



SCIENCE, TECHNOLOGY,
ENGINEERING, AND MATH
COLORADO STATE UNIVERSITY
EXTENSION

ST[EMpower]



CAREER CONNECTION

We have been exploring career ideas over the past 2 months. If you missed those issues, you can find activities 38 and 39 located here:

<http://tra.extension.colostate.edu/stem-resources/>

Last month, you analyzed the results of the interest survey. The 12 broad interest categories are:

- Adventure
- Animals and Nature
- Art
- Business
- Computers
- Math
- Music and Dance
- Science
- Sports
- Talking
- Travel
- Writing

Look at your ranking. What are your top 3 or 4 categories? For example, my top 4 would be Animals and Nature, Math, Science, and Travel. I love my job, and it incorporates all four of those interests. I am a paleontologist and I travel to Argentina to collect data on how a variety of different ancient mammals walked.

You are going to start exploring what careers combine your interests so that you can work towards your rewarding career! Awesome!

MY LITTLE CHICKADEE

How to Survive the Winter in Colorado

Dr. Barbara J. Shaw



Black-capped Chickadee Audubon

BACKGROUND

Information

Colorado is home all year long to two species of chickadees: Black-capped Chickadee and Mountain Chickadee. The Black-capped Chickadee is found everywhere, however the Mountain Chickadee is only found in the western half of our state.

Both these birds are very small. Mountain Chickadees weigh the same as 4 US cents and Black-capped Chickadees weigh a bit less than 5 US cents. In these activities, you will explore the relationship of their size to the **abiotic** components (cold temperatures and water access) during our winter months, adding body fat in the fall, and behaviors they use to help them stay warm .

Birds have three strategies to survive winter in Colorado and other cold climates:

1. Migrate

- Many of the Colorado songbirds (chickadees are in the songbird family) migrate south to warmer climates for the winter months. Not our little Chickadees, though!

2. Enter Dormancy

- There are various kinds of **dormancy** from deep to light hibernation. Hibernation involves lowering the body temperature, slowed breathing to conserve energy. Only 1 species of bird is known to hibernate, the Common Poorwill. Its breeding range is in western Colorado, but migrates south before winter to hibernate.



Common Poorwill (Audubon)

3. Tough It Out

- Colorado has winter bird residents for example Bald Eagle, Green-winged Teal, Raven, Hairy Woodpecker, Pygmy Nuthatch, Red Crossbill, Pine Grosbeak, Mourning Dove, and of course, our two species of Chickadees. This is just a short list of our residents. How do they survive?

Objectives

You will:

- Conduct a series of experiments to determine
 - How size impacts heat loss
 - How fat can insulate animals
 - What behaviors help Chickadees (or other birds) stay warm during cold temperatures
- Collect information about similarities and differences between these two species of Chickadees
- Design a bird bath that provides water (not ice or snow)
- Design sheltered area for Chickadees
- Write a winter Haiku
- Use your top interests from the interest quiz (last 2 months) to pick an activity to further explore things you enjoy doing (Career Connection)

Materials:

- Computer with internet and speakers
- 3—recycled containers of different sizes, e.g. an individual yogurt container, 1 pint yogurt container, 1 gallon milk jug (cut off the top)
- Measuring cup
- Thermometer (you can use an outdoor thermometer)
- Lard, suet, or peanut butter (suet is the preferred food)
- Bagels (stale is fine)
- Yarn or string - about 18 inches
- Scissors
- Bird seed that includes black oil sunflower seeds
- Plastic knife (butter or table knife will work)
- 4—quart size ziplock plastic baggies
- 1—can shortening, and a spoon to scoop
- 1—large container filled with ice (lots of ice) and water
- Data sheets (page, 11-14)
- Color pencils
- Printed 2-sided copy of the chickadee cards (pages 7-10) cut apart

Pick at least one of the following and explore the ideas further.

- What are your very favorite books, movies, and TV shows? Why? What are the common threads? Write them down. Look at your top interest categories, and how do they relate to each other?
- Write a story about yourself set in 2030. What are you doing? How are you doing it? Be as wildly creative as you like in your story.
- Design something using recycled materials. This project can be anything from designing artwork to a robot that plays with your cat. How did this project relate to your top interests?
- Keep a journal to track your activities over the course of the month. Set it up with the amount of time at each task (including your chores). At the end of the month, add up the time it takes for each (i.e. 143 hours for school). Even with the tasks we have to do, some are enjoyable. Note the activities that you enjoyed doing during the “have to” time. Next look at your free time. How did you spend it? What was the most enjoyable to you? Do you see a pattern emerge?
- You can work with 3 other friends on this idea. Develop a themed day for younger 4-H members. For example, present the 4-H day, with 1 activity from each of the Head, Hand, Heart, and Health. Each one of you presents your activity to younger members. What did you like best about this?

