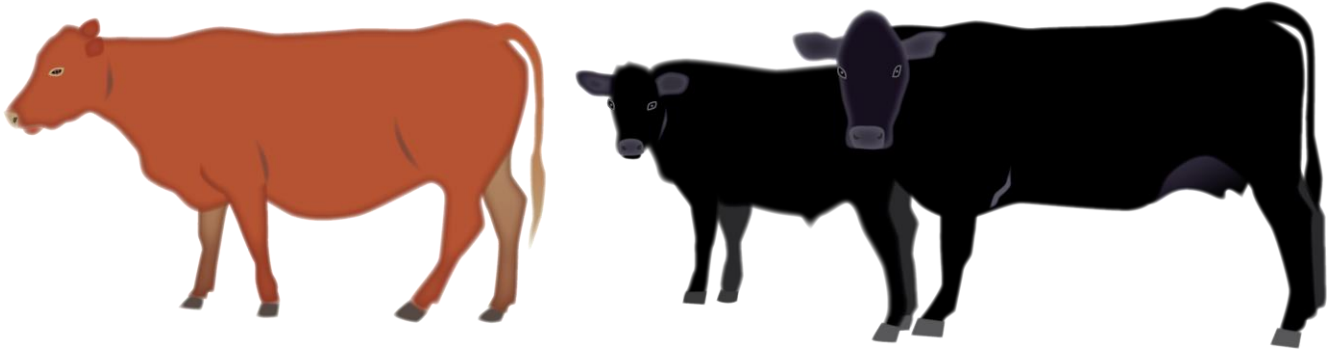
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About this Guide

This teacher's guide contains lesson plans and other resources designed to help teachers engage their students in thinking critically about the sagebrush ecosystem and ways to support it. Lessons are aligned to the Next Generation Science Standards and Common Core State Standards, and they contain numerous adaptations / extensions to meet the divergent needs of students in grades 4 – 12. Care has been taken to incorporate the perspectives of diverse stakeholders, including plant and wildlife biologists, ecologists, educators, fire managers, indigenous peoples, and ranchers.



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Questions or comments?

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Introduction to Greater Sage-Grouse and the Sagebrush Ecosystem

Lesson Overview

After assessing students' current understanding, an introduction to sage-grouse and the sagebrush steppe ecosystem is presented, broken up by activities which help students better understand them. Activities include examining artifacts from organisms of the sagebrush ecosystem and discussing the adaptations which help those organisms to survive. Lesson adaptations / extensions are listed at the end of the lesson including field, research, writing, and art projects.

Lesson Goals

Students will think critically about systems and discuss the adaptations of species such as the greater sage-grouse that help it to survive and reproduce in the sagebrush ecosystem, as well as the species' importance and other factors which contribute to a healthy sagebrush ecosystem.



A greater sage-grouse hen finds food and shelter in a diverse community of sagebrush and other plants.

Subject Areas Science

Grade Level 4 – 12 (Ages 9 – 18)

Time 50 – 75 minutes or more

Objectives

- Students will connect the concept of a system with an example in their own lives and discuss how systems are comprised of parts which shape the system.
- Students will observe artifacts of living organisms from the sagebrush ecosystem and think critically about how the organisms' adaptations help it to survive in the often-harsh climate.
- Students will present their conclusions to the class about the organisms' adaptations and discuss how the unique physical and behavioral traits of wildlife species such as sage-grouse and other organisms in the sagebrush ecosystem help to create a healthy ecosystem.
- Students will discuss how human activities have had an impact on the living and geological systems in the sagebrush ecosystem.

Next Generation Science Standards

Crosscutting Concepts

- Structure and function
- Systems and system models
- Stability and change

Core and Component Ideas in the Life Sciences

LS1: From Molecules to Organisms: Structures and processes

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4: Biological Evolution: Unity and Diversity

- LS4.C: Adaptation

Core and Component Ideas in Earth and Space Sciences

ESS2: Earth's Systems

- ESS2.C: The Roles of Water in Earth's Surface Processes

ESS3: Earth and Human Activity

- ESS3.C: Human Impacts on Earth Systems

Common Core State Standards

Speaking and Listening Standards for Grade 6

(similar standards for grades 4-5; 7-12)

Standard 4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

Standard 6. Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

College and Career Readiness Anchor Standards for Writing (if Adaptation / Extension #5 is completed)

Standard 6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Standard 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

1. *Sagebrush Ecosystem Pre-Test* (Appendix A, one for each student)
2. *Greater Sage-Grouse and the Sagebrush Ecosystem* PowerPoint presentation; available on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>
3. Computer access and Microsoft PowerPoint software
4. Display screen
5. *Optional:* The Sagebrush Ecosystem educational poster available at <http://www.fws.gov/greatersagegrouse/education.php>
6. *Optional:* Sagebrush Ecosystem Trunk available from Audubon Rockies. Contact Jacelyn Downey at (307) 756-3941 or jdowney@audubon.org for more information.
7. *Optional:* If you have skulls available from the trunk or elsewhere, make copies of the "Mystery Skull Worksheet" on page 14 of the *Wildlife Skull Activities* booklet from the University of Arizona



Cooperative Extension for each student. This is an excellent resource for facilitating discussion about adaptations evident in skulls, as is the rest of the guide:

<http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1145.pdf>

8. *Optional:* Enough copies of “The Sagebrush Steppe” poster from Audubon Rockies for small groups to share: http://rockies.audubon.org/sites/g/files/amh431/f/sagebrushposter_fsc.pdf
Contact Jacelyn Downey at (307) 756-3941 or jdowney@audubon.org for the 18” X 24” poster.
9. *Optional:* Habitat Flashcards from Audubon Rockies:
<http://rockies.audubon.org/conservation/wyoming-habitat-flashcards>
10. *Optional:* One or more sets of wildlife SteppeUp cards developed by the Bureau of Land Management (BLM); available in the trunks and on the website listed above
11. *Optional:* Markers, crayons, or colored pencils for students to share

Preparation

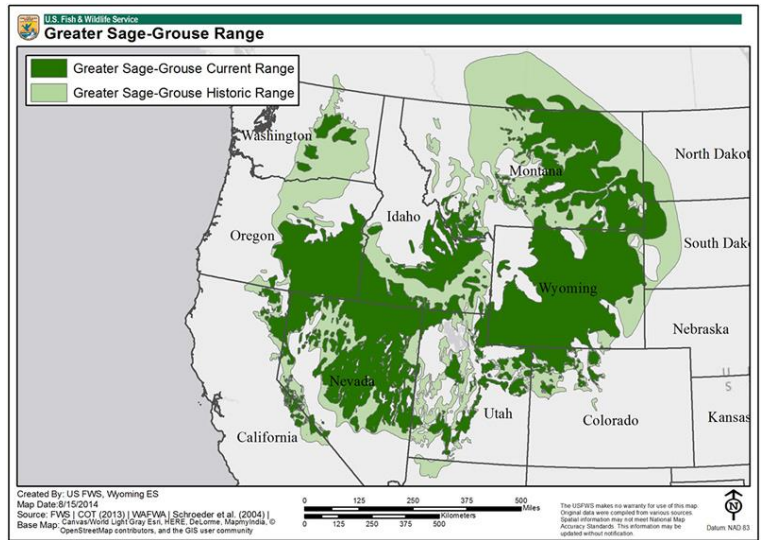
1. If possible, identify an expert partner to work with your class. Contact information and recommendations for partners such as the USFWS, BLM, state wildlife agencies, Audubon, and the Nature Conservancy can be found at <http://www.fws.gov/greatersagegrouse/education.php>. The Sage Grouse Initiative website also has a page which lists many excellent partners/experts, such as the Natural Resources Conservation Service: <http://www.sagegrouseinitiative.com/about/partners>. The NRCS should be considered for many of the lessons in this curriculum—especially those tied to plants and soils, but also for those focused on wildlife and restoration.
2. Ensure all materials above are ready for student use.
3. Get ready to show one or more video clips such as the 1-minute “On a Sage-Grouse Lek” video from The Cornell Lab Bird Academy: <http://academy.allaboutbirds.org/features/fancymales/on-a-sage-grouse-lek>. The live “lek cam” can also be exciting to watch during the spring lekking season: <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/oregon/our-priorities/sage-grouse-lek-cam.xml>
4. *Optional:* Review the excellent “Wildlife Skull Activities” booklet from the University of Arizona Cooperative Extension to prepare to discuss adaptations evident in skulls:
<http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1145.pdf>
5. *Optional:* Watch the following additional videos for more background information in preparation for teaching the complete curriculum:
 - *The Sagebrush Sea* from the *Nature* website: <http://www.pbs.org/wnet/nature/sagebrush-sea-full-episode/12341/>.
 - Short clips from film: “Sagebrush Sea: A High Desert Ecosystem” on the PBS LearningMedia site: http://opb.pbslearningmedia.org/search/?q=%22Sagebrush+sea%22&selected_facets
 - “Sage Advice for Sage Lands” from This American Land (5 minutes): <http://www.thisamericanland.org/news/sage-advice-for-sage-lands>
 - Oregon Public Broadcasting (OPB), Oregon Field Guide, “Sage Grouse” (11 min.): <http://watch.opb.org/video/2365357596/>
 - “Borah High kids learn about sage grouse in Owyhee County”: <https://youtu.be/d4ml0scuPh8>
 - The Sage Grouse Initiative and the Eastern Oregon Agricultural Research Center, “Unraveling Sagebrush Community Change to Manage for Resilient Sage Grouse Habitats”: <https://www.youtube.com/watch?v=YbwaA9ziLLw>
 - Sage Grouse Biology & Ecology webinar: <https://www.youtube.com/watch?v=smvSE-VJXic>

Teacher Instructions

1. Tell students they will be starting an interesting new unit about a type of system. Ask them an essential question to start them thinking about what they already know about systems, such as "How do parts shape systems?" Give students an example of a system they know well, such as your classroom, and ask them to quickly brainstorm different parts of it. They could chime in with parts such as the teacher, the different students, the desks, the clock, the whiteboard, the computers, the pencils, etc.
2. Next, ask the students to think more about another system in their own lives (e.g. the school, their home, a sports team, a youth group, a bike, etc.). Direct students to:
 - Write down the name of the system and some of its parts, putting a star next to the part(s) which they think is/are most important. They should explain why they believe that/those part(s) have the greatest impact on the system.
 - Write down what they think would happen if that part (or those parts) of the system was/were removed.
3. Circulate around the room, answering questions, if necessary. After about 5 minutes, ask for a couple of volunteers to share which system they chose, which part(s) they felt were most important and why, and what they thought would happen without those parts. Then explain to students that this lesson will be all about figuring out a new system and its unique parts, how they work together, and what happens when the system becomes unbalanced.
4. Tell students that the fascinating system they will be learning about is the sagebrush ecosystem, but first they will get to see what they already know. Pass out the *Sage-Grouse & Sagebrush Ecosystem Pre-Test* to each student and allow 10 – 15 minutes for them to complete it. Tell the students they are not expected to know the answers, so they should just do the best they can. This survey serves many purposes, including evaluating current student knowledge and helping students focus on topics to be discussed.
5. Ask students to trade the pre-tests with another student while you open the *Sage-Grouse and the Sagebrush Ecosystem* PowerPoint presentation.
6. Introduce the expert visitor if one is present. If so, he or she can ask the first four questions one at a time for students to answer. After the students answer each question, the PowerPoint presentation can be advanced one image/slide at a time so students can see images of sage-grouse, a lek, and the sagebrush ecosystem.
 - What is a greater sage-grouse? Definitions could include:
 - A large bird about the size of a chicken that lives in the West
 - The largest grouse species; lives in the high desert of the American West
 - What is a lek? Answers could include:
 - An area where sage-grouse gather in the spring to breed
 - An open area where males show off and compete for mates



- Are there greater sage-grouse located near your school or somewhere in your state? (11 states: Washington, Oregon, Idaho, Wyoming, Montana, Utah, Nevada, California, North Dakota, South Dakota, Colorado. Feel free to check with Sarah Levy of the U.S. FWS if you aren't sure: sara_levy@fws.gov.



- What is a sagebrush ecosystem? Definitions could include: a type of dry grassland with sagebrush plants.

Note: You may want to briefly discuss how the ecosystem is often

called the **sagebrush steppe**, because so much of it is found in areas that fit the definition of a steppe: an arid area at high elevation which is generally flat. This would be especially helpful if you plan to use the SteppeUp cards, to explain how they got their name. However, there are areas with a sagebrush ecosystem that are not considered steppe, especially in the Great Basin region with areas of lower elevation.

- Close the discussion by talking about how sage-grouse and many of the other species in the ecosystem need a large amount of undisturbed open space in order to survive.
7. Ask for a student volunteer to collect the pre-tests while you and/or the visitor get ready to present a video clip to students showing the greater sage-grouse and a lek. A good choice would be the 1-minute "On a Sage-Grouse Lek" video from The Cornell Lab Bird Academy: <http://academy.allaboutbirds.org/features/fancymales/on-a-sage-grouse-lek>. If you have more time—possibly later in the lesson—you could show one or more of the other sage-grouse videos listed in the Preparation section above, such as "Sagebrush Sea: A High Desert Ecosystem" on PBS LearningMedia: http://opb.pbslearningmedia.org/search/?q=%22Sagebrush+sea%22&selected_facets

8. Have the visitor (if present) show the students items from the Sagebrush Ecosystem Trunk (if available), such as skulls, beaks, feathers, etc. The artifacts can come from sage-grouse as well as other organisms from the sagebrush ecosystem. Explain to students that all of these artifacts reveal amazing **adaptations** that help the wildlife to survive. Write the word "adaptations" on the board to reinforce the concept and brainstorm a couple of the adaptations with students, such as light feathers to help the birds fly and camouflage to hide from predators.



9. Form groups of about 4 students. Distribute the items from the trunk among the groups for students to examine carefully and discuss how their features—adaptations—might help the organisms to survive. You can do use the *Wildlife Skull Activities* booklet listed in the Materials section for great ideas about how to incorporate skulls, and you can also distribute sets of the SteppeUp cards, if desired and available. If so, the students can match the artifacts with the card of the organism each comes from and learn more about the organisms by reading the cards. Tell groups they should be prepared to present their ideas to the class and direct group recorders to write down these 3 things that you can list on the board:

- Names or descriptions of the artifacts (i.e. beak, feather, etc.)
- Possible organism each comes from
- Adaptations that the artifacts reveal

10. After 10 – 15 minutes, tell students they have 5 more minutes to work and remind them that they should be prepared to present to the class. Different members of each group should be ready to stand

up and share the artifacts, their ideas about which organisms they come from, and the possible adaptations.

11. Direct each group to take turns presenting to the class, giving other class members a chance to ask questions at the end of each short presentation. After each group presents, other groups can also respectfully challenge their ideas, backing up their alternative ideas with evidence from observations and the SteppeUp cards.
12. Collect the artifacts and have students return to their groups. Continue with the PowerPoint presentation using the speaking notes shown at the bottom of the presentation. Ask questions to engage students and explain how they will be traveling to the field and/or working to restore a sagebrush ecosystem (if applicable).
13. Ask students to observe “The Sagebrush Steppe” illustration (slide 4) and/or pass out The Sagebrush Steppe posters to the groups. Ask a series of questions to get them to look more carefully and think critically about the sagebrush ecosystem, such as:
 - Where is the sage-grouse lek? Why do sage-grouse use a lek and other birds do not?
 - What things might sage-grouse eat? Possible answers:
 - Sagebrush (especially in winter when other foods are not available)
 - Other plants like wildflowers (forbs)
 - Insects
 - What predators do students see? Which might be a threat to sage-grouse?
 - What do sage-grouse use for shelter and protection from predators?
 - Answer: Sagebrush and tall bunch grasses
14. Tell students that because sage-grouse need sagebrush for food and shelter, they are considered a sagebrush “obligate” and write that word on the board. Discuss how obligate means that something is required, in this case, sagebrush for sage-grouse and other species to survive. For older or more advanced students, ask if they have heard a similar word, and then discuss the word “obligation,” including what it means and how it compares to how the word obligate is used in this sense.
15. Complete the presentation, focusing on the role humans play in shaping the sagebrush ecosystem and how fire has historically been a part of it. Be sure to discuss ways we can restore the environment and bring natural systems more in balance, referring to the specific exciting projects that are planned for the coming unit. For example, tell them about any upcoming field experiences and ask them to keep thinking about the different parts of sagebrush ecosystems—including which parts they think are most important—because they will be creating a visual model of one in the next class.

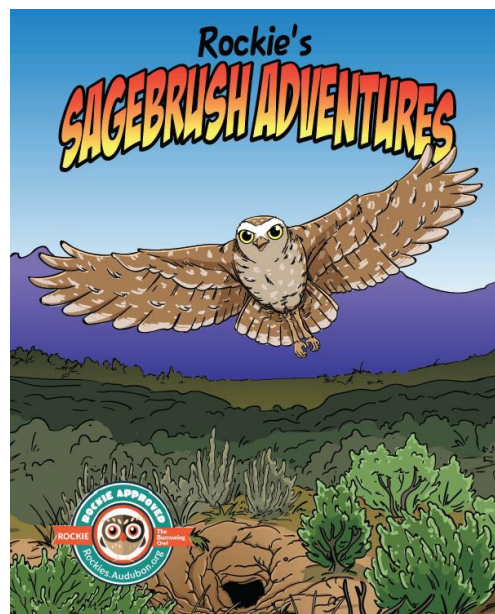
Adaptations / Extensions

1. It is recommended that you take students on a field trip to explore the sagebrush ecosystem first hand, if possible. Have students engage in an activity such as creating a nature journal or field guide of the organisms they observe. A lesson plan entitled “Field Journaling” can be found on the Idaho Rangeland Resource Commission education website: <https://idrange.org/wp-content/uploads/2017/06/5-FieldJournaling.pdf>. Excellent information on creating nature journals can also be found on the BirdSleuth website: <http://www.birdsleuth.org/nature-journaling>.
2. The “Sage-Grouse Scavenger Hunt” available from the Idaho Rangeland Resource Commission is another good option for a field activity: <https://idrange.org/wp-content/uploads/2017/06/SageGrouseFieldtripScavengerHunt.pdf>
3. Have students sketch one or more of the artifacts observed



during the lessons. Provide colored pencils, crayons, and/or markers to color the illustrations. Have volunteers share their drawings with the class.

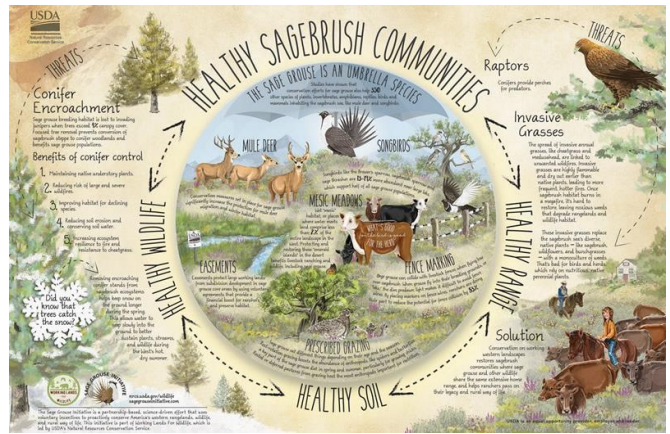
4. Do a more involved lesson with the wonderful Wildlife Skull Activities from the University of Arizona Extension and 4-H: <http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1145.pdf>
5. Read stories with your class about organisms from the ecosystem. Many are included in the Sagebrush Ecosystem Trunks from Audubon Rockies, including their new book *Rockie's Sagebrush Adventures* by Jacelyn Downey. Children learn about the sagebrush steppe through the beautifully illustrated adventures of 3 wildlife characters as they learn about the ecosystem and how each of them survives in their habitat. Contact Jacelyn if you would like to receive the trunks and/or details about getting more books: jdowney@audubon.org.
6. Have each student choose an organism from the SteppeUp cards or The Sagebrush Steppe illustration in the PowerPoint presentation to research in depth. They can research elements such as what the organism needs to survive and how human activities have impacted it over time. Provide a rubric so students know how they will be evaluated on the project, and findings could be shared with the rest of the class through written reports and/or oral presentations.



More Resources / References

- More Teacher Trunks from Audubon Rockies: <http://rockies.audubon.org/traveling/trunks>
- *Sammy's Quest to Save the West*. Print copies available through BLM Idaho: <https://www.blm.gov/contact/idaho>. Download at <https://www.blm.gov/documents/idaho/public-room/educational-material/junior-ranger-sammys-quest>.
- *FireWorks Encyclopedia for the Sagebrush Ecosystem*. BLM Idaho State Office. Available early 2018 from Idaho Fire Information: <http://www.idahofireinfo.com>
- Contact your local 4-H for more resources related to your local area: <http://www.4-h.org>.
- Copeland, Holly. Conserving the Sagebrush Sea, the Place "In-between". <http://www.pbs.org/wnet/nature/blog/conserving-sagebrush-sea-place/>
- "Discover Montana's Ecosystems" website from Montana Fish, Wildlife, & Parks: <http://fwp.mt.gov/education/ecosystem/shrub/>
- Discussion of sagebrush obligates and near obligates, etc.: "Wildlife Diversity in Sagebrush Habitats." University of Nevada. <http://www.unce.unr.edu/publications/files/nr/2003/FS0365.pdf>
- Greater Sage-Grouse resources from the U.S. Fish and Wildlife Service: <http://www.fws.gov/greatersagegrouse/>
- Idaho Rangeland Resource Commission education resources: <http://range.idaho.gov/education/teachers.htm>
- Klamath Bird Observatory. 2012. "Sage Grouse: Adaptations & Habitat" lesson plan. http://www.klamathbird.org/images/stories/kbo/pdfs_k12_library/sage_grouse_adaptations_habitat.pdf

- Sage Grouse Initiative resources:
 - Conserve our Western Roots poster and postcard from the Sage Grouse Initiative: <https://www.sagegrouseinitiative.com/roots>
 - Healthy Sagebrush Communities poster: https://www.nrcs.usda.gov/Internet/FSE_MEDIA/nrcseprd1338811.jpg
 - Proactive Conservation information: <http://www.sagegrouseinitiative.com/our-work/proactive-conservation/>
 - Sagebrush News & Resources: <http://www.sagegrouseinitiative.com/news-media>
 - Sagebrush Science & Policy <http://www.sagegrouseinitiative.com/our-work/science-policy>



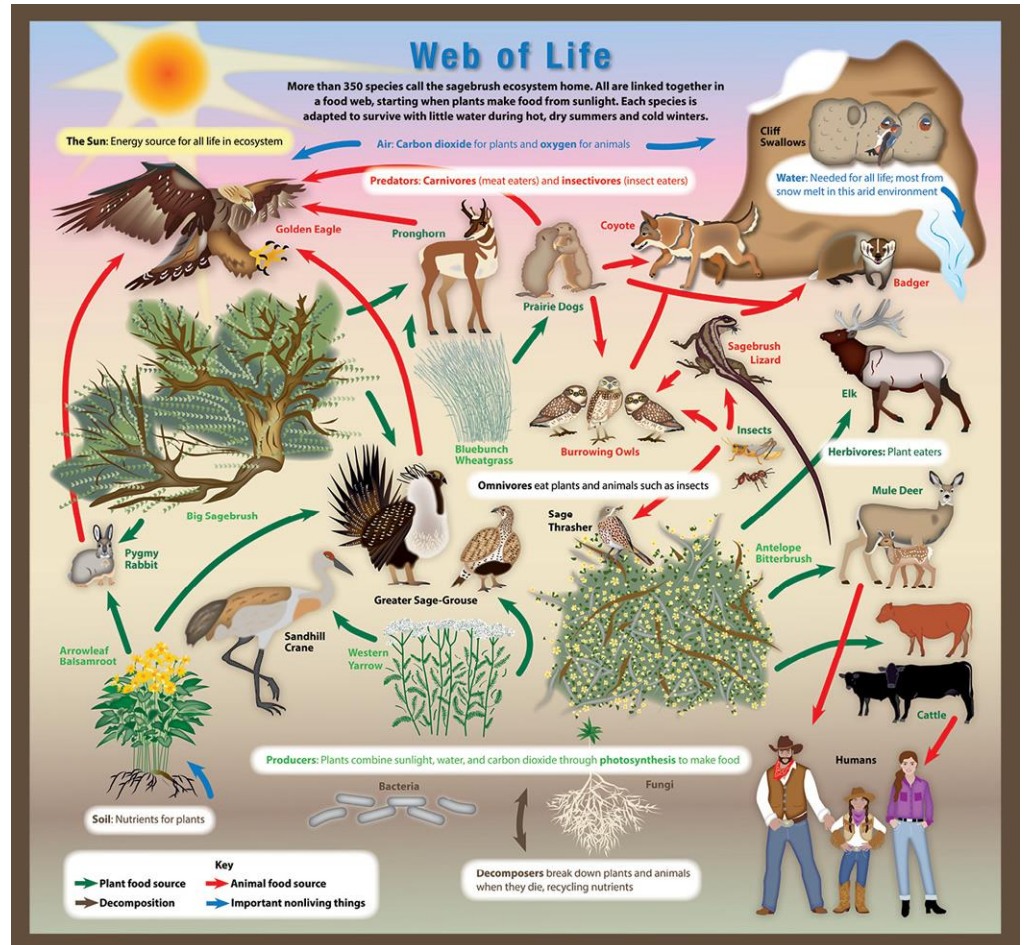
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.
- Opar, Alisa. “Unprecedented Conservation Efforts Keep Greater Sage-Grouse Off Endangered Species List.” Audubon. National Audubon Society. <https://www.audubon.org/news/unprecedented-conservation-efforts-keep-greater-sage-grouse-endangered-species>
- Dumroese, R Kasten et al. 2015. “Conserving and restoring habitat for Greater Sage-Grouse and other sagebrush-obligate wildlife: the crucial link of forbs and sagebrush diversity.” *Native Plants Journal* 16 3. http://www.fs.fed.us/rm/pubs_journals/2015/rmrs_2015_dumroese_k005.pdf
- Montana Outdoors resources:
 - Sage Grouse video library: <https://www.youtube.com/user/MontanaFWP/search?query=Sage+grouse>
 - Where Can Sage Grouse Live? <http://fwp.mt.gov/mtoutdoors/HTML/articles/2013/sagegrouse.htm#.VmoRb8uFP5o>
 - Down But Not Out: <http://fwp.mt.gov/mtoutdoors/HTML/articles/2006/sagegrouse.htm>
- Rowland, M. et al. 2005. “Greater sage-grouse as an umbrella species for sagebrush-associated vertebrates.” <http://naldc.nal.usda.gov/download/27907/PDF>
- “The Sagebrush Steppe” ecosystem photos from Audubon Rockies: http://rockies.audubon.org/sites/g/files/amh431/f/web_of_life_print-outs_sagebrush_2.pdf
- *Sally Sage-Grouse Explores Idaho* Junior Explorer booklet for students in grades 4-6 (and younger): <https://www.blm.gov/documents/idaho/public-room/educational-material/junior-explorer-kids-activity-book-sally-sage>
- Many other Junior Explorer booklets are available on BLM’s site, including *Native Plants* which has quite a bit of sagebrush information: <https://www.blm.gov/tag/junior-explorer>
- “Seriously Sage-Grouse” activity book for elementary students from the Sage-Grouse Initiative: <http://www.sagegrouseinitiative.com/wp-content/uploads/2013/08/seriouslysagecoloringbook.pdf>



The Sagebrush Sea's Web of Life

Lesson Overview

Lesson adaptations and extensions offer a variety of ways to engage all learners, but one enjoyable option for starting the lesson is for students to act out a simple food chain of different organisms which feed on each other in the sagebrush ecosystem. Next, pairs of students can create more involved visual representations of the food web. The whole class can then work together to create a food web which demonstrates the resilience that comes with biodiversity. The lesson closes with a brief discussion of the many interdependent relationships in the ecosystem that allow all of the species to survive in the arid, challenging climate.



Creating food webs of an ecosystem helps students understand the basic ecological principle that everything in nature is connected. By analyzing the relationships in the sagebrush ecosystem, students will increase their understanding of community ecology and the underlying relationships that bind living things together.

Lesson Goals

Students will understand that the multitude of organisms in the sagebrush ecosystem—also called the sagebrush sea—are woven together in an interconnected web of life known as a food web. They will understand that this interdependence among species, supported by nonliving things such as water, air, rocks, and soil, enables wildlife and plants to survive and live in balance with each other for the ecosystem's long-term health.

Subject Areas Science, Language Arts, Art, and Social Studies

Grade Level 4 – 12 (Ages 9 – 18)

Time One or two class periods of 50 – 60 minutes, or one longer block; additional time if one or more of the adaptations / extensions at the end of the lesson are incorporated

Objectives

- Students will create a visual representation of the concept of a food web and how organisms are linked to one another by the transfer of matter and energy in an ecosystem.
- Students will show the interconnections among living and nonliving things in the sagebrush ecosystem with a visual model.
- Students will show visually and explain verbally how energy from the Sun and photosynthesis forms the foundation of the sagebrush ecosystem.
- Students will simulate as a class the sagebrush web of life, including the interactions in the ecosystem and the factors which create healthy sagebrush ecosystems.

