BEAVERS AS ENGINEERS

FIFTH GRADE TEACHER GUIDE

Ecology in Classrooms & Outdoors

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BEAVERS AS ENGINEERS
UNIT OVERVIEW

SUMMARY

Besides humans, beavers change their environment more than any other species on Earth! In this unit, students will participate in activities to understand how beavers, found all over North America and particularly important to the Pacific Northwest, act as engineers in their environment and have a significant effect on biodiversity. This unit uses a hands-on approach to allow students to explore how beavers build dams and lodges for their habitats, while also studying ways in which beaver dams can change ecosystems by creating complex habitats. In addition, students look through multiple social and cultural lenses to gain a deeper understanding of humans' relationship to beavers throughout time and the points of conflict and harmony between human and beaver habitats.

OVERALL GUIDING QUESTION

In what ways do beavers in the Pacific Northwest engineer their habitat and affect the systems they live in?

OBJECTIVES

Each student will be able to:

- Explain how beavers use their environment to engineer a suitable habitat
- Build a model to understand and demonstrate how beavers engineer their dams and lodges
- Use math, language arts, art, and science to explore how beavers are an important species in Pacific Northwest ecosystems for biodiversity

USING THIS GUIDE

The ECO Beavers as Engineers unit incorporates four interdisciplinary lessons to fully explore beavers and their ecological importance and engage students across science, math, English language arts, social studies, and art. It is necessary to present the science lesson before the additional lessons to lay the foundation of understanding. ECO has created a recommended order beyond the science lesson, but teachers are free to modify the sequence.

Each lesson offers suggestions for a closing circle, discussions, or journal prompts. These suggestions may be used anytime throughout the unit as an assessment to monitor student progress.

Each Place-Based Unit has been intentionally designed to consider Diversity, Equity, and Inclusion in every classroom.

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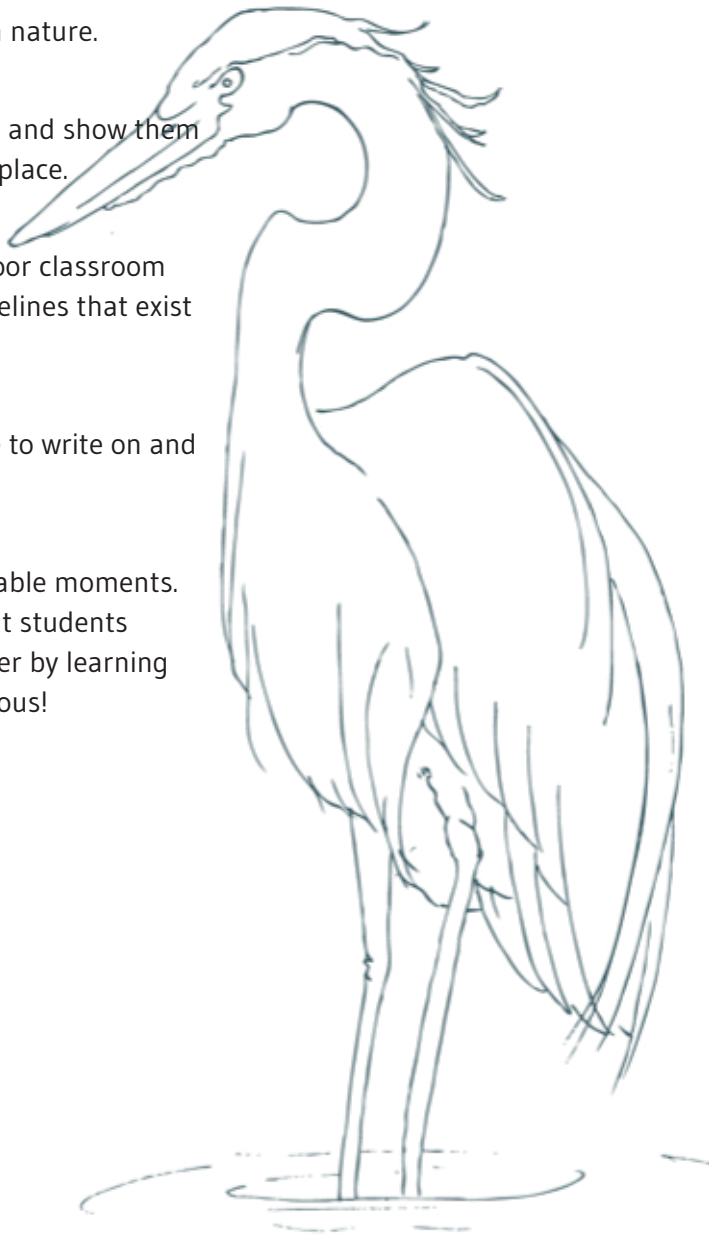
BEAVERS AS ENGINEERS

UNIT OVERVIEW

WANT TO TAKE THE LEARNING OUTSIDE?

This unit is designed to be delivered indoors or outdoors! We encourage teachers to find spaces in the schoolyard where students are able to learn and interact directly with nature.

- Take students on a walk around the schoolyard and show them the outdoor classroom before the lesson takes place.
- List expectations and boundaries for your outdoor classroom so that students remember that the same guidelines that exist inside, exist outdoors.
- Make sure to bring clipboards or a hard surface to write on and have students wear appropriate clothing.
- Remember, outdoor learning is all about teachable moments. Encourage curiosity, pause for observations that students are excited about, and nurture a sense of wonder by learning alongside your students. Enthusiasm is contagious!



SUPPORT

Please contact **support@ecologyoutdoors.org** with any questions or concerns.

TRAINING

Videos of ECO educators delivering select sections of the lessons are available. Contact **support@ecologyoutdoors.org** for access.

