DEVELOPING A SCIENCE-BASED CLIMATE RESILIENCE CURRICULUM FOR INDIGENOUS YOUTH THROUGH THE LENS OF INTERSECTIONAL ENVIRONMENTAL JUSTICE AND COMMUNITY BUILDING

by

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This paper and educational curriculum was created on the stolen lands of the Coast Salish, Puyallup, Nisqually, Cowlitz, Squaxin, S'Klallam, Twana, and Skokomish people. It is essential to note, curriculum materials were made through the lens of a privileged white woman, who has been formally educated through primarily Western pedagogy.

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ABSTRACT

Our climate is quickly changing and it is affecting populations throughout Washington State, specifically areas surrounding Washington's waters. To prepare for our changing climate and for our transition from a reliance on views and beliefs that have led us to our current global environmental problems, we must focus on teaching high school youth skills to monitor and track changes in their local environments and to organize and make changes that build community resilience. Native youth are at the forefront of the changing climate and see climate disasters daily. A co-production of educational curricula using traditional knowledge and western knowledge can allow for an educational curriculum that builds resilient communities and community members. Through review of literature, cooperation with varying organizations, and focus on hands-on aquatic monitoring skills, I developed a curriculum for high school youth. The high school curriculum, composed of 11 modules of lessons, activities and site visits, is a living tool and should change and adapt with the students. It will be reviewed by educators, tribal members, tribal elders, students, and Washington State employees for continued betterment and relevancy. As a live document, the curriculum will incorporate feedback from students, and the results of learning efficacy surveys. Education, hope, and resilience are essential to a future in an ever-changing world. Through kinesthetic learning opportunities in environmental monitoring, students will become more prepared to take action on climate. This knowledge coupled with knowledge of policy, organizing, and justice will ensure students are well equipped for professional opportunities and to overcome various societal constraints.

INTRODUCTION

Community building and community action are integral to traditional knowledge and native communities (Native Indian Collective [NDN Collective], 2021). These tools and skills are essential in the preparation for the effects of climate change. Knowledge of the scientific process is critical for understanding the impacts and effects of climate change, but so is knowledge in changing policy, building community power, and preparing climate-resilient cities (Finucane, 2009). Knowledge of environmental science alone is not enough to fight for a future in our quickly changing world. The ability to effectively communicate environmental science to organizers, planners, representatives and the public is also an essential skill to prepare communities for these future impacts (Brownell et al., 2013).

Community education is a critical agent to address the issue of climate change (Canada, 2021). Local community engagement in science can have multiple benefits. Foremost, it educates the community on locally relevant environmental issues and can improve scientific research's rigor, relevance, and reach (Balazs & Morello-Frosch, 2013). For instance, Western Washington community members are dependent on the Washington's waters for recreation, food, livelihood, and wellbeing. The Salish Sea is a unique fjord ecosystem that provides essential habitat to a wide range of species. However, it is facing extreme pressures from rapid population growth and climate change (Canada, 2021). Local communities have an important voice in the management and protection of Washington's waters. There is an opportunity to include them in the process of scientific data collection and analysis, to help focus on the needs of local community members and ensure they have their voices heard.

Youth from communities throughout Western Washington can act as community scientists and can improve environmental research. Knowledge of aquatic monitoring skills such as collecting data on water parameters, biological data collection, field safety, and data analysis, allow community members to participate in and contribute to local science on the effects of climate change on the Salish Sea. Community involvement in monitoring and understanding climate change impacts on local watersheds can create a sense of agency with community members and can be used as a power to create change (Sinnott & Gibbs, 2014). Community science provides a foundation for environmental advocacy and appreciation as well as a sense of community connection to the land. With scientific research and analysis skills, community members can identify issues in their local watersheds and then advocate for change in their local communities based on this research. Implementing hands-on aquatic-based field research and analysis in conjunction with education on environmental justice, policy development, and community building will give youth the power to be agents of change.

Educational internships are becoming increasingly common as training opportunities for young adults and adults, to develop tools, passions, and skills for goals later in life. In Western Washington, young adults have a better chance to contribute to building solutions to the climate crisis with a foundational knowledge in climate science, hands-on aquatic monitoring and analysis, environmental justice, and the principles of community building.

The goals stated in the Washington State Department of Natural Resources climate resiliency plan match the basic concepts and ideas of Traditional Ecological Knowledge (TEK) and indigenous knowledge (Siemann, 2020). Following a deep history and current continuation of systemic and racist oppression of indigenous peoples, settler colonialism, and the destruction of traditional ecological knowledge and indigenous land management traditions, many government agencies need to rethink and rebuild their management practices. The climate resiliency plan acknowledges that tribes bring valuable science, leadership, expertise, and local and indigenous knowledge that can help better inform the management of natural resources in Washington State (Siemann, 2020). As a state agency based on resource extraction, DNR walks an intriguing line between extraction and environmental stewardship, one that is needed in our nation's current commitment to management of natural resources. DNR aims to build climate resilience and to sustainably use natural resources to support community and environmental health now and into future generations. This commitment leads to the development of this curriculum and the relationship between DNR Aquatics and the Skokomish Tribe. Skokomish Community members and other partnering organizations encourage the result of a hands-on curriculum that focuses on career skill-building and climate resiliency.

