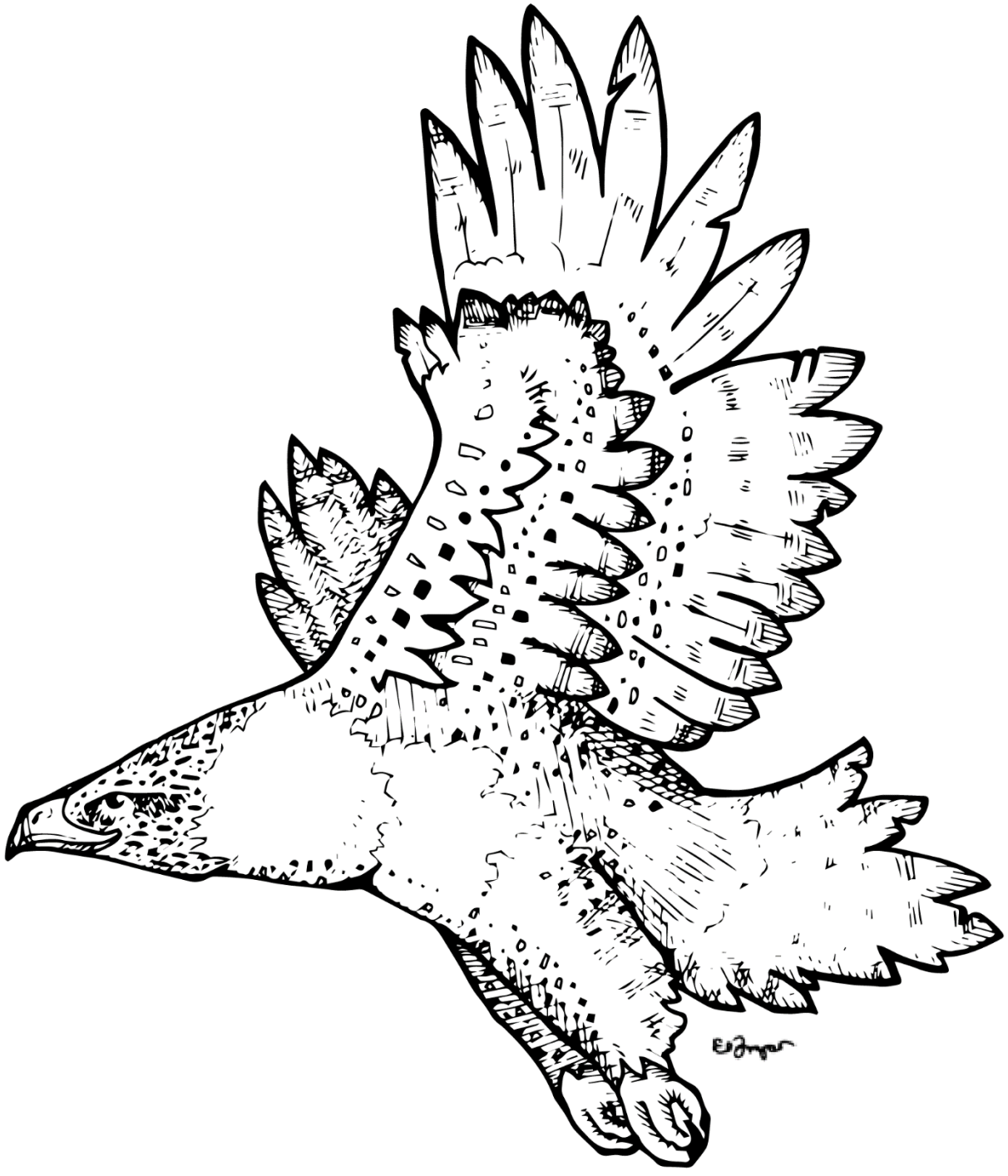
Plumas Audubon Society's

Plumas Environmental Education Program (PEEP)

Birds and Climate Change Curriculum



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Plumas Environmental Education Program
Birds and Climate Change Curriculum

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We dedicate this work to *all* the children of the world.♡

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Plumas Audubon Society's
Plumas Environmental Education Program (PEEP)

Birds and Climate Change Curriculum

(Elementary School)

Brief Introduction for Educators

The goal of this curriculum is to CULTIVATE STEWARDSHIP in the next generation of learners, thinkers, and doers. This curriculum aims to cultivate stewards of the earth by opening an AWARENESS of climate change and its effects on the natural environment, wildlife, and society; building a RELATIONSHIP with the land, its resources, and the organisms who depend on such, including human communities; developing a sense of RESPONSIBILITY and CAPACITY to address both the problems and solutions to climate change; and fostering a feeling of EMPOWERMENT which calls stewards to take ACTION towards the well-being of the earth.

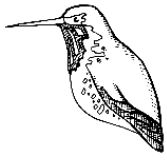
The curriculum is composed of five units, a concluding reflection lesson plan, and associated PAS Birding Journal for students to take into the field. It is desirable but not necessary to start at the beginning, do all lessons, and offer lessons in order as the curriculum units build on each other and are designed to guide students along the path of environmental awareness and knowledge, through critical thinking and problem solving, to decision making and action, and, finally, to a sense of stewardship within and for their communities.

Before embarking on this path, we encourage you to offer your students the Pre-Survey to gauge their familiarity with their surrounding environment and birds as well as their understanding of climate change and its effects. After concluding the curriculum—or a portion of it—you can offer this again as a Post-Survey which, when compared to the Pre-Survey, can indicate student progress along the path to environmental stewardship.

In the lessons that follow, students will explore their natural and built surroundings with all their senses to observe and understand the concepts of climate change, its effects on natural and human communities, as well as think critically about solutions for the future. Each lesson is structured using BSCS's "5E" instructional model: Engage, Explore, Explain, Elaborate, Evaluate.

Climate change is a daunting subject to teach to our youth, and yet, it is important. Our world is changing and our children are inheriting the consequences of the ignorance of the past and the disregard of the present. The effects of climate change and the rapid acceleration of it are troubling and alarming. We have attempted to present this information in an honest, yet digestible, manner.

Even in the face of climate disruption we can take heart; there is hope! Solutions abound! We *all* can choose to actively take part in solving the climate crisis. We hope you and your students come away from this curriculum with a renewed sense of empowerment, optimism, and courage for the future. May you "be like a hummingbird" and may you be well.



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Birds and Climate Change Curriculum

(Elementary School)

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PEEP Birds and Climate Change Curriculum
Pre-/Post-Survey

Name _____
Date _____

1. Name up to five (5) different birds that you've seen in the Upper Feather River Watershed or Plumas County.

   _____ _____ _____ _____ _____

2. What are three things that birds use or need from a healthy habitat?

   _____ _____ _____

3. Name two places in the Upper Feather River Watershed that provide a healthy habitat for birds.

   _____ _____

4. True or False: Birds can tell us whether the environment is healthy or not.
5. True or False: Birds can tell us whether the environment is changing.

6. Why do you think it is important for humans to help birds?

Native plants are plants that have lived and evolved in our area for a very, very long time.

7. True or False: Native plants tend to use less water than other plants.
8. True or False: Native plants provide food, water, shelter, and cover for birds.

9. What is climate change? (Check one answer.)
   - ☐ Changes in weather from day-to-day
   - ☐ Changes in weather from year-to-year
   - ☐ Changes in weather patterns over a long time period (eg. 10 years or more)

10. True or False: Most scientists (97%) agree that climate change is mainly caused by humans burning fossil fuels (coal, oil, natural gas).

11. Climate change is causing: (Check all that apply.)
    - ☐ many birds, other wildlife, and plants to move northward
    - ☐ many birds to migrate earlier
    - ☐ many birds to lay their eggs earlier
    - ☐ snow in our mountains to melt earlier in the spring
    - ☐ more human migration
    - ☐ more water in the oceans and higher sea levels
    - ☐ more wildfires
    - ☐ bigger storms
    - ☐ more flooding
    - ☐ worse drought (very little to no water)
    - ☐ coral reef die-offs

12. How is climate change affecting you or your community now?

13. Why is it important for humans to work together to solve environmental problems, including climate change?

14. What can you do to help solve the climate crisis?

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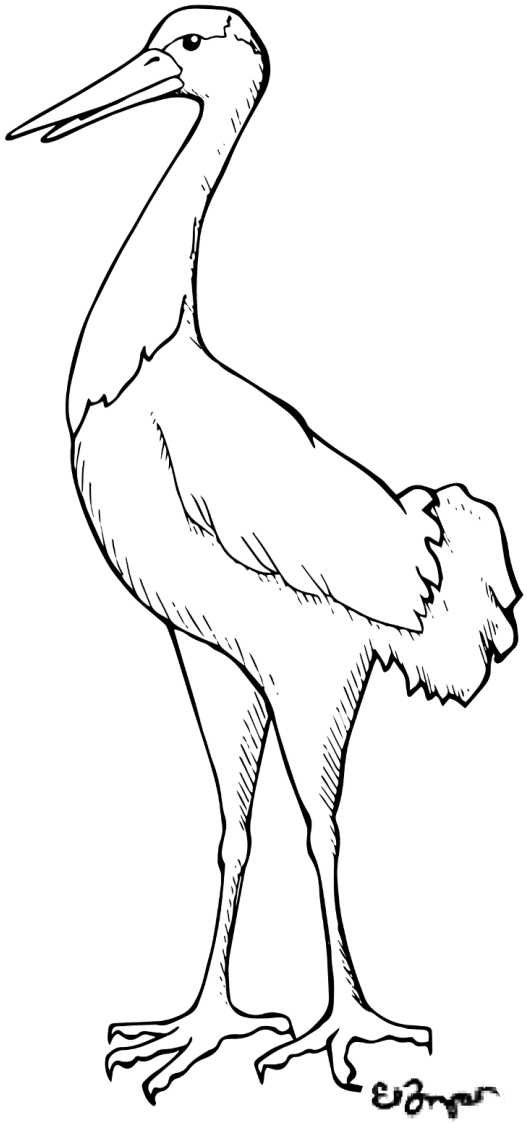
"*I realized that if I had to choose, I would rather have birds than airplanes*."
— Charles Lindbergh[1]

Unit 1: AWARENESS
Why Birds?

- Lesson 1.1: Why Birds Matter
- Lesson 1.2: The Language of Birdsong
- Lesson 1.3: Bird Behavior Scavenger Hunt
- Lesson 1.4: What's That Bird? Species Identification
- Lesson 1.5: Community Science: eBird and More



[1] Lindbergh was an aviator, author, inventor, explorer, and environmental activist. He made the first solo, non-stop transatlantic flight.

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Plumas Audubon Society

UNIT 1: AWARENESS
Why Birds?

Lesson 1.1

Performance Expectations:

- Practice thinking like a scientist: pose questions, think critically about how these questions might be answered, make conjectures based on evidence and observations.

Specific Learning Outcomes:

- Understand why and how birds serve as environmental indicators and what they can tell us about climate change.
- Understand that over half of North America's bird species are threatened by climate change.

NGSS:

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

Prior Student Knowledge:

- Students probably see birds everyday, even if they don't always notice them.
- Students can most likely identify some birds they see or have some prior knowledge of certain species or types of birds (Bald Eagles, American Robin, Common Ravens, bluebirds, hawks, etc.)

Why Birds Matter

Brief Lesson Description:

This lesson explains why this curriculum teaches climate change through the study of birds. Students will learn that birds serve as indicators of environmental change and can help us to explore and understand the broader effects of climate change on the world as a whole and in our local environment. This lesson begins with a short video screening (on YouTube) and a brief reading from the *California Birds in a Changing Climate* booklet that can be done in class, before, or after the screening, followed by discussion questions.

Narrative/Background Information:

Besides being beautiful and intriguing life forms worthy of wonder, respect, and appreciation in their own right, birds also matter to us because they provide a wide variety of **ecosystem services** that benefit humans both directly and indirectly such as pollinating flowers, dispersing and planting seeds, cycling nutrients within and between ecosystems, and devouring pests. Additionally, birds can tell us a lot about the environment. We can learn about the overall health of an ecosystem and gain insight into any changes it is experiencing by observing birds. What might it mean if we notice multiple individuals of a bird species not before seen in a specific region? What might it mean if a bird species we used to regularly see in one spot has declined or even disappeared in recent years? The presence, absence, abundance, or behavior of birds can offer clues about what may be happening in an ecosystem. We consider many bird species as "**indicator species**", which serve as measures of environmental conditions. By monitoring specific bird populations, we can learn about, understand, and anticipate changing conditions in a given environment.

An historical and often referenced example of an indicator species is the canary in a coal mine. Until the 1980s, canaries were used to detect risks to human health in coal mines: miners would bring canaries into the mines to warn of dangerous levels of toxic gases. If a canary began to show signs of poisoning or died, miners knew their own lives were at risk and were smart to exit the mine tunnel immediately. We also refer to species such as the canary as "sentinel species" because their behavior can warn us of environmental risks to humans.

Many bird species around the world can be considered "canaries in the coal mine" to alert us about different environmental changes and degradation, including those caused by climate change. Birds are among the best indicators of environmental health and change because:

- Birds are highly sensitive to environmental change. They are usually high in the food chain and have relatively long life-spans, therefore environmental stresses that accumulate over time are evident in bird populations and behavior.

- Students most likely have heard about and have some knowledge or concept of climate change.

Possible Preconceptions/ Misconceptions:

- Students may take birds for granted because they are present almost everywhere.
- Students may need clarification and definition of climate change.
- Students most likely do not understand the effects of climate change on birds.

Materials:

- PAS Birding Journal and pencils
- Computer with internet
- Common Plumas County Birds slideshow and means to project or show to class
- Napa Solano Audubon's booklet *California Birds in a Changing Climate: 170 Species At Risk*

Educator Tip:
Teachers should also read pages 6-9 in Napa Solano Audubon's booklet *California Birds in a Changing Climate: 170 Species At Risk* (sections "Climate Change and Birds" and "The Audubon Birds and Climate Report").

Educator Tip:
A slideshow of some common Plumas County birds can be found and downloaded at: http://www.plumasaudubon.org/birds-and-climate-change-curriculum.html

- Birds are everywhere; they are found in almost every ecosystem across the planet.
- Birds are relatively easily seen or heard and, thereby, observed and identified. Birds are the one form of wildlife most people see or hear everyday. Not many other organisms readily call or sing out revealing their presence and ID.
- Birds have been very well studied for a long time. We know a lot about them: their biology, their life-histories, their behaviors, and their migratory patterns. Therefore, we have a very good baseline against which any change can be easily identified and monitored. Much of this data comes from citizen scientists—everyday folks who like to birdwatch and simply note what they see, when and where. This information is compiled with thousands of other records, resulting in a huge amount of data to draw on. Even you and your students can add to this data, you don't have to be an expert! *Lesson 1.5* in this unit provides an opportunity to contribute to eBird, a community science database that provides valuable information to scientists studying bird populations and migrations.

Because they are such good indicators of environmental health and biodiversity, bird populations, behavior, and reproductive success often closely reflect the stability of an ecosystem.

Currently, birds are telling us that climate change is real and environmental conditions are changing dramatically and rapidly. Half of North America's bird species are considered climate threatened or endangered because they are expected to lose more than half of their current range by the end of this century (2080) due to changing climatic conditions. In order to give birds a chance we need to do two things: 1) We need to protect the places on the ground that we know birds will need today and in the future, and 2) we need to work together to reduce the severity of global warming.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

CONNECT WITH PLUMAS COUNTY BIRDS

Pass out the PAS Birding Journals connected to this curriculum and have students turn to the back page containing an abbreviated checklist of common Plumas County birds. Instruct students to check off the birds they have seen before --perhaps in their own backyard or schoolyard, but to leave the checkbox blank next those birds that they have never seen in real life. Students can put a star next to the name of a bird they really hope to see!

Show the class the slideshow of common Plumas County birds that students will likely have seen before or will likely see on a fieldtrip this year. Allow for some interaction and connection with the content of the slideshow by asking students to raise their hand if they have truly seen that type of bird before. If time allows, select students to share where they've seen each bird.

BIRDS AND CLIMATE CHANGE VIDEO SUMMARY

As a class, watch National Audubon Society's short video, "Birds and Climate Change," (3:25 minutes): https://www.youtube.com/watch?v=aN2-a82_3mg

EXPLORE: Lesson Description-- Probing or Clarifying Questions

PLUMAS COUNTY BIRDS AND CLIMATE CHANGE

Ask the class, "Are *our* birds in trouble?" Let's find out!

With the class, visit climate.audubon.org, click on the "All Species" tab, and then use the search bar to try to look up a given species. Have students offer suggestions for which local species to look up from their checklist.

If a given species cannot be found, then it is considered "climate stable", meaning that by the end of the century (2080 in the Audubon study) the species is expected to either gain or lose less than 50% of its current **range** due to climate change.

If a given species is found, click on the link to the species page to see whether the bird is considered "climate threatened" or "climate endangered". Climate threatened species are projected to lose more than 50% of their current range by the year 2080. Climate endangered species are projected to lose more than 50% of their current range by the year 2050.

Also, look at whether the bird's range is expected to shrink or shift in the future. Zoom in to California on the interactive map to see if the species will still be likely to be seen in Plumas County at the end of the century.

EXPLAIN: Concepts explained and vocabulary defined

Use the background information as a guide to review and discuss ecosystem services provided by birds and why birds are considered barometers of environmental health.

Review what the class learned from the video and Audubon website. Ask students the following questions:

- How are birds being affected by climate change? Cite from the video ways birds have noticeably been affected by climate change.
- Why do we need birds? Provide some examples from video or get student-inspired ideas. *[They plant trees, they pollinate, they bring us joy, etc.]*
- What are the three classifications Audubon gave to birds to help identify how they will be affected by climate change by 2080?
  [climate endangered, climate threatened, and climate stable]
- How much of their current range are climate endangered and threatened species predicted to lose by the 2050 and 2080, respectively? *[50% or more; over half!]*
- What are the two main things we can do to help birds facing climate change according to the National Audubon Society's report?
  [1. reduce carbon emissions, 2. protect bird habitat]

VOCABULARY

- **range -** The area where a species can be found during its lifetime.
- **climate change -** The general definition for "climate change" is a fluctuation of temperature, up or down, in Earth's average climate and its related effects observed over a long period of time. The "climate change" you most often hear talked about today (and what we will focus on in this curriculum) is the observed trend of a rapidly warming global climate caused by humans.
- **indicator species -** An organism whose presence, absence, or abundance reflects a specific environmental condition.

ELABORATE: Applications and extensions

THINK LIKE A SCIENTIST!

What do scientists do? In general, a scientist observes the world, asks a question based on observations, and then goes about trying to answer that question (which more often than not leads to many more questions).

Ask your students to imagine themselves as scientists--curious, observant, and judicious. Ask them to consider investigating, as a scientist, the ways that birds can inform us about the health of the environment and climate change. Have your students brainstorm and write their ideas on the board for the following:

1) What kind of question(s) might we ask to better understand the connection between birds and the environment?
2) How could you go about answering such question(s)?
3) How can you feel confident that your answers are correct?

EVALUATE: Reflect

WHY BIRDS MATTER

Pass out Napa Solano Audubon Society's *California Birds in a Changing Climate: 170 Species At Risk*. As a class, read aloud the two examples of ecosystem services provided to plants and humans by Clark's Nutcracker in the U.S. and sparrows in China on pages 7 and 13, respectively.

After reading these examples, ask the class to reflect in their journals answering the question: "Why do birds matter?" Encourage students to consider the value of birds to humans, to other organisms, and to life and the planet in general.

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Student participation in activity and discussion

Summative Assessment (Quiz/project/report):

- Evaluate write-up of "Think Like a Scientist" activity, to evaluate students' grasp on scientific methods.

Plumas Audubon Society

UNIT 1: AWARENESS
Why Birds?

Lesson 1.2

Performance Expectations:

- Practice birding and develop birding skills
- Practice careful listening and observing
- Practice recording observations in detail
- Practice bird identification

Specific Learning Outcomes:

- Learn how to begin birding by ear, specifically, how to listen carefully to bird calls, record their observations, and compare to known/recorded bird calls
- Hone observation skills using their senses.

NGSS:

1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing
4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

Materials:

- *The Listening Walk* by Paul Showers
- Internet and a means to play video with audio

The Language of Birdsong

Brief Lesson Description:

This lesson is a teacher-guided observation activity to build awareness of one's surroundings and then to focus specifically on birds through active listening. Students draw a map of the area in their journal, placing themselves in the center. When they hear a song, they will write down the location and description of the song, trying to be as descriptive as possible.

Narrative/Background Information:

Birding is a great way to build knowledge, awareness, and a stronger connection with the outdoors. It can be overwhelming to start because it does require skills that take time to develop. The nature of birding involves quickly finding and identifying birds that may only stay in eyesight or earshot for a moment or two. Many bird species look alike, some birds look different based on sex, other birds may be too far away to correctly identify. It also helps to know which birds are found in your area at certain times of the year, which also requires experience. Fortunately, there are birding techniques that anyone can use even on their first day.

Often, birds can be heard before being seen. Identifying bird songs can tell us more about the environment than our eyes alone. "Birding by ear" is an important ingredient to a successful bird walk and attempting to translate the sounds you hear into written words can be entertaining and challenging.

Most bird guidebooks will offer descriptions about vocalizations from certain species. For example, Great-Horned Owls are often described as having a deep, rhythmic, "*hu hu hoo, hoo, hoooo*" while Mountain Quails make a loud, clear whistling "*quee ark*" call. These types of descriptions are usually followed by the author's caveat:

- "Word syllabifications in most books vary; ears differ." (Peterson 1990)
- "Words at best provide a very feeble sound impression." (Sibley 2003)
- "One birder's *chip* is another's *tsip* or *chik* or even *peek*." (Dunn and Alderfer 2006)

There are two ways to describe bird song; analogy and phonetic descriptions: **Analogy** is comparing one sound to another (eg. *"it sounds like a squeaky door").* **Phonetic** is translating the sound into human words or **onomatopoeia** (eg. "*weee*", "*quack*", or "*here, sweetie*").

Neither of these methods are perfect. Analogy will only be useful if the listener has a good idea of what the comparison sounds like. Phonetic descriptions are limited by our own human vocal range and are not able to describe many

- Whiteboard or blackboard (optional)
- PAS Birding Journals and pencils

Prior Student Knowledge:

- Students do not need to have any prior experience with bird watching.

Educator tip:

Watch and/or listen to *The Listening Walk* by Paul Showers on Youtube: https://www.youtube.com/watch?v=BLs4r8lHUSg

Educator Tip:

In addition to online bird guides, there are many free birding apps for smartphones, including features to play recorded bird vocalizations. Check out:

- Audubon Bird Guide App: find it in the App Store or on www.audubon.org

Educator Tip:

Offer the Listening Circle and other mindfulness activities (like "Birds of a Feather" in *Lesson 1.4* and "One with an eagle" in *Lesson 2.1*) regularly to help improve your students' cognition and focus, along with many other mental and physical health benefits associated with practicing mindfulness.

qualities of birdsong such as pitch or tone. This activity will allow students to be creative while communicating their observations to each other. It will be helpful to first have students share ideas as a group and figure out some ways to describe certain sounds.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Start this lesson by reading to your class *The Listening Walk* by Paul Showers. There are many examples of phonetically described sounds in this book that offer a model for how your students will practice this in the following activities.

Before going outside, play a few recorded bird vocalizations for the class. Species commonly seen/heard in our area and distinctive suggestions are listed below. You can search these species in online bird guides and play their songs and calls (Cornell Lab of Ornithology, https://www.allaboutbirds.org; Audubon, https://www.audubon.org/bird-guide). Ask for volunteers to try and describe what it sounds like to them and write their analogous or phonetic descriptions on the board to show how people describe songs differently. Ask if students can identify the bird based just off of the sound.

- American Robin
- Common Raven
- Cedar Waxwing
- Mountain Chickadee
- Red-tailed Hawk
- Red-winged Blackbird
- Sandhill Crane
- Song Sparrow

Now, take your students outside!

LISTENING CIRCLE

When you get outside, take 5-10 minutes to settle the class and get everyone tuned in to their senses. Our senses are some of the best tools that we have out in the wilderness. When you are paying attention to all of your senses you can be better at hearing where water is, noticing animal tracks, feeling wind direction, etc. The following activity can help get you and your students more tuned in to your senses and more tuned in to the rhythms of nature which can help us be more aware of what is in front of us, behind us, under us, above us, around us, and in us!

First, ask for a moment of silence in which students take in the landscape around them. Still asking for silence from the group, have students stand in a circle or lie on their backs and pay attention to the suggestions that follow. Wait a few moments between each suggestion to allow everyone to focus on each of the following:

- Close your eyes and take a few deep breaths.
- Feel the ground under your feet/back.
- Feel your clothes against your skin.
- Feel the warmth of the sun/the coolness of the wind on your face. Which direction is it coming from? Is it strong or subtle?
- Now quiet your sense of feel and focus in on your sense of smell. What can you smell in the air?
- Can you smell the plants or soil around you?
- Now shift your focus to your hearing. Listen for the loudest or most obvious sound that you can hear.
- Listen for the softest sound you can hear.
- Listen for the farthest sound.
- Listen for any sounds of wildlife. What do you hear?
- Slowly open your eyes now and with a soft gaze try to see everything in your field of view with an equal, soft focus.
- Now, notice all the different colors and shades of color in the landscape.
- Look at a tree or bush nearby and see if you can detect any subtle or obvious movement among the leaves or branches.

Invite students to break the silence by sharing with the group what they noticed from this experience. Did anything interesting come to your attention? What have we learned about this area just by sitting quietly for a few moments? Ask students to describe what they heard. Could they identify the sounds?

EXPLORE: Lesson Description-- Probing or Clarifying Questions

SOUND MAPPING

Next, send students to sit individually throughout the area with a journal or blank piece of paper to write on (there is a Sound Mapping page in the PAS Birding Journal). If using a blank sheet, instruct students to draw a dot or X in the center of the page representing themselves. Next, have students sketch a simple map of nearby habitat or other distinctive features (eg. trees, creek, path) in relation to their location.

When students hear bird calls, have them write down what the calls sound like in the phonetic or analogous form (perhaps both!), recording it on their map in the approximate location and distance of where the sound came. If there seems to be very little bird activity, you can expand the exercise to map anything in the soundscape (eg. wind, insects rustling through leaves on the ground, branches snapping, water flowing, etc.). Ask the students to record as many different bird calls (or other sounds) as possible for five minutes.

Educator Tip:
One of the hardest things about bird walks with groups of people is to keep everyone quiet enough to not disturb and flush the birds away before anyone has a chance to see or hear the birds.

One method to help with this is to encourage your students to behave like a group of private investigators or detectives. Before starting your walk, ask your students what behaviors or qualities we tend to attribute to a private investigator or detective, for example, "attentive", "stealthy", "secretive", "quiet", "clever", "curious". Remind students of their role as necessary when out listening or looking for birds.

If a bird is seen singing or calling, ask the students to also take very brief notes of what the observed bird looks like (color, size, beak shape, etc.). The description of the song or call along with a visual description (as well as the kind of habitat, which should already be illustrated on their maps) can help you later identify the species with the help of a bird guide, online resources, or other birders.

After the five-minute period, gather the group to share what they've found. As students share, ask if others may have heard the same things. For bird calls, ask how students described the call. Did anyone else hear similar calls? How did others describe the call? How many different songs/calls did students hear? What might the amount of bird chatter--or lack thereof--mean?