Next Generation Science Standards

Crosscutting Concepts

- Systems and system models
- Energy and matter
- Stability and change

Core and Component Ideas in the Life Sciences

LS1: From molecules to organisms: Structures and processes

- LS1.B: Growth and Development of Organisms

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Common Core State Standards

College and Career Readiness Anchor Standards for Reading

Standard 7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

College and Career Readiness Anchor Standards for Writing (if Adaptation / Extension #4 is completed)

Standard 6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Standard 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

- Computer with Internet access and display screen
- “Constructing a Food Web of the Sagebrush Sea” activity handout found here: <http://www.pbs.org/wnet/nature/sagebrush-sea-food-web>
- Glue sticks for students to share
- Markers, crayons, or colored pencils for students to share
- Large pieces of paper or poster board to share (can use backs of used paper/poster board for this activity, if available)
- Printed pictures and/or names of organisms from the ecosystem—either cut up cards from the activity above or larger ones if you have time to make them. If you use the cut up cards, you will at least need

to write out the names of more organisms on cards or sheets of paper so you have one for each student in the class, or students can help you as explained in step 11 of the Teacher Instructions.

- Ball of colorful yarn
- *Optional:* Class whiteboard, chalkboard, or interactive whiteboard
- *Optional:* Colored markers or chalk to write on board
- *Optional:* Sagebrush Ecosystem poster/graphic available on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>
- *Optional:* Sagebrush Ecosystem Trunk from Audubon Rockies: <http://rockies.audubon.org/traveling/trunks>. Contact Jacelyn Downey at (307) 756-3941 or jdowney@audubon.org for more information.
- *Optional:* “The Sagebrush Steppe” poster/graphic from Audubon Rockies: http://rockies.audubon.org/sites/g/files/amh431/f/sagebrushposter_fsc.pdf
- *Optional:* One or more sets of wildlife SteppeUp cards developed by the Bureau of Land Management (BLM).

Preparation

1. Depending on the age level and degree of comfort with each other as a class, prepare to do the recommended warm-up activity in steps 1 – 5, or skip ahead to step 6 for classes for which you think the activity might not be as successful as those that follow in the lesson, including those in the Adaptations/Extensions at the end.
2. Ensure all materials above are ready for student use.
3. *Optional:* Watch the following videos for more background information in preparation for teaching the complete curriculum:
 - *The Sagebrush Sea* from the *Nature* website (53 minutes): <http://www.pbs.org/wnet/nature/sagebrush-sea-full-episode/12341/>.
 - “The Sagebrush Sea: A High Desert Ecosystem” on the PBS Learning Media site (3 minutes): http://opb.pbslearningmedia.org/search/?q=%22Sagebrush+sea%22&selected_facets

Teacher Instructions

1. Engage the students with an activity or discussion which will help reconnect them with what they learned in the introduction to the sagebrush ecosystem lesson. One option is to arrange the class into a circle with 5 groups around the outside of it, and then ask the students to share the name of one of their favorite species from the ecosystem with each other. This can be an animal or plant that they have learned about or seen in the wild.
2. If you start with this warm-up activity, you can then ask the groups to choose 2 – 3 of the species and volunteers to represent the group and play the role of the species to act out a simple **food chain** for the rest of the class. Write the term on the board, and ask one of the student groups to send a representative to the center of the circle to play the role of an animal at the top of the food chain, a large predatory one which eats other animals. Ask the student to try to make themselves look and/or act like the animal they are playing.
3. Ask another group to send a representative to play a different animal which eats other animals, but that might be eaten by the first animal. Ask the second student to act out their animal, while the first gets ready to try to eat it. Ask the class if they know a word used for animals that eat other animals and a word for the animals which get eaten. Write or type the words **predator (carnivore)** and **prey** on the board. Then ask the groups to identify another animal that might get preyed upon and what predator might eat it; have a student representative come to the center of the circle and ask one of its predators to move near its prey, as well.

4. Ask the class what important parts of the sagebrush food chain are missing. Where do the prey species like the sage-grouse and prairie dog get their energy from? Instead of calling on a student raising her/his hand, tell the class that at the count of 3, all of them should shout out the organisms they think are most important for the ecosystem. Count 1-2-3, and hopefully many of them will shout PLANTS!— or sagebrush or something else important, like insects.
5. Ask for volunteers from the groups to play the role of sagebrush and other plants—the **producers**— and invite those students to join the food web simulation in the circle; write the word producers on the board, as well. Unless students have already studied photosynthesis very recently, ask the class to again shout out—at the count of 3—where the plants get their energy from, and hopefully most of them will shout THE SUN! or PHOTOSYNTHESIS! Write the **Sun** and **photosynthesis** on the board and ask the students playing plants to act like they are soaking up the Sun’s energy so they can convert it into food—sugar, starch, and other nutrients—that supports the whole ecosystem.
6. Ask students if they know the prefix of the word photosynthesis, and what the prefix means. Write **photo-** when someone says it and ensure students understand that it means “light.” Then ask what the main part of the word—synthesis—means. Students should know that it means “combining.” Then ask: How and what do plants combine to make energy? Review with students that plants use **chlorophyll** (write the word on the board)—what makes them green—to combine sunlight with water and carbon dioxide (CO₂) gas found in the air to complete the amazing process. Consider giving the students playing the role of plants cups of water for them to drink labeled “snowmelt”—the source of most water in the sagebrush ecosystem—and ask them to inhale and exhale deeply to complete the photosynthesis analogy.
7. Ask students what else prey species like sage-grouse might eat, and one of them should suggest insects. Explain that the sagebrush ecosystem is very complex, with over 350 species of animals and native plants—all of them interconnected through a complex **food web** and supported by nonliving things such as sunlight, water, and air. Write food web under food chain and explain that it is the interaction of multiple food chains.
8. Ask for a round of applause for the ecosystem actors, and ask them to take their seats. Explain that you will play a short video which will show the students more of the diverse organisms living in the interconnected **community** of the sagebrush ecosystem, and how the food web enables them to survive. Write the word community on the board when you say it, and ask students if they hear that word used in other ways. Briefly discuss how both humans and other living things exist together and support each other in communities.
9. Explain to students that they will now create an art project which will be a visual representation of a more complex food web. This one will better represent the rich **biodiversity** of a healthy sagebrush ecosystem. Write that term on the board when you say it, too.
10. Have students choose a partner and pass out copies of the “Constructing a Food Web of the Sagebrush Sea” activity handout found here: http://opb.pbslearningmedia.org/asset/nat15_doc_sagefood. Pairs will also need a large sheet of paper or poster board to share; consider having a few stacks of used sheets around the room from which students can choose (to use the back of it).
11. Explain to students that they will be cutting up the organism cards and arranging them on the paper in a food web, leaving space to add simple drawings and labels for other organisms and nonliving components that they think are critical for the ecosystem. If students prefer, they could also draw simple illustrations of all of the organisms—or symbols to represent them. Then they should add arrows pointing from the animals to the organisms they eat and glue everything down with a glue stick. Students should also add the indispensable Sun and a title to the diagram. Additional resources such as books, the SteppeUp Cards, the Sagebrush Exploration trunk, and the Internet can be made available for students to conduct additional research, if necessary.
Optional: Students can include humans and livestock in their diagrams, if desired.

Optional: Show students the Sagebrush Ecosystem poster/graphic available from the USFWS on the Greater Sage-Grouse Education page as an example:

<http://www.fws.gov/greatersagegrouse/education.php>

12. Direct students to use different colored arrows for the different types of interactions on their diagrams, and write this on the board with color-coded markers or chalk, if available, or type it to display on the screen or interactive whiteboard:
 - **Orange** to connect the **Sun** with producers (plants)
 - **Green** to connect **herbivores** to plants
 - **Red** to connect **predators** to their prey
 - **Brown** to connect **decomposers** to the plants and animals they break down after they die.
13. When pairs of students begin to finish (after about 25 minutes), prepare to simulate the web of life with yarn:
 - Pass out images and/or names of organisms from the ecosystem—one per student. Use either cut up cards from the activity above or larger ones if you have time to make them. Student pairs who complete their webs early can also help you make these based on the additional organisms they and other students added to their webs.
 - If you use the cut-up cards, you or the students will at least need to write out the names of more organisms on cards or sheets of paper so there is one for each student in the class.
 - Ask the class to move their desks aside or go outside so you have a large area to form a circle with the whole class, directing students to take their images with them.

14. When the class is in a circle, tell students that you will now be recreating the sagebrush ecosystem web of life. Give the end of the ball of yarn to one of the students representing a plant species. Ask the student to say the name of an organism it interacts with and toss the ball of yarn to the student representing it.



15. Ask the second student to do the same thing, passing the ball to another organism it interacts with while holding the end of the yarn; continue until all the students are connected in the web of life, completing the sagebrush ecosystem.

16. Ask the students to step back and/or gently pull on the yarn until the web is taut. Then ask the students to remain still. Explain that in a moment the student who started the web will tug on it, and only those students who feel a tug will tug back.

Ask the student playing the plant to begin the process, and continue until all the students can feel a vibration moving through the web. Then ask students to choose an organism that might be less important for the ecosystem and ask that student to drop the yarn.

17. Continue this process several more times, then ask students a few questions to promote critical thinking and generate discussion:
 - How did removing organisms from the sagebrush ecosystem impact the web? *Possible answer:* Organisms that depend on the food web are impacted and the web changes shape.
 - When were the changes to the web most dramatic? *Possible answers:* When there were less species, losing one of them had a greater impact on the ecosystem.
 - When was the web the most stable and why? *Possible answers:*
 - The web was most stable when there was the largest number of species.

- In general, the more **biodiversity** (point to the word on the board), the more stable the environment and the less it is impacted by changes in the environment.
 - If time allows, talk about the prefix bio- and the root diversity.
 - How might humans impact the web if they were added to it? *Possible answers:*
 - They might cause more species to leave the web.
 - This would be especially true if the humans don't try to minimize their impact and protect the biodiversity of the ecosystem.
18. After the discussion, direct students to roll up the yarn and clean up the classroom. Explain that if students did not have time to complete their diagrams they can do so in class after they complete another assignment or outside of class time. (Give students a deadline by which they will need to be completed.) Complete diagrams—or the best of them—can be displayed on the classroom walls or on a hallway bulletin board or other display.

Adaptations / Extensions

1. Start the lesson with an essential question such as, "How does all life on Earth depend on the Sun?" Students could start with a quick free write in their journal/notebook. Then you could ask them to create a simple food web with them at the center. This could help illustrate the concept of being an obligate and could be used at a different time in the unit. For example, you could ask something like, "Look at your personal food web and circle the food that you would choose if you could only have one. What might be some limitations of only being able to eat one type of food?" Another quick front-loading activity could be to have students take a favorite food and trace it back to the Sun (e.g., hamburger patty comes from a cow, cow eats grass, grass grows because of the Sun). These quick 5 – 10-minute activities can help activate prior knowledge and prepare students to focus their thinking in new ways.
2. Take students outside and have them explore your local ecosystem. Organisms discovered can be recorded in student-created field guides or journals and observed to determine how they interact with other organisms in a food web. Back at school, research can be conducted to develop a deeper understanding of the organisms and how they interact in the ecosystem.
3. Students can choose an organism from the sagebrush ecosystem to research and write about, preferably diverse species including birds, mammals, reptiles, plants, and insects. Provide students with an assessment rubric and/or graphic organizer, if desired, to help them direct and organize their work. They should include information such as:
 - Where in the sagebrush ecosystem does it live?
 - What does it eat? (for animals)
 - What eats it?
 - With which other organisms and nonliving things does it interact, and how does it depend on them for survival?
 - How does the organism impact the sagebrush ecosystem?
4. Research findings could be shared with the rest of the class through oral presentations.
5. Students can write a poem related to one of the organisms they have been learning about and its role in the food web of the sagebrush ecosystem.
6. Student groups could diagram food webs from other ecosystems, even tiny ones like those found in the school yard.
7. Students can use software such as Inspiration, Kidspiration, Explain Everything, or Adobe Illustrator to create their food web diagrams, rather than create them on paper.



Invasive Plants

A Serious Threat to Sagebrush Ecosystems

Lesson Overview

A short multimedia presentation can be shared on the problems with invasive plants. If possible, students will then go outside to an area where they can observe invasive plants and work towards restoring the area if time and resources allow. Ideally this will be in the sagebrush ecosystem, but another area such as one near the school is also an option. Invasive plants will be identified and their seeds will be collected to observe adaptations which are beneficial for dispersal. This can be done later in the classroom using microscopes, if available. (Plants and/or plant parts can also be collected for drying and to observe more closely in the classroom, if desired). Students can then embark on a service learning project to help restore the area by removing invasive plants. The work will be documented and shared to educate others about the project and the need to restore natural areas with native plants such as sagebrush.

If outside work is not possible, students can learn more about invasive plants through hands-on activities in the classroom as explained in the Teacher Instructions that follow. Adaptations and extensions are listed at the end of the lesson including research, writing, and art projects.



Cheatgrass overtakes the sagebrush ecosystem.

Lesson Goal Students will be able to explain the role invasive plants play in changing sagebrush ecosystems.

Subject Areas Science, English/Language Arts, and Art

Grade Level 4 – 12 (Ages 9 – 18)

Time 75 minutes or more

Objectives

- Students will be able to explain the factors which create healthy sagebrush ecosystems.
- Students will be able to properly identify invasive plants and demonstrate proper removal techniques.
- Students will document and reflect on the benefits of their service work through journal writing and sharing their findings through a variety of mediums.

Next Generation Science Standards

Scientific and Engineering Practices

- Asking questions (science) and defining problems (engineering)
- Obtaining, evaluating, and communicating information

Crosscutting Concepts

- Stability and change

Core and Component Ideas in the Life Sciences

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4: Biological Evolution: Unity and Diversity

- LS4.C: Adaptation

Common Core State Standards

College and Career Readiness Anchor Standards for Writing (if Adaptation / Extension #2 is completed)

Standard 6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Standard 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

1. Plastic bags to gather seeds
2. Digital camera(s) and/or video camera(s)
3. Student journals
4. *Optional:* Work gloves for each student
5. *Optional:* Tools to remove invasive plants present at restoration site, such as shovels, which students can share
6. *Optional:* Microscopes or magnifying glasses
7. *Optional:* Petri Dishes
8. *Optional:* Plant presses to dry plant specimens
9. *Optional:* Bags, if necessary, for the removal of specific invasive plant species on site (See the chart “Common Invasive Plants and Removal Techniques” later in the lesson.)

Preparation

1. If possible, identify an expert partner to work with your class. Contact information and recommendations for partners such as the U.S.FWS, BLM, state wildlife agencies, Audubon, the Nature Conservancy, Cooperative Extension, Conservation Districts, and Wyoming Weed and Pest Council as options for experts who can come into classrooms or offer resources can be found on the Greater Sage-Grouse Education page of the FWS website: <http://www.fws.gov/greatersagegrouse/education.php>. The Sage Grouse Initiative website also lists many excellent partners/experts, such as the Natural Resources Conservation Service: <http://www.sagegrouseinitiative.com/about/partners>.
2. Have students return signed permission forms (found in the Appendix) if the class will be traveling beyond the school campus.
3. Remind students to wear appropriate clothing, such as warm clothes and boots, and to bring a water bottle.
4. If desired and time permits, tell students to bring snacks and/or lunch the day before the site visit.

5. Ensure all materials are ready for student use and/or ask students to bring materials from home. For example, ask students to bring in work gloves if they have them.

Teacher Instructions

1. If possible, take the students to an area degraded by invasive plants. If this is not possible, gather the students around a large table or set of desks with specimens of invasive and native plants (at least some of which have seeds).
2. Introduce the class visitor, if one is present. The visitor (or you) can then ask the class, “What is an invasive species?” This should lead to a quick discussion of why some plants are considered invasive and how they negatively impact ecosystems. Be sure students understand that invasive plants are those that have been introduced to an area, so they do not have natural enemies and they can spread quickly. If necessary, follow up with “How do invasive plants negatively impact habitat for wildlife species such as sage-grouse?” Reasons to be discussed could include:
 - By outcompeting native plants, they create **monocultures** which do not provide good habitat for native wildlife and lack the biodiversity needed for healthy ecosystems. Some species, such as sage-grouse and other sagebrush obligates, cannot survive if native plants like sagebrush are driven out.
 - Most invasives do not provide as much food and shelter as wild plants like sagebrush, bunch grasses, and wildflowers (forbs) do, negatively impacting wildlife habitat.
 - Invasives like cheatgrass and medusahead increase the threat of severe wildfires because they are extremely flammable, especially during the long dry season.
 - Invasives tend to have shallower roots and less complex root structures than native plants, causing increased erosion of soil.
 - They did not evolve in the ecosystem and therefore lack natural predators.
 - Their roots are generally shallower than those of diverse native plant communities, so they do less to slow erosion and promote the creation of healthy soils.
 - They use water that could be used by beneficial native plants.
 - The monocultures they create lack the complex structure and varied plant height needed to support a diverse ecological community.
3. Ask the students if anyone can guess which plants are invasive in the outside area or on the table. Walk over to (or hold up) the invasive plants present and teach students how to identify each of them. See the chart of common invasive plants and other resources at the end of the lesson.
4. If students are in the field and they will be removing invasives, follow the steps below. Otherwise, skip to step 5.
 - Go over safety rules and then pass out work gloves and tools. Ensure students can identify the invasive plants that are on site, such as those listed in the table that starts on the next page, and demonstrate the best techniques of removing them, ideally with the help of experienced students.
 - Have student groups begin removing the invasive plants. Circulate among the groups and be ready to answer questions. Provide guidance, as necessary, to ensure that students are practicing good safety and removal techniques. Identify students who have photography and/or filming experience and ask them to document the student groups working, as well as before and after images of the site.
 - Fifteen or twenty minutes before you are scheduled to leave, ask student teams to clean up the site, including completing piles and/or bagging plants, as necessary, and packing up the tools.

- To encourage students to reflect and help meet science and writing standards, pass out student journals and ask students to write for about 10 minutes on how their work will help transform the area. Encourage them to include vivid details about their experience and specific ways in which the rehabilitated site will improve the environment. For example, how might habitat for wildlife like sage-grouse be improved by removing the invasive plants and planting natives like sagebrush, forbs, and bunch grasses? If necessary, brainstorm ideas with students to help them get started.
 - Give students a one-minute warning to finish writing. Then gather the class together and ask for one or more volunteers to share an excerpt of what she or he wrote.
 - If students will be doing ongoing service work at the site, explain that the students' good work today was just the beginning of their service project to increase the health and biodiversity of the site. They will use the notes gathered in their journals, as well as the images and/or video recorded, to create more resources which educate others about what they have been doing.
5. Ask students to form groups of 3-4.
 - If students are in the classroom, pass out bags with invasive plants and seeds to the groups.
 - If students are in the field, pass out plastic bags for groups to collect seeds from the invasive plants. Tell students to be very careful not to spread the seeds around, and to clean their shoes and clothes carefully before boarding the bus. You may also want to skip this step and carefully gather seeds yourself to avoid the risk of spreading the noxious weeds.
 6. Students can carefully observe the seeds and other parts of the invasive plants in the classroom. Ask them to think about what adaptations on the seeds help them to disperse and germinate. Include a discussion of invasive weed vectors, such as vehicles, livestock, pet dogs, and clothes, emphasizing the importance of cleaning shoes before and after entering natural areas. Students can also observe the other plant parts if those were gathered, and microscopes can be used, if available, to observe the seeds and other parts on a microscopic level.
 7. Ask students to choose one or more seeds and/or plants to illustrate in their journals. Demonstrate how to make careful scientific drawings which include all of the structures of the seeds and/or plants. Direct students to label the seeds and/or plants and any of the structures they can identify.
 8. Close the lesson with a class discussion about the amazing adaptations of invasive plants. How have they been able to conquer such vast stretches of the sagebrush ecosystem and other important ecosystems? How can we stop them before they further damage wildlife habitat, rangeland for livestock, and the long-term health of the land for humans and wildlife alike?

Adaptations / Extensions

1. Have students design their own wind-dispersal method for a seed to help students develop their engineering skills and better appreciate seed adaptations:
 - Give pairs of students each a dry seed or bean and access to supplies to develop their own creative way to disperse their seed or bean by wind as far as possible. Supplies can include:
 - Pieces of paper
 - Scissors
 - Fiberfill
 - Tissue paper
 - Tape and glue
 - Bubble wrap
 - Anything else that students might think to use
 - Put a fan on a table or counter.

- When designs are complete, direct student teams to each drop their seed from the same height in front of the fan. Allow each team three attempts, using a measuring tape to record the distance traveled for each and then calculating the average distance traveled.
 - Have teams share their data in one large table to determine which design(s) traveled the farthest. Discuss which seed(s) traveled the farthest and hypothesize why those designs were successful.
 - If time permits, allow students to revise their designs to see if they can improve their seed's wind-dispersal distance.
2. Do a simple classroom simulation to demonstrate how invasive plants can quickly become a problem. For example:
- Do some work with ratios (which supports Common Core math standards).
 - Have a couple sets of plant cards—each deck having one card for each student in the class. These could be made from simple 3/5 index cards.
 - Let students know that there is only room in the model ecosystem for X number of plants (equal to the number of students).
 - The first round of play could involve a functional ecosystem with a mix of cards replicating native shrubs, forbs, grasses, etc. The teacher and students could figure out how many plants there are in each category and list them on the whiteboard. Then the cards could be collected and the new deck distributed.
 - The new deck would include invasive weeds and fewer native plants.
 - This activity could include an option for the teacher to have a student roll a die or draw a card that describes a change in the system that might introduce more invasive weeds. Or, the teacher could have a simple narrative (paragraph or two) to read in between each round of the game.
 - The final round of the game could end with the deck of cards being entirely invasive weeds and even a video clip or photos/story about a real place where fire or other factors have completely displaced a native sagebrush plant system with invasive weeds.
3. Ask students to save samples of the invasive plants. These can be preserved by pressing and drying to use when educating others about the project. A Plant Collection and Pressing Guide can be found on the Idaho Rangeland Resource Commission's "Rangeland Plants" education webpage: <http://idrange.org/LiteratureRetrieve.aspx?ID=143189>
4. Have students research a specific invasive species to learn more about its life cycle and its negative role in ecosystems. Students can also research its origins and how it traveled to your area. Findings could be shared with the rest of the class through multimedia class presentations and/or written reports. One possible *Invasive Species Project* is explained following the invasive plants guide at the end of the lesson and another is "Plant Immigrants" from Earth Partnership for Schools: <http://www.litzsinger.org/EPS/10-10-Plant-Immigrants.pdf>.
5. Seeds can be germinated in petri dishes and observed with microscopes or magnifying glasses. Prior to or following the field work, have students research a specific invasive plant to learn more about its life cycle and its negative role in ecosystems. Findings could be shared with the rest of the class through class presentations. One possible *Invasive Species Project* is explained following the invasive plants guide at the end of the lesson.
6. Prior to or following the field work, have students watch *The Silent Invasion* documentary film from Oregon Public Broadcasting (OPB): <http://www.opb.org/programs/invasives>.
7. Talk about how sometimes plants are introduced by humans with the best intentions to try to solve problems, but they have themselves lead to ecological declines (e.g. buffelgrass (*Cenchrus ciliaris*) and *Poa bulbosa*, both introduced to reduce erosion and stabilize soils).

More Resources / References

- List of common invasive plants in the sagebrush ecosystem and removal techniques which starts on the next page
- Excellent invasive weed curriculum for grades K-12: *Invasives: Plants on the Move*. <http://www.weedinvasion.org/>
- Idaho Rangeland Resource Commission education resources on Rangeland Plants: <https://idrange.org/education-2/lessons-and-activities>
- Excellent lesson plans on invasive and native plants and more: *Return of the Natives*. <https://csumb.edu/ron/lesson-plans>
- Montana Dept. of Agriculture Noxious Weed Education: <http://agr.mt.gov/agr/Programs/AgClassroom/k-8projects/noxiousweededucation/>
- The engineering seed dispersal extension was inspired by a lesson called “Scattering Seeds” on the Discovery Education website: <http://school.discoveryeducation.com/lessonplans/programs/scatteringseeds/>
- Cramer, J. and Einerson, J. (2011). *From Salmonberry to Sagebrush*. Corvallis, OR: Institute for Applied Ecology. You can download the complete 300+ page book here: [http://www.blm.gov/style/medialib/blm/wo/Law Enforcement/nlcs/education interpretation/teachers_page.Par.40262.File.dat/Oregon Native Plant Curriculum.pdf](http://www.blm.gov/style/medialib/blm/wo/Law%20Enforcement/nlcs/education_interpretation/teachers_page.Par.40262.File.dat/Oregon%20Native%20Plant%20Curriculum.pdf)
- USDA PLANTS database: <http://plants.usda.gov>
- Conserve our Western Roots poster and postcard from the Sage Grouse Initiative: <https://www.sagegrouseinitiative.com/roots>
- Earth Partnership for Schools’ process from Litzsinger Road Ecology Center for schools doing ecosystem restoration with lessons: <http://www.litzsinger.org/education/resources/earth-partnership-for-schools>.
- *FireWorks Encyclopedia for the Sagebrush Ecosystem*. FireWorks Educational Program. BLM: <https://www.frames.gov/partner-sites/fireworks/curriculum/sagebrush-ecosystem>
- *Sammy’s Quest to Save the West*. BLM Idaho: <https://www.blm.gov/documents/idaho/public-room/educational-material/junior-ranger-sammys-quest>
- “Explore Sagebrush Prairie” KIDS activity booklet from Project WET Foundation: <http://www.projectwet.org/what-we-do/publications/kids-activity-booklets/explore-sagebrush-prairie-kids-activity-booklet>
- DiTomaso, J. (2013). *Weed control in natural areas in the Western United States*. Davis, Calif.: University of California Weed Research and Information Center.
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.
- Teacher Trunks from Audubon Rockies, including Sagebrush Exploration. Contact Dusty Downey at (307) 756-3941 or ddowney@audubon.org for more information.
- Contact your local 4-H (<http://www.4-h.org>) for more resources related to your local area.

Common Invasive Plants in the Sagebrush Ecosystem and Removal Techniques

Cheatgrass (Downy Brome)

Bromus tectorum



Photo credit: Jim Kennedy

Manual removal (recommended for student groups):

- Hand pull or dig in spring before seeds ripen
- Repeat when new plants appear

Mechanical removal:

- Disking/tilling of live plants before seeds ripen
- Use disk, rototiller, spike-tooth harrow, etc.

Biological (cultural) removal:

- Livestock grazing by goats, sheep, and cattle in spring before seeds form
- Can heavily graze the area and repeat 3 weeks later
- Repeat for at least 2 years

Chemical removal:

- Chemicals can be used, but this method is not recommended for students, due to their toxicity.

Controlled burning:

- Dangerous and not recommended for student groups, of course!

Medusahead

Taeniatherum caput-medusae



Photo credit: Matt Lavin

Manual removal (recommended for student groups):

- Hand pull or dig in spring before seeds ripen; repeat when new plants appear
- Removal of thatch by raking in areas where a heavy thatch exists.

Mechanical removal:

- Disking/tilling of live plants before seeds ripen
- Use disk, rototiller, spike-tooth harrow, etc.

Biological (cultural) removal:

- Because of its high silica content, livestock avoid grazing medusahead

Chemical removal:

- Chemicals can be used, but this method is not recommended for students, due to their toxicity.

Controlled burning:

- Dangerous and not recommended for student groups, of course!

Ventenata (North African Wiregrass)

Ventenata dubia



Photo credit: Matt Lavin

Manual removal (recommended for student groups):

- Hand pull or dig in spring before seed is ripe and when soil is moist to uproot this shallowly rooted species
- Repeat when new plants appear

Cultural (livestock) removal:

- Grazing is unlikely to be effective due to low palatability

Chemical removal:

- Chemicals can be used, but this method is not recommended for students, due to their toxicity.

Controlled burning:

- Dangerous and not recommended for student groups, of course!

Common, Cutleaf, & Fuller's Teasel

Dipsacus fullonum, *Dipsacus laciniatus*,
& *Dipsacus sativus*



Photo credit: Jim Kennedy

Manual removal (recommended for student groups):

- Hand pull or dig in spring before flowering
- When digging, sever the root below the soil surface
- Repeat when new plants appear

Mechanical removal:

- Tilling effectively controls emerged plants, but can stimulate new germinations

Biological (cultural) removal:

- Livestock may graze rosettes, but teasel has low palatability at most growth stages.

Chemical removal:

- Chemicals can be used, but this method is not recommended for students, due to their toxicity.

Bull, Canada, Musk, and Scotch Thistle

Cirsium vulgare, *Cirsium arvense*,
Carduus nutens, & *Onopordum acanthium*



Manual removal (recommended for student groups):

- Hand pull or hoe before flowering
- When digging, sever the root below the soil surface

Mechanical removal:

- Mowing is only effective if done immediately before flowering or when plants are just starting to flower.
- A single mowing is ineffective due to variation in plant maturity and must be repeated at least every 2-3 weeks

Biological (cultural) removal:

- Large livestock tend to avoid grazing thistles, but horses, goats, and cattle have been known to eat flowerheads and sheep to eat rosettes.

