Restoring Ecosystems
(8 50-minute class periods)

Authors

Caitlin Meador
Christine Girtain

SUBJECT/GRADE LEVEL

Biology/Life Science
6-9

Materials

- Wolves Meet Rivers Video
- Marsh Food Web Animal Cards (ADI lesson)
- Yellowstone Food Web Cards (adapted from NPS"Eat or Be Eaten)
- String or Yarn
- Chart paper
- Computer access for teacher and students
- Plan for a class of 30 students.

STANDARDS

Next Generation Science Standards

- MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem
- MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems
- MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Mathematics Standards | Common Core State Standards

- MP.2 Reason abstractly and quantitatively.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

English Language Arts Standards | Common Core State

- CCSS.ELA-Literacy.SL.7.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade topics, texts, and issues, building on others' ideas and expressing their own clearly.
- CCSS.ELA-Literacy.SL.7.3: Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.
- CCSS.ELA-Literacy.SL.7.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
- CCSS.ELA-Literacy.RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- CCSS.ELA-Literacy.WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- CCSS.ELA-Literacy.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- CCSS.ELA-Literacy.RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

LESSON OBJECTIVE(S)

Students will read, analyze, and discuss videos or articles on the ecology of apex predators and other endangered wildlife from the literature, especially on population dynamics, food web relationships, habitat selection, and effects of human impact and prepare/present a presentation and poster that will showcase their knowledge.

CAREER CONNECTION(S)

Mentor Background: Dr. Bertrand Lemasson, Research Ecologist

Dr. Lemasson is a research ecologist in the Environmental Laboratory of the U.S. Army's Research & Development Center (EL-ERDC). He is stationed at the Hatfield Marine Science Center (HMSC), which is part of Oregon State University and hosts several state and federal agencies. His research centers on discovering the variety of ways that ecological and anthropogenic processes influence how organisms move through their environment and where we find them. Dr. Lemasson began his career as a field biologist for Rutgers University, where he was tasked with dragging nets through various estuaries in New Jersey and Delaware to help scientists learn how changing marsh characteristics influenced regional patterns in fish abundance. He then went on to graduate school at Utah State University to help model how fish can navigate their way past artificial barriers in our rivers. During his studies he also

became captivated with how interactions among individuals influence their movement decisions, which afforded him the opportunity to model collective behavior at the University of Washington's School of Aquatic and Fishery and Sciences. In his current position at EL-ERDC he is fortunate enough to integrate all his past experiences to pursue questions in both basic and applied ecology. He uses a variety of statistical and computational tools to address his questions. He also runs laboratory experiments or helps collect field data. Each day he learns what he was getting wrong the day before and how to improve moving forward, one step at a time. Dr. Bertrand Lemasson loves being a scientist.

STEM Careers:

https://work.chron.com/list-jobs-ecologists-13743.html

1. Research Ecologist
2. Army Corp of Engineers
3. Field Ecologist
4. Restoration Ecologist
5. Park Naturalist.
6. Marine Biologist
7. Environmental Consultant
8. Environmental Protection Specialist
9. Natural Resource Manager
10. Administration and Teaching

CENTRAL FOCUS

How does the presence or absence of an animal affect an ecosystem? A food web is a network of linked consumer-prey interactions. The apex predators in food webs are usually large animals that feed on other species but have no predators themselves.

ENGAGEMENT: Wolves Change Rivers

Brief Description: Students will be introduced to an ecosystem that was changed by the removal of an organism, but also changed by the reintroduction of that organism. Students will analyze the cause and effect relationship between the removal and damage caused by the removal as well as the reintroduction. Adapted from a lesson from *Earth: A New Wild from PBS* and *Eat or Be Eaten* by *NPS*

Background information:

Procedures:
Time frame: 1 50-minute class period.

Part 1: Food Web Simulation Activity

1. Distribute food chain cards to students and ask them to assemble in a circle. These can be made into necklaces, or can be held

2. Starting with the energy source (The sun), which can be the teacher for this activity, pass the string to the producer (plant) in the activity. Students will have to walk or weave through all the connections to get the string to the appropriate connections and other organisms they need to be connected to. Students will need to hold on to the string as it is passed. Students should have at least one connection with another organism in the food web.
3. If students get stuck, or don't know what sort of relationships there are, the cards they have are detailed with what each organism eats and is eaten by. To support students as they progress through the activity.
4. Ask one student (any organism will work, just not the wolves), to drop their string and simulate the removal of that organism from the food web.
5. Discuss with students what they think the impact that this has on the environment. ***(formative assessment and eliciting prior knowledge)***
    a. What animals will this impact with the removal of this other organism?
    b. What impact will its removal have on the greater ecosystem?
    c. Will only biotic (living factors) be affected? Or will abiotic factors be affected? How? What will happen?
    d. What about the ecosystem itself? How will it change as a result? Accept all answers and gauge student knowledge of these relationships. Some students may already be very knowledgeable about this topic.
6. Questions can be tailored for your students and their knowledge levels.

