Students as Polar Scientists! Alaskan Permafrost Expedition

Overview

This lesson plan transports students to two field sites outside of Fairbanks, Alaska to investigate the interconnected relationships between climate change and permafrost. Students will use authentic field data from site photographs, soil temperature, and thaw depth measurements to draw inferences. An ESRI StoryMap, faux field journal, and 360 site images are used to engage students in the inquiry.

Objectives

1. Students will learn about methods of collecting data in polar science.
2. Students will understand compounding impacts of forest fires on the Alaskan boreal forest.
3. Students will use data to draw inferences about the positive feedback loop between permafrost thaw and climate change.

Lesson Preparation

Prior to completing this lesson plan, students need introductory understandings of:

* Permafrost
* Climate Change
* Carbon Cycle
* Scientific Method

This lesson plan is best done with 1-1 or 1-2 technology access; either through tablets or laptops. It does not require immersive viewers but does include 360 elements for teachers who are familiar with the technology.

Procedure

The teacher should serve as the guide on the side monitoring student progress, asking probing questions, and clarifying instructions as needed. Spend ~5 minutes at the beginning of class going over assignment instructions and materials. Allow ~40 minutes for student exploration of the [ERSI StoryMap](https://arcg.is/1eH4Xu0) and site data; working individually, in pairs, or groups. Bring the class back together to debrief sharing ideas and larger connections made as part of the activity.

Extension

Ideas for extension activities after this lesson plan:

* Further investigation of the role of winter respiration in the Arctic and Woods Hole Research Center's Soil Respiration Station measurements. What is the "permafrost time bomb"?
* Permafrost Tunnel
* Social impacts of thawing permafrost – infrastructure, population displacement

Transferability

This lesson plan designed to be used in a World History class, but is easily transferable to Earth and Environmental Science classes. Given its student-centered approach, it can also be used in informal education settings. Informal educators may have more opportunities to utilize the

immersive elements of the lesson plan or give student hands-on experience with how soil temperature and thaw depth data would be collected.

##Resources

1. Alaska Department of Fish and Game, [“Boreal Forest in Alaska”](http://www.adfg.alaska.gov/index.cfm?adfg=boreal.main)
2. 360 Tour of Permafrost Tunnel https://www.youtube.com/watch?v=FiRuDaMRGMg
3. BBC, “Inside the Permafrost Tunnel” https://www.youtube.com/watch?v=Gwr8IgXPGU4
4. [360 Tour](https://poly.google.com/view/de6gf--Xdzi) of Woods Hole Research Center NASA ABoVE Sites on Winter Respiration

##Assessment

Student completion of field journal and participation in debriefing discussion are the primary forms of assessment.

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Field Journal – Alaska Permafrost Research Expedition

Site #1 – Hess Creek Unburned (HCU)

Site #2 - Hess Creek Burned (HCB)

Analysis: Sim/Diff between sites?

Table 1: *Soil Temperature at 15 cm depth at the Hess Creek Unburned (HCU) Site, and at the Hess Creek Burned (HCB) Site. Data is provided for both sites at two-week intervals starting on July 15th, 2017 and ending on July 14th, 2018.*

RECORD	DATE	HCU Soil Temperature	HCB Soil Temperature
1	15-Jul-2017	5.6	6.4
2	29-Jul-2017	5.2	6.2
3	12-Aug-2017	4.2	6.3
4	26-Aug-2017	3.0	4.8
5	9-Sep-2017	1.6	2.9
6	23-Sep-2017	1.0	2.1
7	7-Oct-2017	0.5	0.8
8	21-Oct-2017	-0.6	0.0
9	4-Nov-2017	-0.4	0.0
10	18-Nov-2017	-1.1	-0.2
11	2-Dec-2017	-1.5	-0.4
12	16-Dec-2017	-1.1	-0.4
13	30-Dec-2017	-3.6	-1.3
14	13-Jan-2018	-4.7	-1.8
15	27-Jan-2018	-5.3	-1.4
16	10-Feb-2018	-8.3	-2.3
17	24-Feb-2018	-5.2	-0.8
18	10-Mar-2018	-5.1	-1.0
19	24-Mar-2018	-5.4	-0.8
20	7-Apr-2018	-5.3	-1.1
21	21-Apr-2018	-4.8	-0.9
22	5-May-2018	-0.1	-0.1
23	19-May-2018	0.4	0.0
24	2-Jun-2018	1.6	0.9
25	16-Jun-2018	2.2	1.8
26	30-Jun-2018	3.6	3.9
27	14-Jul-2018	4.3	5.7

Soil Temperature Graph

What is the minimum and maximum soil temperature at each site?