Chemical removal:

- Chemicals can be used, but this method is not recommended for students, due to their toxicity.

Russian Thistle

Salsola tragus



Photo credit: Matt Lavin

Manual removal (recommended for student groups):

- Hand pull or dig in spring before seed is ripe
- Repeat when new plants appear

Mechanical removal:

- Tilling before seed set will control seedlings and larger plants, but must be repeated for 2+ years until the soil seedbank has been depleted.

Biological (cultural) removal:

- Livestock may graze young plants

Chemical removal:

- Chemicals can be used, but this method is not recommended for students, due to their toxicity.

Yellow Star Thistle

Centaurea solstitialis



Mark Stannard, USDA-NRCS Pullman Plant Materials Center

- Removal same as other thistle, above

Other Common Invasive Plants Found in Wetter Areas (Such As Riparian Areas and Wetland Meadows) and Removal Techniques

English Ivy

Hedera helix



- Removal from trees is easily done by “air gapping” (cutting the runners at chest height around the tree and pulling everything below chest height out of the ground). Anything above on the tree will die.
- Ivy on the ground is pulled out from the roots with hands and rakes.

Old Man’s Beard Clematis

Clematis vitalba



- Same as above

Armenian (Himalayan) Blackberry

Rubus armeniacus



- Cut the canes with loppers down to a foot above the ground. Pull the canes to a central pile and cut into 1-2 foot sections.
- Dig up the roots; the foot-long blackberry plants mark the locations. Bang the roots on the ground to knock off the top soil and deposit them on top of the cane pile. (We don't remove invasive plants from sites, but rather "chop and drop" them since the debris piles offer good habitat for wildlife. For example, Green Team students conducted a salamander survey and found many of the charismatic amphibians in the piles!

Garlic Mustard

Alliaria petiolata



- Pull out by hand in spring. Since the plant will regenerate if left on site, it needs to be bagged and thrown away. It's also important to use brushes on shoes if students walk in an area infested with Garlic Mustard as the seeds travel easily on shoes.

Morning Glory or Field Bindweed

Convolvulus arvensis



- This invasive will re-root if left on site, so lay out a tarp and put the debris pile on the tarp to dry out. Then two or three weeks later the tarp can be removed and the plant won't re-sprout.

Reed Canary Grass

Phalaris arundinacea



- One of the most difficult plants to remove, a good strategy is to cut the grass down right before the first native planting, and then plant the natives very densely (2-3 feet apart).
- Installing biodegradable coffee bags around the native plants gives them some protection from the invading grass and reduces or eliminates the need for mowing.
- Reed canary grass prefers full sun, so shade can help control.
- Dense willow staking can also help control the invader.

Invasive Species Project

Adapted with permission from a project in the SOLVE Environmental Service Learning curriculum by Erin Cole

Your Assignment

Research an invasive plant or an invasive animal that is impacting the sagebrush ecosystem or another ecosystem. Create an “eradication sales pitch” to share your information and warn others about the dangers of these noxious organisms!

Overall Guidelines

You will be trying to convince your classmates that your plant or animal is the MOST concerning to the sagebrush steppe or another ecosystem and that all our money and resources should go to eradicating it NOW! Some things to think about in your sales pitch:

1. Is your plant one that is already causing widespread damage?
2. Is it one that is not that big a problem in our area yet, but it may become really damaging?
3. Is it causing significant economic damage? Environmental damage? Aesthetic damage?
4. Is it cost-effective to get rid of?
5. Is there an organization which is already trying to get rid of it? If so, could they use help?

Information Requirements

1. Common and scientific name of your plant or animal
2. Detailed description of what it looks like; how to not confuse it with similar organisms
3. Its original ecosystem (where they are native and originally from)
4. Where it can be found now (region, specific place in ecosystem)
5. How they harm humans and ecosystems (Be specific: for example, if they take over land from other plants, HOW do they do it? If they cause economic damage, to what industries or structures?)
6. What humans are trying to do to stop the invasion (Again, be as specific as possible: is there a specific organization which is already trying to stop them? What tools/chemicals/methods are they using, and are there pros and cons to the various methods?)
7. All sources of information, including photos, are cited in MLA format

Formatting and Aesthetic Requirements

1. 4-10 slides created with PowerPoint or another program, including a sources page at the end
2. A title slide with a photo or drawing of the plant or animal that has been stylized to look “evil” or “wanted” (created with graphics software or drawn by hand and scanned)
3. The presentation should last no longer than 3 or 4 minutes and should seem like a “sales pitch,” not just an informational session—be persuasive!!!

Evaluation

Your presentations will be scored as follows:

Requirement	Score
Information: All information requirements met, including sources	/ 20
Organization: Presentations are neat and organized, with proper grammar and spelling	/ 5
Creativity: Photo or drawing on first slide has been “evilized” and presentation is persuasive	/ 5
Total	/ 30

Choices

Invasive Plants

1. Cheatgrass (Downy Brome)
2. Medusahead
3. Ventenata (North African Wiregrass)
4. Bull, Canada, Musk, and Scotch Thistle
5. Common, Cutleaf, or Fuller’s Teasel
6. Russian Thistle
7. Yellow Star Thistle
8. Scotch (Scot’s) broom
9. Purple loosestrife
10. Knapweeds
11. Knotweeds (Japanese or other)
12. Thistle and Teasel (various species)
13. Traveler’s Joy / Old Man’s Beard Clematis
14. Laurel
15. Garlic Mustard
16. English Ivy
17. English Holly
18. Tree of Heaven
19. Yellow Flag Iris

20. Indigo Bush/Butterfly Bush

21. Reed Canary Grass

Invasive Animals

1. Zebra and Quagga Mussels
2. Chinese Mitten Crab
3. Nutria
4. European Starling
5. English House Sparrow
6. Asian Carp/Asian Leaping Carp/Silver Carp
7. American Bullfrog
8. Rusty Crayfish
9. Feral Pig/Feral Swine
10. Red-eared Slider
11. Oriental Weatherfish
12. Northern Snakehead
13. New Zealand Mud Snail
14. Yellow Perch
15. Asian Clam
16. European Green Crab
17. Red Swamp Crayfish

Resources

- USDA Plants database: <http://plants.usda.gov/>
- *The Silent Invasion* documentary film from Oregon Public Broadcasting (OPB): <http://www.opb.org/programs/invasives>
- Oregon Invasive Species Council: <http://www.oregon.gov/OISC>
- USDA Invasive Species resources: <http://www.invasivespeciesinfo.gov/unitedstates>
- Oregon Dept. of Fish and Wildlife (ODFW) Invasive Species resources: http://www.dfw.state.or.us/conservationstrategy/invasive_species.asp



Native Plants in the Sagebrush Ecosystem

Structures, Benefits, and Student Action

Lesson Overview

Students learn to identify native plants, including shrubs, grasses, and/or forbs (wildflowers), and how they benefit ecosystems. Ideally, students travel to a sagebrush ecosystem restoration site where they learn to identify the important plants and plant structures. They then learn to use transects to approximate the distribution of plants at the site and take action to improve the health of the ecosystem by planting native plants. Even if that is not possible, students can observe native plants on the school campus and/or in the classroom, either as live or dried specimens or through images. Students then create detailed drawings of their favorite plants in journals and label the plant structures. Adaptations and extensions are listed at the end of the lesson, including additional research, writing, and art projects.



Students conduct a line transect.

Lesson Goals Students will learn to identify plant structures and specific native plants. They will understand the ecological benefits of native plants and, if possible, work to improve the health of an ecosystem—preferably sagebrush steppe—by planting one or more species of native shrubs, grasses, and/or forbs (wildflowers).

Subject Areas Science, Math, English/Language Arts, and Art

Grade Level 4 – 12 (Ages 9 – 18)

Time 75 minutes or more, depending on lesson components incorporated

Objectives

- Students will demonstrate understanding of the many ways native plants help maintain healthy ecosystems.
- Students will demonstrate knowledge of plant structures through the creation of detailed diagrams.
- Students will correctly identify and plant native plants.

Next Generation Science Standards

Scientific and Engineering Practices

- Asking questions (science) and defining problems (engineering)
- Planning and carrying out investigations
- Constructing explanations (for science) and designing solutions (for engineering)

Crosscutting Concepts

- Patterns
- Structure and Function
- Stability and Change
- Systems and System Models

Core and Component Ideas in the Life Sciences

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4: Biological Evolution: Unity and Diversity

- LS4.C: Adaptation

Common Core State Standards

Common Core State Standards for Mathematics

Ratios and Proportional Relationships

Standard 6.RP.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

Standard 6.RP.A.3.C Find a percent of a quantity as a rate per 100.

College and Career Readiness Anchor Standards for Writing

College and Career Readiness Anchor Standards for Writing

Standard 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Materials

1. Copies of “Transect Survey” handout (found after this lesson) and clipboards for each group; plastic cover sheets if precipitation expected
2. Student journals and pencils
3. *Optional:* Copies of the “Plant Identification Booklet” from the Idaho Rangeland Resource Commission: http://idrange.org/literature_140279/Plant_Identification_Booklet
4. *Optional:* Colored pencils
5. *Optional:* Digital camera(s) and/or video camera(s)
6. *Optional:* Tape measures or strings with measurement lines for student groups to share
7. *Optional:* GPS devices and/or smartphones for students to share
8. *Optional:* Whiteboard or poster board and markers
9. *Optional:* Work gloves for each student, flagging tape, and tools to plant native plants, such as shovels
10. *Optional:* Plant presses to dry plant specimens
11. *Optional:* Microscopes or magnifying glasses
12. *Optional:* Plastic bags to gather seeds
13. *Optional:* Petri dishes or pots and soil to sprout seeds
14. *Optional:* Sagebrush Ecosystem Trunk from Audubon Rockies: contact Jacelyn Downey at (307) 756-3941 or jdowney@audubon.org for more information

15. *Optional: The Sagebrush Steppe* poster from Audubon Rockies:
http://rockies.audubon.org/sites/g/files/amh431/f/sagebrushposter_fsc.pdf
Contact Jacelyn Downey at (307) 756-3941 or jdowney@audubon.org for the printed poster.

Preparation

1. If possible, identify an expert partner to work with your class. Contact information and recommendations for partners such as the U.S.FWS, BLM, state wildlife agencies, and Audubon can be found on the Greater Sage-Grouse Education page:
<http://www.fws.gov/greatersagegrouse/education.php>. There you can also find contacts who can help with gathering the materials above. Sarah Levy from the U.S. FWS is one of the contacts who can help connect you with resources and/or restoration partners: sarah_levy@fws.gov.
2. Have students return signed permission forms (found in the Appendix) if the class will be traveling beyond the school campus.
3. Be able to identify native plants in the area you will be visiting, such as those found in the chart “Common Native Plants in the Sagebrush Steppe” later in the lesson.
4. Remind students to wear appropriate clothing, such as warm clothes and boots, and to bring a water bottle.
5. If desired and time permits, tell students to bring snacks and/or lunch the day before the site visit.
6. Ensure all materials are ready for student use and/or ask students to bring materials from home. For example, ask students to bring in work gloves if they have them.

Teacher Instructions

1. If possible, take students to an area containing native plants—preferably with plants found in the sagebrush ecosystem—or show students live or dried specimens in the classroom. Teach students how to identify native plants such as the following:
 - Shrubs: Sagebrush, such as the specific species found in your observation area
 - Grasses: Such as native perennial bunchgrasses; tell students these are species that come back every year and ask them what they think annual grasses are and how they are able to regrow the following season.
 - Forbs: Wildflowers such as arrowleaf balsamroot; try to show at least one example of both an annual and perennial forb.
 - Trees: Juniper: native, but considered invasive in the sagebrush ecosystem
2. *Optional:* Pass out plant guides such as copies of the Plant Identification Booklet and the “Common Native Plants in the Sagebrush Ecosystem” handout at the end of this lesson for students to share. Students can use either or both of these to help them identify plants and plant structures. Talk through the different parts of the guides with them.
3. Ask students which plants at the site are invasive and review concepts from the last lesson on invasive plants and their negative impacts on the environment.
4. Ask students how native plants help to create healthy ecosystems. (Ask for a volunteer to record the ideas on a whiteboard or poster board (if available) while you facilitate discussion.) Add to the list students created by explaining the rest of the ways native plants help ecosystems. For example, native plants in the sagebrush ecosystem provide essential habitat for countless organisms, such as birds, insects, and reptiles. Incorporate important concepts into the discussion, such as natural selection, adaptation, biodiversity, and the interconnectedness of ecosystems. If available, use a visual aid such as *The Sagebrush Steppe* poster to help review the concepts.
5. Tell students they will be surveying the area to measure the current distribution of different types of plants. The method they will be using is called a transect line survey. Demonstrate the process of

collecting data, which can vary depending on available materials and the method used, but may include these steps:

- Form groups of 3 – 4 students and pass out the “Transect Survey Data” sheet (found after this lesson) to each group with a clipboard.
 - Groups mark the spot of the first survey point and unroll a measuring tape or marked string to a distance of 10 meters or more. (Thirty meters is another common distance to measure, which is why there are that many spaces on the data sheet, but they do not all need to be used).
 - Groups use the data sheet to record what is found along the line, starting with the first survey point and continuing at each meter mark (or another interval, such a foot or 3 steps).
 - Percentages of each type of vegetation or ground cover are calculated by adding up the number of times each was counted, divided by the total number of data collection points. For example, if invasive grass was recorded at 10 out of 20 data collection points, the percentage recorded for that category would be 50%.
 - A similar method that does not involve measuring tape is demonstrated here: <https://www.youtube.com/watch?v=OUahqcpxaZg>
6. After students have completed the surveys and calculated the percentages, come together as a class to share the findings. Which type of plants or ground cover were the most common? Least common? What factors might have contributed to the conditions at the site? If invasive species were found, what can students do to help restore the native ecosystem?
7. *Optional:* If students will be planting native species:
- Show students one of each species they will be planting that day and explain what each is and some characteristics to remember it. You can share ethnobotany facts about the species, as well. Many books and websites explain the traditional uses of the plants by Native Americans, such as *Ethnobotany of the Middle Rockies* by the BLM: <http://www.blm.gov/style/medialib/blm/wy/programs/pcp/docs.Par.29345.File.dat/EthnobotanyMiddleRockies.pdf>
 - Ask students to work with a partner to flag plants with flagging tape for future identification if requested by the restoration site partner. If there are an odd number of students, ask for a volunteer to work independently or form a group of three.
 - Demonstrate for students how they will work with a partner to properly prepare and plant the native plants. Techniques will vary based on environmental conditions, so consult with your restoration partner and/or other experts in the area.
 - Ask students to begin working. If plants were not placed ahead of time, ask students to space them appropriately depending on the species. Circulate among the student groups and ensure that all plants are planted properly.
 - Direct students to stop working 20 minutes before it is time to leave and clean up the site.
7. Ask for one or more volunteers to help pass out student journals and have students work on them for the remainder of the time on an assignment such as the following:
- Sit with your favorite plant from today. Draw it in DETAIL, explaining plant structures you see that we learned about today. If time allows, write a haiku or another type of poem about the plant; one idea is to illuminate one or more of its benefits for the environment. (This can be completed back in the classroom or for homework, if necessary.)
 - Alternative projects are listed in the Adaptations / Extensions section which follows.



Photo courtesy Drew Nash,
Times-News

8. Gather the students together and congratulate them on all they accomplished today. Close the lesson with two or three questions which remind them about some of the important concepts they learned, such as the important roles the specific plants you learned about play in the ecosystem and the structures which help them to survive, as well as how their transect line surveys will help document changes to the landscape over time.

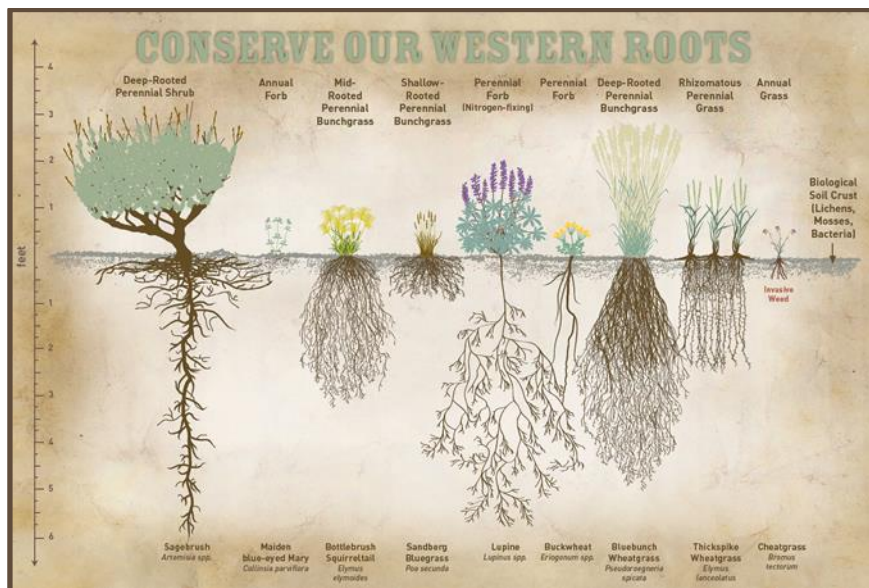
Adaptations / Extensions

1. Students can graph the percentages of each type of vegetation or ground cover calculated from the transect data. For example, pie charts and/or histograms can be drawn and labeled by hand or created with software such as Microsoft Excel or Google Docs.
2. Students can record the GPS coordinates of their transect line points. These can be used to record data at exactly the same points in the future and make it easier to compare changes over time. In addition to standalone GPS devices, smartphone apps are also available, such as “Record my GPS position,” a free app for iPad/iPhone, Android, and Windows phone.
3. Students can document the condition of the site using photographs and/or video. These can be used to show changes over time at the site. See the “Photo Point Monitoring” document in the Appendix for a detailed explanation of the process. A video explaining a similar process is found here: <https://www.youtube.com/watch?v=JdtAExrzJtY>
4. Ask students to save samples of the native plants. These can be preserved by pressing and drying to use when educating others about the project. A Plant Collection and Pressing Guide can be found on the Idaho Rangeland Resource Commission’s “Rangeland Plants” education webpage here: <http://idrange.org/LiteratureRetrieve.aspx?ID=143189>
5. Have students create plant descriptions to go with the pressed plants. Then they can either create a class field guide or display the pressed plants and descriptions somewhere in the school, such as the library, front office, or a prominent location in a hallway. Students love making real things for real audiences.
6. Compare the plant diversity in the school yard to that in a natural environment with native species. Use a transect line to compare both locations.
7. Collect seeds of native plants and have students experiment testing growth rates of different plant species under different conditions. Seeds can also be germinated in petri dishes and observed with microscopes or magnifying glasses.
8. Have students create journals prior to visiting the field. A Field Journaling lesson, including a description of one way to make a journal, can be found in the list of “Rangeland Plants” lessons on the Idaho Rangeland Resource Commission’s website: <https://idrange.org/education-2/lessons-and-activities>. Cornell’s BirdSleuth site also has excellent information on nature journaling: <http://www.birdsleuth.org/nature-journaling>.
9. Students can find the soil type at their school or home and then research the native plants that should be growing there. Here is a good website to gather data: <http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>
10. Prior to doing field work, have students watch one or more videos on how to conduct a transect such as:
 - This one produced by college students: <https://www.youtube.com/watch?v=OUahqcpxaZg>.
 - “Range Monitoring catches on with Idaho ranchers”: <https://www.youtube.com/watch?v=OYPeGZzgmUM>
 - Simple one-minute transect line video: <https://www.youtube.com/watch?v=wr-kegUQb4c>
 - How to set up a line transect—Plant Demography: <https://www.youtube.com/watch?v=TDe7eOVW8Gw>

11. Prior to or following the field work, have students research a specific native plant from the sagebrush ecosystem to learn more about its life cycle and its beneficial role in the ecosystem. Findings could be shared with the rest of the class through class presentations.
12. Arrange for students to visit your public library—either as a class or after school—to research specific native plants in your area.
13. Discuss pollination with the class. This is a very important concept everywhere, but especially in sagebrush ecosystem areas such as those in Idaho, Eastern Oregon, and Eastern Washington, because many native plants only have a single species of pollinators. This makes wildfire much more of an issue because when the native vegetation burns, the essential pollinators are lost, as well.
14. Discuss with students how sustainable grazing management can lead to vigorous native plants that are resilient to drought, weeds, etc. For example, moving livestock frequently can be highly beneficial.
15. Discuss "Species Groups" that are preferred by sage-grouse in order of life form and key palatable characteristics; e.g. yellow composites with milky sap or tender legumes versus coarse forbs like borage and mustards.

More Resources / References

- “Common Native Plants in the Sagebrush Ecosystem” and “Sage-Grouse / Pollinator Beneficial Plant Species” which follow lesson
- *FireWorks Encyclopedia for the Sagebrush Ecosystem*. BLM Idaho: <https://www.frames.gov/partner-sites/fireworks/curriculum/sagebrush-ecosystem>
- Conserve our Western Roots poster and postcard from the Sage Grouse Initiative: <https://www.sagegrouseinitiative.com/roots>



- *Sammy's Quest to Save the West*. BLM Junior Ranger: <https://www.blm.gov/documents/idaho/public-room/educational-material/junior-ranger-sammys-quest>
- Rangeland Plants education resources from the Idaho Rangeland Resource Commission: <http://idrange.org/education/lessons-and-activities/rangeland-plants>
- Restoring Native Plants video and teacher's guide from This American Land: <http://www.thisamericanland.org/lesson-plans/restoring-native-plants>
- *Backpack Guide to Idaho Range Plants*. The University of Idaho Rangeland Center and the Idaho Rangeland Resource Commission. <http://idrange.org/store/books/backpack-guide-to-idaho-range-plants>

- *Sagebrush Country: A Wildflower Sanctuary* by Ronald Taylor is another excellent field guide which contains excellent photos for easy plant ID. <http://www.amazon.com/Sagebrush-Country-A-Wildflower-Sanctuary/dp/0878422803>
- Highly rated apps for iPhone/iPad and Android include:
 - Audubon Wildflowers: <http://www.audubonguides.com/field-guides/wildflowers-north-america.html>
 - Idaho Wildflowers: <http://www.highcountryapps.com/IdahoWildflowers.aspx>
- Excellent lesson plans on invasive and native plants and more can be found on the *Return of the Natives* site, California State University Monterey Bay: <https://csumb.edu/ron/lesson-plans>
- USDA Plants database: <http://plants.usda.gov>
- Shultz, L. (2012). *Pocket Guide to Sagebrush*. PRBO Conservation Science. http://www.sagestep.org/pubs/pubs/sagebrush_pock_guide.pdf
- Native Plants Classroom Investigation Series from BLM: https://www.blm.gov/sites/blm.gov/files/uploads/IB2015-012_att1.pdf
- Native Plants Junior Explorer booklet for students in grades 4-6 (and younger) from BLM: https://www.blm.gov/sites/blm.gov/files/uploads/IB2015-045_att1.pdf
- Contact your local 4-H (<http://www.4-h.org>) for more resources related to your local area.
- Cramer, J. and Einerson, J. (2011). *From Salmonberry to Sagebrush: Exploring Oregon's Native Plants*. Corvallis, OR: Institute for Applied Ecology. You can download the complete 300+ page book here: <http://appliedeco.org/wp-content/uploads/Oregon-Botany-Curriculum-Salmonberry-to-Sagebrush.pdf>
- Montana Sagebrush Guide from Montana Dept. of Fish, Wildlife & Parks (black & white): http://sagemap.wr.usgs.gov/docs/MT_Sagebrush_Guide.pdf
- If you will be doing environmental service work, these additional resources may also be helpful:
 - An inspiring short video showing inmates planting the sagebrush that they grew with the Institute for Applied Ecology: <http://youtu.be/zSu28gsltpQ>
 - "Great Basin Native Plant Selection and Increase Project" presentation: http://www.fs.fed.us/rm/boise/research/shrub/projects/PowerPoint_Presentations/2012/Shaw.pdf



Photo courtesy Tetona Dunlap, Times-News

Names: _____ Date: _____ Location: _____

Transect Survey Data

1. Record the code of the ground cover type for the locations along the line in the bottom table.
2. Calculate the percentages for each cover type, below.

Categories

Use this coding system to record your data in the bottom table.

Vegetation / Ground Cover	Code	Ratio of # of Data Points to Total # of Points	Fraction Equivalent	Decimal Equivalent	Percentage Cover
Shrub	S				%
Native Perennial Grass	PG				%
Invasive Grass	IG				%
Perennial Forb	PF				%
Annual Forb	AF				%
Tree	T				%
Humus / Organic Litter	L				%
Rock / Gravel	R				%
Bare Ground	BG				%
Total (should add up to 100%)					%

Transect Data Collection

What is found at each interval along the line?

Transect Line Marks	Code	Transect Line Marks	Code	Transect Line Marks	Code	Transect Line Marks	Code	Transect Line Marks	Code
1 _____ (meter, foot, etc.)		7		13		19		25	
2		8		14		20		26	
3		9		15		21		27	
3		10		16		22		28	
5		11		17		23		29	
6		12		18		24		30	

Common Native Plants in the Sagebrush Ecosystem

Photos by Sarah Kulpa, U.S.FWS botanist, unless otherwise noted

SHRUBS

Basin Big Sagebrush

(*Artemisia tridentata* subsp. *tridentata*)



Leaves and Flowers

Wikimedia Commons

Key Characteristics

- Member of sunflower family (Asteraceae)
- Grows 5–7 feet (1.5–2.1 m) tall; tallest of big sagebrush varieties
- Found on deep, well-drained soils in cool air valleys
- Crowns are irregular and rounded
- Leaves are gray-green, narrowly wedge shaped, and 3-lobed
- Flowers are tiny and occur in dense clusters called heads; each head contains 3–7 florets or smaller flowers
- Blooms from late summer to late fall
- Strongly aromatic and does not re-sprout after fire

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_artrw8.pdf

Sagebrush Pocket Guide:

http://www.sagestep.org/pubs/pubs/sagebrush_pock_guide.pdf

Mountain Big Sagebrush

(*Artemisia tridentata* subsp. *vaseyana*)



Wikimedia Commons

Key Characteristics:

- Member of sunflower family (Asteraceae)
- Grows 2–4 feet (0.6–1.2 m) tall
- Grows at mid to high elevations, typically on mountain slopes
- Crowns are flat-topped with flowering stalks that rise above the crown in elongated spikes (sometimes called the “cake and candles” look)
- Leaves are gray-green, broadly wedge shaped, and 3-lobed
- Flowers are tiny and occur in dense clusters called heads; each head contains 3–9 florets or smaller flowers
- Blooms from late summer to late fall
- Strongly aromatic and does not re-sprout after fire

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_artrw8.pdf

Sagebrush Pocket Guide:

http://www.sagestep.org/pubs/pubs/sagebrush_pock_guide.pdf

Wyoming Big Sagebrush

(*Artemisia tridentata* subsp.
wyomingensis)



Key Characteristics

- Member of sunflower family (Asteraceae)
- Grows 2–4 feet (0.6–1.2 m) tall
- Grows on harsh, dry sites at lower elevations in valleys up to mountain slopes
- Crowns are unevenly rounded
- Leaves are gray-green, narrowly to broadly wedge shaped, and 3-lobed
- Leaves look similar to mountain big sagebrush except the middle lobe of the 3-lobe is slightly extended and offset from the neighboring lobes
- Flowers are tiny and occur in dense clusters called heads; each head contains 4–8 florets or smaller flowers
- Flowering stalks are short and remain on the plant for years giving it a characteristic “twiggy” or “shaggy” appearance
- Blooms from late summer to late fall
- Strongly aromatic and does not re-sprout after fire

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_artrw8.pdf

Sagebrush Pocket Guide:

http://www.sagestep.org/pubs/pubs/sagebrush_pock_guide.pdf

Antelope Bitterbrush

(*Purshia tridentata*)



Key Characteristics

- Member of the rose family (Rosaceae)
- Grows 1–10 feet (0.3–3 m) tall depending on where it is growing
- Leaves are clustered on short branches and are thick, dark green, have cobwebby hairs, and are 3-lobed
- Flowers have 5 yellow spoon-shaped petals, numerous stamens, and greenish centers
- Seeds are spindle-shaped with a tapering beak and shatter at maturity
- Blooms in the spring
- Important browse plant for wildlife

More Info.

USDA Plant Guide: http://plants.usda.gov/factsheet/pdf/fs_putr2.pdf

Mockorange

(*Philadelphus lewisii*)



Wikimedia Commons

There are at least 8 varieties of mockorange; other common names include syringa.

Key Characteristics

- Member of the hydrangea family (Hydrangeaceae)
- Grows 4–12 feet (1.2–3.7 m) tall and 3–9 feet (0.9–2.7 m) wide
- Leaves are oblong to broadly lance-shaped, opposite, and 1–3 in (2.5–7.5 cm) long
- Flowers are white with 4 petals and a bright yellow center
- Very fragrant and smells like orange blossoms
- Blooms from May to July

More Info.