EXPLAIN: Concepts explained and vocabulary defined

Birding by ear is an important skill to develop as it can help you identify a bird that is otherwise hidden by dense foliage or night, is too far away, or looks very similar to another species. Even if you don't know your bird calls well enough to identify the species by its call, this is still an extremely useful and important skill to practice as it helps the birder know where to focus attention. With more practice, bird calls and songs can become easy to recognize as the voices of familiar friends.

VOCABULARY

- **analogy -** a comparison of one thing to another; related to birdsong, analogy refers to the comparison of the song or call to another familiar sound
- **phonetic -** relating to speech sounds; related to birdsong, phonetic refers to the translating the song or call into words or onomatopoeia
- **onomatopoeia -** a word that imitates the natural sound of a thing

ELABORATE: Applications and extensions

It takes quite a bit of energy for birds to make such audible and distinct calls. What might be the benefit of this behavior? Could there be any negative effects? Have students make two lists, one of the benefits or reasons why birds call or sing and one of the costs or risks of calling or singing.

EVALUATE: Reflect

JOURNAL

Think of the different bird songs and calls that you heard during the Listening Circle and Sound Mapping activities. Did you notice different patterns or rhythms of songs or calls? Look up a songbird (eg. Mountain Chickadee) on one of the online bird guides listed above and listen to the different songs and calls that species tends to have noting the different patterns in cadence and rhythm. What might one pattern you heard mean as compared to another you heard?

Just as humans use language to communicate information, ideas, and emotions to others, birds also use their songs and calls to communicate to other birds (and other wildlife). What might they be communicating to each other?

EXTEND FURTHER: Enrichment

Thayer's Birds of North America is a birding software with photos, bird calls, and video clips of 1,007 birds found in North America. Identify and record the birds you see, take quizzes, compare two birds side-by-side, and read about the species using the software. Students under 18 can download the software for free by going to www.ThayerBirding.com, selecting the Windows or Mac download, and entering the special code PlumasAudubonYoungBirder.

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Student participation in activity/discussion
- Evaluate birding journals, sound maps created, and written answers to questions
- Student participation in activity and discussion

Summative Assessment (Quiz/project/report):

- Turn extended journaling activity in the "Evaluate" section into a mini research project on a specific songbird and the meanings of different calls.

Showers, Paul. *The Listening Walk*. New York: Harper Collins Publishers, 1991.

Alderfer, Jonathan, and Jon L. Dunn. *Illustrated Birds of North America.* National Geographic, 2006.

Peterson, Roger Tory. *Peterson Field Guide to Birds of Western North America.* Fourth Edition. Houghton Mifflin Harcourt, 1990.

Sibley, David Allen. *The Sibley Field Guide to Birds of Western North America.* Second Edition. Alfred A. Knopf, Inc., 2003.

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Plumas Audubon Society

UNIT 1: AWARENESS
Why Birds?

Lesson 1.3

Performance Expectations:
- Students are expected to spend time actively watching birds in the environment and recording observations of their behavior.
- Students will propose an explanation for the behaviors they observe.

Specific Learning Outcomes:
- Practice making, recording and analyzing scientific observations.
- Based on their observations, students will infer explanations for certain behaviors.
- Make a connection between bird behaviors and environmental factors.
- Practice identifying birds.

NGSS:
1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
3-LS2-1. Construct an argument that some animals form groups that help members survive.
3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

Materials:
- PAS Birding Journals and pencils
- Binoculars

Bird Behavior Scavenger Hunt

Brief Lesson Description:

This is a student-driven exploration of bird behavior. Students will observe birds in their habitats and record the behaviors they see. Based on their observations, students will attempt to explain why birds exhibit certain behaviors. Students need not identify to species the birds they see, though behavior can be an important clue in identification and practicing bird identification is always encouraged.

Narrative/Background Information:

Bird behaviors can offer important clues for identification. Your students may not be able to identify bird species right off the bat, but they will surely be able to identify what the birds are doing. Birds may be observed flying, soaring, singing, perching, feeding, fighting, preening, swimming, walking, hopping, or a variety of other behaviors that are all part of a survival strategy. Birds, like all organisms, have **behavioral adaptations**: traits or behaviors a species adopts as it evolves over time allowing them to better survive and reproduce. For example, a bird call is a behavioral adaptation. Birds call or sing to warn other birds away from their territory or to attract a mate. Having the ability to call increases the likelihood of a bird to survive and reproduce. Some bird species (like the Bank Swallow) nest in colonies. This behavioral adaptation of communal nesting helps defend against predators and helps birds stay warm at night. Even migration, the seasonal movement of species to suitable habitat, is a behavioral adaptation.

An organism's behavioral adaptations help to carve out its specific ecological niche within its environment. A niche is an organism's specific role and position in its environment, including its interactions with other organisms and its environmental requirements. While many general behaviors are similar between species, differences in the specifics of some behaviors can help create and define different species' niches, thus offering alternative ways for species to meet food and shelter requirements and different ways of survival and reproduction. For example, different raptor species will behave differently while hunting: some species tend to search for prey by perching on a tall object while others tend to search from the air—even here there is more behavioral and niche differentiation between high and low altitude flying and high and low speed diving or gliding.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Begin the activity by brainstorming general human behaviors and motivations for why we do certain things or behave in a certain way. The following questions are examples that can be used as discussion prompts:

Prior Student Knowledge:

- Students do not need to have any prior experience with bird watching.

Possible Preconceptions/ Misconceptions:

- Students will easily be able to infer the cause for certain behaviors, like preening, while others like woodpecker drumming may need to be researched.
- Personification of bird behaviors may make it easier to understand motivations behind these behaviors, but birds and humans are not the same and not all bird behavior can be explained in human behavioral terms.

Educator Tip:
If your students are new to binoculars, Teacher's Supplement 1.3 offers some tips and tricks for how to best use and adjust binoculars.

- Why do we eat?
- Why do we talk?
- Why do we bathe?
- Why do we wear warm clothing when it's cold?

EXPLORE: Lesson Description-- Probing or Clarifying Questions

Pass out binoculars and take your students outside, reminding them to bring their PAS Birding Journals along. Students can work individually or in pairs or small groups. It can be interesting to take them to a spot with varied habitat. For example, the edge of a forest where it meets a meadow is a space with two different habitat types and will have a diverse set of resources for a diverse set of species.

Instruct students to open their Birding Journals to the Bird Behavior Scavenger Hunt page where they will check off and record the kinds of behaviors they see as they observe birds in the field. Remind them that they will see and hear more if they are quiet.

EXPLAIN: Concepts explained and vocabulary defined

When time is up, gather the students or go back to the classroom to discuss the following questions:

- What interesting behaviors did students notice? What would explain such behaviors?
- Were you able to identify a species based on its behavior?
- What physical adaptations did you observe that allow birds to perform certain behaviors that may be different from other birds or organisms?
- How might the behaviors you observed be different in different seasons?

Explain or have the students research any behaviors that may not be easily understood.

VOCABULARY

- **behavioral adaptations** - changes in an animal's behavior over time through evolution which allow it to survive in its environment.
- **niche** - an organism's role and position in its environment; how an organism meets its needs for food and shelter, how it survives and reproduces.

ELABORATE: Applications and extensions

TOWARD A CLOSER ID

Bird behavior can help in generally identifying types of birds (eg. a swimming bird could easily be identified as a duck or duck-like bird and not easily mistaken for a raptor or songbird) and even help with specific species identification. For example: Brown Creepers and Red-breasted Nuthatches are both often seen climbing along tree trunks searching for insects. Both are approximately the same size, but are otherwise distinctive from one another. However, even

without knowing what they look or sound like, their tree-climbing behavior could help you identify them: the nuthatch will often climb down the tree head first in a zig-zag pattern but will also climb upward and sideways, while the Brown Creeper will start near the base and hop in a spiral up the tree trunk.

Make a list with your students of behaviors they observed that either may help identify the general type of bird or identify the particular bird species, include any other descriptions of the bird (or its habitat) associated with each behavior. Use this list and compare or refer to your bird guides to look up the types of birds or figure out the particular species that were observed.

EVALUATE: Reflect

What bird behaviors did you observe that are similar to human behaviors? Why do you think we share those behaviors? What other similarities do we share with birds?

How might changes in the environment like climate change or pollution lead to changes in bird behavior? How might it change human behavior?

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Teacher observation of students.
- Participation in observation and discussion.

Summative Assessment (Quiz/project/report):

- Evaluate observations made on Bird Scavenger Hunt worksheets.

Adapted from Mark Musselman's "Bird Behavior Scavenger Hunt"
for Audubon at the Francis Beidler Forest, available at:
http://web4.audubon.org/states/sc/sc/PDFs/bird_behavior_hunt.pdf

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Teacher's Supplement 1.3

How to Use Binoculars

So, you're leading a bird walk. Great! You've probably realized that the birds don't always show up where and when you'd like. Or maybe the birds show up, but they don't get close enough to show you the markings that will help you distinguish between a Red-breasted Nuthatch and a Mountain Chickadee. Then the closer you try get the further they fly from you. Luckily, though, with a decent set of binoculars, you can view birds from long distances with surprising clarity. Follow these instructions to learn the best way to effectively use your binoculars and enjoy viewing the wonders of wildlife from a safe, secretive distance!

Think of binoculars as being two adjustable mini telescopes that work with our binocular (two-eyed) vision to see things that are far away with depth perception. Most binoculars have a standard design and can be used and adjusted in a similar fashion. Follow the instructions below to get started:

- First and foremost, always remember to put the strap around your neck! Binoculars have very precise, delicate pieces of glass and prisms inside of them and dropping a pair can permanently damage them. Also, keeping them around your neck makes sure they are always right in front of you when you need them.

- Remove lens caps. NOTE: Only use lens cloths that come with your binoculars to clean them. Never use your sleeve to wipe the lens as even soft cotton shirts can put tiny scratches on the lens and over time such scratches diminish clarity and visibility.

- Each individual eyepiece is adjustable at the *eyecup* to space the lens the proper distance from your eye. If you wear glasses, you want the eyecup fully retracted. If you do not wear eyeglasses, fully extend the eyecups on each lens by twisting.

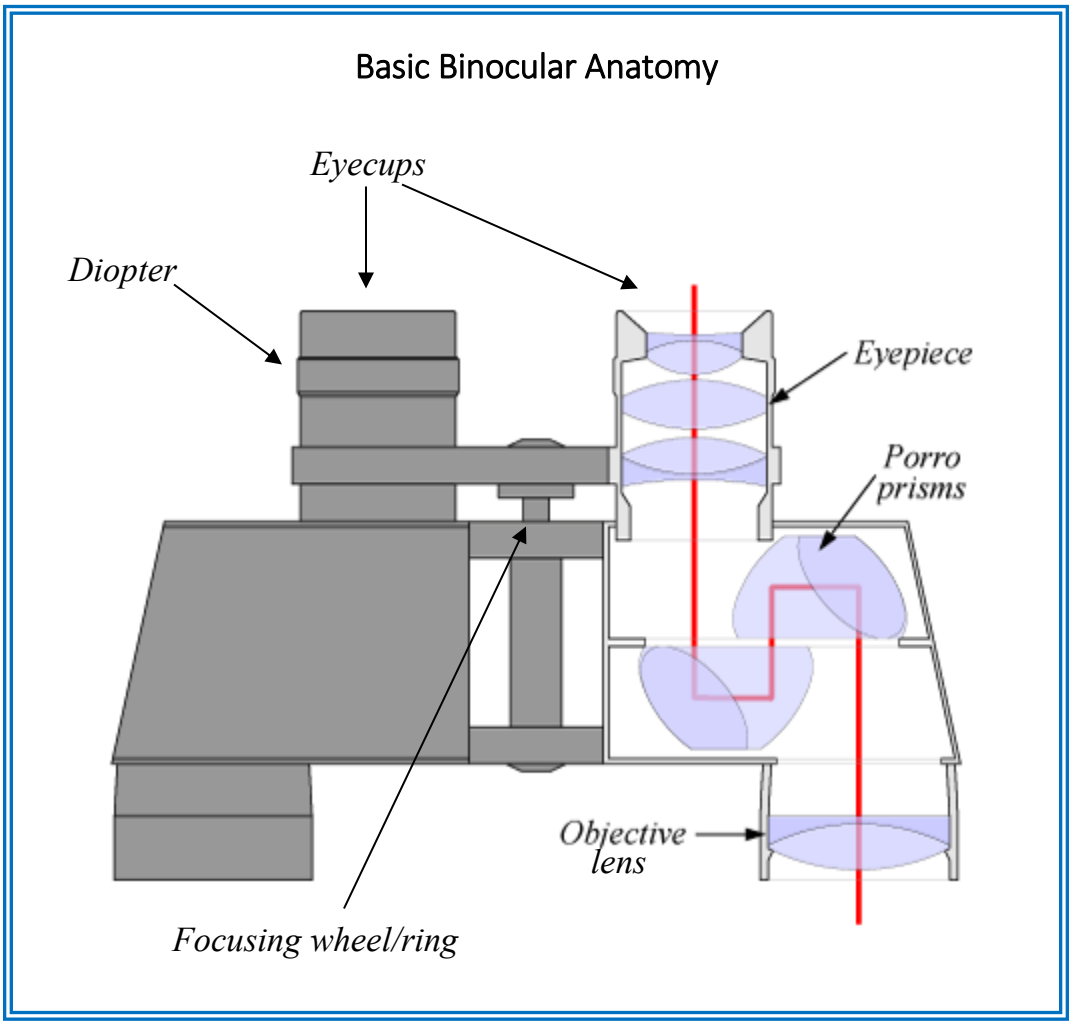
- Adjust the distance between the eyepieces so that they are the right width and fit perfectly over your eyes. You should see one clear circle when looking through both lenses; if you see black edges in the view or overlapping circles with a blurry image your eyepieces are either too close together or too far apart.

- Next, look through the binoculars and adjust the focus with the *focusing wheel* found in between the eyepieces to get a clear, sharp image.
    - For more customized focusing, first close your right eye or cover the right lens so you are only looking through the left eyepiece. Look at an object through the left eyepiece and adjust the focusing wheel until you see a sharp image. Then close your left eye or cover the left lens and look at the object with only your right eye. Adjust the *diopter ring*--located on the right eyepiece--until you get the sharpest image. For some people adjusting the diopter ring makes a significant difference, for others it can be subtle or even unnoticeable. NOTE: This customized focusing is good practice, but may be too nuanced and time-consuming for large youth groups.

- Now practice focusing on things at different distances. You will need to turn the focusing wheel one way to focus on objects far away and the other way to focus on near objects. The more you practice, the easier this will be and the faster you'll get at spotting and tracking that Lazuli Bunting that just shot by!

TIPS for finding a bird (or other subject/object) through binoculars:

- First, start by using your naked eye to spot a bird. Don't shift your gaze too much and look for movement among branches and leaves. Once you spot a bird lock your eyes on it. It can be helpful to also note any distinguishing physical feature near the bird that you can use as a helpful landmark (this could be a bright leaf or an oddly shaped branch).
- Then, without moving your eyes off the bird, bring the binoculars up to your eyes and align them with your view. Hopefully your eye will still be targeted right on the bird. You may need to use your landmark(s) to find it again, but by bringing the binoculars to your eyes without looking down to grab the binoculars your gaze should be aimed quite close.



"What do the numbers on my binoculars mean?"

You may have noticed that your binoculars have a set of numbers on them such as "7 x 35", "8 x 42", or "10 x 42". What does this mean? The first number indicates the strength of magnification, so an 8 means the object you see through the binoculars appears 8 times closer than it would without the binoculars. Note: more magnification isn't always better here because the shakiness of your hands also gets magnified! The second number indicates the size of the *objective lens* measured in millimeters. The greater the size here means more light can enter the binoculars allowing you to see the object better. But, once again, bigger is not always better; the larger the lens, the heavier the binoculars will get! Birders commonly use 8 x 42 or 10 x 42 binoculars.

Plumas Audubon Society

UNIT 1: AWARENESS
Why Birds?

Lesson 1.4

Performance Expectations:

- Practice species identification
- Practice using binoculars
- Practice making and recording observations
- Students are expected to spend time actively watching birds in the environment and recording observations of their behavior.
- Students will propose an explanation for the behaviors they observe.

Specific Learning Outcomes:

- Learn how to make detailed observations and record them
- Learn about characteristics that distinguish bird species
- Learn to use field guides
- Learn about species ranges in North America

NGSS:

1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

What's That Bird? Species Identification

Brief Lesson Description:

This is a student-driven lesson designed to teach about accurately identifying species. Students will spend time in the field making observations about birds and use field guides to help classify and identify the birds they see. Students will then research the birds they find to determine whether or not they are migratory birds and where else in the world they might be found.

Narrative/Background Information:

With nine to ten thousand bird species in the world and over 800 species of birds in North America alone, it can feel a bit daunting to identify birds to species. However, with a handful of basic tips and an eye for field marks—those characteristics of a specific bird that help identify it in the field—one can quickly become familiar with common species and even start to find it fun to piece clues together to identify more difficult species.

Scientists group birds into different "families" which can be a useful starting point for identification and, to a degree, can be somewhat obvious to even beginner birders. For example, your students will likely be able to tell an owl from a hawk, and a duck from a goose. Some field marks such as shape, size, proportions, and posture can help you place a bird into the right (or close) group. Encourage your students to use the Groups of Birds page in their Birding Journals regularly.

Some other aids for identification are touched upon in other lessons:

- *Lesson 1.2 Language of Birdsong* addresses the recognition of bird calls and songs which takes a lot of practice, but even beginners can become familiar with common and distinctive bird voices;
- *Lesson 1.3 Bird Behavior Scavenger Hunt* explores behavior; and
- *Lesson 2.1 Ecosystems, Habitats, Resources, and Survival* looks at habitats which are excellent clues in identification.

In this lesson we will focus on visual field marks and touch on range and season as identification aids.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

REVIEW PLUMAS COUNTY BIRDS

Take out your PAS Birding Journals and turn to the back page with the abbreviated checklist of common Plumas County birds. If you did not already do so in *Lesson 1.1 Why Birds Matter*, instruct students to check off the birds they have seen before --perhaps in their own backyard or schoolyard, but to

Materials:

- Common birds slideshow and a means to project or show in class
- (optional) Ethically-sourced feathers*
- PAS Birding Journals and pencils
- Binoculars
- Field guides
- Napa-Solano Audubon's *California Birds in a Changing Climate* booklet

Prior Student Knowledge:

- No prior student knowledge is required for this lesson, but it will build upon observation and identification skills learned and practiced in *Lessons 1.2 The Language of Birdsong*, and *1.3 Bird Behavior Scavenger Hunt*.

Possible Preconceptions/ Misconceptions:

- Students will most likely have an idea of what migration is, and may know some common names of birds they see.

Educator Tip:

A slideshow of some common Plumas County birds can be found and downloaded from Plumas Audubon Society's website at: http://www.plumasaudubon.org/birds-and-climate-change-curriculum.html

Educator Tip:

*Wild bird feathers are protected under various state and federal statutes, including the Migratory Bird Treaty Act.

Ethically-sourced feathers can come from local farms where chicken or fowl feathers that leave the checkbox blank next those birds that they have never seen in real life. Students can put a star next to the name of a bird they really hope to see!

Review with the class the slideshow (see sidebar) of common Plumas County birds that students will likely have seen before or may see on today's bird walk. With each bird, ask students to point out prominent markings on the bird, bill shape and size, and any other notable features of the bird. This is just the start of the practice of noting field marks. **Field marks** are visible characteristics in color and pattern of plumage, bill shape and size, body shape and size, flight pattern, habitat etc. that will help identify the species.

PARTS OF A BIRD

Now, turn to the "Parts of a Bird" page in the Birding Journal and allow students time to study the image and work individually or in pairs to fill in the blanks. After about five minutes, go over the answers to this page and instruct students to correct any labels where necessary.

(Optional) BIRDS OF A FEATHER

This optional mindfulness activity can help your students settle and tune in to their senses just before going outside on a bird walk.

Ask students to close their eyes and hold out their hands. Pass out one feather* to each student. While keeping their eyes shut, ask them to silently feel the object. After a moment of this, offer the following questions as a guide, waiting a moment between each question to allow everyone to focus on each of the following and silently answer the question to themselves:

- How does the object feel in your hands?
- How does it feel in your fingers?
- Is the object heavy or light?
- Is the object soft or hard? Smooth or rough?
- What do you imagine the object to look like? What color? What shape?
- What do you think this this object is used for?
- Where do you think it came from?

After the visualization, talk about feathers. What is the purpose of a feather? *[Keeps birds warm. Keeps birds dry. Helps birds fly. Gives birds distinct colors, patterns, and appearance which is used to identify species and find mates, etc.]*

EXPLORE: Lesson Description-- Probing or Clarifying Questions

LOOKING FOR FIELD MARKS

Pass out binoculars and field guides and head outside! Students can work individually or in groups of 2-3 and have at least one set of binoculars and one field guide per group.

have naturally molted may be collected with permission. Alternatively, such feathers can be purchased online (eg. from Acorn Naturalists: https://www.acornnaturalists.com/bird-feathers-expansion-collection-animal-signaturesr-kit.html).

Even if your students have never been birding before, they probably can identify a few very common species of birds. Start by asking students about different groups of birds. Use the journal page on bird groups. If your students have never been birding before, this can be a helpful resource for narrowing down the type of birds they see in the area.

Allow students at least 15 minutes to sit or walk through the area--quietly--to observe birds. Instruct students to make notes in their journal of which types of birds they see (eg. blackbirds, doves, finches, hawks). With each bird species, students should focus on recording specific field marks they notice--these can be physical or behavioral characteristics, and even habitat type. Again, field marks are visible characteristics in color and pattern of plumage, bill shape and size, body shape and size, flight pattern, habitat etc. that will help identify the species.

After the observation period, bring students all back to discuss and share observations:

- What kinds of birds did you see?
- Could any be confidently identified to species? What field marks helped with this identification?
- What field marks did different students notice about the same bird species?
- Did you see anything surprising?

EXPLAIN: Concepts explained and vocabulary defined

KNOW YOUR BIRD

Bring students back to the classroom. Assign or have each student choose one bird species to research, either from a list of identified species just observed in the field or from their checklist of common Plumas County species. Allow them time to use field guides or online resources find out basic information about the bird to include in their Bird Journals using one of the "Field Notes" pages:

- The bird's full common name (eg. a robin's full common name is American Robin)
- Field mark descriptions
- What kind of habitat that bird tends to be found in, and
- Whether or not their species is migratory.

RANGE

All plants and animals live in a geographic **range**--where the species is found. Some bird species are **migratory** and so have winter and summer ranges, others are **resident** birds that can be found in a particular area all year round. Knowing where species tend to be found at which time of year is another helpful clue in identification and can help to rule out species that are not commonly present in a given location or at a certain time of year.

In their Bird Journals, have students turn to the "Range" page with a blank map of California. Using an online guide or field guide book for reference, students

should outline or color in on the map the range of their bird. Have them shade the species' winter range and summer range in two different colors or shades, allowing for a mix of the chosen colors or a third color for areas of overlap.

VOCABULARY

- **field mark** - a visible characteristic used to identify a bird
- **range** - geographically, where a species is found
- **migratory -** a species that seasonally travels to a different place
- **resident -** a species that can be found all year round in a particular area
- **endemic -** existing only in a defined geographic location; found nowhere else in the world

ELABORATE: Applications and extensions

GET TO KNOW YOUR BIRD BETTER -- DRAW AND COLOR IT!

Allow students time to draw and color their chosen species. Taking the time to look at and reproduce the details of a bird will help students become much more familiar with it. Students will then be able to spot its field marks easier the next time they see the bird in real life.

Many field guides use illustrations as examples for readers. Authors and artists such as John James Audubon, David Allen Sibley, and John Muir Laws are all prolific artists whose works blend art and science to create guidebooks. Show your students some examples of these and encourage them to replicate a drawing based on a bird they've observed outdoors or hope to see.

Educator Tip:
In addition to encouraging your students to create their own drawings, students can practice studying field marks by coloring in the bird coloring pages associated with this curriculum provided on Plumas Audubon Society's website at: http://www.plumasaudubon.org/birds-and-climate-change-curriculum.html

EVALUATE: Reflect

JOURNAL

Have your students consider the following:

- Is your bird species found in Plumas County year round? Where else does your bird species live?
- How far did your bird travel to get here?
- How long might your bird stay in this ecosystem? What might have brought them here?
- What sorts of behaviors did you witness from your bird?

Ask students to consider the bird species they each researched and ask the class as a group, the following:

- What might alter a bird's migration pattern?

EXTEND FURTHER: Enrichment

Birds are sensitive and adapted to particular climatic conditions (primarily temperature, precipitation, and seasonality), therefore, climate can play a large role in each species specific habitat requirements (some species are more tolerant and therefore can be found in a larger range of climates, while others need a very specific suite of conditions in order to survive) and, therefore, where they are found.

A change in climate may cause a species' range to move, expand, or shrink. If an area experiences a sustained change in temperature, precipitation, humidity, or any other climatic factor, the plants and animals living in that area will be affected. Some will be able to adapt, others will have to move, and still others, unable to adapt or move, will be either be extirpated (local extinction) from the area or go extinct.

KNOW YOUR BIRD, CONTINUED

Look up the species on climate.audubon.org to see if the bird's range is expected to shrink or shift in the future and to see if the bird is considered climate stable, threatened, or endangered. Have students go back to the "Range" page in their Bird Journals and, in two additional colors, outline or color in the projected future climatically suitable winter and summer ranges for their focal bird species.

CALIFORNIA BIRDS IN A CHANGING CLIMATE

Choose or assign students individually or in pairs or small groups a species from the Napa-Solano Audubon's *California Birds in a Changing Climate* booklet to read about. Students should read the two pages on their species as well as the two pages on the region associated with that species in the booklet. After reading, ask students to consider how climate change might affect particular behaviors of their species. Students should write down what they think and why, referring to information they read in the booklet.

For example, Yellow-billed Magpies (p18-19) live in oak savannas and are **endemic** to California, meaning they live nowhere else in the world. Human land development, warming and drying of the Central Valley will lead to major loss of oak savannas, causing the Yellow-billed Magpie to lose their wintering habitat. In this case, the changing climate is expected to result in almost the complete loss of this species' range. Yellow-billed Magpies will be forced to try and live elsewhere, adapt to future conditions, or go extinct.

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Teacher observation of student participation in the field.
- Participation in class discussion.

Summative Assessment (Quiz/project/report):

- Assess journal entries for completion and thoroughness.

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Plumas Audubon Society

UNIT 1: AWARENESS
Why Birds?

Lesson 1.5

Performance Expectations:
- Practice bird identification
- Practice counting birds and recording data
- Practice scientific observation and forming conclusions based on observations and data

Specific Learning Outcomes:
- Understand why scientists count birds
- Practice counting birds, collecting and recording data
- Participate in community science project by entering data on eBird
- Identify birds on a bird walk

NGSS:
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

Materials:
- PAS Birding Journal or a notebook
- Pencil
- Handout 1.5

Prior Student Knowledge:
- Students will have prior experience with birding and bird identification from previous lessons in Unit 1.

Community Science: eBird and More

Brief Lesson Description:

Students will learn why counting birds, as opposed to simply recording a type of bird seen on bird walks or in their backyard is important to the overall study of birds in a broader context.

Narrative/Background Information:

The Cornell Lab of Ornithology created eBird as an online database of bird observations to provide scientists, researchers and amateur naturalists with real-time data about bird distribution and abundance.

Anyone may contribute observations to the database. The database's information is accessible to everyone around the world. eBird is an example of **community science**, a tool in which people from the general public contribute information to help researchers collect far more data and from a wider geographic area than they could collect alone. When tens of thousands of people submit their observations to eBird, researchers are gifted with a rich and broad set of data that they can use to help show migration patterns; identify resident versus non-resident species; and reveal and track changes due to climate change, species distribution, or species abundance. Users can look at others' data to learn more about birds in an area of interest.

