EXPLORATION: TUNDRA FIRES IN ALASKA

Grades 9-12

ENDURING UNDERSTANDING:

With the changing climate, scientists are noticing an increase in the frequency of tundra fires.

Part 1 (50 *minutes*)
RESEARCH QUESTIONS

You will conduct research to answer the following major questions:

1. What evidence is there that tundra fires are increasing in frequency and/or size in Alaska? If they are increasing, where and by how much? How do scientists know this?

2. What are some reasons why tundra fires are increasing?

3. What are the short and long-term impacts of tundra fires?

4. Provide some examples of recent tundra fires.

NGSS STANDARDS:

HS-LS2-2.	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
HS-LS4-5.	Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
HS-LS2-2.	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
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Wildfires are extensive in Alaska. When you think of wildfires, you might imagine fires raging through trees. In Alaska, the boreal forest is especially prone to frequent large fires but the treeless tundra can burn too! The tundra is made up of many kinds of grasses, sedges, lichens, flowering plants, and small shrubs. Beneath the surface, most tundra is underlain by permafrost, which can melt during a fire. With the changing climate, scientists are noticing an increase in the frequency of tundra fires. What is this increase, and what are the impacts?

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Use the Table 1 below from the Rocky Mountain Research Station, to answer the following sub questions that will help you to answer parts of the first major question (I.).

1. What was the average fire return interval (the time between fires) for these areas during the last 12,000 years or so (the Holocene)? (Give a range).
2. What scientific methods did the scientists use to determine this?
3. Where was the longest fire return interval reported?

Mean fire-return intervals for Alaskan tundra ecosystems during the late Holocene

Location	Plant community	Mean fire-return interval	Methods	Reference
North Slope	Tussock-shrub tundra	>5,000 years	Charcoal deposits in sediments of 2 lakes spanning 5,000 years BP	Jandt, et al. (2008)
Noatak National Preserve (entire 31 mile transect)	Tussock-shrub tundra, birch & ericaceous (heather) shrub tundra, willow-shrub tundra with white spruce	260 years * (range = 30-840)	Pollen grains and charcoal deposits in lake sediments from 4 lakes spanning transect, records spanned from 6,000 years BP to 2007	Higuera, et al. (2011)
Noatak National Preserve (eastern part of transect-Poktovik & Little Isac lakes)	Tussock-shrub tundra, birch & ericaceous (heather) shrub tundra, willow-shrub tundra with white spruce	142 years * (range = 115-174)	Pollen grains and charcoal deposits in lake sediments from 4 lakes spanning transect, records spanned from 2,500 years BP to 2007	Higuera, et al. (2011)
Noatak National Preserve (western portion of the transect, Raven and Uchugrak lakes)	Tussock-shrub tundra, birch & ericaceous (heather) shrub tundra, willow-shrub tundra with white spruce	263 years * (range = 175-374)	Pollen grains and charcoal deposits in lake sediments from 4 lakes spanning transect, records spanned from 2,500 years BP to 2007	Jennifer Allen personal communication cited in LANDFIRE Biophysical Settings (2009)
Seward Peninsula	Sedge-tussock tundra	240 years	Pollen grains and charcoal deposits in lake sediments	Jennifer Allen personal communication cited in LANDFIRE Biophysical Settings (2009)
Beaufort Coastal Plain	Sedge-tussock tundra	>1,000 years	Pollen grains and charcoal deposits in lake sediments	FRCC Experts Workshop 2004 personal communication cited in LANDFIRE Biophysical Settings (2009)
Throughout Alaska	Sedge-tussock tundra	50-300 years	Expert opinion	FRCC Experts Workshop 2004 personal communication cited in LANDFIRE Biophysical Settings (2009)
	Tundra	35-200 years	Expert opinion	Duchense and Hawks (2000)

* The fire-event return interval was calculated for a 0.6 mile area around each lake. The term "fire event" was used to acknowledge that some peaks in charcoal deposits might include more than 1 fire.

This table is from Appendix C from Innes, Robin J. 2013. Fire regimes of Alaskan tundra communities. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/fire_regimes/AK_tundra/all.html (2016, April 14).

