



**PROBLEM BASED LEARNING**  
**EDUCATING *for* SUSTAINABILITY**

# **Why Do Orcas Need Snow?**

**Puget Sound Ecosystem Impacts from Climate Change**

**Grade Level: 9-10**

**Subject: Biology**

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# PHENOMENON

Why do orcas need snow?

# PROBLEM STATEMENT

*How will our Puget Sound population of orcas be affected by the projected impacts of climate change and what actions can we take to mitigate these impacts?*



# Lesson Contents

**Entry Event** - Introducing the Phenomenon: Why do orcas need snow?

**Lesson Sequence 1** - What are the needs of Puget Sound orcas?

**Lesson Sequence 2** - What factors contribute to declining Chinook salmon populations?

**Lesson Sequence 3** - How can I engage my community to mitigate the impacts of climate change on the Puget Sound ecosystem?

## SUMMARY

Throughout this unit, students will be using science and engineering practices to explain the phenomenon of **why orcas need snow** and how **climate change will affect the orca population** in Puget Sound over the coming decades.

For [local Tribes](#), salmon have always been a main source of food and are important to tribal culture. Orcas and salmon are inextricably linked in the ecosystem as **top predator** and [keystone species](#). Their success relies, in part, on our ability to **mitigate and limit our contributions to climate change**.

Climate change directly impact orcas and their central food source, **Chinook salmon**. These impacts include [changes in freshwater and saltwater ecosystems](#). For example, altered stream flow and temperature, contaminants in stormwater runoff, increased sedimentation, sea level rise and ocean acidification, alter habitats and food sources. Simply put, climate change results in **changing seasonal weather patterns** that reduce snowpack.

This leads to changes in streamflow (both flooding and drought) that limit the success of Chinook salmon populations. **Without a reliable food source, orcas suffer.**

This unit covers ecological life science standards, earth and space science standards, and environmental sustainability standards. It also connects students with their community sustainability goals, such as their city or county climate action plan, watershed management plan, or environmental justice strategy.

The lessons are designed to engage students in a **local issue** where they will use the critical skills of **obtaining information, analyzing data, asking questions, modeling, creating explanations, and engaging in argument from evidence** to measurably impact the future of their community.



## Learning Objectives

1. I use the dynamic factors of ecosystems to explain how orca population survival is interconnected with their environment and other species.
2. I apply systems thinking to build connections between my personal experience and the range of current and expected local impacts from climate change.
3. I understand the basic science behind projected climate impacts in our bioregion.
4. I can take personal action to reduce my carbon footprint.

## Formative Assessment

*Menu of possibilities...*

1. An initial personal reflection, mind map or video-self-interview on how local climate changes are already impacting me personally.
2. An analysis of Infographics on local climate change science and related impacts.
3. Jigsaw notes on analysis of readings, websites, and group discussion on how local climate change impacts will disproportionately affect people with lower incomes and communities of color.
4. Review and prioritization of possible impact projects for reducing my carbon footprint.
5. Initial and revised models completed throughout the unit.



## Summative Assessment

1. Complete a final model that shows how the southern resident orca population in the Puget Sound depends on snowfall. The model covers many aspects of the interdependence of the biotic and abiotic aspects of the ecosystem. You could also ask students to explain their model in a format they are comfortable with (written, oral, dance, etc.)
2. Implement a final impact project that demonstrates a clear connection between key learning, personal action, and one or more policy frameworks or performance measures valued by local government, the school district, or a leading community group.

# ACADEMIC STANDARDS

## Next Generation Science Standards

### Disciplinary Core Ideas:

LS2.A: Interdependent Relationships in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4.D: Biodiversity and Humans

ESS2.D: Weather and Climate

ESS3.A: Natural Resources

ESS3.C: Human Impacts on Earth Systems

ESS3.D: Global Climate Change

ETS1.B: Developing Possible Solutions

### Science and Engineering Practices:

Developing and Using Models

Analyzing and Interpreting Data

Engaging in Argument from Evidence

Constructing Explanations and Designing Solutions

Obtaining, Evaluating, and Communicating Information

## Crosscutting Concepts:

Patterns

Systems and System Models

Energy and Matter

Stability and Change

Cause and Effect

## 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**

**My School and School District**

**My City Climate Action Plan**

**My County Climate Action Plan**

**My Energy and Water Utility**

**My Waste, Recycling, Compost Company**

**My Watershed Salmon Recovery Plan**

**Puget Sound Regional Council**

**Puget Sound Vital Signs**

**Washington Dept of Fish and Wildlife**



# Breaking Down the Problem Statement

***How will the orca population of Puget Sound... be affected by the projected impacts of climate change... and what actions can we take to mitigate these impacts?***

***How will the orca population of Puget Sound...***

- What do we already know about orca? What is their life history?
- How do they fit into the Puget Sound ecosystem?
- Is there a population of orca unique to Puget Sound? How many individuals are in this group? What is the current health of this population?
- How do we know?
- Who is working on this and what are their methods?