Remember the National Audubon Society's *Birds and Climate Change Report* mentioned in *Lesson 1.1 Why Birds Matter*? Data collected by amateur to expert birders a-like (folks just like you) from two community science projects--the Audubon Christmas Bird Count (CBC) and the Breeding Bird Surveys (BBS)--contributed to this report! The observations you record on eBird can actually help real scientists answer important questions and make models that help us identify real-world problems and point to real-world solutions!

Recording the number of birds you observe is important

Taking a routine census of bird populations measures the distribution and abundance of species over time--the information from a census basically tells us *how many* of *which birds* are *where*. Doing so can help detect declines in a population, as well as detect and monitor at-risk or endangered species. Bird counts help track the populations of native birds and can help facilitate management plans for conservation and protection.

An estimate offers a lot more information for scientists than simply saying a bird was present. This is because in biological terms the lack, abundance, or any amount in between of a given species reveals information about the health of a particular environment. For example, the difference between 1 bird and 0 birds is presence and absence, a very significant difference. The difference between 1

Possible Preconceptions/ Misconceptions:

- A major component of this lesson is grasping the importance of counting birds and recording an estimate of how many of a species was observed on a walk. Students, like many others, may assume that simply seeing a bird and recording it on eBird is beneficial enough because they are unsure of the precise number they observed and don't want to be wrong.

Educator Tips:

- Teacher's Supplement 1.5 walks through bird counting tips and tricks to teach to your class.
- This lesson is based off of eBird's articles on Bird Counting. It may be helpful to read the following article before this lesson: https://ebird.org/news/counting-101/

bird and 10 birds may be a rare and unusual sighting versus a rather common occurrence. The difference between 10 birds and 100 birds may indicate something about the habitat or available resources in a location.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

CONNECT WITH PLUMAS COUNTY BIRDS

Explain that scientists study birds by counting them year after year, during different seasons, sometimes even monthly!

Why would scientists count birds?
To begin to answer this question, ponder the following:

- What is the difference between 0 and 1 in terms of the presence of birds?

  [The difference is huge! Zero birds means the bird was not present at all! One bird means the bird is present, but leads to more questions…]

- What is the difference between 1 or 2 birds?

  [Again, another huge difference! Observing one bird alone of a specific species might mean its presence is an anomaly, or at least not very common in your area. Two might mean something else altogether: that this species is uncommon or is conspicuously present in a place where it is not usually found.]

- What might 3-10 birds tell us? What about 50-100 birds? 1,000-5,000 birds?
- What if hundreds of a particular species were historically seen in an area, but the past few years only a handful had been observed?

  [*Presence/absence information alone would not reveal that a change has occurred.]*

Your counts contribute to eBird's Abundance Models, which predict the number of birds you would expect to see in specific locations across North America. Thus, noting only the presence of a species with an 'X' in your eBird entry does not sufficiently contribute to this study.

Numbers from bird counts entered on eBird are used for research and monitoring, conservation planning and actions, habitat management and protection, species population assessment, and can even help inform law and create environmental and land policy. This is why eBird encourages counting and best estimates.

Estimating numbers can be tricky but also really fun, so let's get to it! Read the Teacher's Supplement 1.5 to walk through bird counting tips and tricks that you can teach to your students.

Educator Tip:
Answers to Handout 1.5: A) 67; B) 102; C) 164; D) 62; E) 46
Note that these are estimates and so are approximate counts. Therefore, student estimates should be close to these, but do not have to match exactly.

Check it out:
For more complicated counting tips and tricks with large flocks mixed flocks and moving groups.
https://ebird.org/news/counting-201/

EXPLORE: Lesson Description-- Materials needed/Probing or Clarifying Questions

PRACTICE COUNTING

Go over Tips & Tricks for bird counting in Teacher's Supplement 1.5 and pass out Handout 1.5 to the class. Use the first picture with 10 birds circled as an example to go over as a class. Then allow students to practice estimating numbers of birds either individually, in small groups, or as a class using the photographs in the handout. See sidebar for answer key.

GO OUTSIDE and COUNT SOME BIRDS!

Counting birds can be practiced whether you can accurately identify birds to species or not. Submitting your observations to eBird, however, does require that you are confident in your ability to accurately identify the birds you report. Refer to the instructions and aid materials provided in the birding lessons earlier in this unit to help hone your identification and bird watching skills. If you do not feel confident in your ability to accurately identify birds, go outside and practice anyway. Practice, practice, practice is the name of the game when learning your birds. You can also consider inviting a Plumas Audubon Society volunteer along on your bird walk!

Head outside, making sure students bring their PAS Birding Journal or a notebook and a pencil along with them on your walk to record the birds they see, their counts, where, and what time of day. Remember to be conservative with your counts! For example, if you are traveling while observing, refrain from counting birds of the same species if you double back or return to the same spot at any point in your walk, it is possible that these are the very same birds you saw and counted before. Use common sense and try to report the most accurate count you can.

Upon returning to the classroom, remember to only enter into eBird those counts for which you feel your species identification is sound. See the "Explain" section of this lesson for instructions on how to submit observations in to eBird.

EXPLAIN: Concepts explained and vocabulary defined

ENTER COUNTS IN eBIRD

Please keep in mind that it is important to accurately identify the birds you saw and counted before you enter your numbers in eBird.

1. Set up an account for your class on eBird.org by clicking on the green "Create an account" in the upper right-hand corner. Enter some basic information and then activate your account via the email sent to you from "Team eBird".
2. Login to your eBird account and take your class through the submission process:
   a. Click on the **Submit Data** tab.
   b. Type in or find on the map the location from where your observations came.

c. Then enter the date, type, time, duration, and number of participants of your observations and click **Continue**.

d. Enter any confirmed sightings into the species list, being as specific as possible with estimated numbers of species when doing so. Remember, you can always enter 'X' to indicate the presence of a bird if you are not sure of the count, but it is best to offer a count estimate and only enter '1' if you saw exactly one bird of a species. You can also click the "Add Details" button next to a species if you'd like to include any descriptions of the bird, its behavior, or its habitat or upload a picture or sound file of the bird.

e. Once you've entered in all your observation counts, answer the question at the bottom right-hand page whether you are submitting a complete checklist or not (you should usually check "Yes" here, but click the question mark button next to this question to review a description of when to select "No").

f. Click **Submit**, then review your entry and make any necessary edits before moving on.

VOCABULARY

- **community science -** amateur naturalists from the general public (everyday people like you) contribute information to a source to help researchers gather more data.
- **census -** a count or survey of a population

Did you know…
"Community science" is a newer, more inclusive term adopted by Audubon in place of the better-known term "citizen science" which is still widely used.

ELABORATE: Applications and extensions

EXPLORE eBIRD

Allow your class time to navigate around this website and explore the different ways to view these community science observation data.

1. Login to your eBird account and go to the **Explore Data** tab at the top search bar. This will let you view ways in which eBird is used to share data.
2. Select a search criteria. Choices include:
    a. Explore species
    b. Explore a region
    c. Species maps
    d. Search photos and sounds
    e. Explore hotspots
    f. Bar charts
1. To start, choose either "explore a region" or "species maps". "Explore a region" will allow you to search all species and sightings in a given area (eg. "Plumas, California, US") and "species maps" will show you where specific birds have been seen.

Check it out:
eBird Abundance Models available at: https://ebird.org/science/status-and-trends

COOL STUFF YOUR DATA DO

As mentioned earlier, researchers use the data submitted into eBird by community scientists to study bird abundance and migration, and answer a variety of other questions. Check out some of the ways scientists have modeled these data:

Explore samples of eBird's Abundance Models by selecting the **Science** tab at the top of the page and then clicking the **Explore eBird Status and Trends** button. Click on various species to look at abundance maps and to watch an animated model of the migration and relative abundance of some species. See if your students can estimate what time of year they might get the rare chance to see a Purple Martin in our area.

EVALUATE: Reflect

Have your students consider the following:

- What is community science? How can I become a part of it?
- Why is community science valuable? How might it be flawed?
- Why monitor a population of birds? What does this information tell us?

EXTEND FURTHER: Enrichment

MAKE IT A HABIT

Extend this lesson into a weekly or monthly bird count project in one or a few locations to more consistently monitor bird populations in your area. Students will become very familiar with using eBird and are thus, more likely to continue the practice of community science beyond class.

MORE COMMUNITY SCIENCE OPPORTUNITIES

Encourage participation in other local bird counts and community science projects. There are many community science projects that your class can participate in for a class assignment, extra credit, or just for fun! Below are just a few ideas for community science projects focused on or involving birds, but there are many more out there:

- **Christmas Bird Count** (National Audubon Society): The longest running community science project in the world, this is a census count of bird species in the Western Hemisphere, performed annually between December 14 to January 5. Birders of all skill levels search for as many species as they can identify in a 15-mile diameter circle within a 24 hour period.

  https://www.audubon.org/conservation/science/christmas-bird-count

- **Great Backyard Bird Count** (Cornell Lab of Ornithology and National Audubon Society): Over a four-day period in February this global event involves bird watchers of all skill levels watching birds for at least 15 minutes and submitting their observations on eBird. http://gbbc.birdcount.org/

- **Project FeederWatch** (Cornell Lab of Ornithology): This winter-long (November-April) survey of birds that visit feeders at backyards,

community areas, and other locales in North America involves participants periodically counting the birds they see at their feeders and sending in their counts to Project FeederWatch. https://feederwatch.org

- Climate Watch (National Audubon Society): Climate Watch occurs over two distinct thirty-day periods each year, in the winter non-breeding (Jan 15- Feb 15) and in the summer breeding (May 15- June 15) seasons. Participants conduct 12 five-minute bird surveys in one day, recording and counting all the birds they can identify within 100m, with special focus on a bluebird or nuthatch species, to help track range changes. https://www.audubon.org/conservation/climate-watch
- BioBlitz (various organizations): A BioBlitz is an intense period of biological surveying in an attempt to record all the living species within a designated area. Look for one happening in your area!

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Participation in discussion
- Participation in bird count.

Summative Assessment (Quiz/project/report):

- Monitor and evaluate the quality of students' recorded observations.

Teacher's Supplement 1.5

BIRD COUNTING TIPS & TRICKS

- Write it down: Don't go birding without bringing along a notebook and pen or pencil. Get in the habit of recording what you see, how many of each species you see, where you see them and when. Doing so is easier with a birding checklist-- you can check off species quickly as you go and tally the number you see along the way. This also makes it easier for you to add your count to eBird!
- eBird recommends erring on the conservative side:

  ...If you see a male Northern Cardinal in the first five minutes of your walk, and then see a female later, your count would be two. But, if you see a male Northern Cardinal in roughly the same place on your way back we'd recommend leaving your count at one. While it is possible that two male Northern Cardinals were present, it's best to be conservative. If you saw a male Northern Cardinal at the beginning of your walk, and then another .5 miles away, you should safely count two!

- Counting **flocks:**
  - Relatively small stationary or moving flocks might be easy enough to count individually. Larger flocks, however, may be more challenging.
  - Count in timed increments: if many birds are moving past a location over a period of time (during migration for example) try counting and recording every 15 minutes. It is easier to keep track and add up a grand total at the end of your watch.
  - Count in smaller groupings within a flock to get a size estimate and apply to the entire flock:

Counting 10 in a small section of the flock (circled area) allows us to get a sense of how much space 10 birds in the flock occupies. Then we can apply that rule to estimate the count in the whole flock.

- Remember you are observing birds in three-dimensional space! There may be more birds in a similar sized section if they are farther away in space:

This clump contains 25 birds.

Here is the group divided into similar sized sections visually.

The groupings in the background contain nearly twice as many birds in the foreground!

Images and info from https://ebird.org/news/counting-101/

Handout 1.5

Practice Counting Birds

Estimating the number of birds in a large group can be tricky. A helpful tip is to break a large flock into visual sections that roughly contain the same amount of birds in each. If you have a pretty good idea of what 10 birds looks like out of a larger group, you can visually divide a big flock of birds into multiple groups of ten birds. Use these images to help you practice estimating.

A) There are 10 birds circled. Use that information to quickly estimate how many birds are pictured.

Photo: Chesapeake Bay Program via Flickr, 2010, Flock of Canada geese flying at sunrise

B) Draw out your own clump of ten birds and estimate the total number of birds in this photo.

Photo: Mick Thompson 2017, Short-billed Dowitchers

C) Circle a clump of 25 birds. Use this to estimate the total number of birds in the photo.

Photo: Mick Thompson 2012, Snow Geese in the Skagit Valley

D) Using the method practiced above, estimate the total number of birds in this photo (hint: this photo has a foreground and a background! Birds in the foreground appear larger than those in the background!)

Photo: Mick Thompson 2016, Snow and Ross's Geese

E) Last one…the furthest birds in this photo just look like dots in the sky!

Photo: Teresa Arrate 2018, Cliff Swallows from Stampfli Lane, Indian Valley

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"*Let us live in a way that Earth will be grateful for us*."
— Robin Wall Kimmerer[2]

Unit 2: RELATIONSHIP
Habitats, Resources, and Reciprocity

- Lesson 2.1: Ecosystems, Habitats, Resources, and Survival
- Lesson 2.2: Environmental Reciprocity

[2] Kimmerer is an author, Professor of Environmental and Forest Biology at SUNY-ESF Syracuse, and founding Director of the Center for Native Peoples and the Environment. She is a practitioner and proponent of Traditional Ecological Knowledge.

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Plumas Audubon Society

UNIT 2: RELATIONSHIP
Habitats, Resources, and Reciprocity

Lesson 2.1

Performance Expectations:
- Practice making detailed observations, use critical thinking and logic to form conclusions
- Empathize with all living things (as opposed to empathizing only with other human beings)
- Begin to consider the interconnections within an ecosystem: how one minor change in an ecosystem may affect multiple aspects in a community

Specific Learning Outcomes:
- Students will examine an ecosystem and determine what resources are available to organisms.
- Define and understand the terms "ecosystem" and "habitat".
- Students will observe and discuss the ways birds rely on resources in their environment to survive.

NGSS:

2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.
3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Time: *60 minutes*

Prior Student Knowledge:
- This lesson may build upon sound mapping, bird behavior, and species range concepts from Unit

Ecosystems, Habitats, Resources, and Survival

Brief Lesson Description:

A habitat is an area that provides enough food, water, shelter, and space for organisms to live in and reproduce. This activity will help students explore the habitat needs of birds, consider how those needs are met, and how they may be altered due to changes to the environment such as with climate change.

Narrative/Background Information:

An **ecosystem** is comprised of living (biotic) and non-living (abiotic) elements interacting in a given area. Ecosystems exist at all scales: areas as small as a community of microorganisms in a puddle to as large as the entire earth can be considered ecosystems. Ecosystems involve the complex interaction of living things (eg. plants, animals, fungi) and nonliving things (eg. water, minerals) in a single, defined space. The different areas in an ecosystem where organisms live and find the resources they need are called **habitats**. An ecosystem contains many habitats. For example, in a forest ecosystem, there are habitats along river corridors, habitats in meadows, habitats along high mountain ridges, habitats at low elevations, and even underwater habitats all within one section of forest. 16

Different habitats have different compositions of living and non-living things. The various habitats, however, generally provide the same things, or **resources**, for every living thing within the ecosystem: food, water, shelter, and space. Organisms have different needs for **water** and **food** (what kind, how much, how often). **Shelter** refers to the availability of protection from weather or predators, as well as a place to raise offspring. **Space** simply means that there are enough of these resources in a given area to support a certain amount of individuals. In general, the larger the organism, the greater their need for space.

Humans are *part* of some (but not all) ecosystems and, in turn, those ecosystems are *part of us*. We affect, both directly and indirectly, habitats and entire ecosystems. Some organisms are extremely sensitive to any changes to their environment, whereas others are able to adapt to changes, and some even thrive with human created changes to their ecosystem. For instance, Cliff Swallows and Rock Pigeons have learned to nest on awnings of buildings rather than their natural habitats of cliffs and rock outcrops.

In the current age of climate disruption, it is virtually impossible to find an ecosystem unaffected by humans. However, we can still find healthy, undeveloped areas where habitats are mostly or close to in their natural conditions. Such areas can offer us a good reference point when considering our aims as stewards of our environment.

1, but no prior knowledge is necessary for this lesson's success.

Possible Preconceptions/ Misconceptions:

- Habitats are not permanent and an organism's survival in a given space is dependent on several factors (availability of food, water, shelter, space), which are subject to change. Students should understand that even slight variability in these factors can alter a habitat and have a ripple effect on the entire ecosystem because of the interconnectedness of all things in the environment.

Materials:

- Field journals and pencils

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

CONNECT WITH PLUMAS COUNTY BIRDS

Before you go outside for the activity, ask and discuss briefly the following questions:

- What resources do all living things need to survive?
- How might climate change affect the resources in an ecosystem?
- How are ecosystems different? How does this affect the species living there?

EXPLORE: Lesson Description-- Probing or Clarifying Questions

LEARNING FROM NATURE

Take your students to an outdoor space and explain that we are going to try to learn *from* nature rather than *about* it. With as many of their senses as they can tune into, ask them to first take in the entire ecosystem in which they are standing for a few moments. Help guide their visual and auditory attention to both the living and non-living parts of the ecosystem (trees, other vegetation, insects, wildlife, rocks, streams, etc). Then ask them to identify different habitat types they can see around them. As a group, consider the following questions:

- What kind of organisms do we see here? What kind of organisms might live here even if we don't see them right now?
- How are living organisms' needs being met here? What resources are they taking advantage of?
- Do these resources appear to be in a healthy state? Why or why not?
- Are these resources abundant or scarce here?
- What challenges are the organisms living here faced with?
- What opportunities are they offered in this place?
- What kind of adaptations might different organisms have to be able to live here?
- If this area were to receive much less precipitation in the future, what would happen to the various resources it currently offers?
- How might a shift in seasonality (eg. shorter or longer seasons) affect the organisms living here?

A BIRD'S PERSPECTIVE

Now ask your students to imagine that each of them is a bird-- any species of bird they might imagine utilizing the ecosystem you are standing in. Ask the students to think silently about the following questions, giving some pause between each question as you ask them to allow students time to answer the question in their imaginations:

- What kind of bird are you?
- What are you doing in this particular ecosystem or habitat?
- Where do you find food? What kind of food?
- Where do you get water?
- Where do you sleep?

- Is there anything that might try to eat you? Where would you hide if something were coming for you?
- Where do you lay your eggs? How do you protect your babies?

Pair students together and have them interview each other, asking the same or similar questions, allow each pair time to complete their interviews. Then, as large group, share some ideas that came out of this process. Highlight any major differences you might hear along the way.

EXPLAIN: Concepts explained and vocabulary defined

Check for understanding; all students should know that species cannot survive in a habitat without enough food, water, shelter, and space. Reiterate and discuss the idea that some birds, along with other plants and animals will struggle to adapt quickly enough to a rapidly changing environment.

VOCABULARY:

- ecosystem - A biological community of living and non-living elements interacting in a given area.
- habitat - The natural, physical environment where an organism lives. A habitat is made up of abiotic, physical factors like temperature, soil type, amount of light (these things then affect the presence of plants and animals, and, therefore, the availability of food).
- resource - Something in the environment that is required by an organism for survival and normal growth, maintenance, and reproduction.

ELABORATE: Applications and extensions

MAPPING A HABITAT

Tell students that they are going to create a detailed map of the area, paying special attention to ways in which the area helps to meet habitat needs of birds and other wildlife. Ask them to draw the map from a bird's eye view and include features of the habitat that would help a bird survive in the wild. They should label at least three of the habitat features on their sketch and what type of resource need each helps fulfill.

After students complete their drawings, but while you are still outside, ask them to spend a few minutes watching a bird. Ask them to pay careful attention to what they bird is doing and where it is doing it. The important thing to emphasize is the relationship of the bird to other parts of the habitat. Ask students to share what they observed. Were there any similarities?

EVALUATE: Reflect

JOURNAL

Consider the habitat just visited and all the parts (both living and non-living) that make up the ecosystem there. Write about some of these different parts and how they are connected to each other.

Next, imagine that one of those parts has disappeared. Describe how you imagine that would that change the ecosystem and affect the organisms living within it?

EXTEND FURTHER: Enrichment

HABITAT DIVERSITY

If time and resources allow, offer this activity again at another location in a different ecosystem or habitat type and then ask the students to compare and contrast the various ecosystems/habitats that were visited. Did they notice any differences in community composition (ie. the kinds and numbers of plants and animals found together in an area)?

ONE WITH AN EAGLE

Regular practices of mindfulness activities—like the "Listening Circle" in *Lesson 1.2* and "Birds of a Feather" in *Lesson 1.4*—can help improve your students' cognition and focus, along with many other mental and physical health benefits associated with practicing mindfulness. Mindfulness training has also been found to help build empathy, a critical social and emotional skill that allows us to understand others and to cooperate. Offer the following mindfulness activity to practice building empathy for our non-human kin:

First, ask for silence from the group, have students stand in a circle or lie on their backs and pay attention to the suggestions that follow. Wait a few moments between each suggestion to allow everyone to focus on each of the following:

- Close your eyes and imagine that you are a Golden Eagle.
- You are a large bird and in place of hair, you now have feathers that cover your body.
- Your eyesight is excellent.
- Your toenails have become strong, sharp talons.
- Your nose and mouth have become a large curved bill.
- Your arms are now wings.
- Open your wings and spread them as wide as you can.
- Start to flap your wings with large, powerful beats and lift your body off the ground.
- Fly.
- Fly higher.
- Higher and higher.
- Now let your wings rest as you soar on the wind.
- Feel the wind in your feathers.
- Look around you.

- What do you see up high in the sky?
- What do you see far below you?
- A quick, darting movement below has caught your eye. Tuck your wings and dive!
- As you approach the ground, you pull your head back and reach your legs out with feet, talons, and wings wide open.
- You missed your target and land on the ground. Fold your wings against your back and relax.

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Teacher observation of students
- Student participation in activity and discussion

Summative Assessment (Quiz/project/report):

- Review written journal reflection.
- Consider creating a journaling/reflection assignment with the questions from the activity.

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Plumas Audubon Society

UNIT 2: RELATIONSHIP
Habitats, Resources, and Reciprocity

Lesson 2.2

Performance Expectations:

- Practice reading aloud fluently and accurately with appropriate pacing, intonation, and expression.
- Practice and strengthen reading comprehension skills and literary analysis.

Specific Learning Outcomes:

- Student will understand the interconnectedness of all things, living and non-living, and be able to define certain kinds of biological relationship within ecosystems.
- Students will learn and discuss the concept of environmental reciprocity, taught through American Indian teachings and perspectives.
- Students will consider and explain ways their actions affect the environment.
- Discern main ideas and concepts presented in text, identifying and assessing evidence that supports those ideas.

NGSS:

5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

Time: *60 minutes*

Environmental Reciprocity

Brief Lesson Description:

This is an oral reading and reading comprehension lesson in which students will connect the principles of American Indian philosophy on human and land relationships to their everyday lives, thinking about how we use the land today, what our relationship to the Earth is today, and what we can do to establish a more respectful relationship with our environment.

Narrative/Background Information:

All life on Earth is connected in a diverse and complex web. **Biodiversity** is the variety of life that exists on Earth or within a defined area, including the diversity within species (genetic diversity), between species (variety of different species), and of ecosystems. More biodiversity in an area offers a healthier, more productive, and more resilient ecosystem and world.

Relationships in ecosystems are complex. Organisms compete and cooperate for available energy (food) and resources in an ecosystem in order to survive and reproduce. Here are the types of ecological relationships between species in an ecosystem:

- **Mutualism:** A reciprocal relationship that benefits both species; cooperation among species.
  - EXAMPLE: Birds and plants have a mutualistic relationship: birds feed on fruits and berries of plants, and then scatter the plant's seeds in their feces, allowing new plants to grow.
- **Competition:** Two organisms, within or between species, compete for one resource. In some cases, competition leads to one species outcompeting the other, causing displacement, extirpation, extinction, or evolution (long-term).
  - EXAMPLE: Two or more males of the same species may compete for one female mate (intraspecies competition). The Allen's Hummingbird is a climate-endangered species facing a significant reduction in range due to climate change. This range reduction may force the birds into the territory of other hummingbird species, like that of the Anna's Hummingbird, where they may be out competed for resources (interspecies competition).
- **Predation:** One organism, the predator, eats the other, the prey.
  - EXAMPLE: The Osprey is a large predatory bird (bird of prey) or raptor. Ospreys prey (hunt and feed) on fish and small mammals.
- **Parasitism:** One organism, the parasite, benefits from the relationship while the other, the host, is harmed, sometimes weakened and killed.
  - EXAMPLE: Cuckoo birds and cowbirds lay their eggs in the nest of

Materials:

- Reading 2.2a and 2.2b

Prior Student Knowledge:

- Students may be familiar with the importance of the environment in Maidu culture, or other Native American cultures across the Americas. Prior knowledge is not necessary for this lesson, but gauge students' knowledge by asking if they are familiar with any Native environmental traditions or sacred sites in the area.

Possible Preconceptions/ Misconceptions:

- The stories you will read refer to hunting of which student may have negative, positive, and/or neutral preconceptions on the topic.

another bird, sometimes shoving the host bird's eggs out of its nest to make room for their own. Unbeknownst to the host bird, it warms and cares for the eggs of a foreign bird rather than its own.

- **Commensalism:** One organism benefits from the relationship while the other is unaffected.
    - EXAMPLE: When a bird builds a nest in a tree, the tree is unaffected, but the bird gains shelter and protection from the tree's structure.

All life forms on Earth are connected, directly or indirectly, through communications, energy flows, and relationships in ecosystems. Humans are part of these connections and these connections are a part of us: we are dependent on biodiversity to provide things like clean air and water, soil and food, building materials for infrastructure, medicines, cultural perspectives and practices, livelihoods and economic development, natural spaces for recreation, and much, much more.

Daily actions affect the environment and many practices in modern human life--like the burning of fossil fuels--disrupt the delicate web of life. Human-induced climate disruption is affecting biodiversity in communities large and small around the world. What happens when the complex relationships in a given ecosystem are disrupted?

As part of Earth's web of life, humans have a moral obligation to protect and preserve the planet's rich biodiversity and to try to regain a balance with the natural world. The term "environmental reciprocity" comes from the idea in indigenous philosophies across the globe (not just Native American!) of balanced and mutual interactions and exchanges in communities, not only among people, but also between people and their natural surroundings.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Discuss the concept of **reciprocity**. Reciprocity is the practice of exchanging things with others for mutual benefit or can also refer to the practice of contributing to the common good.

After getting a good grasp on the general concept of reciprocity, discuss what the meaning or the class's understanding of the term "environmental reciprocity" may be.

Then, as a class, brainstorm how we humans interact with our environment in different ways, both big and small, everyday. Based on your class' understanding of environmental reciprocity, what are some ways that humans practice this?

EXPLORE: Lesson Description-- Probing or Clarifying Questions

THE SEED, THE DEER, AND THE MOUNTAIN LION

Read the story "The Seed, the Deer, and the Mountain Lion" (Reading 2.2a) as a class, selecting six students to each read one paragraph aloud.

After reading ask students to point out different connections or relationships in the story and take time to discuss each one. Consider both the movement of energy and nutrients as well as communication and any other interrelationships the class can identify.

EXPLAIN: Concepts explained and vocabulary defined

Relationships in ecosystems are complex. Organisms both compete and cooperate for available energy (food) and resources in an ecosystem in order to survive and reproduce.