POWER WORDS

- **abiotic**: physical rather than biological; not derived from living organisms.
- **behavior**: the way in which one acts.
- **dormancy**: a period in an organism's life cycle when growth, development, and (in animals) physical activity are temporarily stopped; minimizes metabolic activity to help an organism conserve energy; tends to be closely associated with environmental conditions.
- **endotherm**: an organism that makes body heat that is higher or lower than the environment.
- **haiku**: a Japanese poem of seventeen syllables, in three lines of five syllables, seven syllables, and five syllables, traditionally evoking images of the natural world.
- **hibernate**: the condition or period of an animal or plant spending the winter in a dormant state.
- **migration**: seasonal movement of animals from one region to another.
- **torpor**: decreased physiological activity in an animal, usually by a reduced body temperature and metabolic rate; enables animals to survive periods of reduced food availability.

FASCINATING FACTS Chickadees

- These small birds can live a relatively long life. The oldest banded Black-capped Chickadee in the wild lived 12 years and 5 months.
- Chickadees are named after their distinctive call.

DO:

Get to Know the Colorado Chickadees!

- How can you tell these two birds apart?
- Print double sided the chickadee images and information to make cards. Cut them apart. Read the cards, examine images, and note differences and similarities between these two species of chickadees.
- Do you live in an area where the Mountain Chickadees live?
- Go online using the Audubon and All About Bird webpages listed below to listen to the birdsong. Can you tell the difference between their songs? They can!
 - The Cornell Lab of Ornithology All About Birds (<https://www.allaboutbirds.org/>) has wonderful resources on the web for exploring birds, including our two species of Chickadees. Many of the images in this activity were captured from the websites below.
 - https://www.allaboutbirds.org/guide/Black-capped_Chickadee/id
 - https://www.allaboutbirds.org/guide/Mountain_Chickadee/id
 - National Audubon (<http://www.audubon.org/>) also has great resources. The picture of the Black-capped Chickadee on the first page is from the Audubon North America Bird Guide as well as many other images used throughout this activity.
 - <http://www.audubon.org/field-guide/bird/black-capped-chickadee>
 - <http://www.audubon.org/field-guide/bird/mountain-chickadee>

Small Size and the Cold

- All organisms on Earth require water, an **abiotic** component of every ecosystem. Do Chickadees drink water during the winter? How do you think that impacts their survival?
- To explore Chickadee challenges during cold temperatures, you will conduct an experiment how the size of a bird (Chickadee—little, Magpie—medium, and Eagle—large) loses or gains heat. You need 3 different size containers, water, a thermometer, a measuring cup, the datasheet on page 11, a pencil or pen to record your data, and a sheltered place outside to set the containers.
- Use the same temperature of water for all containers to start. Measure the water in the container with the measuring cup and record that on the datasheet. Do not fill to the top. If the container has a lid, that is perfect for transporting to experiment location, but remove the lid.
- Take and record the temperature of the water for each container.
- Place the containers at a suitable location outside for the day. The best is in the shade, on the north side of your house.
- Collect data once every hour for a 4 hour period by going outside and taking the temperature of the water.
- Graph results (temperature change through time). Use a different color pencil for each container (blue for the smallest, green for the medium, and red for the largest container).
- What does this experiment mean in relationship to body size of different **endotherm** (warm-blooded animals), like our Chickadees?



Body Fat for Insulation

- While Chickadees do not have blubber, they do gain weight in the fall to prepare for the cold of winter. This is a demonstration how fat helps to keep us warm. You will make a “blubber” glove with shortening insulation between 2 baggies and a control glove with no shortening.
- You need 1 bucket of ice water (use lots of ice), 4 quart-size plastic ziplock baggies, shortening, and a spoon.
- Turn 2 of the baggies inside-out.
- Insert each the inside-out baggies inside each of the right-side-out baggies.
- Add enough shortening between the 2 baggie layers in only one set of the baggies to completely coat the inside of that baggie. The other baggie set has no shortening.
- Ziplock the inside-out baggie to the right-side-out baggie. Be sure that you squeeze out the air, and you have a good seal. You have two baggie gloves, one with and one without shortening.
- Put on the two “gloves”: one on each hand. Dip both hands into the bucket of ice water. Don’t dip the gloves over their ziplock seal.
- How does this apply to Chickadees?



