Dr. Michael J Passow Names in your group:

"Phenology and Climate Patterns"

Phenology refers to the study of natural events, and has been a very useful way to understand climate change. It is especially useful to re-construct in a broad way climates before accurate instrument records were kept. For example, medieval monks kept records of grain and grape harvests which provide us a glimpse of "good" and "bad" growing seasons many centuries ago.

In this first activity, you will be asked to "**mine data**" provided about Hudson River ice closing between 1789 and 1856. At that time before railroads, sailing and steamships were the main form of transportation between New York City and Albany. These data come from *The New York Almanac and Weather Book for the Year 1857*. (Such books were very popular before the Internet.)

1) **Examine the accompanying table and notes to look for patterns and special events. Write 2 – 3 paragraphs about importance facts and patterns you observe, and create at least two questions for further study. Attach your analysis to your report.**

2) **What other types of evidence could you use to learn more about the climate of the Hudson Valley during this time period? That is, what types of "proxy data" could you use? Where might you be able to get such data?**

3) Today, the Hudson River is never fully closed by ice, so shipping can take place year-round. **What might be two reasons for this ability to have continuous river traffic? What evidence supports your reasons?**

In this second activity, you will access two web sites to learn more about how phenology helps us understand the Earth System.

Open http://www.uwgb.edu/biodiversity/phenology/index.asp. This website is created by Dr. Gary Fewless, Herbarium Curator at the Cofrin Center for Biodiversity, University of Wisconsin-Green Bay. Since its founding in 1970, UWGB has been one the nation's leading environmental science research and teaching centers.

4) **After browsing through the website resources write 3 -4 paragraphs about phenology, and the stories provided by Dr. Fewless. Explain why you chose these examples.**

Open https://www.usanpn.org/. This is the USA National Phenology Network, a program designed to link science research and citizen-scientists like you.

5) Browse through the resources provided by USA-NPN and **write 2- 3 paragraphs about the information available. Explain why these were of most interest to you.**

NOAA (National Oceanic and Atmospheric Administration) has developed an online Climate Resilience Toolkit https://toolkit.climate.gov/tool/usa-national-phenology-network. NOAA partners on this project with other government agencies and the USA-NPN.

6) **Examine the Topics linked on the right-hand side. Select two of these of special interest to you and write brief summaries of what is available in these resources. Tell why these interest you.**
7) **If time permits, watch one or more of the Training/Tutorials videos. Write a brief "reaction paper" describing what you learned from the video.**

Enrichment Activities

1) The Hudson River Ice Closings studied in the first part of this lesson took place during a period in Climate History known as the "Little Ice Age."
Use online or other resources to learn more about the Little Ice Age. Try to find at least three examples of how conditions during that time influenced artists and writers. (For example: How was the origin of the "Frankenstein" story related to severe climate conditions?)

2) No matter where you live, seasonal changes take place in your neighborhood.
Think about some of these, and then create a plan for a phenology research project that would be done in your home area. Provide the questions to be studied, the types of evidence you would need to collect to answer your questions, the time period over which you would need to collect the data, and an example of how knowing these answers can be used to benefit your community.

Additional Resources

The GLOBE Program (http://www.globe.gov/web/guest/home)

Lilac Phenology Phenological Gardens

Selected NGSS Science and Engineering Practices

Asking Questions and Defining Problems; Analyzing and Interpreting Data; Constructing Explanations; Engaging in Argument from Evidence

Selected NGSS Crosscutting Concepts

Patterns; Scale, Proportion, and Quantity; Stability and Change

Selected Disciplinary Core Ideas

ESS2.A Earth Materials and Systems; ESS2.D Weather and Climate; ESS3.D Global Climate Change; LS2.C Ecosystem Dynamics, Functioning, and Resilience

Hudson River Closings by Ice

Source: *The New York Almanac and Weather Book for the Year 1857*

Winter	River closed or obstructed by ice	River open or free of ice	# of days closed
1789-90	Feb 3, 1790	Mar 27, 1790	52
1790-91	Dec 8, 1790	Mar 17, 1791	99
1791-92	Dec 8, 1791	Early Mar 1792	about 90
1792-93	Dec 12, 1792	Mar 6, 1793	84
1793-94	Dec 26, 1793	Mar 17, 1794	81
1794-95	Jan 12, 1795	1st sloop arrived at NY from Albany Mar 29, 1795	about 77
1795-96	Jan 28, 1796	[Blank = no record for opening]	
1796-97	Nov 28,1796		
1797-98	Nov 28,1797		
1798-99	Nov 29, 1798		
1799-1800	Jan 6, 1800	Feb 28, 1800	53
1800-01	Jan 3, 1801		
1801-02	Feb 3, 1802	Mar 19, 1802	44
1802-03	Dec 16, 1802		
1803-04	Jan 12, 1804	Apr 6, 1804	84
1804-05	Dec 13, 1804		
1805-06	Jan 9, 1806	Feb 20, 1806	42
1806-07	Dec 11, 1806	Apr 8, 1807	121
1807-08	Jan 4, 1808	Mar 10, 1808	65
1808-09	Dec 9, 1808		
1809-10	Jan 19, 1810		
1810-11	Dec 14, 1810	Mar 10, 1811	86
1811-12	Dec 20, 1811	Mar 16, 1812	86
1812-13	Dec 21, 1812	Mar 12, 1813	83
1813-14	Dec 22, 1813		
1814-15	Dec 10, 1814		
1815-16	Dec 2, 1815		
1816-17	Dec 16, 1816		
1817-18	Dec 7, 1817	Mar 25, 1818	108
1818-19	Dec 14, 1818	Apr 3, 1819	110
1819-20	Dec 13, 1819	Mar 25, 1820	102