Review the types of relationships between species in an ecosystem (ie. competition, predation, parasitism, mutualism, and commensalism) described in the Background of this lesson. Offer examples (provided in the Background) and see if your class can come up with other examples for each type of relationship.

Based on the relationships that exist in ecosystems, ask the class what kinds of relationships we as humans have with our environment and discuss why.

VOCABULARY

- reciprocity - an exchange of items or of kindness for mutual benefit; an offering given in exchange for something received; contributing to the common good can also be considered a form of reciprocity

ELABORATE: Applications and extensions

JOURNEY WITH THE ABENAKIS

Read "Journey with the Abenakis" (Reading 2.2b) as a class, selecting eight students to each read one paragraph aloud. Follow with discussion and reflection.

DISCUSSION

- What are the rituals surrounding the hunt?
- Can you think of any comparable present-day hunting rituals, routines, or practices?
- How do the hunters in the story help maintain a balance with nature?
- Can we relate the lessons of silence, respect, sharing, and circles to ways we use the Earth to survive other than hunting? In what other contexts is it important to remember these lessons?
- What other resources do we use from nature?
- What is the difference between wants and needs?
- How can we use these resources sustainably to maintain a balance with

nature? Answer keeping the story's lessons of silence, respect, sharing, and circles in mind.

EVALUATE: Reflect

JOURNAL

- What is environmental reciprocity?
- What kinds of relationships (competitive, predatory, parasitic, commensalistic, mutualistic) do we as human beings have in our local ecosystem? What kinds of relationships do we as human beings have with the environment as a whole? How are you part of the web of life?
- How do you use the land in your everyday life?
- How can we give back to the land? What can we do to appreciate the land and all it provides us?

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Teacher observation of student participation in class reading and discussion.

Summative Assessment (Quiz/project/report):

- Assess writing, comprehension of text and concepts, and reflection through journaling assignment.

Michael J. Caduto and Joseph Bruchac: "A Journey with the Abenakis." *Keepers of the Earth: Native American Stories and Environmental Activities for Children*. p 169-170. Fulcrum Publishing, 1997. Reprinted with permission.

The Center for Indian Community Development. *Environmental Protection Native American Lands: A Cultural Approach to Integrated Environmental Studies*. Humboldt State University: Arcata, CA. 1995.

Reading 2.2a

The Seed, the Deer, and the Mountain Lion: A Web of Life story

By Michael Hall

In the springtime, the warmer temperatures and longer daylight hours signal to a grass seed that the seasons are changing and that it is time to start growing. As the seed sprouts, it uses sunlight to grow. This growth takes carbon from the atmosphere and minerals and water from the soil to build cells. This grass, along with many others in the meadow, helps keep moisture in the soil and filter and slow the water that passes through. After several days a young mule deer walks through the meadow, carefully watching the edges of the meadow for predators. She sees the young grass shoot and eats it slowly. Eating this grass will give her energy to live, and the sugars will be converted into cells, which will help the deer grow to full size.

After many weeks and meals the deer has grown larger, now moving quickly and confidently through the forest. She has ticks buried in her skin. Biting flies circle around her. These insects will eat small parts of the deer, but in such small quantities she hardly notices. She hardly notices either, the California Scrub-Jay eating the ticks off her back. While she drinks from the cool, clean stream of snowmelt, she does notice the sudden departure of her blue avian friend as a large mountain lion creeps slowly towards her along the edge of the meadow. But she barely has time to react before the lion pounces, snapping her neck in one powerful motion.

The deer is now deceased and is carried off by the mountain lion. The large cat eats what he can, then drags the rest to a cache underneath a downed log. Summer is here and the lion knows that there will be many deer out in the coming months. Inside the mountain lion, the deer meat is slowly digested and converted to energy, which is used to help the mountain lion grow stronger and larger. Inside the mountain lion, a small creature no larger than a strand of thread is moving in its intestine. This tapeworm has been living here for weeks now, after hatching from an egg on a piece of scavenged meat the cat ate earlier. It is quickly growing larger and taking an increasingly greater portion of food that the lion has consumed.

Months go by and the lion continues its life in the mountains. Yet for some reason, hunting has been more difficult for him; he feels weak and malnourished. He is losing weight. The deer are too quick for him; he becomes hungry and desperate. It has been many weeks since his last full meal. The tapeworm inside of him continues to consume the lion as a resource. Eventually, the lion is too weak to hunt, he lays down in a shelter near a cliff band. Growing increasingly weak and sickly, this is the last place the lion will lie. He dies several days later.

As days go by, the lion carcass begins to decompose. The smell of rotting meat attracts ravens, bear, coyotes, skunk, and a variety of insects. These organisms feed on the dead lion, anxious to consume whatever food they can before it disappears completely. The lion is quickly consumed, and many animals lose interest in scavenging what little energy remains here. Eventually, microorganisms are all that remain, slowly breaking down the remains into chemical and mineral form.

Time passes and grasses sprout from the place where the lion died. These seeds thrive in the abundance of nutrients left here after the body decomposed. These young sprouts are tender and nutritious; they attract a family of deer. Cautiously these animals eat the grasses. The energy here will help them survive and grow in the forest. One of these deer will soon feed the family and friends of a human hunter.

Reading 2.2b
Journey with the Abenakis*

Our journey begins in the pine woods. As we walk, the wind sighs through the pine boughs and causes them to wave. Little patches of sunlight shine on the soft pine needles beneath our feet. A twig cracks underfoot. There is a clearing in the distance and gentle curls of smoke rise into the sky. We can smell wood burning as we approach.
[...]

[We watch as] people prepare to go on a hunt by burning tobacco, a sacred plant whose smoke carries their prayers up to the "Owner" or Creator, Tabaldak, and the animal spirits. These prayers ask for permission to hunt. They also express the people's respect and appreciation for the lives of the animals they will soon hunt, and offer thanksgiving for the food, clothing, and other gifts the animals will give the people. Soon the hunters leave the fire ring, carrying their weapons, and walk through the pine grove.

Some faint deer signs are found and two of the hunters begin to follow the trail very quietly. After a long, slow, tiring search, some animals are heard chewing on the buds of a small tree up ahead. The hunters creep closer and look through the branches of a low bush. The animals are deer! And so we learn one of the lessons of survival in nature: SILENCE.

The hunters look carefully at the deer in the herd, recognizing each one individually. Two of the deer are pregnant who the hunters know are expecting fawns--these two will not be hunted. Finally, the hunters decide on a certain buck as their quarry.

In an instant several arrows are strung and sent whistling through the air. The buck is shot and it falls kicking on the ground, blood flowing from wounds in its side. One deer alone is taken because the others are needed to produce more young to keep the herd alive and because the hunters take only what they need. A second lesson in nature is learned: RESPECT for other life besides people's.
[...]

The deer is not kept by the hunters and their families; it is cut into smaller pieces and given to all those who need food beginning with those who are most hungry. Another lesson is learned of how people can survive in the natural world and with one another: SHARING--sharing the gifts of nature.

As the meat is prepared, the people burn some fat on the glowing coals of the cooking fire. The smoke that drifts upward is an offering to Tabaldak. Every part of the deer is used, because to waste any would show disrespect to Tabaldak and the animal spirits and make them angry. Finally, the deer's bones are returned to the land where it was killed. This offering of the bones completes the circle of giving and receiving--the Creator and deer give life through the gifts of food and clothing to the people, and the people complete the circle by giving the deer bones back to show respect, appreciation, and thanks. A final lesson is learned for living well with the natural world: CIRCLES [of giving and receiving].

SILENCE - RESPECT - SHARING - CIRCLES--
These are lessons to be remembered each day. If we live by them we will be able to live in peace with other people and in balance with the Earth and all living things.

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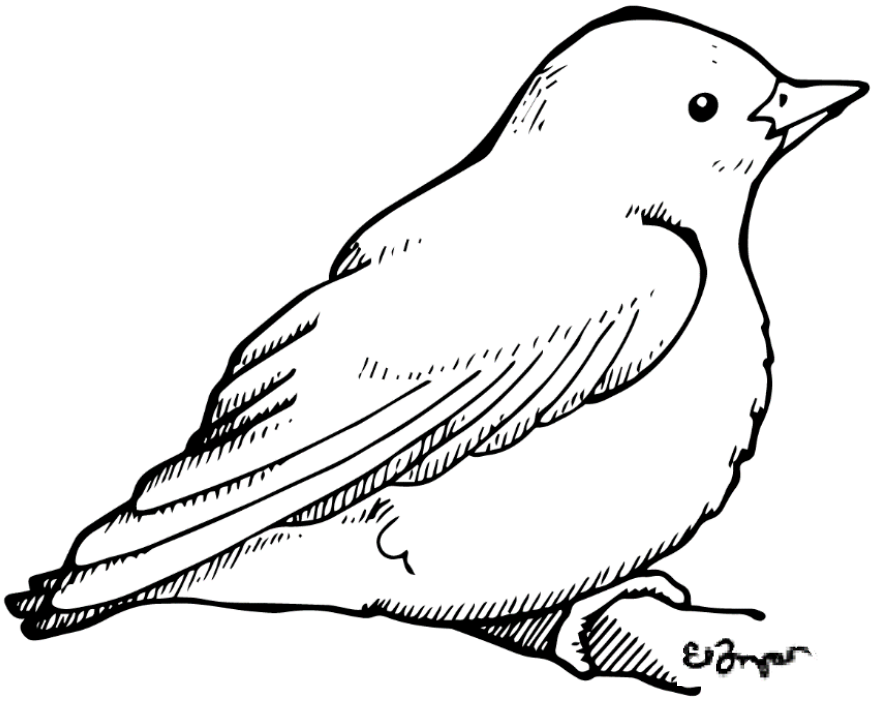
*Reprinted with permission from *Keepers of the Earth: Native American Stories and Environmental Activities for Children* by Michael J. Caduto and Joseph Bruchac.

"*So why worry about global warming, which is just one more scale of climate change? The problem is that global warming is essentially off the scale of normal in two ways: the rate at which this climate change is taking place, and how different the "new" climate is compared to what came before*."
— Anthony D. Barnosky[3]

Unit 3: KNOWLEDGE
Climate Change Basics

- Lesson 3.1: Climate vs. Weather
- Lesson 3.2: The Greenhouse Effect: A CO_2 Experiment



[3] Barnosky is an author, Professor of Biology at Stanford University, and Executive Director of Jasper Ridge Biological Preserve. He researches past planetary changes and what they mean for forecasting the changes to come on Planet Earth.

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Plumas Audubon Society

UNIT 3: KNOWLEDGE & RESPONSIBILITY
Climate Change Basics

Lesson 3.1

Performance Expectations:

- Create a weathervane with provided materials.
- Use science tools to make observations about the weather.
- Plot local weather data and observe a trend.

Specific Learning Outcomes:

- Understand the difference between climate and weather.
- Understand the difference between variation in individual data points, which describe the weather, and a trend line, which describes the climate.
- Discover local climatic changes and understand the trends.

NGSS:

2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.
3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes for each activity*

Prior Student Knowledge:

- Students will know what weather is, but may not know the difference

Weather vs. Climate

Brief Lesson Description:

Weather and climate are two terms that are often confused and used mistakenly. This lesson describes the differences between weather and climate, and provides examples of ways in which weather and climate affect or influence each other. Students will make a weathervane and go outside to observe the weather and determine if it is typical for the season in our area. As an extension, students will plot local weather data, observe a warming trend, and discuss the anthropogenic cause of Earth's rapid warming.

Narrative/Background Information:

Weather and Climate are two terms that are often confused and used mistakenly. **Weather** refers to the state of the local atmosphere at a given point in time. Wind, rain, temperature, cloudiness, etc. are all examples of atmospheric conditions that describe the weather of a specific place at a specific time. **Climate** refers to trends in weather conditions that occur over longer periods of time--decades or more. A period of intense cooling, like previous ice ages would be considered part of a climate trend. An exceptionally warm month in the middle of an ice age would be considered a period of warm *weather*, not necessarily indicative of climate. Plumas County's *climate* has generally been characterized by cold, wet winters and hot, dry summers even though the *weather* may be warm on a given day in the winter or wet and cool on a given day in the summer. However, recent years have seen warmer and drier conditions in many parts of Plumas County than in the past, indicating a shift in our regional climate.

Climatology, or climate science, is the scientific study of climate, including study of the causes and long-term effects in variation in regional and global climates, including those affected by humans. Climatologists look at long term periods of weather data from various sources to recognize patterns and shifts in the climate over a long period of time and use that information to model predictions of future conditions. The vast majority (97% or more) of climate scientists agree that the global climate is currently experience a rapid warming trend caused primarily by human emissions of greenhouse gases into the atmosphere.

This activity will show examples of ways in which climate and weather affect or influence each other. Climatic changes can cause extreme shifts in weather. These shifts are often misunderstood as they do not always reflect the average global climate shift of rising global temperatures.

between climate and weather.
- Use of meteorological tools: students will most likely know how to use a thermometer, but the compass, weathervane, and cloud guide will require instruction and help.
- Students should have some prior basic experience graphing data.
- If interpreting the graphs and data in the "Elaborate" and "Extend Further" sections are advanced for your class, this NASA Climate Kids resource may help break down how to interpret and understand graphs and climate data: https://climatekids.nasa.gov/graphs/

Possible Preconceptions/ Misconceptions:
- Students likely do not know that 97% of climate scientists agree that humans are causing the global climate to warm rapidly.
- The terms "global warming" and "climate change" are often used interchangeably, but they are not exactly the same. Climate change is a more general term to refer to many various types of changes observed in the global and regional climates. Global warming is a type of climatic change and refers to the trend of increasing global average temperature.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

WEATHER vs. CLIMATE

Begin the activity by discussing and defining weather and climate. Use the information in the Background of this lesson to guide your students to accurate definitions of weather and climate.

1. Discuss the weather today.
   a) Is it warm? Is it cold? Rainy? Cloudy? Dry? Humid? etc.
   b) What do you expect the weather to be like tomorrow? And the day after?

   [Weather can change from day to day, hour to hour, even minute to minute. Weather describes short-term atmospheric conditions.]
2. Discuss the climate of our region.
   a) What kind of summers do we have here? What kind of winters?
   b) How do you know what to expect?

   [We expect summer to be hot and dry and winter to be cold and wet in Plumas County because our climate has, in general, historically followed this pattern. Climate is the long-term weather trends of a region.]
3. Use the questions below to help students grasp the difference. The answer to each of the following questions should either be *weather* or *climate*:
   a) Which helps you decide what kind of clothes to wear for the day? *[weather]*
   b) Which helps you determine what kind of clothes to buy or have ready for a particular season? *[climate]*
   c) Which changes dramatically from year to year? For example: "We had a very snowy winter last year. This year we haven't gotten much snow." *[weather]*
   d) When you imagine a faraway place, which helps paint the picture in your mind? *[climate: it's what you expect]*
4. Now discuss a bit about variation.
   a) Has anyone noticed any weather conditions during the summer or winter that you wouldn't expect for our climate during that season? *[For example, sometimes it is very warm and sunny in the middle of the winter!]*
   b) Day to day, does the weather change? What about year to year? *[Yes, weather is variable and things like temperature and precipitation will vary up and down from day to day and year to year.]*
   c) Is weather different in different parts of the world/country/state/county? *[Yes, weather varies across the world and even varies between very close localities.]*

space, long-term patterns can be observed. Those long-term patterns are what we are talking about when we refer to *climate*. The climatic patterns may differ across space and change over time and the term *climate change* refers to both of these phenomena.

5. After establishing the definitions of and distinction between weather and climate, you may want to show one or more of the following videos that describe and illustrate what weather and climate are:
    - National Geographic's Cosmos with Neil deGrasse Tyson (2:09 min): https://www.youtube.com/watch?v=cBdxDFpDp_k
    - Detailed video for youth by Crash Course Kids (4:32 min): https://www.youtube.com/watch?v=YbAWny7FV3w
    - Educational animated video Colorado State University (6:24 min): https://www.youtube.com/watch?v=VHgyOa70Q7Y

EXPLORE: Lesson Description-- Materials needed/Probing or Clarifying Questions

Let's explore our weather now!

CONSTRUCT A WEATHERVANE

Before heading outside your students can construct their own weathervanes, using simple materials, to measure the direction and relative strength of the wind.

Materials:

- a stick
- masking tape
- an 8 inch piece of string
- ethically-sourced, naturally-molted feathers*

1. Hold the end of string to the end of the stick. Wrap masking tape around the string and stick, securing the string to the end.
2. With another piece of tape, secure the feather to the opposite end of the string (the loose end).

WHAT IS OUR WEATHER?

Split the class into groups of three to four student to share tools and take the class outside to observe the day's weather. How will we determine if the day's weather is typical of the season's climate in our region? We will look at:

- Air temperature (using the thermometer)
- Wind strength (relative) and direction (using the weathervane and compass)
- Approaching weather (by looking at the clouds and referencing the cloud guide)

Materials:

- Journal and pencil
- Thermometer

Materials:

- Computer with internet and means of projecting or showing to class
- Sticks
- Masking tape
- String
- Feathers*
- Thermometer
- Compass
- Field journals and pencils
- Handouts 3.1a, 3.1b, 3.1c

Check it out:

You can also make your own anemometers to measure wind speed! https://www.scientificamerican.com/article/bring-science-home-wind-speed/

Educator Tip:

*Wild bird feathers are protected under various state and federal statutes, including the Migratory Bird Treaty Act.

Ethically-sourced feathers can come from local farms where chicken or fowl feathers that have naturally molted may be collected with permission. Alternatively, such feathers can be purchased online (eg. from Acorn Naturalists: https://www.acornnaturalists.com/bird-feathers-expansion-collection-animal-signaturesr-kit.html).

- Compass (one or multiple)
- Weathervane (can be made as an activity before the lesson; see instructions below)
- Cloud Key and Cloud Guide (Handout 3.1a)

As you go through each step teach the students about each meteorological tool and explain how to use them.

1. Take the air temperature using the thermometer. Record.
2. Observe the wind direction and relative strength. First, ask them to close their eyes and feel the wind on the cheek or clothing and ask if they can tell which the direction the wind is coming from (N, NW, W, SW, S, SE, E, NE). Explain how to use the compass. Have the students hold the compass so that the label "N" is at the top, then instruct them to turn their body to face in line with the compass needle pointing north and then stop in that position. Have the rest of your students face the same direction (ie. North) and hold their weathervanes in the air. Record the following observations:
   a) Is the wind strong enough to blow the feather in the air? Is the wind strong, mild, or weak? *[Students should be able to observe the amount of displacement of the feather from the stick to infer the relative strength of the wind.]*
   b) From which direction is the wind blowing? *[Students should be able to estimate the approximate direction of the wind without looking at the compass, but can refer to the compass for accuracy and more precision].*
3. Look up at the clouds. The altitude, shape, color, and movement of the clouds are a great way to predict what the weather (wind, temperature, and precipitation) will be like in the upcoming hours or even the next few days. Use the dichotomous Cloud Key (Handout 3.1a) to identify which type of clouds you are observing and compare your observations to the descriptions and pictures in the Cloud Guide (Handout 3.1a). Record your observations.
   a) Describe the appearance of the clouds you see.
   b) What types of clouds are they?
   c) What direction and how fast are they moving?
   d) What might these indicate in terms of weather?

Did you know…
The north end of a compass is magnetically drawn to align with Earth's magnetic North Pole.

There is a difference between Earth's magnetic North Pole (which can shift) and "true north," which is Earth's geographic location known as the North Pole, and the difference can be measured, but that is beyond the scope of this exercise.

EXPLAIN: Concepts explained and vocabulary defined

WEATHER, CLIMATE, and BIRDS

Just like we are accustomed to the weather and climate in our region, so are birds. Birds react to weather similar to us: for example, in good weather, birds are likely to be out and about, but in cold, rainy weather birds will hunker down, seeking shelter. Birds also rely on the climate to determine where they live, find food, when and to where they migrate, and when and where they reproduce and raise their young.

Birds are sensitive and adapted to particular climatic conditions, primarily temperature, precipitation, and seasonality. Therefore, climate plays a large role in each species' specific habitat requirements, and determines where birds are found. Some species are more tolerant, and therefore can be found in a larger range of climates, while others need a very specific suite of conditions in order to survive.

A change in climate may cause a species' range to move, expand, or shrink. If an area experiences a sustained change in temperature, precipitation, humidity, or any other climatic factor, the plants and animals living in that area will be affected. Some will be able to adapt, others will have to move, and still others—unable to adapt or move—will be either be extirpated (local extinction) from the area or go extinct.

Is the climate changing? If so, how? We'll explore this in the next section.

VOCABULARY

- **weather -** the state of local atmospheric conditions (wind, precipitation, temperature, etc.) at a given point in time
- **climate -** trends in weather conditions that occur over longer periods of time
- **climatology -** the scientific study of causes and long-term effects in variation in regional and global climates, including those affected by humans.
- **trend -** a general direction in which something is developing or changing
- **trend line -** also known as the "line of best fit", it is a line that represents the behavior of a set of data to determine if there is a certain pattern

ELABORATE: Applications and extensions

Educator Tip:
Additional help for kids on how to interpret graphs and data is available at: https://climatekids.nasa.gov/graphs/

Now let's examine the climate -- global and local! Project a copy of Teacher's Supplement 3.1a so students can see the following graphs. Help them interpret the data as a class.

GLOBAL CLIMATE

Climatologists are observing a change in the global climate: Earth's average temperature is increasing. While not all places on Earth are experiencing a warming trend, the upward march of the global average is stark. This rise in average temperature is attributed to the increase in greenhouse gases in Earth's atmosphere due to human activity. Refer to the Teacher's Supplement 3.1a for the chart titled "History of global surface temperature since 1880", which displays data from land and sea surface measurements.

REGIONAL CLIMATE

The United States is a broad region also experiencing warming. Refer to the graph in the Teacher's Supplement 3.1a showing the upward trend in average temperature recorded in the United States (contiguous) for a six-month period from the year 1895 to 2018.

LOCAL CLIMATE

What is happening locally? Are we experiencing a similar warming trend as the U.S. and the globe?

Check it out:
To see the full records and to look up data for other cities, visit Western Regional Climate Center's US Cooperative Stations Map page at: https://wrcc.dri.edu/coopmap/ On this page select a particular state in the drop down menu next to "Select all in state" and that will generate a list with links to datasets for of all the cities with available climate data in that state.

1. Have your students graph by hand the local historical climate records of the average temperature in July in Quincy, CA (Handout 3.1b). [Note: Historical data for Quincy, CA were used as this dataset had the oldest and most complete records in the area.]
    a) Pass out copies of the 10-year-average datasets (Handout 3.1b) and copies of the blank graph sheet (Handout 3.1c) or you can have students create their own graphs from scratch with graph paper.
    b) Have the students create a scatterplot entitled "10-year-average of Average Temperature (F) in July from 1895-2014, Quincy, CA," with appropriate axis labels, where the x-axis represents time in decades and the y-axis represents temperature in degrees Fahrenheit.
    c) Use the data from Handout 3.1b, Table 1 to graph the data. Instruct students to plot the data point for each decade on the year that decade ends (eg. for the decade 1895-1904, the 10-year average of 65.3°F, should be plotted on the graph above the year 1904).
    d) Students can then connect data points to each other to convert the scatterplot into a line graph, which can help aid visualization of the year-to-year variation in temperature and help distinguish these data points from those students will graph in the next step.
2. Now, in a different color students should plot the **trend line** points provided in Handout 3.2a, Table 2. These data points are calculated from the trend line equation (y = 0.0384x - 8.2017) derived from the scatterplot that your students graphed in step 1. Use a straightedge to connect these points with a line using a color or pattern different from that used in steps 1c and 1d, above. This is the trend line or "line of best fit." Teacher's Supplement 3.1b provides plotted graphs with trend lines for reference as to what the data should look like when graphed by students.

EVALUATE: Reflect

DISCUSSION

As a class, analyze the data and answer these questions:

1. We just graphed both weather and climate. Looking at our graphs, what represents the weather and what represents the climate? *[Help students identify the individual data points as representations of "weather" and the trend line as a representation of the "climate".]*

2. How does the average temperature change from day to day? From year to year?
3. What does the historical data show, overall, about the trend of our region's climate in terms of temperature in July?
4. Based on your graph, what do you expect the climate to be like over the next 10/20/50 years? How old will you be then?
5. Using the predictions for the average temperature in July in Quincy in the years 2050 and 2080 as reference, extrapolate from the trend line to estimate a prediction for the average temperature at the end of the century (2100). What does our future climate look like according to these predictions?
6. Project the copy of Teacher's Supplement 3.1c. Review again the graphs and compare and contrast your students' graphs of local climate data to those of regional and global climate data. Are we experiencing a trend similar to the broader U.S. and the globe?

JOURNAL

- Considering the historical temperature trend and predicted future trends, what does this pattern of average July temperatures mean for us?
- How do you think this type of change in climate affects your life?
- How might it affect plants and animals?

Educator Tip:
Your class can easily make its own simple rain gauge, using a plastic bottle and some rocks!
1) Cut the top third off a plastic bottle, saving the top.
2) Place some rocks inside the bottom of the bottle as weights.
3) Place the top upside down inside the bottle to create a funnel.
4) Draw a measuring scale along the side of the bottle with the zero starting at the top of the rock line.
5) Add water to the bottle until it meets the zero line/top of the rock line.
6) Place the bottle outside in the open.
7) Measure the amount of precipitation after 24 hours, record, and then empty the bottle and repeat.

EXTEND FURTHER: Enrichment

PROJECT: REGULAR LOCAL WEATHER OBSERVATIONS

Design a long-term project (as brief as a month, as long as the entire school year, or somewhere in between) in which students routinely collect weather data with their meteorological tools, record weather observations, and compare their collected data to the historical data records for your area archived by the Western Regional Climate Center (WRCC). Upon comparison, students can assess whether their student-collected data is typical for their area and the time of year (given normal day-to-day and year-to-year variation) or if they are observing an outlier (a data point distant from other observations) or a change from the norm (multiple data points distant from previous observations, accounting for normal variation).

PROCEDURE

This is a general procedure for such a project; details can be determined by the teacher. According to your discretion, resources, and time constraints:

1. Choose a routine (everyday, once weekly, twice weekly, etc.) to go outside and observe the weather. Have students record their observations using the meteorological tools you have available, noting temperature, precipitation, etc.
2. Once all data has been collected in the determined timeframe, look at

the WRCC website to compare data for your area from last year, 20 years ago, 50 years ago, etc. To look up data for various cities, visit WRCC's US Cooperative Stations Map page at: https://wrcc.dri.edu/coopmap/. On this page select a particular state in the drop down menu next to "Select all in state" and that will generate a list with links to datasets for of all the cities with available climate data in that state.

3. (Optional) Graph the historical data.
4. Compare your observations to the historical records.
5. Write up an analysis and conclusion: Is the weather you observed typical for the time of year (given normal variation)? Why or why not.

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Teacher observation of students' participation in activities and discussion as well as student understanding /proper use of meteorological tools for weather data collection

Summative Assessment (Quiz/project/report):

- Evaluate recorded data from weather collection
- Review students' graphs for accuracy.
- Review students' journals or write-ups to evaluate their understanding and conclusions drawn.

Handout 3.1a

Cloud Key*

Answer the questions and follow the instructions to identify the type of cloud you are observing. Then look up that cloud type in the Cloud Guide below and compare the description to your observations. If you think you have accurately identified your cloud, record it along with a description of what kind of weather you might expect.