Part 2: Wolves Change Rivers

1. Have students make a prediction in their science journal or on a notecard of what they think will happen if we removed wolves from this ecosystem. Collect these from students prior to watching the **How Wolves Change Rivers [REMASTERED HD] - George Monbiot**. (***formative assessment).***
2. Watch the video through once while students just watch. Then, watch it again, but this time, ask students to write down as many questions as they can think of related to the video.
3. Afterward, have them work as a pair or team of four to compile and make a list of all of their questions.
4. Ask students as a team to go through their list and eliminate questions that are duplicates.
5. Ask students to then go through the list and as a team decide on the top 5 questions that are most pertinent to be answered in regards to the essential questions and goals for this lesson.
6. Have students share their questions and make a list of all group questions on chart paper or in a digital document so they can be saved and referenced later by all students.
7. These questions will be referenced throughout the unit and by the end of the unit, students should be able to answer some of them.

EXPLORATION Del Rey Marsh Activity Part 1

Brief Description: Students will engage in an ADI investigation that has students analyze an ecosystem and the relationships between animals to propose what would happen if an animal disappeared from the food web. For questions about ADI, or ideas for how to implement it see the link here.

Procedures: Time frame 1 50-minute class.

Phase 1: Task, Ideas and Plan

Task

1. Have students watch the video attached here. While they watch, have them ponder what they are seeing and ask questions about what they are seeing. Have them write down things they noticed and things they wonder about
2. Introduce the task to students, ask them to read and annotate the document that details what they are going to be doing. Answer any questions that they may have. Their goal is to build a food web for the marsh, and then determine how removing certain organisms will affect everything else that lives in the marsh. They are looking to answer the question: Which removed populations would have the biggest effect on the marsh food web?
3. Students should then construct a possible food web using their prior knowledge of animals that might live in a marsh and label this as clearly as possible. This is their first model.

Ideas

4. Introduce key vocabulary and ideas to students if needed for background information. Things like ecosystem relationships, **food webs, producers, consumers, herbivores, carnivores and omnivores** are all essential vocabulary for students. For lower levels this will be an introduction, for older grades, this will be a review of concepts learned previously. Review all terminology and ensure that students know these key terms before moving on by using a mini-quiz or other activity.

Plan

5. Distribute marsh organism cards to pairs of students.
6. Ask students to look at these cards and devise a plan for how they will answer the essential question (Which removed populations would have the biggest effect on the marsh food web?
7. Guide students through the process of developing an investigation. Ask them about what they can observe or measure with the data they have been provided, how will they analyze this data? What charts or graphs will they be utilizing?
8. Emphasize to students that there is no right or wrong way to complete this investigation, but as long as they execute their plan in a logical, controlled and thought out process, what they discover will still be important and valuable.
9. As students struggle, or need assistance, resist giving answers, instead, ask them if they have looked at all the data. What relationships do they notice between all the cards? ARe there any commonalities? Is there an organism or two that shows up more frequently? Or Less frequently? How will they judge impact? How will they measure the effect of an organism on the ecosystem? The idea is for students to construct their own ideas and not necessarily all come to the same conclusion. Creativity is key in this as they find solutions to the problem.
10. End the class period by having students summarize what they know about the topic on a notecard to turn in ***(formative assessment)***

EXPLANATION Del Rey Marsh Activity Part 2

Brief Description: Provide a concise overview of the proposed activity.

Procedures: Time Frame: 2 50-minute classes

Phase 2: Do, Share, Reflect

Do:

1. Students will collect data utilizing the plan they developed previously with their partner.
2. Students will organize this data into tables or graphs and begin working on crafting their

argument by analyzing their data.

3. Teachers will guide their students through the process of analyzing and organizing by providing support and guidance. As you facilitate, look for gaps in understanding and guide students towards the goal.

Share:

1. Students will take their data that they have collected from their investigation, they will craft their argument. This is intended to be their thinking at the current moment based on the data that they have collected. Students will follow the template provided.
2. Teachers will need to teach students the difference between Claims, evidence and justification.
    a. **Claims:** Answer to the guiding questions
    b. **Evidence** gathered from the investigation that supports the claim and is analyzed. (graphs or tables that are explained)
    c. **Justification**: The science and supporting knowledge that explains why the evidence is important.
3. This section can be scaffolded and modeled with the whole class as an example to support learners who need more help. You can also provide a template and sentence stems for students to use as they share their arguments.
4. After arguments are crafted, students will share their arguments with the entire class. This can be done in multiple ways. Whiteboards for each group, a digital slide deck and brief presentations or chart paper.

