VULTURES: INDIA'S CLEAN-UP CREW

Subject Area: Science

Grade Levels: 6-8

Purpose and Overview: This lesson plan is divided into two parts. In Part 1, students learn about the cause and consequences of the vulture population decline in India. A short video clip provides context for a discussion and activity related to the role or niche of scavengers and decomposers in an ecosystem.

In Part 2, students examine Colony Collapse Disorder in bees and determine if there are suitable organisms to fill the role of honeybees if Colony Collapse Disorder continues to increase in severity.

In Part 3, students participate in a Socratic Seminar to discuss the role of mosquitoes in several ecosystems and to use their understanding of niches to discuss the consequences of a world without mosquitoes.

Time:

- Part 1: Two 45-minute class periods
- Part 2: One 45-minute class period
- Part 3: Reading for homework before lesson, plus one 45-minute class period

Introduction:

Vultures fill an important role in an ecosystem; they are nature's clean-up crew and help get rid of some of the less desirable things in our environment. They are carnivores, but instead of hunting for live prey, they are scavengers and feed on dead animals or discarded prey left behind by predators.

Vultures image courtesy of Passion Planet, EARTH A New Wild

Vultures have many interesting adaptations that help them fulfill this role. As you can see in the picture to the right, vultures lack feathers on their heads. This adaptation helps to prevent vultures from getting flesh and other materials stuck to their heads when they are eating carcasses, keeping vultures from getting infections from the rotting flesh they consume. They also have excellent eyesight and a strong sense of smell, which helps them to locate their food. Additionally, they have very acidic stomachs, which help them to digest diseases like anthrax and rabies. You may have seen vultures soaring in the air, barely flapping their wings. By soaring on thermals, vultures expend very little energy, which is helpful since they may have to wait a few days between meals.

In the video "Vultures: India's Clean-Up Crew" that accompanies this lesson plan, the role of the vulture is examined in detail, including what happens when there is a drastic decline in the vulture population in India in the late 1990's. Scientists determined that the population decline was caused by the veterinary drug diclofenac, which had been used in cattle. Vultures who fed on the diclofenac treated cattle did not

survive. Because of the practice of disposing of cattle carcasses in carcass dumps, there were high concentrations of diclofenac treated cattle in parts of India. This proved catastrophic for the vulture population and vulture species such as *Gyps indicus* declined by more than 95%. Because vultures are so thorough when they clean carcasses, removing all the flesh and leaving only bones, the loss of the vultures proved disastrous for the ecosystem as well. Dogs soon filled their niche and began eating the cattle remains. However, dogs are not as thorough as vultures in cleaning off all of the rotting flesh and they cannot digest disease-causing viruses and bacteria. As a result dogs that ate the carcasses contracted diseases and passed them on to the human population and the carcass dumps filled up and began to smell.

This lesson plan will examine the role of vultures in an ecosystem and will also dive deeper into the roles of scavengers and decomposers in general. These roles don't often fit neatly into the trophic pyramid as taught in most ecology lessons. Instead, by examining a food web in which decomposers and scavengers are highlighted, students will begin to understand the more cyclical characteristics of an ecosystem with regard to the transfer of energy and matter throughout a food web.

Part 1: Scavengers and Decomposers

Purpose: The purpose of this activity is to introduce students to the special role that scavengers, like the vulture, play in an ecosystem. Additionally, students will explore the difference between niche and habitat and examine the concept of niche replacement.

Time: One 45-minute class period

Materials:

- Teacher - computer, internet connection, LCD projector
- Copies of student worksheet Part 1: Scavengers and Decomposers (located at the end of this document)
- Video "Vultures: India's Clean-Up Crew | EARTH A New Wild" (can be downloaded)
  URL: https://vimeo.com/116273820
- Optional – student access to computers to explore interactive content for the vulture ecosystem
  URL: http://www.pbslearningmedia.org/resource/5aeed659-7f0b-417f-81d9-5f2e9c747644/ecosystem-explorer-earth-a-new-wild/

Objectives:

The student will…

- Explain the role of vultures in an ecosystem.
- Identify the cause of vulture population decline in India and describe the consequences of this decline to the ecosystem.
- Describe niche replacement.
- Identify the scavengers and decomposers in an ecosystem.
- Evaluate the role of scavengers and decomposers in an ecosystem and hypothesize what would happen if these organisms were to disappear from an ecosystem.

Next Generation Science Standards:

Disciplinary Core Ideas

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Cross-Cutting

- Patterns
- Cause and Effect
- Energy and Matter
- Stability and Change

Performance Expectations

Middle School

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

Vocabulary:

Abiotic: a nonliving factor in an ecosystem; examples include rocks, water, sunlight, etc.

Adaptation: a change in which an organism becomes better suited to its environment; the result of natural selection.