1. Is it raining?

No: go to #2

Yes, with thunder, lightning, and heavy rain: your cloud is a *cumulonimbus.*

Yes, but only drizzly with small raindrops: your cloud is a *nimbostratus.*

2. Is it a high wispy cloud, like a horse's tail?

No: go to #3

Yes: your cloud is a *cirrus.*

3. Is it flat and layered, puffy and bumpy, or some of both?

Yes, flat and layered: go to #4

Yes, puffy and bumpy: go to #5

Yes, some of both: If your cloud is a nearly solid layer of large puffs your cloud is a *stratocumulus*.

4. How high and how thick is your flat layered cloud?

If your cloud is high, thin, and the sun is shining casting distinct shadows, it is a *cirrostratus*.

If your cloud is thicker, the sun is dimmer, and there are hardly any shadows, it is an *altostratus*.

If your cloud is a low cloud, so low it's hard to see the bottom and it covers most of the sky, it is a *stratus*.

5. Hold your hand up toward the cloud and look at the size of the puffs compared to your hand:

If the puffs are about the size of your fingernail (very small), your cloud is a *cirrocumulus*.

If the puffs are about the size of your thumb (medium), your cloud is an *altocumulus.*

If the puffs are about the size of your fist (large), your cloud is a *cumulus*.

**(Cloud Key adapted from Dr. Tina Cartwright's "Cloud Identification Guide: A Dichotomous Key," Marshall University. http://wvscience.org/clouds/Cloud_Key.pdf)*

Cloud Guide

Altostratus: These large gray clouds tend be featureless and cover the whole sky allowing little sunlight through, but the sun is still weakly visible through them. They indicate a storm in the very near future.

Altocumulus: These small clumpy patches of clouds, or cloudlets, can blanket the entire sky and if you see them in the morning, they can be indicative of an afternoon thunderstorm.

Cirrocumulus: Sometimes neatly aligned, these clouds of white streaks and small puffs, or cloudlets, sometimes look like scaly fish skin (referred to as "mackerel skies") and generally indicate fair weather for now, but can be indicative of a coming storm.

Cirrostratus: These sheet-like clouds that cover the sky are fairly thin and transparent allowing the sun or moon to be seen through them (look for the halo they produce). They indicated moist weather later in the day or the next.

Cloud Guide, continued

Cirrus: Describing their wispy appearance, the name cirrus means "curling lock of hair". These clouds generally indicate fair weather now, but warn that a storm is likely headed your way in the next day or two. By watching their movement and know which direction the wind is blowing, you can get a sense of which direction the stormy weather will be coming from.

Cumulonimbus: Known as "the king of clouds," these thunderclouds tend to be tall and sometimes anvil-shaped and are almost always associated with a thunderstorm. The anvil tends to point in the direction the storm is moving. These are the only type of cloud that can produce hail, thunder, and lightning, which you can expect along with rain and strong wind.

Cumulus: With a name that means "heaping" and "humble," these clouds typically indicate nice weather with sun and warm temperatures. However, a cold front could lead to a thunderstorm, so keep your eye out if these clouds grow taller.

Nimbostratus: This type of cloud is like a large, flat, gray sheet, thick enough to block out the sun, and will most likely come with rain or snow that may last for several hours.

Stratocumulus: These low-lying large bumpy clouds with a well-defined base have some darker parts than others and tend to come in rows, waves, and patches. Often mistaken for rain clouds, these do not tend to bring precipitation, but can be present in both dry and wetter conditions.

Stratus: The lowest-lying of clouds (that at their lowest level form as mist or fog) cover the sky and block most of the sunlight. These clouds tend to contain water, but will bring little (drizzle or light snow) or no precipitation.

Handout 3.1b

Local Historical Climate Data (Quincy, CA)

1. Graph the data given below in Table 1. Plot the data point for each decade on the year that decade ends (eg. for the decade 1895-1904, the 10-year average of 65.3°F should be plotted on the graph above the year 1904)

Table 1. Abbreviated dataset with 10-year averages for the average temperature in July in Quincy, CA.

Scatterplot Points:

Decade	Average Temperature (F) in July
1895-**1904**	**65.3**
1905-**1914**	**65.0**
1915-**1924**	**66.4**
1925-**1934**	**66.8**
1935-**1944**	**65.7**
1945-**1954**	**65.8**
1955-**1964**	**66.4**
1965-**1974**	**67.8**
1975-**1984**	**66.4**
1985-**1994**	**68.5**
1995-**2004**	**69.0**
2005-**2014**	**70.2**

2. Connect neighboring data points to each other with a straight line between two points to turn the scatterplot into a line graph.

3. Plot the trend line points given in Table 2 on your graph, making sure you don't confuse these points with the points you graphed in step 1.

Table 2. Data calculated from the trend line equation (y = 0.0384x - 8.2017) derived from the scatterplot created in step 1.

Trend line Points:

Year	Average Temperature Trend
1900	**64.8**
1920	**65.5**
1940	**66.3**
1960	**67.1**
1980	**67.8**
2000	**68.6**
2050	**70.5**
2080	**71.7**

4. Use a straightedge to connect these points with a line using a color or pattern different from that used in steps 1 and 2. This is the trend line or "line of best fit."

5. After graphing, discuss the following:

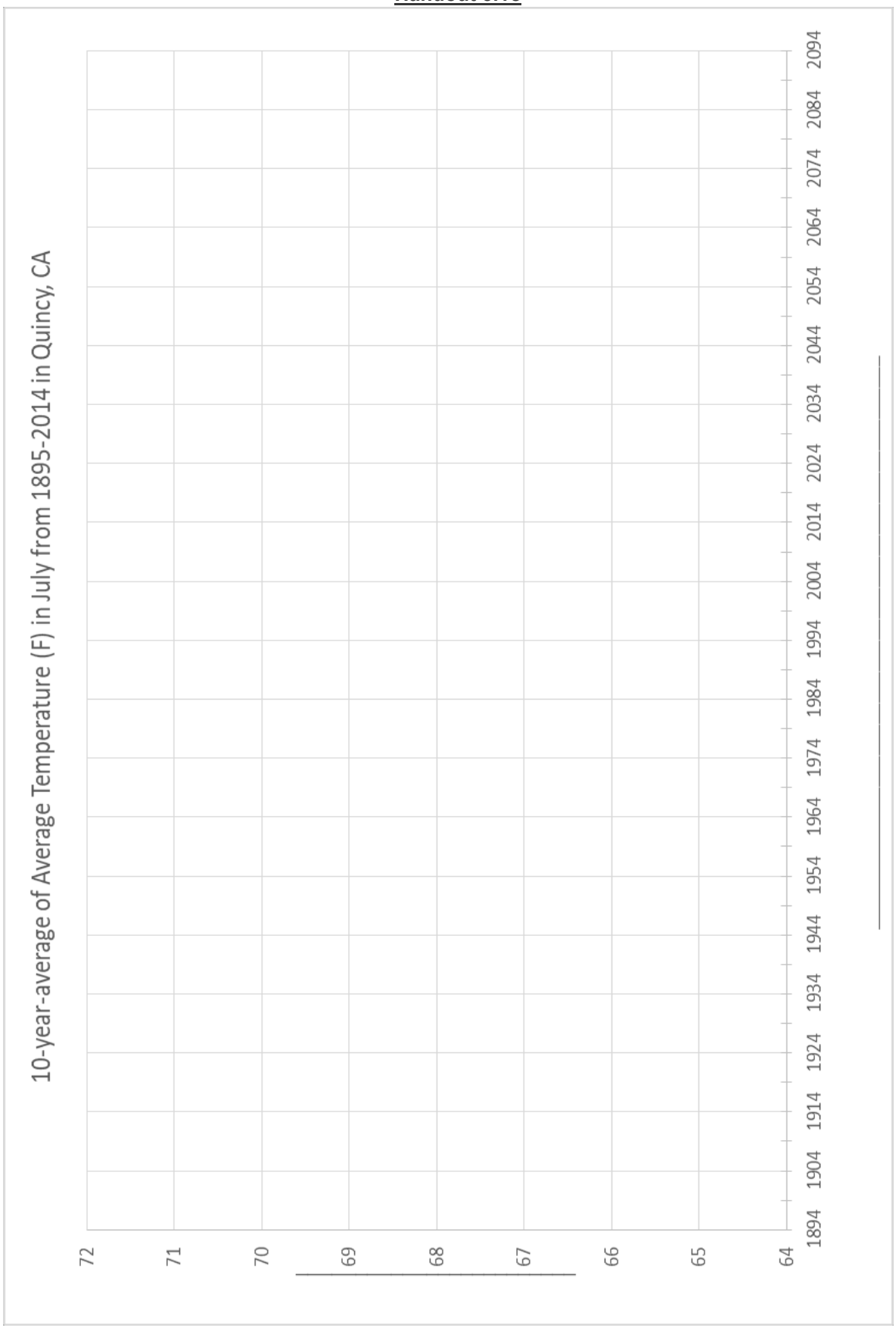
a) Which element of your graph represents *weather*?

b) Which element of your graph represents *climate*?

c) What does the data show overall about our region's climate in terms of temperature in July?

d) Extrapolate from the trend line to estimate what the predicted average temperature will be at the end of the century (2100). What does this mean for us?

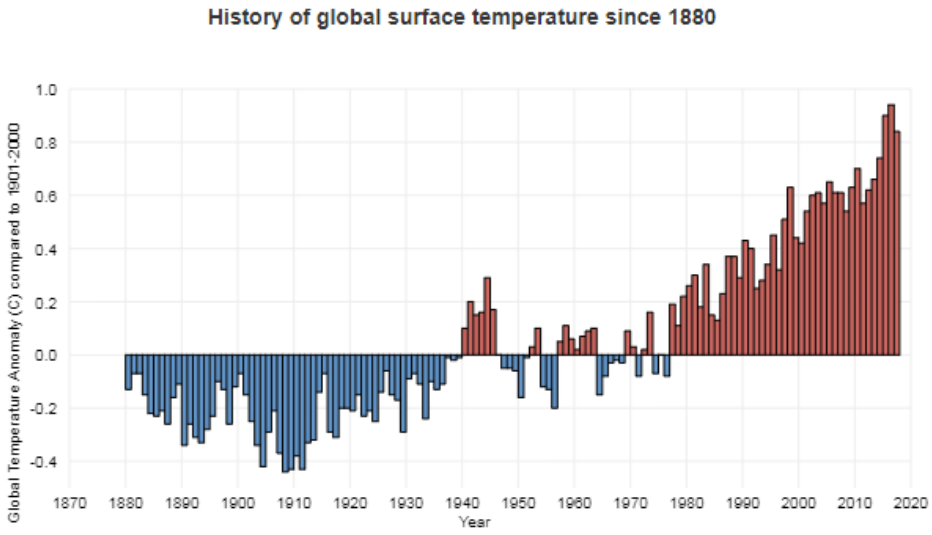
Handout 3.1c


10-year-average of Average Temperature (F) in July from 1895-2014 in Quincy, CA
72
71
70
69
68
67
66
65
64
1894
1904
1914
1924
1934
1944
1954
1964
1974
1984
1994
2004
2014
2024
2034
2044
2054
2064
2074
2084
2094

Teacher's Supplement 3.1a

GLOBAL CLIMATE

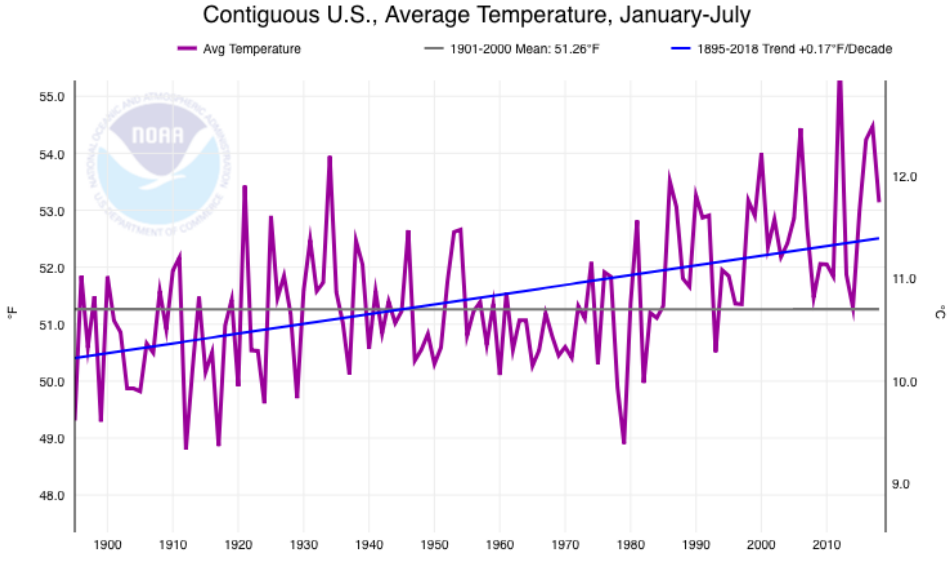
The chart below shows how annual average temperatures have changed worldwide since 1880, using data from land and sea surface measurements.



The graph shows average annual global temperatures since 1880 compared to the long-term average (1901-2000). The zero line represents the long-term average temperature for the whole planet; blue and red bars show the difference above or below average for each year.
https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
Data Source: NOAA, 2018

REGIONAL CLIMATE

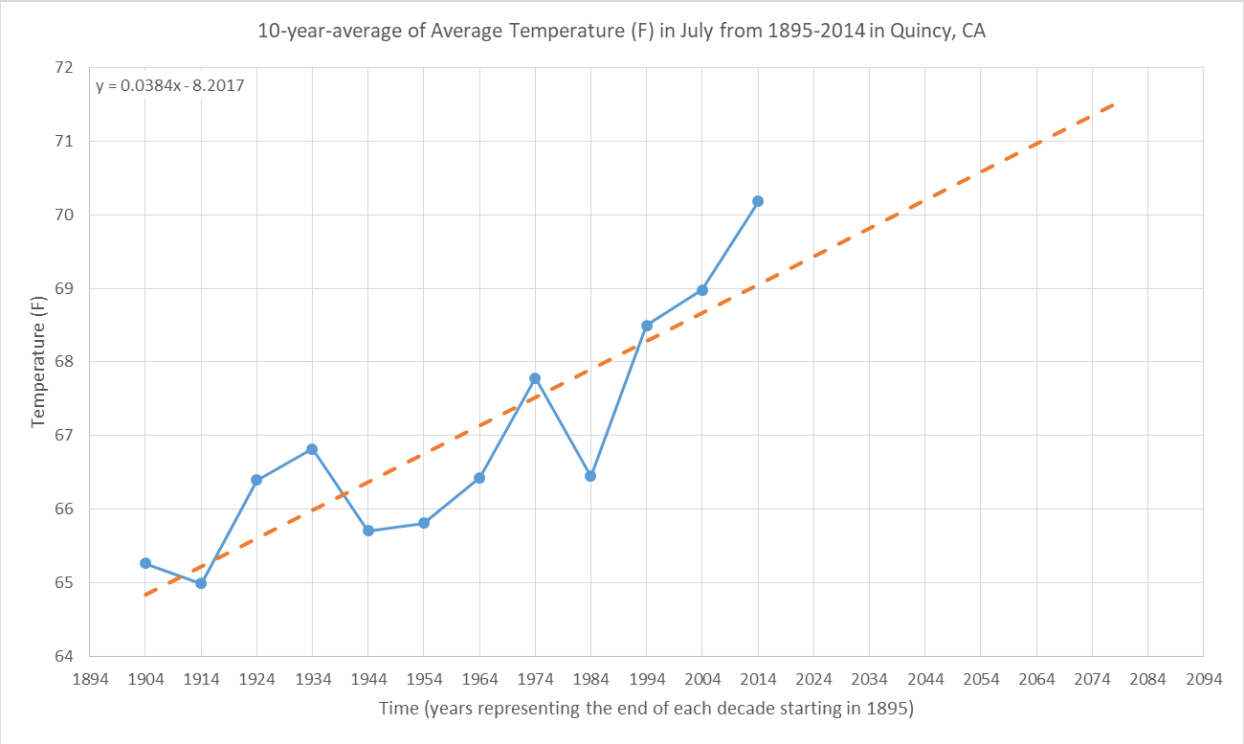
The graph below shows the upward trend in average temperature recorded in the United States (contiguous) for a 6-month period from the year 1895 to 2018.



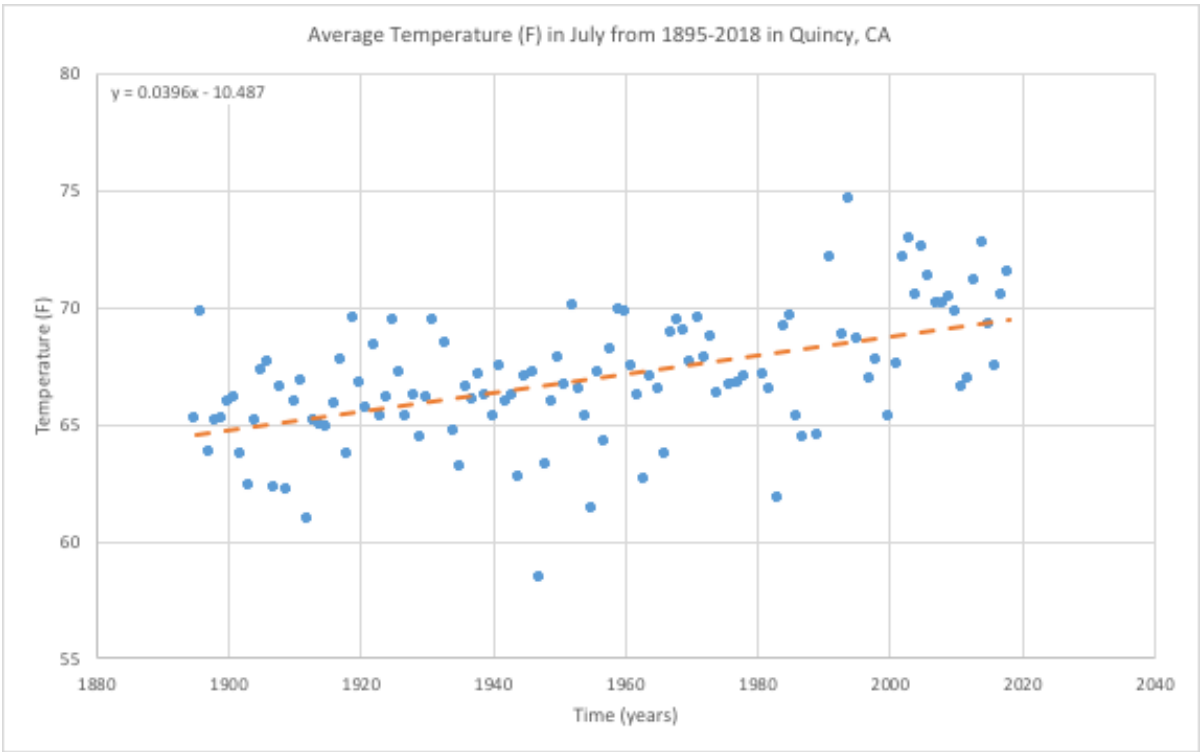
Graph from National Oceanic and Atmospheric Association. Obtained Aug. 14, 2018.
https://www.ncdc.noaa.gov/cag/national/time-series/110/tavg/7/7/1895-2018?base_prd=true&begbaseyear=1901&endbaseyear=2000&trend=true&trend_base=10&begtrendyear=1895&endtrendyear=2018

Teacher's Supplement 3.1b

Student line graphs with the abbreviated dataset (10-year averages) and trendline, extending to a 2080 forecast, should resemble the following:



For reference, the full dataset of average July temperatures from 1895-2018 is provided below:



Plumas Audubon Society

UNIT 3: KNOWLEDGE & RESPONSIBILITY
Climate Change Basics

Lesson 3.2

Performance Expectations:
- Follow instructions to perform a scientific experiment.
- Accurately record observed data from experiment.

Specific Learning Outcomes:
- Understand and demonstrate the greenhouse gas effect.
- Consider the cause and effect relationship between an increase in greenhouse gases in the atmosphere relative to the average temperature of the earth.
- Define greenhouse gas effect.
- Practice the scientific method: formulate a hypothesis, perform an experiment with a control, record data, and make conclusions using data as evidence.

NGSS:
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *90 minutes*

The Greenhouse Effect: A CO_2 Experiment

Brief Lesson Description:

Students will demonstrate the heat-trapping abilities of carbon dioxide using bottles and seltzer tablets that release carbon dioxide. Students will compare the temperature of the bottle and compare to a control. The experiment may be done as a class with the whole class coming up with a hypothesis and performing the experiment; or, depending on the level of the class, the experiment could be done in small groups. A conclusion write-up may be assigned as homework and evaluated by the teacher.

Narrative/Background Information:

The Earth is like a greenhouse. A greenhouse allows the sun's light to enter through the glass, and that energy remains trapped as heat inside the enclosure. The light and trapped heat inside allow people to grow plants in a warmer temperature than outside of the greenhouse.

How is the Earth like a greenhouse? Light from the sun radiates through space and enters Earth's atmosphere. When that energy hits the Earth's surface, some of it is absorbed and some of it bounces back outwards towards space. If all of that energy bounced back out to space, Earth would be much, much colder than its average temperature of 59 degrees Fahrenheit. In fact, it would probably be a barren, frozen wasteland.

In 1827, French mathematician and physicist, Joseph Fourier, wondered how Earth's average temperature is approximately 59°F (15°C) instead of 0°F (−18°C). Fourier predicted there must be something happening in Earth's atmosphere that kept the Earth warmer than 0°F— a process similar to what happens in a greenhouse.

The process that keeps Earth warm is called the **greenhouse effect**. The sun's energy bounces off Earth's surface and moves outward back into space, but not all of it escapes: some heat is trapped by gases in Earth's atmosphere. These gases--water vapor, carbon dioxide, methane, and other trace gases--are called **greenhouse gases**. Greenhouse gases reemit the trapped heat. Some of that heat leaves the atmosphere and some returns to Earth's surface. This natural process, known as the greenhouse effect, warms Earth to an average global temperature of 59°F (15°C), allowing life to flourish.

What happens when more greenhouse gases are added in to the atmosphere? How does this affect Earth's average global temperature?

Some scientists foresaw climate change and global warming as humans started burning fossil fuels in the Industrial Revolution. In the 1860s, physicist John

Materials:

- Two (2) empty 2-liter bottles (glass or plastic)
- Two (2) small candy thermometers
- At least 16 seltzer tablets
- Water
- Two (2) lumps of clay (to be used as bottle seals)
- Plastic wrap
- Light source (direct sun or halogen or other high-wattage lamp, 100W or more)

Prior Student Knowledge:

- Students will likely know what a greenhouse is.
- Ensure students understand that carbon dioxide naturally exists in Earth's atmosphere.

Possible Preconceptions/ Misconceptions:

- Ensure students understand that the greenhouse gas effect is a naturally occurring phenomenon and that without it, Earth and all the living things that inhabit it would not exist as we know it. Humans, however, are *enhancing/exacerbating* the greenhouse effect by adding more greenhouse gases to the atmosphere, primarily as carbon emissions from burning fossil fuels. Humans did not cause the greenhouse effect, but we are causing the global average temperature to increase by adding more greenhouse gases than is natural to the atmosphere.
- Some students may

Tyndall observed the Earth's natural greenhouse effect and predicted that changes in the atmosphere could influence and alter the climate. In 1896, Swedish scientist Svante Arrhenius surmised that changes in concentrations of carbon dioxide in the atmosphere would affect the natural greenhouse effect and significantly increase Earth's surface temperature.

In fact, ice core samples taken from Greenland, Antarctica, and mountain glaciers in the tropics show historical shifts in Earth's climate with changes in greenhouse gas levels. According to these ice samples and other paleological evidence such as tree rings, sedimentary rock, and ancient coral reefs, the Earth is warming at a rate ten times faster than the temperature rise after the ice age!

Since the Industrial Revolution of the late 19th century, Earth's average surface temperature has risen at least 1.8°F (1°C) due to carbon emissions in the atmosphere from human activity. Moreover, the most drastic warming occurred in the last 35 years.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Start this activity with a discussion of what a greenhouse is and how it works. If your school has a greenhouse, consider going in to the greenhouse to hold this discussion. Your students likely know that a greenhouse is a type of structure usually with transparent walls and roofing that is typically used to grow plants, but ask them *how* that type of building helps grow plants. Through questioning, guide your students to the understanding that a greenhouse lets sunlight in (which plants need to grow) and traps much of the heat energy that entered as sunlight (thereby keeping plants at an optimal temperature for growing).

Now tell your students that Earth's atmosphere is like a greenhouse. Ask your students what that means? Your students should be able to answer that, like a greenhouse, the atmosphere lets sunlight in and traps heat. This phenomenon is called the "greenhouse effect".

There is not a giant glass structure surrounding the earth, so what is it about the atmosphere that allows it to act like a greenhouse? The answer is that the atmosphere contains heat-trapping gases, also known as "greenhouse gases," that keep a lot of Earth's heat from escaping back out into the atmosphere. Can a gas really trap heat? Let's find out!

EXPLORE: Lesson Description-- Probing or Clarifying Questions

CO_2 EXPERIMENT

In these experiments, students will construct two models: one modeling the natural greenhouse effect (the "**control**" model), and another modeling an amplified greenhouse effect (the "experimental" or "treatment" model) to answer the following questions:

erroneously equate the hole in the ozone layer with the greenhouse effect. These are two different phenomena and should not be confused.

Educator Tip:

- To convert temperature between degrees Celsius and Farenheit use: T(°F)=T(°C) x 9/5 – 32
- Every degree change in Fahrenheit is 1.8 (or 9/5) times the degree change in Celsius.

1. Does carbon dioxide, a greenhouse gas, really trap heat?
2. Does the concentration of carbon dioxide affect the air temperature in a closed environment?

Summarize the experimental methods below, explaining that when seltzer tablets dissolve in water they release CO_2. After summarizing the methods, work as a class or in pairs to come up with two **hypotheses** that address each of the two questions above. All students should write their hypotheses down on their worksheets (Handout 3.2). See necessary materials in the side bar.

EXPERIMENT #1

Perform the first experiment following the *Methods* below:

1. Fill each bottle with 100 mL of water.
2. Label one bottle "Control" and the other "CO_2 added" (The bottle labeled as CO_2 is the experimental or "treatment" bottle and will have Alka-Seltzer tablets added to the water in step 5. When seltzer tablets dissolve in water they release CO_2).
3. Cover the openings of the bottles with lump of clay to create an airtight seal. Insert a thermometer into each bottle through the seal. Make sure the thermometer is hanging in the air above the water.
4. Tear two sheets of plastic wrap and set aside.
5. Carefully removing the seal with the thermometer on the CO_2 bottle, drop 4 Alka-Seltzer tablets into the water bottle and quickly reseal, ensuring once again that the thermometer is suspended in the air inside the bottle.
6. Immediately cover the top of each bottle (including the thermometer inserted in the clay) loosely with the plastic wrap. Use a rubber band to secure the plastic wrap around the top of the bottle.
7. Immediately record the temperature in each bottle to eliminate the possible misconception that the seltzer tablets themselves add heat somehow (0:00A minutes in table below).
8. Next, place the bottles directly under or beside your light source (either direct sun or a high-wattage lamp) ensuring that the light is shining evenly, directly, and the same distance from both bottles. Ensure that no other heat source or sink is nearby or closer to one bottle than the other.
9. Record an initial temperature reading for each (0:00B minutes in table below). Start a stopwatch or monitor a wall clock recording temperatures of both bottles every two (2) minutes for 10-20 minutes (see table below). You can stop the experiment when you notice the temperature is no longer increasing, but do not stop before the 10 minute mark.