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BEAVER AS ENGINEERS

STANDARDS OVERVIEW

SCIENCE (NGSS)

- 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.
- 5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

MATH

- CCSS: 5.G.1 Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond.
- 5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

ELA

- 5.W.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences. a. Orient the reader by establishing a situation and introducing a narrator and/or characters; organize an event sequence that unfolds naturally. b. Use narrative techniques, such as dialogue, description, and pacing, to develop experiences and events or show the responses of characters to situations. c. Use a variety of transitional words, phrases, and clauses to manage the sequence of events. d. Use concrete words and phrases and sensory details to convey experiences and events precisely. e. Provide a conclusion that follows from the narrated experiences or events.

ART

- VA.5.PR2.5 Identify and explain how and where different cultures record and illustrate stories and history of life through art.
- VA.7.RE1.5 Identify and analyze cultural associations suggested by visual imagery.

SOCIAL SCIENCE

- Multicultural Studies (Geography) 5.10 Compare and contrast movement of people, goods, ideas, and cultural patterns in the United States, considering past, present and future trends.

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BEAVER AS ENGINEERS BACKGROUND

Beavers are often described as engineers because they are second to human beings in the degree to which they alter their physical environment. In the Pacific Northwest, beavers and beaver activity has contributed to the landscape, culture, farming, and overall ecosystem in many ways.

Beavers build dams across flowing streams, creeks, rivers, and near pond outlets in order to slow the flow of water and create deeper, wider pools. By slowing water flow and creating pools, beavers are able to accomplish two major goals. First, they are able to "farm" their food source, which consists of trees, shrubs, and wetland plants. Second, pools give them a space to build lodges, their dwellings, which create a perfect hide-out from predators and a place to store food underwater in the winter. Beaver's diet consists of the cambium (new, green growth) under the bark of fast-growing trees, saplings and buds, leaves, tubers, and other plants or plant parts that are scarce in the coldest months.

Beavers use their chisel-like front teeth to cut down trees and their long, sharp claws to dig up mud to create a solid dam. When they hear the sound of trickling water, beavers get to work to patch up any leaks in their dam. Beavers are quite resourceful and have been known to use smaller sticks, rocks, bark, grasses, and other materials to ensure they have a sturdy dam

WHY STUDY BEAVERS?

Today's changing climate is altering the way our natural environment functions. Many areas are experiencing drought, abnormally large wildfires, and more extreme weather events such as floods and hurricanes. Beavers may seem like an unlikely friend in these times, but the work that they do can help humans while these changes are taking place.

Farming: Farmers need water to grow food and to give to their farm animals. When less rain falls, or if it happens too quickly, there may not be enough water at the farm. Beavers build dams that hold water in large ponds, often at higher elevations, instead of letting it flow quickly towards the ocean. The water held in these ponds can then be used to water plants and animals on agricultural land further down in the watershed. Additionally, beaver habitat retains healthy soils and plants that act as a filter to toxins added to the environment.

Flooding: When a very large amount of rain falls over a short amount of time, we can experience flooding. Water will quickly move down to the lowest area. This can cause houses to flood, and an increased sediment load will make water very muddy and contaminated. If water is flowing down through an area that has beaver dams, the water will be held behind the dams, slowing it down. As water flows through dams, the mud and contaminante will be filtered out of the water, making it cleaner as it moves downstream.

Fires: When wildfires burn, they can destroy forests and buildings if they are beyond the scale of a natural fire cycle. The land around beaver dams stays wetter and plants can remain full of water, even during hot summer months. These areas can often avoid being destroyed by fires because there is adequate moisture in plants and in the soil. Beavers also naturally help thin the forest of fuel by falling trees and removing woody debris from the forest floor to build with or eat.

By studying beavers, we can better understand how their work can help during droughts, floods and extreme weather. Beavers are an important strand in the web of the ecosystem; in the Pacific Northwest, beaver dams have restored complex salmon habitat, which is linked to food availability for orca whale populations in the Pacific Ocean. When environmental managers encourage beavers to live in more places, combined with simulating the way that they build dams, we have a better chance of saving humans and wildlife from the problems we are facing today.

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SCIENCE LESSON

ECOSYSTEM ENGINEERS

SUMMARY

In this lesson, students explore the engineering process by planning, designing, and testing out a miniature beaver dam. Through this activity, students will think about how beavers are important ecosystem engineers, creating habitat for many other species, and impacting the landscape in the Pacific Northwest.

OBJECTIVES

By the end of the lesson, students will be able to:

- Define what an engineer is and what kind of work they do
- Demonstrate using a model how a beaver is a civil engineer
- Identify characteristics of beaver dams that create benefits for the environment

GUIDING QUESTIONS

1. What is an engineer and what do they do?
2. How are beavers engineers of the environment?
3. Why and how are beavers essential for the health of an ecosystem?

LESSON-AT-A-GLANCE

GRADE LEVEL 5

INTEGRATED LEARNING FOCUS Science

LESSON DURATION 10 minutes to gather and set up dam building materials, print worksheets

CLASS SIZE Any

ACTIVITY TEAMS Groups of 3 - 5

MATERIALS

- Ecosystem Engineers worksheets (2 per group)
- Trays (6)
- Mud containers (6)
- Sticks and twigs of many sizes
- Pebbles, marbles, and other rock-like objects
- Soil and water to create mud
- Mosses, leaves, sand, and other found natural materials
- Pitchers or other containers, filled with water
- Thick books (one or more per group)

NGSS

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.

5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment

ACADEMIC VOCABULARY

engineer	**lodge**
dam	**biodiversity**
wetland	**keystone species**

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ACTIVITY PROCEDURE

1. PREPARE THE ACTIVITY

Gather materials that will be used later in the lesson to create and test beaver dams: sticks, twigs, mud (soil and water), pebbles and rocks, grasses, moss, sand, and other natural materials; trays or containers for each group of students; pitchers of water for pouring; thick books to set tray on to create an angle.

