Building like a Beaver
Teacher Guide
Unit for Smith River Alliance and BFT Youth Stewardship Project

Statement of Inquiry: "Beavers are wetland engineers who physically modify the environment more than any other non-human organism in the Northern Hemisphere." (Beaver in California: Creating a Culture of Stewardship" Occidental Arts and Ecology Center WATER Institute)

Essential Questions:

- What is the role of beaver on Klamath Mountains watersheds?
- How do beaver structures affect the ecosystem?
- How can the engineering and design process help us solve problems?

Objectives: I can…

- Explain beaver ecology (knowing/understanding)
- Use and reflect on the engineering and design process (processing/evaluating)
- Connect to current research (reflect on impacts of science)

Overview: Students will gather information on beaver ecology and apply this to a hands-on activity. Using the engineering and design cycle students will design, test, and redesign beaver-inspired structures and evaluate their process by reflecting in journals. Students will demonstrate their understanding through writing a letter as the culminating piece of the unit. (Unit is modifiable for distance-learning)

NGSS Alignment:

MS-LS2-4.	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]
MS-LS2-5.	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]
MS-ETS1-1.	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Key science vocab:

- Keystone species
- Watershed
- Engineering and design process

Outline:

*aligned to middle school standards. All activities can be up or down leveled for different grades by providing more or less student-led inquiry (vs. teacher provided information), depth of ecology content, depth of engineering and design content, and depth of the final product.

Days 1-2: Beaver Ecology (knowing and understanding)

- Anticipatory set
- Reading-ecosystem impacts of beaver

Days 3-4: Engineering and Design (processing and evaluating)

- Introduce engineering and design process
- Design-test-redesign
- Reflect on design: strengths and weakness of model

Days 5-6: Current research and assessment (impacts of Science)

- Presentation by Biologist from site specific watershed
- Assessment: letter

Part 1: Introduction & Beaver Ecology

Introduce: see-think-wonder (images projected on board or digital board like Padlet)
Readings: reciprocal teaching method

Part 2: Engineering and Design

Use the Engineering Design process to build Beaver Dam Analogues (BDAs).
Reflect on the process.

Part 3: Current research and Assessment

Presentation/interview from local beaver expert (local, careers)
Assessment: letter using argumentative writing.

Part 1: Introduction & Beaver Ecology

Introduction:

Overview: Students will access prior knowledge and ask questions to introduce the unit.

Goal: I can demonstrate what I know and ask questions.

Set-up & Materials:

- Teacher SlideshowBuilding like a Beaver-Teacher Slides to project on board
- Notebooks/paper for students
- Distance Adaptation: make a sharing board like www.padlet.com

Procedure:

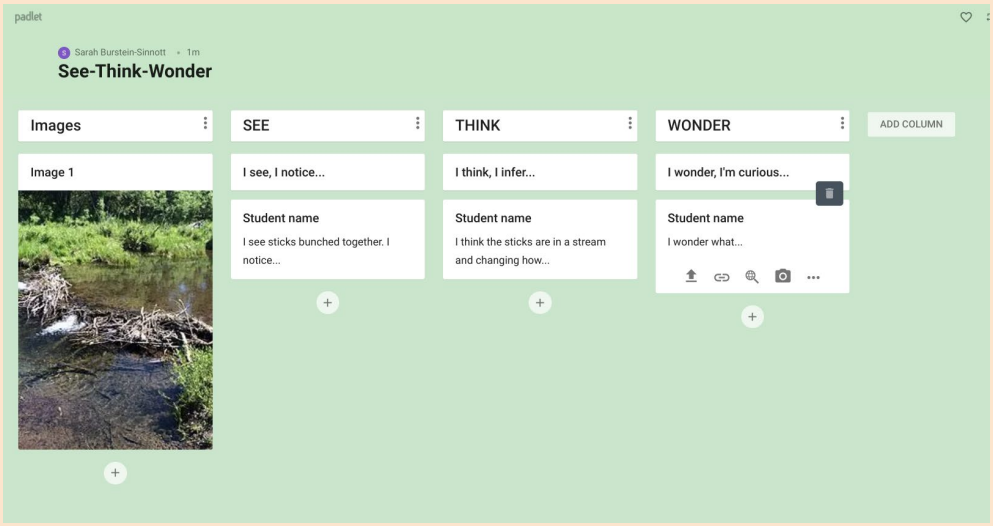
1) Before introducing the topic of the unit have students complete the See-Think-Wonder Activity. Use the images provided in Google Slides.
2) Students set up 3 columns in their notebooks/paper. Label as seen below with space to write. Sentence stems are provided to get students started.

