Where There is Water, There is Life!

 Exploring the endemic and cosmopolitan diatom species in the McMurdo Dry Valley, Antarctica using the MCM LTER database

Summary

Microbes, specifically diatoms are not only abundant in all ecosystems on Earth but have a profound impact on the functioning of the Earth as a system. Understanding and identifying diatoms becomes important to determine the success of the ecosystem. Humans also have a profound impact on the environment by transporting alien species through tourism and scientific research expeditions. Students will be exploring what endemic and cosmopolitan species are on a local, regional and global scale using a variety of activities and technology. Students will also explore the positive and negative roles humans play in changing an ecosystem.

*[TAGS: Native, Endemic, Invasive, Cosmopolitan Species, MCM LTER, diatoms, Polar Science]*

Key Concepts

* Analyzing, interpreting and communicating scientific data.
* Utilizing data to determine solutions
* Recognizing endemic and cosmopolitan species on a local, regional and global scale
* Further understanding of human impact on the environment
* NGSS Practices: Obtaining, evaluating, and communicating information; constructing explanations for science; analyzing and interpreting data

Objectives

Students will be able to:

* ***Observe*** and ***identify*** the endemic and cosmopolitan species in their area and in the MCM dry valley, Antarctic.
* ***Record*** which species are endemic and cosmopolitan
* ***Demonstrate*** understanding of the difference between endemic and cosmopolitan species
* ***Critically think*** about the role humans play in spreading cosmopolitain species and the implications these species have on an ecosystem
* ***Evaluate*** and ***reflect*** on their work and the work of their peers
* ***Communicate*** possible solutions through an environmental memo

Materials

* Diatom Morphology Matching Cards (Print out number of sheets needed and cut)
* Endemic & Cosmopolitan Graphic Organizer
* Idenifying endemic and cosmopolitan diatoms worksheet
* Environemntal policy memo instructions
* Reading Materials:
	+ **What are Diatoms?** <http://huey.colorado.edu/diatoms/about/diatoms.php>
	+ **Alien Species Invading Antarctic via Tourists, Scientists** <http://news.nationalgeographic.com/news/2012/03/120305-antarctica-invasive-species-environment-science-tourists/>
* You Tube Links:
	+ **Antarctic Climate Secrets : Diatom Tour Video** (2:07 min) <https://youtu.be/mCA5gdGAhUg>
	+ **Antarctic Film Fest: Diatoms Video** (3:05 min) <https://youtu.be/uENqq6m4nY8>
	+ **Diatoms in Antarctica Video** (1:57 min) <https://youtu.be/H7ejnoo7Xc8?t=48s>
* Websites:
	+ **Microbe Morphology Check** <http://huey.colorado.edu/diatoms/morphology/index.php>
	+ **Fortune teller instruction sheet** <http://www.peoriapubliclibrary.org/files/Fortuneteller-Instructions.jpg>
* Computers

Procedure

*On a global basis...the two great destroyers of biodiversity are, first habitat destruction and, second, invasion by exotic species. - E.O. Wilson*

Engage: *What is a freshwater diatom? What is an Antarctic ecosystem?* *Where is the MCM LTER?*

1. On the board or screen: *“What is an antarctic ecosystem? How do diatoms play a role in the antarctic ecosystem?”*
2. Give the students time to record their answers. As they finish, put the *What are Diatoms* link on the screen for all students to read. Have the students add any additional thoughts based on the reading to their initial question responses.
3. While the students are adding to their responses, pull up the two videos.
4. Watch the **Antarctic Climate Secrets : Diatom Tour Video** (2:07 min)
5. Watch the **Antarctic Film Fest: Diatoms Video** (3:05 min)
6. Once again, have the students add additional thoughts to their initial responses based on the videos. After all students have completed their responses, ask a few volunteers to share both their initial thoughts and revisions after the reading and videos.
7. Introduce and pass out the **Diatom Morphology Matching Cards**. (Print out the number of cards needed and pair or group students based on proximity.)
8. Once the students have matched up the diatom cards, pull up the **Diatom Morphology website** and have the students check to see if their pairings match. Explain and discuss the size of diatoms, the process that scientists must go through to identify each diatom as they collect samples, and the importance of such a tiny organism in the antarctic ecosystem. Discussion questions could include: *“What possible adaptations are needed for the diatoms to survive?” “Why does shape matter” “How might saltwater diatoms look different? “Do certain diatoms prefer to live in one location vesus another?”*
9. Watch the **Diatoms in Antarctica Video** (1:57 min) that displays diatoms through the microscope. Then discuss the scientific methods used.