***be affected by the projected impacts of climate change...***

- What are the climate impacts expected in our Puget Sound Bioregion?
- How can we analyze snowpack data to identify historical patterns and project future trends?
- Based on projected snowpack trends, what are the ecosystem and species impacts in our bioregion?
- With the same amount of precipitation moving through the water cycle, but with higher temperatures due to increasing levels of carbon emissions, should we expect more water (floods) in the winter when we don't need the water, and more droughts in the summer when we do need the water?

- How does increased volume, velocity, turbidity of stream flows in the winter impact salmon spawning habitat?
- How does reduced stream flows and warmer water temperatures in the summer impact migrating salmon?

***and what actions can we take to mitigate these impacts?***

- Am I responsible as a change agent in this system?
- What is my cultural, gender, racial, or economic lens?
- Do I assume that someone else will solve the problem?
- Will scientists solve this problem for us? How does science inform my values and decisions?
- Will engineers? What's my agency as a designer? Innovator?
- Will the business community solve it? What's my agency as a consumer? Employee? Entrepreneur?
- Is it up to the government to solve this? What's my responsibility in a democracy?
- What knowledge and skills do I have or need to develop to solve this problem?
- If I designed an impact project, how would I measure that it actually had an impact?
- Who are the stakeholders that can help inform the design of my impact project, folks who are already working on this issue? And who are the stakeholders that my impact project can positively influence?

## ***Inquiries Across the Curriculum***

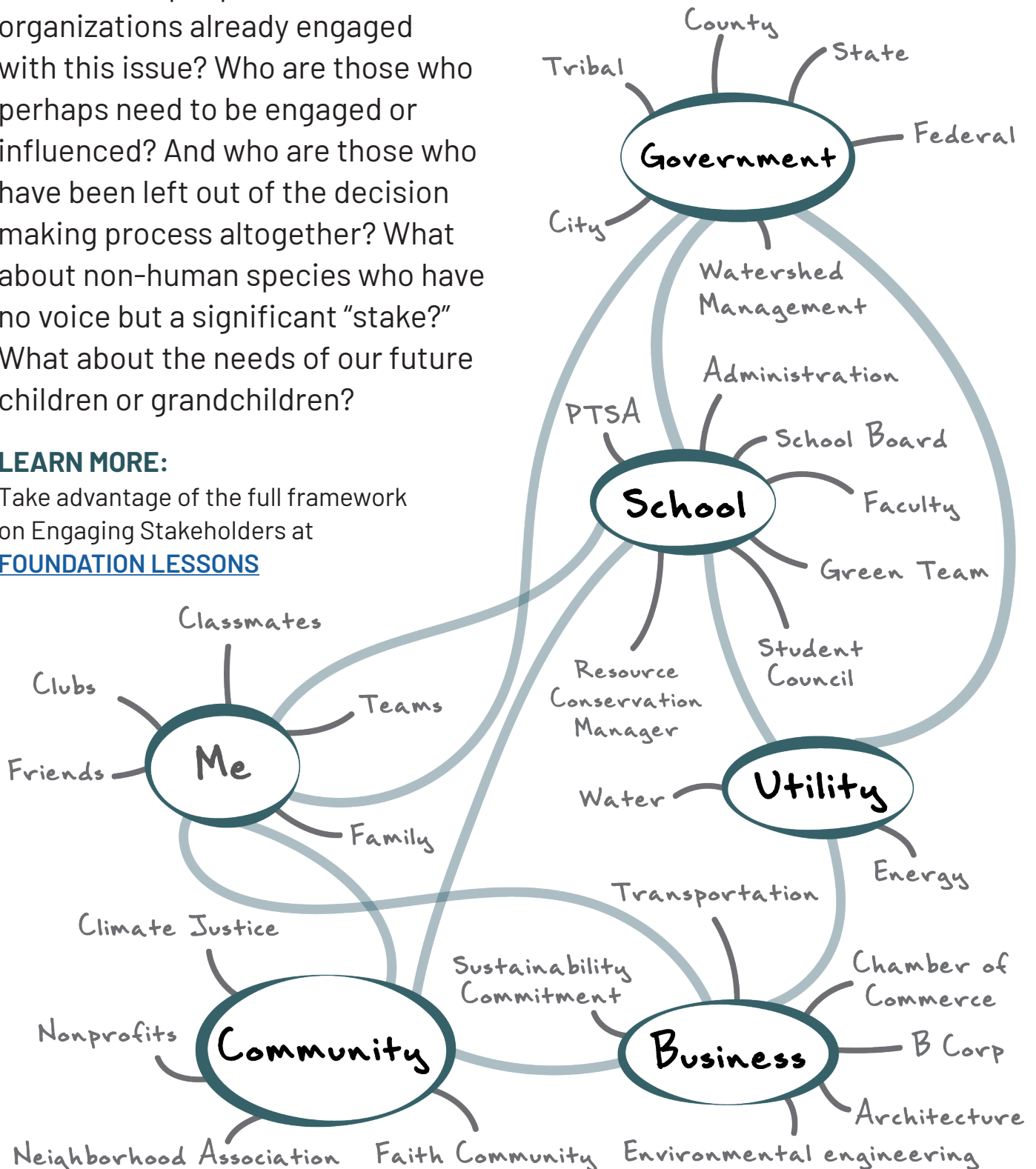
To understand more about the breadth and depth of curricular concepts using local climate impacts and our shrinking snowpack as a catalyst, explore a rich set of additional inquiries. [Snowpack List of Lesson Inquiries.](#)

