Weather, Climate, and Wildlife[1]

Content areas:
Science, math

NC Essential Standards:
Strong connection: 6.L.2.3, 7.E.1.4,
Possible connection: 7.E.1.2, 8.E.1.1

Common Core:
R.1, R.3, R.8, W.2

Next Generation Science Standards:
MS-ESS2.A MS-LS2.A, MS_LS2.C

Materials:
- ☐ Thermometers (one for each group)
- ☐ Species Cards (several cards per group)
- ☐ Wildlife Matching Game (one set per group)
- ☐ Printouts of Local Weather and Climate Data (one for each student)
- ☐ Student Data Collection Sheets (one for each student)
- ☐ Graph Paper OR Graphing Software (i.e. Excel)

Activity Time:
1-3 45-minute class periods, depending on if you have students collect their own data

Setting: Classroom and/or outside

Objectives:
At the end of this activity, students will be able to:
1. Collect and graph local weather and climate data
2. Describe the difference between weather and climate
3. Explain that daily weather is highly variable compared to long-term climate data
4. Describe how weather is more variable than climate.
5. Identify ways in which weather and climate events may affect local wildlife species.

Background:
Weather describes the atmospheric conditions, such as temperature, precipitation, wind, and humidity, on a given day. Weather is happening today or in the near future (up to two weeks). **Climate** is represented by the statistics of the environment over time, including seasonal cycles, extreme events, and year-to-year variations. Climate describes the trends of the weather[2]. For instance, in the winter, we expect it to be cold with snow on the ground in Maine, and relatively warm in Florida because these conditions reflect the climates there. However, a winter day that is warm in Maine, or a major ice storm in Florida can happen because weather is variable. The Community Collaborative Rain, Hail & Snow Network provides a good background video on weather vs. climate: (https://www.youtube.com/watch?v=VHgyOa70Q7Y)

Scientists look at large amounts of data to determine the "normal" climate for a location which is usually calculated as a 30-year average, and can be compared to weather on a particular date. For example, the 30-year average maximum air temperature in Raleigh, North Carolina, for December 12th is 54°F but the maximum temperature on December 12, 2013 (considered part of that day's weather) was 44°F, or 10°F below the 30-year average. How do scientists determine the "normal" climate as well as any trends for a location? They consider patterns in ice cores, tree rings, and soils to determine how the climate has varied in the past (more than 100 years ago) and continue to make weather and atmospheric observations to keep track of changes in climate over the past 100 years and into the future. Worldwide averages are used to determine global climate, which is generally highly stable[3]. Regional averages can change without changing global averages. For instance, it may become warmer in Africa and cooler in Mexico, and the global average will stay the same. If regions of the world warm without being balanced by other areas that cool, however, then the global climate warms[4].

Both weather and climate affect wildlife. In general, changes in weather will have more short-term effects than climate. For instance, one week of hot weather in the mountains may reduce dissolved oxygen levels in streams, suffocating trout eggs, and in turn, trout populations are lower the next year. However, if mountain climates become warmer (i.e., the change persists for many decades), the trout may be extirpated (i.e., eliminated in that location) because the trouts' eggs never survive[5]. In this activity, students will understand the difference between weather and climate and predict how changes in each may affect wildlife.

Getting ready

1. Download weather and monthly average temperature data for your region.
    - (a) Go to www.accuweather.com
    - (b) Search for the town where your school is located in the search bar.
    - (c) Select "Month" from the menu bar along the top.

    Select the List view by clicking the icon to the right next to the word View.

This will provide you with actual highs and lows for days in the past and forecasted highs and lows for the remainder of the month. The observations and forecasts for the month will be the weather data. The last two columns represent the average high and lows for that day based on past decades. This represents the normal temperature ranges based on your climate.