Have students clean off their desks, or designate an outdoor space (such as picnic tables) for the activity to take place. Collect supplies to clean up after the activity, as it may become quite messy!

Plan for students to work in small groups of 3-5, and print two Ecosystem Engineers worksheets for each group.

2. WHAT IS AN ENGINEER?

Introduce the lesson by prompting the class with some introductory questions.

Ask: Does anyone know an engineer? What do they do? What is an engineer's job?
There are a lot of different types of **engineers**, but first let's think about scientists. Scientists study the world and discover how it works. Engineers take that knowledge and use it to create new things that help us live in the world. An engineer might make a bridge, a car, a computer, or a spoon! Engineers are very important because they design the things we use every day. You may think humans are the only species on Earth that are engineers, but there are actually many animals that are engineers.

Ask: How is a beaver an engineer?
Beavers build, or engineer, using materials in their environment to ensure their survival. Beavers engineer by cutting down trees and using mud, sticks, and logs to build **dams** and **lodges**.

Ask: Why do beavers build dams and lodges?
Beavers build dams to slow the flow of water and cause it to back up, creating small flooded areas around streams. These flooded areas are called wetlands, but may also be called swamps, marshes, or bogs. There are two major reasons that beavers build dams and lodges:

1. Wetlands support the growth of trees and other woody plants that beavers eat. By building a dam and creating a flooded wetland, beavers are securing food, especially for the winter when food is scarce.
2. Beavers build and live in a **lodge**, which is designed to store food and allow beavers to have a safe space. Lodges are built where water is deep enough for an underwater entrance and slow-moving enough to not wash away. A lodge is an excellent protective home, because predators like wolves, cougars, bears, and hawks cannot access the entrance!

An excellent side-effect of beavers' engineering is that by building a dam, they have created habitat for many different species to call home, increasing **biodiversity** - the measurement of the variety of species in an environment.

Because a beaver is an animal that, if they disappeared, would have a major impact on the health of the ecosystem, they are known as a **keystone species**.

3. HOW DO THEY DO IT?

After the discussion, have students watch a short video to see footage of beavers building their dams.

How Beavers Build Dams, from "Leave it to Beavers" by PBS, ~3 minutes https://youtu.be/Zm6X77ShHa8

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4. INTRODUCE THE ENGINEERING DESIGN PROCESS

Break students up into small groups of 3-5 and pass out two engineering beaver dam worksheets to each group. Allow a few moments for each group to read over the worksheet.

Ask: Why do you think this design process is important for engineers?
All engineers, no matter the kind, follow the same general design process that is shown on the worksheet in front of you. Engineers ask questions, brainstorm solutions, design prototypes, analyze how they could improve, and then go through the process several times until they arrive at the best solution. Think of it like the scientific method, but for engineering. It's important, because it allows engineers to be efficient, transparent, and focused on creating the best solution possible.

5. BUILDING BEAVER DAMS

Now that students have seen how beavers use different materials found in nature to create dams, explain that they will now create their own dams and test them. At this time, determine where students will be building and testing their miniature dams (indoors or outdoors).

Explain that each group will need to work together to use the materials they are given and the worksheet to document their engineering design process in order to build a functional dam. Remind students that they will get to build another dam after the first attempt, so they should be sure to save enough materials for the second round of dam building. Before handing out materials, prompt students to fill out steps 1-3 on the worksheet.

Pass out all the materials needed for each group:
- Ecosystem Engineers worksheet
- Tray
- Mud container
- Sticks and twigs of many sizes
- Pebbles, marbles, and other rock-like objects
- Soil and water to create mud
- Mosses, leaves, sand, and other found natural materials
- Thick book(s) to create an angle with the tray

Once the group has completed their dam and they feel it is ready to be tested, invite them to get a pitcher of water and slowly pour water into their tray. It will help to prop one end of the tray up on a book to ensure it is at an angle, simulating how water flows downhill. Explain that this is to mimic a flowing river or stream that they (the beavers) are trying to get to create a pool of water.

6. REBUILD AND REPEAT

Ask them to observe the successes or failures of their construction. Now that they have observed what has happened, what should they do differently in their second attempt? Students should record their ideas for improvement on step 5 of their worksheets.

Have the students repeat the exercise. After completing the process a second time, ask them to compare what was different and why.

CLOSING CIRCLE

Choose whether students will be writing in their journals for reflection or discussing as a group:

- What happened to your dam the first round?
- What improvements did you make for the second round?
- What did you notice about the flow of water? Are dams always going to stop every drop of water? (Have students think about large rain events and flooding, as well as downstream flow. Beaver dams will typically allow some water to continue down stream).

ASSESSMENT OPTIONS

Engineering design worksheets and discussion can be used as assessment tools.

FURTHER READING

Why BEAVERS Are The Smartest Thing In Fur Pants" by It's OK To Be Smart on PBS Digital Studios
https://youtu.be/Zm6X77ShHa8