# Stakeholder Brainstorming

Who are the people and organizations already engaged with this issue? Who are those who perhaps need to be engaged or influenced? And who are 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?

## LEARN MORE:

Take advantage of the full framework on Engaging Stakeholders at [FOUNDATION LESSONS](#)



# Stakeholder Perspectives and Engagement Strategies

As students identify specific 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 expanding our capacity for empathizing with stakeholder perspectives different than our own.

## EXAMPLE: Stakeholder Engagement Table

STAKEHOLDERS	INTERESTS	GOALS	APPROACH
Name of stakeholder group	What motivates them? What do they care about? What are they responsible for?	Do they have specific action plans, goals, or projects they are pursuing?	What is the best message and timing to engage with this group?
My family	Survival & the ability to carry out normal activities in spite of a changing climate.	Surviving & thriving in spite of climate change.	Word of mouth, sharing media or news, informal conversation.
School (Green Team, RCM, PTA, ASB)	Implementing resource conservation strategies that protect the environment & keep the school running.	Saving money. Conserving natural resources. Planning for the future.	Green Team group chat or social media. PTA & school e-news. School or District Climate Action Plan.
My City	Ensuring residents have access to clean drinking water, clean energy, and housing as we experience climate change.	Transportation, water, & clean energy systems that can withstand a changing climate.	Presenting at City Council meetings. Proposing resolutions. Contacting city staff and elected representatives.
Southern Resident Orcas	Survival in their current habitat. Having enough food and reduced noise pollution. Somewhere safe to their rear young.	Longevity of their species. Maintain the intricate matriarchal survival strategies that co-evolved with salmon abundance.	Ecological restoration, policies that protect critical freshwater and marine habitats.
Tribal Governments	Access to fishing grounds for salmon, shellfish, and plants as guaranteed by treaty rights.	Maintain natural resources for current & future livelihoods plus cultural connections.	Letters of support and allyship acknowledging treaty rights and improving relationships.



# 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.

**The ecosystem and humans all depend on snowpack.** Over the last hundred years, we have constructed dams across a number of our Cascade river canyons to hold water in huge human-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.

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

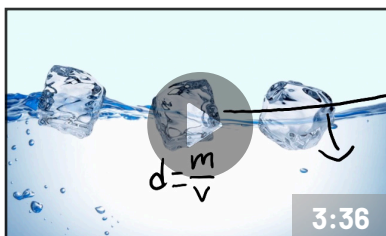
continues to bring warmer temperatures, **less of this precipitation will be held in the form of snow.** Diminished snowpack throughout the winter means diminished water supply late in the summer.

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 behind climate change and shrinking snowpack 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.

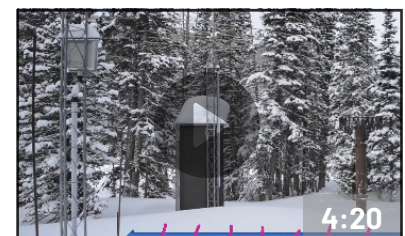
For additional support, student teams with Sustainability Ambassadors have researched and produced a series of [short videos on snowpack issues](#). All of these videos are voiced by students.



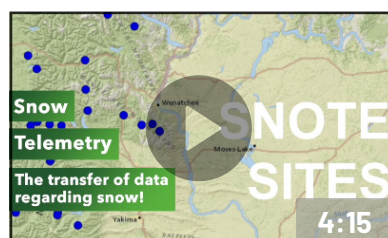
[What is Snow Water Equivalent?](#)  
[Harini Baskar](#)



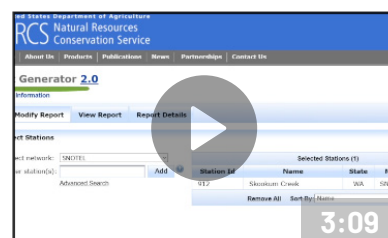
[Introduction to SNOTEL](#)  
[Rishi Hazra](#)



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



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



[Generating SNOTEL Data Reports](#)  
[Rishi Hazra](#)

# So... Do Orcas need Snow?

## Connecting Orcas, Chinook Salmon and Snowpack

There are three distinct groups of Puget Sound orcas ([Orincus orca](#)) throughout the [Salish Sea](#) ecosystem typically classified as **Southern residents, transients, and offshores**. These groups vary by diet, morphology, and behavior.