2. Download a graph of the average temperature in the US for the last century.
    a. Go to http://www.ncdc.noaa.gov/cag/.
    b. Select the following options:
        i. Parameter: Average temperature
        ii. Time Scale: 12-month
        iii. Month: the month you are currently in
        iv. Start year: 1895; end year: current year
        v. State/Region: your state
        vi. Climate Division/City: your region
        vii. In the Options box, uncheck Display Base Period. Check Display trend and select "per decade"

This will provide a graph showing the average temperature for each year of the selected month along with a trend line showing how the average temperature per decade has changed over the last century. *See the graph on page 9.*

3. Prepare the *Species Cards* (Appendix A)
    Choose 3-4 species to focus on during this lesson. Make enough copies so that each student has access to at least one of the species cards for the selected species.

4. Decide how much weather students will collect and how much you will provide. *This lesson was designed for students to collect weather data for 5 days. Alternatively, you may provide weather data for students by downloading local weather data for the current week. You may also choose to have students collect data for longer than 5 days.*

5. Prepare student data collection sheets. Each student will need a data collection sheet for each day data is collected. *Alternately, you may choose for students to use a journal to collect their data using the aspects of weather data the collection sheet provides.*

Procedure:

Pre-activity: Introduction and data collection

1. Introduce or review the concept of weather with students. Students should know how the cycling of water within the hydrosphere influences weather. Students should also know how winds form and how major storms such as hurricanes and thunderstorms develop. Have students list various aspects of weather data (*temperature, precipitation, wind, cloud cover, humidity*) and how the data could be collected for each aspect.

2. Ask students to describe how weather can affect them. Ask students how they think weather may affect wildlife. *Answers may include a severe storm toppling trees where flying squirrels or eagles are nesting, a hurricane eroding a beach and destroying sea turtle nests, a heat wave decreasing dissolved oxygen in a stream so that hellbender or trout eggs suffocate.*

3. Explain to students that as a class, they will be tracking the weather over the course of a week.

4. Explain that each day, working in pairs, students will collect temperature, cloud cover, precipitation, and wind observations, as well as the time the data was collected. *This can either involve the entire class each day, or you may choose to send one or two pairs of students outside daily and report to the class.*

5. Have students record their data on the Weather, Climate & Wildlife student sheet or in their weather journal.

Day 1: Weather graphing

1. In groups, have students compare their weather data. Are everyone's measurements the same? This is a good opportunity to discuss concepts of accuracy and precision. Ask students to identify any patterns they see between the temperature and other weather data measured (wind, precipitation, cloud cover).

2. Determine the class average for temperature. This average will be used for students to graph. Either in Excel, Google sheets, or on paper, students should create a data table with the date, time and temperature values.

3. Have students make a line graph of their weather data, either in Excel or on graph paper. (Y axis = temperature, x axis = date). If students are hand-drawing their graphs, they will need to make sure the X axis includes room for the entire month. This means that if you begin collecting data on the 15th, the axis should still begin on the 1st. You will add climate data to this graph later.

4. Introduce 3-4 local wildlife species (see species cards in Appendix A). Either distribute species cards to each group (each to all groups, or each group gets one species) or project the information for the entire class.

5. Ask students to discuss how the local weather in the last week may have affected these wildlife species. Sample answers:

Example Species	*Weather impacts*
Eastern hellbender	*Hellbenders dig out nests where they lay their eggs. Droughts can cause silt to accumulate in these nests, which could make it hard for the eggs to survive. A particularly rainy spring can keep hellbender nests free of silt. However, in areas where streams are close to development or agricultural lands, increased rainfall can bring extra sediment or pollutants from pesticides and herbicides. In pristine ecosystems, rainfall is generally good for stream health, but in other areas, it can depend on what the rain brings to the streams. For students, you may want to assume a pristine ecosystem to make a simple, clear connection between weather and wildlife health, but a discussion of how land use interacts with this relationship may also be fruitful.*
Northern flying squirrel	*A large wind storm could knock down trees where flying squirrels nest*
Eastern wild turkey	*Turkeys have a hard time staying warm when their feathers are wet, and this is especially the case for juvenile turkeys because they are smaller. A cold and wet spring can reduce survival rates of juvenile turkeys but warmer drier springs can increase survival.*
Sea Turtle	*A cold snap can "cold-stun" sea turtles, preventing them from swimming and making them vulnerable to hypothermia and predators*
Brook trout	*During droughts, silt can build up in streams, which can be bad for trout spawning beds and eggs. Heavy rains wash silt out of spawning beds making them more suitable for trout to lay their eggs. However, rains can bring sediment and pollution depending on how protected the surrounding lands are from soil disturbance or agricultural lands.*
Quail	*Quail depend on heavy ground cover for nesting. The cover hides the nests from predators. Rainy springs cause more vegetation growth, which can increase survival for juvenile quail.*
Marbled salamander	*Marbled salamanders depend on ephemeral (temporary) pools for breeding. Heavy rains in the spring create more dependable pools while drier springs may make pools too small or short-lived for the salamanders to lay their eggs.*

Day 2: Climate graphing

1. Ask students if they think the weather they have observed over the last week is "typical" for this time of the year. Introduce the idea of climate, the statistical representation of the environment over time, including seasonal cycles, extreme events, and year-to-year variations.

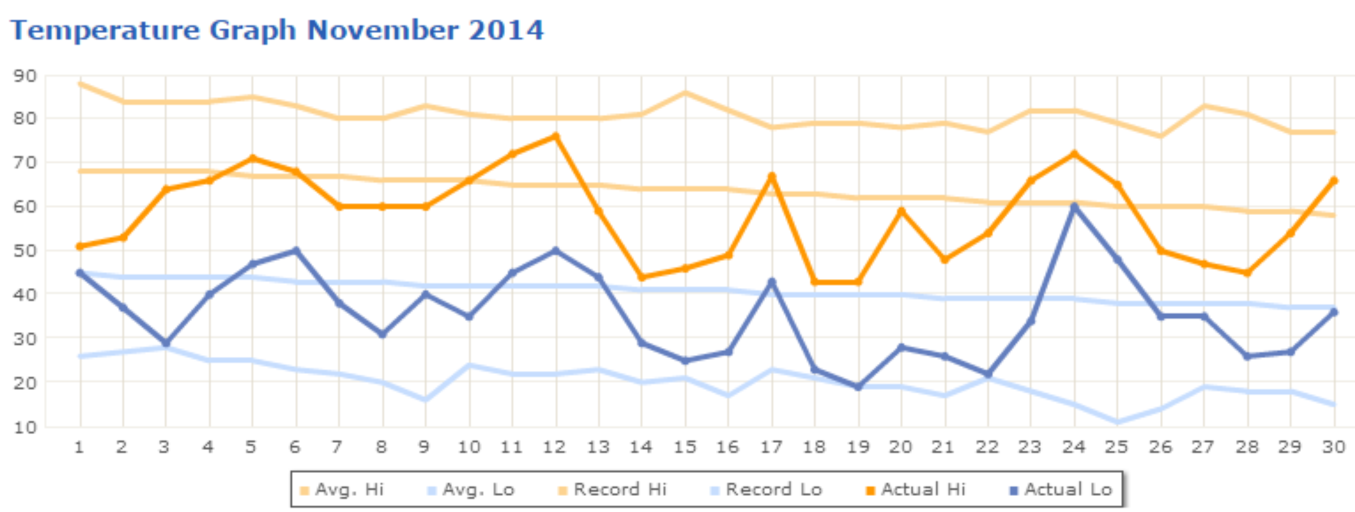
2. Provide students with weather observations and/or forecast and climate data for the current month (see Getting Ready).

3. In groups, have students add the weather (observations and/or forecasts) and climate data to their weather graphs (from day 1). Explain that the average temperature is based on 30-year averages, which reflects the climate for the area. In Excel or Google sheets, students can add monthly weather and climate data as new series to their existing graphs. If students are making graphs by hand, they

can add the new data points directly to their existing graphs. Depending on the time of day students collected the weather data, their weather data may be more in line with the high or low temperatures. Ask students whether their weather data was more aligned to the high or low temperatures for that day.

