Changing Climate

Seasonal Shifts

High School Guide

REACH Up

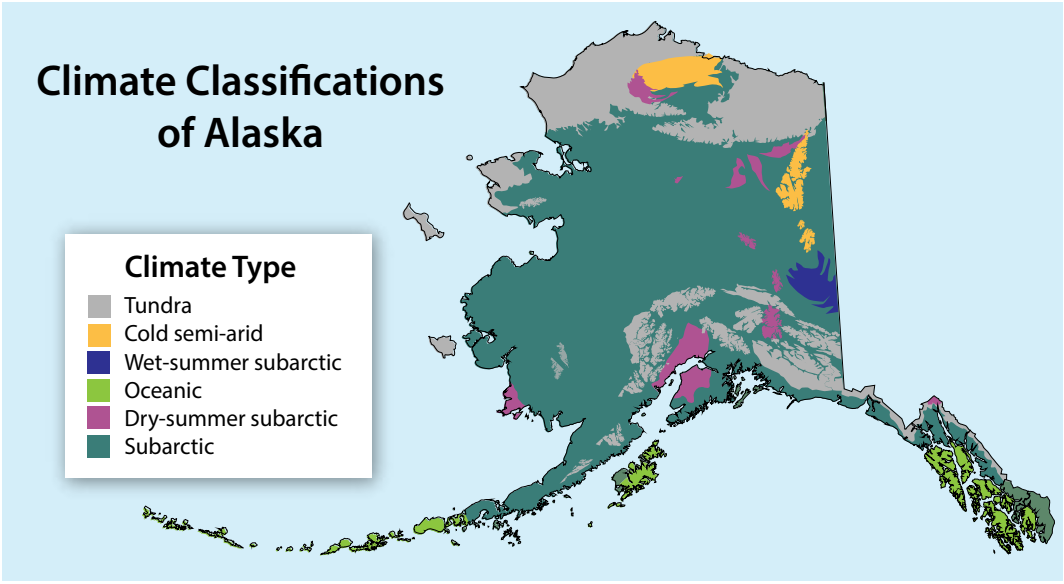
Raising Educational Achievement through Cultural Heritage Up

Changing Climate

What is Climate?

Climate is the long-term average of weather conditions that occur in a particular region. The Bering Strait region of Alaska includes subarctic and tundra climates. Subarctic climates are characterized as having their coldest months average below 0°C (32°F) and at least one month that averages above 10°C (50°F). Much of Alaska has a subarctic climate in which there is no significant difference in the amount of precipitation between seasons. Some areas get most of their precipitation in winter (dry summer subarctic), while other areas get most of their precipitation in summer (wet summer subarctic.) The tundra climate is characterized by temperatures that average below 10°C (50°F) in the warmest months. The tundra climate is a subcategory of polar and alpine climates; the other subcategory of polar climate is an ice cap climate, where all twelve months of the year average below 0°C (32°F). Which climate classification describes your community?

Residents across the Bering Strait region report changes to the local climate. Scientists, both local and distant, are working to understand this climate change. The changes have been so extensive and persistent that a New Arctic is emerging. The New Arctic is warmer, with less sea ice and shorter winters. In the New Arctic, permafrost is thawing and glaciers are shrinking. Measuring and understanding climate change requires collecting data about the weather and environmental conditions in the area over a long period of time. Both ***qualitative data*** (the use of words to describe what is observed) and ***quantitative data*** (the use of numbers to describe what is observed) are used in climate science. Qualitative data might include descriptions of visual environmental observations, oral histories of extreme weather events, and photographs of sea ice conditions. Quantitative data about weather, such as temperature, wind speed, and snow depth can be gathered using instruments. What qualitative and quantitative environmental observations do you make? When and why do you observe weather?



Map based on Wikimedia map "Köppen Climate Types of Alaska." *Source: WorldClim.org.*

Seasons Are Changing

Elders and scientists have been observing the seasons for many generations. Their observations tell us that the seasons are shifting. Spring thaw arrives earlier, freeze up is later, and winters are warmer than they used to be. Changes in the seasons are caused by changes in the climate and physical environment, such as warming temperatures and less snow and sea ice.

