

**PROBLEM BASED LEARNING
EDUCATING FOR SUSTAINABILITY.**



SNOWPACK COLLECTION

SNOWPACK 102

How to Analyze SNOTEL Data

Written for Middle School and High School Courses
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This collection was funded through the Washington
State Legislature Clime Time Proviso.



PHOTO SOURCE: WSDOT, Sustainability Ambassadors

PROBLEM STATEMENT

To effectively manage our local water supply, it is critical for us to understand changes in the timing and depth of the snowpack in our mountains. How can we get precise measurements on a regular basis?

SUMMARY

This lesson can be used in concert with **Snowpack 101 and 103**. In Snowpack 102, students practice accessing and analyzing snow survey data from a mountain SNOTEL site located in the region where they live. A series of short, youth-voiced videos support students in understanding how a SNOTEL site functions, how to calculate the snow water equivalent of a certain depth and type of snowpack, and how to select and manipulate different variables to generate reports of interest.

Students will apply their skills in accessing data and generating current and historical reports to develop two scenarios projected through the year 2050. For one of these scenarios, **“business as usual,”** students will consider historical patterns continuing into the future with no significant

changes in policy, manufacturing, infrastructure, or consumption.

A second scenario, **“sustainable design,”** will engage students in systems thinking to propose a set of sustainable systems design solutions to improving water conservation and supply opportunities such as behavior change through education, policy innovations, green business decisions that drive market shifts, or engineering and IT solutions.

Learning Objectives

1. I can analyze snow survey data from a SNOTEL site located in my region.
2. I can use SNOTEL data to understand historical patterns and design future scenarios.
3. I understand the basic science behind projected climate impacts in our bioregion.



Formative Assessment

Menu of possibilities...

1. Produce sample graphs and tables generated from SNOTEL data that demonstrate my knowledge of different variables.
2. Craft math story problems with equations that demonstrate my understanding of snow water equivalent.
3. Develop a draft timeline of historical patterns and future trends.
4. Produce a description of local climate change science and related impacts expected in our bioregion. This could be in graphic form, written, video or voice recorded.

Summative Assessment

1. Produce a data-driven summary of historical snow-water equivalent patterns up to the current year.
2. Produce a projected graph or table based on current trends and scientific knowledge up through the year 2050. Include a narrative explaining your data, methods and assumptions.
3. Produce a technical report recommending sustainable design solutions for improvements in water conservation or supply.
4. A reflective commentary on what I learned, how I feel about it, and what actions I can take as an individual.

ACADEMIC STANDARDS

NGSS: MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

[Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage.]

BIG PICTURE

[NGSS Global Climate Change](#)

[NGSS Human Sustainability Standards](#)

[OSPI Environmental Sustainability Standards](#)

[OSPI Social Studies Standards](#)

[College, Career, and Civic Life \(C3\)](#)

[Common Core State Standards](#)