Important note: The goal of this graphing activity is to have students see that weather is more variable than climate. It is possible that by chance you may have student collect data for a week when weather conditions are really stable. By graphing high and low observation/forecasts for the month, it should be obvious, but some months just have more consistent weather than others and they may not be able to see a clear difference between weather and climate data. If that's the case, show students a graph of a different month for your area. Repeat the steps for downloading monthly weather and climate data in the "Getting Ready" section and select a month that is typically more variable. If you scroll down, there should a graph you can show your students. Use this graph to discuss how even though the weather was stable for the week of their study, in general weather is more variable than climate

See the graph below for a good example from November, 2014 in Raleigh, NC. The darker orange and blue lines represent the actual high and low temperatures for each day. The lighter straight lines represent the average high and lows for each day based on previous decades. The averages are representative of the regional climate while the more variable daily observations show weather. Your students' graphs should look similar. Based on the data table provided by accuweather.com, they should be able to generate the middle four lines. Their daily observations would make up a separate line with five data points.



4. Discuss with students that though climate is more stable than weather, it can change over time. Show students the graph of US Temperature since 1880 (visit http://www.ncdc.noaa.gov/cag/ to generate a graph specific to your region or use the graph at the end of this activity). Point out that annual temperatures also vary, but they generally stay within a certain range. In the example graph, although the annual December temperatures visually jump around a lot, they stay around 15°C, plus or minus 1°C (59°F, +/- 2°F). Over the last 100 years, 1-3°C range has been shifting upwards. There have been some very cold winters (see several cold winters in the 1960s and 70s in the example graph) but on average, the temperature is increasing. This means that we may see normal monthly temperatures (the stable lines in the graphs student made) shift upwards in coming decades.

5. Have students consider the species cards again. Ask students which is more variable – the climate or the weather? *(the weather is more variable)* Which do you think determines where wildlife can survive? Why? *Typically, the climate determines where wildlife can survive. Though weather events can affect survival of individual animals over the short term, climate can effect an entire population or species. Climate conditions determine the types of vegetation that are in an area, which determine which kinds of wildlife can live in an area.*

Discussion and assessment:

1. Discuss with students the following questions:
   a. Which is more variable, weather or climate? Why? Weather is more variable than climate. Climate by definition is the statistical representation of the environment over time, including seasonal cycles, extreme events, and year-to-year variations, and describes trends of the weather, so weather will always be more variable.
   b. Was the weather data we collected warmer, cooler, or about the same as the average? (Answers will vary with your data)
   c. If you were predicting the temperature for tomorrow, would it be more helpful to know today's temperature, or the 30-year average temperature for that day? The average temperature will give you an idea of what the normal range may be, but the temperature today as well as information on how immediate atmospheric conditions may change will be more helpful in predicting the temperature for tomorrow.

2. Play "Climate or Weather?" quiz game. Students identify impacts on local wildlife and decide if they are associated with weather or climate events.

3. Create similar graphs for another location. Ask students to identify the weather and climate data and explain their choice.

Extension:

1. Collect weather data for entire year and compare to your local climate data.
2. Participate in the GLOBE program (www.globe.gov). Students from around the world collect and share environmental data.
3. Become a Community Collaborative Rain, Hail & Snow Network (CoCoRaHS) volunteer (http://www.cocorahs.org/) and collect precipitation data to contribute to the large citizen science network.