Birdfeeders

- You need a bagel, string, scissors, birdseed, knife, and lard, suet, or peanut butter. If you use suet, you will also need to melt it first in the microwave in a bowl or stovetop in a pan.
- Thread the string through the hole in the bagel and tie to make a large loop.
- With the plastic knife, spread the lard, suet, or peanut butter on the bagel.
- Dredge the bagel in the birdseed.
- Hang the bagel birdfeeder in a location outside that is easy to see from one of your windows.
- You will need to allow the birds some time to locate the feeders before proceeding with the data collection.



Is That Any Way to Act?

- How do you stay warm in the winter? How can birds stay alive in winter?
 - **Physical Adaptations**
 - **Feathers:** Birds’ feathers provide remarkable insulation against the cold. The oil that coats birds’ feathers also provides insulation as well as waterproofing.
 - **Legs and Feet:** Birds’ legs and feet are covered with specialized scales that minimize heat loss. Birds can also control the temperature of their legs and feet separately which also reduces heat loss.
 - **Fat Reserves:** Birds build up fat reserves to serve as insulation and extra energy for generating body heat.

- Aside from their famous “chick-a-dee” call, they also let out a “fee bee.”
- If you’ve ever listened to a chickadee’s call very closely, you’ll notice that sometimes there is only one *dee* at the end of the *chick-a-dee* and other times there are multiple dees at the end. According to Christopher Templeton at BirdNote, there is actually a code to the number of *dees*. One *dee* indicates that there is no threat, but five *dees* at the end of the call could indicate that there’s a Northern Pygmy Owl in the vicinity.
- Most chickadees are non-migratory, so you’ll often see them at your feeder in winter. This is notable because they are said to need up to 10 times more food in the winter than in summer.

Dormancy

- The difference between torpor and hibernation: Torpor is usually shorter-term in response to environmental temperature and food availability. Longer-term hibernation is driven by day length hormonal changes.
- A hibernating animal’s body temperature and heart rate drops and its breathing and metabolism slow. Hibernating bats can go up to an hour between breaths!
- The common poorwill is the only bird known to hibernate for months at a time. Scientists didn’t discover this until the 1940s, but the Hopi people of the Southwest knowingly called the species “the sleeping one.”

Haiku

- Haiku originated in Japan. It is a fairly new style popular in the 17th and 18th century.
- Because the haiku is so brief, it relies on simple phrases. Every word in the haiku has to play a meaningful role, so haiku poets choose their words carefully.
- The brevity of the haiku lends itself well to imagery.
- The structure of haiku follows a 5/7/5 syllable pattern, for a total of 17 syllables. There is no rhyme scheme.

CITATIONS

Note: images are identified as "Audubon" and "Cornell All About Birds" to give proper credit to the source.

- Cornell Ornithology Lab All About Birds
<https://www.allaboutbirds.org/>
- National Audubon Society
<http://www.audubon.org/>
- Audubon Rockies (the regional office for Colorado and Wyoming)
<http://rockies.audubon.org/>
- Bagel Birdfeeder image:
<https://media.30seconds.com/tip/lq/National-Bird-Feeding-Month-Make-This-DIY-Bagel-Bird-Feeder-13516-331b3d9d92-1488235333.jpg>
- Blubber Gloves images:
<https://learning-center.homesciencetools.com/article/whale-blubber-project/>
- Container images:
 - https://cdn3.bigcommerce.com/s-neo29sbo9q/products/6722/images/5256/37598-b-wb_67064.1495028094.500.750.jpg?c=2
 - https://photos.smugmug.com/Products/AJC-Grocery-Shoot-6-15-10/i-xXZtqPs/0/e26704e3/S/MG_3185%20Daisy%20Sour%20Cream%2016oz-S.jpg
 - https://images-na.ssl-images-amazon.com/images/I/71ZAI4bfbrL_SL1294.jpg

- **Behavioral Adaptations** (pictures of these behaviors page 12)
 - **Fluffing:** Birds fluff out their feathers to create air pockets for additional insulation in cold temperatures.
 - **Tucking:** Birds stand on one leg or crouch to cover both legs with its feathers to shield them from the cold. They also tuck their bills into their shoulder feathers for protection and to breathe air warmed from their body heat.
 - **Sunning:** On sunny winter days, birds will turn their backs to the sun, spread their wings and tails, and raise their feathers slightly. This allows the sun to heat the skin more efficiently.
 - **Shivering:** Birds shiver to raise their metabolic rate and generate more body heat as a short term solution to cold.
 - **Roosting:** Many small birds, including chickadees, gather in large flocks at night and crowd together in a small, tight space to share body heat.