Results

Record the air temperature (˚C) in each bottle at 2-minute intervals for 10-20 minutes. Students should write their observations in the tables provided in Handout 3.2.

EXPERIMENT #2

Clean the bottles out and perform the experiment again following similar methodology as above, but with the following changes:

- In step 2, label one bottle "CO_2 added" and the other "Double CO_2".
- In step 5, as before, add 4 Alka-Seltzer tablets to the "CO_2 added" bottle *and* add 8 Alka-Seltzer tablets to the "Double CO_2" bottle. If limited by seltzer tablets, you can use other amounts, but retain the proportion ratio of 1:2.

Record your data in a second table, titled appropriately to distinguish it from the first results table.

EXPLAIN: Concepts explained and vocabulary defined

COMPARE and ANALYZE DATA

Have students graph the recorded data and connect data points to make a line graphs, using two different colors for the different bottles' data plotted within the same graph. The two separate experiments should be plotted on separate graphs and title appropriately.

Review the data and have students answer the following:

1. What happened to the temperature in the control bottle in experiment #1?
2. What happened to the temperature in the experimental "CO_2 added" bottle in experiment #1?
3. Was there a difference in what happened to the temperature between the control and experimental bottles in experiment #1? If so, describe.
4. Was there a difference in what happened to the temperature between the "CO_2 added" and the "Double CO_2 added" bottles in experiment #2? If so, describe.
5. Do the data support your hypotheses? Explain why or why not using the data as evidence.

VOCABULARY

- greenhouse effect - the natural phenomenon in which gases in Earth's atmosphere trap solar energy from the sun and reemit it back to Earth's surface, keeping the earth warm.
- greenhouse gases - atmospheric gases that absorb solar radiation and reflect them back to Earth's surface, effectively keeping the earth warm. These gases include carbon dioxide, water vapor, methane, chlorofluorocarbons, ozone, and nitrous oxide.
- hypothesis - a proposed explanation or prediction based on what you already know
- control - a sample that remains the same during an experiment; a standard for comparison in an experiment

ELABORATE: Applications and extensions

If all went well, your class should have discovered through these experiments that CO_2 does indeed trap heat and that greater concentrations of CO_2 trap more heat. If your results did not turn out this way, use this as opportunity to think critically about what may have caused your results to turn out differently (eg. consider whether your experiment set the bottles up at the same distance from and angle to the light, or whether another heat source or heat sink was nearby, etc).

GREENHOUSE EFFECT

Remind your class that these experiments modeled the "greenhouse effect". Explain that carbon dioxide is a greenhouse gas that is both naturally occurring in the atmosphere and added to the atmosphere by humans, primarily by burning fossil fuels.

Compare and contrast the model you created in this experiment to Earth's greenhouse effect. What happens to the temperature on Earth when more carbon dioxide is added into the atmosphere?

As a class visit NASA's Global Climate Change: Vital Signs of the Planet, Carbon Dioxide Facts page online (https://climate.nasa.gov/vital-signs/carbon-dioxide/) and answer the following referring to the two graphs on that page:

- What is the current level of CO_2 in the atmosphere (latest measurement)?
- In the past 400 thousand years, when were the levels of CO_2 equal to what they are today?
- In the past 400 thousand years, approximately what was the highest level of CO_2 in the atmosphere?
    - Compare that level to today's level.
    - What do you think that means for Earth's temperature when comparing today's temperatures to any time in the past 400 thousand years?

Educator Tip:
To help put the large and difficult to grasp time period of 400,000 years into perspective, consider that anatomically modern humans (ie. Homo sapiens) emerged in the fossil record about 200,000 years ago and evolved during a time when Earth's climate has been relatively very stable—until most recently.

EVALUATE: Reflect

If materials and time are available, first review pages 20-21 in *The Magic School Bus and the Climate Challenge* and discuss the various ways that humans release more carbon dioxide into the atmosphere.

JOURNAL or DISCUSSION

Ask the class to consider the following:

- What do you think about the fact that humans continue to this day to put more and more CO_2 into the atmosphere?
- In what ways do you think humans could *reduce* how much carbon dioxide we put into the atmosphere?
- How do you think we could *stop* putting carbon dioxide into the atmosphere?

- Can you imagine ways we could *remove* carbon dioxide from the atmosphere?

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Teacher observation of student participation in activities and discussions.

Summative Assessment (Quiz/project/report):

- Assess the students' worksheet or lab report; including their hypotheses; recording of data; tables and graphs, including proper formatting; and written answers.

Handout 3.2

Does the concentration of carbon dioxide affect the air temperature in a closed environment?

Hypothesis

After reviewing the experimental methods with your class, write a hypothesis in the space provided for each experiment. Your hypotheses should address the following questions:

1. Does carbon dioxide, a greenhouse gas, really trap heat?
2. Does the concentration of carbon dioxide affect the air temperature in a closed environment?

Experiment #1 hypothesis:

Experiment #2 hypothesis:

Results

Record the air temperature (˚C or ˚F, but be consistent and fill in the table below) in each bottle at 2-minute intervals for 10 to 20 minutes in the table below. Title your tables.

Experiment #1:

Time (minutes)	Temp. (˚__) of control bottle	Temp. (˚__) of CO_2 bottle
0:00A		
0:00B		
2:00		
4:00		
6:00		
8:00		
10:00		
12:00		
14:00		
16:00		
18:00		
20:00		

Experiment #2:

Time (minutes)	Temp. (˚__) of control bottle	Temp. (˚__) of CO_2 bottle
0:00A		
0:00B		
2:00		
4:00		
6:00		
8:00		
10:00		
12:00		
14:00		
16:00		
18:00		
20:00		

Graph Your Data

Construct a line graph for each experiment in the space provided that summarizes your results. Include a title and a legend for each graph and label the axes.

Discuss Your Results

1. What happened to the temperature in the control bottle in experiment #1?

2. What happened to the temperature in the experimental "CO_2 added" bottle in experiment #1?

3. Was there a difference in what happened to the temperature between the control and experimental bottles in experiment #1? If so, describe.

4. Was there a difference in what happened to the temperature between the "CO_2 added" and the "Double CO_2 added" bottles in experiment #2? If so, describe.

5. Do the data support your hypotheses? Explain why or why not using the data as evidence.

"*The world as we have created it is a process of our thinking.*
It cannot be changed without changing our thinking."
— Albert Einstein[4]

Unit 4: RESPONSIBILITY

Effects of Climate Change: Our Earth, Our Actions

- Lesson 4.1: The Migration Game: Shifting Phenology
- Lesson 4.2: Connect the Dots: Global and Local Impacts
- Lesson 4.3: Unless Someone Like You Cares a Whole Awful Lot

[4] Einstein was a theoretical physicist, philosopher, and Nobel Prize in Physics laureate. He developed the theory of relativity and other groundbreaking theories that influence the philosophy of science.

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Plumas Audubon Society

UNIT 4: RESPONSIBILITY
Effects of Climate Change: Our Earth, Our Actions

Lesson 4.1

Performance Expectations:

- Participate in game to model and understand migration and the challenges to migratory birds presented by human impacts, particularly climate change

Specific Learning Outcomes:

- Identify, discuss, and contemplate the challenges of migration
- Understand how climate change causes phenological shifts
- Understand how shifting phenologies due to climate change affect migratory birds in particular

NGSS:

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

Materials:

- Poker chips or small colored items to represent resources

The Migration Game: Shifting Phenology

Brief Lesson Description:

This kinesthetic game teaches students about the benefits and challenges of migration as well as the exacerbated challenges that migratory species face with climate disruption.

Narrative/Background Information:

Migration is one of the most integral and fascinating parts of bird behavior. For many, the return of migratory bird species is an exciting indication of changing seasons. Generally, birds migrate south towards warmer climate and available food resources in the winter and north toward suitable nesting habitat and the burst of abundant food resources in the spring. Along their migration between winter feeding grounds and summer breeding grounds, birds tend to follow predictable routes, including resting and refueling at **stopover sites**. Such routes are generally referred to as "**flyways**" which usually occur along coastlines, major rivers, and mountain ranges. There are four major migratory flyways over the United States: 1) the Pacific Flyway along the Pacific coast and west of the Rocky Mountains; 2) the Central Flyway over the Great Plains and east of the Rocky Mountains; 3) the Mississippi Flyway along the Mississippi River; and 4) the Atlantic Flyway along the Atlantic coast.

The amount, health, and state of the resources found in habitats all along the migration route--including the winter, summer, and stopover site habitats-- are critical for the survival of birds and entire populations. Such resources are always in a state of flux; however, human-driven climate change is altering many resources at a pace too fast and to an extent such that many species cannot efficiently respond or adapt to it. As a result, although some species will be able to adapt their life cycles quickly enough to new conditions, others will have to move to different areas in order to survive and thrive, while still others will risk extinction.

Many birds rely on environmental cues such as daylength and temperature to know when and where to migrate, when to find a mate, and when to breed. Climate disruption is altering the usual patterns of many birds. Because biological phenomena like when a bird migrates or breeds are related to seasonality, a changing climate may affect how and when these biological phenomena occur. We are already seeing earlier migrations, earlier egg-laying, and entire ranges shift and shrink. The behavioral changes just mentioned are examples of phenological shifts.

Phenology comes from the Greek word "phaino" meaning to show or appear. It is the study of recurring patterns of seasonal, rhythmic plant and animal life cycle stages such as migration, flowering maturity, insect hatches, or leafing as

Prior Student Knowledge:

- Students will most likely know what migration is, but phenology will likely be a new concept.

Possible Preconceptions/ Misconceptions:

- Ask students how they think birds know when to migrate. This will allow you to gauge what they know and open the discussion about phenology.

well as how such events relate to climatic conditions and changes in climate. For example, you have most likely observed geese flying south as winter approaches, and you know spring is on the way when you see the geese return, flying north at winter's end. Phenological events have been keenly observed by humans long before we had a word for it and have informed human behavior for thousands of generations. Nowadays we still collect and monitor phenological data to help us make predictions about plants, wildlife, weather patterns, and other natural occurrences.

Phenological events (leafing, budding, hatching, migration, etc.) are triggered by environmental cues such as daylength or temperature. Different phenological events do not all respond to the same environmental cues in the same ways or at the same time. Alterations in environmental cues due to changing climate, therefore, can throw the choreography of various phenological events that have co-evolved over a very long time out of whack and disrupt whole ecosystem functions. For example, if a change in temperature cues trigger a field of flowers to bloom before insects hatch or come out of dormancy, pollination of that field of flowers will not happen and that, in turn, can have ripple effects throughout the ecosystem.

Migratory species face an especially difficult challenge in the face of climatic and phenological disruptions. A migrating animal cannot predict environmental changes in its destination location based on the conditions of its current environment in an entirely different location. For example, a bird taking its environmental cues in southern Mexico to migrate north to devour the abundance of hatching insects cannot predict, from that site in the south, a phenological shift of delayed insect hatching in the northern stopover and breeding sites. This bird now risks starvation.

Migration is risky business. Migratory species face many challenges along their way including competition, predation, habitat loss, human development (tall buildings, wind turbines, light pollution), and bad weather. Climate change is making it even riskier.

Check it out:
For more information about migration, check out the following articles from the Cornell Lab of Ornithology:
https://www.allaboutbirds.org/the-basics-how-why-and-where-of-bird-migration/

https://www.allaboutbirds.org/the-basics-migration-navigation/

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Use the background information to guide a discussion with your students asking the following questions:

- What is migration?
- Why do many birds migrate?
- In general, where do migratory birds go in the fall? Why?
- In general, where do migratory birds go in the spring? Why?
- Some birds migrate in one long trip without stopping, but many need to stop at "stopover sites". Why?

Now, head to a large open space (eg. an indoor gym or outdoor field) to play the Migration Game.

EXPLORE: Lesson Description-- Probing or Clarifying Questions

THE MIGRATION GAME

Students will play a game modeling different effects of changing phenology. The students will be birds trying to navigate a migration route and pick up enough resources along the way to survive. You will need a large space (indoors or outdoors) where students can run around.

For this activity you will need items of at least three different colors to represent different resources to be collected. Poker chips (blue, red, and white) work well for this activity. Start with enough to have approximately one of each color per student. The three colors represent food (red), water (blue), shelter/cover (white)--three of the primary resources that migratory birds need to find during their journey.

GOAL

Survive the journey of migration by collecting at least one of each resource (food, water, and shelter) while traveling from one end of the field to the other.

Round 1: The Competition Round

SET UP

Distribute the colored resources at stopover sites placed at different intervals along the field. Spread resources out a bit so that students are not all rushing to one location. You can mix the colors/resources or have only one resource per stopover.

To help encourage the understanding of why birds migrate at all, you can place the resources strategically in each migration direction to model the availability of resources and space and explain this placement to the class. For example, to model fall migration, north to south: scatter resources/position stopover sites across the entire field, with few in the north across a wide swath and most in the south in a narrow swath. To model spring migration, south to north: scatter resources/position stopover sites across the field again, but this time with a fair amount in a narrow swath in the south and a whole bunch in a wide swath in the north.

PLAY

Students will line up at one end of the field and, when directed, "migrate" across the field, stopping at "stopover sites" to gather resources along the way, and make it to the other side with enough resources in hand to have "survived". They need at least one of each color (resource) by the end of the journey in order to to have survived.

Students may only fly in a forward direction (sideways movement is allowed as long as it is not also backwards). That is, once a stopover site has been passed, they may not turn around and go back to a site to retrieve a needed resource.

Start the migration race by offering the students an environmental cue to trigger migration (eg. the days are getting shorter and the temperature is

Did you know…

Hummingbirds are the only birds that can fly backward. Some other species are known to be able to flutter backward a bit, but the hummingbird is the only kind that can truly fly backward for a length of time.

Educator tip:
Depending on time allotted, you may want to play more than one trip per round to allow students to first get familiar with the game and then assimilate the lesson behind each round.

You may also wish to play this game multiple times throughout the semester to review the concepts.

Educator tip:
There is no rule about taking more than one of any given resource. Some students may take more than their share leaving others with none. This is an example of competition and can be used as a teaching moment for that concept.

Additionally, you can use this as an opportunity to review the concept of mutualism (introduced in Lesson 2.2) and encourage cooperation. How many more students survive when they attempt cooperation?

getting cooler, time to migrate south). Students should then "take off".

Each time the students run from one end of the field to the other it represents one migration "trip" (eg. north to south or vice versa). After each trip, collect the chips and redistribute them at the stopover sites. You can now start a new migration trip back the other way.

REST and DISCUSS
After one or two simple migration trips, stop to rest and discuss. Did every student get enough resources to survive the migration? Why or why not? Was there competition for resources? Were there other challenges experienced?

Round 2: The Challenges Round

SET UP
Set up the game as before, before you begin pose the following question to students:
What other challenges besides competition do birds face during migration?

Birds face a variety of challenges during migration. There are a few ways we can model that in this game. Select one student to play each of the following roles and discuss these roles out loud to the entire class:

- Habitat loss: Habitat loss is one of the primary drivers of biodiversity loss and poses a great challenge to birds. Select one student to play the role of "habitat loss". This student may move throughout the field and remove stopover points (and their resources).
- Predation: Select one student to be a roaming "predator". Anyone this student tags is out for that trip, meaning they did not survive migration.
- Development: Select one or two students to play the role of a "building" or "city". Have this student pick a spot in the field; this student must stay stationary (like a building or a city) but may tag other students if they come within reach. Tagged students are out.
- Bad weather: Select one student to play the role of "bad weather". This student may move around and tag individuals out.

Have the students playing these challenge roles set up as they choose within the playing field and migrating students line up again along one side of the field.

PLAY
Play the game as before, reminding students that if tagged by another student in the role of predator, development, or bad weather, that student is out and did not survive that migration trip. Those students tagged out can participate again in the next migration trip.

REST and DISCUSS
Discuss the outcome of Round 2. How many students survived migration this time? How did it compare with the previous round? What made this round harder?

Educator tip:
Students role-playing the migratory challenges can either remain the same or swap out with others, but keep the challenges in the game.

Round 3- The Climate Disruption Round

Climate change has been causing some birds to begin migrating earlier in the season, when resources along their migration path and at their destination may not yet be available. In this round we will be modeling what happens when environmental cues shift due to climate change altering the phenologies of birds and of the organisms they depend on for survival.

SET UP

Set up the game similarly as before, keeping the challenges from the last round in place and adding one more:

- Climate change: Climate change poses the greatest threat to birds. Select one student to play the role of "climate change". This student may move resources around and scramble up the distribution of resources across the entire field of play. For example, "climate change" may cause "drought" in one area by removing all the water resources and "flooding" in another area.

Additionally, the instructor will shift phenology in this round. This time set out only *half* of the resources before you start the game. Wait until *after* the game has begun and the students are migrating to distribute the remaining resources at various stopover sites including ones that students have already passed and cannot return to. This action represents a phenological event such as an "insect hatch" and the timing of it represents a shift in the timing of such an event.

PLAY

Play the game as before, again reminding students that if tagged by another student in the role of predator, development, or bad weather, that student is out and did not survive that migration trip.

REST and DISCUSS

Discuss the outcome of Round 3. How many students survived migration this time? How did it compare with the previous two rounds? What made this round harder than the previous two?
Did students notice that more resources were made available *after* migration had already started? Why did that happen?

<u>WRAP-UP DISCUSSION</u>

- How many students survived migration in Round 1? How many in Round 2? Round 3?
- Was each round harder than the previous one? Why?
- How were the effects of climate change modeled in Round 3?
- Why might early or late migration affect a bird's survival?
- What effects do humans have on migratory birds? [*Habitat loss, development, and climate change are all human-caused challenges presented in this game.*]
- How does climate change make migration harder than it already is?

EXPLAIN: Concepts explained and vocabulary defined

Help students understand the concept of shifting phenologies and what happened in the last round of the game. Climate change is altering the phenologies of birds and the organisms they depend on for survival. Warmer climates have triggered earlier migration when resources along their migration path and at their destination may not yet be available (presence of seeds, hatching of insects, availability of water, etc). Birds cannot predict these phenological changes or the availability of resources in a distant area before they begin migrating. Since they rely on environmental cues around them to know when to migrate, climatic changes and resulting phenological shifts across the globe are potentially devastating to migratory species.

VOCABULARY

- **migration -** a seasonal movement of animals from one area to another in response to changes in temperature, food supply, daylight, or other environmental factors.
- **stopover sites -** important habitats where migratory species stop to rest and refuel along their migration route.
- **flyway -** a predictable, general route or flight pathway followed in bird migration
- **phenology -** the study of recurring seasonal, rhythmic patterns in plant and animal life cycles such as migration, flowering, insect hatches, leafing, etc., and how these patterns are connected to climatic conditions and therefore tied to changes in climate.

ELABORATE: Applications and extensions

BIRDCAST

Explore migration maps online at the Cornell Lab of Ornithology's BirdCast (http://birdcast.info/). The Migration Forecast Maps are updated every day, showing where and how much bird migration you can expect across the U.S. over the next three days. The Live Migration Maps (http://birdcast.info/live-migration-maps/) are updated every ten minutes every night, showing near-live migration maps animated from sunset to noon. Watch the animation cycle through a few times and ask students to notice when migration really ramps up each night (*hint: watch what follows the sunset which is depicted as a red line in the map*).

EVALUATE: Reflect

JOURNAL or CREATIVE WRITING

A BIRD'S EYE VIEW

Have your students write a story of migration from the perspective of a bird. Have them each choose a particular migratory species for which they will then research its migration pattern (eg. when it migrates, where it tends to winter and summer, whether it flies in long or short stretches) and habitat type to inform their story. Include in the story some mention of how climate change is affecting their habitats, migration, or other.

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Teacher's observation of student participation in activity and discussion

Summative Assessment (Quiz/project/report):

- Check how students understand migration, the difficulties migratory birds face when they migrate, and their understanding of the human impacts on migration, particularly in light of climate change and its effect on phenology, via discussion participation and by reading and evaluating the journal reflection after playing the game.

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Plumas Audubon Society

UNIT 4: RESPONSIBILITY
Effects of Climate Change: Our Earth, Our Actions

Lesson 4.2

Performance Expectations:

- Read and/or listen to a text, use critical thinking and logic skills to identify the cause and effect relationships of climate change.
- Reference the text to diagram cause-and-effect relationships of climate change (with guidance from teacher, worksheet, and book)

Specific Learning Outcomes:

- Use logic to understand cause-effect/action-consequence relationships
- Understand that one action or cause may have more than one consequence or effect
- Think critically about the causes and effects of climate change.
- Identify local and global impacts of climate change.
- Think about how our actions can make a difference.

NGSS:

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

Connect the Dots: Global and Local Impacts

Brief Lesson Description:

In this activity, students will explore the anthropogenic (human) causes of climate change and its many interconnected effects on global and local communities, ecosystems, and Earth's natural processes. Read and/or listen to the book *The Magic School Bus and the Climate Challenge* and complete the worksheet diagramming the cause-and-effect relationships of climate change.

Narrative/Background Information:

Climate change is happening and we are already experiencing its impacts on global and local levels in many ways. Many things that we value and depend on to survive and thrive are affected by climate change including water, food, energy, wildlife, ecosystems, the economy, human health, and the places we live.

GLOBAL IMPACTS

The global impacts of climate change are numerous, diverse, complex, and often devastating. Higher global temperatures are melting snowpack, glaciers, and the polar ice caps. The melting of glaciers and the ice caps as well as the expansion of warmer ocean waters is causing global sea levels to rise. Rising sea levels will alter coastlines all over the world, destroying communities and homes and forcing people and animals to find new places to live. Human migration has many political, social, economic, and moral implications. Climate change is increasing the frequency and severity of extreme weather events, such as drought, flooding, heat waves, downpours and superstorms which present dangerous, even life-threatening situations for humans and put human health at risk, along with increased pollution and the spread of insect-borne diseases. More rainfall and less snowfall result in faster runoff and less water stored in reservoirs or replenishing groundwater, reducing the availability of water to plants and trees, wildlife, and humans. With limited water, global agricultural crop yields are reduced, pushing food prices upward which causes food insecurity.

Ecosystems and habitats are changing, disrupted, and destroyed, forcing plants and animals to adapt to new conditions, change their ranges, or face extinction. Tree mortality is increasing due to insect infestations, stress from drought, and wildfires. The sea temperature is rising, causing coral bleaching (death of coral reefs) and destruction of underwater life, also affecting industries including fisheries and tourism.

LOCAL IMPACTS

How do you see climate change affecting you and the things around you? You will have noticed your community and communities around you in California

Materials:

- *The Magic School Bus and The Climate Challenge* book and/or audiobook
- Internet and a means to play video with audio
- Handout 4.2: Climate change cause and effect "Connect the Dots" diagram worksheet

Possible Preconceptions/ Misconceptions:

Basic cause-and-effect relationships are generally quite simple: an action or event leads to a consequence, which in turn, can lead to another. It terms of climate change, the effects are varied, vast, and complex, many times triggering a chain or loop of cause-and-effect reactions. While some of these chain reactions and loops are too complex for this grade level and scope of this lesson, it is important to emphasize the fact that the effects of climate change are wide-reaching, complex, and not even fully predictable or understood yet. It is important to acknowledge these impacts so that we can address their causes and learn how to adapt to them.

Educator tip:

Watch and/or listen to *The Magic School Bus and the Climate Challenge* on Youtube: https://www.youtube.com/watch?v=l5jW4EEzQaA

and other western states are on high alert for wildfires. Rising average temperatures along with decreased snowpack and faster snowmelt have extended fire season and create dry conditions for the start and spread of wildfire. You may have also noticed milder winters with less snowfall and more rain. Not only has your ski and snowshoeing season gotten shorter, but the amount of water flowing downstream is happening too fast and too early, threatening flooding and limiting water resources later in the year for all plants, wildlife, and people in California that are dependent on the gradual melt of the snowpack in the mountains. Have you or people you know been affected by flooding recently? Climate change is causing more intense rain events, filling our rivers and streams faster than we are used to or prepared for, causing damage to homes and infrastructure like roads and electrical systems. Severe rain events as well as tree mortality from drought and higher temperatures contribute to increased erosion resulting in mud and rock slides which can be hazardous.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Discuss as a class some general and simple **cause-and-effect** relationships (some examples are provided below). Ask the class to generate some of their own and write these on the board.

CAUSE	EFFECT
Bobby felt cold.	Bobby put on a sweater.
It rained.	There were puddles in the road.
It snowed on Saturday.	We went sledding on Sunday.
The squirrel gathered many nuts in the fall.	The squirrel had a lot of food for the winter.
Too many fish were caught in the lake.	Fewer Osprey were seen at the lake.

EXPLORE: Lesson Description-- Materials needed/Probing or Clarifying Questions

First, read, listen to, or watch *The Magic School Bus and The Climate Challenge* by Joanna Cole and Bruce Degen.

CONNECT THE DOTS

After reading the book, pass out copies of Handout 4.2 Connect the Dots and refer back to the text (especially pages 10-13 and 20-22) to help complete the cause-and-effect diagram. Instruct students to:

1. Fill in the blanks.
2. Draw lines connecting the dots between phenomena on the worksheet.
3. Add a directional arrow to each connection line to reflect the cause and

effect relationship between phenomena. The arrow should be pointing *from* cause --> *to* effect.

Suggest to students that they will likely find more connections than a simple, linear cause-and-effect chain; they may find even loops (feedback loops). Use the directional arrows to indicate these relationships.

Did you know…
A feedback loop occurs when the effect(s) of something feed back into the cause. A positive feedback loop will amplify the system (self-reinforcing); a negative feedback loop will inhibit the system (self-balancing).

Educator Tip:
Teacher's Supplement 4.2 provides an answer key to the "Connect the Dots" diagram worksheet.

EXPLAIN: Concepts explained and vocabulary defined

Share and discuss the diagrams. Go over the diagram and the correct fill-in-the-blank answers as well as correct direction that each connection arrow should be pointing. Instruct students to make any corrections necessary, allowing for students to explain why they had the arrow pointing in the other direction--this offers an opportunity to correct a misunderstanding or to consider a valid argument.

- Ask students to explain why one cause would lead to several effects.
- Discuss how some effects may feed back into the system creating cause-and-effect loops (or feedback loops). What is the significance of these feedback loops? *[Once started, positive feedback loops, such as in the diagram, keep going and growing.]*

VOCABULARY

- **cause-and-effect** - a relationship between actions or events in which one is the result (effect) of the other (cause)

ELABORATE: Applications and extensions

Have students study their completed diagram again at first working on their own to identify which of the causes and effects of climate change on the diagram we have experienced locally. Then, as a class, discuss and agree on the connections, having students put a star or other symbol next to those impacts identified as something experienced locally.

Now, as a class, try to add in two additional impacts to the diagram: "**reduced snowpack**" and "**earlier spring runoff**", including appropriate connection lines with directional arrows to other phenomena in the diagram. This offers an excellent opportunity for critical thinking and may require questioning of first assumptions. Are these part of a simple cause-and-effect chain or part of a loop?

Did you know…
Reduced snowpack and earlier spring runoff are some of the major climate impacts we feel locally that affect water availability for all life in our watershed and downstream. These two impacts are especially concerning for the flood-prone winter and spring and the dry, hot, summer months.

EVALUATE: Reflect

JOURNAL

- Think about the global impacts of climate change. Do you think any life on the planet is or will be untouched by climate change? Explain.
- What local impacts of climate change are we experiencing here in Plumas County? How have such impacts affected our communities, in general? How have such impacts affected your day-to-day life, in particular?
- How are people in your community trying to adapt to these impacts?