Hands-on career development opportunities in aquatic sciences are needed for Native youth throughout the Salish Sea to build community resiliency and influence real world change. The Salish Sea is an inland sea that encompasses the Puget Sound, the San Juan Islands and the inland waters off of Vancouver, BC (SeaDoc Society, 2022) (Figure 1). This study area for my project includes the Washington State portion of the Salish Sea. My paper describes the creation of a curriculum that teaches hard scientific skills alongside skills that encourage climate action and can be used in internships and high school classrooms. Teaching these skills, combined with environmental justice, policy making, and community action, can be difficult and polarizing. Therefore, in this paper I analyze the challenges in developing and producing a climate resilience curriculum for Indigenous youth and discuss the development of a high school internship educational curriculum.

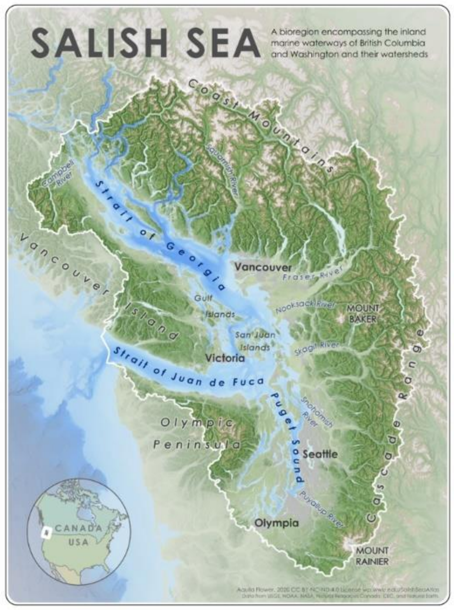

Figure 1 - Map of the Salish Sea Bioregion (SR3, 2021)

Curriculum Inception

To develop this curriculum, I have been working in coordination with governmental and non-governmental groups throughout Washington State. DNR has an interest in creating this curriculum to follow the current Climate Resilience Plan (Siemann, 2020), which focuses on research, education, and community involvement to increase resilience to our quickly changing climate. DNR Aquatics Division has an Aquatic Assessment and Monitoring Team focusing on climate resilience research. This team, led by Dr. Cinde Donoghue, incorporates education and community science into their research. This team has an ongoing project called the Acidification Nearshore Monitoring Network, lovingly known as ANeMoNe. This project focuses on 12 sites throughout Washington's waters and monitors various water parameters and biological parameters.

One of the ANeMoNe sites is located on the Skokomish Delta, near what is now known as the town of Union, WA. The Skokomish Tribe communicated interest in an educational internship program for youth tribal members based on aquatic monitoring surrounding this site. The internship will involve multiple meetings per week focusing on education and field work during the school year, and paid employment with partnering organizations during the summer months. In preparation for this internship, which will begin in the Fall of 2022, I have developed an educational curriculum.

Components of a Good Internship and the Importance of Hands-on Learning

Well-designed internships can have good influences on the lives of youth. Some conditions of successful internships include emotional and physical safety, caring relationships, youth participation, community involvement, and engaging skill building (SacramentoWorks, 2020). Kinesthetic science focuses on the use of physical materials, and gives students experience in scientific methods and analysis (Triona & Klahr, 2007). Students who engage in hands-on activities daily, or even once a week, score significantly higher on science focused standardized tests than students who engage in hand-on activities once a month or less (Stohr-Hunt, 1996). Kinesthetic learning, especially in the field of environmental science, helps to engage students and allows for greater levels of academic success, based on Western educational metrics such as standardized testing and grading systems.

Intersectional Environmental Justice

Environmental education and teaching must be taught through the lens of intersectional environmental justice – a theory and framework used to describe grassroots movements led by communities of color to protect and advocate for their wellbeing, livelihoods, resilience, and Mother Earth (Hernandez, 2017). Having intersectional environmental justice as a critical piece of this educational curriculum will not only provide increased agency to learning hands-on science, but it will allow for a greater understanding of how knowledge of environmental science and monitoring can be used as power to create change in policy and culture.

In developing this curriculum, environmental justice principles were incorporated from books including *Required Reading* by NDN Collective and *As Long As Grass Grows* by Dina Gilio-Whitaker (Gilio-Whitaker, 2020; NDN Collective, 2021). An existing high school curriculum created by EcoRise titled 'Introduction to Environmental Justice' was adapted for use in this curriculum (EcoRise, 2021).