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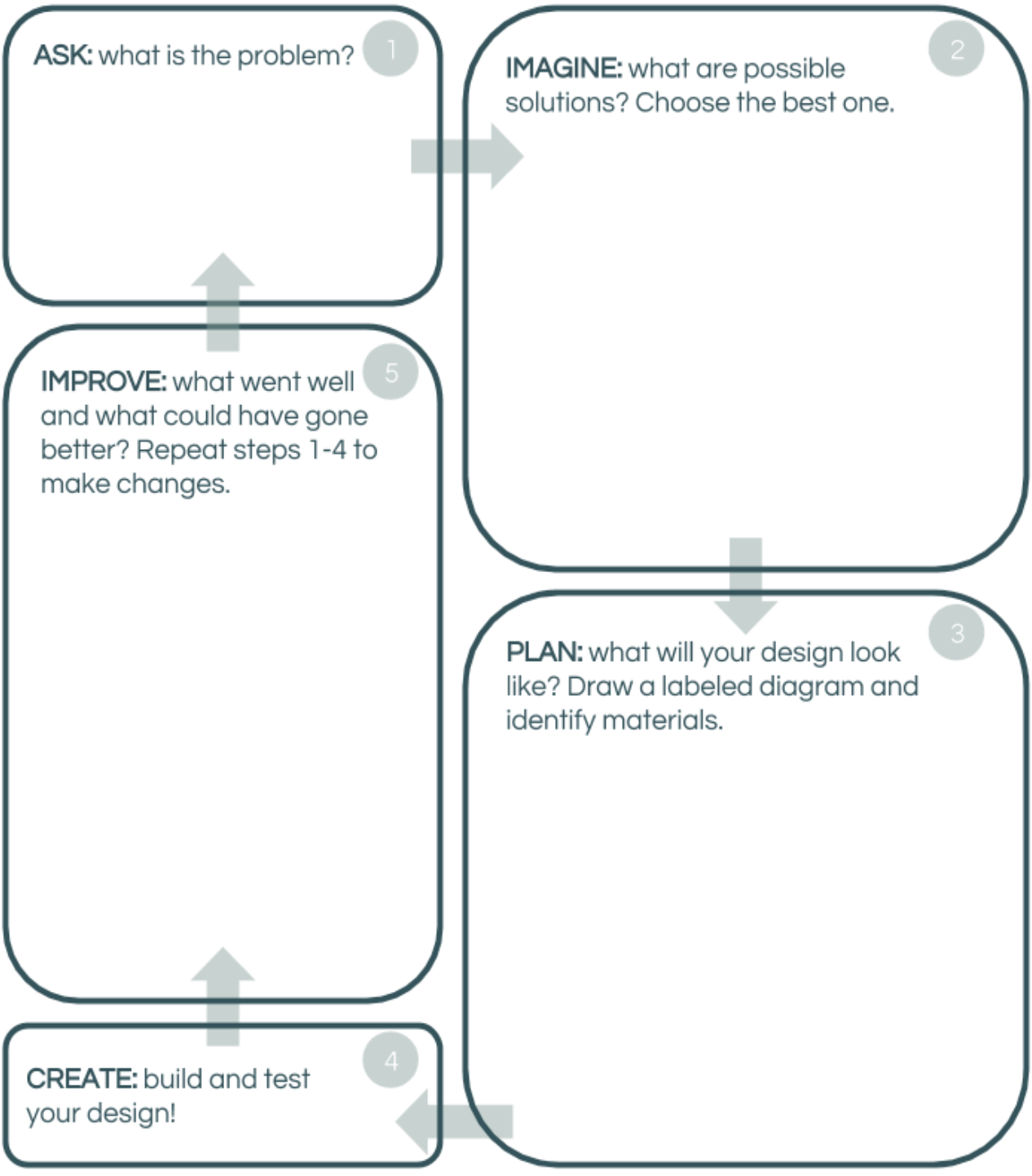
Date:
Name:

Ecosystem Engineers



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MATH LESSON

BEAVER LODGE-IC 2: GRAPHING EDITION

SUMMARY

In this lesson, students study beaver habitat and the fundamentals of graphing by playing an engaging board game, Beaver LODGE-ic 2. While playing, students discover key features of beaver habitat, hone their point-plotting skills, and re-inforce their knowledge of what beavers need to survive in a complex ecosystem.

OBJECTIVES

By the end of the lesson, students will be able to:

- Demonstrate plotting and moving between (x,y) coordinates using a beaver-themed game board to find important resources
- Use addition and subtraction to find the distance between points on a graph

GUIDING QUESTION

1. What resources do beavers require to survive, and how do they obtain them?

ACADEMIC VOCABULARY

ordered pair	**translation**
x-axis	**positive**
y-axis	**negative**
coordinate plane	**resource**
origin	**cambium**

LESSON-AT-A-GLANCE

GRADE LEVEL 5
INTEGRATED LEARNING FOCUS Math
LESSON DURATION 45 - 60 minutes
CLASS SIZE Any
ACTIVITY TEAMS Groups of 3 - 5
MATERIALS

- Beaver LODGE-ic board game:
  - Game board
  - 10-sided die (1)
  - Beaver pawns (5)
  - Set of Resource Cards: Food (30), Building (24), Ecosystem (12), Habitat (6)
- Printed copies of game worksheet, 1 per player
- Pencils

MATH

- CCSS: 5.G.1 Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond.
- 5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

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ACTIVITY PROCEDURE

1. INTRODUCE GRAPHING

Draw a graph showing the first quadrant of a coordinate plane on the board as the class brainstorms the different elements of a graph. Make up the graph as you go, showing students how to plot different data points.

Note: This can be a very basic introduction to graphing coordinates and does not go into plotting points as part of a set of specific data.

Ask: What is a graph?
A graph is a way to show **ordered pairs**, each measured along one of a pair of axes at right angles.

Graphs are common in everyday life and used in most professional fields. In this case, the coordinate plane can be thought of as a map that gives specific directions to a specific place.

Ask: What are the different elements of a graph?
This graph consists of two **axes** called the **x**, or horizontal, axis and **y**, or vertical, axis. The whole area in between the axes is called a **coordinate plane**. The axes are then assigned a value at each line - in this case, each line equals one whole number. Number the graph from 1-10 on each axis.

The point where the two axes meet is called the **origin** and has the coordinates of (0,0).

A point on the graph is recorded as a set of coordinates, or ordered pairs, such as (1,1). These are what you might think of as the "directions" on the map of the coordinate plane.