Biotic: a living factor in an ecosystem; examples include fish, birds, plants, etc.

Ecosystem: a community of interacting organisms and their physical environment.

Decomposer: an organism that breaks down or decomposes organic material; examples are bacteria, fungi, and invertebrates.

Diclofenac: is an anti-inflammatory drug used for cattle. While safe for use in cattle, it is toxic to vultures and eagles. It is now banned in South Asia where it caused a catastrophic decline in several species of vulture. However, the drug is still available and used in some parts of the European Union.

Habitat: the place where an organism lives or occurs.

Niche: the role of an organism in an ecosystem; where an organism lives and its function.

Niche replacement: when one or more organisms fill the role of another organism. Niche replacement can occur when the population or dominance of one species shifts (including extinction), allowing another type of organism to fill the same role. For example, when the vulture population declined in India, dogs filled their niche as scavenger. In this case, however, the dogs weren't a perfect replacement in that they were not as thorough in their scavenging, resulting in a build-up of carcasses and the spread of disease.

Scavenger: an animal that feeds on dead plant material, trash, or dead animals (carrion).

Trophic level: each of several levels in an ecosystem, composed of organisms that share the same function in the food chain; for example, producers, herbivores (primary consumers), carnivores (secondary consumers and so on).

Suggested Flow Part 1:

1. Begin the lesson with an entry task where students must think of one instance in which humans have negatively impacted an organism. They should write this example in their notebooks and explain what it was that humans did and what was the consequence to an organism (or multiple organisms).

   Entry task: Write one example of an instance where humans have negatively impacted an organism. It could be happening now or something from the past and it could be anywhere in the world. Describe what humans have done that has negatively impacted the plant or animal. If you can't think of something specific – write about something in general.

   Possible entry task answers (or examples to share):

   - DDT that was used as a pesticide made bird eggs fragile and as a result populations of birds of prey like the bald eagle declined.
   - Humans imported invasive species (both plants and animals) and these organisms sometimes out-competed native species. The purple loosestrife is an example. It was brought to the U.S. from Europe by immigrants. This plant can choke out native wetland plants and as a result, wetland ecosystems have been impacted.
   - Colony Collapse Disorder (CCD) in honeybees may be caused by humans. Scientists aren't sure yet what is causing CCD, but some suspect that is could be pesticides.
   - Orangutans and other rainforest animals are threatened with extinction due to habitat loss. Humans turning tropical rainforest habitats into palm plantations and other types of agricultural plantations are some of the major causes of habitat loss.

2. Distribute the student worksheet for Part 1 or have students copy the questions into their notebooks before you show the video. The questions will help to guide student viewing of the video.

3. View the video "Vultures: India's Clean-Up Crew" with students (4:41 minutes).

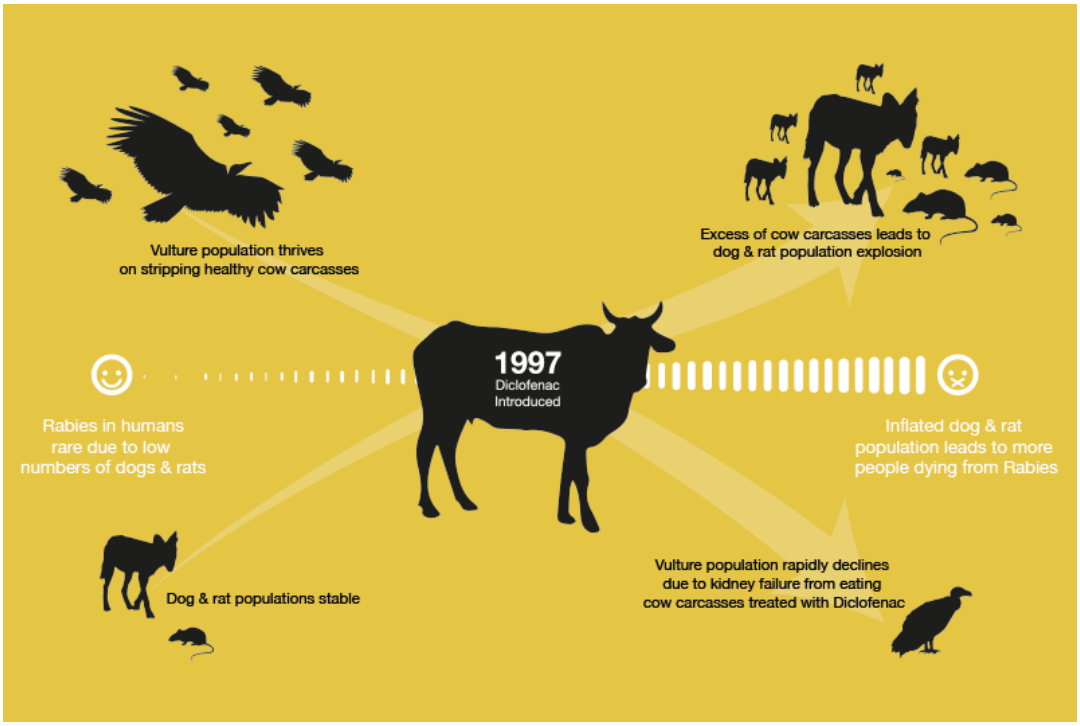
4. Go over the viewing questions with students and make sure they understand the relationship between the diclofenac and the vulture decline. Also make sure they understand that when dogs replaced vultures in their niche, they didn't quite fulfill the same ecosystem role as the vultures did in preventing the spread of disease. In fact, the dogs exacerbated the spread of disease by becoming a vector for diseases like rabies. Answer key is below:

   Part 1: Scavengers and Decomposers Handout - Teacher Answer Key

   1. What adaptations do vultures have that allow them to eat rotten carcasses and not get sick?
      Answer: Some vultures are bald – which keeps them from getting rotting flesh stuck to their heads while they are eating. This prevents infection. They have very acidic stomachs, which allow them to eat and digest the deadly organisms that cause diseases like rabies, botulism, and anthrax.

2. How do the vultures indirectly help humans in India?
   Answer: They help clean up the carcasses of cattle in carcass dumps. This prevents the carcasses from building up and spreading disease. Vultures will eat all of the way to the bone, leaving no flesh behind.

3. Illustrate what happened in India when the vulture population declined.
   Answer: Below is the infographic from the Ecosystem Explorer game. Student answers should include some combination of the following sequence of events: vulture population decrease, cattle carcasses pile up, stray dog population increases, dogs eat the carcasses, the dogs only eat some of the flesh (whereas the vultures would eat everything but the bones), smell worse, diseases that were digested by vultures now left behind, stray dogs get diseases like rabies and then spread these diseases to humans.

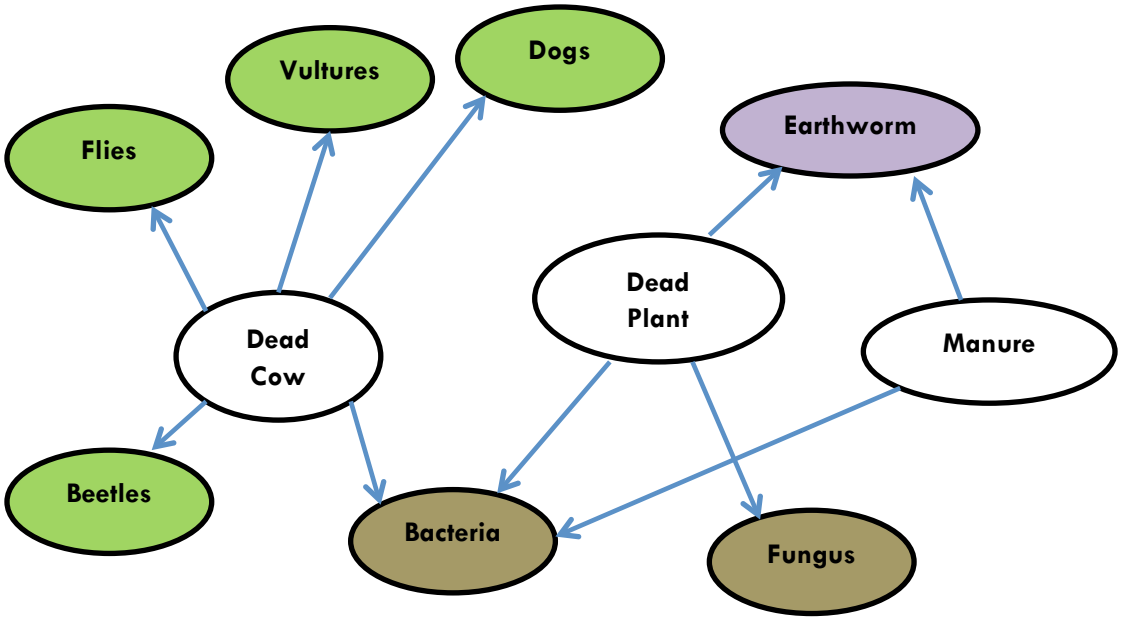


4. List some of the consequences to the human population when the vultures disappeared.
   Answer:
   - Over 20,000 people are infected with rabies every year. 96% of cases result from dog bites.
   - The carcass dumps became piled with rotting cattle.
5. What caused the drastic decline in vulture population?
   Answer: Cattle in India were treated with a drug called diclofenac. This drug was toxic to vultures.