COMMUNITY CONTEXT

My family's sustainable practices

My Neighborhood Association

Nonprofits focused on this issue

My School and School District

My City Climate Action Plan

My City Equity Strategy

My County Climate Action Plan

My County Equity Strategy

My Energy and Water Utility

My Waste, Recycling, Compost Company

Watershed Salmon Recovery Plan

Puget Sound Regional Council

Puget Sound Vital Signs

Washington Dept of Ecology

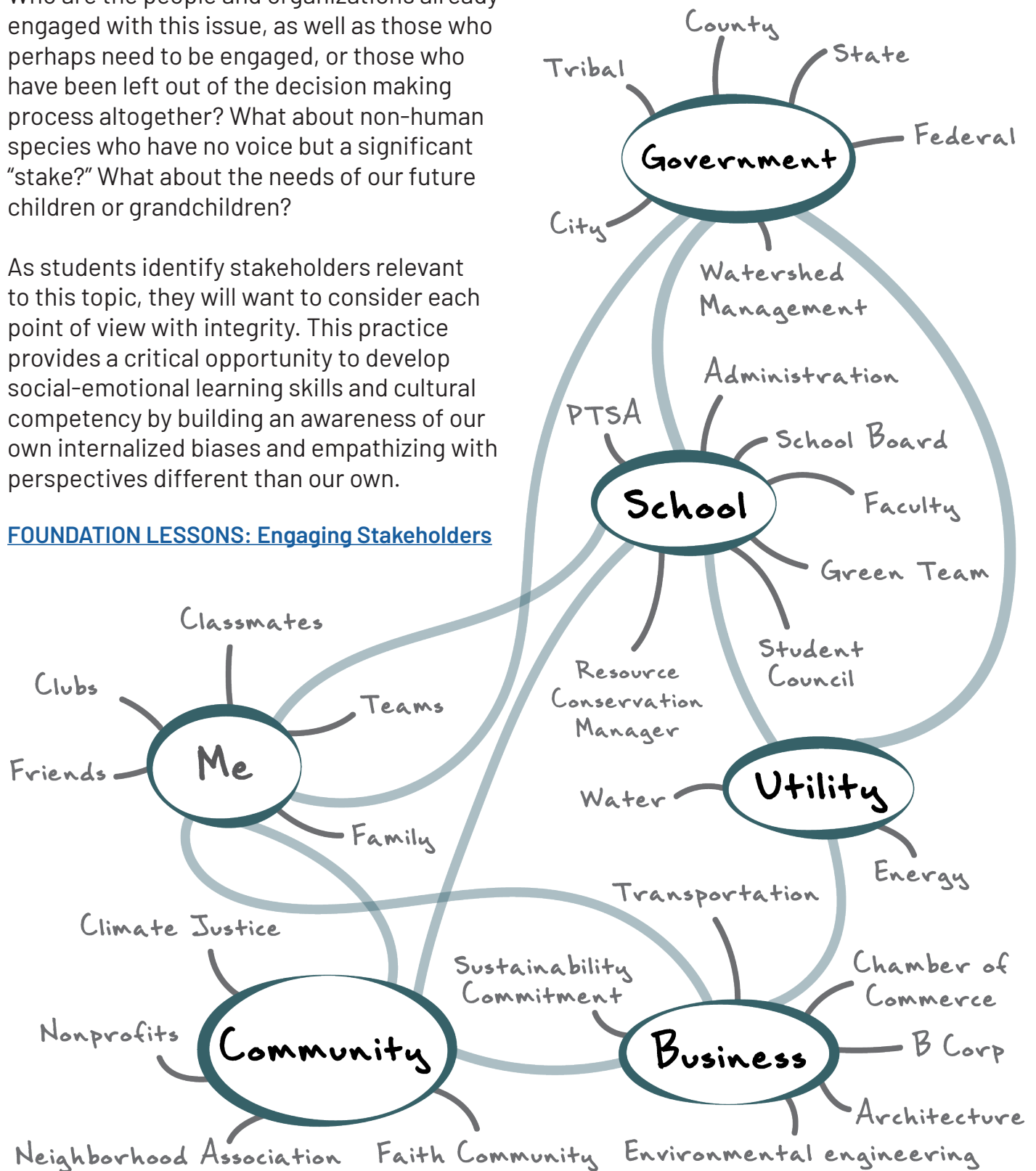
Tribal Treaty Rights

Stakeholders

Who are the people and organizations already engaged with this issue, as well as those who perhaps need to be engaged, or those who have been left out of the decision making process altogether? What about non-human species who have no voice but a significant "stake?" What about the needs of our future children or grandchildren?

As students identify stakeholders relevant to this topic, they will want to consider each point of view with integrity. This practice provides a critical opportunity to develop social-emotional learning skills and cultural competency by building an awareness of our own internalized biases and empathizing with perspectives different than our own.

FOUNDATION LESSONS: Engaging Stakeholders



BACKGROUND

We Depend on Snowpack

We have built our economy, here in the Pacific Northwest, around the assumption of a sustained snowpack. **Our snowpack is shrinking** due to human-caused climate change.

Get the latest science from the University of Washington [Climate Impacts Group](#).

Study the [Climate Change infographics series](#) from King County.

We depend on snowpack. Over the last hundred years, we have constructed dams across a number of our cascade alpine canyons to hold water in huge man-made reservoirs that serve the water supply needs of millions of people. In our region it rains a lot, especially at the higher elevations. This rain can be captured and held in our system of reservoirs.

