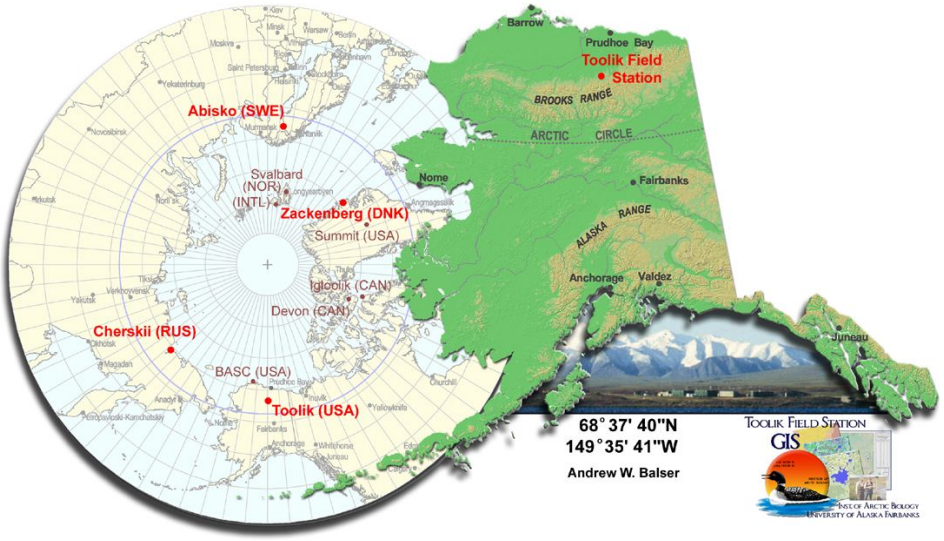
Lesson Materials

Warm-Up

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

Introduction



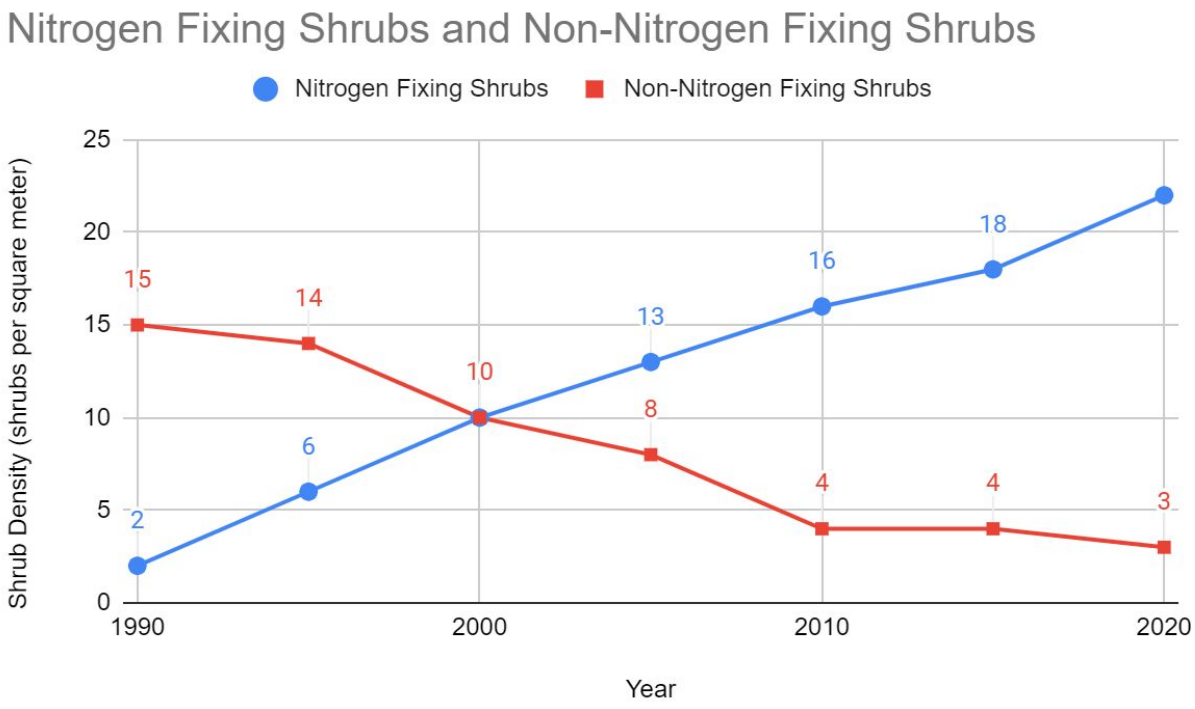
https://toolik.alaska.edu/gis/images/arctic-ak.jpg

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.