6. Why is the vulture population starting to increase now?
   Answer: Diclofenac use was banned in India and parts of Asia. Captive breeding centers are also helping to increase the vulture population.

7. After viewing the short film, what would you say is the vulture's role or niche in an ecosystem?
   Answer: Vultures are nature's clean-up crew – they are scavengers. They clean up dead organisms and help prevent the spread of disease.

8. Niche replacement can happen when one or more species tries to fill another species niche or role. Do you think that when the dogs replaced vultures in the ecosystem they fulfilled the exact same role as the vulture? Why or why not?
   Answer: Dogs didn't really fulfill the same niche as vultures. They ate the carcasses and performed the role of scavenger, but they weren't as thorough as the vultures and didn't clean off all of the flesh. They also weren't able to digest the diseases like rabies. So really, the vultures' role was to clean up the carcasses and help prevent disease. The dogs didn't do the whole job.



9. **Scavengers** don't spend energy hunting and killing prey, but instead feed on dead animals. Scavengers can be larger organisms like hyenas, raccoons, and some insects. Scavengers start the process of decomposition by breaking down larger pieces of dead organisms into smaller pieces. **Decomposers** also get their energy from breaking down dead animals and plants. However, decomposers tend to be very small and in some cases microscopic. Decomposers break down the smaller pieces or decaying organic matter into their chemical parts. When decomposers break down organic materials, they help to release the nutrients that are stored in the materials back into the ecosystem. Plants, also known as producers, use a combination of these nutrients and the energy from sunlight to make their own food. In the food web above, identify the scavengers by coloring them **green** and the decomposers by coloring them **brown**.
   Teacher Note: The earthworm is purple because it doesn't fit neatly into the scavenger/decomposer categories. Earthworms are detritovores and mostly eat dead leaves and plant material. They sometimes do breakdown manure and occasionally a dead animals or small insects. This would be a great talking point show students how things don't always fit neatly into a category. Students could answer either scavenger or decomposer for earthworm and they would be correct based on the information provided.

10. Scavengers and decomposers aren't always looked upon that highly because they have the job of breaking down dead organisms and organic matter. Some people might think that is kind of gross. What do you think would happen if all of the decomposers and scavengers disappeared from the ecosystem? Use the food web above and the information in #9 to help you answer the question.

    Answer:
    - Build-up of waste like manure, dead organisms (animals and plants)
    - Nutrients would be locked up in dead organisms
    - There would be no new nutrients added to the system, which would eventually make it difficult for plants to grow and as a result their food web would crumble…

11. If all of the decomposers/scavengers disappeared, how would humans be affected?
    Answer: It would probably be a pretty disgusting world because there would be so much detritus, dead animals, and feces around. In addition, because nutrients would be locked up in dead organisms, it would be difficult for plants to grow, which would mean less food for humans. In addition, if there were fewer plants, there would be less food for all animals including humans.

5. You can assign question 12 from the Part 1 worksheet "Draw a comic OR write a short paragraph in the form of a story of a world without scavengers/decomposers…" to be completed in class or at home. Have students share their stories and/or drawings with the class.

6. Optional activity: At this point, if you have access to student computers, it may be useful to provide students with another opportunity to interact with the vulture story. The "Ecosystem Explorer" was inspired by content from the EARTH A New Wild series and includes a "Vulture World" where students can explore the vulture ecosystem through interactive, multi-media content. You can find the interactive content here: http://www.pbslearningmedia.org/resource/5aeed659-7f0b-417f-81d9-5f2e9c747644/ecosystem-explorer-earth-a-new-wild/. If time doesn't permit, you could assign this as homework.

Other Resources for Part 1:

- For a more in depth lesson on producers, consumers, and decomposers visit this link: http://www.pbslearningmedia.org/resource/tdc02.sci.life.oate.lp_energyweb/producers-consumers-decomposers/
- To read how diclofenac is in the news again in Europe, check out this article: http://www.nature.com/news/poisoned-vulture-could-herald-european-bird-crisis-1.16161
- To read one theory about the probable effect on an ecosystem if all decomposers died, check out this article: http://education.seattlepi.com/describe-probable-effects-ecosystem-decomposers-were-die-4360.html
- To view a NOVA video about the role of decomposers, check out this link: http://www.pbslearningmedia.org/resource/tdc02.sci.life.oate.decompose/decomposers/

- To view a video about how two companies are making money with bacteria and fungi, check out this link: http://www.pbslearningmedia.org/resource/ffb84bb7-e9d2-4872-bb65-e4e0d377f45e/putting-decomposers-to-work/
- To view a video about how worms decompose organic waste, check out this video: http://www.pbslearningmedia.org/resource/3daedfdc-edec-4c2e-b301-850cb5a8653e/3daedfdc-edec-4c2e-b301-850cb5a8653e/
- To learn about another type of scavenger, the Tasmanian Devil, check out this video: http://www.pbslearningmedia.org/resource/a4be75d8-2dd9-4e8f-8ebf-33e4b32c2218/a4be75d8-2dd9-4e8f-8ebf-33e4b32c2218/

Part 2: The Plight of the Honeybee

Purpose: The purpose of this activity is to have students examine the role of the honeybee in an ecosystem and to brainstorm how its population decline could impact humans and other organisms. Additionally, they will investigate whether or not there is a suitable organism that could fill its niche if its population were to decline dramatically.