Dwarf Alder catkins bloom earlier with warmer late winter temperatures in Kotzebue. *Photo: Putt Clark, REACH Up.*

What is Phenology?

Elders and scientists have tracked the timing of important seasonal events for many generations. This is called ***phenology***. Phenology is the study of timing in nature. It is like nature's calendar. Some examples are: when plants green up each spring; when berries ripen each summer; and when salmon, birds, and other animals migrate each season.

Migrating snow geese prepare to land. Earlier spring conditions along their migratory route encourage them to migrate north earlier. *Photo: Dave Menke, USFWS digital library.*

Ask an Expert

1. Watch the video *Seasonal Shifts* available at *www.k12reach.org/videos.php.*

2. Interview elders or cultural knowledge bearers in your community. Some questions you may want to ask:
   - Have you noticed any changes in the seasons over your lifetime? If so, how have the seasons changed?
   - Have you noticed any changes in when plants green up, flower, or when berries ripen each year?
   - Have you noticed any changes in when and where animals move or have their young?
   - Has the timing of break up or freeze up changed? If so, has this changed safety and travel?
   - Have people in our community made any changes to their subsistence activities to adjust to shifting seasons?

3. If the person you interview speaks an Alaska Native language, ask them what language and dialect(s) they are familiar with. Ask them to please translate the following words:

   - fall
   - rain
   - river
   - snow
   - spring
   - summer
   - tundra
   - winter

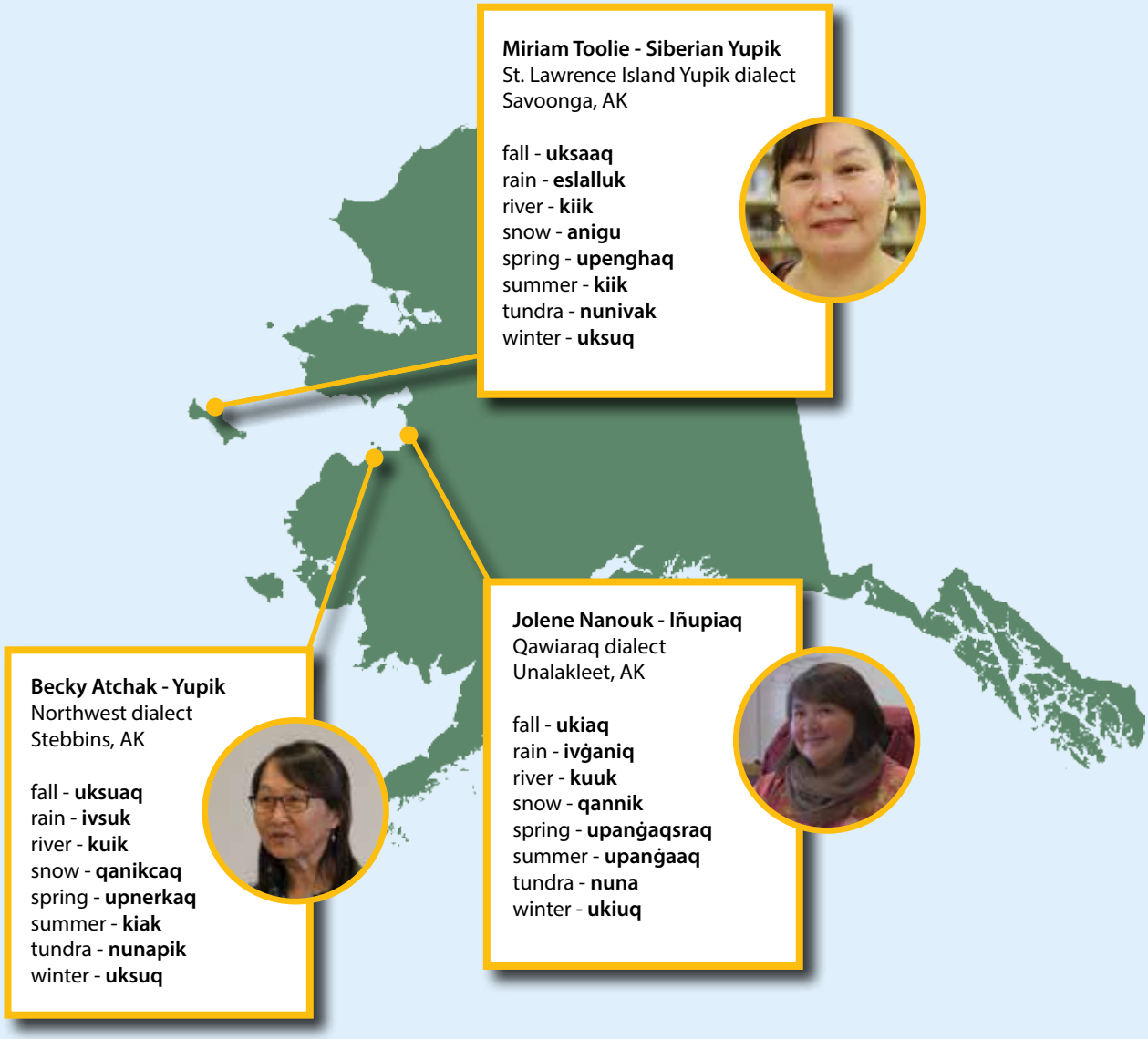
Paul Nagaruk, Elim, discusses his observations about seasonal changes. *Photo: Sean Tevebaugh, REACH Up.*