In Puget Sound, we tend to focus on the **Southern Resident killer whale (SRKW)** population. This group relies heavily on **Chinook salmon** as a central food source. Chinook salmon are also [considered endangered](#).

As climate change progresses, SRKW are facing challenges from reduced Chinook salmon populations, underwater noise pollution and boat traffic, and exposure to [persistent organic pollutants](#) (POPs).

Persistent organic pollutants are especially dangerous because they are fat soluble - meaning when SRKW populations are stressed and lacking food, they metabolize more of their fat reserves which means they are also metabolizing environmental contaminants like POPs that have been absorbed in their body fat. It also means that nursing mothers offload heavy doses of contaminants to baby orcas, because mother's milk is very high in fat.

Since orcas rely on Chinook salmon as their main food source, the impacts of climate change on streamflow and thus fewer salmon are felt acutely.

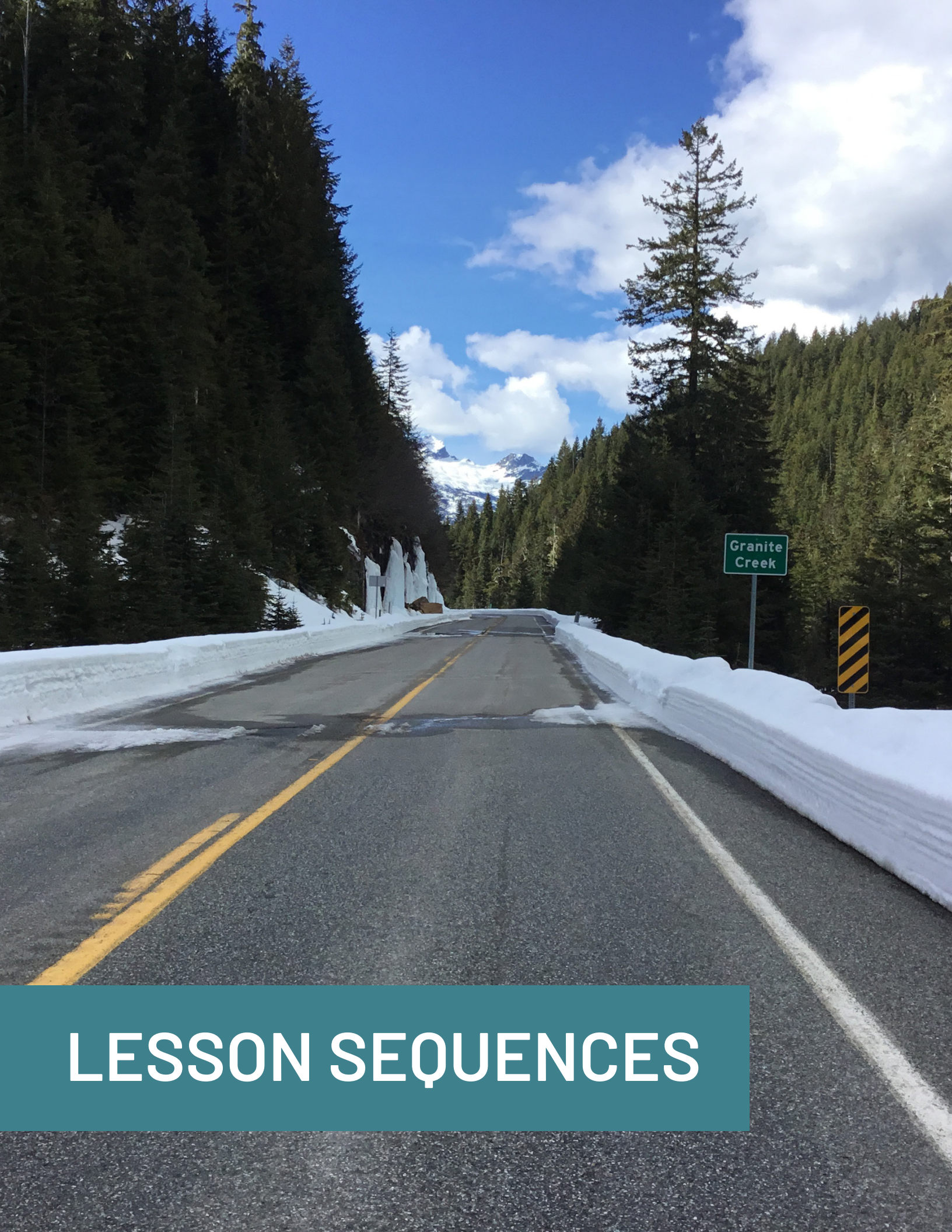
[Chinook salmon](#) ([Oncorhynchus tshawytscha](#)) need **cool, clear streams** to survive. The temperature of the water depends partially on **seasonal snow and glacier melt** from the mountains in the Pacific Northwest.