Time: One 45-minute class period (3 class periods if optional activity conducted)

Materials:

- Teacher - computer, internet access, LCD projector
- Student copies of the Scientific American Article "Plan Bee: As Honeybees Die Out, Will Other Species Take Their Place?" by Christopher Mims
  URL: http://www.scientificamerican.com/article/other-bee-species-subbing-for-honeybees/
- Access to these videos:
  - "Vultures: India's Clean-up Crew | EARTH A New Wild"
    URL: https://vimeo.com/116273820
  - "Pollinators: Putting Food on the Table"
    URL: https://vimeo.com/77811127
- Optional - Copy of the lesson plan "Bee Detective: Discover the Culprit Behind Declining Bee Populations"
  URL: https://www.natureworkseverywhere.org/#resources/527be724c4b7765f18581cb6

Objectives:

The student will…

- Examine the issues surrounding Colony Collapse Disorder with bees.
- Describe the ecosystem impacts of the loss of honeybees.
- Describe the impacts to humans of the loss of honeybees.
- Determine if there is a suitable organism that could replace bees and fill their niche and evaluate their suitability for this role.

Next Generation Science Standards:

Disciplinary Core Ideas

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Cross-Cutting

- Patterns
- Cause and Effect
- Energy and Matter
- Stability and Change

Performance Expectations

Middle School

- 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.

Vocabulary:

Colony Collapse Disorder: is a phenomenon in which worker bees from a European honeybee colony suddenly disappear. The causes are unclear, but there are several possible causes including pesticides, mites, loss of habitat, and several other factors.

Background:

In the "Vultures: India's Clean-Up Crew" video, diclofenac, a veterinary drug for cattle, contributed to the staggering loss of vultures in India. This was not the first instance of human activities that had far-reaching effects on the ecosystem. Over fifty years ago in the United States, Bald Eagles were near extinction because of the pesticide DDT, which was used to control for mosquitoes. The DDT interfered with the birds' ability to produce eggs with strong eggshells. When the birds where incubating the eggs in the nest, the weak eggshells would break. This had huge consequences for the population of Bald Eagles and by 1963, only 487 nesting pairs remained in the United States.

In more recent news, over the last decade, we have been warned about something called Colony Collapse Disorder with bees. Colony Collapse Disorder (CCD) is the sudden demise of a honeybee colony. In 2007, U.S. beekeepers lost more than a third of all of their hives. Scientists aren't quite sure what is causing CCD, but they have a few ideas that include everything from mites, to cell phones, to pesticides and genetically modified crops. New research from the Harvard School of Public Health suggests that a class of insecticides called neonicotinoids is to blame. Could this be another case where human activity is disrupting the ecosystem? Regardless of the cause of CCD, the effects of a decline in bee population could have huge consequences for humans and the world in which we live.

In this activity, your students should brainstorm what a life without honeybees would be like. What organisms would be directly affected by the loss of bees and which organisms would be indirectly affected? Is there an organism that could fill the niche of the honeybee?

Suggested Flow:

1. If you use an entry task, have students answer the questions:
   - What do you know about what's happening to honeybee populations in the United States?
   - What do honeybees pollinate?

2. Discuss the answers to these questions to determine students' prior knowledge about the topic of Colony Collapse Disorder. Generate a class list of items that honeybees are responsible for pollinating. This list could include: alfalfa, apples, apricots, blueberries, cherries, clover, cranberries, cucumbers, melons, nectarines, peaches, pears, plums, pumpkins, squash, and sunflowers.

3. Give students the background (above) behind the various ways that humans have negatively impacted organisms in addition to the example from the "Vultures: India's Clean-Up Crew" video. It is not clear whether humans are to blame for the demise of the bees, but pesticide use continues to be one of the possible factors.

4. Go over the list of things that bees pollinate and students identify what is food for people and what is food for other organisms. Note – clover and alfalfa are food for livestock. Students may need help in identifying this. Explain to students that pollinators provide a valuable ecosystem service to humans, which is in the form of pollinating our food crops.