Compare your words with the translations on the Seasonal Shifts Vocabulary page in this guide. Are any of the terms the same or different? Does your community have other words for seasons that are not listed here?

Seasonal Shifts Vocabulary

Would you like to know Alaska Native language terms related to seasons?

Work with your classmates to practice seasonal vocabulary words in English and the indigenous language of your community. Your teacher will give you vocabulary cards with the English word and an illustration on one side. Write the corresponding indigenous term on the blank line on the back of each card. Use the words that you learned from a local elder or cultural knowledge bearer, or choose the translation below that is closest to your community.



Miriam Toolie - Siberian Yupik
St. Lawrence Island Yupik dialect
Savoonga, AK

fall - **uksaaq**
rain - **eslalluk**
river - **kiik**
snow - **anigu**
spring - **upenghaq**
summer - **kiik**
tundra - **nunivak**
winter - **uksuq**

Jolene Nanouk - Iñupiaq
Qawiaraq dialect
Unalakleet, AK

fall - **ukiaq**
rain - **ivġaniq**
river - **kuuk**
snow - **qannik**
spring - **upanġaqsraq**
summer - **upanġaaq**
tundra - **nuna**
winter - **ukiuq**

Becky Atchak - Yupik
Northwest dialect
Stebbins, AK

fall - **uksuaq**
rain - **ivsuk**
river - **kuik**
snow - **qanikcaq**
spring - **upnerkaq**
summer - **kiak**
tundra - **nunapik**
winter - **uksuq**

What is Phenology?

Materials

- Marker chips in two colors

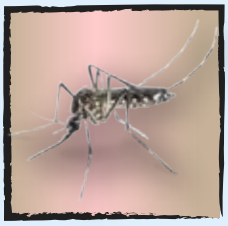
Procedure

1. Look at the list of events. Some are examples of phenology and some are not. Choose one color of marker to indicate "Yes, this is phenology" and the other color to show "No, this is not phenology."
2. Read through the examples and place a marker on each picture to show whether you think each example is phenology or not.