With less precipitation falling as snow thereby **reducing snowpack**, there are lower [streamflows](#) in summer and fall. Streams can increase in temperature during this time, making it even more difficult for juvenile or adult salmon to survive.

Alternately, higher streamflow or floods in winter can damage salmon eggs and gravel beds used for redds. [Compounding streamflow issues](#), stormwater runoff from flooding can harm adult salmon as they return to spawn, especially in urban streams and, where salmon do successfully spawn, pollution can limit oxygen availability to eggs and alevin.

While streamflow, temperature, and pollution are not the only environmental factors that contribute to Chinook salmon survival, they demonstrate the far reaching impacts of climate change throughout every life stage.

*Salmon depend on  
clean, cold, swift water.  
Orca depend on salmon  
abundance. Both  
depend on snowpack.  
Snowpack is shrinking  
due to climate change.  
We are responsible for  
all of it.*



# LESSON SEQUENCES

# VOCAB AND KEY SEARCH WORDS

**Water Cycle**

**Climate Change Impacts**

**Climate Mitigation Actions**

**Seasonal Precipitation Patterns**

**Shrinking Snowpack**

**Snow Water Equivalent**

**Streamflow**

**Keystone Species**

**Top Predator**

**Salish Sea**

**Puget Sound Ecosystem**

**Food Web**

**Biotic and Abiotic elements**

**Environmental Contaminants**

**Puget Sound Orcas**

**Chinook Salmon**

**Life History of Orca and Salmon**



# WHY DO ORCAS NEED SNOW?

**Materials Needed:** Media sources (digital or printed), initial model sheets, whiteboard or chart paper and pens

**Time Needed:** Approximately 50-minute class period

## ENTRY EVENT

### Introducing the Phenomenon

Distribute information from media sources regarding the decline in Puget Sound orca populations. Students can choose which types of sources interest them or the class can jigsaw the sources to consider what is happening to the orca populations.

#### Media Sources to support this activity:

Article- CBS News: [Killer whale population declining in Puget Sound](#)

Blog Post- Puget Sound Institute: [Are the orcas starving? Scientists say it's not that simple](#)

Article with Graphics- Seattle Times Hostile Waters Project: [Orcas thrive in a land to the north. Why are Puget Sound's dying?](#)

Video- King5: [The Puget Sound orca population is declining, here's how you can help - New Day Northwest](#)

Video and Article- KIRO7: [Endangered Puget Sound killer whale found dead](#)

Article- CBC: [Death of killer whale J-32 troubling, say scientists](#)

As they process their media source, students should focus on what they notice about their information by filling out a Noticings/ Wonderings T-chart with their observations and questions.

### Making Initial Sense of the Phenomenon

Initiate a small group or class discussion where students share their noticings and wonderings from whichever media source they explored. Are there patterns in their noticings? Are there patterns in their wonderings? Allow students to voice their initial ideas of what's going on with the orca population, even if they are farfetched. Record the patterns of noticings and wonderings on the board or chart paper to make them visible for all students.

Allow students to construct their own initial explanations of what might be happening with the southern resident orca population and create an initial [model explanation](#) of why orcas need snow.

**Formative Assessment:** Use students' initial models to get a baseline sense of their current understanding of the phenomenon.



# Lesson Sequence 1

## What are the needs of Puget Sound Orcas?

**Materials Needed:** internet access, paper, initial models, print resources listed below (optional)

**Time Needed:** approximately three 50-min class periods

### ENTRY EVENT

Guide student discussion and questioning of the declining populations into the factors for population decline. This is a good entry for population dynamics and carrying capacity lessons if not already covered during the year. Focus students on the concept that populations decline when their needs are not being met.

### ACTIVITY 1.1

Engage students in research within small groups to discover the needs of orcas (especially those in the Puget Sound) and the main factors that could be contributing to their decline.

Resources to support this activity:

[EPA Southern Resident Killer Whale Salish Sea Report](#)

[Puget Sound Vital Signs - Thriving Species and Food Web: Orca](#)

[Orca Task Force - State Department of Ecology](#)

[Washington Department of Fish and Wildlife: Killer Whale Fact Sheet](#)

[Marine Mammal Commission: Southern Resident Killer Whale](#)

The goal of this activity is to allow student discovery of the limiting factors of carrying capacity (food, space, competition, etc.). Have students use a discussion protocol to rank the needs of orcas from most important to least

### ACTIVITY 1.2

At this point in the unit, students have discovered that orca populations are declining due to declining food (Chinook salmon) as it is a highlighted issue in most articles about the declining population. Students should be able to describe how this is a dynamic, systemic issue with many factors to consider.