Data Collection

- You need a copy of the bird behavior datasheet (page 12), the graph paper (page 13) and a pencil or pen. You can collect your data for 10 minutes when the feeder is active. The datasheet is designed to collect data on 3 separate occasions. Select days with different temperatures (i.e. a warm, a cool and a cold day), or collect on a single day at different times (first thing in the morning around lunch, and late afternoon).
- Record the date, time and temperature for each session.
- When you see a bird perform a specific behavior, make a tick mark in the correct cell of your table. For example, if the bird displays shivering and tucking, you mark 1 tick for shivering and 1 tick for tucking. If the bird displays fluffing, mark 1 tick for fluffing.
- Graph your results (for example, a bar graph or a histogram). You can look up how to graph on the internet. Remember to label your axes and give your graph a title. The graph paper is on page 13.

REFLECT

- You have completed a series of experiments and observations to help you figure out how Chickadees stay alive. Pull out our data sheets and look at them.
 - What did the container size tell you about the water losing or gaining heat? How does that relate to Chickadees?
 - What did the blubber glove experiment tell you about a strategy animals use to stay warm? Does this relate to Chickadees?
 - What behaviors do Chickadees use to stay warm?
- Use the Compare/Contrast datasheet (page 14) to review all your information. Here are some other strategies that Chickadees (and other birds) use to stay warm during the winter:
 - Birds shiver through the winter.
 - Birds normally sit wing distance from the next bird. During cold temperatures, they will nestle in tight flocks to share body heat in sheltered areas like shrubbery or hollows in trees.
 - Chickadees, go into **torpor** in the evening. That means they lower their body temperature and breathing so they don't need as much energy, similar to animals that hibernate.
 - Bird feathers are great at keeping out the cold. The outer feathers are waterproof (a gland provides oil that the bird

spreads over the outer wings). The inner layer is down, like a down coat. This fluffy layer traps air to keep them warm.

- *Try this out!* Take a sheet of paper and rub a thin layer of shortening on it. Lay the paper flat on the counter. Add drops of water on the top of the shortening paper. What happens? How does this relate to Chickadee feathers?
- Birds can store fat both for energy and insulation. The most famous insulation is whale blubber, a layer of fat under the skin. Birds can also increase their body mass with fat to help insulate them from the cold.
- They need to eat more. It is estimated that Chickadees may need to eat 10 times more food every day during the winter!

Haiku

- Write a chickadee **haiku**. The Japanese haiku poem consists of 3 lines and a total of 17 syllables. The first line has 5 syllables, the 2nd line has 7 syllables, and the 3 line has 5 syllables.

Chickadees flutter
Dancing on snowy branches
Busy little birds

APPLY

- What can you do to help Chickadees survive a cold snap?
 - <https://www.thespruce.com/how-to-attract-chickadees-386246> has some great tips
 - Make more bird feeders and keep them out until Spring.
 - Use suet. Use black oil sunflower seeds. These little birds need high quality food, packed with calories. Suet and black oil sunflower seeds pack plenty of power!
 - Design a heated bird bath for access to water (rather than snow or ice). Can you design a bird bath that uses solar energy to keep the water from freezing?
 - Design a shelter. Sketch out your design based on what you learned about Chickadees.
 - Share this information with others.

THANKS

Audubon Rockies! John Kloster-Prew, Deputy Executive Director. John provided great insight and information to produce this month's STEM activities.

Check out their website for our local connection to Audubon!

<http://rockies.audubon.org/>

Bill Ekstrom, Rio Blanco's County Extension Director for the blubber glove activity.