USDA Plant Guide: http://plants.usda.gov/factsheet/pdf/fs_phle4.pdf

Woods' Rose

(*Rosa woodsii*)



Photo by Robert Sivinski, CalPhotos

Other common names include: wild rose and mountain rose.

Key Characteristics

- Member of the rose family (Rosaceae)
- Grows 2–10 feet (0.6–3 m) tall
- Forms loose or dense thickets
- Stems are straight, red to gray-brown, and are typically thorned
- Leaves form groups of 5–9 leaflets that are grouped to resemble a feather; leaflet leaves are oval shaped and have toothed margins
- Flowers are pink to rose with 5 petals and numerous stamens
- Fruits are dark red and called “rose hips”
- Blooms May to July

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_rowo.pdf

Yellow Rabbitbrush

(*Chrysothamnus viscidiflorus*)



There are 5 varieties of yellow rabbitbrush.

Key Characteristics

- Member of the sunflower family (Asteraceae)
- Grows 1–3 feet (0.3–0.9 m) tall
- Stems are pale green to gray and can have glands or hairs, depending on the variety
- Leaves are green and narrow, often appearing twisted
- Small, yellow flowers are in flat-topped clusters called heads
- Blooms late summer to late fall

More Info.

USDA Plant Guide:

http://plants.usda.gov/plantguide/pdf/pg_chvi8.pdf

Winterfat

(*Krascheninnikovia lanata*)



Key Characteristics:

- Member of the goosefoot family (Chenopodiaceae)
- Grows 1–2 feet (0.3–0.6 m) tall
- Stems are gray to reddish brown and covered in hairs
- Leaves are green, hairy, and narrow, alternating along the stem
- Male flowers have protruding stamens and are clustered at the top of stems; female flowers are in clusters in leaf axils below
- Bracts under male and female flowers have tufts of hair, giving the flowers a cotton ball appearance
- Blooms in the spring

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_krla2.pdf

USDA Forest Service Fire Effects Information System (FEIS):

<http://www.fs.fed.us/database/feis/plants/shrub/kralan/all.html>

PERENNIAL BUNCHGRASSES

Bluebunch Wheatgrass

(*Pseudoroegneria spicata*)



Howard F. Schwartz, Colorado State University

Key Characteristics

- Member of the grass family (Poaceae)
- Grows 1–4 feet (0.3–1.2 m) tall
- Leaves are green to blue in color and are usually smooth on the back, but have short, fine hairs on the front
- Flowers are arranged in spikes that are 3–8 in (8–20 cm) long
- Spikelets do not overlap and contain 4–8 florets or small flowers
- Awns are up to 0.75 in (1.9 cm) long and spread at maturity. However, this species can also be awnless.
- Blooms from June to August

More Info.

USDA Plant Guide: http://plants.usda.gov/factsheet/pdf/fs_pssp6.pdf

Utah State University:

<http://extension.usu.edu/rangeplants/htm/bluebunch-wheatgrass>

Idaho Fescue

(*Festuca idahoensis*)



Matt Lavin, Wikimedia Commons

Key Characteristics

- Member of the grass family (Poaceae)
- Grows 1–3 feet (0.3–0.9 m) tall
- Leaves are narrow, stiff, and usually bluish green to green in color
- Flowers are arranged in panicles that are 4–7 in (10–18 cm) long
- Spikelets are somewhat flattened and contain 4–7 florets or small flowers
- Awns are short, only up to 0.18 in (0.5 cm) long
- Blooms from June to July

More Info.

USDA Plant Guide:

http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmspg04835.pdf

Utah State University:

<http://extension.usu.edu/rangeplants/htm/idaho-fescue>

Indian Ricegrass

(*Achnatherum hymenoides*)



Dan Ogle, USDA-NRCS

Key Characteristics

- Member of the grass family (Poaceae)
- Grows 1–2.5 feet (0.3–0.7 m) tall
- Leaves are narrow and usually tightly rolled; giving the plant a somewhat wiry appearance
- Flowers are arranged in loose panicles with spreading, hair-like branches
- Spikelets are solitary and contain 1 floret or small flower
- Seeds are black or brown, round, and covered with short, dense, white hairs
- Blooms from April to July

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_achy.pdf

Utah State University: <http://extension.usu.edu/rangeplants/htm/indian-ricegrass>

Needle-and-Thread

(*Hesperostipa comata*)



Robert Sivinski, CalPhotos

Key Characteristics

- Member of the grass family (Poaceae)
- Grows 1–2 feet (0.3–0.6 m) tall
- Leaves are narrow, prominently veined, taper to a point, and 3–12 in (8–30 cm) long
- Flowers are arranged in loose, spreading panicles that are 4–8 in (10–20 cm) long
- Spikelets are solitary and contain 1 floret or small flower
- Awns are 4–5 in (10–13 cm) long and hygroscopic (winds up and unwinds as it becomes wet or dry as a means of seeding itself into the ground)
- Seeds have a sharp attachment point that is the “needle” to the awns’ “thread”
- Blooms from May to July

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_heco26.pdf

Utah State University: <http://extension.usu.edu/rangeplants/htm/needle-and-thread>

Sandberg Bluegrass

(*Poa secunda*)



Sheri Hagwood, BLM

Key Characteristics

- Member of the grass family (Poaceae)
- Grows up to 12 inches (30 cm) tall
- Numerous basal leaves that are 1–3 in (2.5–8 cm) long with boat-shaped tips
- Flowers are arranged in narrow panicles that are up to 4 in (10 cm) long
- Spikelets are purplish before maturity and contain 2–4 florets or small flowers
- Blooms from April to June

More Info.

USDA Plant Guide: http://plants.usda.gov/factsheet/pdf/fs_pose.pdf

Utah State University:

<http://extension.usu.edu/rangeplants/htm/sandberg-bluegrass>

Squirreltail

(*Elymus elymoides*)



Key Characteristics

- Member of the grass family (Poaceae)
- Grows 4–20 in (10–51 cm) tall
- Leaves narrow with raised veins above and visible midrib below
- Flowers are arranged in a dense, bristly spike that is 1–3 in (2.5–8 cm) long
- Two fertile spikelets per attachment point with 2 to a few florets or small flowers per spikelet
- Seed heads appear twisted with awns that look like a squirrel's tail and disarticulates at maturity
- Blooms from April to June

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_elel5.pdf

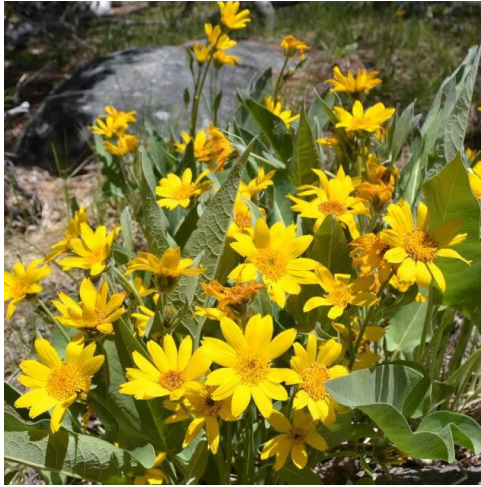
Utah State University:

<http://extension.usu.edu/rangeplants/htm/bottlebrush-squirreltail>

FORBS—PERRENIAL

Arrowleaf Balsamroot

(Balsamorhiza sagittata)



Key Characteristics

- Member of sunflower family (Asteraceae)
- Grows 1–2 feet (0.3–0.6 m) tall
- Shiny, bright green, arrow-shaped leaves 2–18 in (5–45 cm) long
- Yellow flowers are composed of solitary heads (disk flower) with 8–25 overlapping ray flowers
- Blooms from May to August

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_basa3.pdf

Plant of the Week, U.S. Forest Service:

http://www.fs.fed.us/wildflowers/plant-of-the-week/balsamorhiza_sagittata.shtml

Gooseberry-Leaf Globemallow

(Sphaeralcea grossulariifolia)



Clint Shock, Malheur Experiment Station, Oregon State

Key Characteristics

- Member of mallow family (Malvaceae)
- Grows 14–30 in (35–75 cm) tall
- Stem and leaves covered with dense, fine grayish white hairs
- Leaves are deeply 3-lobed, with each lobe again lobed or divided
- Flowers are orange, bowl shaped, and have 5 petals
- Flowers close at night, but open again with the morning sun
- Blooms from May to September

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_spgr2.pdf

Hooker's Balsamroot

(*Balsamorhiza hookeri*)



©2015 Richard Spellenberg, CalPhotos

Key Characteristics

- Member of sunflower family (Asteraceae)
- Grows up to 1.5 feet (46 cm) tall
- Stems are leafless and covered in dense, woolly white hairs
- Leaves are pinnately divided into segments like a feather and 4– 6 in (10–40 cm) long
- Yellow flowers are composed of solitary heads (disk flower) with 10–21 ray flowers that are fringed at the tips
- Blooms from April to July

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_baho.pdf

Indian Paintbrush

(*Castilleja chromosa*)



Key Characteristics

- Member of the broomrape family (Orobanchaceae)
- Grows 6–18 in (15–46 cm) tall
- Hemiparasitic, meaning if paintbrush roots encounter the roots of other plants they will attach to these roots for water or nutrients
- Leaves are below the bracts, linear, and have 3–5 narrow lobes
- The red parts (sometimes orange or yellow) are bracts, not flowers. The bracts attach below the flower and nearly hide the narrow, tubular, greenish-yellow flowers.
- Blooms May to August

More Info.

Jepson eFlora:

http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=18160

Colorado plant database:

<http://jeffco.us/coopext/plantdetail.do?sna=Castilleja%20chromosa&image=0>

Wikipedia article:

<https://en.wikipedia.org/wiki/Castilleja>

Oregon Sunshine

(*Eriophyllum lanatum*)



Ben Legler, University of Washington Burke Herbarium

Other common names include wooly sunflower and golden yarrow.

Key Characteristics

- Member of sunflower family (Asteraceae)
- Grows 4–24 in (5–45 cm) tall
- Stem and leaves are covered with white, wooly hairs
- Leaves are linear, sometimes pinnately divided to resemble a feather, and are 0.5–3 in long
- Yellow flowers are composed of solitary heads (disk flower) with 8–13 ray flowers that are sharply toothed at the tip
- Blooms May to July

More Info.

USDA Plant Guide: http://plants.usda.gov/factsheet/pdf/fs_erla6.pdf

Wikipedia article: https://en.wikipedia.org/wiki/Eriophyllum_lanatum

Royal (Showy) Penstemon

(*Penstemon speciosus*)



Derek Tilley, USDA NRCS Idaho PMC

Key Characteristics

- Member of the plantain family (Plantaginaceae)
- Grows 1–2 feet (12–24 in) tall
- Leaves gray-green, lance shaped, and sometimes folded lengthwise
- Flowers are 1-1.75 in (2.5–4.4 cm) long, among the largest in all of the penstemons
- Flowers grow in showy, purple-bluish clusters, are tube shaped, and 2-lipped with 5 lobes
- Blooms May to July

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_pesps.pdf

Scarlet Globemallow

(*Sphaeralcea coccinea*)



Jim Pisarowicz, National Park Service

Key Characteristics

- Member of mallow family (Malvaceae)
- Grows 4–16 in (10–40 cm) tall
- Entire plant is covered in stellate or star-shaped hairs
- Leaves are palmately lobed or divided from a common point like the fingers of the hand and are 1–3 in (4–6.5 cm) long
- Flowers are deep orange or reddish and have 5 petals
- Blooms from May to July

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_spc0.pdf

Sulphur-Flower Buckwheat

(*Eriogonum umbellatum*)



A. Young-Mathews, California Plant Materials Center

There are 30 subspecies of sulphur-flower buckwheat.

Key Characteristics

- Member of buckwheat family (Polygonaceae)
- Grows 4–24 in (10–61 cm) tall and forms low, spreading mats
- Leaves are mostly basal, oval, and olive-green colored with whitish hairs on the underside
- Bright yellow flowers form large umbel-like or head-like clusters at the tips of leafless stems
- Flowers become reddish or cream with age
- Blooms from May to September

More Info.

USDA Plant Guide: http://plants.usda.gov/factsheet/pdf/fs_erum.pdf

Taper-tip Hawksbeard

(*Crepis acuminata*)



Clint Shock, Malheur Experiment Station,
Oregon State University

Other common names include western hawksbeard, longleaf hawksbeard, and mountain hawksbeard.

Key Characteristics

- Member of sunflower family (Asteraceae)
- Grows 10–33 in (25–84 cm) tall
- Many branched stems with milky sap
- Leaves are mostly basal, 4–16 in (10–40 cm) long, and pinnately lobed with the edges having teeth
- Numerous yellow flowers are composed of solitary heads (disk flower) with 5–10 ray flowers
- Blooms May to August

More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_crac2.pdf

Yarrow

(*Achillea millefolium*)



Curtis Clark, Wikimedia Commons

Key Characteristics

- Member of the sunflower family (Asteraceae)
- One of the most abundant wildflowers in West
- Grows up to 2 feet (61 cm) tall
- Stem and leaves have white, wooly hairs
- Leaves are narrow, fernlike, and finely-divided
- White flower heads (disk flowers) are small and grouped together to form large, flat-topped clusters. Each flower head has 3–8 small, round ray flowers that are beige or brownish.
- Blooms from May to September



More Info.

USDA Plant Guide: http://plants.usda.gov/plantguide/pdf/pg_acmio.pdf

Wikipedia article: https://en.wikipedia.org/wiki/Achillea_millefolium

FORBS—ANNUAL

Blue-eyed Mary

(*Collinsia parviflora*)



Walter Siegmund, Wikimedia Commons

Key Characteristics

- Member of the plantain family (Plantaginaceae)
- Grows 1-6 in (3-15 cm) tall
- Spindly reddish stems
- Green leaves are narrow and pointed.
- Each flower has five lobes. The two upper petals are white (sometimes blue tipped) and the lower two are mostly blue (white at the base). There is a third lower, blue petal but it is followed into a narrow keel or boat shape and hidden between the other two petals.
- Blooms March to July

More Info.

Burke Museum of Natural History and Culture:

<http://biology.burke.washington.edu/herbarium/imagecollection.php?SciName=Collinsia%20parviflora>

Annual Phlox

(*Microsteris gracilis*)



Walter Siegmund, Wikimedia Commons

Key Characteristics

- Member of the phlox family (Polemoniaceae)
- Grows 2–12 in (5–30 cm) tall
- Stem typically branches and is sticky-hairy
- Leaves are narrow; lower leaves are opposite and upper leaves are alternate
- Flowers are typically in pairs at the tips of stems and branches
- Each tiny flower is composed of a fused tube that is white or yellowish, with 5 pink petal lobes that are notched at the tips, creating a heart shape.
- Blooms from March to July

More Info.

Burke Museum of Natural History and Culture:

<http://biology.burke.washington.edu/herbarium/imagecollection.php?SciName=Microsteris%20gracilis>

Rough Eyelash

(*Blepharipappus scaber*)



Wikimedia Commons

Key Characteristics

- Member of the sunflower family (Asteraceae)
- Grows 4–12 in (10–30 cm) tall
- Rough, hairy stem with slender 1 in (2.5 cm) long leaves
- White flowers heads are composed of 6–25 tubular, disk flowers with 2–8 3-lobed ray flowers
- Anthers (pollen bearing portion of male reproductive structure) are black-purple with feathery, bristly pink-purple styles (narrow portion of the pistil connecting the style to the ovary)
- Blooms May to August

More Info.

Jepson eFlora:

http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=1761

TREES

Western Juniper

(Juniperus occidentalis)



Key Characteristics

- Member of the cypress family (Cupressaceae)
- Grows 13–32 ft (4–10 m) tall
- Mature bark is thin, less than 1 in (2.5 cm) thick and reddish-brown, but weathers to grayish brown with broad, shallow furrows and flattened ridges
- Needles are persistent and scale-like, arranged in whorls of 3; back sides of needles are glandular and resin dotted, very aromatic
- Male and female flowers are on different plants; male cones are small, yellow, and terminal while female cones are small, oval, and at the ends of branches
- Cones are small, about ¼ in diameter and round with smooth, leathery scales; green when young, and turning bluish black when mature
- Blooms May to June
- Can be invasive and problematic for sagebrush ecosystems

More Info.

Kalmiopsis article by Ron Halvorson:

<http://www.npsoregon.org/kalmiopsis/kalmiopsis20/kalm20halvorson.pdf>

Virginia Tech:

<http://dendro.cnre.vt.edu/dendrology/syllabus/factsheet.cfm?ID=419>

Sage-Grouse / Pollinator Beneficial Plant Species

Developed by Roger Rosentreter, Ph.D., Ann DeBolt, and Anne Halford; Used by Permission

KEY

S = Beneficial for Sage-Grouse

P = Beneficial for Pollinators

*** = best for sage-grouse**

Common Name	Scientific Name	Beneficial for
Shrubs		
Antelope bitterbrush	<i>Purshia tridentata</i>	P
Basin big sagebrush	<i>Artemisia tridentata tridentata</i>	S
Blue elderberry	<i>Sambucus nigra cerulea</i>	P
Chokecherry	<i>Prunus virginiana</i>	P
Douglas rabbitbrush	<i>Chrysothamnus viscidiflorus</i>	P
Early sagebrush	<i>Artemisia longiloba</i>	S*
Fringed sagebrush	<i>Artemisia frigida</i>	S*
Golden currant	<i>Ribes aureum</i>	P
Low sagebrush	<i>Artemisia arbuscula</i>	S*
Mountain big sagebrush	<i>Artemisia tridentata vaseyana</i>	S
Nootka rose	<i>Rosa nutkana</i>	P
Prairie sagebrush	<i>Artemisia ludoviciana</i>	S
Purple sage	<i>Salvia dorrii</i>	P
Rubber rabbitbrush	<i>Ericameria nauseosa</i>	P
Saskatoon serviceberry	<i>Amelanchier alnifolia</i>	P
Shrubby cinquefoil	<i>Potentilla fruticosa</i>	P
Skunkbush sumac	<i>Rhus trilobata</i>	P
Wax currant	<i>Ribes cereum</i>	P
Wood's rose	<i>Rosa woodsii</i>	P
Wyoming big sagebrush	<i>Artemisia tridentata wyomingensis</i>	S
Forbs		
American vetch	<i>Vicia americana</i>	S
Annual sunflower	<i>Helianthus annuus</i>	Both
Arrowleaf balsamroot	<i>Balsamorhiza sagittata</i>	Both
Aspen daisy	<i>Erigeron speciosus</i>	Both
Bigelow's tansyaster	<i>Machaeranthera bigelovii</i>	P
Bighead clover	<i>Trifolium macrocephalum</i>	Both
Bigseed biscuitroot	<i>Lomatium macrocarpum</i>	Both
Blanketflower	<i>Gaillardia aristata</i>	P
Bolander's yampah	<i>Perideridia bolanderi</i>	Both

Broadbeard penstemon	<i>Penstemon angustifolius</i>	P
Camas	<i>Camassia</i> spp.	Both
Canada milkvetch	<i>Astragalus canadensis</i>	Both
Carey's balsamroot	<i>Balsamorhiza careyana</i>	Both
Cous	<i>Lomatium cous</i>	Both
Douglas' dustymaiden	<i>Chaenactis douglasii</i>	Both
Fernleaf biscuitroot	<i>Lomatium dissectum</i>	Both*
Firecracker penstemon	<i>Penstemon eatonii</i>	P
Freckled milkvetch	<i>Astragalus lentigenosus</i>	Both*
Fuzzytongue penstemon	<i>Penstemon eriantherus</i>	P
Gairdner's yampah	<i>Perideridia gairdneri</i>	Both
Gooseberry-leaf globemallow	<i>Sphaeralcea grossularifolia</i>	Both
Heartleaf arnica	<i>Arnica cordifolia</i>	S
Hoary tansyaster	<i>Machaeranthera canescens</i>	P
Hooker's balsamroot	<i>Balsamorhiza hookeri</i>	Both*
Hotrock penstemon	<i>Penstemon deustus</i>	P
Lowbush penstemon	<i>Penstemon fruticosus</i>	P
Mountain dandelion	<i>Agoseris glauca</i>	S*
Mule ears	<i>Wyethia amplexicaulis</i>	P
Munro globemallow	<i>Sphaeralcea munroana</i>	Both*
Naked-stem biscuitroot	<i>Lomatium nudicaule</i>	Both
Nineleaf biscuitroot	<i>Lomatium triternatum</i>	Both
Nodding microseris	<i>Microseris nutans</i>	Both*
Pacific aster	<i>Aster chilensis</i>	Both
Palmer penstemon	<i>Penstemon palmeri</i>	P
Purple prairie clover	<i>Dalea purpurea</i>	P
Rocky Mountain beeplant	<i>Cleome serrulata</i>	P
Rocky Mountain penstemon	<i>Penstemon strictus</i>	P
Sagebrush false dandelion	<i>Nothocalais troximoides</i> (<i>Microseris troximoides</i>)	Both*
Scarlet gilia	<i>Ipomopsis aggregata</i>	P
Scarlet globemallow	<i>Sphaeralcea coccinea</i>	Both
Shaggy fleabane	<i>Erigeron pumilus</i>	Both
Showy goldeneye	<i>Heliomeris multiflora</i>	Both
Showy milkweed	<i>Asclepias speciosa</i>	P
Sierra pea	<i>Lathyrus nevadensis</i>	S
Silky lupine	<i>Lupinus sericeus</i>	P
Silky phacelia	<i>Phacelia hastata</i>	P
Silverleaf lupine	<i>Lupinus argenteus</i>	P
Slender hawksbeard	<i>Crepis atribarba</i>	Both*
Smoothstem blazingstar	<i>Mentzelia laevicaulis</i>	S*
Sulfur buckwheat	<i>Eriogonum umbellatum</i>	P
Tailcup lupine	<i>Lupinus caudatus</i>	P
Tansyleaf tansyaster	<i>Machaeranthera tanacetifolia</i>	P
Tapertip hawksbeard	<i>Crepis acuminata</i>	Both*
Taper-tip onion	<i>Allium acuminatum</i>	P

Timber milkvetch	<i>Astragalus miser</i>	Both
Utah sweetvetch	<i>Hedysarum boreale</i>	Both*
Wasatch penstemon	<i>Penstemon cyananthus</i>	P
Western aster	<i>Aster occidentalis</i>	Both
Western coneflower	<i>Rudbeckia occidentalis</i>	P
Western hawksbeard	<i>Crepis occidentalis</i>	Both*
Western yarrow	<i>Achillea millifolium occidentalis</i>	P
White evening primrose	<i>Oenothera pallida</i>	P
Whitestem blazingstar	<i>Mentzelia albicaulis</i>	S*
Wild bergamot	<i>Monarda fistulosa</i>	P
Wild geranium	<i>Geranium viscosissimum</i>	S
Wooly mule ears	<i>Wyethia mollis</i>	P
Wyeth buckwheat	<i>Eriogonum heracleoides</i>	P
Yellow beeplant	<i>Cleome lutea</i>	P

Non-Native Forbs which Sage-Grouse Use

Alfalfa	<i>Medicago spp.</i>	S
Bird foot trefoil	<i>Lotus corniculatus</i>	S
Clover species	<i>Trifolium spp.</i>	S
Dandelion	<i>Taraxacum officinale</i>	S
Salsify species	<i>Tragopogon spp.</i>	S
Small burnet	<i>Sanguisorba minor</i>	S
Sow thistle	<i>Sonchus arvensis</i>	S
Suckling clover	<i>Trifolium dubium</i>	S



Fire! Impacts on the Sagebrush Ecosystem and Human Communities

Lesson Overview

Students first participate in a demonstration of fire science and the concept of the fire triangle. They learn additional concepts through a short PowerPoint presentation and/or video(s), and apply what they have learned by working together to design a fire adapted community. Plans and group-created dioramas are presented to the class, and lesson adaptations / extensions are listed at the end of the lesson.

Lesson Goals

Students will understand how wildfires start and spread, and their impacts on the sagebrush ecosystem and human communities. They will also demonstrate understanding of ways to reduce fire risk.



Subject Areas Science, Social Studies, Language Arts, and Art

Grade Level 4 – 12 (Ages 9 – 18)

Time Two 50 – 60-minute class periods (or one long block of 90 minutes or more)

Objectives

- Students will demonstrate how fires start and spread in natural areas and human communities by planning a fire adapted community and safer area for wildlife.
- Students will demonstrate the potential impacts of wildfires on both the sagebrush ecosystem and human communities.
- Students will demonstrate their understanding of fire and fire prevention through models and class presentations.

Next Generation Science Standards

Crosscutting Concepts

- Stability and Change
- Systems and System Models

Science & Engineering Practices

- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

Core and Component Ideas in the Physical Sciences

PS1: Structures and Properties of Matter

- PS1.A: Structure and Properties of Matter
- PS1.B: Chemical Reactions

Core and Component Ideas in Earth and Space Sciences

Core Idea ESS3: Earth and Human Activity

- ESS3.C: Human Impacts on Earth Systems

Common Core State Standards

College and Career Readiness Anchor Standards for Reading:

Standard 7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words

Speaking and Listening Standards for Grade 6 (similar standards for grades 4, 5, 7 and 8)

Standard 4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

Standard 6. Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

College and Career Readiness Anchor Standards for Writing (if Adaptation / Extension #5 is completed)

Standard 6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Standard 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

1. Small birthday candle
2. Clear glass jar with lid
3. Modeling clay
4. Two additional jars with lids
5. Box of wooden matches
6. Rolled up piece of paper, the size of a wooden match
7. Stopwatch (or smartphone with that feature)
8. *Optional:* Short strands of dry cheatgrass
9. Spray bottle filled with water, fire extinguisher, and/or large container of water
10. Copies of the “Tragedy in Sageview” worksheet which follows the lesson for each student
11. Aluminum roasting pans for students to share in groups of 4
12. Modeling clay or Play-Doh and natural materials like dried vegetation and rocks for students to share
13. *Wildfire and the Sagebrush Ecosystem* PowerPoint presentation; available on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>
14. Computer with Microsoft PowerPoint software and Internet access
15. Display screen
16. *Optional:* One or more of the following articles for students to read and/or discuss:
 - “Born of Fire—Restoring Sagebrush Steppe.” USGS Forest and Rangeland Ecosystem Science Center: <http://fresc.usgs.gov/products/fs/fs-126-02.pdf>

- “Big Wildfires in the West: Why, How, What To Do?” Lily Whiteman, National Science Foundation. livescience. July 31, 2013: <http://www.livescience.com/38572-western-wildfires-causes-nsf-bts.html>
- “Science Connections: Western Wildfires & Climate Change.” Infographic. Union of Concerned Scientists: http://www.ucsusa.org/global_warming/science_and_impacts/impacts/infographic-wildfires-climate-change.html
- “Benefits of Fire.” USFWS: <http://www.fws.gov/fire/downloads/Benefits%20of%20Fire%20Case%20Studies.Feb06.pdf>
- Joyce, Christopher. “In Arid West, Cheatgrass Turns Fires Into Infernos.” NPR. Dec. 5, 2012. <http://www.npr.org/2012/12/05/166574589/in-arid-west-cheatgrass-turns-fires-into-infernos>
- Lester, Liza. “Sage grouse losing habitat to fire as endangered species decision looms” Ecological Society of America (ESA). Apr 3, 2014: <http://www.esa.org/esa/sage-grouse-losing-habitat-to-fire-as-endangered-species-decision-looms>
- Schimel, Kate. “The art – and science – of forecasting wildfires.” Mar. 13, 2015. *High Country News*. <http://www.hcn.org/articles/the-art-and-science-of-forecasting-wildfires>

Preparation

1. If possible, identify an expert partner to work with your class, such as a local firefighter or wildland firefighter from the BLM or USDA Forest Service. Recommendations and contact information for potential partners can be found on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>. There you can also find contacts who may be able to help with gathering the materials above.
2. Put the 3 jar lids face down on a table or counter which students will be able to gather around. Mount the small candle on one of them using a small amount of modeling clay.
3. Place a small amount of modeling clay on each of the other two lids. Stick a rolled up piece of paper in one which is about the size of the match. In the other, stick a few short strands of cheatgrass, if you have it, or a few thin strips of paper to simulate it.
4. Put the fire extinguisher or large container of water on or near the table just in case the fire demo spreads.
5. Ensure the computer and PowerPoint presentation are ready. You can also get ready to show one or more video clips such “The Sagebrush Community” by Idaho Fire Info: <https://www.youtube.com/watch?v=yIwbRdLrOX0>.