Reflect:

1. Take time to lead students in a discussion about what they experienced throughout this entire process for the investigation.
    a. Talk about investigative design:
        i. What worked, what didn't?
        ii. What would they change next time if they could?
    b. Talk about the different methods in the room for data collection
        i. Which was the most well designed (in their opinion). Why?
        ii. What data answered the question in the best way?
        iii. What were some of the different ways that others answered the question? Why is it ok that there were different methods?
        iv. Even though there were different methods, did everyone come to similar conclusions?
        v. What conclusions did people come to? What organisms were said to have the biggest impact, do you agree or disagree with their assessment? Does seeing other data change or alter how you would approach the question in the future? What data do you most agree with? Why?
        vi. Ask students to justify their thinking at each stage.
2. If you want to have students complete the report stage, they would need to do so at this time. They can use a scaffolded report to get started, or write from scratch. In general, it is a short report that recounts what they did and how they did it, their claim, evidence and reasoning and what their data suggests.

ELABORATION: Ecosystem Research

Brief Description: Students will complete a research project that looks at the different ecosystems and how they have been impacted by the removal (or addition of organisms) to that particular system. This portion of the lesson cycle is just to complete the research pertaining to their assigned organism (Beavers, Sea Otters, Honeybees and Pythons in the Everglades)

Procedures: (Time frame, 1-2 50-minute class periods)

1. Students will be placed into pairs, or can complete this research individually.
2. Students will either choose or be assigned one of the four animals from the selected case studies. They will then research the organism as well as the ecosystem to present a case (presentation) to the class that explains why this organism is vital (or detrimental) to the ecosystem and why.
3. Students can use predetermined materials (provided), or they can find their own resources. However it is suggested that students who are not familiar with finding credible resources online be provided with a starting point. (see supplemental materials for this information)
4. Students will also construct a food web that is ideal for the selected ecosystem to show understanding of the importance of this balance for nature and ecosystems.

EVALUATION: Restoring Ecosystem Projects

Brief Description: Students will present their completed research on the organism and ecosystem and show their understanding of the importance of reintroducing or eliminating species from an ecosystem for its overall health.

Procedures: (1-2 50 minute class periods)

1. Students will prepare a presentation and poster that will showcase their knowledge of the organism they researched (beaver, pythons, sharks, honeybees or otters), and present this information to their classmates.
2. Students should adhere to and follow the rubric provided in the supplemental materials to complete this portion of the lesson.
3. Students can either construct their presentations on paper, google slides (or other digital media) or in a different manner. This is up to teacher discretion for completion. Teachers will facilitate and help guide students as they construct their presentations
4. Students can also present in front of the class or pre-record short videos to be shown. The format of these presentations is up to teacher discretion.

REFERENCES

- Provide links to resources that you used in the creation of this unit.

  https://www.ibiology.org/ecology/apex-predators/

  Nat Geo Wolves in Yellowstone

  https://web.kamihq.com/web/viewer.html?source=extension_pdfhandler&extension_handler=webrequest_1_autoload_true_user_127735&file=https%3A%2F%2Fd43fweuh3sg51.cloudfront.net%2Fmedia%2Fmedia_files%2FWolves_of_Yellowstone_Teacher_Guide_UPLOAD.pdf&filename=Wolves_of_Yellowstone_Teacher_Guide_UPLOAD.pdf&referer=https%3A%2F%2Fwww.google.com%2F

  Beavers Bear Bison

  https://phys.org/news/2022-02-reintroducing-large-mammals-world-ecosystems.html

20 mammals to reintroduce

https://www.bloomberg.com/news/articles/2022-02-04/how-reintroducing-these-20-animals-could-boost-biodiversity-stabilize-climate

Reintroducing elk in smoky mountains

https://smokymountains.com/park/blog/story-elk-great-smoky-mountains/

Pythons taking over the everglades

https://www.history.com/.amp/news/burmese-python-invasion-florida-everglades

https://ohiostate.pressbooks.pub/sciencebitesvolume2/chapter/1-4-invasive-species-burmese-python-python-bivittatus-and-its-effect-in-florida/

https://www.nature.org/en-us/get-involved/how-to-help/animals-we-protect/black-footed-ferret/

Ash borer beetle destroying Ash trees

https://inspection.canada.ca/plant-health/invasive-species/insects/emerald-ash-borer/identification/eng/1449632962119/1449632962930

https://www.treehugger.com/invasive-plant-swallowing-us-rate-baseball-fields-year-4858740

Sharks & apex predators

https://www.ibiology.org/ecology/apex-predators/#part-3

Sea otters, Urchins & Kelp Forests

https://www.ibiology.org/ecology/apex-predators/#part-2