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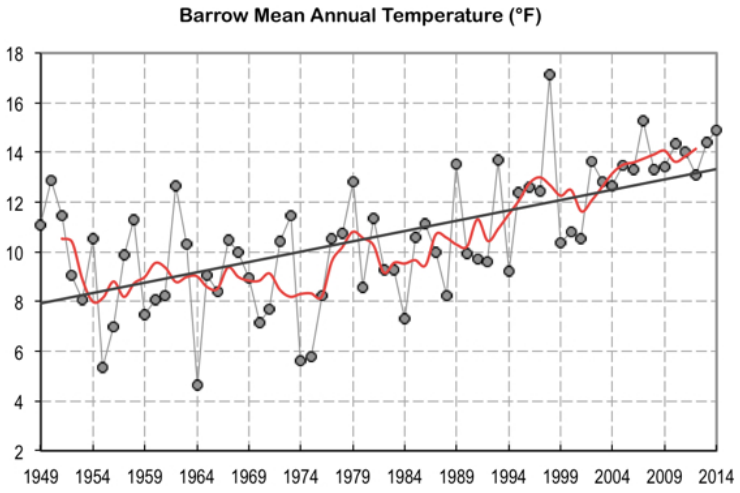
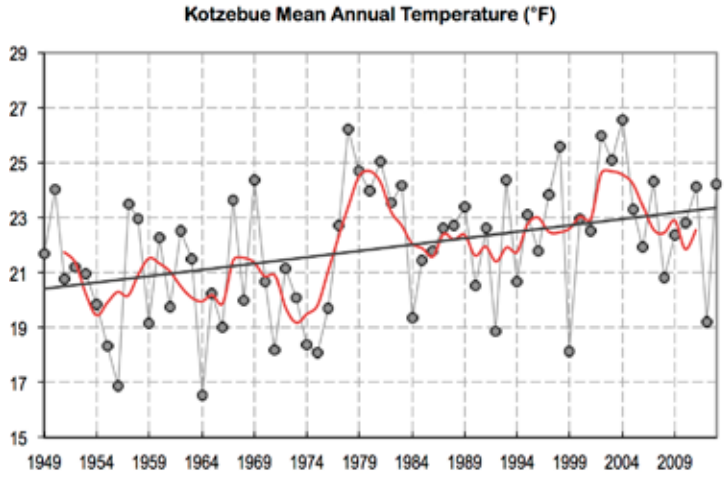
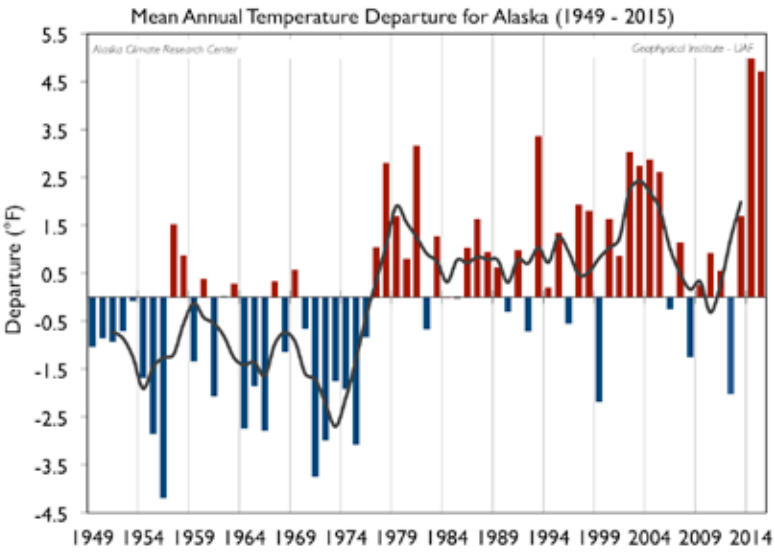
You will use the graphs and tables below from the Alaska Climate Research Center to answer the following sub question that will partly help you to answer the second major question (II).

4. Is the temperature in the arctic increasing?







Total Change in Mean Seasonal and Annual Temperature (°F), 1949 - 2015

Region	Location	Winter	Spring	Summer	Autumn	Annual
Arctic	Barrow	7.6	5.6	3.6	6.3	5.8
Interior	Bettles	7.1	4.2	1.5	2.0	3.7
	Fairbanks	7.2	3.6	2.0	1.0	3.4
	Delta Junction	8.9	3.5	0.7	1.0	3.5
	McGrath	8.1	4.5	2.4	2.7	4.4
West Coast	Kotzebue	7.4	1.8	2.9	3.2	3.8
	Nome	4.9	2.6	2.2	1.6	2.8
	Bethel	7.2	3.7	1.9	1.1	3.5
	King Salmon	8.9	4.1	1.5	1.8	4.1
	St Paul	0.6	1.2	2.5	1.4	1.5
	Cold Bay	2.1	1.3	2.0	1.2	1.6
Southcentral	Talkeetna	9.1	5.0	2.7	3.4	5.0
	Gulkana	7.9	2.5	0.6	0.5	2.8
	Anchorage	6.0	3.5	1.5	1.8	3.2
	Homer	6.6	3.7	3.1	2.4	4.0
	Kodiak	1.5	2.0	1.5	0.2	1.3
Southeast	Yakutat	5.4	2.8	2.1	1.1	2.8
	Juneau	6.6	3.0	1.9	1.6	3.2
	Annette	3.6	2.4	1.7	0.8	2.1
	Average	6.1	3.2	2.0	1.8	3.3