5. It may be useful to show students the Nature Works Everywhere video "Pollinators: Putting Food on the Table" (3:33 min). This video will give them an overview of the role of pollinators.

6. Have students create a diagram or a flow chart that illustrates what might happen to an ecosystem (that includes humans) if the honeybee population continues to decline.

7. Next have students read the Scientific American Article "Plan Bee: As Honeybees Die Out, Will Other Species Take Their Place?" by Christopher Mims and have them try to identify and discuss if there are other species that may suitably fill the honeybees' niche.

8. Optional - If you would like to expand this lesson to include a student investigation into the possible causes of CCD, visit the Nature Works Everywhere site and download the lesson title "Bee Detective: Discover the Culprit Behind Declining Bee Populations". In this lesson students hypothesize the possible causes of CCD based on bee behavior and biology.

Related Resources:

- For more information on the plight of the bees, read the Cool Green Science Blog by The Nature Conservancy "The Plight of the Bumble Bee: Conserving Imperiled Native Pollinators"
  URL: http://blog.nature.org/science/2014/03/19/plight-of-bumble-bee-native-pollinators-ecosystem-services/

- For a short video that explains more about Colony Collapse Disorder and its impact, check out this video clip by NATURE (2:39 min)
  URL: http://www.pbslearningmedia.org/resource/vtl07.la.rv.text.colonycoll/colony-collapse-disorder/

Part 3: Socratic Seminar – Do We Need Mosquitoes?

Grades: 6-8

Subject: Science

Purpose: The purpose of this lesson is to extend and broaden your students' understanding of ecological niches, using a Socratic Seminar as a forum to discuss niche and niche replacement with respect to the value of an organism that is considered by humans to be a pest – the mosquito.

Time: With the reading given as homework the night before, one 45-minute class period

Materials:

- Student copies of the article "A World Without Mosquitoes" by Janet Fang
  - Direct PDF to download (lesson plan references paragraph numbers on this version) URL: http://www.nature.com/news/2010/100721/pdf/466432a.pdf
    - Regular online version: URL: http://www.nature.com/news/2010/100721/full/466432a.html

Objectives:
The student will…

- Read and think critically about the evidence provided in a text on mosquito eradication.
- Cite evidence from the text to support their thinking.
- Identify the niche of mosquitoes in multiple ecosystems.
- Engage in collegial discussion with other students regarding the ideas presented in a text.
- Use evidence from the text to evaluate the necessity of mosquitoes in an ecosystem.

Next Generation Science Standards:

Disciplinary Core Ideas

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Cross-Cutting

- Cause and Effect

Science and Engineering Practices

- Constructing Explanations
- Engaging in Argument from Evidence

Performance Expectations

Middle School

- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Common Core English Language Arts – Science and Technical Subjects (6-8)

- CCSS.ELA-LITERACY.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.
- CCSS.ELA-LITERACY.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
- CCSS.ELA-LITERACY.RST.6-8.5: Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.
- CCSS.ELA-LITERACY.RST.6-8.6: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.
- CCSS.ELA-LITERACY.RST.6-8.8: Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

Vocabulary:

Detritus: waste or debris of any kind; organic matter produced by the decomposition of organisms.

Eradicate: to get rid of or destroy entirely; "to eradicate a disease" is to wipe it out forever.

Larvae: a juvenile form of animals that undergo metamorphosis; examples of organisms with a larval phase include amphibians and insects. Tadpoles are a larval form of frogs. Caterpillars are a larval form of butterflies.

Malaria: a mosquito-borne disease in humans caused by a parasite; symptoms include high fevers, chills, shaking, and flu-like symptoms.

Pathogen: an infectious agent that causes disease or illness in its host; examples include bacteria, viruses, and parasites.

Protozoa: a diverse group of mostly unicellular (one-celled), eukaryotic (has organelles) organisms; examples include amoebas and paramecia.

Vector: is any agent (person, animal, or microorganism) that carries and transmits an infectious pathogen into another organism. Mosquitos are vectors for malaria. Ticks are vectors for Lyme disease.

Background:

A Socratic Seminar is a way to foster active learning, inquiry, and critical thinking skills in students. The teacher's role in a Socratic Seminar is as a guide and coach. The ideal room set-up is for students to sit in a circle with the teacher as part of the circle and at the same height as the students. It's important that the teacher relinquish a little bit of control during the discussion. It's also important to accept that there will be periods of uncomfortable wait time while students think about the text and the discussion. To begin the seminar, use an opening prompt (provided below). During the seminar, if the discussion totally stalls, move the discussion along using prepared prompts like those provided below. If the discussion goes off track, you can restate the opening question. If there are students who have not spoken during the seminar, you may ask "who hasn't had a chance to speak?" If appropriate, you might also ask students to cite evidence from the text or ask them to relate their statements to what someone else has said. It will be very helpful if during the seminar, you are taking notes about the main points of discussion.