1820-21	Nov 13, 1820	Mar 15, 1821	123
1821-22	Dec 13, 1821	Mar 15, 1822	92
1822-23	Dec 24, 1822	Mar 24, 1823	90
1823-24	Dec 16, 1823	Mar 3, 1824	78
1824-25	Jan 5, 1825	Mar 6, 1825	60
1825-26	Dec 13, 1825	Feb 26, 1826	75
1826-27	Dec 24, 1826	Mar 20, 1827	86
1827-28	Nov 25, 1827	Feb 8, 1828	73
1828-29	Dec 23, 1828	Apr 1, 1829	100
1829-30	Jan 11, 1830	Mar 15, 1830	63
1830-31	Dec 23, 1830	Mar 15, 1831	82
1831-32	Dec 5, 1831	Mar 25, 1832	111
1832-33	Dec 21, 1832	Mar 21, 1833	83
1833-34	Dec 13, 1833	Feb 24, 1834	73
1834-35	Dec 15, 1834	Mar 25, 1835	100
1835-36	Nov 30, 1835	Apr 4, 1836	125
1836-37	Dec 7, 1836	Mar 28, 1837	111
1837-38	Dec 13, 1837	Mar 19, 1838	94
1838-39	Nov 25, 1838	Mar 21, 1839	116
1839-40	Dec 18, 1839	Feb 21, 1840	65
1840-41	Dec 5, 1840	Mar 24, 1841	109
1841-42	Dec 19, 1841	Feb 4, 1842	47
1842-43	Nov 29, 1842	Apr 13, 1843	136
1843-44	Dec 9, 1843	Mar 14, 1844	95
1844-45	Dec 11, 1844	Feb 24, 1845	74
1845-46	Dec 4, 1845	Mar 15, 1846	100
1846-47	Dec 15, 1846	Apr 6, 1847	112
1847-48	Dec 24, 1847	Mar 22, 1848	89
1848-49	Dec 27, 1848	Mar 19, 1849	82
1849-50	Dec 25, 1849	Mar 9, 1850	73
1850-51	Dec 17, 1850	Feb 25, 1851	69
1851-52	Dec 13, 1851	Mar 28, 1852	105
1852-53	Dec 22, 1852	Mar 21, 1853	91
1853-54	Dec 30, 1853	Mar 16, 1854	77
1854-55	Dec 18, 1854	Mar 20, 1855	92
1855-56	Dec 26, 1855	Apr 10, 1856	106

"Remarkable Incidents Connects with the Changes of Temperature"
(Source: *The New York Almanac and Weather Book for the Year 1857)*

Date	Comments
Jan 19, 1792	Ice lodged in the East River, allowing several people to walk over it to and from New York to Brooklyn
Dec 24, 1796	Ice from New York to Staten Island
Jan 7, 1797	Ice closed the passage between the Battery and Governor's Island. It moved away with the next tide.
Dec 24, 1797	Ice closed the East river. Several people crossed on foot.
Dec 22, 1800	The river at Albany is open and quite free of ice.
Jan 6, 1805	East River is closed by ice.
Jan 22-23, 1805	Several people crossed the Hudson from New York to Hoboken.
Mar 10, 1810	The steamboat makes her first trip to Albany.
1817-18	This winter was long and intensely cold. On Mar 3, 1818, the ice moved in a body downward for some distance and there remained stationary. The river was not clear until Mar 25.
1820	The river was closed on Nov 13, opened on the 20th, and finally closed on Dec 1. This was one of the four winters during a century in which the Hudson between Paulus Hook and New York was crossed on ice; the other three were 1740-41, 1765-66, and 1779-80.
Jan 25, 1821	The coldest day in thirty years. Thermometer 7 deg below 0.
Jan 12, 1824	The river was clear of ice and remained so for several hours.
1830-31	River opened in consequence of heavy rains and closed Jan 10, 1831.
1842	In consequence of the heavy rains, the river opened in front of the City of Albany on Jan 8, and can hardly be said to have closed again during the season. However, the ice continued to pile up downstream and rendered the river impassable
Jan 20, 1852	Thousands of people crossed the ixce from Brooklyn to and from Manhattan.
1856	People, horses, and wagons crossed between Brooklyn, New York, and Jersey City on several days in Jan and Feb.