References and Sources for More Information

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[1] This activity was utilized: National Center for Atmospheric Research. (2005). Differences between climate and weather. Retrieved from http://eo.ucar.edu/educators/ClimateDiscovery/LIA_lesson1_9.28.05.pdf

[2] National Oceanic and Atmospheric Administration. (2014). What is the difference between weather and climate? Retrieved October 24, 2014, from http://oceanservice.noaa.gov/facts/weather_climate.html

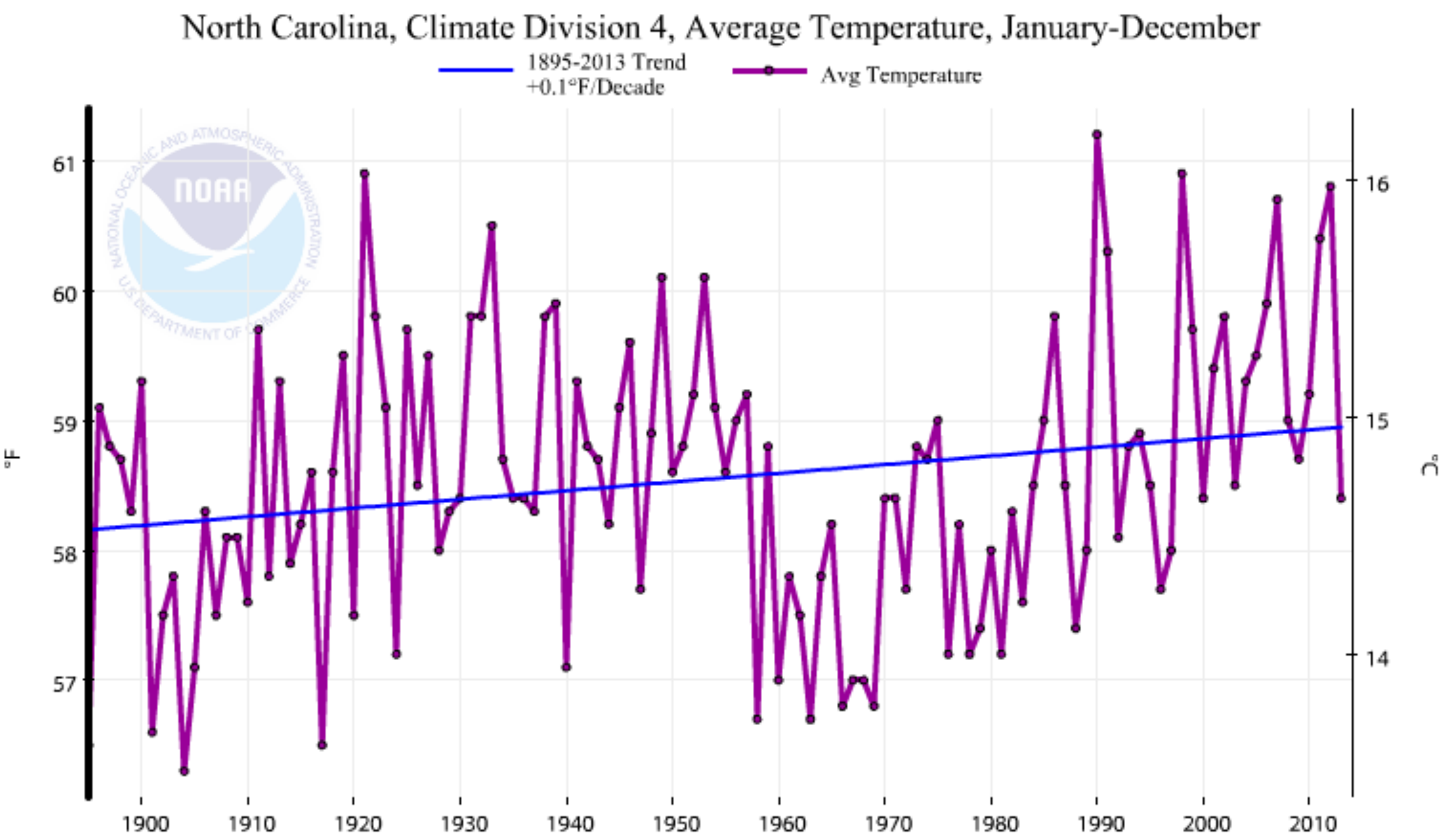
[3] National Oceanic and Atmospheric Administration. (2014). Paleoclimatology Data. Retrieved October 24, 2014, from http://www.ncdc.noaa.gov/data-access/paleoclimatology-data