These videos from the National Interagency Fire Center are related to fire and sage-grouse:

- “Help This Habitat” (30 seconds): <https://youtu.be/0sc9IuKTo3I>
 - “Wildfires and Sage-grouse” (1:03): <https://youtu.be/WxybQRvmpEw>
 - “Standing Up for Sage-grouse” (2:29): https://youtu.be/hzG2G_2nkxw
 - “Ripples” (1:32): <https://youtu.be/eXC7wER6wBY>
 - “Ranchers hit hard by wildfires; How can we avoid them in the future?” —is another excellent video by Life on the Range, though it is longer (almost 14 minutes), so you could show just part of it, if desired: <https://www.youtube.com/watch?v=BqC6iWivE6U>
6. *Optional:* Watch the following additional videos for more background information in preparation for teaching the lesson:
 - “Creating Fire Adapted Communities: A Case Study from Colorado Springs and the Waldo Canyon Fire” from National Fire Protection Association: <https://youtu.be/4p9VYKog3qE>
 - “Colorado Wildfire Destroys 1 Million Acres” (2-minute news coverage): <https://youtu.be/CSB9pTurhi4>

- “Mountain Home ranchers form Rangeland Fire Protection Association” from Life on the Range: <https://www.youtube.com/watch?v=XutZSFwtY2c>
- “Restoring the Land after the Pony and Elk Wildfires in Idaho” from Life on the Range: <https://youtu.be/b5WVQXqI91g>

Teacher Instructions

1. Introduce the expert visitor if one is present. He or she (or you, if you are leading the lesson alone) can ask students one or more questions to get them thinking about what they know about fire, such as:
 - What does fire need to burn?
 - How do wildfires spread?
2. In the discussion about student ideas, it should be explained that there are 3 things fire needs to burn: **heat, oxygen, and fuel**. Write those 3 words on the board in the shape of a triangle and explain that these 3 elements are often called the **fire triangle**. Write that above the triangle to label it.
3. The visitor or you can do a brief demonstration with fire so students understand the fire triangle and the principles of physical science which explain it more fully. This is one possibility:
 - Gather students around a counter or table and put the lid with the mounted candle in the center of it.
 - Ask the students how they could quickly get enough heat to light the candle. One of them should suggest “strike a match.” Take a match box from your pocket and ask students why striking a match will work. *Optional:* For older or more advanced students, discuss how rubbing sulphur molecules in the match tip against the rough surface on the box which contains phosphorus molecules creates a chemical reaction which releases energy in the form of heat which lights the match.
 - Ask students: “What can create enough heat in nature to cause wildfires?” Briefly discuss how **lightning** is the most common cause, but that humans also cause many wildfires. *Optional:* For older or more advanced students and if time allows, discuss how lightning is a sudden movement of electrons between a cloud and the ground—or between clouds—which can reach temperatures of over 50,000 degrees Fahrenheit (almost 30,000 degrees Celsius). This is much hotter than the surface of the Sun, and it causes the air molecules to expand rapidly and bang into each other, making the loud crack and rumblings we know as thunder.
 - Strike the match and light the candle. Explain how the heat has caused the candle to burn, but ask students what else is letting the flame continue burning. They should answer **oxygen** from the air and **fuel** from the wax and wick in the candle.
 - Show students the jar, and ask them to predict what will happen when you screw it onto the lid—and why. One of them should suggest that the flame will burn for a short time before the oxygen is all used up and the flame goes out.
 - Screw the jar onto the lid, but just as the flame starts to go out, unscrew the jar to let in more air (and confirm the student hypothesis). Explain that wind can have this same effect on fire: even if a wildfire is almost extinguished—sometimes with no visible flames, just coals—strong winds can cause it to reignite and spread quickly. Any fire can be greatly intensified and grow out of control if there are strong winds.
 - Ask students to predict what will happen when all of the fuel—the wax and wick—are used up. Tell students that you will let the candle burn all the way down to test the student hypotheses.
 - Direct students’ attention to the lids with the match, rolled up paper, and cheatgrass (or strands of paper) standing up. Ask students to predict which would catch fire and burn most quickly and discuss student ideas about why they hold those hypotheses.

- Ask for one or more student volunteers to use the stopwatch(es) to record the time it takes for each of the 3 fuels to burn from the moment a lit match is placed next to them. Hand the stopwatch(es) to the student(s) and ensure they know how to start and stop them.

Ask the student(s) doing the timing to get ready, then strike a match and put it near the bottom of the cheatgrass (or paper strips). When the grass or paper is completely burned, say “time!” to ensure the student(s) timing stop their watch(es), then screw the jar to the lid to contain any residual smoke and extinguish any remaining embers. Ask for a student volunteer to write “Cheatgrass” (or Paper Strips) on the board and record the time(s) under the label. Repeat this process with the rolled paper and match until a complete table is listed on the board.

- *Optional:* Use water to extinguish the burning match—or another one—before it burns all the way down. Explain that water drastically reduces both heat and oxygen, which extinguishes the flame.
- Discuss the findings as they relate to the flammability of different fuel types; dry grasses, especially cheatgrass, can catch fire most quickly because they are so thin and contain so little moisture, which lets them heat up very fast and allows oxygen to get to all parts of the plant in an instant. From there the fire can spread to other vegetation like sagebrush, just like a campfire can be started with dry paper or thin kindling before it spreads to larger sticks and logs. Fast-moving fires put both wildlife and human communities at risk.

4. Show and discuss the visuals with notes in the PowerPoint presentation to enhance student understanding of wildfires and the importance of the topic, such as:

- How fire travels more quickly up slopes and if there are no firebreaks.
- Positive, as well as negative, effects of wildfires.
- How we can make better fire adapted communities which are safer from fire.

Stop the presentation before you reach the “Fire Scenario” slide.

5. *Optional:* Direct the students to take their seats and present one or more video clips about fire, such as those listed above.
6. Advance to the “Fire Scenario” slide of the PowerPoint presentation. Explain to students that they will be working with their group to plan a fire adapted community and safer area for wildlife. Tell students that they will read about a town impacted by fire and problem solve ways the damage could have been reduced. Their group will then create a labeled diorama or other visual which demonstrates their plan and present it to the class.
7. Break the students into groups of 4 and pass out the “Tragedy in Sageview” worksheet which follows this lesson to each student. Ask the groups to read the scenario out loud to each other so they are prepared to address the challenge before they start working on a plan. Tell students where the roasting pans and other materials are located so their groups can pick them up after they have read through the complete worksheet and begun working on their plans.

You and/or the expert visitor (if present) can circulate among the groups, answering questions and providing more information, as necessary.

Five minutes before the end of class, tell students they have a few more minutes to work and they should start cleaning up soon. Tell students they will be presenting their plans at the end of the next class.

8. During the next class, review with students some key concepts of fire and fire prevention before they begin working. Tell them how much time they have to complete their dioramas and plans, and then allow them to begin working.
9. Have each group present their plans and models, led by the students that each group elected mayor.
10. Close with a class discussion of the ways we can help prevent the spread of wildfires and the negative impacts on human communities and wildlife.

Adaptations / Extensions

1. Have students create matchstick fire simulations and ignite them outside on blacktop. One version of a handout you could use with your students—"Fire Ecology Modeling"—is found at the end of this lesson. It is adapted with permission from one created by Micah Lauer from Heritage Middle School in Meridian, ID. Complete teacher instructions are provided in the "Fire Ecology on the Rim" curriculum from the National Park Service (NPS) which inspired Micah's project. The curriculum is found here: <http://www.nps.gov/grca/learn/education/upload/Fire-Ecology-on-the-Rim-2010-5.pdf>.
2. Consider preparing students to test their dioramas (and plans) with real fire after they present them to the class. If you decide to do this:
 - Have students take the finished dioramas outside to a large area of pavement on a day that isn't too windy.
 - Bring matches and a fire extinguisher or large container of water with you.
 - *Optional:* Add a little more dried vegetation to the dioramas, if necessary, to make them a little more realistic.
 - Gather the students around each project at a safe distance, one at a time, and use a match to start a fire in a corner of the diorama. Discuss the results of each trial with students. What worked well and what might have made the mock Sageviews even better fire adapted to minimize losses?
2. Pass out more fire information for students that they can use to help them create their plans. Options are listed at the end of the Materials section and in the More Resources / References section that follows. One to consider is the Fire Fact Sheet from the Idaho Rangeland Resource Commission: <https://idrange.org/wp-content/uploads/2018/02/Fire2bFact2bSheet.pdf>.
3. Have students create public service announcements or posters about ways to be fire safe. Alternatively, students could create visuals of the fire triangle which show the 3 things fire needs to burn: heat, oxygen, and fuel. Creating PSAs, posters, or other visuals helps students remember the concepts, especially if they are displayed around the classroom or in hallways. Other students in the school would also gain more understanding of fire, its dangers, and fire safety if student projects are displayed or presented publically.
4. Students can research statistics related to wildfires in your state and/or neighboring states or the U.S. as a whole. Data such as the number, sizes, and costs of the fires could be collected in tables and graphed on paper or with software such as Microsoft Excel, iWork, or InspireData to compare the fires and changes over time. Good sources for this data include the USDA Forest Service, state fire agencies, and the National Interagency Fire Center: <http://www.nifc.gov>.
5. Have each student choose an organism from the sagebrush ecosystem to research and learn more about how it is being impacted—or could be impacted—by wildfires and human activities. Provide a rubric so students know how they will be evaluated on the project, and findings could be shared with the rest of the class through written reports and/or oral presentations. A presentation rubric is available in the Appendix.
6. Do a fire simulation which teaches the effects of slope on fires. The "Matchstick Forest Demonstration" lesson from Idaho Rangeland Resource Commission explains how: <https://idrange.org/education-2/lessons-and-activities>. More activities are found in the FireWorks curriculum listed in the next section.

More Resources / References

- Part of this lesson plan was inspired by a Project Learning Tree lesson entitled “Living with Fire.” It is found in their *Pre-K-8 Environmental Education Activity Guide* (2013) on page 350. A simplified version and other resources can be found online: <https://www.plt.org/prek-8-activity-81--living-with-fire>.
- BLM Education:
 - *FireWorks Curriculum for the Sagebrush Ecosystem* and supporting resources. BLM Idaho: <https://www.frames.gov/partner-sites/fireworks/curriculum/sagebrush-ecosystem>
 - *Sammy’s Quest to Save the West from Wildfire*. BLM Idaho: <https://www.blm.gov/documents/idaho/public-room/educational-material/junior-ranger-sammys-quest>
 - More FireWorks resources: <https://www.frames.gov/partner-sites/fireworks/fireworks-home>
 - FireWorks Trunks are available for use in your classroom. Details can be found here: <http://www.firelab.org/project/fireworks-educational-program>
 - Exploring Wildland Fire Educator’s Guide: https://www.blm.gov/teachers/activities/documents/wildland_fire_primer.pdf
- Firewise Teaching Tools: <http://www.firewise.org/wildfire-preparedness/teaching-tools.aspx>
- Fire education resources from the Idaho Rangeland Resource Commission: <https://idrange.org/education-2/lessons-and-activities>
- *Fire-Adapted Communities: The Next Step in Wildfire Preparedness*. Oregon State University Extension Service: http://oregonstate.edu/dept/kbrec/sites/default/files/em9116_0.pdf
- Excellent book to explain fire science for grades 4-8: Cottrell, W. (2004). *The Book of Fire*. Mountain Press Publishing.
- Wildland Fire Map: <http://www.wildlandfire.com/wildfire-map/>
- “Fire In-Depth” site from the National Park Service: <http://www.nps.gov/applications/fire/wildland-fire/learning-center/fire-in-depth.cfm>
- Fire & Aviation Fire Reports: <http://www.fs.fed.us/news/fire/>. Daily fire reports from agencies such as the National Interagency Fire Center and U.S. Forest Service
- Fire Wars classroom activities from NOVA: http://www.pbs.org/wgbh/nova/education/activities/2908_fire.html#materials
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.

Tragedy in Sageview: Could You Prevent It?

Scenario

The once beautiful town of Sageview had a population of 5,000. There were also large ranches on the outskirts of town with thousands of livestock: cattle, sheep, and goats. It was surrounded by prime sagebrush habitat filled with native plants and wildlife—sage-grouse and about 350 other species. The large nearby wilderness area was especially popular with backpackers. There were also patches of cheatgrass that had invaded the area over the past 20 years, making the area more susceptible to wildland fire.

A young man was backpacking through the area one summer day and he needed to go to the bathroom. He couldn't wait for a latrine, so he went behind some large shrubs. Trying to "leave no trace" in the pristine area, he decided to burn his toilet paper and waste. Unfortunately, it was bone-dry and scorching hot, with gusty winds; the fire spread through a dry patch of invasive cheatgrass and burned through the sagebrush with incredible speed. The man barely escaped and was badly burned. Countless wildlife lost their lives as the fire raced up the hillsides to nearby rangeland with little warning. Many livestock and entire ranches were lost, too.

Sageview was not prepared for the fast-moving wildfire, which surged across the rangeland to the neighborhoods bordering it at a terrifying rate. Fortunately, heroic wildland firefighters eventually stopped the fire's advance and most of the residents managed to escape, but many suffered effects from smoke inhalation and over 500 homes, 2 city parks, a school, and dozens of businesses were destroyed. Damage to the town was so severe, experts predict it will take many years to fully recover, if ever.



Your Challenge

Imagine you are a group of leaders: Sageview's mayor, fire chief, and representatives of agencies which fight wildland fires, such as the Bureau of Land Management (BLM) and U.S. Forest Service. Work with your group to:

1. Brainstorm possible ways that the tragedy could have been avoided or minimized. What could have been done to reduce the danger to Sageview's buildings, ranches, and natural areas? Record your ideas on paper.
2. Prioritize the order of what you would try to save first in this scenario: ranches and livestock, wildlife areas, parks, town buildings such as homes, schools, and businesses, etc.
3. Use a roasting pan and materials such as sticks, dried vegetation, clay, and rocks to create a diorama which demonstrates your ideas. Include areas representing buildings, ranches, etc.
4. Work together to write a 2 – 3-minute speech about your plan and how it could help in the event of fire. Elect a member of your group to be mayor and present your plan persuasively to the rest of the class.

Name: _____ Period: _____ Date: _____

Fire Ecology Modeling

Adapted with permission from a project by Micah Lauer based on the "Fire Ecology on the Rim" curriculum, National Park Service

Assignment

Your group will create a small-scale habitat to model wildfire.

Materials

- 96 matches, which will represent plants (your fuel load):
 - Native plants (match tip buried/down)
 - Non-native weeds (match tip exposed/up)
- 200 mL sand
- Small aluminum meatloaf tin or baking pan



Planning Questions

- How might the distribution of native and non-native plants influence fire activity?
- How could plant height affect fire?
- How might fire breaks influence fire activity?

Model Requirements

1. Incorporate at least two of the three following conditions/features:
 - Dense invasive weeds
 - Sparse native vegetation
 - Open space indicating a fire break (e.g. road, stream, etc.)

Choose at least two and list your choices below:

2. Describe the conditions (from question 1) that you chose to model. Why did you choose these conditions? How are they observed in the real world? What led you to make these decisions?

3. Map your fire model on the back of this paper. Include:
 - Symbols for all of your matchsticks
 - A Key to label the conditions/features of your model

Map of Fire Model



Key

4. What do you think will happen to your model? What **percentage** do you think will burn? What might not burn? Add this prediction to your model by shading with orange or red. Add a label to your key to explain.

5. Why could it make sense to construct a model with match tips up for non-native weeds and match tips buried for native plants?

6. Why does fire matter in ecosystems? Write a short summary paragraph in the space below and continue on a separate page, if necessary.

Fire Ecology Modeling Post-Activity Analysis

1. What was the ratio of native plants to weeds in your habitat?
2. What percentage of your habitat burned?
3. How did fire breaks impact the spread of fire?
4. How did native plants impact the spread of fire?
5. Did the outcome match your prediction for your fire model?
6. Why do you think things worked the way that they did?

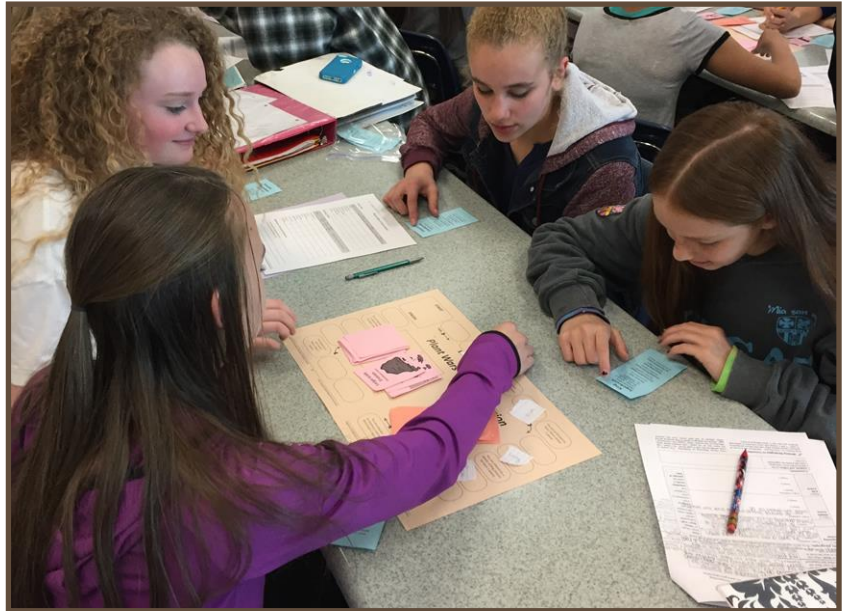


Succession in the Sagebrush Ecosystem

Lesson Overview

In this lesson, students are introduced to the concept of succession—plant community dynamics—through a short presentation and fun, educational game in which students play plant characters from the sagebrush ecosystem. As students play the game, they learn that the plants respond differently to disturbances. They also learn that plants interact with each other.

The game acts like a series of experiments, with students reporting on the results at different stages. Then they participate in a class discussion about what they have learned. To apply their new knowledge, students predict changes in the plant community and attempt to make the community change in specific ways. Adaptations / Extensions are listed at the end of the lesson.



*Students play "Plant Wars of Succession."
Photo courtesy Micah Lauer*

Lesson Goal

Students will understand how plant succession works and its importance for the diverse species in the sagebrush ecosystem.

Subject Areas Science, Language Arts

Grade Level 4 – 12 (Ages 9 – 18)

Time 50 – 60 minutes; longer if one or more Adaptations / Extensions are incorporated

Objectives

- Students will demonstrate their understanding of how disturbance events such as wildfires and overgrazing can quickly change plant communities such as those in the sagebrush ecosystem, and how the changes that come after the disturbances are known as succession.
- Through an interactive simulation, students will demonstrate their understanding of how plant communities are always interacting and changing.
- Students will explain how plant species respond differently to disturbances, which impacts the whole sagebrush ecosystem.
- Students will demonstrate an understanding of the importance of sustainable sagebrush ecosystem management.

Next Generation Science Standards

Crosscutting Concepts

- Stability and Change
- Systems and System Models

Core and Component Ideas in the Life Sciences

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4: Biological Evolution: Unity and Diversity

- LS4.C: Adaptation

Common Core State Standards

College and Career Readiness Anchor Standards for Reading:

Standard 7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words

College and Career Readiness Anchor Standards for Writing (if Adaptation / Extension #3 is completed)

Standard 6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Standard 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

1. Game boards for each group of 4-6 students (follows lesson plan in 2 parts)
2. Set of game cards for each student (found after lesson plan), ideally printed on different-colored card stock
3. Game pieces: anything small enough to fit in the board spaces; assorted items from the sagebrush ecosystem, such as different colored rocks, would be ideal
4. 1 coin for each group
5. Student handout for each student which contains rules and discussion questions (follows lesson and game board)
6. *Succession in the Sagebrush Ecosystem* PowerPoint presentation; available on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>
7. Computer with Microsoft PowerPoint software and Internet access
8. Display screen

Preparation

1. Print enough game boards for groups of 4-6 students to share and tape the two halves together.
2. Make copies of the three types of game cards: Event cards, Interaction cards and Character cards. Cut the cards apart with a paper cutter.
Optional: Print on card stock, using a different color for each of the 3 types of card, if available.
3. *Optional:* Combine all the game components in large zip lock bags, with elastic bands around the sets of cards, to help keep everything organized.
4. Ensure the other materials are ready for student use and that the computer and PowerPoint presentation are ready.



Teacher Instructions

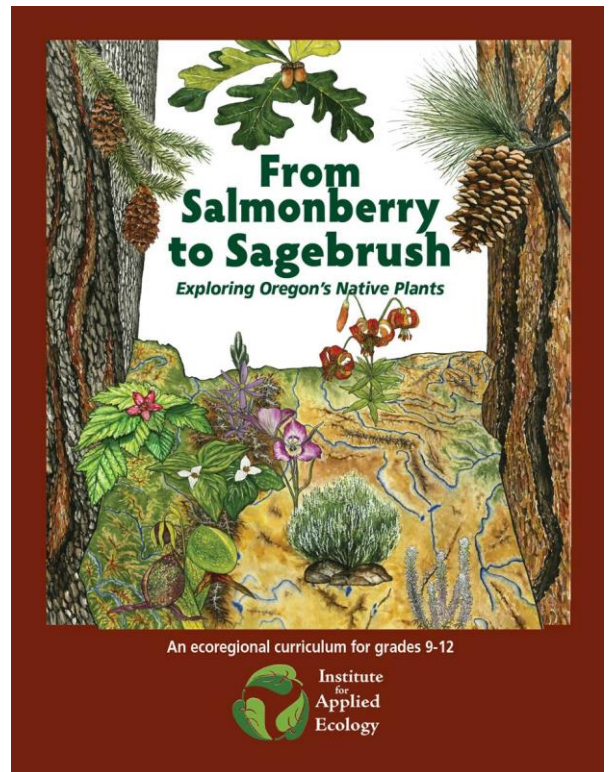
1. Open the PowerPoint presentation. Picking up from the last lesson on fire, ask students: What do you think happens after a serious wildfire burns through an area of the sagebrush ecosystem?
2. Discuss student ideas, and then direct student attention to the visuals with notes in the presentation to teach students about plant succession and how the process can lead to different stages/types of ecosystems.
3. Explain to students that they will now get to play a new game to help them learn more about succession. Have the students break into groups of 4 – 6 and recruit a student volunteer or two to help pass out the “Sagebrush Succession” games: game boards, cards, pieces, and a coin—one set per group—and the handout to each student. Read the rules with the class, and walk them through a round of the game.
4. Ask the groups to review the instructions and rules with each other before they start the game to make sure everyone in the group understands how to play. Circulate among the groups, answering questions and providing more information, as necessary.
5. At the end of the game, have students fill out and discuss the questions on their handout. The last question asks students to make a prediction about the outcome of the game in the absence of invasive species and disturbance cards. Have students make predictions and try the experiment if time allows.
6. Groups can share the results of the different versions of the game with another group to compare and contrast their results and discuss their explanations for the outcomes.
7. Fifteen minutes before the end of class, direct students to start working on their questions and drawings (the last question on the worksheet) if they haven’t yet done so. When they finish, they can start cleaning up.
8. When cleanup is complete, close the lesson with a class discussion of the game and the process of succession. In addition to discussing the worksheet, ask students more questions, such as:
 - How can human activities also impact plant communities?
 - How can we help native plants to recover quickly after disturbance events so that diverse sagebrush ecosystems can thrive?

Adaptations / Extensions

1. Take students on a field trip to an area that has experienced a recent wildfire or other disturbance event. Have students engage in an activity such as planting native plants or seeds to help restore the area and/or write reflections in journals about the site and ways it can be restored for wildlife and human uses. Students can also observe the area closely for signs of life, using binoculars and/or magnifying glasses, if available.
2. Students can develop and play other creative versions of the game, with a variety of different variables. Considerable new research has demonstrated the power of play to enhance learning, creativity, interpersonal skills, and overall human development, so this would be one area of the lesson to integrate more of it.
3. Students could create their own completely original games related to the sagebrush ecosystem or other ecosystems, such as those found where you live.
4. Have students write short essays to reflect on the game and questions such as those listed in step 8 above.
5. Student can choose an organism from the sagebrush ecosystem to research and learn more about how it is being impacted—or could be impacted—by wildfires and other disturbance events, including human activities. Provide a rubric so students know how they will be evaluated on the project, if desired. Findings could be shared with the rest of the class through written reports and/or oral presentations.

More Resources / References

- The game portion of this lesson plan is adapted with permission from “The Floristic Relay: A Game to Teach Succession.” It is found on Arizona State University’s GK-12 website: <http://gk12.asu.edu/node/60>.
- If you will be doing restoration service work, “Restoring Native Plants” from This American Land is an excellent video that highlights what students can do: <http://www.thisamericanland.org/lesson-plans/restoring-native-plants>
- BLM Education resources: <https://www.blm.gov/learn/teachers>
 - *FireWorks Encyclopedia for the Sagebrush Ecosystem*. BLM Idaho: <https://www.frames.gov/partner-sites/fireworks/curriculum/sagebrush-ecosystem>
 - *Sammy’s Quest to Save the West from Wildfire*. BLM Idaho: <https://www.blm.gov/documents/idaho/public-room/educational-material/junior-ranger-sammys-quest>
- Rangeland Plants education resources from the Idaho Rangeland Resource Commission: <https://idrange.org/education-2/lessons-and-activities>
- Cramer, J. and Einerson, J. (2011). *From Salmonberry to Sagebrush: Exploring Oregon’s Native Plants*. Corvallis, OR: Institute for Applied Ecology. You can download the complete 300+ page book here: <http://appliedeco.org/wp-content/uploads/Oregon-Botany-Curriculum-Salmonberry-to-Sagebrush.pdf>
- *Backpack Guide to Idaho Range Plants*. The University of Idaho Rangeland Center and the Idaho Rangeland Resource Commission. <http://idrange.org/store/books/backpack-guide-to-idaho-range-plants>
- Conserve our Western Roots poster and postcard from the Sage Grouse Initiative: <https://www.sagegrouseinitiative.com/roots>
- Montana Sagebrush Guide from Montana Dept. of Fish, Wildlife & Parks (black & white): http://sagemap.wr.usgs.gov/docs/MT_Sagebrush_Guide.pdf
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.



Plant Wars of Succession

Background

After a long, prosperous reign, King Sagebrush is in danger of losing control of the vast realm of Sageland. Disturbances such as wildfires, overgrazing, and erosion have depleted his subjects, and now a new threat—Cheatin' Cheatgrass—has invaded the realm. This wily intruder has overtaken large swaths of territory, using insidious poisons and seeds to fight for control of Sageland. Will he and his band of marauders succeed, or will King Sagebrush or another rival prevail?

Game Overview

- The game is best played with 4 – 6 players. Each player takes the role of one of 6 characters which represents a plant species: King Sagebrush, Queen Rabbitbrush, Prince Penstemon, Princess Balsamroot, Squirreltail, and Cheatin' Cheatgrass.
- Players take turns and first flip a coin: “heads” they move forward a space, “tails” they stay in place. Then they choose an **Event Card**. All the players then move across the playing board based upon the event and their species' response.
- **Interaction Cards** are drawn after each complete round of play when two or more players have landed on the same spot. Each pair of interacting players draws a card.
- The game ends when a player reaches the **Finish** square. The player with the most plants of his or her species in the community wins.
- Each player counts the **Event Cards** that were played in the game, and records the number of each event type in the data table on the back of this sheet.

Rules / How to Play

1. **Character Cards** are shuffled and played face down. Each player then chooses one.
2. Players choose or create a game piece and place it in the “Start” square on the board.
3. A player shuffles the **Event Cards** and places them face down in the **Future Events** spot. Another player shuffles and places the **Interaction Cards** face down in their spot.
4. Players take turns and flip a coin: “heads” they move forward a space, “tails” they stay in place. Then they choose an **Event Card** and place it face up in the **Current Event** spot. All players then move (or stay in place) based upon the event and their species' response listed on the **Character Cards**, starting with the player whose turn it is and going clockwise.
5. When every player has had a turn, check the board for players who landed on the same square. These players are interacting:
 - a. Two at a time, the interacting players draw one **Interaction Card** and play according to the card.
 - b. Interactions are also played clockwise, starting at the player whose turn it is.
6. Repeat Steps 4 and 5 until a player reaches the **Finish** square. Record the order of the players and the number of each type of event that occurred during the game in the data table.

Name: _____ Date: _____

Plants Wars of Succession

Event Data

Event	Game 1 Number of Occurrences	Game 2 Number of Occurrences	Game 3 Number of Occurrences
Wildfire Disturbance			
Overgrazing Disturbance			
Erosion / Landslide Disturbance			
Urban Sprawl Disturbance			
Non-Disturbance Events			

Finishing Order

Player	Game 1 Finishing Place	Game 2 Finishing Place	Game 3 Finishing Place	Ideas why player finished in that place
King Sagebrush				
Queen Rabbitbrush				
Prince Penstemon				
Princess Balsamroot				
Squirrel Tail				
Cheatin' Cheatgrass				

Reflection / Discussion Questions

- Which player won the game most often? _____
- Why do you think that character won?

- Which character did you play? _____

4. What would have had to happen for your character to win most of the time?

5. Which plant(s) did the worst when there were wildfires?

6. Which plant(s) did the worst when there was overgrazing and large-scale erosion / landslides?

7. Which plant(s) did better when there were disturbances? Why do you think that might be the case in real life?

8. Imagine that Cheatn' Cheatgrass had not invaded Sageland. What do you predict might happen if that was the case and all the Event cards were No Disturbance cards?