Ask: How do you move from one point to another point?
When moving from point to point on a graph, the movement horizontally (left or right on the x-axis) or vertically (up or down on the y-axis) is known as a **translation**, which is important to know for the game play later on.

Moving in a **positive direction** (to the right on the x-axis or up on the y-axis) means students will be using addition to move from point to point. Moving in a **negative direction** (to the left on the x-axis or down on the y-axis) means students will be using subtraction.

Show an example and others, including movement in a negative direction, if students need more time to grasp the concept.

2. REVIEW BEAVER FACTS

Once students have reviewed the concept of plotting points on the coordinate plane, it is time to move on to the beaver board game.

Ask: What do beavers need to survive?
Beavers, like any animal, require their habitat to have food, water, and shelter. These things together can be called **resources**, or things they must obtain from their environment to survive.

Ask: What resources do beavers need in their habitat?
Beavers depend on water; they live in and near ponds, lakes, rivers, and wetlands. Since the beaver is one of the few mammals that alters its environment to suit its needs, the beaver needs ample trees with which to build a dam and lodge.

Beavers are known to use the wood and bark of many types of trees to build with, including wetland trees like cottonwood, alder, big-leaf maple, and willow, as well as mixed-conifer forest trees like Douglas-fir, Western red cedar, and hemlock.

Beavers also depend on trees for food. They prefer trees that grow around wet areas, such as alder, willow, big-leaf maple, and cottonwood. Contrary to popular belief, beavers don't eat the outer bark of these trees, but prefer the soft, green inner layer of nutritious plant tissue called the **cambium**.

Ask: What other food sources do beavers rely on, besides the inner bark of trees?
Beavers are also known to eat lots of nutritious green plants such as seges, rushes, lily pads, and cattails. In fact, sometimes beavers are seen rolling lily pads like a fruit roll-up to eat them!

Ask: What are examples of other animals that may share a habitat with beavers?
Wetland ecosystems have many occupants. Students may be familiar with a few, such as frogs, birds, fish, insects, and other mammals.

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3. HOW TO PLAY BEAVER LODGE-IC 2: GRAPHING EDITION

Students will be practicing their graphing skills using plot points to play a beaver-themed board game.

Tip: If your class has visited a wetland before, or you know of a wetland nearby, compare the game board to the site they've visited in real life, and draw connections between the two.

The goal of the game is for each player to successfully collect these resource cards: 3 green food cards, 2 brown building material cards, and 1 blue ecosystem card for a total of 6 cards. Players can count cards in their own hand as well as cards in the Community Cache, which is added to throughout game play. Cooperation is encouraged!

Set up the game by having groups of 3-5 students set out their game board on a table, mix all the triangular resource cards together in a bag, and select a beaver pawn to play with. Make sure each student has a copy of the game worksheet and a pencil. Determine where on the playing surface the Community Cache will be stored during game play (off to the side).

Begin the game by having the player with the nearest birthday roll the 10-sided dice twice to determine their starting location. The first roll will be their x-coordinate and the second roll will be their y-coordinate. Going clockwise, have each player roll twice to put their beaver pawn on the board at the (x,y) coordinate they rolled.

Game Play:

- Each player records their starting location (x,y) on their own worksheet.
- The first player draws a Resource Card from the bag to determine where they will move.

  Food cards may have more than one resource option available for the player to choose from, such as sedge/willow/rush. For these, players may choose which one of the three food resources they want to collect.
- Player finds the dot closest to the resource's image and name on the board, identifies the coordinates of the dot, and records the coordinates on their worksheet.
- Next, the player writes down the addition or subtraction (translation) involved to move from their starting point to the resource.

  For example, a player at (1,1) collecting the sedge at (8,9) will calculate their translation as (+7,+8). A player at (10,10) will figure their translation to the sedge as (-2, -1).
- Players may work together with other players to help figure out their math.
- After calculating their movement, the player moves their beaver pawn from their starting location to the coordinates of the resource to "collect" it. When a player reaches the resource, they keep the card, and it's the next player's turn moving clockwise.
- **Leaky Dam:** if a player draws the dam, they must calculate their movement from their location to the dam to "fix the dam". Because the dam requires building materials, the player must give up one of their building cards to place in a separate pile - the Community Cache. If they do not have a building card when they draw the dam, the player replaces the dam card and their turn is over, remaining at their current location.
- **Store food:** if the player draws the lodge, they must calculate their movement from their location to the lodge to "store food" in the lodge. Because the lodge requires stored food for the winter, the player must give up one of their food cards to place in the Community Cache. If they do not have a food card when they draw the dam, the player replaces the lodge card and their turn is over, remaining at their current location.
- Players who draw a dam or lodge card replace the card back in the bag.
- If the player draws a card they do not need, they may replace it and draw again until they get a card they need.
- Players may count the cards in the Community Cache towards their total number of required cards.
  - For example: a player may have two food cards in their hand and count one food card in the cache to make three food cards.
  - Multiple players may count the same card in the cache towards their own card requirement simultaneously.

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- Once each player has all **six** of their resource cards accounted for, they may help the other players during their turns to make sure every player gets all their cards in the end!

4. COMPLETE THE WORKSHEET

The last section on students' worksheet has them list the resources their beaver collected during the game. Encourage students to draw their resources and label them as food sources, building materials, or other animals that are part of the ecosystem.

CLOSING CIRCLE

Lead a group discussion or have students write independently in journals in response to the following prompt: during the game, you and your group had to work together to move on the board and collect the resources you each needed. In what ways do beavers in real life work together to ensure they get the resources they need such as building materials, shelter, and stored food for the winter?

ASSESSMENT OPTIONS

Students' use of coordinates during the board game can be used as assessment.

