TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

PolarTREC Lesson Resource

The March of Nitrifiers - Good or Bad?

Kate Steeper

Shrubs Snow and Nitrogen in the Arctic 2019

PolarTREC Expedition Page
https://www.polartrec.com/expeditions/shrubs-snow-and-nitrogen-in-the-arctic-2019

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Objectives

Students will be able to:

- Analyze graphical data to draw conclusions
- Compare and contrast the chemical structures of nitrous oxide and carbon dioxide
- Explain how differences in the structure of nitrous oxide and carbon dioxide lead to differences in their reactivity and functions as a greenhouse gas
- Argue how changing shrubbery impacts climate change and greenhouse gases

Preparation

Students will need some background with regards to climate change including the role of carbon dioxide in global warming and chemical equations.

In-Classroom

- Provide students with student handout. Suggested grouping of 3-4 with student roles such as “reporter”, “reader”, “scribe”, “leader”.
- If following the Extension: Rulers, calculators, and/or colored pens or pencils needed

Virtual:

Suggested grouping of 3-4 students (see suggested roles above). This can be achieved with breakout rooms in Zoom. Other platforms may have similar features.

Student presentation software or website access such as PowerPoint or Google Slides

Optional: Students can record videos of themselves presenting and share it with their group or class. There are numerous ways to achieve this. Some options are smartphones, Zoom recordings completed outside of class, or websites such as Flipgrid.

Procedure

Sticky Matrix Warm-Up

In-Class

- Pass out a Post-it to each student as they enter the room.

Resource Details

Region

Arctic

Grade

Middle School and Up

Permission

Download and Share

Expeditions

Shrubs Snow and Nitrogen in the Arctic 2019

Related Members

Kate Steeper

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Materials

Ruler

Calculators

Colored pens or pencils needed

Large whiteboard for each group

Post It or half sheet of paper

Poster or whiteboard with warm-up question where students can place stickies

- Post the question “Which greenhouse gas, carbon dioxide or nitrous oxide, will have a greater impact on climate change?” either on a poster or the whiteboard in plain view that is easy for students to access. This is a formative assessment; there is no right or wrong answer at this point. Tell students they do not need to write their names (to reduce students' fear about getting the “right” answer).

- Ask students to place their sticky for their choice on the poster or board. Students will revisit this question at the end of the lesson. It may be helpful to save the poster or take a picture of it to compare student responses. When students have placed their Post-its on the board they can take their seats.

Snowball Fight Alternative: Have students gather in a circle after writing their choice on a Post-it or half sheet of paper and instruct them to throw the crumpled paper into the circle. Instruct them to pick up the crumpled paper and randomly pick students to read the answers aloud.

- Tally the total for carbon dioxide and nitrous oxide. The teacher may also ask students to volunteer their reasoning. Refer back to this result at the end of the lesson.

Virtual

- If using a platform such as Zoom the teacher can post the question by sharing their screen and ask students to respond in the chat.
- Tally the total for carbon dioxide and nitrous oxide. The teacher may also ask students to volunteer their reasoning. Refer back to this result at the end of the lesson.

Introduction

In-Class:

1. Choose readers to read the introduction. The teacher may also want to project the images and reading at the front of the classroom.
2. Review the graph either in small groups or independently. See Extension directions below for additional challenges for students.
3. Allow students to answer questions 1-3 in small groups or independently before reviewing as a class.
4. Choose readers for the next reading segment. Review chemical equations with the class if needed.
5. To complete the chart, students will need access to computers or books to research answers to each section. The teacher may provide the websites for more support if needed.
6. This is ideally completed as a group.
7. Once students have completed their research allows them to continue on and answer questions 4-6 as a group while writing their answers on the handout. This handout can be collected at the end of the activity for credit.
8. Have groups write their claim, evidence, and reasoning on their posters. It is useful to show the class a format for this such as a 2x2 chart with headers of Evidence and Reasoning for each claim.

- The teacher can ask for more or less than three lines of evidence. It seems to help students focus their thinking by reminding them what evidence is and asking for a minimum number.
- The teacher may also want to provide sentence starters for the claims, evidence, and reasoning.
- Allow enough time for groups to finish their posters or whiteboards.
- Depending on the set of students, they may spend a significant amount of time on the appearance of the presentation rather than the content. If this is the case a class timer is

recommended. If students do not complete their posters before time is up, they can present their information verbally.
- Have one or two students remain with the poster to present it while the remaining members of the group rotate. * It may help to keep students accountable if presenters and reviewers are required to take notes. Instruct reviewers to rotate to each group to listen to presentations and remind presenters to ask for feedback at the end of their presentation. The teacher may provide more structure by only allowing rotations when the timer goes off or allow students to move freely. Depending on how the presentations are progressing and the number of groups the teacher may elect to have students return to their original group if the teacher feels they have gathered enough feedback or information to modify their presentation if needed.