9. Try the game that way. Was your prediction correct? _____

Drawing

Draw a picture of what Sageland might look like 100 years after a disturbance if there were no invasive species. Use the space below or a separate sheet.

King Sagebrush

Character Card



Character Type

Late successional

Disturbance Event

Lose a turn

No Disturbance Event

Move forward 2 spaces

Queen Rabbitbrush

Character Card



Character Type

Late successional

Disturbance Event

Lose a turn

No Disturbance Event

Move forward 2 spaces

Prince Hawksbeard

Character Card



Character Type

Early successional

Disturbance Event

Lose a turn

No Disturbance Event

Move forward 2 spaces

Princess Penstemon

Character Card



Character Type

Early successional

Disturbance Event

Move back 1 space

No Disturbance Event

Move forward 2 spaces

Squirreltail

Character Card



Character Type

Early successional

Disturbance Event

Move back 1 space

No Disturbance Event

Move forward 2 spaces

Cheatin' Cheatgrass

Character Card



Character Type

Invasive species

Disturbance Event

Stay in place

No Disturbance Event

Move forward 2 spaces

Competition for Water

Interaction Card

Late character type has more developed roots to get more water.

Late: Move forward 1 space.

Early: Lose a turn.

Invasive: Stay in place.

If both characters are early or late, flip a coin: the winner moves forward 1 space.

Competition for Light

Interaction Card

Late character type shades early character type.

Late: Move forward 1 space.

Early: Lose a turn.

Invasive: Stay in place.

If both characters are early or late, flip a coin: the winner moves forward 1 space.

Facilitation of Nutrients

Interaction Card

Early character type adds nutrients for late successional.

Late: Move forward 1 space.

Early: Stay in place.

Invasive: Move forward 1 space.

If both characters are early or late, flip a coin: the winner moves forward 1 space.

Facilitation of Shade

Interaction Card

Early character type creates shade for late successional.

Late: Move forward 1 space.

Early: Stay in place

Invasive: Move forward 1 space

If both characters are early or late, flip a coin: the winner moves forward 1 space

Tolerance

Interaction Card

Early and late character types live together in community.

Invasive type produces the most seed; releases toxins which damage other types.

Late: Stay in place or move back 1 space if interact with invasive species

Early: Stay in place or lose a turn if interact with invasive species

Invasive: Move forward 1 space.

Tolerance

Interaction Card

Early and late character types live together in community.

Invasive type produces the most seed; releases toxins which damage other types.

Late: Stay in place or move back 1 space if interact with invasive species

Early: Stay in place or lose a turn if interact with invasive species

Invasive: Move forward 1 space.

Wildfire!

Caused by Lightning Strike
Disturbance Event



Wildfire!

Caused by Careless Camper
Disturbance Event



Landslide

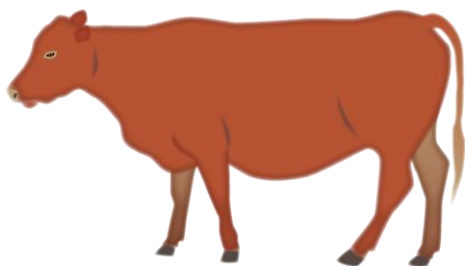
Disturbance Event



Overgrazing

Disturbance Event

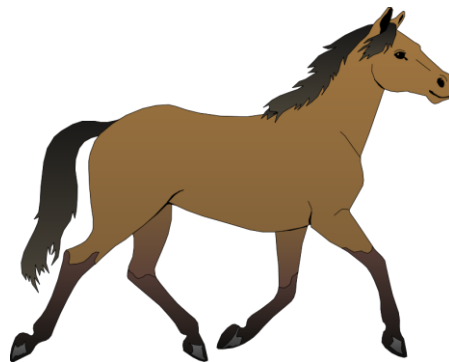
Livestock Stay in
One Place Too Long



Overgrazing

Disturbance Event

Overpopulation
of Wild Horses



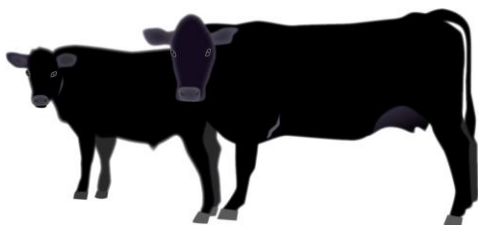
Urban Sprawl

Disturbance Event



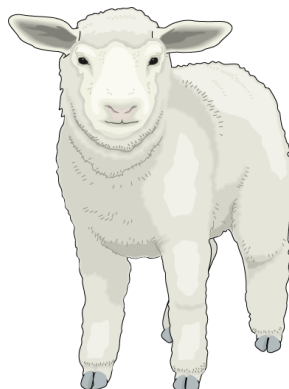
Wildlife-Friendly Cattle Ranching

Non-Disturbance Event



Wildlife-Friendly Sheep Ranching

Non-Disturbance Event



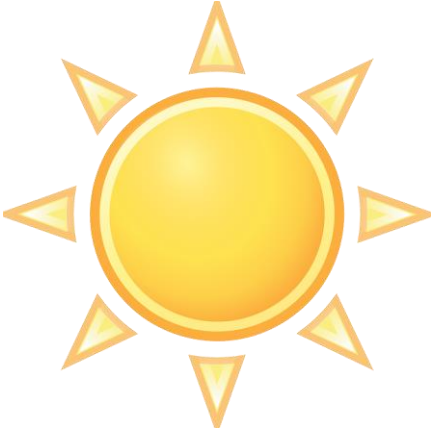
Large-scale Erosion

Disturbance Event



Sunny Weather

Non-Disturbance Event



Cloudy Weather

Non-Disturbance Event



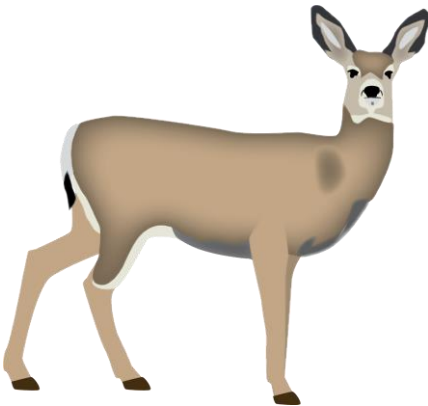
Scattered Showers

Non-Disturbance Event



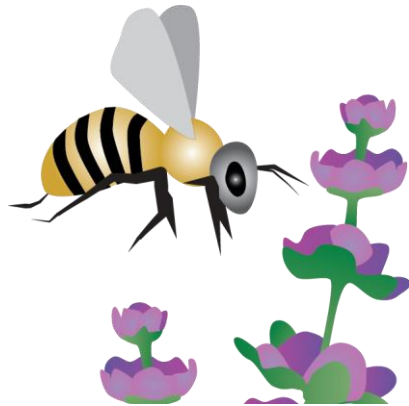
Mule Deer Migration

Non-Disturbance Event



Bees Pollinating

Non-Disturbance Event



Butterflies Pollinating

Non-Disturbance Event



Pronghorn Migration

Non-Disturbance Event



Golden Eagle Hunting

Non-Disturbance Event



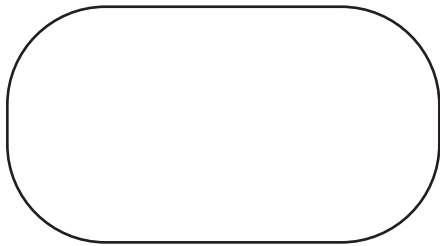
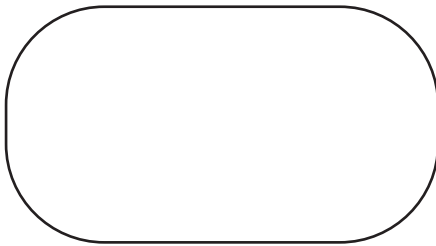
Sage-grouse Lekking

Non-Disturbance Event



START

FINISH



TIME 



Plant Wars



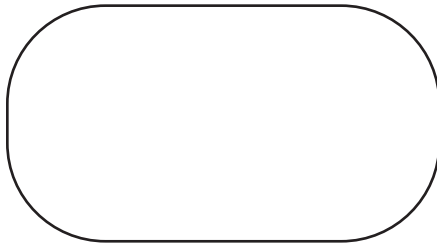
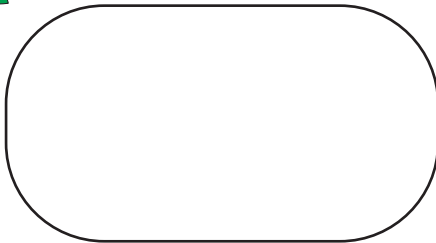
You are besieged by a nasty fungus!
Go back 1 space.



Future Events

Current Event

You disperse all your seeds!
Move ahead 2 spaces.



You freeze when temperatures plummet. Go back 1 space.



You are pollinated by bees! Move ahead 2 spaces.

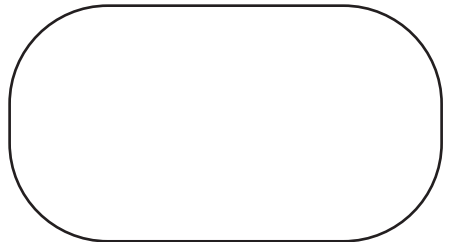


of Succession



Interaction Cards

You are infested by a deadly wilting disease. Go back 2 spaces.



You are attacked by ravenous insects! Move back 2 spaces.



You make seeds! Move ahead 1 space.



Survival in the Sagebrush Sea

Lesson Overview

After a brief multimedia presentation about what wildlife like sage-grouse need to survive year-round in the sagebrush ecosystem, students choose centers with hands-on activities to help them learn more about the wildlife and share what they have learned in creative ways. Possible activities include carefully observing artifacts from organisms of the sagebrush ecosystem and creating labeled scientific drawings of them, constructing new creatures with modeling clay which are perfectly adapted to survive in the sagebrush ecosystem, writing poetry about the wildlife, and creating multimedia presentations about



Photo courtesy Gerrit Vyn

one or more species and how it survives year-round in the sagebrush ecosystem. Lesson adaptations / extensions are listed at the end of the lesson.

Lesson Goal Students will understand what sage-grouse and other wildlife need to live year-round in the often harsh sagebrush ecosystem.

Subject Areas Science

Grade Level 4 – 12 (Ages 9 – 18)

Time 60 – 75 minutes or more

Objectives

- Students will demonstrate understanding that sage-grouse require different types of habitat throughout the year including breeding habitat, brood rearing habitat, and winter habitat.
- Students will understand the importance of water availability in the high desert and how organisms have adapted to survive with limited amounts of it.
- Students will understand the importance of geological features including rock outcroppings for the survival of wildlife including raptors.
- Students will demonstrate understanding of how human activities have an impact on the living and geological systems in the sagebrush ecosystem.

Next Generation Science Standards

Crosscutting Concepts

- Structure and Function
- Stability and Change

Core and Component Ideas in the Life Sciences

LS1: From Molecules to Organisms: Structures and Processes

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4: Biological Evolution: Unity and Diversity

- LS4.C: Adaptation

Core and Component Ideas in Earth and Space Sciences

ESS2: Earth's Systems

- ESS2.C: The Roles of Water in Earth's Surface Processes

ESS3: Earth and Human Activity

- ESS3.C: Human Impacts on Earth Systems

Common Core State Standards

College and Career Readiness Anchor Standards for Writing (if Adaptation / Extension #5 is completed)

Standard 6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Standard 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

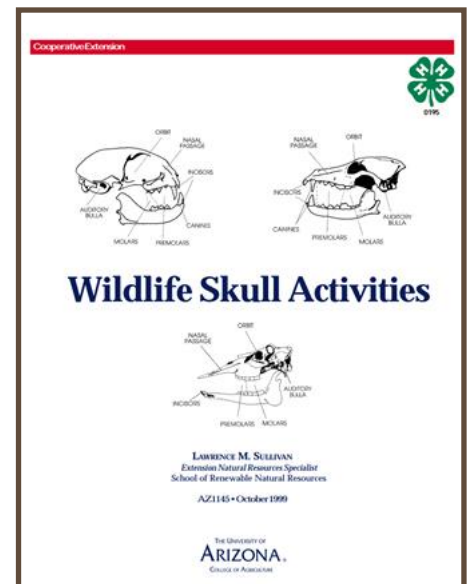
1. *Survival in the Sagebrush Sea* PowerPoint presentation; available on the Greater Sage-Grouse Education page of the USFWS website: <http://www.fws.gov/greatersagegrouse/education.php>
2. Computer access and Microsoft PowerPoint software
3. Display screen
4. Markers, crayons, or colored pencils for students to share
5. *Optional:* Sagebrush Ecosystem Trunk from Audubon Rockies or other partners; contact Jacelyn Downey with Audubon Rockies at (307) 756-3941 or jdowney@audubon.org for more information
6. *Optional:* "Wildlife Skills Activities" booklet from the University of Arizona Cooperative Extension: <http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1145.pdf>
7. *Optional:* Modeling clay or Play-Doh and natural materials like pine cones, pine needles, and dried vegetation for students to share
8. *Optional:* Microscopes and/or magnifying glasses
9. *Optional:* Books with information about sagebrush wildlife, such as field guides, bird books, and the *FireWorks Encyclopedia for the Sagebrush Ecosystem*: <https://www.frames.gov/partner-sites/fireworks/curriculum/sagebrush-ecosystem>
10. One or more sets of wildlife SteppeUp cards developed by the Bureau of Land Management (BLM)
11. *Optional:* Online access for students

Preparation

1. If possible, identify an expert partner to work with your class. Contact information and recommendations for partners such as the USFWS, BLM, state wildlife agencies, and Audubon can be found on the on the Greater Sage-Grouse Education page:
<http://www.fws.gov/greatersagegrouse/education.php>
2. Ensure all materials above are ready for student use.
3. *Optional:* Get ready to show one or more video clips, such as “Sagebrush Sea: A High Desert Ecosystem” on PBS LearningMedia:
<https://opb.pbslearningmedia.org/resource/nat15.sci.lisci.sagebrush/sagebrush-sea-a-high-desert-ecosystem>
4. *Optional:* Watch the following additional videos for more background information in preparation for teaching the complete curriculum:
 - *The Sagebrush Sea* from the *Nature* website: <http://www.pbs.org/wnet/nature/sagebrush-sea-full-episode/12341/>.
 - Sage Grouse—Oregon Public Broadcasting Field Guide: <http://watch.opb.org/video/2365357596/>
 - The Sage Grouse Initiative and the Eastern Oregon Agricultural Research Center, “Unraveling Sagebrush Community Change to Manage for Resilient Sage Grouse Habitats”:
<https://www.youtube.com/watch?v=YbwaA9ziLLw>

Teacher Instructions

1. Introduce the expert visitor if one is present. If so, he or she can give a brief presentation incorporating the PowerPoint presentation.
Optional: One or more video clips can also be shown which illustrate ways wildlife survive and reproduce in the sagebrush ecosystem.
2. Work with the visitor (if present) to show and explain items from the Sagebrush Ecosystem Trunk (if available) to students, such as skulls, animal track impressions, feathers, rubber scat, wildlife identification books, etc. The artifacts can come from sage-grouse as well as other organisms from the sagebrush ecosystem. Discuss with students how the items can be used to identify the wildlife they come from, and how they reveal ways that the organisms survive. Review the concept of adaptations from the first lesson in the curriculum and how the items may reveal those, as well. If you have access to skulls, an excellent resource with details about how to identify carnivores, herbivores, and omnivores, and how the skull features reveal other adaptations, is the “Wildlife Skills Activities” booklet from the University of Arizona Cooperative Extension:
<http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1145.pdf>
3. Tell students that they will be able to choose centers in which to work and rotate through today. They will be responsible for finishing at least 1 quality product of their choice which shows they understand ways that wildlife species survive in the sagebrush step. Explain the available options for centers and possible finished projects, which may include the following (based on available materials and level of the class):
 - A center with items from the sagebrush ecosystem, including from Trunk (if available), and drawing materials. Students can draw items carefully—trying to be as scientifically accurate as possible—and label the important features of them, including the adaptations which help them to survive in the sagebrush ecosystem. If there are skulls, you can print the student handout pages from the “Wildlife Skills Activities” booklet mentioned above, including the



labeled skulls of coyote and pronghorn and the “Mystery Skull Worksheet” for students to fill out. Books, posters, and SteppeUp cards can also be made available with additional information, as can microscopes and/or magnifying glasses to examine the artifacts more closely.

- A second center with different items from the ecosystem, such as the different track impressions and rubber scat. Students can study the items and any additional information about the wildlife, such as in SteppeUp cards and books including field guides and the *FireWorks Encyclopedia for the Sagebrush Ecosystem*. Students can write a summary document which explains what they learned about how to identify the wildlife by the traces they leave behind. Or, if they prefer, they can write one or more poems about the animals which include details which reveal how they survive. Exemplar student poems can be provided for inspiration and/or books which include wildlife poetry.
 - A center with modeling clay and natural materials such as dried vegetation, seed pods, pebbles, and sand. Students can design and construct a new organism that is ideally suited to survive year-round in the sagebrush ecosystem. Students who choose this option should be ready to explain to the class the different structures found on their organism, its behaviors in the wild, and how those adaptations enable it to survive and reproduce.
 - One or more computer stations with access to sagebrush education resources such as those on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>. Students can use images, etc., and create a short multimedia presentation which explains how one of more species survives year-round in the sagebrush ecosystem.
4. Tell students they may not get their first choice for a center, but that they will have the option of rotating to a different center later. For all of the centers, encourage students to ask and/or write down questions that arise as they work, which is one of the most important things scientists do—along with developing hypotheses (their best-informed guesses)—and trying to answer the questions through observation and research.
 5. Walk to the first center and ask students to raise hands quietly if they are interested in it as their first choice? Call over students one by one until you feel that the center is full.
 6. Walk to the other centers and repeat the process until all students have chosen a center.
 7. Rotate though the groups of students with the visitor(s), if present, answering questions and helping students get started on producing their products about the wildlife. Tell students that they should be prepared to present their work to the class.
 8. After 10-15 minutes, tell students that they will soon be able to move to a different center if they choose. The first group that will have the opportunity to move will be the one that is working the most productively together. Preference will also be given to students who have made progress on their individual projects, so they should they should strive to do that.
 9. After about 5 more minutes, tell students that some of them will now be able to move if they are ready. Explain that you will choose a group to start moving, and that when students arrive at another group, students already in that group can raise their hands quietly if they would like to move. Each student arriving at a new center will choose a student to replace, and those students who have been chosen will move to another center to choose different students who would like to move and continue the process. The process will continue until all students who would like to move have been given a chance to do so, provided there are enough students who are ready to move in the desired group. If not, students may have to wait until another student wishes to change places with them.
 10. Move to a group that is working well and ask students to raise hands if they would like to move to a different center. If too many students wish to move, choose those students who have made the most progress and let them go to a different center, starting the process described in the step above.

Monitor the process of moving closely to make sure the process runs smoothly, and stop the class if it becomes too chaotic and remind them of how it is supposed to work.

11. After another 8 – 10 minutes, give students another opportunity to rotate to a different group if they would like, following the process described above.
12. Give students a warning when there are 5 minutes left to work. Tell them that you will be looking for volunteers to make a brief presentation to the class about items they produced today, and ask them to start cleaning up when they are finished. When 5 minutes have passed, ask the remaining students to help clean up.
13. Ask students to raise hands if they would like to share what they made with the class. Call on a few students, one at a time, to stand up and share their work, giving other class members a chance to ask questions at the end of each short presentation.
14. Tell students that they will be able to finish their products for homework or in class the next day (if necessary and as you deem appropriate). Collect the finished products to review more carefully and display around the classroom and/or the school. You could also ask students to revise their work based on constructive feedback you provide to ensure that the work is the best the students can produce before it is displayed publicly.
15. Close with a quick review of concepts learned during the lesson and ask students to call out some of the amazing ways wildlife survive year-round in the sagebrush ecosystem.

Adaptations / Extensions

1. Do a "teach a peer" session at the end of the lesson in which students pair up or get in small groups and share what they learned with each other. This will increase the amount of sharing/discussion, because usually students who are reluctant to share with the whole class will happily do so with a partner or in a small group setting. Consider providing a simple planning sheet to guide their sharing; it could be a quick reflection/summary for one of the stations they explored. This helps ensure that students will have something to share when it is their turn. It could also be collected at the end of class as a check for student understanding.
2. Play the "Knock, Knock . . . Who's There?" activity adapted from the activity of the same name created by Sharon Kessler & Trina Howard in Arizona: Have students listen to sounds of animals from the sagebrush ecosystem—either audio recordings or videos without the pictures showing—and guess the animal and the animal's size. Students then watch the videos or see pictures of the animals to see the animals and/or the way they vocalize. They can then discuss the various adaptations that the animals have for producing sound (e.g. throat sacs), their influence on how the listener perceives the sounds (e.g. Do throat sacs make an animal's voice lower and therefore make the animal seem bigger than it is?), and why those traits might be advantageous to the animal (e.g. Does a throat sac make the animal sound more threatening?). Sounds and videos are available on sites such as Cornell's All About Birds (<http://www.allaboutbirds.org>) and [ARKive.org](http://www.arkive.org).
3. Take students on a field trip to explore the sagebrush ecosystem first hand, with an emphasis on uncovering the ways organisms survive year-round in the sagebrush ecosystem. Have students engage in an activity such as creating a nature journal or field guide (or continuing one started previously) of the organisms they observe. Excellent information on creating nature journals can be found on the BirdSleuth website: <http://www.birdsleuth.org/nature-journaling>.
4. Students could give brief presentations about the creatures they created to the rest of the class.
5. Have each student choose an organism they have learned about to research in depth. They can research elements such as what the organism needs to survive and how have human activities impacted it over time. Provide a rubric so students know how they will be evaluated on the project, and findings could be shared with the rest of the class through written reports and/or oral presentations.

6. An enjoyable game students can play outside is “Camouflage”:
- Choose a student to be "it."
 - That student calls out "CAMOUFLAGE!" so everyone can hear it. Once it is called, they close their eyes and count to ten. They will not be able to move their feet after this.
 - All the other students have 10 seconds to find a hiding place in which they can see the person counting, but the person can't see them.
 - Once the one who is "it" has finished counting, he or she opens their eyes, still unable to move their feet. He or she then holds up a hand to make a sign (pinky up, ring finger down, index finger up, thumb down, hand covering head, etc.). They must hold up the sign for 15 – 30 seconds. During this time, they may twist at the waist, but without moving their feet, and call out people who they see and their hiding spots.
 - Once the 30 seconds are up, the one who is "it" calls out "Show yourselves!" Those who are left undiscovered come out and the first to show the correct sign wins the round and gets to guess the next round.

More Resources / References

- “Wildlife Skull Activities” booklet from the University of Arizona Cooperative Extension: <http://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1145.pdf>
- *FireWorks Encyclopedia for the Sagebrush Ecosystem*. BLM Idaho: <https://www.frames.gov/partner-sites/fireworks/curriculum/sagebrush-ecosystem>
- *Sammy’s Quest to Save the West*. BLM Idaho: <https://www.blm.gov/documents/idaho/public-room/educational-material/junior-ranger-sammys-quest>
- Contact your local 4-H (<http://www.4-h.org>) for more resources related to your local area.
- Greater Sage-Grouse resources from the U.S. Fish and Wildlife Service: <http://www.fws.gov/greatersagegrouse>
- Idaho Rangeland Resource Commission education resources: <https://idrange.org/education-2/lessons-and-activities>
- Sage-Grouse Initiative partners which may be able to assist your class or provide additional resources: <http://www.sagegrouseinitiative.com/about/partners>
- Sage-Grouse Initiative’s list of sagebrush ecosystem wildlife: <http://www.sagegrouseinitiative.com/sagebrush-community/the-wildlife>
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.
- More Traveling Trunks from Audubon Rockies: <http://rockies.audubon.org/traveling/trunks>
- Traveling Trunks and other education programs from the High Desert Museum in Bend, OR; details online at <https://www.highdesertmuseum.org/traveling-trunks>.



Human Connections to the Sagebrush Sea

Lesson Overview

Students are first presented with stories of Native American traditions connected with the greater sage-grouse and other wildlife and plant species in sagebrush ecosystems. A graphic organizer worksheet can be used to summarize and organize the information. Then they learn about ways modern American life is connected with the sagebrush sea and modern practices which both benefit and harm the important ecosystem. Next, they create a visual diagram using art supplies or computer software to present what they know about the human connections to the ecosystem, conducting additional research, as needed. Lesson adaptations / extensions are listed at the end of the lesson.



Lesson Goal

Students will demonstrate understanding that both traditional Native American peoples and modern Americans have depended on and impacted sagebrush ecosystems in both positive and negative ways.

Subject Areas Social Studies, Science, Language Arts, and Art

Grade Level 4 – 12 (Ages 9 – 18)

Time Two 45 to 60-minute class periods; time outside of class, if necessary, to complete projects

Objectives

- Students will be able to demonstrate the many ways the sagebrush ecosystem has positively impacted human health, prosperity, and cultural heritage.
- Students will be able to describe ways that humans have both benefited and harmed the sagebrush ecosystem and the native wildlife and plants found there.
- Students will be able to create a visual diagram which illustrates their understanding of the human connections to the sagebrush ecosystem.

Next Generation Science Standards

Crosscutting Concepts

- Structure and Function
- Stability and Change
- Systems and System Models

Core and Component Ideas in the Life Sciences

LS1: From molecules to organisms: Structures and processes

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Core and Component Ideas in Earth and Space Sciences

ESS3: Earth and Human Activity

- ESS3.C: Human Impacts on Earth Systems

Common Core State Standards

College and Career Readiness Anchor Standards for Reading:

Standard 7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

College and Career Readiness Anchor Standards for Writing

Standard 6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Standard 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

1. Computer with Internet access and Microsoft PowerPoint software
2. Display screen
3. Brief *Human Connections to the Sagebrush Sea* PowerPoint presentation; available on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>
4. Markers, crayons, or colored pencils for students to share
5. *Optional:* Large paper or poster board on which to create visual diagrams
6. *Optional:* Native American artifacts, such as headdresses or drums
7. *Optional:* Samples of the native plants listed below and/or others species you could discuss with importance for Native Americans
8. *Optional:* The Sagebrush Ecosystem educational poster available from USFWS; learn more on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>
9. *Optional:* “The Sagebrush Steppe” poster from Audubon Rockies: http://rockies.audubon.org/sites/g/files/amh431/f/sagebrushposter_fsc.pdf
Contact Jacelyn Downey at (307) 756-3941 or jdowney@audubon.org for the 18"X24" poster.