Authors

Dr. Barbara J. Shaw, Colorado State University Extension Western Region STEM Specialist, 4-H Youth Development

Tom Lindsay, retired HS science teacher (AP and IB Chemistry, Physics, Biology, and Calculus) and university instructor (geology and paleontology)

Bill Ekstrom, Rio Blanco County Extension Director: Contributions to the blubber glove experiment

John Kloster-Prew, Audubon Rockies, Deputy Executive Director

Acknowledgments

Funding for this project provided by Colorado State University System Venture Capital Fund

CJ Mucklow, Colorado State University Extension Western Regional Director; Annette Haas, Colorado State University Extension State Office, State STEM/4-H Specialist; Kellie Clark, Colorado State University Extension Western Region Program Assistant; and Nicole Goza, Colorado State University Extension Montrose County 4-H Assistant

Dr. Joe Cannon and Marketing Strategies students: Berlyn Anderson, Jenna Balsley, Rachel Kassirer, Rachel Richman, Colorado State University, College of Business, for marketing strategies and kit graphics.



ST[EMpower]

Joanne Littlefield, Colorado State University Extension Director of Communications and Doug Garcia, Colorado State University Creative Services Communication Coordinator/ Designer

Colorado State University, U.S. Department of Agriculture and Colorado counties cooperating. CSU Extension programs are available to all without discrimination. No endorsement of products mentioned is intended nor is criticism implied of products not mentioned.

© Colorado State University Extension. 8/14. www.ext.colostate.edu

Supplemental Information



Black-capped Chickadee (Audubon)



Mountain Chickadee (Audubon)



Black-capped Chickadee (Audubon)



Mountain Chickadee (Audubon)



Black-capped Chickadee (Audubon)



Mountain Chickadee (Cornell All About Birds)

This image: https://www.allaboutbirds.org/guide/Mountain_Chickadee/id

Supplemental Information

Mountain Chickadee

Identify: Similar to the Black-capped Chickadee, but black of cap interrupted by a white line over the eye.

Winter: Resident

Black-Capped Chickadee

Identify: The Black-capped Chickadee can be separated from the Mountain Chickadee by the solid black cap in conjunction with its gray back and buffy sides.

Winter: Resident

Mountain Chickadee

Diet: Feeds on a wide variety of insects, including many caterpillars, beetles, and others; often feeds on insect eggs and pupae, as well as spiders and their eggs. Also eats many seeds, some berries and small fruits.

Feeding Behavior: Forages actively in trees, often feeding very high in conifers. Forages by gleaning food from twigs, often hanging upside down. Has been seen using a wood splinter to probe in deep cracks. Sometimes takes food while hovering. Will come to bird feeders for seeds or suet.

Black-Capped Chickadee

Diet: Diet varies with season. Summer: mostly caterpillars and other insects, some spiders, snails, other invertebrates and berries. Winter: insect eggs and pupae, seeds, berries, small fruits.

Feeding Behavior: Forages by hopping among twigs and branches and gleaning food from surface, often hanging upside down to reach underside of branches. Sometimes takes food while hovering, and fly out to catch insects in mid-air. Readily comes to bird feeders for seeds or suet. Will store food.

Mountain Chickadee

Eggs: 5-12. White, dotted with reddish brown, sometimes unmarked. Incubation by female only, about 14 days. Adult disturbed on nest will give a loud hiss, sounding like a snake.

Young: Female spends much time with young at first, while male brings most food; later, both parents feed young. Age of young at first flight about 3 weeks.

Black-Capped Chickadee

Eggs: Usually 6-8, White, with fine dots of reddish brown often concentrated around larger end. Incubation is by female only, 12-13 days. Female covers eggs with nest material when leaving nest. Male often brings food to female during incubation.

Young: Female remains with young most of time at first, while male brings food; later, both parents bring food. Young leave nest at about 16 days. Normally 1 brood per year.

Supplemental Information



Black-capped Chickadee (Cornell All About Birds)



Mountain Chickadee (Cornell All About Birds)



Black-capped Chickadee (Cornell All About Birds)



Mountain Chickadee (Cornell All About Birds)



Black-capped Chickadee (Cornell All About Birds)

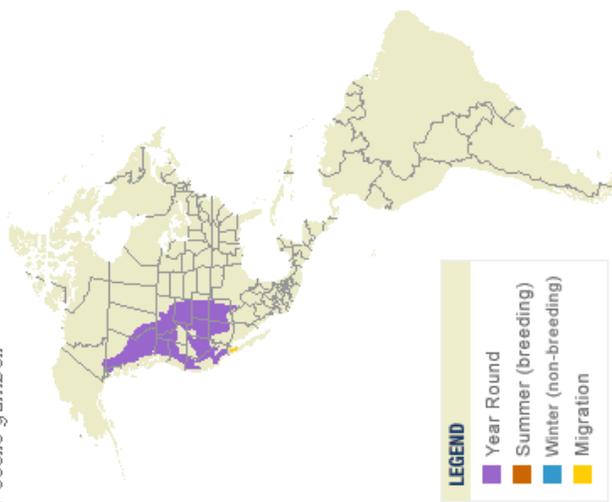


Mountain Chickadee (Cornell All About Birds)