Show students this graphic from [Puget Sound Vital Signs](#) which measures the ecosystem health and progress towards Puget Sound's recovery goals.

Have students discuss noticings and wonderings about what they discovered about orca populations and the indicators mentioned. Focus on the **"Thriving Species and Food Web"** indicator - what do they think that means and what do they know about food webs?

This is a good entry for food web and trophic pyramid lessons if not already covered during the year. If time allows, consider having students use the resources to research and build their own food web of the Puget Sound ecosystem.

Washington Department of Fish and Wildlife also has a quicker [Puget Sound Food Web Activity](#) where students can learn a little bit about the organisms in the ecosystem and build their own food web (cut the cards out and glue them on paper, adding arrows to create a food web).

Or, you can show students the **Food Web of Puget Sound** [POSTER](#) or [SLIDE SEQUENCE](#).

## Resources to support this activity:

[EPA Southern Resident Killer Whale Salish Sea Report](#)

[Salish Sea Marine Survival Project: Research Activities](#)

[VIDEO] [Near Shore Ecosystems Presentation](#) Kollin Higgins,  
Senior Ecologist, King County Dept. of Natural Resources and Parks

[Puget Sound Vital Signs- Orcas](#)

[Puget Sound Vital Signs- Dashboard](#)



## ACTIVITY 1.3

Students consider what they have learned about the needs of orcas and how they are connected to their ecosystem and revise (add to, change, or cross off previous ideas) on their initial model.

Have students share their models with a partner and take turns asking questions about each other's thoughts on the models. They may choose to refine their model again afterwards.

Students should be identifying Chinook salmon decline as one of the main contributors to orca population decline citing evidence such as the Puget Sound food web and vital signs showing Chinook are the primary food source for this population.

**Formative Assessment:** Use students' revised models to review their current understanding of the phenomenon.



Photo Credit: Tom Reese

## Lesson Sequence 2

### What factors contribute to declining Chinook salmon populations?

**Materials Needed:** Internet access, student models from first activity, whiteboard or chart paper

**Time Needed:** Approximately seven 50-minute class periods

### ENTRY EVENT

Initiate a discussion with students to guide them in transferring their knowledge of orca needs to salmon. Salmon should have similar needs in their ecosystem but the factor contributing most to their decline is a very important difference. Students should work together to unpack the conservation concerns of the Chinook and the value of them as a keystone species using the resources below. Resources to support this activity:

[National Wildlife Federation: Chinook Salmon](#)

[Puget Sound Vital Signs - Thriving Species and Food Web: Chinook Salmon](#)

[NOAA Fisheries: Chinook Salmon](#)

[Columbia Climate School: Rising Water Temperatures Could be a Death Sentence for Pacific Salmon](#)

The goal of this entry event is for students to understand that while the salmon share the same base needs as the orcas, the need that plays the greatest role in their decline is habitat and space, not food.

## ACTIVITY 2.1

Students may have background knowledge about the issues that salmon face in the Puget Sound (or Pacific Northwest in general). Invite students to share what they know and what questions they have about salmon before diving into the factors that impact salmon survival. Record these questions as a class.

Divide students into small groups to begin to look into the habitat issues that Chinook salmon face in the Pacific Northwest. This can be done as a webquest or as a jigsaw, depending on how you would like your students to interact with the material.

### Resources to support this activity:

[VIDEO] [Why are Salmon Dying Before They Can Spawn?](#) Kathryn Davis, Stewardship Manager, Puget Soundkeeper

[Mywater.world - "Maps We Love"](#) Salmon, especially:

[Known Freshwater Distribution of Chinook Salmon for Water Resource Inventory Area 8](#)

[Washington Dept. of Fish and Wildlife SalmonScape Map](#)

[And Then What Happened? Map Series \(Activity\)](#)

[Salmon Conservation and Restoration Plan](#)

[Salmon Habitat Recovery](#)

[Salmon Habitat Plan | Goals and Objectives 1 pager\)](#)

[Making Our Watershed Fit for a King Poster](#)

[Ecosystem Services Enhanced by Salmon Habitat Conservation in the Green/Duwamish and Central Puget Sound Watershed](#)

[Chinook Salmon Recovery Timeline](#)

## ACTIVITY 2.2

Students may be starting to notice that changes in water are the main issue regarding habitat for salmon. *Water availability, water supply timing, water temperature, and increased water intensity leading to scoured stream beds* are all major factors for decreasing habitat suitability for salmon populations.