- Allow students to revise their presentations and complete the rotations again. In both rotations, the teacher should make sure to rotate with students so they can help to steer conversations and assess student understanding.

- After the rotations, review findings with the class. Hopefully, there is some consensus about which greenhouse gas is more potent. If not, discuss student research and findings to carefully guide students. The teacher may also want to preview question 7 with the students and begin a class discussion at this point.

- Return to the warm-up question to reassess students. This can be in the form of an exit ticket where the teacher projects the question and asks students to write their answers on a separate sheet of paper.
- Have students complete question 7. Depending on the group of students the teacher may elect to have students write a longer paper in response to the question or they could also ask students to present their answers as a group in a presentation to the class.

Virtual

- The above steps can be modified to be completed in breakout groups and whole-class presentations.
- Students can also record their presentations on Zoom or similar formats such as Flipgrid. They can then share their recorded presentations with others.
- The handout for rotations will be difficult for students to complete virtually while they watch presentations. It is suggested that students either print this document at home or direct students to copy the document's format onto a sheet of paper. The teacher can collect this handout by asking students to take pictures of it and submitting it to the LMS if necessary.

Extension

- You can remove the data points or the entire graph from this lesson for more graphing practice. For example, provide a box for graphing in place of the graph. Then, provide students with data points and allow them to determine how to graph data.
- You can also opt to have students complete graphs in a graphing program such as Excel and determine equations through line-of-best-fit, etc. Review as a class.
- Poster or whiteboard gallery walks help to quickly assess student understanding, identify misconceptions, and encourage student discussions as students support their group-constructed graphs. See argument-driven inquiry (ADI) models for more detail on this procedure.
- Be sure to confirm all students have the correct final graph before moving on to complete this lesson!

Resources

https://argumentdriveninquiry.com/instructional-model

Free downloadable resources are available

Page Keeley Formative Assessment Probes

Assessment

Student worksheet can be assessed.

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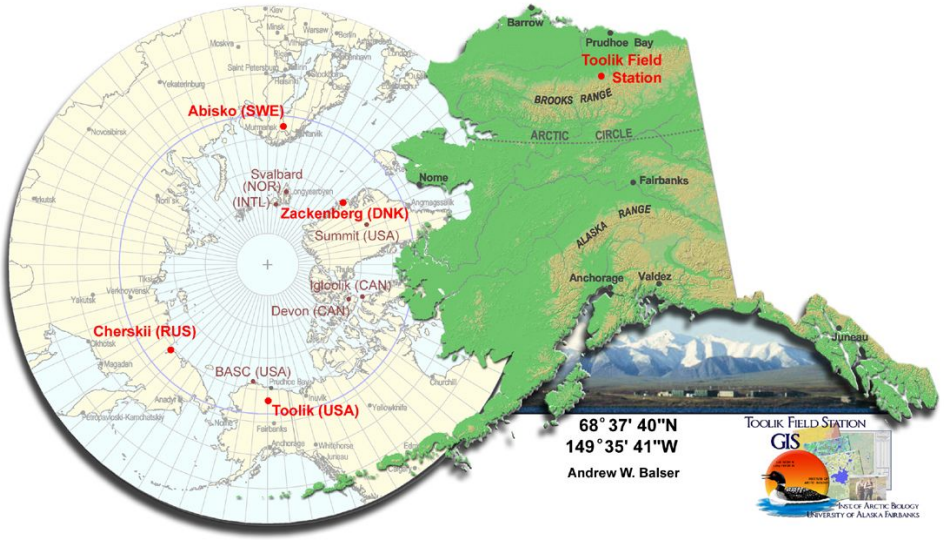
Lesson Materials

Warm-Up

Which greenhouse gas, carbon dioxide or nitrous oxide, will have a greater impact on climate change?	
Carbon dioxide	**Nitrous Oxide**

