Is Punxsutawney Phil Right? Using Groundhog Day to Teach Statistics and the Nature of Science

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Introduction

Numerous demands on our teaching force us to increase our efficiency and be more careful in selecting lessons. Ideally, each of our lessons integrates across science and math and challenges our students to think critically. We have developed a fun activity that spans standards in the atmosphere (EAW V.3 e-1, e-2, m-1), data analysis and statistics (MIII.1, MIII.2, MIII.3), and the nature of science (C I.1 e-1, e-2, e-5, e-6, m-1, m-2, m-5, h-1, h-2 h-5, and R II.1 e-1, m-1, h-1). The activity is open-ended, easy to do, and timely (once a year on February 2). It could be done in almost any grade.

Our goal is to answer a simple question: Is Punxsutawney Phil a reliable predictor of the continuation of winter or the onset of an early spring? To engage our students we show a short clip from the 1993 movie *Groundhog Day*. It shows the typical activity associated with removing Punxsutawney Phil from his box: Phil making observations and not seeing his shadow (cloudy, indicating an early summer) or seeing his shadow (sunny, indicating six more weeks of winter).

Ask your students:
1. Is this an accurate way to forecast weather?
2. How can we design a test of Phil's abilities?

In order to address these questions, students must first determine:
- How to define winter weather vs. spring weather?
- What data set(s) will be needed? Be specific.

One Possible Solution

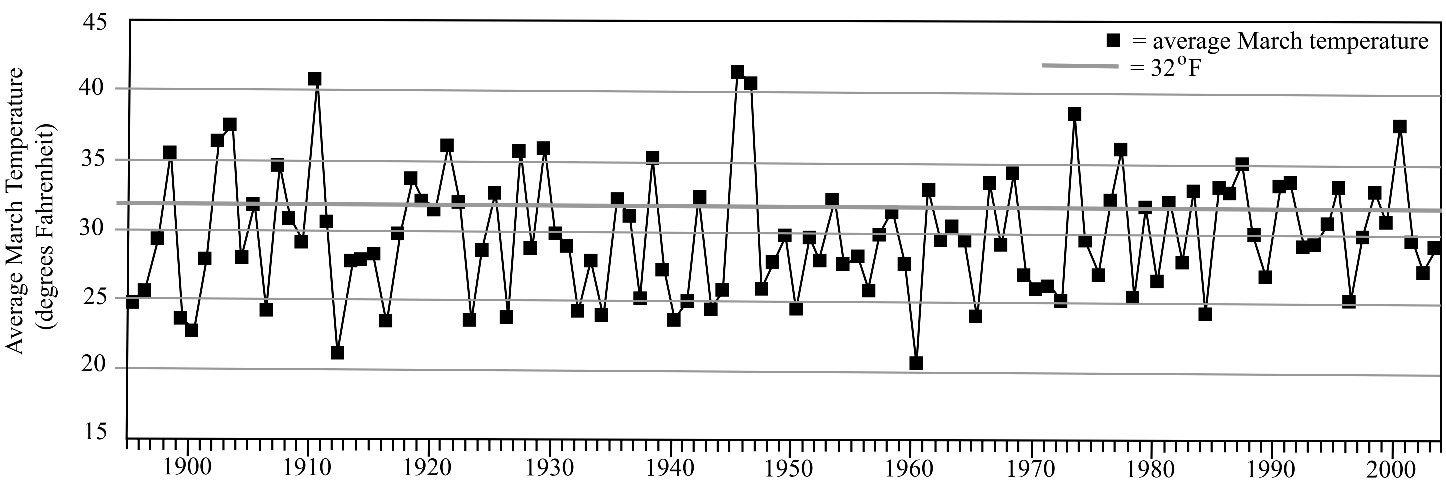
To model how your students might work through this exercise we propose one possible solution.

1. We defined our conditions for winter/spring as follows:
   If, six weeks after Groundhog Day, the temperature is greater than 32 ºF, spring has arrived. If the average temperature is less than 32 ºF, winter reigns.

2. We used one set of data with two variables (Table 1).
   a. First, whether or not Phil saw his shadow? Shown as "Y" (yes, if he did) or "N" (no, he did not) in the table.
   b. The second is a bit more complex. We needed the average temperature six weeks after Groundhog Day (which falls in mid-March). So, we used the average temperature values for the month of March.

Note: Our data set is specific to our location (Grand Rapids).

Figure 1. Comparison of the average March temperature in Grand Rapids to 32 F, our criterion for early spring/more winter.



We plotted the year vs. average March temperature to look for patterns in the data (Figure 1). Seventy-six measurements were below 32 ºF and 34 measurements were above 32 ºF. But, our data indicates that winter, as we define it, tends to extend six weeks beyond February 2. This is not a surprise to those of us living in Michigan. Phil forecast an early spring 12 times and an extended winter 92 times (for six other years there was no record or ambiguous data). We compared the two data sets with simple bar graphs (Figure 2.) The Grand Rapids temperature data does not match Phil's shadow data in absolute numbers but the patterns are similar. Phil predicted six more weeks of winter 88 percent of the time. Based on the temperature in Grand Rapids, six weeks after Groundhog Day winter conditions prevailed 69 percent of the time. Both data sets indicate that six more weeks of winter is more common than an early spring. However, Phil seems a bit pessimistic. He rarely emerges to a cloudy day (i.e., an early spring). The Grand Rapids data suggests that we are nearly three times more likely to have an early spring compared to Phil's data.

Looking at Experimental Design

Perhaps our experimental design, and thus our data, was wrong. Ask your students to compare their results. Do they have the same answers? Probably not. How did the design of their experiments influence their conclusion?