Based on the soil temperature data, around what date would you classify as the start of winter? What date would you classify and being the end of winter? Why?

Why do you think the soil temperature at HCB is warmer than the soil temperature at HCU between November and May? Explain.

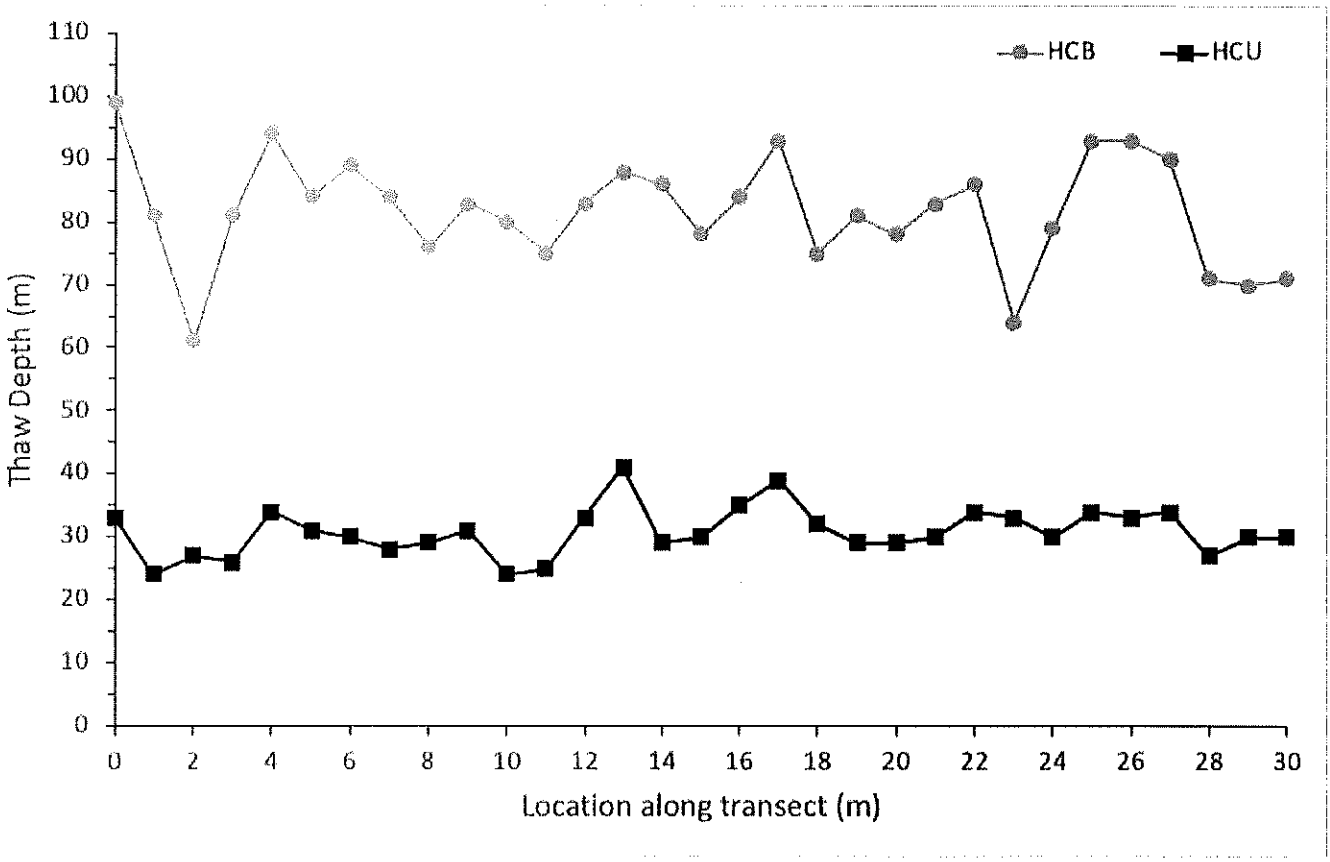

Figure 1: *Measurements of thaw depth (m) along a 30-meter transect at Hess Creek Unburned (HCU) Site and at Hess Creek Burned (HCB) Site. Thaw depth was measured at each site in July of 2018.*

Examine the graph of thaw depth data from HCB and HCU. What are two significant observations?

If the forest where to recover at the burned site (HCB), what do you think could happen to the permafrost? Why?

After completing the further reading, what might be the implications of your data to the larger boreal forest system in the Arctic and climate change?