Explore: *What makes a species native (endemic), cosmopolitan (invasive)? What characteristics do endemic and cosmopolitan species have? What species are endemic and cosmopolitan in your area?*

1. Define and discuss the terms *Native (Endemic) Species and Invasive (Cosmopolitan) Species.* Use the graphic organizer to work as individuals, pairs, or groups to define terms. (Don’t answer questions or add examples yet)
2. Then, have the students rewatch the **Antarctic Film Fest: Diatoms Video** (3:05 min) and record observations from the video that could lead to the introduction of invasive species in Antarctica.
3. Once students have recorded their video observations take time to discuss prevention of invasive (cosmopolitan) species.
4. Pass out the **Alien Species Invading Antarctica Article.** Students work in small groups or indiviually to respond to the questions. After activity, follow up with class discussion covering major points of the article as it relates to the lesson theme.
5. Refer back to the graphic organizer to answer questions and add examples.
6. Explore native (endemic) and invasive (cosmopolitan) species in your own community and/or state. (Use the links in Additional Resources)

Extension Activity:

1. Explore native (endemic) and invasive (cosmopolitan) species in your own community. Create a Project Noah (Link in Additional Resources)

Explain: *Which diatom species in the MCM LTER are endemic? Which are cosmopolitan? What portion of a population sample is endemic/ cosmopolitan?What is your evidence to support your thinking?*

1. Create groups of 2-4 students.
2. Pass out the **Identifying Endemic and Cosmopolitan Diatoms** **worksheet** and use as a guide to access the Antarctic Freshwater Diatoms database.

\*\*There are multiple parts within the worksheet such as creating a product and an observation table.\*\*

Elaborate: *What abiotic variables influence the relative abundance of endemic and cosmopolitan diatoms in a population sample?*

1. In the elaborate portion of the lesson, students should focus on using the MCM LTER freshwater diatom database <http://huey.colorado.edu/diatoms/samples/index.php> to create and explore research questions of their choosing focusing on the abiotic variables (such as stream flow, water temperature, conductivity) that could influcence the relative abundance of endemic and/ or cosmopolitan diatoms in a population sample. This portion is meant to be open ended and flexible for various grade and skill levels.
2. The following questions are meant to help guide students with their research.

It is important to remember, the stream gauge data is collected at a very high frequency (every 15 minutes), whereas diatom samples are collected at a much lower frequency (1 - 2 samples/year). Therefore, there are many ways to analyze the stream gauge data to integrate over a disparity of time scales. For example it may be fruitful to take hourly, daily, or annual averages of the gauge data.

* What is your research question?
* What is your hypothesis?
* What waterbody are you exploring?
* What are the collection years you are looking at?
* What is/ are the collection types you selected?
* If you are searching by taxon name, what taxa are you gathering data for?

3. Once you have decided and recorded your data parameters, populate the data and analyze it.

* Organize data into a table.
* Create a graph or visual to explain data.

4. Answer the follow questions as part of your research:

* How does your data help you answer your research question?
* Does your data support your hypothesis?
* What does your data mean?
* What can you conclude from your data?

Evaluate: *Thinking of the future, what solutions and policy memos can you think of to protect the biodiversity and habitat of the MCM LTER and other ecosystems affected by tourism and scientific exploration?*

1. Using information and experiences from this lesson students will examine the consequences and solutions of human impact on the environment in addressing the problem of scientist and tourist spreading alien species in the Antarctic ecosystem by creating an environmental policy memo. Students will use the origami fortune teller to communicate their ideas through a variety of contextual layers.
2. Have blank paper, various art supplies, the fortune teller and environmental policy memo sheet in addition to the project rubric available for student reference and use.
3. After students have finished the project, allow them present their projects either through a gallery walk or 1 minutes class presentation. Sample questions for project analysis provided on project rubric sheet.
4. Students should also create a brief explanation to accompany their project presentation or gallery walk.

Assessment

* **Performance:** Students will work in small groups or as individuals to explore the MCM LTER database to identify potential endemic and cosmopolitan species.
* **Product:** Students will work in small groups or as individuals to create an environmental policy memo using an origami fortune teller.
* **Assessment:** Students’ understanding will be assessed by using the Environmental Policy Memo Fortune Teller rubric and through follow up discussions and/or reflections.

Additional Resources

* Polar Explorers: Natives & Invasives in Antarctica <https://freshwaterblog.net/2011/10/10/polar-explorers-natives-and-invasives-in-antarctica/>
* National Wildlife Federation <https://www.nwf.org/Wildlife/Threats-to-Wildlife/Invasive-Species.aspx>
* 5 Invasive Species You Should Know <http://ocean.si.edu/ocean-news/5-invasive-species-you-should-know>
* United State Dept of Agriculture <https://www.invasivespeciesinfo.gov/index.shtml>
* Invasive Species Info by State <https://www.invasivespeciesinfo.gov/unitedstates/state.shtml>
* Invasive & Exotic Animals of North America <http://www.invasive.org/>
* Extension Activity: Project Noah <http://www.projectnoah.org/> Also available as an app
* Pacific Northwest Research Station--Invasive Species <http://www.fs.fed.us/pnw/invasives/>
* Graphing and Analyzing Proportional Relationships: Representing and Comparing Rates- Khan Academy <http://www.pbslearningmedia.org/resource/f6rtqczayco/comparing-proportional-relationships-exercise-khan-f6rtqczayco/>