What is not known by most people, is that we have been depending on a certain depth of snowpack each year to serve as a **second, natural reservoir** of water... **A frozen one.** This is important, because as we enter the summer months with little or no rainfall until October, our reservoirs would be drained by the water consumption demands of millions of people if not for our snowpack. The snow that packs down through the long winter will **slowly melt through the summer.** We count on this phenomena to supplement and sustain water levels in our reservoirs. We drink snow in August.

But with a shrinking snowpack over the next several decades, water resource managers, policy makers, and each of us within our own families, schools, and cities, need to make critical decisions about how to conserve water right now.

The same amount of precipitation. Part of this strange new reality is that we will actually have the same amount of annual precipitation. The water cycle will continue to lift vapor from Puget Sound and the Pacific Ocean and drop it across the landscape. But the science points to a much different annual pattern.

We can expect **much more rain in the winter** (when we don't need it) along with bigger storm events, which can cause flooding and mudslides. And we can expect **much less rain in the summer** (when we do need it) which can lead to droughts, forest fires, parched streams for salmon, and dangerous heat waves for humans. We will experience the same total amount of precipitation. It's just that, as each decade continues to bring warmer temperatures, less of this precipitation will be held in the form of snow. Diminished snowpack throughout the winter means diminished water supply late in the summer.

At the same time that we are grappling with how to adapt to our shrinking snowpack, we will need a **thousand good ideas** for how to slow, stabilize, and reverse the effects of climate change. This will take a century or more. It is critical to understand the science and make wise decisions together at all scales right now. We are all stakeholders in this challenge.

SNOTEL stations. Water resource managers carefully monitor our snowpack by analyzing daily and weekly data reports from a series of remote sensing SNOTEL stations built on ridgelines throughout the Cascades. The Natural Resource Conservation Service manages a [Snow Survey Program](#) that provides “mountain snowpack data and streamflow forecasts for the western United States. Common applications of snow survey products include water supply management, flood control, climate modeling, recreation, and conservation planning.”

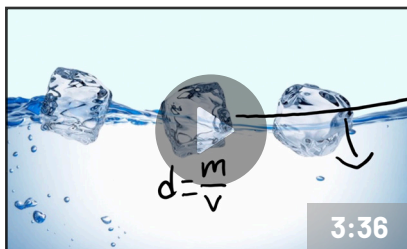
The Washington Snow Survey website includes **snow survey data, products, and reports** that students can use to understand the science and math behind the need to monitor our snowpack and make critical decisions for the current season as well as 10-30 years out.

Inquiries Across the Curriculum

To understand more about the breadth and depth of curricular concepts using snowpack as catalyst, explore a rich set of [additional inquiries](#).

Youth-voiced tutorials

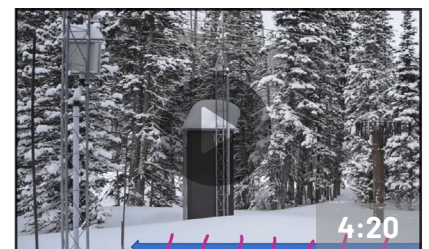
For additional support, student teams with Sustainability Ambassadors have researched and produced a series of [short videos on snowpack issues](#). All of these videos are voiced by students.



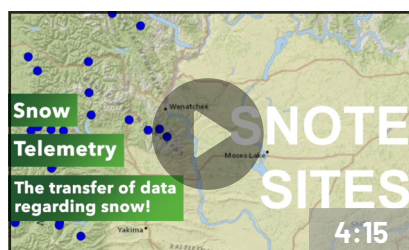
[What is Snow Water Equivalent?](#)
[Harini Baskar](#)



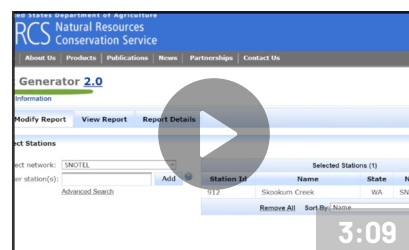
[Introduction to SNOTEL](#)
[Rishi Hazra](#)



