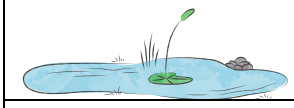
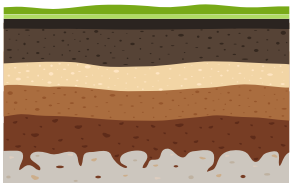
Diatom Data-mania: Background Knowledge

Firstly, let's look at some basic information about relationship between climate change and the energy the receives from the sun.
The earth's energy from the sun is retained and moves in and out of the following physical systems of our planet which include: the atmosphere (air), the hydrosphere (water), the cryosphere (ice/snow), the lithosphere (land), and the biosphere (living organisms). These systems, in turn, absorb and reflect energy and have an effect on our weather and climate.

Atmosphere	The Earth's atmosphere is made up of 78% nitrogen and 21% oxygen. The remaining 1% is called trace gasses which includes water vapor, ozone, carbon dioxide, and methane.
Hydrosphere 	Earth's hydrosphere includes all waters on Earth's surface, such as oceans, lakes, rivers, streams and groundwater.
Lithosphere 	The lithosphere is the solid, outer part of the Earth. These land masses affect weather and climate. The long-term changes in the distribution of land masses has impacted the movement of air around the plant. This has caused large chemical changes in the Earth's climate. Volcanic eruptions also impact the earth's climate as they spew gases into the upper atmosphere which reflect sunlight and alter atmospheric chemistry. More recently, changes in the surface of land from agriculture, forestry, and urbanization have changed the amount of energy that is being absorbed or reflected back to space.
Cryosphere 	Earth's cryosphere includes all frozen water, such as glaciers, sea ice, freshwater ice, and permafrost, which is frozen ground. Almost 70% of the Earth's freshwater is contained in ice caps, glaciers, and regions of permanent snow cover. Ice reflects solar energy back to space helping to keep the earth cooler. This is called albedo. Ice also insulates the ocean and land from the atmosphere which changes the dynamics of wind and weather.
Biosphere 	Earth's biosphere includes all living organisms, which change the chemical makeup of the atmosphere by storing and releasing carbon dioxide as well as altering the albedo of the earth's surface through colour change

For this activity, we will focus on changes we are seeing in hydrosphere and the cryosphere, yet all systems are interdependent when responding to climate change.

An important part of the hydrosphere is the ocean. Covering 68% of the earth's surface, the ocean acts as a vast heat storage device in the climate system. Ocean circulation transports heat from the equator to the poles. Also, gases from the atmosphere can dissolve in the ocean and be

stored for many years in the ocean depths. That said, when carbon dioxide dissolves seawater becomes more acidic which can harm marine life. The ocean is also considered to be a heat sink. Heat sinks are anything proficient at absorbing thermal energy without becoming much warmer. In this way they are substances with high heat capacity, which essentially means Oceans can absorb a lot of energy from the sun while remaining fairly constant in their temperature. Therefore, they also help to regulate temperatures due to heat transfer between the hydrosphere and the atmosphere.

Scientists can also study past and current climates by examining cores (sample) taken from aquatic ecosystems in the hydrosphere. Ice core samples, for example, help scientists understand past ecosystems. Ice core samples from polar and glacial ice can be every useful to scientists for finding climate information as far back as 800 000 years. Scientists can also understand how climate change impacts current aquatic ecosystems by taking sediment cores from lakes. This was done in the following study:

Study Citation: Rühland, K., Paterson, A.M., and Smol, J.P. 2008. Hemispheric-scale patterns of climate-related shifts in planktonic diatoms from North American and European lakes. Global Change Biology 14: 2740-2754. https://www.queensu.ca/pearl/projects/low/Publication%20Page.html

Summary:

These researchers were interested in examining the impact of climate change in lake ecosystems.

In order to determine if climate change is impacting lake ecosystems, they decided to look at a very small unicellular organisms called diatoms. Although small, they play an important role in many ecosystems, as they are food sources, and contributors to energy and nutrient cycles in water. Their most important role, however, would be that they provide us and other beings with oxygen through photosynthesis. In fact, this species is the largest primary producer of oxygen on the planet.

The scientists took cores from different areas in the Hudson's Bay lowlands to examine the populations of diatoms. In this area, they, and Cree communities had seen immense changes due less ice over, and warmer temperatures in the atmosphere. In their research, they discovered that diatoms were appearing in these lakes, where they hadn't previously been before. This "shift" in their population is due to the changes in freshwater quality that are linked to the warmer temperatures from climate change. Therefore, diatoms are also special because they can be a signal for warmer temperatures in water bodies.The researchers are now seeing diatoms in lakes they haven't before, because the lakes are now warmer, and thus diatoms, along with other species, can be a signal of climate change impacts in other lakes as well.

The changes that they saw in this area, already happened in more Arctic regions. This means that changes occurring in the colder, Arctic areas are now reaching areas with more milder temperatures. Areas, such as the lowlands, experienced a change passed the "tipping point" which is a critical threshold, that when crossed, leads to large and often irreversible change in the ecosystem. The lowlands were cooler before because they were protected by ice, but now that protection is gone (and melted), and the tipping point has been crossed.

Furthermore, the area that surrounds the water here, is called peatlands, which absorb carbon dioxide. When the water warms, this land may dry up. When the land dries, it can no longer absorb CO_2 , which means that more CO_2 remains in the atmosphere, contributing more to the climate crisis.

John Smol, a researcher of Queen's University, says that when "you have whole changes in water chemistry, that changes the food web. Some ponds will totally disappear. Some of the wetlands will dry up. You will start getting this whole chain reaction of events" (Max Paris Environment Unit, 2013).

This continuous cycle of climate change is an example of a positive feedback loop, as John Smol, explains. In simpler terms, a positive feedback loop is when something happens (Event 1) causes something else to happen (Event 2), and then the effects of Event 2 this intensify or accelerate the original impact from Event 1, or Event 1 itself.

The climate change impact on this ecosystem is happening in other areas of the globe, and thus it is just another pattern that we see and are experiencing from the climate crisis. Therefore, this study presents a call to action for climate mitigation, using both Indigenous Knowledges and Western Knowledges to determine the best course of action for everyone.

Information adapted from:

- Max Paris Environment Unit. (2013, October 8). *Hudson Bay Lowlands show recent effects of global warming.* CBC News. https://www.cbc.ca/news/politics/hudson-bay-lowlands-show-recent-effects-of-global-warming-1.1930050
- Rogers, S. (October 10, 2013). *Arctic's last refuge from climate change now heating up.* Nunatsiaq News. https://nunatsiaq.com/stories/article/65674arctics_last_refuge_from_climate_change_now_heating_up/
- Queens' University. (2022, August 12). *Peer-reviewed publications on the Lake of the Woods (LoW).* https://www.queensu.ca/pearl/projects/low/Publication%20Page.html