Public Education Programs and Native Youth

There are many challenges that arise when building curricula for high school youth of Native Nations. The long shadow of historic mistreatment of Indigenous peoples by agencies of the United States government under the guise of education is still felt among Indigenous communities. This has created and maintained a lack of trust between Native Nations and United States government (Kirby et al., 2019). This fractured relationship, due to the continued greed of Western white populations, creates challenges in building strong relationships between government agencies and Tribal Nations. Currently, the Skokomish Tribe and the Washington State Department of Natural Resources are working to rebuild and strengthen this relationship.

Current education systems in the United States are failing Native youth, and need to actively make changes to incorporate the needs of native communities. In an interview by Ferlazzo in 2019, Dr. Susan C. Faircloth mentions that native populations in the United States are unique because the federal government has had a direct obligation to provide educational programs and services, but the population has the lowest rates of educational achievement. Faircloth also mentions that if our public institutions do not listen to native children, pay attention to their needs, and meet them where they are that tribal nations will continue to be at risk (Ferlazzo, 2019b).

To rebuild the necessary structures, policies, teaching approaches, relationships, and overall contexts for Native students to find the success they deserve we need to focus on culturally responsive teaching. To do this, we need to adopt strength based approaches (which focus on the resiliency of community members, students, and tribes), listen to young people, ensure curricula are based on the right information, support indigenous-language development, ensure time exists for mastery of content, and prioritize social and emotional supports (cultural insights and connections) (Ferlazzo, 2019a).

Educational programs, especially those in native communities, need to be planned to be long-term. Long-term planning for educational programs allows for sustained support, this can truly build institutional capacity and long-term strategies to promote climate resilience (Schramm et al., 2020). This educational internship is designed to be one year long and will occur every year if the pilot program succeeds.

Knowledge Systems

A knowledge system is an organized structure and dynamic process that generates and represents content, component classes, or types of knowledge that are domain specific or characterized by the domain-relevant features as defined by a user or consumer (Massachusetts Institute of Technology, 2020). Content is reinforced by a set of logical relationships that connect the content of knowledge to its value, this is enhanced by a set of processes that enable the evolution, revision, adaptation, and advancement of knowledge. A knowledge system is also subject to criteria of relevance, reliability, and quality (Massachusetts Institute of Technology, 2020). A definition of a knowledge system is the backbone for understanding the different knowledge systems throughout the world that are based on different cultures, ideologies, belief systems, and values. In the case of this environmental science internship, I will focus on two knowledge systems that have been defined by Western populations: Traditional Ecological Knowledge (TEK) and Western Knowledge (WK) (Figure 2). TEK is defined as body of knowledge and beliefs transmitted through oral tradition and first-hand observations that includes a system of classification, a set of empirical observations about the local environment and a system of self-management that governs resource use (Tsuji & Ho, 2002). WK is knowledge that relies on the established laws through the application of the scientific method and is also defined as the content and context of knowledge systems created by the cultures and values of Western civilizations (Chapin et al., 2013; Gumbo, 2017).