At the end of the seminar ask students to summarize the main points that were made in the discussion. To close the seminar, debrief with students about the process and share your own observations about the experience.

With respect to grading and assessment, some teachers offer points for participation in the seminar. At the end of the seminar, you could also have students write a reflection on the process and have them detail their initial perspective about the article and then have them comment on how the discussion may have shaped their ideas.

To learn more about Socratic Seminars, check out the following resources:

- National Paideia Center website: http://www.paideia.org/
- NSTA article on Socratic Seminars by Jeanne Ting Chowning: http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/4/tst09_076_07_36
- To see a Socratic Seminar in action in the science classroom and hear advice from a teacher, check out this video by Northwest Association for Biomedical Research (NWABR): https://www.youtube.com/watch?v=9TckVI4e3Y0

Suggested Flow:

1. Give students the article to read as homework before the Socratic Seminar. In order to participate in the seminar they MUST have read the article. **Before photocopying the article, be sure to number each paragraph.** It is much easier to cite evidence from the text when students can refer to a numbered paragraph.

2. Before you begin the seminar, share the purpose of the discussion and the rules with the students.
    a. The purpose: To understand the ideas and values in the "A World Without Mosquitos" text through shared discussion.
    b. The rules for students are:
        - No hand-raising. Focus on the speaker and wait until it's their turn to talk.
        - Only one person can speak at a time.
        - Be courteous to each other, even when disagreeing.
        - Respond to each other by name.
        - Listen carefully.
        - Monitor your air time.
        - Reference the text to cite evidence for your statements.
        - Keep an open mind and be willing to be flexible in light of new information.

3. Read aloud the Socratic Seminar opening question to students:
    The article "A World Without Mosquitoes" begins with the sentence "Eradicating any organism would have serious consequences for ecosystems – wouldn't it? Not when it comes to mosquitoes, finds (the author) Janet Fang." After reading the article, do you agree with this statement? Or were there facts in the article that make you think differently?

4. Below are possible prompts that you can use during the discussion as needed.
    a. Are there any words or ideas in this article for which you would like a definition or clarification?
    b. Analyze the author's purpose in writing this article.
    c. What evidence does the author supply to support the eradication of mosquitos?
    d. Did the author supply evidence AGAINST the eradication of mosquitos? If so, what?
    e. Were there aspects of the article that were based on judgment or speculation rather than scientific facts?
    f. What is the mosquito's niche?
    g. In which cases would the absence of mosquitoes be felt by an ecosystem?
    h. Are ecosystems and their functioning more or less important that the human suffering caused by disease carrying mosquitoes? Are there statements in the article that support either side?
    i. In the "Vultures: India's Clean-up Crew" video, when the vultures disappeared from the ecosystem, they were replaced by dogs. An instance where organism B can fill the niche of organism A (in the absence of organism A) is called niche replacement. Are there examples of niche replacement in this article?
    j. Do all organisms have value, even those that we don't like or those that harm us? Is this an emotional argument or can this be supported by scientific evidence?
    k. In paragraph 19, there is a statement "The ecological effect of eliminating harmful mosquitoes is that you have more people. That's the consequence." According to the article, what are the positive aspects of mosquito elimination for the humans? Are there any negative ecosystem consequences to an increased human population? Does the article talk about the consequences of human population growth versus human suffering?
    l. If mosquitoes are eliminated, that could potentially eradicate diseases like malaria. In paragraph 20, a scientist's work suggests that human suffering would be temporarily relieved until another organism filled the mosquito's niche as a disease vector. Does this provide a reason not to eliminate mosquitoes since another organism will just fill its niche and take its place?

5. To close the seminar, you might ask the following questions:
    a. Do you think the author has provided sufficient evidence in her argument to eliminate mosquitoes? Is there anything missing from the argument that would help you make a decision to eradicate mosquitos (or not)? If so, what?
    b. Do you think that mosquitoes should still be allowed to exist? Why or why not? Base your answer on evidence from the article.

6. Have a student or students summarize some of the main points of the seminar.

7. Before the end of class, be sure debrief the seminar with students. You could ask them if the norms were followed and if they felt like there was enough participation. You could ask them how their viewpoints changed during the course of the discussion.

8. As mentioned previously, as a final assessment of the activity, you could have students write a reflection on the seminar process and their final thoughts on the topic of niche replacement and the value of organisms like mosquitoes (or the value of organisms in general).