Introduction



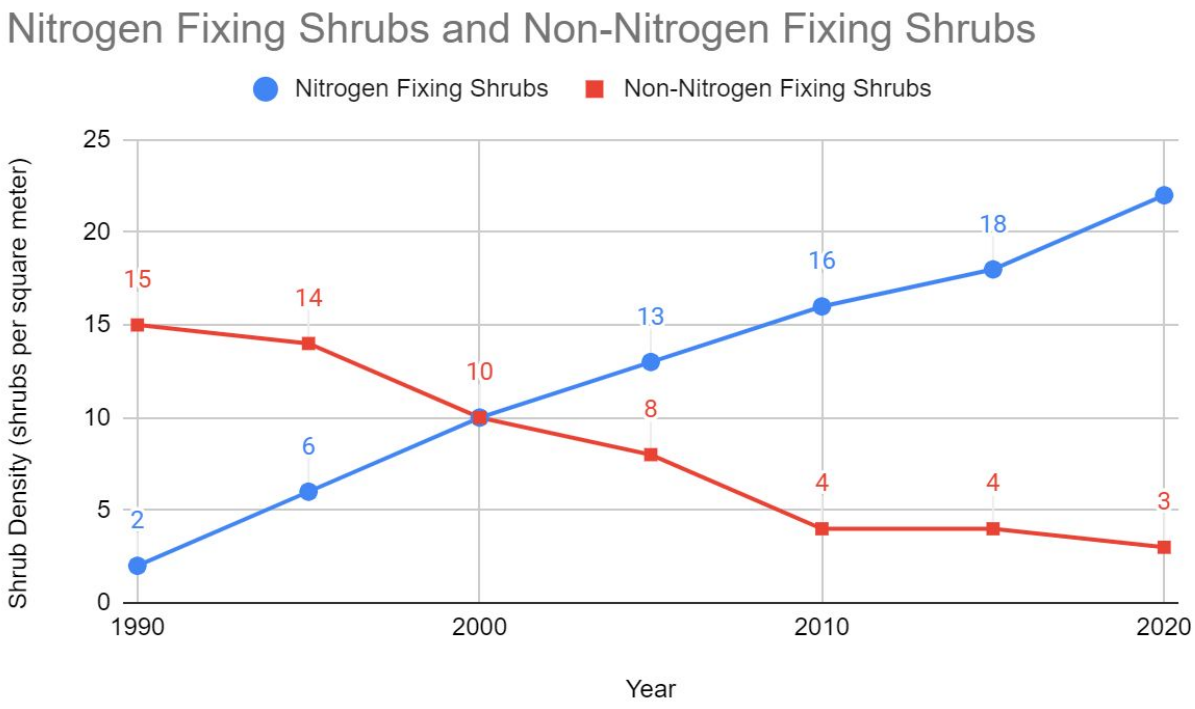
https://toolik.alaska.edu/gis/images/arctic-ak.jpg

Field biologists or researchers can collect and look at plants to understand how an ecosystem changes over time. Recently, areas above the Arctic circle have come under increasing scrutiny as researchers analyze the region's relationship to climate change. In areas such as the tundra, researchers can look at **shrub density** to understand how tightly packed different types of plants, or specifically shrubs, are in a specific area. The results they collect are reported in the number of plants per square meter.

Sample research area above Sagwon River near Toolik Field Station, Alaska

Researchers look at many small areas (1 meter by 1 meter) to analyze shrub density. Sagwon River near Toolik Field Station, Alaska.

After researchers collect their data on shrub density they analyze it using graphs to see different relationships that might give them clues to how the Arctic region is responding to climate change. Below is an example of data that can be collected from arctic regions similar to the two pictures above taken near the Toolik Field Station in Alaska.



1. What do you notice about the different types of shrubs over time?

2. What do you notice about the TOTAL shrub density over time?

3. How do you predict the changes you see in the shrubs over time impact climate change? Remember that plants take in carbon dioxide in the process of photosynthesis.

One thing that the bacteria in nitrogen fixing shrubs do is take atmospheric nitrogen (N_2) and turns it into ammonia (NH_3) that the plants can use. This is done by the following equation:

$$N_2 + 8\ H^+ + 8\ e^- \rightarrow 2\ NH_3 + H_2$$

Ammonia is the primary way plants bring nitrogen into their body. Once in the plant, ammonia is broken down to use the nitrogen for making amino acids which in turn make up essential proteins. Obviously this process is really important for plants. In fact, if there is not enough ammonia in the soil ready for use by plants, some farmers add nitrogen in the form of fertilizer.

All these good things don't come without consequences though. Ammonia can oxidize into nitrous oxide, a different type of greenhouse gas. Which greenhouse gas will have a greater impact on climate change, though? The shrubs sequester, or take in the carbon dioxide, but end up releasing nitrous oxide. Complete some research on carbon dioxide and nitrous oxide using the chart below to guide your research. You may either pick your own sources or your teacher will provide them. Then, fill in the chart below to help figure out which one is worse for climate change effects.

Nitrous Oxide vs. Carbon Dioxide

	Nitrous Oxide	**Carbon Dioxide**
Molecular Formula		
Structural Drawing		
Molecular Weight		
Sources		
Stability (how long does it last)		

Heat added to the atmosphere		
Other effects on environment		
Connection to Shrubs in Alaska		

4. Based on the information above, make a **claim** about which is a more potent greenhouse gas between nitrous oxide and carbon dioxide.

5. What **evidence** from the table above supports your claim?

6. **Reason**, or explain why, your evidence supports the claim.

7. Finally, make an argument if the changing shrubbery in the Toolik Field Station is positively or negatively impacting greenhouse gases and the greenhouse effect. You'll need to discuss the role of nitrifying bacteria, carbon dioxide, ammonia, and nitrous oxide in your response.