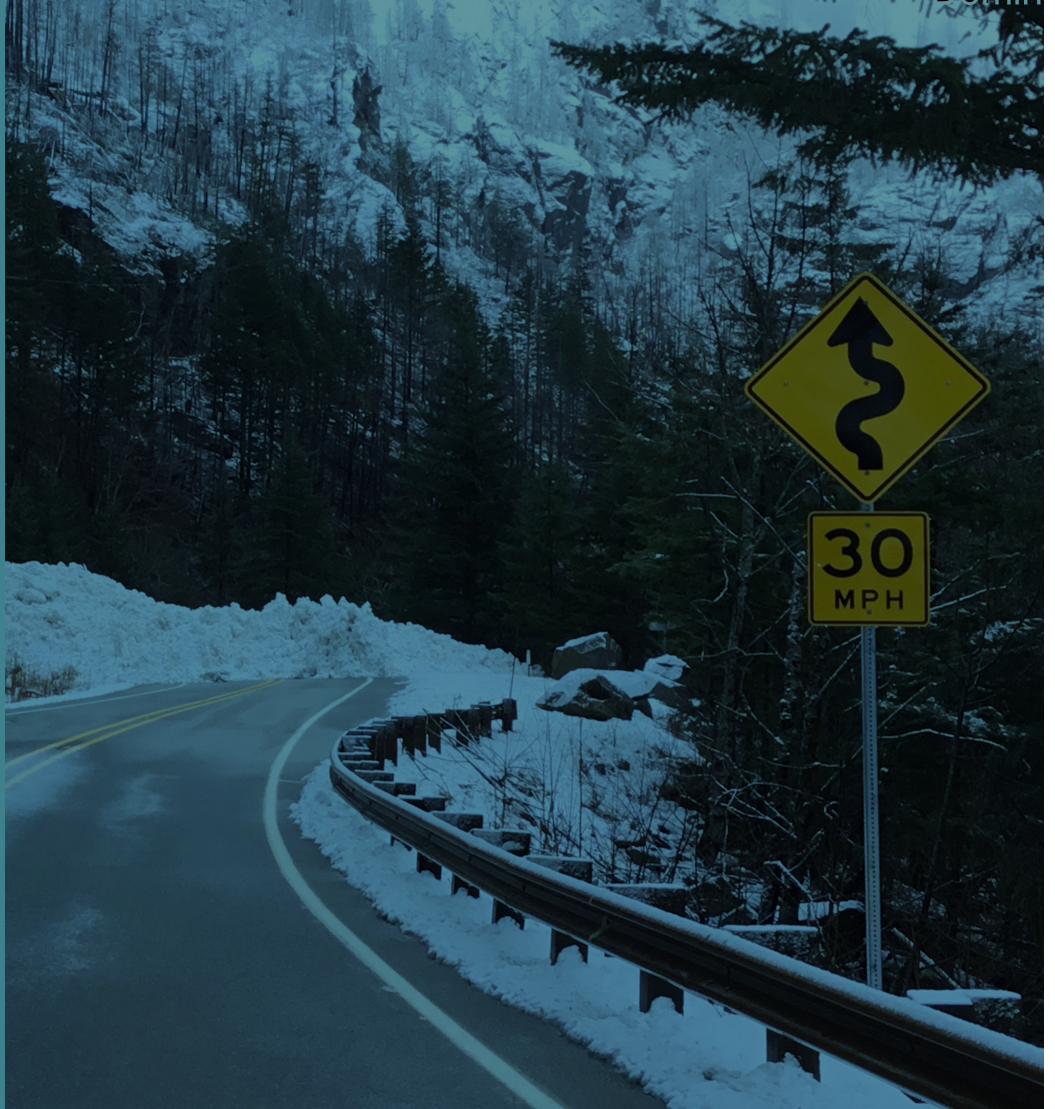
[How do SNOTEL Sites Work?](#)
[Santoshi Pisupati](#)



[Locate Your SNOTEL Station](#)
[Rishi Hazra](#)



[Generating SNOTEL Data Reports](#)
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LESSON OUTLINE

Materials Needed

Internet Access

Time Needed

2-3 class periods

ENTRY EVENT

Initial Model Part 1: Invite students to reflect on their own for 5-10 minutes to develop an initial model for how they would gather accurate snowpack data on a regular basis. Once they are satisfied with their initial model, students share in small teams and make refinements through peer-feedback.