When the first flower in the tundra blooms

When the river breaks up

When I travel for a basketball game

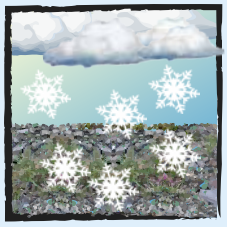


First mosquito of the year

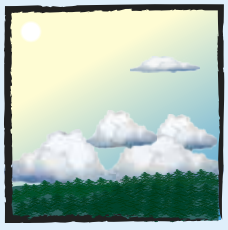
How many birds I see fly over the school

How many salmon are in the smokehouse at fish camp

When the caribou have their young



Date of the first snowfall

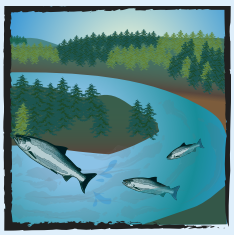


Date of the summer solstice (the longest day of the year)

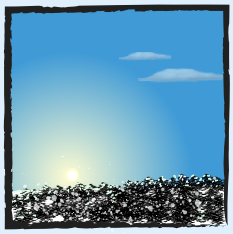
Date when school gets out for summer vacation

When bears wake up from hibernation

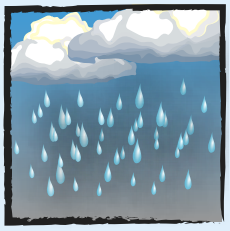
Last group of swans spotted flying over the river in the fall



First salmon swimming upstream



Date of the winter solstice (shortest day of the year)



The number of times it rains in the summer

Date the sea ice is safe to travel

Number of caribou killed by hunters this year

Date the berries are ripe in my traditional picking spot

Discuss

1. Share your results with your classmates.
2. If there is a different opinion about the answers, discuss the ones you chose.
3. Can you think of more examples of phenology that are important in your community?
4. What examples of phenology are most important to your life?

Phenology is Important to Survival

The timing of important life events for many living things depends on the timing of the seasons. For example, the timing of bird migration is related to spring thaw. Over many generations, birds such as geese and swans have arrived in Alaska when the snow and ice have melted and the first green plants are available to eat. Nesting is timed so that eggs hatch when the most nutritious and abundant food is available for young nestlings. Birds depart when the landscape begins to freeze, and food and water are no longer available. Can geese, swans, and other birds respond to shifting seasons and changing phenology? Elders and scientists are studying them to find out.

Phenology is also important to subsistence, cultural traditions, and safety. For many generations, elders carefully studied phenology. They use this knowledge to teach us when to hunt, fish, and gather subsistence foods. Their knowledge of phenology teaches us when it is safe to travel on frozen rivers, when to find subsistence foods in different locations, and when to stay off the sea ice. How will Alaskan people and communities respond to shifting seasons and changing phenology?

Knut Kielland, Sam Demientieff and Dave Norton wrestle with a snowmachine that got stuck when crossing an ice bridge over open water on Luke's Slough on the Tanana River, February 12, 2010. *Photo: Karen Brewster, UAF Oral History Program.*

Phenology is Changing

Bearberry in the tundra. *Photo: USFWS digital library.*

Phenology is changing with the changing climate. Across Alaska, seasons are shifting. Spring thaw is happening earlier than it used to. Rivers are breaking up earlier in spring, and freezing later in fall and winter. Elders and scientists have observed that some living things are changing, too. Plants are greening up and flowering earlier. Some birds are arriving earlier, and leaving later. Insects hatch and berries ripen at different times than in the past. Can all living things respond to changes in phenology? Elders, scientists and Alaskan communities are studying them to find out.

Changing phenology can have ripple effects throughout the food web. Many parts of Alaska ecosystems are changing, and not everything is changing at the same rate or in the same direction. This can lead to mismatches in timing for animals, plants and people. For example:

- If birds arrive and build their nests at the same time they have in the past, but spring has arrived earlier, then their eggs may hatch when there is not enough nutritious food for chicks to eat.
- If rivers break up earlier and freeze later, it can be dangerous or impossible for people to travel at times when they have traveled in the past.
- If animals are no longer present in traditional hunting and fishing areas when they used to be, or if the landscape is not safe for travel, people may not have the subsistence foods they had in the past.

Studying how plants and animals respond to shifting seasons can help us plan for climate change impacts to habitats, wildlife and subsistence.

