Clark Fork Coalition
Snow and Tell Curriculum

Introduction:

Mission

The Clark Fork Coalition's unique snowpack curriculm connects middle school and high school students to climate science, snowpack, and our regional watersupply through developmentally appropriate applications of math, science and technology. The program fosters an appreciation for sustainable use of Montana's water resources by deepening the understanding of, and appreciation for, the sources of our rivers.

Vision

This program promotes the resiliency of water resources in the Clark Fork Basin by explaining and elaborating on concepts that promote appreciation for these resources during an era when changing climate is drastically impacting their availability and sustainability.

Discussion:

The *Snow and Tell* snowpack curriculum, developed by the Clark Fork Coalition, is a two-part curriculum, geared towards middle school and high school students. Field-based exploration of the students' local winter environment generates real-world research and analysis skills and promotes a deeper understanding of water resources in students' local place.

Throughout the first activity, *Snow and Tell*, students engage their prior knowledge of snow to explore their winter environment. The observational data they collect is combined with a facilitated discussion to introduce new knowledge; specifically, the connection between snowpack, streamflow, and water supply in the intermountain west. The new knowledge students construct provides the foundation for the real-world research skills taught in the next activity.

The *How to Track Snowpack* activity also focuses on engaging learners in the scientific exploration of snow, however this investigation utilizes appropriate technologies for the collection of quantitative data to determine the amount of water held in snow. Once field data collection is complete a facilitated data analysis and discussion provides students the opportunity to share their data and reflect on what it may mean. This activity mimics procedures used by snow scientists, illustrating to students the real-world applicability of collecting data to make predictions about our environment.

Activity 1: Snow and Tell-- a place-based data collection activity

Time: 1 hr. *prior to this lesson, identify appropriate outdoor space for data collection **Grade:** grades 6-12 **Purpose:** Students will explore their environment by examining snow and connecting winter climate to their rivers and communities.	**Objective:** Students will: • describe the state of matter and physical properties of snow • infer snowpack's role in a watershed • discuss how changes in climate can impact water availability in streams and rivers • discuss the importance of studying snow **Unit Essential Questions:** 1. Why is snowpack important to watersheds? 2. How does snowpack impact Clark Fork watershed residents?
Materials: • Observational data collection sheet • Writing utensil • Clip Boards • Winter attire, including gloves • Clark Fork Coalition Snow Science PowerPoint	**State Science benchmarks:** 6-8 CS2, Benchmark 4, CS4, Benchmark 4B, CS5, Benchmark 3 9-12 CS1, Benchmark 2- 6, CS4, Benchmark 4;CS5, Benchmark 5; CS6,benchmark 1,3

Lesson Outline:

This lesson takes students outside to collect observational data on the snow and the environment. It concludes by developing connections between snowpack and stream flows.

Part One: Engage

- Break students into small groups (3-5 students) and pass out the observational data collection worksheet and clipboard.
- Explain to students that they will be working in their groups to collect information about snow and their environment. Students will need to be prepared for being outside for a substantial period of time.

Part Two: Explore (25 min)

- Take students outside. Set appropriate boundaries, safety protocols, and behavior rules for the outdoor setting.
- Give students 10-15 minutes to work in their small groups to collect and record their observations.
- Once students have completed their observations return to the classroom to review their data collection sheets. Use open ended questioning to give students an opportunity to reflect on time outside. Encourage students to write down questions they had during data collection.

Part Three: Explain (15 min)

- Use the CFC presentation to review the water cycle, watersheds, and how snow pack affects the amount of water in Montana's rivers and streams.
- Facilitate group discussion of observational data throughout presentation. Identify and discuss reoccurring themes and major discrepancies.
- The themes addressed in this lecture and the discussion prepares students for the following snowpack data collection activity by introducing them to important key vocabulary and concepts.

Guiding questions to help facilitate these discussions include (questions are also included in the PowerPoint notes):
• What are snowflakes? Where do snowflakes come from? What happens to a snow flake once it hits the ground? • What percentage of water resources in the United States originates as snowfall? *60-80%* • Where did we find the most snow in our area? • What time of year is water in the Clark Fork River at its highest? Why is that? What about when it is at its lowest? • Why is it important to predict stream runoff? • How does a changing climate affect our snowpack? Our rivers and streams? • Why is it important to measure snowpack?
Key Vocabulary: **Water Cycle:** the continuous movement of water on, above, and below the surface of the Earth **Hydrology:** scientific study of the movement, distribution, and quality of water **Watershed**: an area of land where all surface waters flow to a common outlet **Tributary:** a freshwater stream that feeds into a larger stream or river **Climate:** the weather conditions prevailing in an area over a long period, typically thirty years or more **Weather:** the state of the atmospheric conditions at a place and time, explained in terms of hot or cold, wet or dry, calm or stormy, clear or cloudy

Part Four: Expand 5 min

- Wrap up this lesson by reminding students of the next data collection activity they will be participating in.
- Provide an introduction to the snowpack data collection activity.