Larger Group Discussion: Many students will perhaps imagine a model that has teams of workers hiking into the mountains to physically measure the depth of the snowpack with a long pole and tape measure. You might ask extending questions such as:

How often would workers need to physically measure the snowpack?

How many sites would we need to get useful data for our watershed? Or our region such as Eastern vs. Western Washington?

Would it be important to collect data at the same location each time? How would you find it?

For a state-wide snowpack survey, where would you place the SNOTEL sites? How many of them would we need?

What would be the training and the cost for these crews of snow survey workers?

Initial Model Part 2: Ask, "Can we imagine a way to collect snowpack data remotely? What kind of system would you design?" Students work in teams to refine their initial model with the new challenge to design a complete system that will gather and transmit snowpack data on an hourly basis 24/7 without the need for a human crew.

Activity 1

Webquest

Provide students with a link to the [Washington Snow Survey](#). Invite them to click on any links that they are curious about. Their goal is to work as a team to explain the following:

What is the purpose of the Washington Snow Survey website?

What kinds of data, products and reports can we access?

How current is the latest report?

Is there a way to look at historical patterns?

Who needs this kind of data for making decisions that impact all of us?

Activity 2

Independent Exploration Part 1 Locating a SNOTEL Station

Challenge each team to try their hand at finding a **SNOTEL site** in their region using the interactive map on the website. They will need to click on "**Station Inventory**" to display the location of SNOTEL Stations. What does SNOTEL stand for? How does one of these sites work?

Students track new questions online using a shared document.

Activity 3

Independent Exploration Part 2 Generating a Report

Challenge each team to try their hand at generating a data report using the "**Report Generator**" under the drop down menu "**Quick Links**."

Students track new questions online using a shared document.

Activity 4

Video Jigsaw

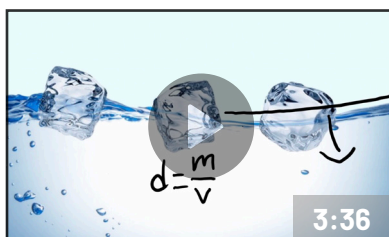
Once students have had a thorough opportunity to independently explore and explain how they think the website functions, set up a jigsaw to learn more using each of the youth-voiced videos provided in the collection of thumbnails in the Background information above.

Using their new information from the Video Jigsaw, invite students to return to the challenge of generating a data report that interests them.

Screenshot Tutorial: Use this [step-by-step tutorial](#) based on screen shots from the Washington Snow Survey website to support students in knowing how to access data and generate a report.

For additional lesson support, use some or all of the [SNOTEL Graphs with Sample Worksheets](#). Once you see how these worksheets are designed, you may want to generate examples that use data from the SNOTEL station most relevant to your location. You may also want to compare data from two different regions of Washington State such as west and east of the Cascades which receive very different amounts of prescription.

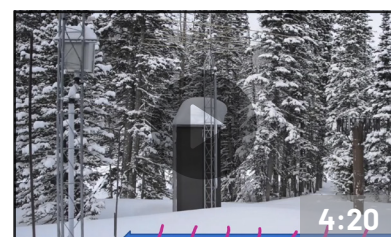
Encourage individual exploration and problem solving and invite teams to troubleshoot and coach each other before providing direct instruction. When needed, the screenshot tutorial can be helpful along with encouraging students to revisit any of the videos.