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VULTURES: INDIA'S CLEAN-UP CREW

Student Worksheet

Part 1: Scavengers and Decomposers

Section A: Video Viewing Guide

Watch the video "Vultures: India's Clean-Up Crew" and answer the questions below.
URL: https://vimeo.com/116273820

1. What adaptations do vultures have that allow them to eat rotten carcasses and not get sick?

2. How do the vultures indirectly help humans in India?

3. Illustrate what happened in India when the vulture population declined.

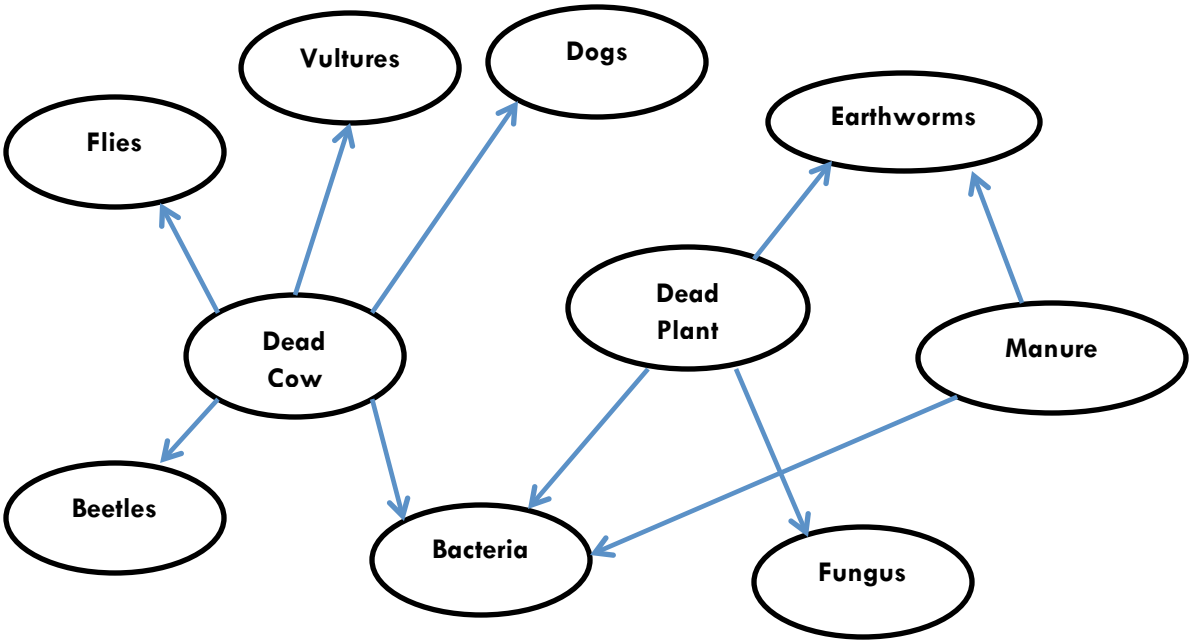
4. List some of the consequences to the human population when the vultures disappeared.

5. What caused the drastic decline in vulture population?

6. Why is the vulture population starting to increase now?

7. After viewing the short film, what would you say is the vulture's role or niche in an ecosystem?

8. Niche replacement can happen when one or more species tries to fill another species niche or role. Do you think that when the dogs replaced vultures in the ecosystem they fulfilled the exact same role as the vulture? Why or why not?



9. **Scavengers** don't spend energy hunting and killing prey, but instead feed on dead animals. Scavengers can be larger organisms like hyenas, raccoons, and some insects. Scavengers start the process of decomposition by breaking down larger pieces of dead organisms into smaller pieces. **Decomposers** also get their energy from breaking down dead animals and plants. However, decomposers tend to be very small and in some cases microscopic. Decomposers break down the smaller pieces or decaying organic matter into their chemical parts. When decomposers break down organic materials, they help to release the nutrients that are stored in the materials back into the ecosystem. Plants, also known as producers, use a combination of these nutrients and the energy from sunlight to make their own food. In the food web above, identify the scavengers by coloring them **green** and the decomposers by coloring them **brown**.

10. Scavengers and decomposers aren't always looked upon that highly because they have the job of breaking down dead organisms and organic matter. Some people might think that is kind of gross. What do you think would happen if all of the decomposers and scavengers disappeared from the ecosystem? Use the food web above and the information in #9 to help you answer the question.

11. If all of the decomposers/scavengers disappeared, how would humans be affected?

12. On a separate piece of paper, draw a comic OR write a short paragraph in the form of a story of a world without scavengers/decomposers. Be sure to illustrate how humans will be affected by this change.

Optional: Your teacher may assign you to check out the "Ecosystem Explorer," which was inspired by the EARTH A New Wild series and includes a "Vulture World" where you can explore the vulture ecosystem through interactive, multi-media content. You can find the interactive content here: http://www.pbslearningmedia.org/resource/5aeed659-7f0b-417f-81d9-5f2e9c747644/ecosystem-explorer-earth-a-new-wild/