Guide students into asking questions about why water has changed so much and what factors affect water in the Puget Sound area. From this discussion, lead students into the lessons on snowpack using snow telemetry (SNOTEL) data. See [Snowpack Lesson Collection](#)

The following are select lessons from the [Snowpack 101 - It's Personal](#) lesson outline which can be used to help students build understanding for the [Snowpack 102 - How to Analyze SNOTEL Data](#) (activity 3).

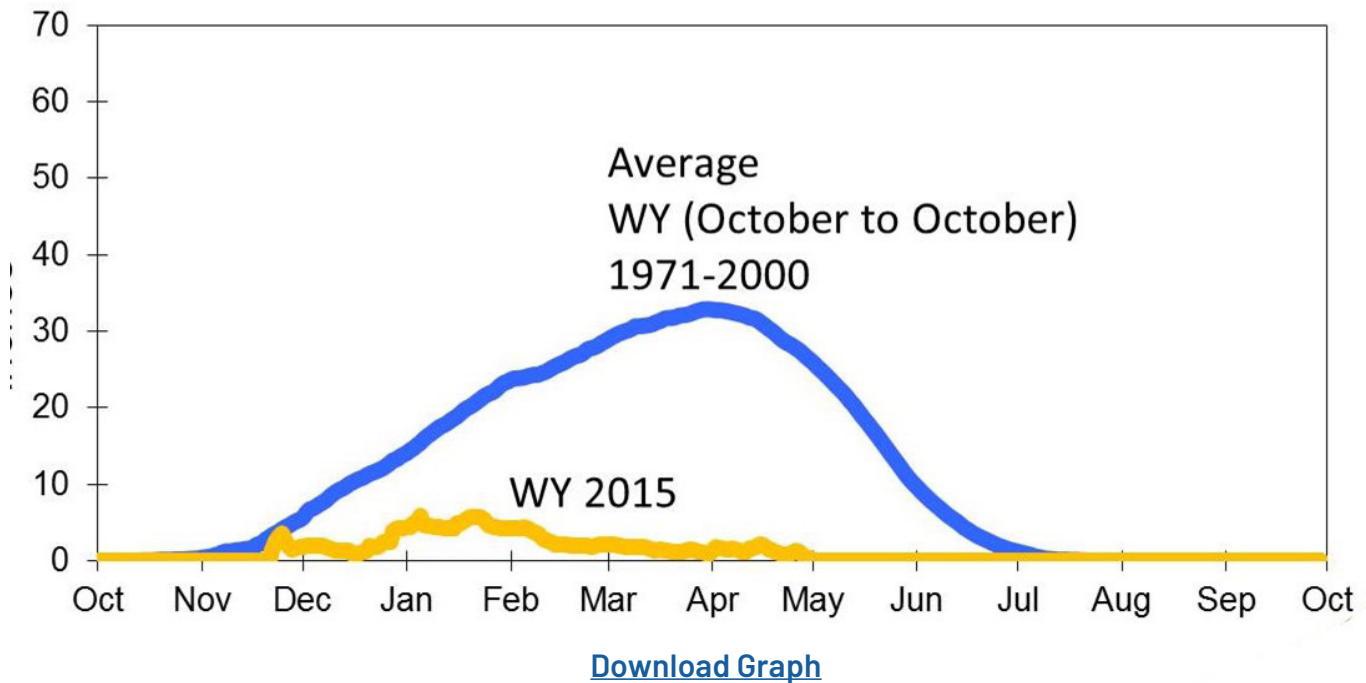
### Water Year Comparison Graph

Invite students to explore and discuss the relationship between the two lines on the graph pictured on the next page. The letters "WY" stand for **water year**.

The yellow line tracks **snow water equivalent** for the drought year of 2015 and the blue line tracks snow water equivalent over a 30-year average.

Is 2015 the new normal for our lifetimes? How can we find out? If true, what will be the impacts? **What actions can we take** to minimize or adapt to these impacts?

## Cumulative Snowpack (Snow Water Equivalent) Weighted Average Cedar/Tolt



### Additional Research

In this research phase, based on understanding the science, you may want to support individual or team-based research, or engage students in a jigsaw using some or all of the following resources:

[How Severe Is the Western Drought? See For Yourself.](#) A New York Times article from June 2021 with a number of compelling maps, charts and graphs.

The Natural Resource Conservation Service manages a [Snow Survey Program](#) that uses remote sensing SNOTEL stations to produce mountain snowpack data and streamflow forecasts for our region. Also see one or more of the student-produced, short videos in the SNOTEL series featured in the background section of this lesson.

[Northwest Climate Impacts in Brief.](#) One concise paragraph on each of the major impacts expected in the coming decades based on climate change data analyzed by the University of Washington Climate Impacts Group.