[4] National Oceanic and Atmospheric Administration. (2014). Global Climate Change Indicators. Retrieved October 24, 2014, from http://www.ncdc.noaa.gov/indicators/

[5] National Fish Wildlife and Plants Adaptation Partnership. (2012). *National Fish, Wildlife and Plants Climate Adaptation Strategy*. Washington, DC. doi:10.3996/082012-FWSReport-1

Sample Average US Temperature Graph

The graph below represents the average December temperatures in the central Piedmont region of North Carolina each year from 1895-2014. The purple line shows changes in average temperatures from year to year. The blue line represents the trend over the time period shown based on average per decade. On average, the May temperatures rose 0.1°F per decade.



Weather, Climate, and Wildlife
Student Sheet[1]

Name: ___________________________   Date: _____________________________

Data collected by (names): ____

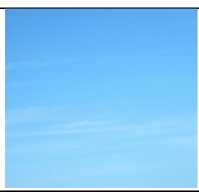
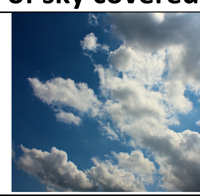
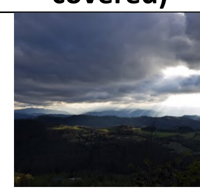
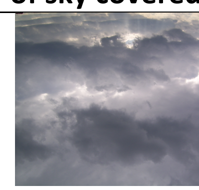
Time (make sure you collect data at roughly the same time each day): __________________________

Observations:

The temperature outdoors is:

____________ ^{o}C   ____________ ^{o}F

Cloudiness (circle one):

No clouds	Clear (clouds in <10% of sky)	Isolated clouds (10-25% of sky covered)	Scattered clouds (25-50% of sky covered)	Broken clouds (50-90% of sky covered)	No blue sky showing (100% of sky covered)
					

Precipitation:

- ☐ Heavy rain
- ☐ Light rain
- ☐ Light snow
- ☐ Heavy snow
- ☐ Hail
- ☐ None
- ☐ Other: _________________

Wind:

- ☐ Completely calm
- ☐ Light breeze (leaves move)
- ☐ Moderate breeze (small branches move)
- ☐ Strong breeze (trees sway)
- ☐ Heavy winds (difficult to walk in wind)
- ☐ Other: ________________

Compare your observations with data reported on a local weather website such as www.weather.com or www.accuweather.com. Click on the monthly forecast for your area, and the high and low temperature should be listed on the calendar for the previous day.

Are your measurements close to the measurements you find online?

Climate or Weather?
Wildlife Quiz Game

As a class, in small groups, or in pairs, have students quiz each other on whether a particular event can be attributed to weather or climate. Cut out each card and either attach the answer to the back of each scenario or use this as a key.

Front	Back	Front	Back
A seasonal drought causes the stream levels to be too low and slow flowing to dissolve enough oxygen for brook trout eggs to survive.	Weather	Decreased rainfall over a thirty year period means that stream levels are too low to support brook trout populations	Climate
A hurricane creates a large storm surge that floods a nearby coastal wetland destroying clapper rail nests	Weather	Rising oceans cover up a coastal wetland, eliminating nesting sites for the clapper rail	Climate
A storm blows down a large tree, eliminating a Northern flying squirrel nesting cavity	Weather	Warmer winters eliminate spruce-fir forests from its southernmost range, potentially eliminating Northern flying squirrel habitat in North Carolina	Climate
A warm winter helps more juvenile alligators survive.	Weather	Warmer, winters allow alligators to expand their ranges further north and inland.	Climate
An unusually warm winter allows Carolina wrens to survive farther north.	Weather	A series of warmer winters over time allows for Carolina wrens to expand their normal range further north.	Climate