Working Together to Study Changing Phenology

Living things are adapted to survive the climate and phenology that existed in the past. Seasons are changing, and Alaskan scientists and community members are interested in studying how living things may be changing, too. One way to do this is by collecting quantitative data. Quantitative data uses numbers to describe what is observed, such as the date a river breaks up and the date migratory birds return to your village. Another way to study change over time is to collect qualitative data. Qualitative data uses words to describe observations, such as when the sea ice is safe to travel, or where animals are present at different times of the year.

In order to study if and how living things might adapt to shifting seasons, we need to look at both quantitative and qualitative observations collected over long periods of time. These are called ***long-term data sets***.

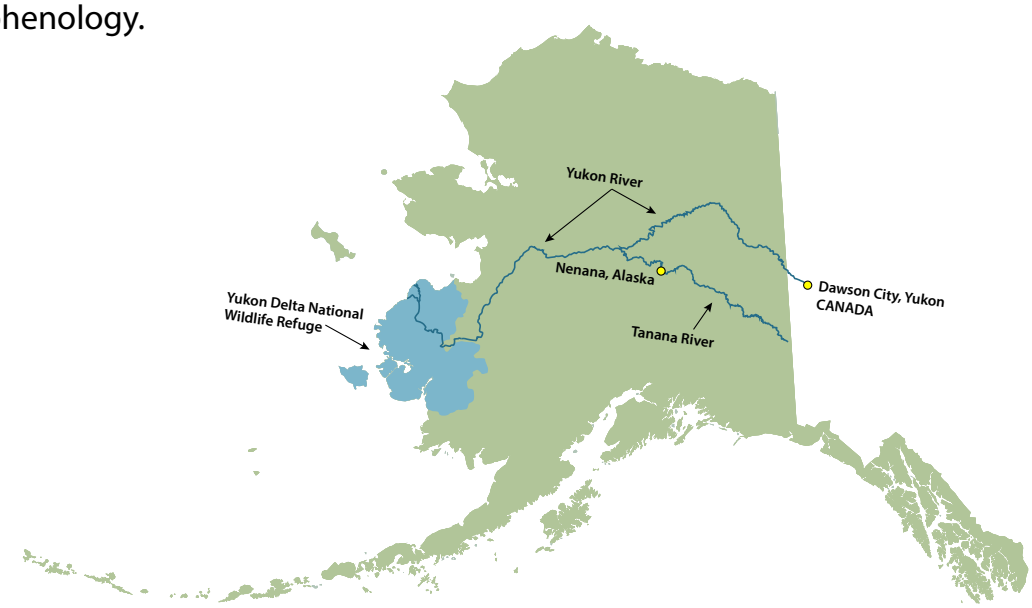
BSSD teachers and paraprofessionals take notes on their qualitative observations and use scientific insturments to gather quantitative data while studying the Unalakleet River during the 2017 REACH Up Science & Culture Camp. *Photo: Sally Kieper, REACH Up.*

Long-term Data Sets: Break Up on the Yukon and Tanana Rivers

Is the phenology of rivers around our communities changing with the climate? Break up is an exciting time in many Alaskan communities. Spring has arrived. Frozen rivers break apart and snow melts. Water begins to flow again and mud is everywhere. Many Alaskans notice the date the river in their community breaks up each year. Some people even keep careful records of over time.

This is the official tripod for the Nenana Ice Classic. The tripod is attached to a clock on the shore by a cable. When the ice under the tripod breaks or starts to move, the tripod moves, pulling the cable and stopping the clock. *Photo: James Brooks, https://www.flickr.com/photos/jkbrooks85/3384528606.*

The Nenana Ice Classic has tracked break up on the Tanana River in central Alaska since 1917. This annual competition has paid several million dollars in winnings to the people who come closest to guessing the exact date and time the river ice will break up. A similar tradition exists on the Yukon River in Dawson City, Canada. There, breakup dates have been recorded since 1896! River ice breakup is more than just a competition. These communities have built long-term data sets that can be used to study changes in climate and phenology.