Part Five: Evaluate

- Observe students and assess their ability to make detailed observations and explore questions related to snowpack.
- Work sheets can be evaluated on a scale of poor, fair, good, and excellent

Snow and Tell
Observational Data Collection Worksheet

Name:_____ **Date:**_____

Location:_____

Describe the snow. Is it light and fluffy? Heavy and thick? What shapes do you find? What are some of its characteristics?

_____

_____

What do you think gives the snow those characteristics (from question #1)?

_____

_____

What type of matter (solid, liquid, or gas) does water form as snow? What type of matter will it turn into? What might cause this change?

_____

_____

Look around your environment. Describe the places where you see the most snow accumulation.

_____

Why do you think it accumulates there?

_____

_____

Where do you think the snow goes from those places it accumulates once it begins to melt?

_____

Please write down one two or three question generated from your observations!

_____

_____

Activity 2: How to Collect Snowpack Data

Time: 1 hr. *prior to this lesson, identify appropriate outdoor space for data collection **Grade:** grades 6-12 **Purpose:** Students use appropriate tools and technology to measure snow depth, temperature, and calculate snow-water equivalent. Student gain real world research skills and apply the data they collect to making predictions about their environment.	**Objective:** Students will: • define snow water equivalent (SWE) • apply the inquiry process and mathematical skills to study depth, temperature, and water content of their snow pack • draw conclusions as to what their data means and make predictions about the effects snowpack on their local water supply • communicate results and compare differences in data by presenting their findings to their peers • work collaboratively to collect data. **Unit Essential Questions:** 3. How can we determine the amount of water held in our snowpack? 4. How do scientists make predictions about our water supply?

Materials:
• Snow sampling equipment
  ○ Non-contact infrared laser temperature gun (5)
  ○ Shovels (5)
  ○ Snow sample containers : 3-4 per group
  ○ Labeling markers and tape
  ○ Colored popsicle sticks
  ○ Metric measuring tape
 	
• Data collection worksheet
• Pencil, clipboard
• Calculator (not required)
• Winter attire, including gloves
	State benchmarks:
	Science:
	
	6-8
	CS1, Benchmark2,3; CS2, benchmark2,4; CS4, benchmark 4; CS5,benchmark 1,2
	
	9-12
	CS1, Benchmark 2- 6, CS4, Benchmark 4;CS5, Benchmark 5; CS6,benchmark 1,3

Lesson Outline:

Part One: Engage

- Review the observational data that was collected in the preliminary activity. Ask students to contribute scientific questions about snowpack that their observations have inspired. Write questions down for later use.

- Today students will explore how scientists go about answering questions like theirs. They will again collect data from their winter environment- this time using new methods to collect countable and comparable data.

Part Two: Explore (30)

- Break students into small groups (3-5 people) and pass out the data collection protocol and worksheet. Assign one person to be the "data cop". Their job is to record all the data on the data sheet. One student should be assigned to be responsible for the use and care of each piece of equipment as well!
- Explain to students they will use the equipment to collect each piece of data. Show students the various tools they will use and how they function. Provide a demonstration of how to dig a snow pit and collect data with the equipment.
- Take students to outside area and allow groups 35 minutes to collect their data. Make sure snow samples are stored in warm pockets to facilitate melting!

Part Three: Explain (15)

- Bring students back indoors. Work individually with groups to complete data analysis and calculate the thermal index and snow water equivalent for their pits.
- Have each group share their results with the class. If results vary, have students determine what may have caused the variations in data.

Guiding questions to help facilitate these discussions include :
• How does a changing climate affect our snowpack? Our rivers and streams? • Do you think (local stream) is fed by snowmelt at any time of the year? • What time of year is water in the river/ stream highest? • Why is it important to predict stream runoff?
Key Vocabulary: **Snow water equivalent**: the amount of water contained within the snowpack **Forecast:** a prediction or estimate **Natural Resource Conservation Service**: federal agency who uses specially trained scientists and remote technologies to provide water supply forecasts **United States Geographical Society**: federal agency that uses specially trained scientists and remote technologies to produce streamflow information that meets local and regional needs

Part Four: Elaborate (5)

- Challenge groups to describe ways snow scientists might apply the information they get from measuring snow pack to the needs of their community.