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Name _____

Date _____

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BEAVER LODGE-IC 2: GRAPHING EDITION WORKSHEET

For each turn, record the (X,Y) coordinates of your beaver's starting location the name & (X,Y) coordinates of the resource you will move to. Blow the arrow, show the movement (positive or negative) on the x-axis and the movement (positive or negative) on the y-axis.

Example:
Move from: (3, 9) → (+1, -2) → Move to: (4, 7) ALDERS

Starting location: (,) → (,) Move to: (,)

Move from: (,) → (,) Move to: (,)

Move from: (,) → (,) Move to: (,)

Move from: (,) → (,) Move to: (,)

Move from: (,) → (,) Move to: (,)

Move from: (,) → (,) Move to: (,)

Move from: (,) → (,) Move to: (,)

RESOURCE LIST

What did you and your teammates collect during the game? Sketch & label your resources here
(use the back if needed)

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ELA LESSON
BEAVER TALES

SUMMARY

In this lesson, students practice their narrative writing skills by telling an imagined story based on the sequence of events that take place when beavers engineer dams in a stream. After studying examples of how beaver dams in the Pacific Northwest create a sequence of events leading to different outcomes for the environment, students will write a story that focuses on how beaver dams shape the environment and bring about many changes that have positive consequences for many organisms, including people.

OBJECTIVES

By the end of the lesson, students will be able to:

- Express an understanding through written narrative about the essential role beavers play in their native habitat
- Express an understanding of how ecosystems would change if beavers were not around

GUIDING QUESTIONS

1. How do beavers affect surrounding rivers, ponds, wetlands, and other aquatic habitats?
2. How do forest ecosystems change when beavers are removed from the system?

LESSON-AT-A-GLANCE

GRADE LEVEL 5

INTEGRATED LEARNING FOCUS ELA

LESSON DURATION 30 - 40 minutes

CLASS SIZE Up to 30

PREP 5 minutes to set up video

MATERIALS

- Pencils for each student
- Writing paper or writing journals for each student
- Screen for showing video

ELA

- 5.W.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences. a. Orient the reader by establishing a situation and introducing a narrator and/or characters; organize an event sequence that unfolds naturally. b. Use narrative techniques, such as dialogue, description, and pacing, to develop experiences and events or show the responses of characters to situations. c. Use a variety of transitional words, phrases, and clauses to manage the sequence of events. d. Use concrete words and phrases and sensory details to convey experiences and events precisely. e. Provide a conclusion that follows from the narrated experiences or events.

ACADEMIC VOCABULARY

ecosystem
agriculture
sediment
biodiversity
resilience
narrative
sequence

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ACTIVITY PROCEDURE

1. PREPARE THE ACTIVITY

Determine whether students will be writing their narrative story in a journal or on loose writing paper, and gather materials needed for writing.

Set up a preferred method for showing an online video to the group.

2. AN ECOSYSTEM TELLS A STORY

Ask: Do you think an ecosystem tells a story? In what ways can an ecosystem or a habitat tell a story?
Discuss this question with students and give them time to come up with ideas around the concept of an ecosystem telling its own story. Remind students that an **ecosystem** describes the interactions between living and nonliving things in a particular place.

Give an example, such as the story of a river: beginning from a spring on the side of a mountain, making its way through valleys, connecting to other bodies of water, and ending in the ocean. There are many characters involved in the story of a river, plot twists and turns, and interactions. There are changes over time, which may occur quickly, like a flash flood event, or slowly, like the erosion of the rocks carried downstream.

Show students the image below from Pollock et. al. as a visual aid, having them point out differences they notice between each diagram (a-f). Notice how the images in the left-hand column are showing higher flows of water and the images in the right-hand column show lower flows. Over time the landscape is changed dramatically as more water is held in the system and vegetation is able to remain year-round.

3. DISCUSS BEAVERS IN THE LANDSCAPE

Beavers in the Pacific Northwest alter their environment by building dams in creeks, streams, and rivers to slow the flow of water. This creates prime habitat for them to harvest and store food, build lodges, and survive. The long history of beavers living in the Pacific Northwest has even helped to create much of the fertile **agricultural** (farming) land that we benefit from as humans!

Ask: When beavers build dams, they create pools of water and wetlands. What else may happen, as a result?
Give students three to five minutes to discuss this question with one person next to them or with a small table group. Then, invite one student from each small group to write their ideas on the board as a list. Brainstorming with students, make sure your list includes these essential ideas:

- Helps with flooding by retaining water in areas for longer, and creating a more complex system of channels and pools for water to flow in and out of
- Slows down the flow of **sediment** (sand, silt, rocks, soil, and other particulates), leading to cleaner water downstream
- Cultivates areas with higher amounts of vegetation (plants)
- Creates viable habitat for other animals like fish, amphibians, mammals, and birds, leading to an increase in **biodiversity**, or variety of species present in the ecosystem
- Helps to manage wildfire damage by slowing down or stopping fires