See	Think	Wonder
I see, I notice...	I think, I infer...	I wonder, I'm curious...

3) As you show each image, students will look carefully with attention to detail. Then they will fill in the chart for each image.
4) Students will share what they see-think-wonder for each image.
5) Connect wonder questions to the statement of inquiry for the unit "Beavers are wetland engineers who physically modify the environment more than any other non-human organism in the Northern Hemisphere." (Beaver in California: Creating a Culture of Stewardship" Occidental Arts and Ecology Center WATER Institute)
6) Listen to the word for "beaver" in several Indigenous languages of the Klamath Mountains by clicking on the audio files in the Slides (no audio file available for Hupa language). Note: this is a sampling of several languages of the region but does not include all.

7) Explain how students will learn more about how beavers change their environment in this unit by studying beaver ecology and designing and building their own beaver inspire structures.
8) **Extend/Homework:** Read Leave It to Beavers | Infographic: Beavers 101 | Nature. This infographic explains beaver adaptations.

Distance Adaptation: Set up See-Think-Wonder on Padlet.
Example:



Beaver Ecology Reading

Overview: Students will use the Reciprocal Teaching strategy to read about the benefits of beavers.

Goal: I can work with my team to learn how beavers benefit ecosystems.

Set-up & Materials:

- Reading handouts. 1/student. Building like a Beaver-Reading Handout
- Notebooks/paper for taking notes
- Groups of 4 students

Procedure:

1) Each student will have their reading handout and their own notebook/paper for taking notes.
2) Section out the handout with designated stopping points (such as at the end of each paragraph) depending on your students' abilities. Have students mark the stopping points clearly on their handouts.

3) Break students in groups of 4 (while maintaining 6 feet distancing. Students will discuss with each other but will not need to be in any closer contact)
4) Students will read the handout using the Reciprocal Teaching strategy. Model with one group aloud before groups start working on their own. Assign roles:
   Summarizer-points out key ideas the group has read so far
   Questioner-ask questions about unclear parts and puzzling information
   Clarifier-addresses questions just posed by Questioner
   Predictor-offers predictions about what the text will say next
5) Students will read 1-2 paragraphs and use their regular note-taking strategies. At the stopping point students will discuss the reading using their roles.
6) Students will switch roles and read the next paragraphs. Students will continue to read, discuss, and switch until they have completed the reading.
7) Note: Adjust number of paragraphs read at a time based on grade level/abilities. Feel free to sub in any reading strategy that your class already works with.
8) Summarize reading as a class by having each group present a paragraph. Double up on the paragraphs with the most content.
9) **Extend/Homework:** Watch Leave It to Beavers | How Beavers Build Dams | Nature. This video shows how beavers create their structures.

Distance Adaptation: Students use Reciprocal Teaching in breakout rooms. Or students read and note-take independently and then summarize each paragraph together in breakout rooms before whole class discussion.

Part 2: Engineering and Design:

Overview: Students will use the Engineering Design process to build Beaver Dam Analogues (BDAs) and reflect on the process.

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Goal: I can use and reflect on the engineering and design process to build a structure that mimics a beaver dam.

Set-up & Materials:

- Engineering Design Diagram in Teacher Slideshow Building like a Beaver-Teacher Slides
- Student handout Building like a Beaver_ED Student Handout
- Sticks of varying sizes
- Clay-ceramics studio clay, or mud with high clay content
- Small rocks-gravel size or smaller
- Rectangular tub that can hold water: plastic tubs, turkey trays (bigger the better)
- Cups for pouring water
- Textbook or low block to be placed under one end of the tub
- For Challenge: fish food flakes, pepper flakes, or vegetable oil with food coloring as contaminants. Loose soil as excess sediment.