Long-term Data Sets: Hatch Dates for White-fronted Geese and Cackling Geese in the Yukon Delta National Wildlife Refuge

Is the phenology of migratory birds changing with changing seasons? The return of migratory birds is another exciting time in communities around Alaska. Each spring millions of birds from all over the world return to Alaska to nest and raise their young. Scientists on the Yukon Delta National Wildlife Refuge have been recording when young geese and other birds hatch for over 30 years. To do this, they search for nests in the tundra. When they find a nest, they float the eggs in water to determine their age. These scientists are building another long-term data set that can help us study how changes in climate and phenology are impacting Alaskan wildlife.

Scientists float the eggs in water to determine their age. The angle and depth at which the egg floats help scientists estimate the date the egg was laid and when it will hatch. *Photo: Gulf Coast Bird Observatory.*

Goose nest on the tundra. *Photo: Alaska Biological Research (ABR), Inc.*

Long-term Data Sets

Long-term, quantitative data sets can be graphed to look for patterns. One way to look for a pattern is to draw a ***line of best fit***. A line of best fit is also called a ***trendline*** because it illustrates a trend, or the direction in which the graph is changing. The computer program Microsoft Excel can draw the trendline for you.

In this activity you will look for trends in long-term data collected by Alaskan elders, scientists and communities. Your class will work in teams to look at the phenology of spring break up on the Yukon and Tanana Rivers and the phenology of migratory geese on the Yukon Delta National Wildlife Refuge.

Materials

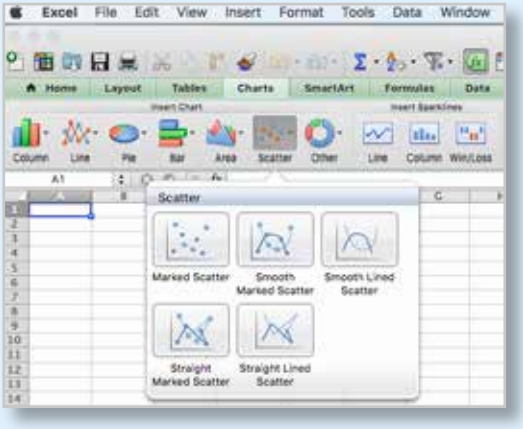
- Student Worksheet and graph paper
- Pen/pencil
- Computer with access to the REACH UP website and Microsoft Excel
- Printer (optional)

Procedure

Your teacher will assign you to a team: Tanana, Yukon, White-fronted Geese, or Cackling Geese. Each team should follow the directions below for their data set.

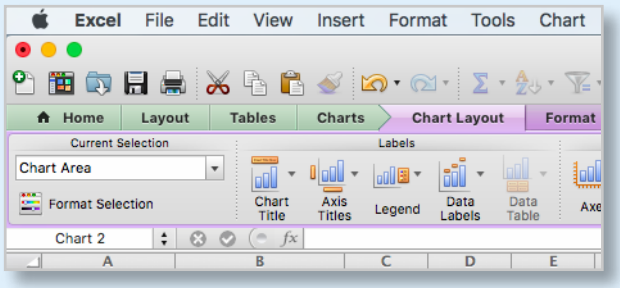
	A	B
1	YEAR	Date
2	1982	4-Jul
3	1983	24-Jun
4	1984	27-Jun
5	1985	2-Jul
6	1986	30-Jun
7	1987	28-Jun
8	1988	24-Jun
9	1989	1-Jul
10	1990	24-Jun
11	1991	22-Jun
12	1992	1-Jul
13	1993	24-Jun
14	1994	19-Jun
15	1995	20-Jun
16	1996	18-Jun
17	1997	17-Jun
18	1998	25-Jun

1. Download your data set from: *http://k12reach.org/grade9-12theme1.php.*
2. Open the file to view a chart of your data. The data is in two columns. The first column (A) contains the year. The second column (B) contains the date. Row 1 is the title for each column.
3. Highlight all the cells containing data. Do not highlight the titles (Row 1). To do this, click on A2 and drag the highlighted box over all the data.
4. Next, find Insert in the menu bar. Click it and select ***Charts***. Choose ***Scatter***, then ***Marked Scatter***.