Supplemental Information

Mountain Chickadee

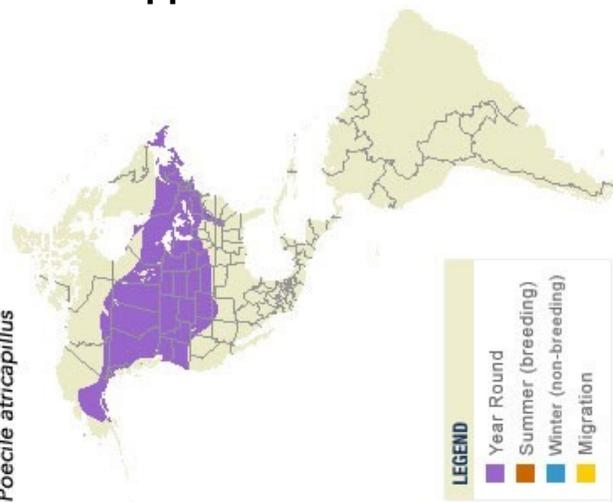
Mountain Chickadee
Poecile gambeli



Map by Cornell Lab of Ornithology
Range data by NatureServe

Black-Capped Chickadee

Black-capped Chickadee
Poecile atricapillus



Map by Cornell Lab of Ornithology
Range data by NatureServe

Mountain Chickadee



14 cm (5.5 in)
long with a
wingspan of 19
cm (7.5 in), and
weight about 11
gram (0.39 oz)

Black-Capped Chickadee



14 cm (5.5 in)
long with a
wingspan of 21
cm (8.3 in), and
weight about 14
gram (0.49 oz)

Mountain Chickadee

The tiny Mountain Chickadee is a busy presence overhead in the dry evergreen forests of the mountainous West. Often the nucleus in mixed flocks of small birds, Mountain Chickadees flit through high branches, hang upside down to pluck insects or seeds from cones, and give their scolding *chick-a-dee* call seemingly to anyone who will listen.

Black-Capped Chickadee

A bird almost universally considered “cute” thanks to its oversized round head, tiny body, and curiosity about everything, including humans. The chickadee’s black cap and bib; white cheeks; gray back, wings, and tail; and whitish underside with buffy sides are distinctive. Its habit of investigating people and everything else in its home territory, and quickness to discover bird feeders, make it one of the first birds most people learn.

Supplemental Information

Small Size and the Cold

Today's Date:

Today's Temperature Outside:

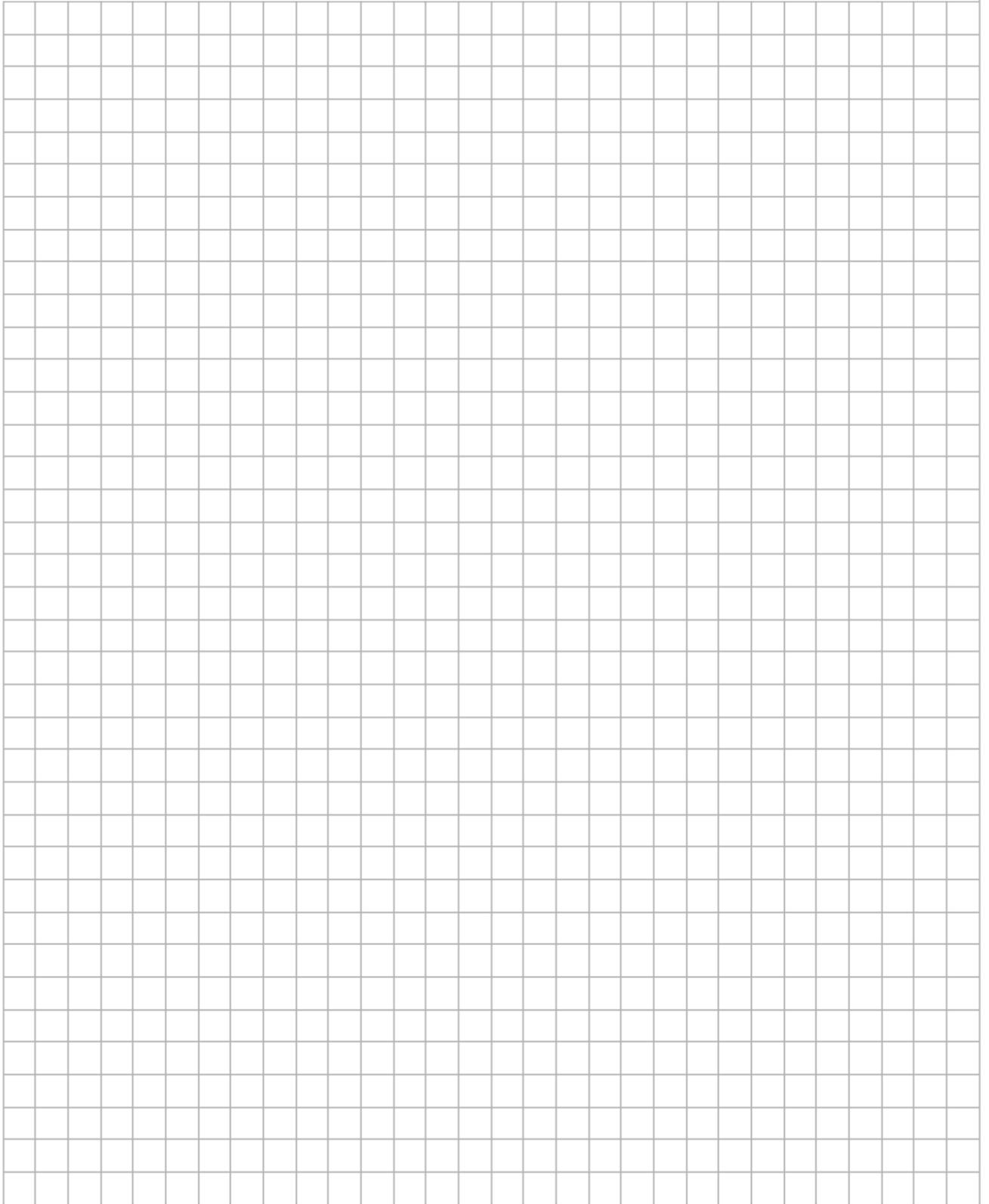
Blue line	Green line	Red line	80°F	27°C					
			78°F	26°C					
How much water is in the smallest container?	How much water is in the middle container?	How much water is in the largest container?	76°F	24°C					
			74°F	23°C					
			72°F	22°C					
			70°F	21°C					
Starting Temperature of Water	Starting Temperature of Water	Starting Temperature of Water	68°F	20°C					
			66°F	19°C					
			64°F	18°C					
			62°F	17°C					
1. Time / Temperature	1. Time / Temperature	1. Time / Temperature	60°F	16°C					
			58°F	14°C					
			56°F	13°C					
			54°F	12°C					
2. Time / Temperature	2. Time / Temperature	2. Time / Temperature	52°F	11°C					
			50°F	10°C					
			48°F	9°C					
			46°F	8°C					
3. Time / Temperature	3. Time / Temperature	3. Time / Temperature	44°F	7°C					
			42°F	6°C					
			40°F	4°C					
			38°F	3°C					
4. Time / Temperature	4. Time / Temperature	4. Time / Temperature	36°F	2°C					
			34°F	1°C					
			32°F	0°C					
			Temperature		Start	60 min.	120 min.	180 min.	240 min.
			Time Min.						

Bird Behavior Data Sheet

Name: _____

	Practice Data Collection	First Data Collection	Second Data Collection
	Date:	Date:	Date:
	Time:	Time:	Time:
	Temperature:	Temperature:	Temperature:
Behaviors:	Behavior Observed:	Behavior Observed:	Behavior Observed:
 <p>Black-capped Chickadee (Audubon)</p>	Fluffing	Fluffing	Fluffing
 <p>Black-capped Chickadee (Audubon)</p>	Tucking	Tucking	Tucking
 <p>Black-capped Chickadee (Audubon)</p>	Sunning	Sunning	Sunning
 <p>Black-capped Chickadee (Audubon)</p>	Shivering	Shivering	Shivering

Supplemental Information



Supplemental Information

Compare/Contrast Datasheet



Black-capped Chickadee

Mountain Chickadee