Preparation

1. If possible, identify an expert partner to work with your class. Contact information and recommendations for partners such as the U.S.FWS, BLM, state wildlife agencies, and Audubon can be found on the Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education>.
2. Ensure all materials above are ready for student use.
3. Get ready to show the video clips “The Chicken Dance” (2-minutes) and “Sage Grouse Legends of the Wasco and Paiute Tribes” (3-minutes). They are linked from slides 2 and 3 of the PowerPoint presentation. The High Desert Museum produced them and they are shown on the Sage-Grouse Initiative’s website: <http://www.sagegrouseinitiative.com/sagebrush-community/the-people>.
4. *Optional:* Get ready to show the short video “Human Impact in the Sagebrush Sea” (which plays in 2 linked clips for a total of just under 4 minutes): <https://opb.pbslearningmedia.org/resource/nat15.sci.lisci.hisage/human-impact-in-the-sagebrush-sea>

Teacher Instructions

1. Introduce the expert visitor if one is present. If so, he or she can ask students if they know any ways that traditional Native Americans and/or today's Americans have benefited from the sagebrush ecosystem, otherwise you can lead the lesson. Either of you can lead a brief discussion with the class about their ideas.
2. Start the *Human Connections to the Sagebrush Sea* PowerPoint presentation. Click the images on slides 2 and 3 to show the short videos one at a time which depict traditional Native American practices related to the sage-grouse and other wildlife. The videos are found on the Sage-Grouse Initiative's website: <http://www.sagegrouseinitiative.com/sagebrush-community/the-people>
3. *Optional:* Prior to or after showing the videos, pass out a graphic organizer for each video such as one or more of those found in the Resource Packet on the This American Land website: http://www.thisamericanland.org/literature_110166/Resource_Packet. Graphic organizers such as these help students to think critically about the content, summarize it, and remember it, in addition to helping to organize it.
4. After showing each video—and giving students enough time for most of them to complete the organizer (if one was given), discuss what students learned and answer any questions. If necessary to facilitate a rich discussion, ask questions such as:
 - Why do you think Native American peoples have respect for the greater sage-grouse?
 - In what ways did the men from the Eastern Shoshone Tribe imitate the greater sage-grouse?
 - Why do you think the Native Americans only hunted roosters (males), took only what they needed to live, and hunted only in the spring?
 - What do the Native American legends teach us about their connections to the greater sage-grouse and the sagebrush sea, in general?
5. *Optional:* Ask the students to stand up, move their desks aside and show the “The Chicken Dance” video again, starting at 0:30. You and/or the visitor can demonstrate the dance for students and ask them to try it while the chanting and drumming from the video continues. Alternatively, you could ask for student volunteers to come to the front of the room and try to demonstrate the dance for the other students. Trying the dance would be even more fun, educational, and memorable if you are able to obtain Native American artifacts to incorporate, such as headdresses or drums.
6. You and/or the visitor can then talk with students about some of the ways Native Americans have used plants for medicine, food, and spiritual practices. Tell students that all peoples around the world have used plants in these ways, and that the word for the study of these cultural practices is **ethnobotany**. Write the word on the board and ask students to identify the two main parts of it: the prefix “ethno,” meaning people or culture, and “botany,” the study of plants. Use sample plants as visual aids, if you have them, and/or the PowerPoint slides from the “Human Connections” presentation which shows the plants. Species you might talk about include:
 - **Basin, Mountain, and Wyoming Big Sagebrush** (tall/big sagebrush): many uses of the subspecies of big sagebrush, including treating wounds and fungal infections, stomach problems, sore throat, and headaches. Modern science has proven its powerful anti-bacterial, anti-fungal, and antioxidant properties. Strong teas made from the leaves have been the most common way to use big sagebrush and other sagebrush species—to make an antiseptic and



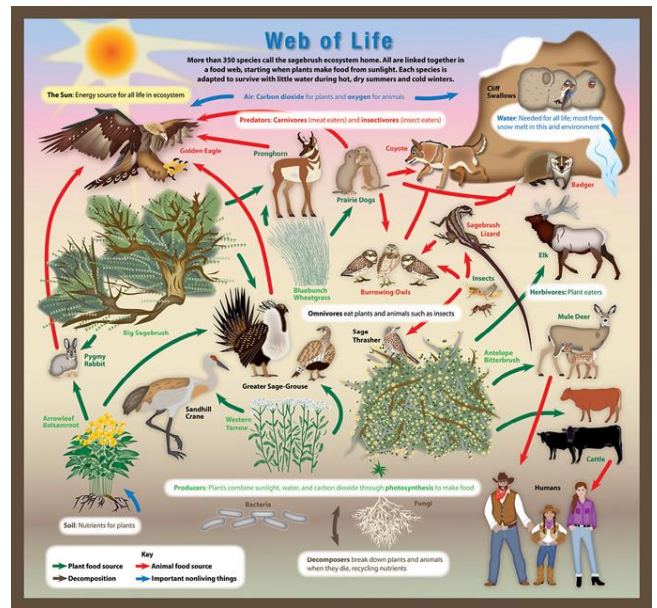
anti-fungal wash, for instance, but moistened, green leaves can also be crushed to make a poultice which is applied to the skin.

- **Yellow Rabbitbrush:** similar to sagebrush, a tea can be made to treat colds (viruses) and stomach upset
- **Desert Buckwheat** (also called umbrella plant and parsnipflower buckwheat): strong tea used to treat joint pain and swelling, relieve pain; many other uses, including as an eye medicine, heart aid, and stomach aid
- **Brown's Peony:** many uses, including as an anti-inflammatory, disinfectant, and immune system stimulant
- **Sheep Sorrel:** used to treat skin rashes and cancers (modern science has shown that chlorophyll—found in abundance in this plant—may be a primary source of the benefits)
- **Winterfat** (*Krascheninnikovia lanata*; also called white sage, winter-sage, feather-sage, sweet sage, lambstail): was used by many tribes to treat fever and pain; powdered root or poultice used to treat skin problems like rashes, burns, and sores

7. The visitor and/or you can then discuss with students how some native plants, especially **juniper**, can have negative effects on the ecosystem and humans, just like invasive nonnative plants. Advance to the next slide of the PowerPoint which shows juniper encroaching on sagebrush habitat and discuss how human activities have helped the juniper to spread, reducing habitat for sage-grouse and other species. Show students samples of juniper and cut sections of trunk, if available. If so, these can be passed around to have student groups examine closely and count rings to determine the age of the trees, discussing why some rings are wider than others. Tell students that juniper is being removed because of its negative effects on the ecosystem, but that the wood can be useful for fence posts and other uses, since it is naturally resistant to rotting. Ask: What else could they build with it?
8. Discuss how humans have impacted the sagebrush ecosystem in other ways. Show students the short video “Human Impact in the Sagebrush Sea” (which plays in 2 linked clips for a total of just under 4 minutes) and then discuss the concepts raised, such as fragmentation of the land and using it for energy production.

9. Advance to the next slide of the PowerPoint to show the “Web of Life” example, and explain how it is a visual representation of the sagebrush ecosystem. Explain to students that they will now create their own diagram to teach others about what they have been learning about sagebrush ecosystems and the human connections to it, both positive and negative.

10. Direct students to form groups of 3-4 and have the groups brainstorm topics that they could include in their diagrams on scrap pieces of paper, in their journals, or by using available technology such as iPads and software such as Inspiration Maps, Kidspiration, Google Docs, or iWork. As students work, walk around with large pieces of paper and art supplies for groups to share, and answer questions or help students with the brainstorming, as necessary.



11. After about 5 minutes, tell students that they can begin creating their visual diagrams when they have a plan for it worked out. Review with them the options available, such as a hand-drawn illustration or computer-aided diagram. Advance through the next couple of slides for students to see more examples. Students can then begin working on their diagrams.

12. Inform students when they have 5 more minutes to work. After that time, ask them to clean up and put the room back in order.
13. Thank the class visitor, if present, and review with students what they learned about the human connections to the sagebrush ecosystem and the native plants and animals found there. Be sure they understand they have started a challenging project; they do not have to create a perfect visual in their first attempt. They will have another whole period to work, and more time outside of class, if necessary, so there will be plenty of time to revise their ideas and create excellent diagrams.
14. At the start of the next work session, review with students the goals of the diagram project and how they will be assessed (consider providing a rubric). Discuss what is challenging about the project and answer any questions before students begin working. At the end of the period, tell students how much time they will have outside of class to complete their visual, if necessary.

Adaptations / Extensions

1. Take students on a field trip to immerse them in one or more concepts from the lesson more fully. For example, a Native American festival which incorporates dancing or an area with juniper or other native plants discussed in this lesson. Students could also participate in a service learning project in the area.
2. If you have samples of beneficial plants, pass them around for students to observe more closely and sketch in journals or field guides.
3. Students can give oral presentations about their diagrams. Their finished projects can also be posted on the classroom walls, around the school, and/or in community buildings such as the public library or town hall.
4. Do an activity involving juniper. For example:
 - Have “juniper cookies” (cross sections of trunk or branches) and ask students to count the rings to determine their age. Discuss possible reasons for the differences in ring width (more or less water those years, etc.).
 - Have a contest with juniper. You and/or the students can bring juniper to class and make creative projects with it. Tell students that it can be an ideal building material for things that will be placed in the ground, such as fences and posts, because it is resistant to rotting.
5. Watch and discuss the short video “Developing Grazing Systems” from the Sage-Grouse Initiative and ranchers:
https://www.youtube.com/watch?v=laf_VaZ2lI0



More Resources / References

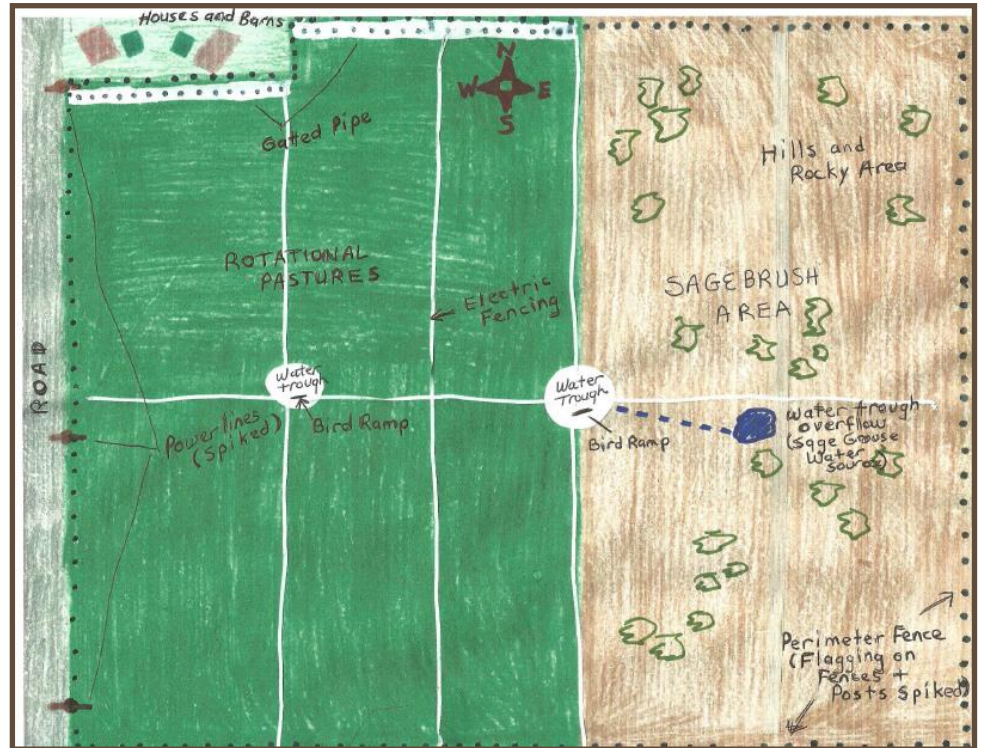
- Contact local tribes, history museums, and/or universities for information related to your local area. Superb resources include:
 - Tamástslíkt Cultural Institute, Pendleton, OR: <http://www.tamastslíkt.org>
 - The Museum at Warm Springs, Warm Springs, OR: <http://www.museumatwarmsprings.org>
 - High Desert Museum, Bend, OR: <https://www.highdesertmuseum.org>
- Moerman, D.E. (2000). *Native American Ethnobotany*. Portland, OR: Timber Press.
- Foster, S. & Hobbs, C. (2002). *The Peterson Field Guide Series: A Field Guide to Western Medicinal Plants and Herbs*. New York, NY: Houghton Mifflin Co.
- *Green Pharmacy*, Dr. Jim Duke's Botanical Desk Reference. <http://greenpharmacy.com>
- Native American Ethnobotany: A Database of Foods, Drugs, Dyes and Fibers of Native American Peoples, Derived from Plants. Univ. of Michigan: <http://herb.umd.umich.edu>
- Ethnobotany—Native Plant Dyes: <http://www.fs.fed.us/wildflowers/ethnobotany/dyes.shtml>
- Cramer, J. and Einerson, J. (2011). *From Salmonberry to Sagebrush*. Corvallis, OR: Institute for Applied Ecology.
- Yellow Rabbitbrush info: http://plants.usda.gov/plantguide/pdf/pg_chvi8.pdf
- *Celebrating Gaia's Herbal Gifts*, including the article "Teasel, Wild Rose and Parsnipflower Buckwheat": <https://herbalgoddessmedicinals.wordpress.com/tag/native-plants/>
- Video from Montana Fish, Wildlife & Parks about research on the effects of grazing for sage-grouse: http://fwp.mt.gov/education/videoLibrary/outdoorReports/video_0371.html
- Woodfield, M. et al. *Native American Ethnobotany of the Four Corners Region*: <http://meggiewoodfield.me/media/uvu/native-american-ethnobotany.pdf>
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.
- Contact your local 4-H (<http://www.4-h.org>) for more resources related to your local area.



Developing Plans to Restore Habitat for Sage-grouse and Other Wildlife

Lesson Overview

Students are first presented with stories and images which highlight ways scientists and ranchers are helping to restore habitat for wildlife of sagebrush ecosystems. After being presented with a hypothetical scenario, students then work in small groups to develop their own plans to restore wildlife habitat based on the available information presented in the scenario and what they have learned throughout the sagebrush ecosystem unit. Plans should include a written component as well as a visual representation of their choice, such as a poster, diorama, or computer-aided diagram. Lesson adaptations / extensions are listed at the end of the lesson.



Lesson Goal

Students will create wildlife restoration plans to restore habitat for sage-grouse and other wildlife species of the sagebrush ecosystem.

Subject Areas Science

Grade Level 4 – 12 (Ages 9 – 18)

Time Three class periods (45 to 60 min.); time outside of class, if necessary, to complete projects

Objectives

- Students will be able to describe ways scientists and ranchers are helping to improve habitat for sage-grouse and other wildlife living in sagebrush ecosystems.
- Students will be able create visual models such as dioramas or posters which illustrate their plan for wildlife restoration.
- Students will effectively communicate their restoration plan ideas in writing.
- Students will be able to explain how human activities can benefit, as well as harm, living systems.

Next Generation Science Standards

Crosscutting Concepts

- Cause and Effect: Mechanism and Explanation
- Structure and Function
- Stability and Change
- Systems and System Models

Science & Engineering Practices

- Developing and Using Models
- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

Core and Component Ideas in the Life Sciences

LS1: From molecules to organisms: Structures and processes

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4: Biological Evolution: Unity and Diversity

- LS4.C: Adaptation

Core and Component Ideas in Earth and Space Sciences

ESS2: Earth's Systems

- ESS2.C: The Roles of Water in Earth's Surface Processes

ESS3: Earth and Human Activity

- ESS3.C: Human Impacts on Earth Systems

Common Core State Standards

College and Career Readiness Anchor Standards for Writing

- Standard 6.** Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
- Standard 7.** Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Materials

1. *Wildlife Restoration* PowerPoint presentation; available on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>
2. Computer with Microsoft PowerPoint software and Internet access
3. Display screen
4. Markers, crayons, or colored pencils for students to share
5. Optional: Poster board
6. *Optional:* Sagebrush Ecosystem Trunk from Audubon Rockies or other partners; contact Jacelyn Downey at (307) 756-3941 or jdowney@audubon.org for more information
7. *Optional:* Video, "Oregon Ranchers Protect Sagebrush Habitat": <https://www.youtube.com/watch?v=qAqgH5bEvw>
8. *Optional:* Sets of wildlife SteppeUp cards developed by the Bureau of Land Management (BLM) for groups to share
9. *Optional:* Sagebrush Ecosystem educational poster available on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>

10. *Optional:* Video, “Developing Grazing Systems” from the Sage-Grouse Initiative which features ranchers: https://www.youtube.com/watch?v=laf_VaZ2II0



Preparation

1. If possible, identify an expert partner to work with your class. Contact information and recommendations for partners such as the USFWS, BLM, state wildlife agencies, and Audubon can be found on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>.
2. Ensure all materials above are ready for student use.
3. Get ready to show one or more video clips such as “Jared Brackett - Ranching in a Fish Bowl in Idaho” (6.5 minutes) from Life on the Range: <https://youtu.be/ILNxe7HF35U>.
4. *Optional:* Watch the following additional videos for more background information in preparation for teaching the complete curriculum:
 - “Tom Page improves sage grouse habitat in Pahsimeroi Valley”: <https://youtu.be/NLHeZLgFRGM>
 - “Sage Grouse” from Oregon Public Broadcasting (OPB) Field Guide: <http://watch.opb.org/video/2365357596/>

Teacher Instructions

1. Introduce the expert visitor if one is present. If so, he or she can ask students if they know ways to help greater sage-grouse and other wildlife in the sagebrush ecosystem, otherwise you can lead the lesson. Either of you can lead a brief discussion with the class about their ideas.
2. Either the visitor or you can then present the PowerPoint presentation one image/slide at a time to students, so they can think about each image and how it reveals problems for wildlife and/or ways that scientists and/or ranchers are helping to improve habitat for sage-grouse and other wildlife species in the sagebrush ecosystem. Pause after each image, and ask students to describe what they see and how what is shown demonstrates ways to help and/or hurt sage-grouse and other wildlife species. Images (with speaking notes at the bottom of the presentation) include:
 - Reflective markers on wire fencing
 - *Makes fencing more visible to sage-grouse and other low-flying bird species like owls, as well as running animals*
 - *Most important in areas with a lot of sage-grouse, such as within 1.2 miles of a lek and in wintering habitat*
 - PVC (plastic) cover on top line of fencing (*another way to increase visibility*)
 - Top rail (not barbed wire) on fencing (*another way to increase visibility*)

- Ramp on water trough (*to allow wildlife like sage-grouse to get out if they fall in*)
 - Spikes on the top of telephone poles and fence posts (*to prevent predators like raptors, ravens, and crows from perching in sage-grouse areas*)
 - A skeleton of a wild ungulate tangled in a fence (*top wires too close together and/or fence too high*)
 - Open fence gate (*to allow wildlife like elk and mule deer to pass through in high traffic areas...show this on the next slide*)
 - Laying down an area of fencing (*to allow wildlife to pass through*)
 - A very tall fence
 - *Impossible for wildlife to jump over*
 - *Mention that fences should ideally be 40" high or less, and no more than 42" high*
 - Fence on hill slope
 - *Increases barrier for wildlife trying to go up hill*
 - *Fences on steep slopes can become almost impossible to jump over without injury*
 - A larger gap between the top two lines of fencing
 - *Deer and elk often get entangled in fencing if lines are closer together*
 - *The gap should be 12" or greater*
 - Smooth (not barbed) wire for the lowest string on fence wire, well above the ground
 - *Allows antelope and other wildlife to pass under*
 - *Bottom wire at least 16" and preferably 18" above ground*
 - Movable electric wire fence
 - *Can keep livestock out of sensitive habitat areas*
 - Managed grazing to leave enough cover of healthy grasses and forbs (*especially important in early spring to allow sage-grouse and other wildlife optimal cover and food for nesting and brood-rearing*)
 - Open vertical pipe like ventilation pipes on buildings and porta-potties, as well as fence posts (*birds and other small animals can go in and get trapped; install caps or wire mesh over openings or remove pipes if not needed*)
 - Fence around riparian area (stream) in springtime (*to protect from grazing livestock*)
 - An area with pumped water (*to keep livestock away from stream and pond*)
 - An area of burned land
 - An area overrun by cheatgrass
 - An area of overgrazed land turned barren
 - A healthy area of sagebrush steppe with wildlife and livestock living in harmony
3. Advance to the next slide of the PowerPoint to show the visual representation of the wildlife restoration plan. Explain to students that they will be working to create a plan to restore habitat for sage-grouse and other wildlife of the sagebrush ecosystem. Tell them that they will be working with a group and will be given a choice of the type of visual model they will create which explains their plan. Tell them the options available, such as a diorama, poster, and/or computer-aided diagram. Advance through the next couple of slides for students to see more examples. They will also be writing up their plan to explain it more fully.
 4. Form groups of 3 – 4 students.
 5. Pass out the "Habitat Restoration Plan Project" handout sheets, which follow the lesson plan and include a description of the project, a budget worksheet, and a rubric.
 6. Ask for student volunteers to read the first handout—the Background and Your Challenge sections—aloud to the class. Ask if there are questions, then turn to the budget worksheet and explain it. Again, answer questions, then turn to the rubric and talk about the different parts of the plan which should be included.

7. Explain to students that they can first brainstorm the species they would like to help, along with the greater sage-grouse, and then come up with a family and/or ranch name. Then they can brainstorm the restoration strategies they plan to implement and do a quick sketch of what the ranch might look like after the project is complete. Then they can start working on their budget and written plan, with the last step being their final visual.
8. Explain the options for finished visuals to students: dioramas, posters, computer-aided diagrams, etc. Show students the available materials to complete the projects when they are ready for that step.
9. Tell students that they will eventually be presenting about their plans and/or service learning work they have done to others outside the class, so they should keep that in mind as they work; their projects are important and they will be helping to educate others in the community about ways we can help wildlife.
10. Ask if there are any more questions, then students can begin working. You and the expert visitor(s) (if present) can circulate through the groups, answering questions and providing assistance, as necessary.
11. Tell students when they have 5 more minutes to work. After that time, ask them to clean up and put the room back in order.
12. Congratulate students on what they accomplished, and be sure they understand this is a challenging project; they do not have to create a perfect plan, budget, and visual in their first attempt. They will have two more whole periods to work together, and more time outside of class, if necessary, so there will be plenty of time to revise their ideas and create excellent wildlife restoration plans if they work efficiently together.
13. At the start of the next work sessions, review with students the goals of the project and how they will be assessed (the rubric). Discuss what is challenging about the project and answer any questions before students begin working. At the end of the last work session, tell students that they can arrange to meet with their group to finish their final draft and visual(s), if necessary.
14. See the next lesson in the curriculum, Community Presentations and Engagement, for details about how student presentations about their projects can be organized.

Adaptations / Extensions

1. Prior to asking students to create plans, take a field trip to a model ranch which uses techniques such as those described above which benefit wildlife. The students can also participate in service learning projects, such as installing reflectors on wire or planting native plants.
2. Print the images depicting the wildlife restoration techniques for student groups to share. Instead of spending time discussing the images as a class, students can discuss them in groups and have them for reference while working on their restoration plans.
3. Students can choose one wildlife species to focus on for their plans, such as greater sage-grouse or one of the other species from the SteppeUp cards or posters.
4. Students can give oral presentations about their plans, in addition to, or instead of, creating written plans. See the next lesson for more ideas about how presentations can be shared with the community.

More Resources / References

- A Landowner's Guide to Fences and Wildlife: Practical Tips to Make Your Fences Wildlife Friendly. The Sage-Grouse Initiative. http://www.sagegrouseinitiative.com/wp-content/uploads/2013/07/Wyo_FenceGuide.pdf
- Sage-Grouse Initiative resources:
 - Proactive conservation: <http://www.sagegrouseinitiative.com/our-work/proactive-conservation>
 - Sagebrush ecosystem wildlife: <http://www.sagegrouseinitiative.com/sagebrush-community/the-wildlife>
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.
- Contact your local 4-H for more resources related to your local area: <http://www.4-h.org>.



Wildlife Restoration Plan Project

Background

Your group is a 4th generation family of ranchers on a beautiful 200 acre ranch in the sagebrush steppe. Situated at an elevation of about 5,000 ft. (1,500 meters), it contains:

- 100 acres of irrigated pastures
- A pond
- A riparian area (stream and area near it) with spring runoff
- A lush wetland meadow in spring
- Unlike most areas of steppe which are fairly flat, your ranch contains rolling hills, as well as dramatic rock outcroppings.

Most of the land was once prime sagebrush ecosystem habitat for sage-grouse and many other wildlife species, but the population of most of the species has been in decline for decades. Many factors have been blamed, including:

- Invasive plants, especially cheatgrass, and a wildfire that burned 50 acres 2 years ago. Cheatgrass has overtaken the area again.
- Old barbed wire fencing around the perimeter of the property are dividing it into several sections. The top wire in most sections is roughly 48 inches tall (4 ft. or 1.2 meters), and the bottom wire is a 12 inches (30 cm) above the ground.
- Encroaching juniper trees on 20 acres of the highest elevation land.
- Livestock overuse of the stream and pond, which has destroyed most of the native plants in those areas and eroded the stream banks.

Your family cares about the wildlife and diverse native plants on your ranch, as well as your livestock, so you have committed to develop and implement a plan to help the sage-grouse and other species recover. Fortunately, the Nature Conservancy will help your family with some of the funds needed for the project, and to help you recruit volunteers including students to help.

Your Challenge

- Develop a plan to restore the habitat and help two or more wildlife species, greater sage-grouse and at least one other species. What practices can you use to help the wildlife while still having a productive ranch for livestock for at least 4 more generations?
- Work within a budget of \$9,000, including family money and funds from the Nature Conservancy.
- Create a visual model and written description of your plan.

Team Member Names: _____ Date: _____

Wildlife Restoration Plan Budget

Family and/or Ranch Names: _____

Possible Restoration Measures	Cost / Unit	# Needed / Area to Implement	Total Cost
Fencing, Visibility, and Wildlife Safety			
Reflectors	\$0.07 each (one marker every 3 ft.)		
PVC pipe to cover wires	\$3 / 10 ft.		
Solar electric fence system for movable fence	\$300		
Solar electric fence section	\$200 / 300 ft.		
Smooth (not barbed) wire	\$100 / 1,300 ft.		
Top Rail for fencing	\$10 / 8 ft.		
Ramp for water trough	\$25 each		
Screen to cover open pipes	\$4 / sq. ft.		
Invasive Species Removal			
Work gloves for volunteers	\$3 / pair		
Shovels for volunteers	\$14 each		
Chemical treatment	\$87 / acre		
Native Plants			
Sagebrush seedlings	\$0.50 / bare root stock		
Sagebrush seed	\$10 / pound for basin big sage		
Native forb (wildflower) mixed seed	\$59 / pound		
Native bunch grass mixed seed	\$15 / pound		
Other Expenses			
TOTAL:			

Team Member Names: _____ Date: _____

Wildlife Restoration Plan Rubric

Family and/or Ranch Names: _____

Project Component	Maximum Points Possible	Group Self Score <small>(fill out before project submitted)</small>	Teacher Score
Part 1: Background			
Wildlife species to be helped identified	5		
Management objectives identified	5		
Part 2: Plan Development			
Habitat needs of species accurately explained	10		
Ranch areas accurately evaluated as habitat (What is present and what is lacking?)	10		
Part 3: Plan Implementation			
Appropriate management practices included	10		
Effect of various management practices on habitat and species demonstrated	10		
Appropriate native plant species used and invasive species removed	10		
Part 4: Plan Evaluation			
Realistic methods for monitoring success of plan presented	15		
Part 5: Format of Visual and Written Plan			
Visual clearly demonstrates plan with all necessary labels	10		
Written plan is well written, organized, and easy to understand	10		
Grammatical and spelling conventions followed	5		
TOTALS:	100		



Wildlife Community Presentations and Engagement

Lesson Goals Students make presentation(s) about their wildlife restoration plans and/or the service learning work they participated in and its importance. In this way, students strengthen their understanding and skills and magnify their impact on the community.

Subject Areas Science and Language Arts

Grade Level 4 – 12 (Ages 9 – 18)

Time Will vary

Objectives

- Students will create effective presentations and/or videos which educate the community about their work to improve habitat for sage-grouse and other wildlife of the sagebrush ecosystem.
- Students will effectively present their work to peers and the broader community with the assistance of multimedia technology.



Next Generation Science Standards

Crosscutting Concepts

- Stability and change

Core and Component Ideas in the Life Sciences

LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Core and Component Ideas in Earth and Space Sciences

ESS3: Earth and Human Activity

- ESS3.C: Human Impacts on Earth Systems

Common Core State Standards

Speaking and Listening Standards for Grade 6 (similar standards for grades 4 – 5 and 7 – 12)

Standard 4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

Standard 6. Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

College and Career Readiness Anchor Standards for Writing

- Standard 6.** Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
- Standard 7.** Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

Lesson Overview

This lesson provides guidance in conducting effective community presentations. Presenting their wildlife restoration plans and/or accomplishments with restoration work strengthens student understanding and skills and magnifies their impact on the community. Audiences could include city or town leaders, parents, the rest of the school including administration, and/or another school, as well as restoration partners, land owners, and the community at large. The exercise helps students further reflect on what they have learned throughout the sagebrush ecosystem unit, understand that their work is important to the public, further educate others on what they have learned, and develop their public speaking and presentation skills.

Materials

1. Computer access and software such as PowerPoint, Prezi, and/or iMovie to create multimedia presentations and/or videos
2. Display screen
3. *Optional:* Tables for students or partner organizations to display information

Preparation

1. Schedule an event well in advance and, if desired, work with partners to invite community members such as funders, parents, administrators, and partner organizations such as governmental agencies and nonprofit organizations interested in the sagebrush ecosystem.
2. Encourage students to dress appropriately when it is time to present to the public.
3. Consider encouraging students to incorporate props into their presentations which will better engage the audience and help convey their points.

Teacher Instructions

1. Talk to students about ideas for the format of the community presentations. This will give them the opportunity to incorporate their ideas for the event(s) and have more “buy-in” and enthusiasm for them. For example, what groups do they think should be invited? When should the event be held?
2. Explain to students that they will be working with their small groups from the wildlife restoration plan project to create a 5 – 10-minute long oral presentation or video about their project and/or the restoration work they participated in (if applicable). Engaging multimedia content should be incorporated using software such as PowerPoint, Keynote, or Prezi, or videos can be created using software such as iMovie. Encourage students to conduct additional research to enhance their presentations/videos and bolster their arguments.
3. Discuss or provide students with a sample outline they can use to help them structure their presentations and videos. For example, instruct students to include details such as:
 - All the elements of their wildlife restoration plans, including visuals
 - What they learned during the restoration work and sagebrush steppe unit
 - How their field work enhanced what they learned in the classroom
 - How they changed because of this project

Details such as those above are especially important if restoration partners, funders, and/or school administrators will be in the audience. Additional elements that could be included in a sample outline are listed below as they related to a potential project removing invasive cheatgrass.