Procedure:

1. Review Engineering Design Process. See diagram in Teacher Slideshow.
2. Go over student handout. Read the background section aloud, or in groups. Students should read the entire procedure before moving forward.
3. Students go outside in the schoolyard to collect materials, or bring supplies from home.
4. Students design, test, and redesign their BDA.
5. Tips: BDA must be a combination of sticks and clay-clay is used to support the stick structure and fill in the gaps between sticks, just like how beavers use mud. Avoid building a solid clay wall by limiting the amount of clay per student. To improve flows, increase the height of the textbook/block under one end of the tub. Students may complete this indoors or outdoors. Size of BDA will depend on the containers used-you may scale up or down.
6. For the Challenge Criteria: students redesign to include one, or all, challenges.

    a. Slow the spread of contaminants: Add contaminants and observe if it goes through BDA.
    b. Trap sediment: add loose dirt and observe if BDA traps it
    c. High flows. Do this last! Pour a higher volume of water, quickly, into the tub. Observe how BDA reacts.
7. If classroom management with COVID allows, have students tour each other's structures before clean-up. For clean-up students may "throw away" natural components of BDAs in an outdoor space depending on materials used.
8. Students wrap up the activity by writing a one paragraph reflection on the strengths and weaknesses of their design.
9. **Extend:**
    a. Take it Outside: If your students have access to a creek you may build here-be sure to break down your structure afterwards.
    b. Data Collection and Math Connection: Use timers to record how long it takes water to flow through BDAs. Record time without a BDA, first design, and second design. Discuss variables and controls. For a math connection, calculate the speed of the flow by measuring the distance the water travels across your tub in addition to the time (speed = distance/time).
    c. Scott Valley BDAs: Check out these BDAs created by the Scott River Watershed Council Water, Beaver & Fish — Scott River Watershed Council. Scroll down to see photos of different wildlife using the BDAs captured on game cameras! You can also click on each BDA project to see photos of how they were built, and before and after shots.

Distance Adaptation: Due to the no cost/outdoor access of materials students can design and build BDAs at home. Plan ahead to encourage students to save recyclable containers to build in.

Part 3: Current Research and Assessment

Overview: Students connect with a local Biologist and assess their understanding of the unit through summarizing the benefits of beavers in a letter.

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

Goal: I can connect to current research and demonstrate my understanding (reflect on impacts of science)

Set-up & Materials:

- Local Biologist
- Presenter/Interviewee handout Building like a Beaver-Biologist Interview
- Letter writing handout Building like a Beaver-Assessment Letter

Procedure:

1. Contact a biologist from your local watershed and/or Tribal organization. Provide the biologist with a copy of the Building like a Beaver-Biologist Interview handout as linked above. This handout gives the speaker some background and talking points.
2. Students generate a list of questions for the biologist.
3. Coordinate an in-person or Zoom presentation/interview.
4. Follow up the presentation/interview with a whole class discussion.
5. Introduce the letter writing assessment by reviewing what students have learned so far in this unit (beaver ecology, how beaver dams and BDAs function, and local info).
6. Go over handout and GRASPS for the task.
7. Students write letters and self-assess using the rubric.

Distance Adaptation: The content and materials for this section are all accessible for distance-learning.

Additional Information

Resources for Students

Poliquin, Rachel. 2018. Beavers: The Superpower Field Guide. Houghton Mifflin Harcourt Publishing Company, New York, NY.

- Illustrated book for upper elementary and middle school readers. Covers beaver ecology with an engaging format, informative illustrations, and lots of cool science.

The Guardian 2/23/21. Beaver believers: Native Americans promote resurgence of 'nature's engineers'

- Article about tribes in WA and CA reintroducing beavers-features Yurok Tribe.

Teacher feedback

If you've used this curriculum we'd love your feedback. Please email sarah.bursteinsinnott@gmail.com

---

Sources

Beavers. Pacific Grove Museum of Natural History. https://www.pgmuseum.org/beavers#beaverabout

Hupa Online Dictionary and Texts UC Davis Hupa

Karuk Language Linguistics Berkeley Karuk and email communication with Francisca Tripp, Karuk Tribe

Leave it to Beavers. Nature/PBS. 2014 Leave It to Beavers | How Beavers Build Dams | Nature

Lunquist, Kate and Dolman, Brock. 2020. Beaver in California: Creating a Culture of Stewardship. Occidental Arts and Ecology Center WATER Institute. Beaver In California: Creating a Culture of Stewardship

Poliquin, Rachel. 2018. Beavers: The Superpower Field Guide. Houghton Mifflin Harcourt Publishing Company, New York, NY.

Scott River Watershed Council. https://www.scottriver.org/scott-river-beaver-dam-analogues

Tolowa Dee-ni' Nation, Education Department. Email communication with Lenora Hall and Pyuwa Bommelyn.

Yurok Language Project Linguistics Berkeley Yurok

This unit was created by Sarah Burstein (Smith River Alliance) for the Bigfoot Trail Alliance Youth Stewardship Project through funding from the S.H. Cowell Foundation