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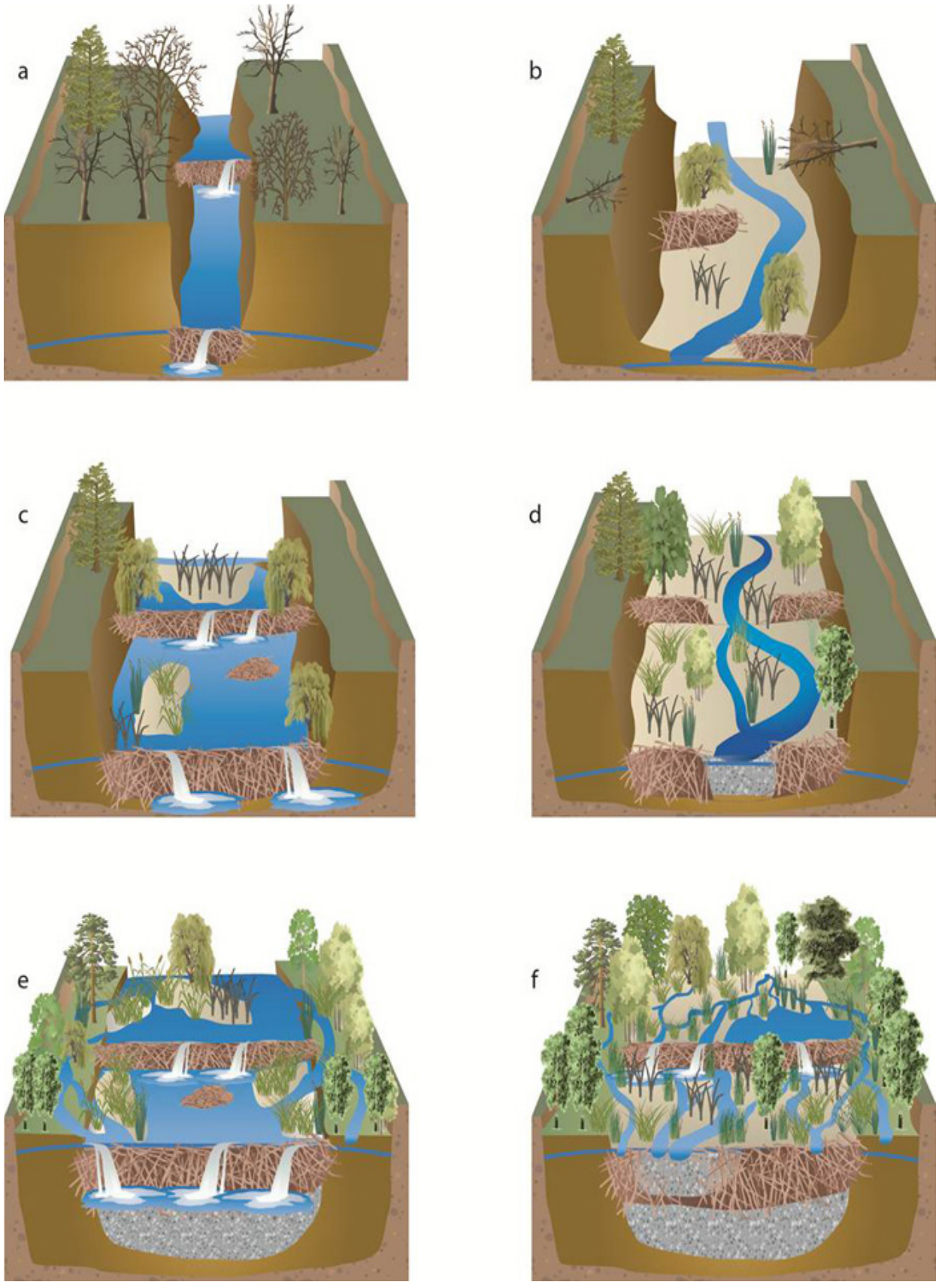

"Beaver dams help a stream to progress from an incised trench (a) to an aggraded channel (e–f) by creating a positive feedback loop that changes physical processes and vegetation to improve habitat for themselves and other species."

Stream Progression image sourced from Working with Beaver to Restore Salmon Habitat, Michael Pollock, Chris Jordan, Nick Bouwes, Joseph Wheaton, Carol Volk, Nicholas Weber, Jason Hall, and Josh Goldsmith

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4. SHOW THE VIDEO

Before moving on to the writing activity, show a short video called Beavers and Wildfire: a stop-motion story by Emily Fairfax to visualize the effects of a beaver dam being built in a river. Note how the habitat created by the beaver is **resilient**, or remains relatively intact, after the effects of a wildfire, which is a natural occurrence in many types of forests in the Pacific Northwest.

https://www.youtube.com/watch?v=lAM94B73bzE

5. WRITE A NARRATIVE

To tell the story of a beaver in the Pacific Northwest, explain that students will have to think of a beginning, middle, and end to their story, writing in the form of a narrative, or the telling of a series (or sequence) of events or experiences.

Use the following prompts, or create your own, to get students started on writing their short story:

- Imagine a beaver begins to make a dam in a nearby river…what happens next?
- Imagine beavers moved away from a local forest, after living there for a long time…what would change, and how?
- Imagine you are an animal other than a beaver living in a wetland…what is your relationship or connection with the beaver?

Encourage students to incorporate writing conventions such as dialogue, transitional words, sensory details, and descriptions to help the story flow.

When students are finished, give them time for illustration if they'd like to add pictures. Another choice for students may be to create a comic strip of their story.

CLOSING CIRCLE

Invite students to share their story with the class, acknowledging that reading one's work out loud can be intimidating. Invite all students to be active listeners and good audience members.

FURTHER READING

NOAA Fisheries case study of an Oregon creek restored for salmon habitat using beavers on the landscape:

https://www.nwfsc.noaa.gov/research/divisions/fe/wpg/beaver-assist-stld.cfm

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ART AND SOCIAL SCIENCE LESSON

MEANINGFUL MURALS

SUMMARY

In this lesson, students channel the beaver's cooperation skills and work together to create a group mural depicting the story of beavers. Before getting to work, students learn about the intersection of story, art, and nature by exploring narrative art and how beavers have been featured in different kinds of art pieces throughout history. Then, students choose whatever elements they want to put in their mural - lodge, dam, people, etc. - and bring their story to life.