- a. History of the land where the restoration work occurred, including background on the sagebrush steppe ecosystem.
 - b. Report findings from research questions such as:
 - i. What is cheatgrass?
 - ii. Where did it come from?
 - iii. How was it brought here?
 - iv. What does it look like?
 - v. How does it influence habitat and ecosystem/ranch health?
 - vi. How is it allelopathic (possesses the ability to biochemically inhibit growth in other plant species) and what are the implications of that?
 - vii. What does it do to the sagebrush ecosystem?
 - viii. What are some common removal techniques?
 - c. How have we been removing cheatgrass?
 - d. Why do we pull it out in spring?
 - e. Where can one report sightings of cheatgrass?
4. Pass out copies of the Presentation Rubric found in the Appendix (or your own rubric) to guide student learning and let them know how they will be assessed. Tell students that they will complete the “Self-Score” portion of the rubric and turn it in to you before they present.

If desired, work with partner organizations to develop an agenda for the community presentations. Other organizations can also be invited to attend who can staff tables and offer sagebrush ecosystem volunteer opportunities after the presentations are complete.

5. On the day of the event, sit back and watch the students shine!

Adaptations / Extensions

1. Collaborate with grade level English/Language Arts teachers to support standards that have been taught in the students' English classes. Students could do a joint project in which they work on science and literacy together in both their English and science classes.
2. Students can present to younger students to teach them about their work.
3. One or more awards could be presented to outstanding class members, either individuals or groups. Awards could be for exceptional additional volunteer efforts, the most outstanding restoration plan, etc.
4. Identify students who have photography and/or filming experience and ask them to use a camera(s) and/or video camera(s) to document the community presentations. Students can then share their presentations via YouTube, the school website, social media, etc., as allowed by school and district policy.

More Resources / References

- Professionals can be invited to serve as keynote speakers for community presentation events from organizations such as those listed on the Greater Sage-Grouse Education page: <http://www.fws.gov/greatersagegrouse/education.php>.
- Sage-Grouse Initiative Resources:
 - Sagebrush ecosystem cooperative conservation partners: <http://www.sagegrouseinitiative.com/about/partners/>
 - Proactive Conservation information: <http://www.sagegrouseinitiative.com/our-work/proactive-conservation/>
 - Additional sagebrush ecosystem resources: <http://www.sagegrouseinitiative.com/sagebrush-community/additional-resources>
 - News and Resources: <http://www.sagegrouseinitiative.com/news-media/>
 - Sagebrush Science and Policy: <http://www.sagegrouseinitiative.com/our-work/science-policy/>
- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned, can be found at <http://www.nextgenscience.org/framework-k%E2%80%9312-science-education>.
- More information about the Common Core State Standards and links to the complete documents can be found at <http://www.corestandards.org>.
- Contact your local 4-H (<http://www.4-h.org>) for more resources related to your local area.

Appendix



Sagebrush Ecosystem Pre-Test

We want to find out what you learned from this program that you didn't know before! Please answer the following questions the best you can by yourself. Please **do not** put your name on your paper.

1. What is a greater sage-grouse?

2. What the heck is a lek?

3. What is the sagebrush ecosystem?

4. What are four animals commonly found in the sagebrush ecosystem?

1. _____ 3. _____

2. _____ 4. _____

5. Circle **TRUE** or **FALSE**: Plant communities stay the same for long periods of time.

6. What are three ways that planting native plants benefits the environment?

1. _____

2. _____

3. _____

4. What is an invasive species?

5. Please name two different **invasive** plant or animal species.

1. _____ 2. _____

6. Please name four plants—or plant types—that are **native** to the sagebrush ecosystem?

1. _____ 3. _____

2. _____ 4. _____

7. What factors add to the threat of wildfire?

Sagebrush Ecosystem Pre-Test Answer Key

1. What is a greater sage-grouse?

It is a large, rounded-winged, ground-dwelling bird, about the size of a chicken. Their habitat is sagebrush country in the western United States and southern Alberta and Saskatchewan, Canada. They cannot survive in areas where sagebrush does not exist.

2. What the heck is a lek?

A lek is an area where male sage-grouse display for the purpose of gaining breeding territories and attracting females. The areas are usually open with short vegetation within sagebrush habitats.

3. What is the sagebrush ecosystem?

The sagebrush ecosystem is an interconnected community dominated by sagebrush with 350+ species; it is a landscape with shrubs, grasses, and forbs (wildflowers) with few trees.

4. What are four animals commonly found in the sagebrush ecosystem?

See the animals on the Sagebrush Ecosystem poster, such as pronghorn, mule deer, golden eagles, prairie dogs, sagebrush lizards, sage thrashers, coyotes, elk, and burrowing owls.

5. Circle **TRUE** or **FALSE**: Plant communities stay the same for long periods of time. **FALSE**

6. What are three ways that planting native plants benefits the environment?

1. Diverse native plants provide food and shelter for diverse wildlife species.
2. Deep roots and ground cover slow runoff and erosion, protecting soil and retaining water.
3. Native plants, with their deep taproots and other adaptations, can retain more moisture than invasive plants, benefitting wildlife and reducing the risk of wildfires.

Other benefits:

4. Native plants filter water, clean the air, and produce oxygen needed for humans and animals.
5. Evapotranspiration from native plants cools the air during hot summer months.
6. Native plants along streams provide shade which cools the water, increasing dissolved oxygen; this benefits fish and other wildlife.

4. What is an invasive species?

A species, usually nonnative, that spreads and crowds out native species, causing harm to the environment, economy, and/or human health

5. Please name two different **invasive** plant or animal species.

Cheatgrass (downy brome) and medusahead are damaging invasive plants in sagebrush ecosystems. Other species are listed at the end of the Invasive Plants lesson, such as teasel and thistle species.

6. Please name four plants—or plant types—that are **native** to the sagebrush ecosystem?

Big sagebrush, antelope bitterbrush, bluebunch wheatgrass, western yarrow, and others listed at the end of the Native Plants lesson.

7. What factors add to the threat of wildfire?

Heat, dry weather (low precipitation), fuel build-up, climate change, high winds, and hill slope

Sagebrush Ecosystem Post-Test

We want to find out what you learned from this program that you didn't know before! Please answer the following questions the best you can by yourself. Please **do not** put your name on your paper.

1. What is a greater sage-grouse?

2. What the heck is a lek?

3. What is the sagebrush ecosystem?

4. What are four animals commonly found in the sagebrush ecosystem?

1. _____ 3. _____

2. _____ 4. _____

5. Circle **TRUE** or **FALSE**: Plant communities stay the same for long periods of time.

6. What are three ways that planting native plants benefits the environment?

1. _____

2. _____

3. _____

4. What is an invasive species?

5. Please name two different **invasive** plant or animal species.

1. _____ 2. _____

6. Please name four plants—or plant types—that are **native** to the sagebrush ecosystem?

1. _____ 3. _____

2. _____ 4. _____

7. What factors add to the threat of wildfire?



Student Feedback

Sagebrush Ecosystem Experience

We want your opinion about your experience! Help us find out what was good and bad about the program, and what difference it made for you. There are no right or wrong answers and no one will know your responses (please don't put your name on the paper).

Please read each statement below and decide if you agree or disagree with the statement.

Put an X in one box in each row.

Statement	Strongly NO	Sort of No	I'm Not Sure	Sort of Yes	Strongly YES
What I did in this program was interesting.					
The things I learned in this program will stay with me the rest of my life.					
I see some things differently because of this project.					
I care more about what happens to the sagebrush ecosystem after participating in this project than I did before.					
I can see the connection between this program and the other things I am learning in school.					
I would volunteer to help sagebrush ecosystem habitat even if it wasn't part of school.					
I might like to enter a career dealing with the environment because of this project.					

Do you have any suggestions or comments about this program?

THANK YOU—Your input helps a lot!

Youth Permission and Waiver Form

Project: _____ Site Location: _____ Date: _____

ALL PARTICIPANTS UNDER THE AGE OF 18 WHO ARE UNESCORTED BY AN ADULT MUST HAVE A PARENT OR GUARDIAN SIGN THIS PERMISSION AND WAIVER FORM. Escorted youth may be included by their parent, guardian or authorized adult on the adult registration and waiver form.

This is a waiver and release. Please read it carefully before signing. I am the parent or legal guardian of Participant named below and I, the undersigned, enter this Release and Waiver of liability and Assumption of Risk Agreement ("Agreement") on behalf of myself, the Participant, my personal representatives, next of kin, heirs, successors, and assigns and anyone else who may make any claim for or on behalf of the Participant.

- I will **cause the Participant to agree and comply** with the terms of the Agreement and not to take any actions that would assist or cause the Participant to invalidate, renounce, negate, revoke, or disclaim any part of the Agreement.
- I make this Agreement for the benefit of partner organizations, other individual volunteers, project coordinators, sponsors, suppliers, supporters, and all private and public land owners on whose property the project described above may be located (collectively the "Released Parties), including, without limitation, the Released Parties' employees, agents, personal representatives, next of kin, heirs, successors and assigns.
- I make this Agreement in consideration of the Released Parties providing Participant with the opportunity to **participate as a volunteer** in this project.
- I understand that the Project may include **dangerous or hazardous** activities and that the Project may take place on a location or under conditions that may be dangerous to Participant.
- Participant and I **accept full personal responsibility** for all risks arising from or relating to this Project.
- Participant's involvement in this Project is **completely voluntary** and neither participant nor I have received nor expect to receive any compensation for participation in it.
- Participant will read, listen to and follow all **safety instructions and procedures** presented in conjunction with this Project and **use best judgment** based upon physical and mental abilities at all times, and to immediately terminate participation in this Project if activities become too strenuous, difficult or hazardous.
- I agree to **waive all liability** of the Released Parties, **discharge them, and covenant not to sue them** for any liability, claims, sums, costs, or other expenses on my account that may be caused in whole or in part by Participant's involvement in the Project.
- I agree that this Agreement shall act as a **complete bar against all actions or claims** that I might otherwise bring against the Released Parties, including negligence claims, arising from or related to this project.
- I have read this Agreement, fully understand its terms, understand that I have **given up substantial rights** by signing it, and have **signed it freely** and without any inducement or assurance of any nature. I intend this Agreement to be a **complete and unconditional release of all liability** to the greatest extent allowed by law, and I further agree that if any portion of this Agreement is held invalid, then the balance of the Agreement shall continue in full force and effect.
- I understand that a photographer may be present to photograph the activities at the Project and that Participant may be photographed while participating in the Project. I agree that Participant will contact the photographer if he or she does not wish to be photographed.
- I hereby grant the irrevocable and unrestricted right to **use and publish photographs of Participant**, or in which Participant may be included. I hereby release Photographer and his/her legal representatives and assigns and partner organizations from all claims and liability relating to any such photographs.

Thank you for filling out the form below and signing to give permission for your student to participate in field work. Please print clearly. We would never sell or trade your information.

Name of Participant		<input type="checkbox"/> Male <input type="checkbox"/> Female
Name of Parent/Guardian		
Relationship to Participant	Phone - -	<input type="checkbox"/> Home <input type="checkbox"/> Business
Address		<input type="checkbox"/> Home <input type="checkbox"/> Business
City	State	Zip
Age of Participant		
Signature of Parent or Guardian		Date

Are you able to chaperone? YES No Maybe

If so, please indicate your preferred method(s) of contact.

<input type="checkbox"/> Email, using address below (please write your email address in the boxes below)	<input type="checkbox"/> Mail, using address above	<input type="checkbox"/> Phone
		<input type="checkbox"/> Home <input type="checkbox"/> Business

Name(s): _____ Date: _____

Presentation Rubric

Title: _____

Presentation Component	Maximum Points Possible	Self-Score (fill out before presentation)	Teacher Score
Part 1: Content			
Subject and purpose of presentation clearly introduced	10		
Key concepts identified and clearly explained in well-organized way	10		
Ideas supported by examples, data, graphs, etc.; All information accurate and obtained from reliable sources	10		
Conclusion summarizes key points in persuasive way; Questions answered thoroughly and accurately	10		
Part 2: Delivery / Audience Engagement			
Speech delivered clearly at appropriate volume and speed (not too fast, slow, loud, or soft)	10		
Speed, volume, and voice inflection are varied to engage audience and emphasize key points	10		
Speaker connects with audience through eye contact and does not spend too much time looking at notes or screen	10		
Speaker demonstrates enthusiasm for topic throughout presentation; audience is persuaded by speaker	10		
Part 3: Visuals			
Visuals help to clearly explain concepts	10		
Part 4: Writing Conventions			
Grammatical and spelling conventions followed	10		
TOTALS:	100		

Comments:



Photo Point Monitoring

Adapted with permission from the *SOLVE Environmental Service Learning Teachers Guide* and *Student Watershed Research Project*, Saturday Academy, Photo Point Monitoring Instructions

Summary: Photo Monitoring can be an effective way to determine if the goals of a restoration project are being met, while being a simple and affordable monitoring technique. Photographs can reveal changes that other measurements may miss over time.

Monitoring with photographs requires establishing permanent (or at least semi-permanent) points which can be maintained in a consistent manner.

In order to set up your photo points, you need **goals** for the project being monitored. The goals of the project will help you formulate the best regime and vantage point for photographs:



One of the photos taken in the same location throughout the year by Valley Catholic High School students in Oregon to document changes to their restoration site

Goal	Regime	Outcome
Wildlife habitat restoration	Summer, Fall, Winter, Spring	Captures seasonal habitat variations
In-stream flow modifications	Summer, Winter	Captures high and low flow periods
Landscape changes	Once per year	Shows long-term changes
Reed canary grass control	Once per year	Photo plots – effectiveness within test plots

Use or both of these types of photographs depending upon the goals of the project:

Feature Photos	Landscape Photos
Feature photos document change on or around larger objects such as rock dams, stream banks, or stream profiles. Photos are usually taken from opposite ends of an imaginary line, such as opposite sides of a stream, downstream and upstream, or along a fence line to show contrast between different land management activities.	Landscape photos are an overview of the area showing the feature and its relationship to the surrounding area. A landscape photo might be taken from a nearby hill showing from a distance the same section of a stream where the feature photo was taken.

Establishing Photo Points

Photo points which are well-documented will be much easier to maintain on an ongoing basis.

Materials

- Data sheets
- Camera
- Clipboard
- Compass

Optional (if your site is lacking permanent landmarks):

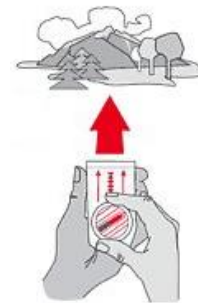
- Stakes (*rebar or wooden*)
- Brightly-colored spray paint to mark stakes
- Mallet

Procedure

1. Fill out the first page of the Permanent Record Data Sheet at the end of the activity (so called because it is used repeatedly throughout the year).

Provide:

- Site name
 - Clear directions to the site
 - Description of the project
 - Goal(s) for photo point monitoring
 - Attach other maps and info
2. To assist in relocating your photo points, roughly sketch a bird's eye view of your site (or include a photograph of the site) in the box provided at the bottom of the first page of the Permanent Record Data Sheet. Draw a north arrow on the map parallel to the border of the box.
 - To determine North ↑, use a compass and remember "Red in the shed."
 - Hold the compass level at arm's length in front of you.
 - Turn the compass dial to 0 degrees (North) and rotate yourself until the red north arrow is in alignment with the orienting arrow (the "shed").
 - Sketch your map facing north including major features and permanent landmarks of your site.
 - Compass apps are also available for smartphones.
 3. To set a photo point, choose a point that will capture the intended feature or landscape from a permanent landmark¹—or stake your photo point with a brightly colored wooden or rebar stake (only use rebar with approval from site owner or manager).
 - You will have better accuracy with replicating your photos if you capture another permanent landmark in your photo. This becomes especially important if you are monitoring vegetation that will look different seasonally and over time.
 - Avoid taking photos too close to vegetation, as future vegetation growth might obscure your view.



¹ **Permanent Landmarks** – Try to choose landmarks that are actually permanent. Buildings, telephone poles, roads, light posts, bridges and signs make good landmarks. A well-established tree is okay, except that it may die and/or fall before the next monitoring cycle.

4. On page 2 of the Permanent Record Data Sheet, record the directions to the photo point marker and the goal of the photo.
5. Look through the camera viewfinder and determine the center of the photo.
6. Hold your compass at arm's length away from your eye with the directional arrow pointing at the object you determined to be the photo center. Turn the dial on the compass so that north is aligned with the direction of the red needle. Note the compass angle (bearing) that is in line with the directional arrow.
7. Look through the camera viewfinder again and make a rough sketch of the photo in the rectangle provided, labeling any permanent landmarks.
8. Record the location of the photo point and an arrow indicating the direction of the photo on your General Site Map.
9. Take photo.
10. Repeat for subsequent photo points, numbering each based on the following system:
 - Begin a new number for each new point from which you take photos (i.e. Photo Point 1 = telephone pole; Photo Point 2 = East end of bridge)
 - If you take photos at multiple bearings from the same point, use letters to separate the Photo Point numbers. EXAMPLE: Photo Point 1A = telephone pole facing 45° (NE); Photo Point 1B = telephone pole facing 90° (E)



The same location as shown at the start of the lesson, documented before the restoration work. That invasive Armenian blackberry has to go!

Maintaining Photo Points

Once you have established your photo points and determined your monitoring regime (yearly, quarterly, etc.), the following instructions can be used to maintain photo data collection.

Equipment

- Permanent Record Data Sheets
- Camera
- Clipboard
- Compass (*magnetic*)

Procedure

1. Follow the directions to the site from the first page of the Permanent Record Data Sheet.
2. Use the general site map and the directions to locate each photo point.

3. Use the photo point sketch and compass bearing to frame the photo.
4. Take the photo. Repeat steps 2-4 for each photo point on your Permanent Record Data Sheet.
5. It may be necessary to take additional photos that are not established photo points – i.e. if you notice changes that would be significant to assessing the effectiveness of the restoration project, such as a bank failure up or down stream from a riparian planting project.

Saving Photos

Digital images should be given a descriptive name. Names should provide enough information that the image does not need to be opened in order to determine the photo contents. This means the image name should include information about:

- Site
- Photo point number
- Date

An example image name for photo point 3A at Rock Creek Park taken on March 26, 2016 would be:

RCP_3A_3-26-16.JPG



Restoration site after blackberry removal; using a system which indicates site, photo point number, and then date will help you to easily locate images

Be Consistent!

By using a consistent naming protocol, **images stored in the same file folder on a computer should be sorted by site, then by photo point number and then by date.** This can make it easier to insert photos taken at a particular photo point over time into a report. Image data can also be stored in spreadsheet or database files, which might be a consideration if you have limited computer storage space. Adjusting the photo size can also save computer space, since smaller images require less memory. Standardizing the image sizes during storage can make reporting or posting photos on a web site easier.



Removing the blackberry; don't forget to document the site with photos before and after the restoration work!

Image Format

The final thing to keep in mind when storing photo images is the **format**. If you plan to display photo data on a web site, saving images as JPEG (or JPG) is the preferred format. If images will be inserted into printed reports, .tiff or .bmp formats can be used, but high resolution .jpeg files can also work.

Photo Point Monitoring Permanent Record Data Sheet*

Site Name: _____

Directions to Site: _____

Site Description: _____

Goals for Photo Point Monitoring: _____

Duration of Photo Point Monitoring: _____

Monitoring Regime: **Fall** **Winter** **Spring** **Summer**

General Site Map

*Sketch a bird's-eye map of your site including major landmarks and a **NORTH** ↑ arrow. Mark and number your photo points as you establish them. Note: A time-saving option is to insert a photograph of the area, but the map can be beneficial.*

* Adapted with permission from *Student Watershed Research Project, Saturday Academy, Oregon*

Photo Point Monitoring Permanent Record Data Sheet - Page 2

Photo Point #: _____ Bearing: _____

Directions to Photo Point Marker:

Goal of Photo:

Photo Point #: _____ Bearing: _____

Directions to Photo Point Marker:

Goal of Photo:

Photo Point #: _____ Bearing: _____

Directions to Photo Point Marker:

Goal of Photo:

Glossary of Sagebrush Ecosystem & Greater Sage-Grouse Terms

adaptation – process in which an organism changes over many generations to better fit its habitat

Example: If plants have deep roots, they are more likely to survive and reproduce during dry years. In this way, future generations are more likely to have the adaptation of deep roots, as well.

alternate – leaf pattern in which one leaf grows from each node on alternating sides of the stem



annual – a plant that completes its life cycle in one year

anther – the pollen-bearing part at the top of a flower's stamen

banding – putting metal or plastic rings (bands) on the legs of birds, making the individual birds identifiable for management and research projects

biennial – a plant that takes two years to complete its life cycle

botany – the scientific study of plants

bract – leaf-like structure at the base of a flower head or inflorescence

biodiversity (biological diversity) – the variety of life and the interrelationships among various levels of living things

biological control – management of a pest species by the introduction of a natural enemy or predator, such as beetles or fungi

biology – the study of living things

biome – the world's major ecological communities which cover large areas; examples are desert, forest, and grassland

brooding – when parents warm baby birds (nestlings) that cannot maintain their own body temperature

bud – undeveloped (or baby) stem or flower; covered with scales

bulb – a short, vertical, thickened underground stem such as an onion; NOT a root

bunchgrass – a grass having a bunched growth form which lacks rhizomes

candidate species – species being considered for listing under the federal Endangered Species Act

classification – in biology, a method to group and categorize organisms

climate – the average weather conditions of a place, such as temperature and rainfall levels, over a long period of time

climax community – the final stage of succession, in which there is a relatively stable plant community

clutch size – the number of eggs laid by an individual female bird

community – all the organisms in a habitat, which interact in a complex food web

common name – a name by which a species is known, rather than its scientific name; can vary by region or country, unlike scientific names

competition – an interaction between organisms or species for a limited supply of one or more resources (such as food, water, and territory) that are used by both

composite flower – the clustering of many small flowers on a single flower base

compound leaf – a leaf divided into two or more separate leaflets

conservation biology – the study of how to protect species, their habitats, and ecosystems through stewardship of entire biological communities

conservation measures – actions to preserve, improve, and/or restore habitat for one or more wildlife species and/or future human use

conservation/restoration plan – recorded decisions of a landowner on how to use his/her land for maintenance or improvement of its natural resources, including soil, water, wildlife, and plant resources

conservation strategy – an approach for protecting a particular species, habitat, or ecosystem

contiguous – connected; meeting or joining at the border

controlled burn – a fire set intentionally, with specific vegetation and weather prescriptions, in order to achieve a specific resource objective

corridor – in terms of conservation biology, a connection between habitat fragments in a fragmented landscape

cover – shelter or protection from vegetation; normally used to assess nesting habitat

cultivation – the plowing and other preparation of land for agricultural planting

cultural resources – locations of human activity, occupation, or use, including archaeological, historic, architectural, and scientific sites

culture – a system of beliefs that guide behavior which are shared by a group of people and passed from generation to generation

diversity – a variety of different things; the number of different species, communities, or habitats; can also apply to human communities

dominant males – the male sage-grouse of a lek who defeat rivals to obtain the best positions on the lek and attract mates

dormancy – a temporary state when a plant or seed is not growing

ecosystem – the plant, animal and other living organisms interacting together and with their environment; often thought of as a functioning unit

ecosystem services – the life-sustaining functions of healthy, diverse ecosystems, such as flood control, food, and water/air purification

endangered species – an organism that is in danger of extinction throughout all or a significant part of its range

Endangered Species Act of 1973 – federal law designed to protect species at risk of extinction and the ecosystems on which they depend; administered by the U.S. Fish & Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration (NOAA)

eradication – complete elimination of something, such as a plant or animal species

ethnobotany – the study of the relationship between people and the plants in their environment

exotic – not native, introduced

extinct – a species that no longer exists

fauna – animal life of an area

field journal – a place to record observations, illustrations, data, and ideas

filament – a thin stalk that supports an anther in a flower

fire suppression – when natural or prescribed burning is not allowed

flora – the plant life of an area

flower – the reproductive part of some plants; used to help make seeds

forage – food available to grazing animals

forb – a non-woody, broad-leaved plant (wildflower)

fruit – ripened flower part that contains the seeds

fuels reduction – using management techniques such as thinning, brush removal, and controlled burns to reduce the amount of surface fuels and prevent or lessen the severity of wildfires

germination – the process through which a seed starts to grow and it is no longer dormant

greater sage-grouse – *Centrocercus urophasianus* is a large, rounded-winged, ground-dwelling bird. Their habitat is sagebrush country in the western United States and southern Alberta and Saskatchewan. They cannot survive in areas where sagebrush does not exist.

groundwater – underground water in soil or permeable rock, often feeding springs and wells

habitat – the place or type of site where an organism lives

herbicide – a chemical designed to control or destroy plants, weeds, or grasses

introduced (nonnative) species – a species brought into an ecosystem by humans (accidentally or intentionally)

invasive species – a species, usually nonnative, that spreads and crowds out native species, causing harm to the environment, economy, and/or human health

invertebrates – animal species which lack a backbone, such as insects, snails, and worms; includes 97 percent of all animal species

landscape – the visible expanse of an area of land, made up of physical elements (landforms, water bodies), living elements (dominant flora and fauna), and human elements (buildings, roads, farms)

leaf – flattened, above-ground piece of a plant attached to a stem, which is usually green during the growing season; uses sunlight to make food for the plant through photosynthesis

leaflet – a division of a compound leaf that is similar to a leaf but is attached to a leaf vein instead of the plant's stem

lek – an area where male sage-grouse display for the purpose of gaining breeding territories and attracting females; areas are usually open with short vegetation within sagebrush habitats; also called “strutting ground”

litter – accumulation of dead plant material on the soil surface

microscopic – so small as to be invisible without a microscope

mineral – any natural, inorganic material that can be extracted from the earth

mitigation – steps taken to avoid or minimize negative environmental impacts

monoculture – area consisting almost entirely of a single plant species

mutation – a rare change in the DNA of genes that creates genetic diversity

native plant – a plant that is naturally found in an area

natural selection – the process in which organisms better adapted to their environment survive to produce more offspring

nectar – a sweet liquid produced in flowers to attract pollinators

node – knob where new plant growth originates

noxious – harmful, poisonous, or very unpleasant

obligate – essential, necessary; for example, sage-grouse are sagebrush obligates because sagebrush is their main source of food in the winter

observation – the act of noticing or paying attention using one's senses

opposite – a leaf pattern in which two leaves grow across from each other at the same node on the stem



organism – individual living thing that can react to stimuli, reproduce, and grow

ovule – the part of the ovary of seed plants that becomes the seed after fertilization

perennial – a plant that lives for more than two growing seasons

pesticide – a chemical designed to control or destroy insects or other organisms

photosynthesis – the process of using energy in sunlight to convert water and carbon dioxide into carbohydrates and oxygen

pioneer species – plant species that grow first in an area without vegetation

policy – a statement of guiding principles or procedures

pollination – the process of transferring pollen between the anthers and stamen of flowers

predation – when one species (the predator) feeds on another (the prey)

public land – land owned by the United States and administered by the Department of the Interior

raptor – bird of prey with sharp talons and strongly curved beaks; includes eagles, hawks, owls, and falcons

rehabilitate – to make habitable or useful again; to return to original condition

reintroduction – to return members of a species to their historical range

restoration – the process of returning a degraded or former habitat to a healthy condition

riparian area – the important strip of habitat along rivers and streams where water is more abundant

rhizomes – horizontal, underground plant stems that send shoots to the surface

root – part of a plant without leaves, usually found underground; roots anchor the plant and take up water and nutrients

rosette – a circular cluster of leaves growing close to the ground

sagebrush ecosystem – an interconnected community dominated by sagebrush with 350+ species; a landscape with shrubs, grasses, and forbs (wildflowers) with few trees; receives most of its water from snow melt

sagebrush steppe – a shrub community dominated by sagebrush; a landscape with shrubs, grasses, and forbs with few trees which is generally flat and found at higher elevations

saline – containing salt; saline soil contains enough salts to negatively impact plant growth

scientific name – the two-part Latin name assigned to a species; system established by botanist Carl Linnaeus in the 1700s

seedbank – all seeds stored in the soil

shrub steppe – a landscape that is a mixture of shrubs, grasses, and forbs with few trees

seed – a mature or ripened ovule; used by plants to reproduce

species – a group of organisms that share a unique set of characteristics and that (usually) can reproduce among themselves

species diversity – the number and variety of species present in a community, as well as the relative abundance of each species

stem – the part of a plant that supports the leaves and buds

stewardship – caring for our natural resources in a way that preserves them for future generations

succession – in ecology, the process of change in an ecosystem through the gradual replacement of one community by another

taproot – a large root that grows straight down and is important for tapping groundwater

threatened species – a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range

topography – the earth surface features of a region, such as mountains, plains, or hills

understory – the portion of a plant community growing underneath the taller plants

ungulate – a hooved mammal such as deer, elk, pronghorn, cattle, and sheep

veins – in leaves, the structures that transport water, sugars, and minerals; can be seen radiating throughout the leaf

watershed – the land area that drains into a river, stream, or other body of water

weed – any plant out of its native habitat that is unwanted and has an ability to spread

whorled – a leaf arrangement in which three or more leaves are growing from the same node on a plant stem

wildfire – an unplanned, rapidly spreading fire over brush, woodland, or grassland

wildflower – a wild or uncultivated flowering plant

wilderness – an area of undeveloped land which has its native character, without permanent improvements or human habitation

woody – plants that are made of, contain, or resemble wood; made hard by lignin in the cell walls

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