Did you know…
Wangari Maathai was the founder of the Green Belt Movement and the 2004 Nobel Peace Prize Laureate. She was the first woman in East and Central Africa to earn a doctorate degree and she was an activist for democracy, human rights, and environmental conservation.

The Greenbelt Movement is an environmental organization in Kenya that empowers communities, particularly women, to conserve the environment and improve livelihoods.

Dirt! The Movie is a documentary featuring well-known environmentalists, exploring the relationship between humans and soil. http://www.dirtthemovie.org/

EXTEND FURTHER: Enrichment

EMPOWERMENT

The sheer number and potential severity of the effects of climate change can feel incredibly overwhelming. To counter this feeling and to help foster a sense of empowerment in your students have the class watch some inspiring stories:

- Listen (and watch) to Nobel Peace Prize Winner Wangari Maathai's telling of "I will be a hummingbird," in an excerpt from *Dirt! The Movie*: http://www.greenbeltmovement.org/get-involved/be-a-hummingbird (2 min)
- Watch a few success stories from *Young Voices for the Planet* film series of youth taking very doable actions to make big, positive changes for a healthy planet: https://www.youngvoicesfortheplanet.com/youth-climate-videos/ (Most of these videos are between 4 and 7 min long.)

After watching some of the videos, discuss ideas for how individuals and groups can help address the causes and effects of climate change. This can as simple as eating a plant-based diet, riding a bike, carpooling, or simply buying less to reduce greenhouse gas emissions or as large as getting involved in local and national government to create legislation to help mitigate, adapt to, and solve the climate crisis. What will *you* and *your* class do?

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

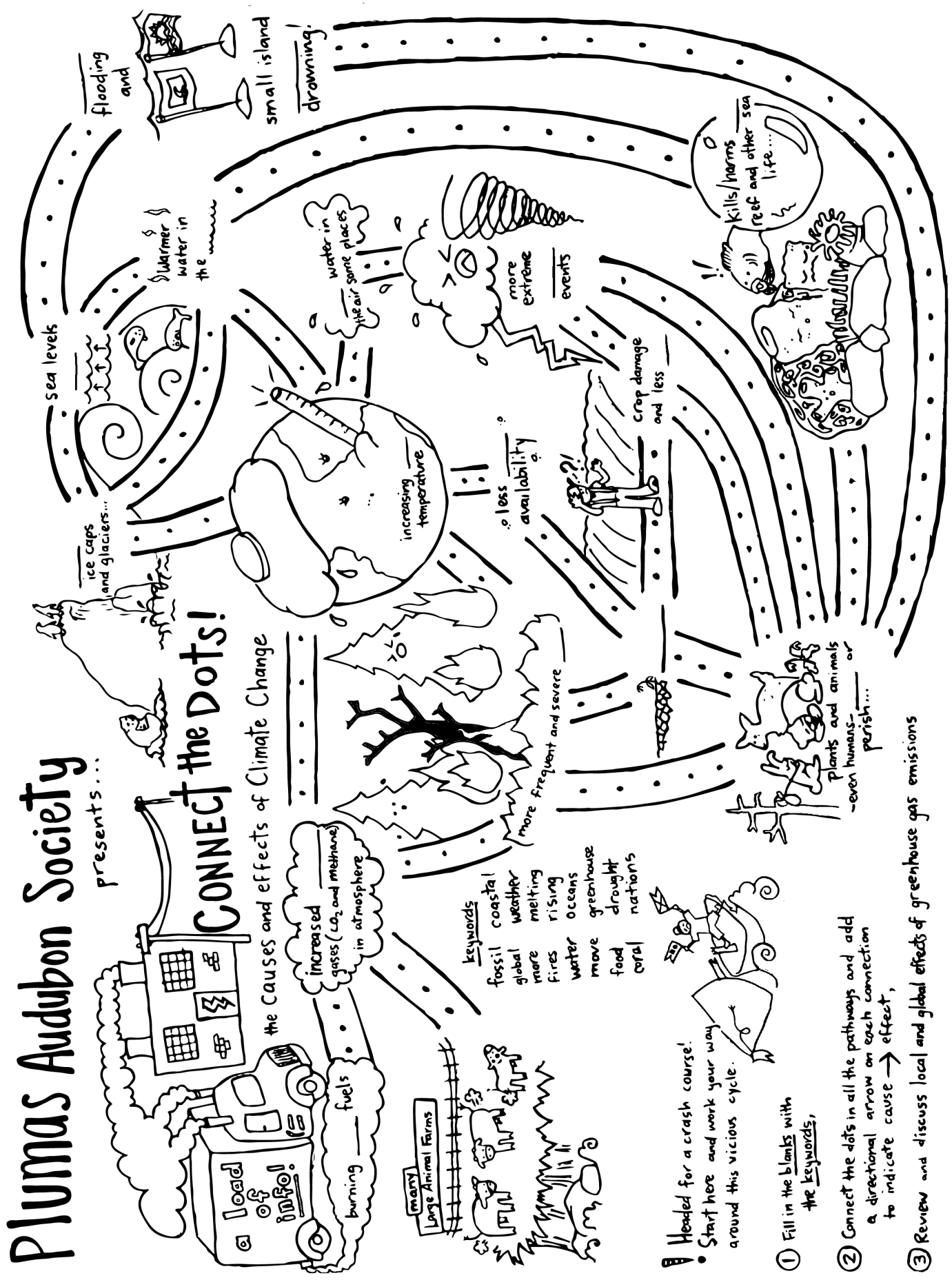
- Teacher's observation of student participation in activity and discussion

Summative Assessment (Quiz/project/report):

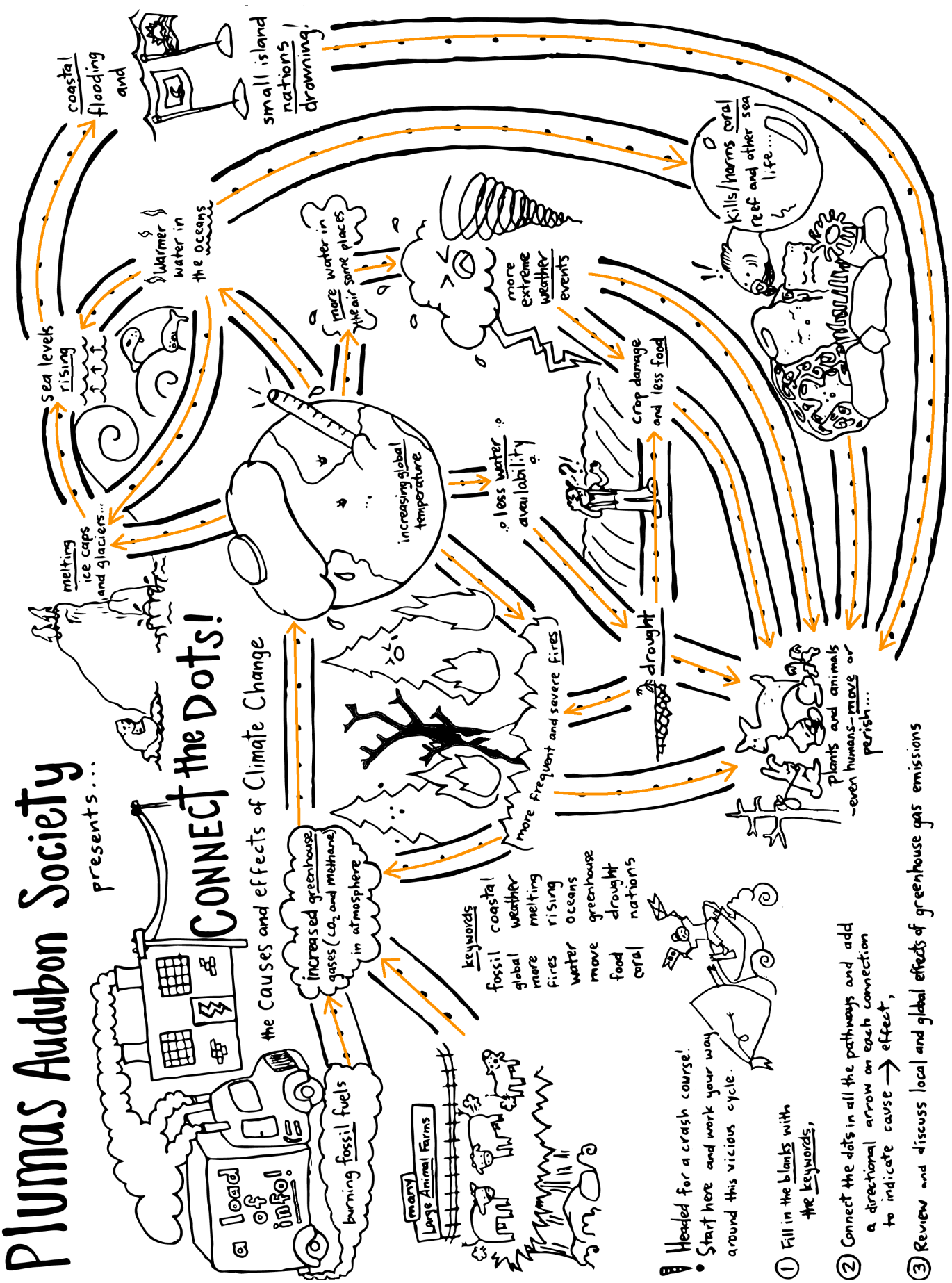
- Assess students' understanding of the complex cause and effect relationships related to climate change by evaluating their worksheets and reading and evaluating their journal reflections post activity.

Cole, Joana and Bruce Degen. *The Magic School Bus and the Climate Challenge*. New York: Scholastic Press, 2010.

Handout 4.2


Plumas Audubon Society
presents...
CONNECT the Dots!
the Causes and effects of Climate Change
load of info!
burning ___ fuels
increased gasses (CO_2 and Methane) in atmosphere
many Large Animal Farms
keywords
fossil
global
more
fires
water
move
food
coral
coastal
weather
melting
rising
oceans
greenhouse
drought
nations
more frequent and severe ___
ice caps and glaciers...
sea levels
flooding and
small island
drowning!
warmer water in the ____
water in the air some places
increasing temperature
more extreme events
loss availability
crop damage and less ___
Kills/harms reef and other sea life...
Plants and animals -even humans- ___ or perish...
Headed for a crash course!
• Start here and work your way around this vicious cycle.
① Fill in the blanks with the keywords,
② Connect the dots in all the pathways and add a directional arrow on each connection to indicate cause → effect,
③ Review and discuss local and global effects of greenhouse gas emissions

Teacher's Supplement 4.2



Plumas Audubon Society

UNIT 4: RESPONSIBILITY
Effects of Climate Change: Our Earth, Our Actions

Lesson 4.3

Performance Expectations:

- Read and/or listen to a text, use critical thinking and logic skills to identify the cause and effect relationships of climate change.

Specific Learning Outcomes:

- Understand and reflect on the way our everyday lives affect the environment.
- Draw conclusions and make predictions about the future based on our actions in the present.
- Learn about the concept of sustainability and how the lesson of *The Lorax* can apply to real-world resources management.

NGSS:

3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Time: *60 minutes*

Materials:

- *The Lorax* by Dr. Seuss

and/or

- Internet and a means to play Youtube video with audio

Unless Someone Like You Cares a Whole Awful Lot

Brief Lesson Description:

Students will read, listen to, and/or watch Dr. Seuss's *The Lorax* and reflect upon the content and real-world lessons with journal reflections questions.

Narrative/Background Information:

The Lorax is a cautionary tale that teaches about the importance of responsible and **sustainable** land use and stewardship, demonstrates the interconnectedness of all things in the environment and the cause-and-effect relationships within it, and warns of the hazards of greedy business practices and unsustainable growth models to the environment and society.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Before reading or listening to the story, discuss as a class the difference between needs and wants. A need is something you must have to survive, like food, water, and shelter. A want is something that is nice to have, but that you can survive without.

Recall the question from *Lesson 2.1: Ecosystems and Habitats*: "What resources do all living things need to survive?"

- What do plants need to survive?
- What do animals need to survive?
- What do humans need to survive?
- Is there much of a difference?

Now think about the difference between needs and wants. Ask the class to define a "need" and and a "want." As a class or individually, brainstorm a list of needs and a separate list of wants. Examples of needs are food, water, shelter, and space. Examples of wants are a new computer, an ice cream sundae, cool light-up sneakers, etc. What about clothes and electricity? Are these wants or needs?

We all have needs and wants. Explain that wants are not inherently bad: while humans have bare-minimum needs in order to survive, most of us nowadays do not live solely off the land providing only for our basic survival needs--such a lifestyle nowadays would likely include significant challenges to functioning in modern American society. We seek to live comfortable, meaningful lives, and fulfilling some of our wants, material and non-material, help us achieve this. It is important, however, to moderate our wants and to reflect on how our wants and needs affect others and the world around us, including the environment and the plants and animals that live here too.

Prior Student Knowledge:

- This lesson builds upon concepts of cause-and-effect relationships in the environment and environmental reciprocity established in prior lessons in Units 2 and 4.

Possible Preconceptions/ Misconceptions:

- Students may have heard of, but may not understand the concept of sustainability.

Educator tip:

Watch and/or listen to *The Lorax* by Dr. Suess on Youtube: https://www.youtube.com/watch?v=8V06ZOQuo0k

EXPLORE: Lesson Description-- Probing or Clarifying Questions

LESSONS OF THE LORAX

Read, listen to, or watch *The Lorax* by Dr. Suess.

Consider some of the following questions to discuss and reflect with your class:

1. Compare and contrast the environment when the Once-ler "first came to this glorious place" and after he chopped down the last of the Truffula trees.
2. Why did the Once-ler chop down Truffula trees?
3. What is a "thneed"? What are some things that you think you need, but could probably do without?
4. Why didn't the Once-ler stop cutting Truffula trees even after the Lorax pointed out the damage it was doing? Was he considering the needs of the animals that lived there?
5. What could the Once-ler have done differently? Do you think it would have been possible for him to keep his Thneed business going without ruining the habitat of all those animals?
6. Do you think the Brown Bar-ba-loots, Swomee-swans, and Humming Fish were able to find another place to live? What if they were not?
7. Is there anything in real-life that reminds you of the Once-ler's Thneed business?
8. Is "more" or "bigger" always better? Provide some examples to support your opinion.
9. What happened to the Once-ler and his business when all the Truffula trees were gone? Based on the description of his current home and state of mind, do you think he is happy? Do you think he was "successful"? Do you think he feels regret?
10. What do you think the Lorax meant with the word that he left: "UNLESS"?
11. At the end, was the Once-ler hopeful for the future? Why or why not?
12. Can you relate to the child in the story? How so?
13. Overall, what message do you take away from *The Lorax*?

EXPLAIN: Concepts explained and vocabulary defined

Help students understand the meaning of "biodiversity", "natural resources", and "sustainability" by connecting these concepts to the story of *The Lorax*:

- *biodiversity*: Truffula trees, Brown Bar-ba-loots, Swomee-swans, Humming Fish, and the Lorax are all part of the original biodiversity make-up of the area, and even the Once-lers become part of this count once they arrive!

- *natural resources*: clean air, clean water, Truffula Fruit, and Truffula Tree tufts
- *sustainability*: The Once-ler's business model was not sustainable; he used up all the resources (Truffula Trees) until they were gone and then not only could his business not continue, but nothing could live in that place either. The Once-ler did not think about the well-being of the forest, the animals that lived there, or the future when he was cutting down the Truffula Trees to make Thneeds. He was only concerned with making as much money as possible, as fast as possible.
    - Did running his business in an *unsustainable* way have a good result for him? For his family? For the plants and animals around him?
    - Could the Once-ler have run a *sustainable* business? What could the Once-ler have done differently in order to build a successful business without wiping out the Truffula Trees and driving away all the animals that shared the Truffula Tree and a clean environment as resources?

Return to the discussion question: What did the Lorax mean by the word "UNLESS"? Nothing will get better, unless we care enough to change it; nothing will change, unless we do. So, what do we want to do?

VOCABULARY

- **biodiversity** - the variety of living beings on Earth or in a defined area
- **natural resources -** things that naturally occur in the environment such as minerals, plants, animals, fresh air, clean water, and fertile land which are used by all life for basic survival, and used additionally by humans for livelihoods, recreation, and economic gain.
- **sustainability -** Human activity that meets the needs of the present and can be maintained indefinitely in a responsible way that does not endanger the well-being of the environment or the ability of future generations to meet their needs.

ELABORATE: Applications and extensions

RESEARCH

1. Think of some real-life examples of Truffula trees, Brown Bar-ba-loots, Swomee-swans, and Humming Fish in your area. Choose one example and research it:
    a. If it is a resource (like Truffula tree), how is it being used? How is the resource, if at all, being managed?
    b. If it is an animal (like a Brown Bar-ba-loot, Swomee-swan, or a Humming Fish), how or why is it threatened or endangered?
2. What are some natural resources near you? Why are those natural resources important for your community? Are those natural resources also important for other communities even if they are further away from them? What can people do to help protect these natural

resources? What can you do to help protect the environment and the plants and animals that live near you or even far from you?

EVALUATE: Reflect

JOURNAL

The Lorax spoke for the trees "for the trees have no tongues". Who or what would you speak for? What would you say?

EXTEND FURTHER: Enrichment

THE LORAX, CONTINUED

Write a sequel to *The Lorax*. Start your story from the end of *The Lorax* imagining what happens next if the child in the story "cares a whole awful lot".

"UNLESS" BOARD

Create an "UNLESS" bulletin board collage in your classroom or school hallway with contributions from the whole class. What does your class "care a whole awful lot" about?

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Observation of student participation.
- Assess students' understanding of the moral of the story by listening to their discussion.

Summative Assessment (Quiz/project/report):

- Assess students' understanding by:
- Reviewing their answers to the research and journal questions in the Elaborate and Evaluate sections,
- Reading students' follow-up stories and reviewing the collage in the Extend Further section.

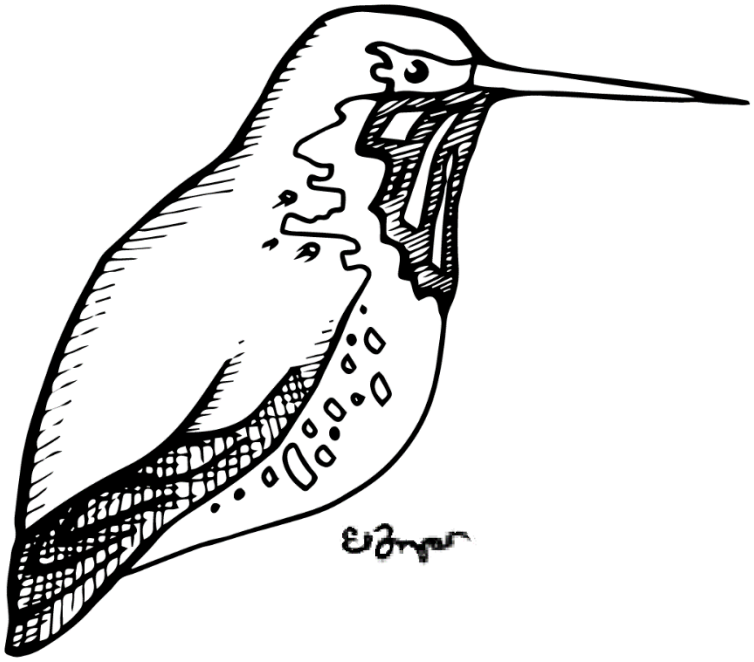
Seuss, Dr. *The Lorax*. New York: Random House, 1971.

"*There comes a time when humanity is called to shift to a new level of consciousness . . . that time is now.*"
— Wangari Maathai[5]

Unit 5: EMPOWERMENT & ACTION

Service Learning for Our Communities: Bird-Friendly and Climate-Wise Gardening

- Lesson 5.1: Survey Your Schoolyard and Choose Your Plants
- Lesson 5.2: Plant Propagation: Growing From Seed
- Lesson 5.3: Get Your Hands Dirty! Dig In and Keep It Up!



[5] Maathai was an author, Nobel Peace Prize laureate, environmental and political activist, and founder of the Green Belt Movement. She was the first woman in East and Central Africa to earn a doctorate degree, she has assisted women in planting more than 20 million trees for the purposes of poverty reduction and environmental conservation, and is internationally recognized for her persistent struggle for democracy, human rights and environmental conservation.

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Plumas Audubon Society

UNIT 5: EMPOWERMENT & ACTION
Service-Learning for Our Communities:
Bird-Friendly and Climate-Wise Gardening

Lesson 5.1

Performance Expectations:

- Perform a site assessment and record observations
- Brainstorm and collaborate on creating a bird-friendly and climate-wise garden

Specific Learning Outcomes:

- Define a native plant.
- Explain the importance of native plants to birds, in particular, and to the ecosystem, in general.
- Understand why planting native plants is a form of climate action.

NGSS:

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Time: *Varies.* Assessment can be done in one class period, research and planning could be another.

Materials:

- Trowel or small shovel
- Notebook and pencil
- Handout 5.1

Survey Your Schoolyard and Choose Your Plants

Brief Lesson Description:

Students will take climate action by growing native plants from seed to include in or initiate their school's "Bird-friendly and Climate-wise" garden, benefitting birds and other wildlife as well as the community.

Narrative/Background Information:

Plants are critical components of all habitats, providing food, shelter, and cover for wildlife in forests, prairies, lakes, oceans, and even extreme environments like the desert. Plants also keep our air and waterways clean and healthy by filtering pollutants, controlling erosion, and providing shade. **Native plants** are plants that occur and evolved naturally (i.e. without human introduction) in a specific area. Most native plants attract birds, butterflies and other pollinators, and benefit native insects that co-evolved with them, making native plants crucial to overall habitat and ecosystem health. Unfortunately, non-native plants are out-competing native plants resulting in a loss of biodiversity, reducing wildlife habitat and the overall health of ecosystems.

Climate threatened and endangered birds are expected to lose more than 50% of their current range by 2080 due to changes in climate alone. Habitat loss is another major threat to the survival of wildlife across the globe, and is exacerbated by climate change. Your class can help restore vital habitat for birds and help to reestablish ecological functions within our built environments by creating a "Bird-friendly and Climate-wise" garden or yard focused on planting native species.

Because of the water conservation, habitat, and biodiverse resources that native plants offer, creating a bird-friendly and climate-wise garden is a climate action that benefits birds and other wildlife, as well as our communities.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

Native plants are well adapted to local habitats and conditions. Most California natives are **drought tolerant**, meaning they are able to grow and thrive with minimal water or rainfall, because of the unique climate in which they evolved.

As discussed in *Lesson 3.1 Weather Vs. Climate*, climate describes the long-term weather patterns in a given area. Ask your students to describe California's climate. *[Generally, California has cold or cool and wet winters and warm or hot and dry summers.]*

Prior Student Knowledge:

- Habitat components (food, water, space, shelter, cover)

Did you know…

Native plants tend to use less water than non-natives and far less than green lawns.

Educator tips:

- Before starting this service-learning project on school grounds, consult with your school's groundskeeper or school gardener about available and appropriate locations for a native plant garden.
- Teacher's Supplement 5.1 provides a list of possible funding sources to help fun your garden project.

As our climate is shifting to warmer and drier winters and summers, water conservation has become critical in California.

- Ask your students which they think would be better at conserving water: a yard with mostly California native plants or a mowed lawn with mostly non-native grass? Why?
- Which do they think would provide a better habitat for birds and other wildlife? Why? (Remind them to consider the various components of a habitat: food, water, space, shelter, cover.)

EXPLORE: Lesson Description-- Probing or Clarifying Questions

GARDENING WITH NATIVE PLANTS

Native plants are generally easy to maintain if planted in an appropriate setting. The key to growing and gardening with native plants is to mimic, as best as possible, the conditions found in the plant's natural setting.

Therefore, the first consideration when starting or adding to a "Bird-friendly and Climate-wise" garden is choosing the right plants for your particular yard. Plants that naturally occur in your area (not all California natives are native to Plumas County) and in a similar type of setting (soil, sun, and topography) as you have available in your schoolyard will be easier to grow and will survive and thrive better than California natives that are not really native to your location or not well-suited to your yard's conditions.

SITE ASSESSMENT

Grab a small shovel or trowel and take your students outside to assess the conditions of the area(s) where you intend to plant. Consider soil, sun, and topography and have them note their observations in their journals.

SOIL

Dig in to the soil and have your students feel it. What is the best description for its texture? Note whether it is sandy (rough, coarse particles), silty (smooth, small particles), clay-like (sticky or very smooth, very fine particles), or loamy (combination of the previous types)? Soil type/texture will determine how well water is held in and drains from the soil. Some plants do better with well-drained, sandy soil whereas others prefer a nice loam.

SUN

How much sun or shade does the area get? Identify and note which spots (if at all) receive sun all day, part of the day, and which are shaded most of the day. Different plants have specific preferences about how much sun or shade they can tolerate.

TOPOGRAPHY

Is the planting area on a flat space? On a slope? In a pit? Moderately drought tolerant plants will like somewhat moist soils often found on north-facing slopes and lower slope sections whereas very drought tolerant plants will like dry soils often found on south-facing slopes. Why? Discuss with your students

the difference in sun exposure (and, therefore, evaporation) on a north- versus south-facing slope. **Riparian** plants (plants found alongside streams and rivers) prefer moist soils that stay moist most or all-year round.

EXPLAIN: Concepts explained and vocabulary defined

NATIVE VS. NON-NATIVE: WHY DO WE CARE?

As non-native and invasive plants replace native ones, there are fewer and a lower diversity of native plants available to provide the necessities for existing wildlife. While some animals have a varied diet and can feed on a wide number of plant species, many are highly specialized and can only feed on specific plant species. Using native plants in your project will benefit the local wildlife and habitat issues in your area.

VOCABULARY

- **native plants -** plants that grow naturally in a given area in which they evolved
- **non-native plants -** plants that have not historically grown in a given area and have been brought their by humans or animals.
- **invasive species -** species (plants or animals) that thrive in an area where they are not native, sometimes taking over and pushing out native species.
- **drought tolerant -** plants that are able to grow and thrive with minimal water or rainfall
- **riparian** - the area alongside streams and rivers
  water conservation - using less water

ELABORATE: Applications and extensions

PLANT SELECTION

As a class search your zip code on Audubon's Plants for Birds database to view a list of native plants that includes pictures, plant descriptions, and the types of birds each plant may attract. The list can be filtered by type of plant, plant resource, and type of bird attracted. As you go through the list ask your students for input on which kind of plants they like and which kinds of birds they want to attract.

Review the list of plants provided in Handout 5.1 or from a specific area search on Calscape and look at the photos and descriptions provided. Make a list of plants of interest and then compare your notes from the Site Assessment in this lesson to the "Natural Setting" conditions described on each plant's page in Calscape to determine which plants might be best suited to your schoolyard site.

DESIGN YOUR GARDEN

With the list of plants and associated natural settings, design your bird-friendly and climate-wise garden mapping out which plants you plan to put where. It is practical to group together plants with similar moisture requirements.

Check it out:

Audubon's Plants for Birds Database has a lot of useful information where you can create a customized plant list: https://www.audubon.org/native-plants
(Note: When entering this site, the email field is optional.)

Las Pilitas Nursery also provides a great list of California native plants, the birds they attract, and the part of the plant used by birds: https://www.laspilitas.com/bird.htm

Educator Tip:

Search your address, town, or click on the map on California Native Plant Society's Calscape website to find plants native to your specific area as well as specific planting conditions and descriptions for each species. https://calscape.org/

GETTING YOUR SEEDS or PLANTS

Once you have a list of plants that your class would like to grow, you'll need to obtain the seeds or plants. Local native seeds can be ordered from Sierra Seed Supply (https://www.sierraseedsupply.com/) based out of Greenville or from a variety of suppliers found online that sell California native seed. Native plants can be ordered from California Sister Nursery (http://featherriverhotsprings.com/nursery/) based out of Twain or from a variety of nurseries found online that sell California natives.