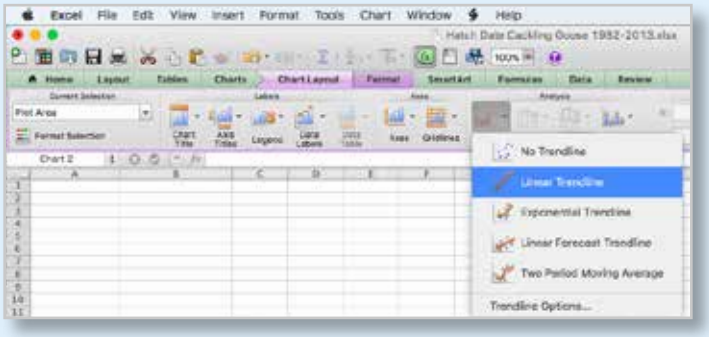


5. You will now see a graph prepared by Excel. Drag the corner of your graph to make it appear bigger or smaller.

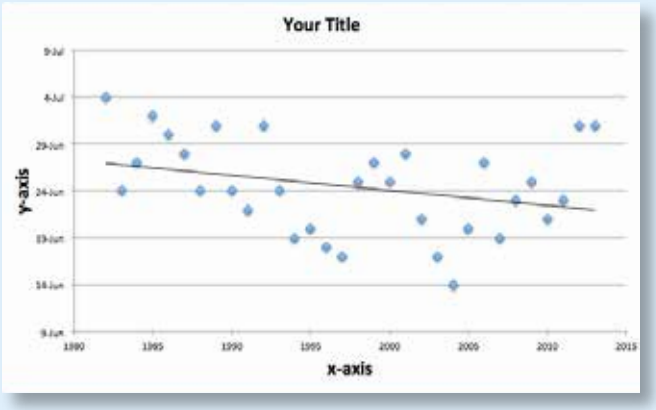
You will need to keep the data and graph highlighted for steps 6-11.



6. The next step is to give your graph a title. Select ***Chart*** Layout, then ***Chart Title***. Choose ***Title Above Chart*** and type your title in the text box that appears. The title should describe your graph, for example, "Break Up on the Yukon River, 1982-2013." You can double click the text box if you want to change the font, size, and color of your title.



7. Next, you will label the x-axis. Select ***Axis Titles*** then ***Horizontal Axis Title***, then ***Title Below Axis***. Type "YEAR" into the text box that appears. Double click the text box to change the font, size, and color of your label if you want.
8. Next, you will label the y-axis. Select ***Axis Titles***, then ***Vertical Axis Title***. You will have three choices of how you want the words to be arranged on the y-axis. Choose the one you like and type "DATE" into the text box that appears. Double click the text box to change the font, size, and color of your label if you want.



9. Click on the legend. It should say "Series 1." Delete it. You can also do this by selecting ***Legend*** from ***Chart Layout*** and choosing ***No Legend***.
10. The last step is to add the trendline. Select ***Chart Layout***. Choose ***Trendline***, then ***Linear Trendline***. A straight line will appear on your graph. This is the line of best fit. It shows us the direction of change over time.
11. Finally, print your graph. Make sure your computer is connected to a printer and your graph is highlighted. Choose ***Print*** from the ***File*** menu. You may need to change the orientation of the page, or choose ***Fit to Page***.

Discuss

Discuss the following questions with your team, then share your results with your class.

1. How would you describe your trendline?
    - Is it sloping down (showing a trend toward earlier breakup/hatching)?
    - Is it sloping up (showing a trend toward later breakup/hatching)?
    - Or is it level (showing no change in phenology over time)?

2. As you can see by looking at your graph, there is a lot of variation from year to year. Some years are early, and some years are late. Some years are extreme. This is why elders and scientists make observations over long periods of time. Repeated observations over many years help us detect more gradual change. Making a graph with a trendline helps us see this change.

   Using the direction of the trendline as a clue, use your graph to make a projection about how the phenology of the river or birds may change far into the future, when you are an elder.

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