- What did students think about the amount of water in their snow? How could they find out how much water their snowpack contributes to the streamflow of their local water ways?

Part Five Evaluate: (5)

- Observe students and assess their ability to make detailed observations and explore questions related to snowpack.
- Work sheets can be evaluated on a scale of poor, fair, good, and excellent.
- Have each student submit a written answer to the following question. “Describe at least two reasons why snow is important to your town and two reasons why it’s important to the region/state.” Evaluate students’ answers for concepts and connections to curriculum.

IEO Extension:

- Explore how Montana Tribes view and talk about climate change and water resources. https://www.washingtonpost.com/video/national/how-montana-tribes-rely-on-tradition-to-fight-climate-change/2015/11/23/d90ccbd2-8fdc-11e5-934c-a369c80822c2_video.html

Track snowpack
Data Collection Methods and Worksheet

Name:_____

Location: _____ Date: _____

Instructions: Follow the steps to collect data on your Data Collection worksheet.

1) Use a shovel to dig a pit. Carefully cut a headwall that is perpendicular to the ground. Make sure sun shines on your headwall.
2) Use a metric measuring tape to create a transect parallel to your headwall. **Record the total snow depth.**
3) Use popsicle stick to slice into snow exposed in headwall, working from the top to the bottom. Pay attention to where snow consistency changes and mark each different layer with colored sticks. **Record the thickness of each layer, labeling layers 1-x from the top down.**
4) Use the thermometer to measure the temperature in the center of each layer, the temperature at the ground-snow interface, and the air above the pack. **Record the temperature of each layer, the temperature of the ground, and the temperature of the air.**
5) **Fill a test-tube with snow from each layer** (one test tube per layer). Fill each tube to the 50 mL line, but be careful not to compress or pack the snow as you take the sample. Close and label the test-tube and melt the snow by stashing it in your pocket.
6) Follow the steps and equations on the worksheet to determine the thermal index and the snow water equivalent of the snow.

Figure 1: This student is measuring the depth of snow layers in a completed snow pit. Her measuring stick is positioned against the snow pit headwall- or the flat profile of all the layers of snow- which she has carefully dug with a shovel. Colored popsicle stick mark the snow layers she has observed.

Snow Pit Site Description:

Sampling Conditions:

Weather at time of sampling (mark all that apply)

___ Clear ___ Partly cloudy ___ Overcast ___ Raining ___ Snowing ___Blowing

___ Freezing ___ Thawing

Total Snow Depth:_____

Air Temperature:_____ Ground Temperature:_____

Layer one: Thickness (cm): Temperature (F): Volume (mL) Mass(g) Density (g/cm3) Thermal Index: Snow water equivalent:	Layer one: Thickness (cm): Temperature (F): Volume (mL) Mass(g) Density (g/cm3) Thermal Index: Snow water equivalent:	Layer one: Thickness (cm): Temperature (F): Volume (mL) Mass(g) Density (g/cm3) Thermal Index: Snow water equivalent:
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Total Thermal Index:

Snow is an important insulator! At a Thermal Index of 150-200, the ground is not affected by 24 hr temperature cycle!

Total Snow Water Equivalent (cm):

This number reflects the depth of water if all the snow were to melt right now.

Space for calculations…….

Important Information:

Mass: to determine mass begin by melting your snow samples. Remember, one mL of water= one gram of water. **There is no math in this step!** This easy conversion is not a coincidence, but a result of how these units were defined. Many scientific units are defines using water, since it is such a common but important substance.

Volume: This is the volume of the snow sample container. For volume calculations 1 mL= $1cm^3$

Equations:

$$\text{Density} = \frac{\text{snow mass (g)}}{\text{Volume on the container (cm3)}} = \text{snow density (g/cm3)}$$

Snow Water Equivalent: This is the amount of liquid water contained in the snow pack

$$\frac{\text{Snow thickness (cm) x Snow density (g/cm3)}}{} = \text{Snow Water Equivalent}$$

Thermal Index: This is the insulating power of snow

$$\frac{\text{Snow Thickness (cm)}}{\text{Snow Density (g/cm3)}} = \text{Thermal Index}$$