[State of Knowledge Report – Climate Change in Puget Sound.](#) A comprehensive synthesis report summarizing relevant research on the likely effects of climate change on the lands, water, and people of the Puget Sound region.

## ACTIVITY 2.3

Follow along with the activities in the [Snowpack 102 - How to Analyze SNOTEL Data](#) lesson. This lesson will walk students through how to retrieve and analyze data from the snow telemetry sites from Washington. There are many different ways to adapt this for students, from pulling the data and giving them the processed charts/graphs to analyze, or allowing students to use the tutorials to decide which data is most relevant and create their own charts/graphs for analysis. As you work through these lessons, keep the question we are studying in their minds for students: **What factors contribute to declining Chinook salmon populations?**

To support using the data analysis to answer the question, **students will need to know:**

*What is snowpack and why is it important?*

*How does snowpack affect the salmon habitats (like streams)?*

*How is climate change affecting the snowpack and watersheds?*

*What changes might we expect to see due to continuing changes in the climate?*

Some additional resources which will be valuable in tying the Snowpack 102 lesson with the decline in habitat are:

[Table 1: Anticipated climate effects, impacts to salmon and critical geographic areas](#) of occurrence from WRIA 7 Climate Change Impacts to Salmon Issue Paper (March 2017)

[Salmon Climate Impacts - Tulalip Tribe](#) (paper with many supporting graphs and images, selected graphs below)

[Figure 1: Salmonid life stages and impacts of climate change - Chinook Salmon ONLY](#) (adapted from Beechie et al., 2012)

[Figure 2: Salmonid life stages and impacts of climate change - ALL Salmonids](#) (adapted from Beechie et al., 2012)

### [Figure 3: Streamflow Changes in Green River vs Nearshore 2040-2080](#)

[VIDEO] [Reducing Stream Temperature for Salmon – Newaukum Creek Presentation:](#)

Josh Kahan, Middle Green/White River Basin Steward, King County Dept. of Natural Resources and Parks, Water and Land Resources Division

### EXTENSION ACTIVITY

Have students practice informational text decoding provided in the Lesson: **Nonfiction Reading on our Shrinking Snowpack** lesson. [See Snowpack Lesson Collection](#)

## ACTIVITY 2.4

After understanding the importance of snowpack and its effect on salmon, have students return to their models to construct a full explanation of why orcas need snow. Students can either revise their initial models or be given a new template to create a final explanation. Some students may want to design their own by hand or digitally.

When the models are complete, facilitate a small group or large group carousel where students review each other's ideas and use sticky notes to ask clarifying questions or show agreement/support for the modeler's ideas.

These models will be used in the final lesson sequence of the unit as evidence for students' impact projects.

**Summative Assessment:** Use students' final models to review their understanding of the phenomenon. This summative covers many aspects of the interdependence of the biotic and abiotic aspects of the ecosystem. You could also ask students to explain their model in a format they are comfortable with (written, oral, dance, etc.)

# Lesson Sequence 3

## How can I engage my community to mitigate the impacts of climate change on the Puget Sound ecosystem?

**Materials Needed:** varies depending on the impact projects

**Time Needed:** varies depending how in depth the impact projects are

### ENTRY EVENT

Through lesson sequence 1 and 2 students have explored the dynamic ecosystem of the Puget Sound and how climate change will impact the ecosystem for the entire watershed. Engage students in considering the future with climate change by following the [What if Drought is the New Normal?](#) lesson.

### ACTIVITY 3.1 – Impact Projects

Lesson sequence 3 is a project exploration to apply their learning of the dynamic ecosystem to implement solutions to mitigate effects from climate change at different scales. Students could decide to implement individual, household, neighborhood, community, or city-wide solutions depending on their interests, but all impact projects should be measurable in some way.

To prepare for their impact projects, students could spend some time learning about what healthy Puget Sound Vital Signs are ([website](#), [research graphic organizer](#)) or, reviewing other restoration or impact plans such as:

[Salmon Recovery Plan](#)

[Kokanee Salmon Restoration](#) (King County)

[Spawning Grounds documentary](#) featuring the work of the Snoqualmie Tribe, biologists, and private landowners to restore Kokanee habitats

[Tribes Use Western and Indigenous Science to Prepare for Climate Change](#) article

For ideas to get the program started, consider the Lesson: [Our Classroom Climate Action Plan](#). Students can also use the [Impact Project Design Template](#) from Sustainability Ambassadors to design their project.

Students can also find a bank of great [Student Impact Project Ideas](#) on the Sustainability Ambassadors website.

**Performance Assessment:** Have students show on their final model of why orcas need snow the effect their impact has on the southern resident orca population in Puget Sound. They should be able to directly tie their impact to supporting the population using the evidence they gathered throughout the unit to support their connection.



# ACKNOWLEDGEMENTS



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## 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/>