Refer to the list of Potential Funding Sources for Bird-friendly and Climate-wise Yards in the Supplemental Materials (Teacher's Supplement 5.1) and consider applying for a grant to fund your project.

EVALUATE: Reflect

JOURNAL

- Why should we garden with native plants?
- What is your favorite of the native plants you and your class looked at? Why?

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Observation of students' participation in activities and discussion

Summative Assessment (Quiz/project/report):

- Evaluate students' recorded observations of site assessment conditions.

Handout 5.1

Native Plants Starter List for Plumas County

Botanical Name	**Common Name**
Acer macrophyllum	Big Leaf Maple
Achillea millefolium	Common/White Yarrow
Aesculus californica	California Buckeye
Allium campanulatum	Sierra Onion
Amelanchier alnifolia	Western Serviceberry
Aquilegia formosa	Western/Crimson Columbine
Arctostaphylos canescens	Manzanita
Asclepias speciosa	Showy Milkweed
Balsamorhiza sagittata	Arrowleaf Balsamroot
Calochortus coeruleus	Blue Star Tulip
Calycanthus occidentalis	Spice Bush
Castilleja miniata	Giant Red Paintbrush
Cercis occidentalis	Western Redbud
Cercocarpus betuloides	Mountain Mahogany
Chrysothamnus nauseosus	Rubber/Gray Rabbitbrush
Cornus nuttallii	Mountain Dogwood
Cornus sericea	Creekside Dogwood
Delphinium nudicaule	Red Larkspur
Epilobium canum	California Fuchsia
Eriodictyon californicum	Mt. Balm, Yerba Santa
Frangula californica	California Coffeeberry
Fraxinus dipetala	California Ash
Helianthus bolanderi	Bolander's Sunflower
Lonicera ciliosa	Orange Honeysuckle
Lupinus albicaulis	Sickle-keeled Lupine
Lupinus grayi	Sierra Lupine
Mahonia aquifolium	Oregon Grape
Monardella odoratissima	Pennyroyal, Mtn Coyote Mint
Penstemon newberryii	Mountain Pride
Penstemon speciosus	Royal/Showy Penstemon
Philadelphus lewisii	Mock Orange
Ribes aureum	Golden Currant
Ribes cereum	Wax Currant
Ribes nevadense	Sierra Currant
Ribes roezlii	Sierra Gooseberry
Rosa californica	California Wild Rose
Sambucus nigra or mexicana	Blue Elderberry
Spiraea douglasii	Spirea
Wyethia mollis	Mules Ears
Xerophyllum tenax	Bear Grass

Teacher's Supplement 5.1

Possible Funding Sources for Your Bird-Friendly and Climate-Wise Garden

Cornell Lab of Ornithology BirdSleuth K-12 Garden Grants

$500-$2,000 grant, gardening supplies, and BirdSleuth's ***Habitat Connections*** kit. Funds can support a new garden or the revitalization of an existing one. In addition to funding food/veggie gardens, preference will be given to bird, pollinator, native habitat, rain, and other natural projects. Read more and find out how to apply at http://www.birdsleuth.org/garden-grants/

Captain Planet Foundation Grants

The mission of the Captain Planet Foundation is to promote and support high-quality educational programs that enable children and youth to understand and appreciate the world through active, hands-on projects designed to improve the environment in their schools and communities. The foundation intends its grants to serve as catalysts for getting environment-based education into schools and inspire youth and communities to participate in community service through environmental stewardship. Requests for funding less than $500 will be given preference and occasionally grants of up to $2,500 will be considered. Schools and organizations with operating budgets of less than $3 million are eligible to apply. Read more and apply at https://captainplanetfoundation.org/grants/

The Nature Conservancy Nature Works Everywhere Grants

$2,000 awarded to 50 schools for projects that implement green infrastructure to address environmental problems. Find out more and how to apply, as well as peruse many garden building resources at https://www.natureworkseverywhere.org/grants/

Kids Gardening Youth Garden Grants

Supports school and youth educational garden projects that enhance the quality of life for students and their communities with cash grants and/or gardening supplies. Learn more and apply at https://kidsgardening.org/2019-youth-garden-grant/

Wild Ones Seeds for Education Grants

$100-$500 grants awarded to naturally landscaped garden projects where youth participate in planning and planting using native plants and seeds. Learn more and and find out how to apply at https://wildones.org/seeds-for-education/

National Environmental Education Foundation Grants

Several funding opportunities of varying amounts. Find out more, check the current list of funding opportunities and apply at https://www.neefusa.org/grants

Project Learning Tree Greenworks Grants

Up to $1,000 in funding for environmental service-learning projects, including establishing a school garden. Applicants must complete a PLT training (in-person workshops or online training), project must have at least one community partner (Plumas Audubon Society!), and at least 50% matched funding (in-kind acceptable). Learn more and find out how to apply at https://www.plt.org/resources/greenworks-grants/

The Pollination Project Grants

Small starter grants of up to $5,000 to a wide variety of projects that spread good and compassion. Read about the wide range of projects they have funded since 2013 and how to apply at https://thepollinationproject.org/

Plumas Audubon Society

UNIT 5: EMPOWERMENT & ACTION
Service-Learning for Our Communities:
Bird-Friendly and Climate-Wise Gardening

Lesson 5.2

Performance Expectations:
- Follow instructions to germinate native seeds
- Sow seeds
- Keep detailed record of observations of germination process in journal, including drawings

Specific Learning Outcomes:
- Learn new gardening skills and plant biology
- Define germination and propagation

NGSS:
2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.
2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Time: *time will vary.* You will need to account for seed pretreatment, seed planting, and germination

Materials:
- seeds
- soil
- gardening tools: rake for outdoor sowing; trowel
- flats or pots for seed sowing indoors
- Notebook and pencil

Plant Propagation: Growing from Seed

Brief Lesson Description:
Now that students have identified native plants they would like to include in their garden they will have the opportunity to germinate and propagate native plants from seeds.

Narrative/Background Information:
Your native seeds may be dormant. Many native plant seeds have a dormancy mechanism that protects the seed from germination until the proper environmental conditions for growth occur. Before you sow indoors or outdoors, you may need to break this dormancy. Most native species will not require pretreatment, but some seeds may need to be pretreated in a way that mimics the conditions they would experience in nature to break them out of dormancy.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions
SEED PRETREATMENT: BREAKING DORMANCY
Common simple treatments to break dormancy include:
- Scarification: chipping or scuffing the seed coat mechanically
- Cold stratification: temperature and moisture treatment to mimic winter conditions
- Freezing and thawing
- Light exposure
- Hot water

Refer to the "Propagation" notes in the "Landscaping Information" section of each plant page on Calscape to determine what, if any, pretreatment your seeds may need.

Be sure to consider the recommended length of pretreatment when planning the timeframe for your service-learning project. You will need to account for pretreatment, seed planting and transplanting to the garden. For example, cold stratification, common to many natives, may last a few days to several months, depending on the plant species.

EXPLORE: Lesson Description-- Materials needed/Probing or Clarifying Questions
SEED SOWING: INDOORS or OUT?
Native seeds are ideally suited to germinate outdoors and some species will germinate better outdoors than in a greenhouse. For outdoor propagation,

Possible Preconceptions/ Misconceptions:

- Not all seeds germinate equally. Native seeds can require certain conditions to break them out of dormancy before germination can occur.

Did you know…

Birds plant trees! Some seeds in the wild require moving through the digestive system of a bird to successfully germinate. Birds also help seed dispersal by dropping seeds further from the mother plant.

Educator Tip:

Simplest cold stratification method: All native seeds that require cold stratification can simply be sown and placed outdoors in the fall or winter.

Educator Tips:

- There are many different container options and you can get creative with reusing various types of containers you can find for free, but be sure to thoroughly clean and make drainage holes in whichever type of container you choose.
- If using outdoor soil, pasteurization by heating the soil to 140°F for 30 minutes can help prevent seedling loss to soil-borne disease or pests.
- No fertilizer is needed; most California natives will not tolerate it.

seeds can simply be sown and placed outdoors in the fall or winter. Spring sowing can also be successful, but certain seeds may require artificial cold stratification using soaking and refrigeration to mimic winter conditions prior to planting.

You may be interested in sowing your seeds indoors so that your class can have a more "hands-on" approach and watch the development more closely. For indoor propagation, seeds can be sown in the spring. Be sure to check whether stratification or another pretreatment is necessary for the seeds.

You can also experiment with planting some seeds both indoors and outdoors to test which results in better germination and growing success.

Whether indoors, outdoors, or both, have your students maintain a journal with drawings of each stage of the plant's development.

<u>OUTDOOR PROPAGATION</u>

Native seeds can be propagated outdoors either directly on the ground or in flats, trays, or pots. Seeds can be sown in fall or early winter and will germinate when the outdoor conditions are optimum for each species.

DIRECT FIELD SOWING

If sowing directly on the ground, the soil should first be broken up, loosened, and leveled. Large seeds can then be lightly raked in, followed by light watering, and small seeds should be simply broadcast on top of moistened soil. It can be helpful to place labels in the ground with the sowing date to remind you which species were sown where. The area should be kept moist throughout the germination period.

FLATS and POTS

1. Native seeds can be sown in flats, trays, or pots at least 3" deep. Spread soil, soilless mix, or potting mix, spread evenly in containers (trays, flats, or pots at least and tamp to about ½" below rim.
2. Native seeds can be planted close together (⅛" to ¼" apart), but for more ease in later transplanting, space seeds at least ¼" apart in rows 1 or 2 inches apart and plan to pot-up or transplant seedlings while they are still small to avoid root entanglement between plants.
3. Take care not to plant seeds too deeply; while they could germinate deep in the soil, the shoot may die before reaching the light at the surface. Generally, plant medium to large seeds as deep as the seed is thick. Small seeds can be sown onto the soil surface and very lightly covered. Very fine seeds should be sown on the surface and gently patted down.
4. Water lightly with a spray bottle.
5. Label the plants and include sowing date.
6. Place the planted containers outside in a sheltered, shady spot until the plants germinate.

7. Keep the soil moist, lightly watering approximately every couple days to a week.

Note: Some seeds may not germinate the first year, but will the following year. If a flat of seeds fails to germinate, don't throw it out, be patient, and give it a second chance the following year.

EXPLAIN: Concepts explained and vocabulary defined

VOCABULARY

- dormancy - seeds will delay germination until conditions for growth are suitable. This delay is called dormancy; the seed remains dormant or "asleep" until the proper conditions are present for successful germination.
- scarification - seed dormancy is broken by scratching or cracking the seed's shell. Sometimes a seed's shell is so hard, it doesn't let in water and needs scarification to break its dormancy.
- stratification - breaking seed dormancy by simulating the chilling and warming it would experience naturally when the seasons transition from winter to spring.
- germinate - when a seeds grows and sprouts, putting out shoots
- propagate - to grow new plants from seeds, cuttings, or other plant parts. When a plant propagates from seed, this process is called germination.
- sow - to plant a seed

ELABORATE: Applications and extensions

INDOOR PROPAGATION

When propagating from seed indoors, you can have your students individually plant seeds and take individual responsibility for germination and seedling care, you can have a communal project with everyone working to care for all of the plants, or some combination of the two.

Educator Tip:
Communal planting and caretaking allows the class to share not only the responsibility, but also both the germination and seedling successes and failures.

SOWING and GERMINATION

1. Follow the same initial sowing instructions #1-4 and #6 as in the "Flats and Pots" part of Outdoor Propagation described earlier in the Explore section.
2. Next, cover the container with clear plastic; this will create a greenhouse effect, which will help keep the soil and seeds moist and will trap some heat. Support the plastic covering with a frame or sticks and tuck the edges into the top of the pot or tray so condensed moisture can run back into the soil. Alternatively, you can pull the plastic taut with a rubber band around the container. Do not allow the covering to rest directly on top of the soil as seedlings could get stuck to the cover when they emerge. A single sheet of newspaper on top can help prevent too much heat build-up. Keep the container out of direct sunlight until germination.
3. Moisture and warmth are important for successful seed germination.

Educator Tip:
This is a good opportunity to review or connect back to the lessons and concepts of the greenhouse effect and global warming (see Unit 3).

Check the soil daily to ensure that seeds are kept consistently moist until they germinate (generally one to four weeks for most species). If the soil is drying out, water gently and avoid overwatering; do not allow the soil to stay too dry or too wet.

4. Once the seeds germinate, remove the newspaper and allow the seedlings to acclimate by poking a few more holes in the plastic each day for about a week before removing the plastic entirely. Take care that the plastic does not touch the leaves of the seedlings. Do not leave covered plants in strong sunlight or damage will occur.
5. Once uncovered, place seedling containers near a window in direct sunlight where possible. When choosing an indoor location for growing your plants consider the amount of light your plants receive on the windowsill. The amount will depend on the direction the window faces (southern- and western- facing windows receive the best light), any shade from trees or other buildings, and the time of year.

MAINTENANCE DURING SPROUT GROWTH

Water plants only when they need it; again being careful to not over- or under-water. Check the soil moisture regularly by sticking your finger about an inch into the soil.

Plants should not be left unattended for more than a few days. During periods of active growth, plants use water rapidly.

EVALUATE: Reflect

JOURNAL and DISCUSSION

How successful was the class's germination rate (number of seeds that sprouted divided by number of seeds planted)? What factors may have affected this level of success?

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Observation of students' participation in activities and discussion

Summative Assessment (Quiz/project/report):

- Evaluate students' recorded observations (notes and drawings) of germination process.

Additional Resources:

- Poles. Tina M. *A Handful of Seeds: Seed Study and Seed Saving for Educators.* Occidental Arts and Ecology Center. Available at: https://oaec.org/wp-content/uploads/2014/10/A-Handful-of-Seeds.pdf

- Santa Barbara Botanical Garden. *Seed Propagation of Native California Plants*. Available at: https://calscape.org/seed_propagation.php

- Wild Seed Project. *How to Grow Natives from Seed.* Available at: https://wildseedproject.net/how-to-grow-natives-from-seed/

Plumas Audubon Society

UNIT 5: EMPOWERMENT & ACTION
Service-Learning for Our Communities:
Bird-Friendly and Climate-Wise Gardening

Lesson 5.3

Performance Expectations:
- Follow instructions for correct planting and garden care
- Create interpretive signs for their garden

Specific Learning Outcomes:
- Learn about plant biology
- Learn basic gardening skills
- Reflect on the impact of planting native plants on wildlife and the community

NGSS:
2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Time: *time will vary.* You will need to account for germination, hardening off, and transplanting to larger pots (if necessary) before planting in the ground. Garden installation outside should take a full day.

Materials:
- Seeds
- Soil
- Gardening tools: rake for outdoor sowing; trowel
- Flats or pots for seed sowing indoors
- Notebook and pencil

Get Your Hands Dirty! Dig In and Keep It Up!

Brief Lesson Description:
When the seedlings are large enough, students will transplant them into larger pots, and eventually, the ground. They will also create signage for their garden and consider care and maintenance to establish the plants' roots.

ENGAGE: Opening Activity-- Access prior learning/Stimulate interest/Generate questions

PREPARING THE PLANTS

POTTING UP

Young seedlings that are large enough (check plant size and whether roots are filling the soil mass in the container or growing out of the container) should be potted up to a larger container size or transplanted into the ground in your bird-friendly and climate-wise garden. Wait to transplant if the plant is tiny, slow to germinate, developing roots but not shoots, or hasn't yet developed its first true leaves.

In general, the larger the type of plant you are growing, the more potting up (sometimes multiple times) before planting in the ground is better for the plant. Annuals can be transplanted right into the ground; herbaceous perennials do well with potting up once and then transplanting to the ground once they have filled the larger container; and shrubs and trees do better when potted up a couple times before transplanting into the ground (trees may even do better with an extra growing season in a five-gallon container before moving to the ground).

HARDENING OFF

To help seedlings grown indoors to acclimate to outdoor conditions, it is helpful to "harden off" the plants by placing them outside in a partially sheltered spot for part of the day and bringing them back inside at night. Continue this hardening off process for about two weeks leaving the plants outside for progressively longer periods each day until transplanting occurs.

PREPARING THE GROUNDS

1. Remove unwanted existing plants or grass around the area you plan to plant.
    a. Weeding is important both before planting and during the growing season as other vegetation around your native plants will try to compete for water and nutrients in the soil.
2. If you are building raised beds, install them.
3. Prepare soil beds.
    a. Remove large rocks and separate hard clumps of dirt with a rake.

Possible Preconceptions/ Misconceptions:

- Not all seeds germinate equally. Native seeds can require certain conditions to break them out of dormancy before germination can occur.

Educator Tip:

Teacher's Supplement 5.3 has a list of additional gardening resources.

b. Your groundskeeper or school gardener should be able to advise whether or not your planting area will need soil amendments like compost, fish emulsion, or organic fertilizer (most native plants, however, do not require fertilizer). Consult with them to determine what is needed and how much.

EXPLORE: Lesson Description-- Probing or Clarifying Questions

DIGGING IN!

1. Stage plants according to your design.
    a. For older students, you may use colored flags or stakes to delineate areas where specific plants will go. With younger students, you may want to physically place plants in their temporary pots where plants will be put into the ground. You can use stakes and string to create guidelines.
    b. If you are planting an area that is open on all sides, start in the middle and work your way out. If you are planting up against a barrier like a wall or a fence, begin nearest the barrier and work your way outward.
    c. Before staging, water the plants one last time if possible.
    d. If you have multiple seedlings in trays, the trays can be cut during staging. Keep all plants in their plastic pots/trays until a hole is dug and the plant is ready to be put in the ground.
    e. Make sure each plant has a enough room for growth. Check the backs of seed packets, refer to your students' research, or check the labels that came with the plants from the nursery for guidance.
2. Transplant seedlings or purchased plants.
    a. Do a demonstration for students. Depending on age and experience level, you may want to do a classroom demonstration before the planting day, as well as a demonstration on site on the planting day.
    b. Dig a hole deep enough and wide enough so that the plant in its existing pot soil will fit evenly with the ground soil. Do not set plants so deep that you bury the stem or so shallow that the existing soil from the pot sticks out of the ground.
    c. Remove the plant from its temporary plastic pot by gently squeezing the sides of the pot to loosen dirt and roots. Gently pull at the base of the stem to free plant from pot.
    d. Sometimes the roots will be "root-bound" and growing in circles inside the temporary pot. In this case, gently break apart tangled up roots at the base (just a bit, do not overdo this!). This will give the roots air and room to grow.
    e. Place the plant in the hole and push soil around the plant to fill gaps and pat down to secure.

Educator Tip:
The Plumas County Fire Safe chipping program may be able to provide mulch for free. The program only operates for a few weeks twice per year (in late spring and late summer), and may not be able to provide chip delivery. Please contact PlumasFireSafe@plumascorporation.org for inquiries and coordination.

Did you know…
Drought tolerant plants evolved to rest during the hot summer months, therefore, too frequent of direct watering can kill the plant.

f. Students may need volunteer supervision or a double-check when they are finished to ensure planting was done correctly.

g. Water the plant into the ground with a watering can or lightly flowing hose. If soil sinks around it, add a bit more soil.

3. Add mulch if desired.
    a. Mulch will create a uniform look, prevent weeds from growing, hold moisture in the soil longer, and contribute nutrients to the soil as it breaks down.
    b. You can use dried leaves, wood chips, grass clippings, or hay as mulch.
4. The plants will need extra attention and care when they are newly transplanted. Make sure to check on them in the next few days and water as needed.

TIPS

- Create a work plan for the planting day. Divide the number of plants by number of students; one student should be able to plant up to 10 quart-sized plants in an hour. Determine how many adult volunteers will be needed to help students. More students may be around and willing to work than there is work to do, so come up with an activity for students to do while they are not planting. Students will be most interested in planting, however, so make sure you have divided the plants so that each students has an opportunity to plant.
- It's best to do your transplanting on a cloudy or cool day to reduce the stress on the young plants.
- Even though you may be planting native plants, no matter what, the garden will need to be cared for in the first year in order to allow the roots to establish.

MAINTENANCE

Native plants do not require as much water attention as non-natives, but care is still needed--especially in the first year in the ground as their roots establish. Water deeply but infrequently to encourage plant roots to spread far and wide, and help them find their own sources of water in the drier months.

EXPLAIN: Concepts explained and vocabulary defined

LABELS AND INTERPRETIVE GARDEN SIGNS

Making labels for your plants is important for educating students and visitors to the garden, as well as informative for student gardeners who will care for the plants in the future. Label-making is a fun, creative project that will beautify the garden and help create an inviting space. Signs should be easy to read, long-lasting, and weatherproof. Consider the following types of signs for your garden:

Educator Tip:
Las Pilitas Nursery provides a useful table on their Bird Garden page that describes which birds use which native plants, for what, and when! The website also has information on other pollinator wildlife.
https://www.laspilitas.com/bird.htm

- Inviting signs: welcome people into the space.
- Informative signs: can be general garden signs and/or specific to each plant
    - What kind of garden is it?
    - Who built it and why?
    - What are the plants growing here? Be sure to include scientific names and common names.
    - What wildlife might you see in the garden?
    - What benefits do they bring to wildlife and the environment?
    - How have these plants historically been used or enjoyed by people?
    - What groups of people used these plants? What time in history?
- Inspiring signs: get people excited to spend time in the garden and come back.

VOCABULARY

- **transplant -** to move a fully germinated seedling or mature plant to a permanent location in the ground for the growing season.
- **"hardening off" -** the process of moving plants from inside to outside for a few hours each day to adjust them to the outdoor conditions of sunlight, varying air quality and temperatures, and less frequent watering.

EVALUATE: Reflect

JOURNAL and DISCUSSION

- How is your bird-friendly and climate-wise garden helping birds?
- How is your garden helping your community?
- How do native plants increase the health of streams and habitats in our watershed?

EXTEND FURTHER:

CELEBRATE YOUR BIRD-FRIENDLY AND CLIMATE-WISE GARDEN!

When your space is complete, organize a Grand Opening Celebration. Invite the whole school, the community, and the local press. The more people know about the garden, the more people are going to want to spend time there and maybe help with future upkeep and planting.

TEACHER ASSESSMENTS:

Formative Monitoring (Questioning/discussion):

- Observation of students' participation in activities and discussion

Summative Assessment (Quiz/project/report):

- Check students' understanding of the importance of bird-friendly gardens by reviewing their journal entries.
- Review the information as well as thoroughness and effort put into the creation of interpretive plant labels.

Teacher's Supplement 5.3
Additional Resources

- USFWS's *Schoolyard Habitat Project Guide*: https://www.fws.gov/external-affairs/marketing-communications/printing-and-publishing/publications/3012-Schoolyard-Habitat-Guide.pdf

- California Native Plant Society. *Calscape Natural Gardening Tips.* Available at: https://calscape.org/planting-guide.php

- National Gardening Association. 2006. *GrowLab: A Complete Guide to Gardening in the Classroom*. South Burlington, VT: National Gardening Association.

- Nature Works Everywhere by The Nature Conservancy provides resources for teaching and learning about science and nature. The organization's website has several Tip Sheets and videos about planning and building a garden. Here are some useful links:
  - https://www.natureworkseverywhere.org/resources/?type=garden-tip-sheet
  - https://www.natureworkseverywhere.org/resources/how-to-build-garden-in-a-day/

- KidsGardening.Org has tons of resources to help your school create a garden. Here are some useful links:
  - Soil preparation: https://kidsgardening.org/gardening-basics-preparing-the-soil/
  - Transplanting: https://kidsgardening.org/gardening-basics-transplanting-and-direct-seeding/
  - Bird-friendly specific tips: https://kidsgardening.org/gardening-basics-the-winter-bird-friendly-schoolyard/
  - All gardening basics links: https://kidsgardening.org/gardening-basics/

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"*The greatest threat to our planet is the belief that someone else will save it.*"
— Robert Swan[6]

Curriculum Conclusion: STEWARDSHIP
The Bird is the Word

- Conclusion: Reflections of Fledgling Stewards

[6] Swan is an author, explorer, and environmental activist. He was the first person to walk to both the North and South Poles.

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Plumas Audubon Society

CURRICULUM CONCLUSION: STEWARDSHIP
The Bird Is the Word

Conclusion

Lesson Objectives:

- Reflect on what students have learned throughout this curriculum
- Take their stewardship outside of the classroom and share with the community and the world.

Time: *Varies.* Depends on project idea.

Educator Tip:
Have your class take the PEEP Post-Survey. If your class took the Pre-Survey, a comparison of the two will offer insight into your students' development on the path to becoming environmental stewards. If not, the Post-Survey can still offer useful insights into your students' understanding of climate change and its effects.

Reflections of Fledgling Stewards

Brief Lesson Description:

If your class did any lessons from the curriculum, this is an opportunity to have students reflect on what they learned, how their perspective may have developed or changed, if they feel a new or deeper sense of responsibility to care for the environment, and if they feel they have become empowered stewards of the environment.

Narrative/Background Information:

Recall that the purpose of the "Birds and Climate Change" curriculum is to cultivate stewardship in students by opening an AWARENESS of climate change and its effects on the natural environment, wildlife, and society; building a RELATIONSHIP with the land, its resources, and the organisms who depend on such, including human communities; developing a sense of RESPONSIBILITY and CAPACITY to address climate issues; and EMPOWERING students to take ACTION to make positive change as stewards of the earth.

When creating your reflection activity or project, think of ways you can incorporate one or more of the four concepts in relation to one or various lessons your students completed from this curriculum:

1. Open an AWARENESS: Why should we care about birds? What is climate change?
2. Build a RELATIONSHIP: What kind of natural resources do birds and humans depend on? How are our lives connected to our environment? Why is the conservation of biodiversity important?
3. Develop a sense of RESPONSIBILITY: What is the main cause of climate change? What are the effects of climate change? How does it affect birds? How does it affect humans? How does it affect you and your community right now?
4. Foster a feeling of EMPOWERMENT and call to ACT: There is hope for change as we already know of a vast array of solutions for mitigating, adapting to, and solving the climate challenge and its effects. What small, medium, and large things can we do to help solve climate change? How can we help birds and wildlife? What will you do in your everyday life to make a difference? What can we do, collectively as communities, to make a difference?

EVALUATE and EXTEND:

This activity can focus on individual student reflections of their experience with the curriculum, or you can take it a large step further by asking the students to

now become the teachers and take what they have learned and spread the word out into the school, community, county, or even further! It is open to interpretation and imagination.

Here are a few activity or project ideas:

- Write a reflective journal entry or essay assignment.
- Design a bulletin board, posters, or flyers to display at school or around the community.
- Creative writing: write a story or a poem about your experience. For those willing/interested, consider submitting such pieces to local newspapers for publication.
- Do an art project such as a collage, painting, or drawing to hang or display publicly.
- Create a group presentation or play to present to the school or community.
- Create a podcast, video, or photo series and share with other classes, post online, and/or send to a public representative or the local radio station.
- Write a letter (narrative, descriptive, expository, persuasive, or a combination) to your County Supervisor, State Senators and Assembly members, U.S. Senators and Representative.

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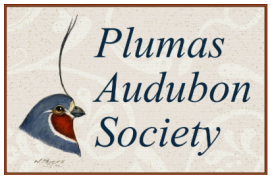

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Plumas Environmental Education Program
Birds and Climate Change Curriculum