Some points to consider:

- Could the change to winter/spring be defined other ways, such as temperature on March 14th, the last day with snow (or frost), or the first appearance of certain birds (robins or orioles)?
- Maybe Grand Rapids is the wrong city. Would Detroit or Marquette work better?
- Does Phil's predictions match the observed weather in nearby cities in Pennsylvania?
- Would we get better results using data for Fairbanks and Miami?

Extensions

1. What other weather variables might influence Phil seeing clouds or clear sky?
   Lake effect snow, passing cold or warm fronts, type of cloud, etc.
2. What other variables might influence Phil? *Maybe the crowd was noisy and he wanted back in his box. Perhaps he was hungry.*

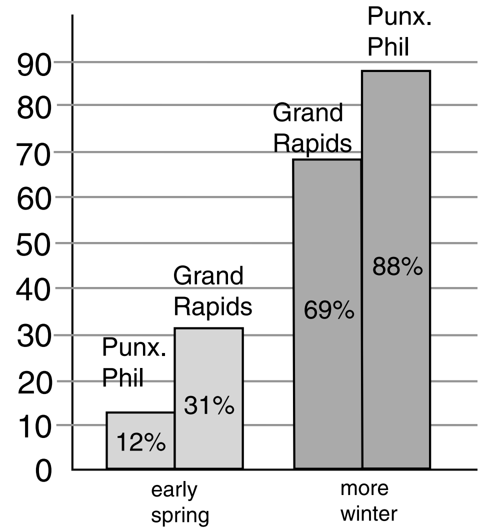


Figure 2. Bar graph comparing Phil's predictions to observed weather in Grand Rapids.

3. Do you think using other animals might yield better results? *Probably not but maybe Punxsutawney needs another test animal.*
4. Is the first Punxsutawney Phil used in 1895 the same one used last year? Would the change in "observer" cause variations in the data? *We are uncertain of the lifespan of a well-cared for groundhog but we are certain that the original Phil has passed on. Perhaps the data needs to be divided into subsets based on which Phil was observing?*
5. Would a "Milwaukee Moose," a "Zeeland Zebra," or a "Grand Rapids Groundhog" have a different chance of seeing their shadow? Explain your answer. *Zeeland and Grand Rapids commonly have Lake Effect snow. Lake effect snow is rare in Milwaukee.*

We are sure you and your students will devise new experiments and extensions. We would enjoy hearing from you.

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Table 1. Year, average March temperature in Grand Rapids, Michigan, and whether Phil saw his shadow (Y is for yes; N for no).

Year	Ave March Temp	Saw Shadow	Year	Ave March Temp	Saw Shadow	Year	Ave March Temp	Saw Shadow
1895	24.8	No Record	1932	24.3	Y	1969	27	Y
1896	25.6	No Record	1933	27.9	Y	1970	26	N
1897	29.3	No Record	1934	23.8	N	1971	26.2	Y
1898	35.3	Y	1935	32.2	Y	1972	25.2	Y
1899	23.5	No Record	1936	31.1	Y	1973	28.5	Y
1900	22.7	Y	1937	25.2	Y	1974	29.6	Y
1901	27.9	Y	1938	35.1	Y	1975	27.1	N
1902	36.2	N	1939	27.3	Y	1976	32.4	Y
1903	37.3	Y	1940	23.7	Y	1977	36	Y
1904	28	Y	1941	25	Y	1978	25.5	Y
1905	31.7	Y	1942	32.4	Partial Shadow	1979	31.9	Y
1906	24.3	Y	1943	24.5	Didn’t Appear	1980	26.6	Y
1907	34.5	Y	1944	25.7	Y	1981	32.5	Y
1908	30.8	Y	1945	41.2	Y	1982	28	Y
1909	29.1	Y	1946	40.5	Y	1983	33.1	N
1910	40.5	Y	1947	26	Y	1984	24.3	Y
1911	30.4	Y	1948	27.9	Y	1985	33.2	Y
1912	21.2	Y	1949	29.7	Y	1986	32.9	N
1913	27.8	Y	1950	24.4	N	1987	35	Y
1914	27.9	Y	1951	29.5	Y	1988	30.1	N
1915	28.3	Y	1952	28	Y	1989	26.9	Y
1916	23.3	Y	1953	32.3	Y	1990	33.5	N
1917	29.7	Y	1954	27.7	Y	1991	33.7	Y
1918	33.6	Y	1955	28.3	Y	1992	29.2	Y
1919	32	Y	1956	25.9	Y	1993	29.3	Y
1920	31.4	Y	1957	29.9	Y	1994	30.8	Y
1921	35.9	Y	1958	31.5	Y	1995	33.5	N
1922	31.9	Y	1958	27.8	Y	1996	25.3	Y
1923	23.5	Y	1960	20.7	Y	1997	29.8	N
1924	28.6	Y	1961	33	Y	1998	33	Y
1925	32.6	Y	1962	29.6	Y	1999	30.8	N
1926	23.8	Y	1923	30.5	Y	2000	37.9	Y
1927	35.6	Y	1964	29.4	Y	2001	29.6	Y
1928	28.7	Y	1965	24	Y	2002	27.4	Y
1929	35.8	Y	1966	33.5	Y	2003	29.1	Y
1930	29.7	Y	1967	29.1	Y	2004	39.3	Y
1931	28.9	Y	1968	34.2	Y	2005		

Acknowledgements

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Useful Resources

Climate at a Glance: March temperature in Michigan; http://climvis.ncdc.noaa.gov/cgi-bin/cag3/hr_display3.pl. Accessed March 12, 2004.

The Official Site of the Punxsutawney Groundhog Club; http://www.groundhog.org. Accessed March 12, 2004. Source of data in Table 1.

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