OBJECTIVES

By the end of the lesson, students will be able to:

- Discuss how narrative art is used to tell a story
- Create a group mural depicting the story of the beaver

GUIDING QUESTIONS

1. What is narrative art?

2. How can beaver imagery be used to tell a story about beavers in the Pacific Northwest?

LESSON-AT-A-GLANCE

GRADE LEVEL 5

INTEGRATED LEARNING FOCUS ART & SOCIAL SCIENCE

LESSON DURATION 60 minutes

CLASS SIZE Any

PREP TEAMS Gather materials and prepare space for mural painting

MATERIALS (example list, but can be modified to suit the needs of your mural):

- Presentation: Meaningful Murals
- Cardboard - a large piece for painting mural on
- Pencils
- Thick markers
- Paint
- Construction paper
- Scissors
- Glue

ART

- VA.5.PR2.5 Identify and explain how and where different cultures record and illustrate stories and history of life through art.
- VA.7.RE1.5 Identify and analyze cultural associations suggested by visual imagery.
- Multicultural Studies (Geography) 5.10 Compare and contrast movement of people, goods, ideas, and cultural patterns in the United States, considering past, present and future trends.

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SOCIAL SCIENCE

- Multicultural Studies (Geography) 5.10 Compare and contrast movement of people, goods, ideas, and cultural patterns in the United States, considering past, present and future trends.

ACADEMIC VOCABULARY

narrative
art
symbolism

ACTIVITY PROCEDURE

1. PREPARE MATERIALS AND MURAL SPACE

Decide which materials might be of interest to your students and be sure to gather them for the activity. Depending on the desired level of complexity, materials that could be used include magazines, cardboard, construction paper, paint, thick markers, paper mache, glue, and scissors. Feel free to get creative with material availability.

Clear some space for the mural, whether on an actual wall or using large pieces of cardboard or plywood as a canvas. It should be pretty sizable, but the exact size is up to you.

2. BEAVERS AND NARRATIVE ART

Open the Meaningful Murals presentation. Invite the class to discuss the intersection of art, story-telling, and beavers.

Slide 2: Narrative Art
Ask: What is narrative art?
Narritive Art tells a story. Since the beginning of humanity, before there was language, people used images to tell their stories. It is different from other forms of art, because it generally preserves those stories across different groups of people and for future generations.

Slide 3-4: Narrative Art Examples (cave painting and Egyptian stone murals)
Ask: How do these images tell a story? What do they tell us about the lives of the people that created them?
The images in these two examples depict different aspects of daily life. In the cave painting, there are people riding horses, which could have been a means of transport, war, or hunting. The ancient Egyptian art depicts agriculture techniques of the time; they used cow-driven ploughs to harvest their food. These two examples show that narrative art uses images to capture cultural norms.

Slide 5: Telling the story of the beaver
Explain to students that the theme for this art project revolves around the American beaver and their impact on both the landscape and on humans. Students will be looking at examples of beavers in arts and culture, then make a mural collaboratively with their classmates to tell a story.

Slide 6: Examples in Pacific Northwest Culture: Sports OSU - Beaver mascot
Ask: What well-known beaver imagery can you think of?
One of the most well-known examples of beaver imagery in Oregon is the orange beaver, "Benny", of Oregon State University.

Slide 7: Native American Beaver Art
However, beavers have played a significant part in art and culture long before OSU was founded. Native tribes in the Pacific Northwest are diverse, but share a similar use of bold lines, colors, and patterns in their art. Much of the art you may recognize using this style is from the Tlingit-Haida tribes of what is now Southeast Alaska and British Columbia. Traditionally, colors came from locally, naturally available pigments: black, red, blue and green. The beaver is a builder of the mind, body, and soul and symbolizes, or represents, resourcefulness, cooperation, creativity, and harmony.

Slide 8: Other examples (Audubon beaver painting and retro Canadian poster)
Ask: What stories are these images telling us? What are they telling us about the culture at the time?
Both images highlight the resourcefulness and hard-working nature of beavers. The Canadian poster is using that symbolism to encourage its citizens to work together to keep the economy strong. The saying "busy as a beaver" is born from similar reasoning.

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3. INTRODUCE MURAL PROJECT

Slide 9: Activity: Making a mural
Let students know that the class will be creating a mural together that tells a modern or current story of the beaver through art, using the knowledge they've gained throughout this unit. Break students into groups of 3 or 4 to brainstorm different elements that they would like to include in the mural.

Encourage students to use the principles of narrative art while brainstorming, such as representing something about culture, everyday life, or generally telling a story. Then, after a few minutes, bring the class back together and make a list of the different elements students discussed. Either through voting or some other mechanism, decide on the elements that will go into the mural. Possible elements include lodge, dams, wetlands, trees, and predators (coyotes, hawks, black bears, northern river otters), but can include anything that the students feel is important to incorporate within reason.

4. CREATE A MURAL

Set out the materials you chose for the mural. Break the mural into different parts and assign them to students in groups of 3-5. The different parts that each group works on can be the different elements the class decided on or the mural could be broken up into other categories such as background, plants, animals, water, or whichever methods makes the most sense for your class and your mural.

CLOSING CIRCLE

Bring the class back together once the mural is complete and ask a few of the below questions to reflect on the class mural:

- What features of a beaver's life did we include? Why?
- What is the story that is being depicted in the mural?
- In what way are we portraying beavers (positively, negatively, neutral)?

ASSESSMENT OPTIONS

Each group's contribution to the mural can be used for assessment, or assign a self-assessment for students to complete that describes their contribution.

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APPENDIX
IMAGE ATTRIBUTIONS

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Pollock, Michael & Beechie, Timothy & Wheaton, Joseph & Jordan, Chris & Bouwes, Nick & Weber, Nick & Volk, Carol. (2014). Using Beaver Dams to Restore Incised Stream Ecosystems. BioScience. xx. 1-12. 10.1093/biosci/biu036.

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"Beaver, totemic art, teeth, tail, leafy stick, work of paper, designs, red, cobalt blue, brown, green paint, Tlingit-Haida style, Washington Department of Transportation, Washington State Ferries, Seattle, USA" by Wonderlane Attribution 2.0 Generic (CC BY 2.0)

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