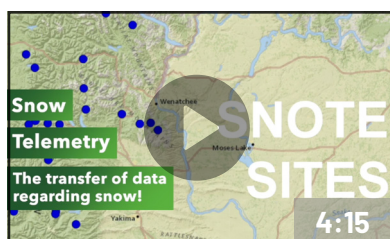
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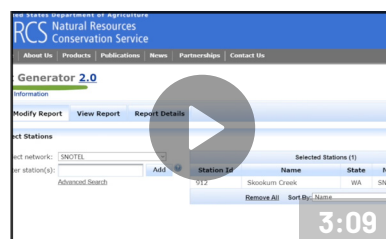
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Activity 5

Historical Patterns

Using their new knowledge, students generate a data report on historical snow-water equivalent patterns up to the current year. Encourage peer-to-peer coaching and refer to the videos and screenshot tutorial as needed. Students may also want to simply analyze the existing data here: [30-Year Climatic and Hydrologic Normals \(1981-2010\)](#)

Inquiry: Based on the data, what is your analysis of these patterns?

Activity 6

Future Trends

Invite students to work collaboratively to produce an “estimated” graph or table based on current trends and scientific knowledge up through the year 2050.

Inquiry: Based on these projected trends what might be some of the expected impacts in our bioregion during our lifetime?

According to the University of Washington **Climate Impacts Group**, our region is projected to experience significant changes in water resources, forests, species and ecosystems, oceans and coasts, infrastructure, agriculture, and human health. [See Climate Impacts In Brief](#)

Fabulous Resource!

State of Knowledge Report– Climate Change in Puget Sound

The UW Climate Impacts Group has developed this “comprehensive synthesis of the relevant research on the likely effects of climate change in our region. The report details observed and projected changes for Puget Sound’s climate, water resources, forests, species and ecosystems, coasts and ocean, infrastructure, agriculture, and human health in an easy-to-read summary format designed to complement the foundational literature (peer-reviewed science, community and agency reports, and publicly available datasets) from which it draws. The report also describes local climate change risk reduction activities and highlights data resources available to support local climate adaptation efforts.”

From the [Climate Impacts Group website](#) students can access the full report, read the Executive Summary, or click on any one of the chapters that are provided in pdf form.

Activity 7

What can we do?

Students conduct independent and/or collaborative research to produce a brief, technical report on a set of recommended sustainable design solutions. Solutions may be developed at variety of different scales or types such as:

Household, School, Neighborhood, City, Region

Behavior change through education

Policy innovations

Green business decisions that drive market shifts

Engineering solutions

Information technology solutions

Great starting places for climate solutions

[Ideas for Student Impact Projects](#)

[Project Drawdown](#)

[The Circular Economy](#)

[C40 - City Mayors leading on Policy Innovations](#)

[Climate Solutions](#)

[Green New Deal](#)

The Sustainable Solutions Report can be in any format that best supports **student voice**: written, powerpoint, panel presentation, or a video.

The report could be presented to an **authentic stakeholder audience**, an individual or group who needs to know, such as family members, the school or district Green Team, student government, PTA, the District Resource Conservation Manager, city staff working on this issue, or a local nonprofit with a similar mission.



ACKNOWLEDGEMENTS



Thank you to our **Washington State Legislature** for funding the **ClimeTime Proviso**. Your investment in climate science education is vital for engaging the next generation in applied learning for a sustainable future that benefits everyone. We thank you for your vision and commitment.



Thank you **Cascade Water Alliance** for supporting student and teacher research on SNOTEL data analysis as a foundational understanding for water resource management decision making. And for supporting the original design of the PBL Curriculum Design Lab and Teacher Fellows Program.



Thank you **King County WaterWorks Grant Program** for supporting additional partnership building and curriculum design related to water quality.

About Sustainability Ambassadors

Sustainability Ambassadors is a professional development program for student leaders, teacher leaders and community leaders committed to rapidly advance a sustainable future by aligning classroom rigor with community relevance for real world impact.

We support a year-round training program for over 60 highly motivated youth, a paid Equity Advocacy Internship, a Green Jobs Youth Pathways Portal, and a Teacher Fellows Program, working with hundreds of educators to design new models of problem-based, place-based learning around a shared vision of **educating for sustainability**.

We focus on middle school and high school youth, the teachers and school districts that guide their learning, and the community stakeholders, local government and business leaders who are relying on the next generation to be engaged voters, informed taxpayers, conscious consumers, and employees who can create and lead sustainability initiatives.

Visit: <https://www.sustainabilityambassadors.org/>