Alaska Climate Research Center *Geophysical Institute, University of Alaska Fairbanks*

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OTHER READINGS TO HELP YOU ANSWER THE QUESTIONS:

Quick overview of wildfires in Alaska and how they are changing with climate change in both the boreal forest and tundra:

University of Alaska Fairbanks Cooperative Extension Service, 2013. Alaska Climate Change Adaption Series: Wildfires. Available [on line] at https://www.uaf.edu/files/ces/publications-db/catalog/cred/ACC-00100.pdf. (Accessed April 2016)

SOME IMPACTS TO TUNDRA CAUSED BY FIRE:

Klingerman, Randi 2016. Fire Scars on the Alaskan Tundra. Available [online] at http://phys.org/news/2016-04-scars-alaskan-tundra.html. (Accessed April, 2016).

Qiu, Jane 2009. Arctic Ecology: Tundra's Burning. Nature vol 461, pages34-36. Available [online] at http://www.nature.com/news/2009/090902/full/461034a.html. (Accessed April, 2016).

Racine, C. 2010 Willow Shrub Expansion Following Tundra Fires in Arctic Alaska. ABSTRACT only available [online] on Research Gate: https://www.researchgate.net/publication/252258508_Willow_Shrub_Expansion_Following_Tundra_Fires_in_Arctic_Alaska. (Accessed April 2016).
Sherwonit, Bill 2010. Arctic Tundra Is Being Lost as Far North Quickly Warms. Environment 360 Jan 2010. Available [online] at http://e360.yale.edu/feature/arctic_tundra_is_being_lost_as_far_north_quickly_warms/2229/ . (Accessed April 2016).

INFORMATION ABOUT THE 2007 ANAKTUVIK RIVER FIRE:

University of Alaska Fairbanks, 2011. Largest Recorded Tundra Fire Yields Scientific Surprises. Available [online] at http://phys.org/news/2011-07-largest-tundra-yields-scientific.html . (Accessed April 2016)

Rosen, Y. 2015. Study: Big North Slope tundra fire sparked long-term permafrost thaw. Arctic Newswire Nov 6 2015. Available [online] at http://www.adn.com/article/20151106/study-big-north-slope-tundra-fire-sparked-long-term-permafrost-thaw. (Accessed April 2016).

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Use the remaining time to answer the questions below. Your answers to these questions will be scored. Also, they will help you think about the information you read and reviewed, which will also help you write your essay. Answer the questions in the spaces provided below them.

QUESTIONS:

I. What evidence is there that tundra fires are increasing in frequency and/or size in Alaska? If they are increasing, where and by how much? How do scientists know this?

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II. What are some reasons why tundra fires are increasing?

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III. What are the short and long-term impacts of tundra fires?

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IV. Provide some examples of recent tundra fires.

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Part 2 *(45 minutes)*
STUDENT DIRECTIONS

You will now have 30 minutes to review your notes and sources, plan, draft and revise your essay, which will be based on the essay topic below You may use your notes and refer to your sources, but please work on your own! You may also refer to the answers you wrote to earlier questions, but you cannot change those answers. Now read your assignment and the information about how your essay will be scored, and then begin your work!

ESSAY TOPIC:

The term positive feedback is used to describe a snowballing situation where some event has an impact, which then causes the initial situation to happen again, resulting in an even bigger impact than before. For example, your friend misses a few days of school and gets behind in math. When he returns, he no longer understands the math lesson, can't do his homework and gets more behind. The next day he finds he is even more confused than the day before. He now has twice as much unfinished homework and is even more behind. If your friend does not get tutoring help soon, he is going to remain caught in a positive-feedback cycle than results in him failing the class.

Your essay assignment is to explain how tundra fires could result in one or more positive feedbacks. Hint: there are at least four potential feedback cycles – you should talk about two at least. Be sure to clearly identify and explain the feedbacks, as well as the evidence that this may be happening.

Your Essay should be at least six full paragraphs. It may be much longer.

Part 3 *(15 minutes)*
SCORING YOUR ESSAY

Your essay will be evaluated based on:

1. **Organization:** How well you included an introduction, reasons that are supported with details, and a clear conclusion.
2. **Use of examples to support your opinion:** How well you used various examples and scientific information to explain your opinion and new concepts.
3. **Scientific accuracy:** How accurate the facts were that you presented.
4. **Language and vocabulary:** how well you used precise language and vocabulary to explain your opinion.

How well did you think you did? Score yourself by giving yourself 1-5 (5 is highest and 1 is lowest) for each of the above evaluations.

1. Organization _____
2. Examples _____
3. Accuracy _____
4. Language and Vocab. _____

TOTAL _____

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Part 4
OTHER RESOURCES

Funding for this project was made possible by a partnership with the USDA Forest Service

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