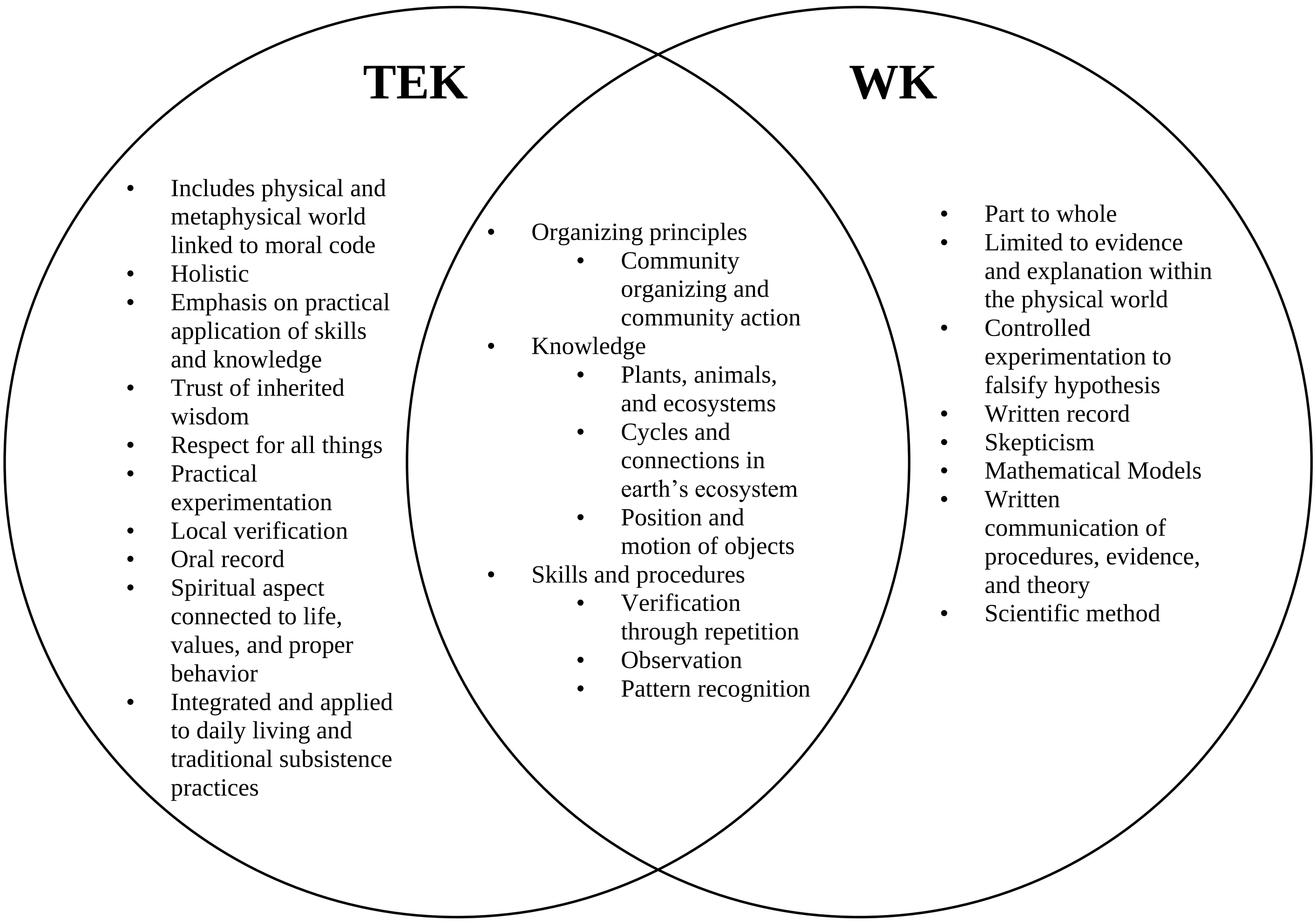

Figure 2- Similarities between Traditional Ecological Knowledge (TEK) and Western Knowledge (WEK) modified from figure 4.2 in Traditional Knowledge and Wisdom: A Guide for Understanding and Shaping Alaskan Social-Ecological Change by Stuart Chapin III.

Community building and organizing exist as an element of both systems. Even though there are more examples of demonstrated success in Traditional knowledge than in Western Knowledge, both knowledge systems use principles and values centered on community (Gilio-Whitaker, 2020). Community organizing in the United States was fathered by Saul Alinsky in the 1930s (Schutz & Sandy, 2011). Community organizing is typically a place-based method of engaging and empowering people with the intentions of increasing the influence of historically underrepresented groups. Community organizing works to organize members of communities to act collectively on shared interests. Though Saul Alinsky is seen as the 'father' of community organizing, the principles and actions of community organizing have existed for thousands of years, especially in Indigenous communities (Schutz & Sandy, 2011).

This curriculum focuses on teaching the basics of community organizing by working with both knowledge systems and providing examples of organizing success and methodology from books including *As Long as Grass Grows* by Dina Gilio-Whitaker, *Required Reading* by NDN Collective, and *Roots for Radicals* by Edward Chambers (Chambers, 2003; Gilio-Whitaker, 2020; NDN Collective, 2021).

Integrating TEK and WK

"Simply stated, science without wisdom is science without a conscience." (Hoagland, 2017)

Currently, most of the management making decisions in the natural resource management field are based on the principles of Western Knowledge (Hoagland, 2017). Many of these practices based on Western knowledge have been shown to cause more harm than good (Hoagland, 2017). An example of this is fire suppression throughout the Western United States.

Fire suppression became policy in the United States when the Weeks Act passed in 1911. The concept of fire suppression was developed because of the desire to protect the western societal values of profiting off forests and timber products (Forest History Society, 2022). Indigenous peoples have managed resources through complex cultural systems for millennia and this involves starting fires to manage the amount of understory material buildup and manage food supply (Buono, 2020; McKemey et al., 2022). The Weeks Act worked to outlaw indigenous methods of fire management and called for fire protection efforts (suppression) at all levels (Palmer, 2021). This suppression since 1911 caused wildfire fuel to accumulate, causing current fires to be more catastrophic and burning up to hundreds of thousands of acres (Palmer, 2021). Another example of successful indigenous management and the benefits of sustainable harvest are shown in Figure 3. Sustainable harvest is the harvesting naturally occurring plants and animals that then encourages the growth of the harvested species (Kimmerer, 2015). The act of sustainable harvest for human use is beneficial not only for humans but also for the growth and success of the species being harvested (Anderson, 2005).

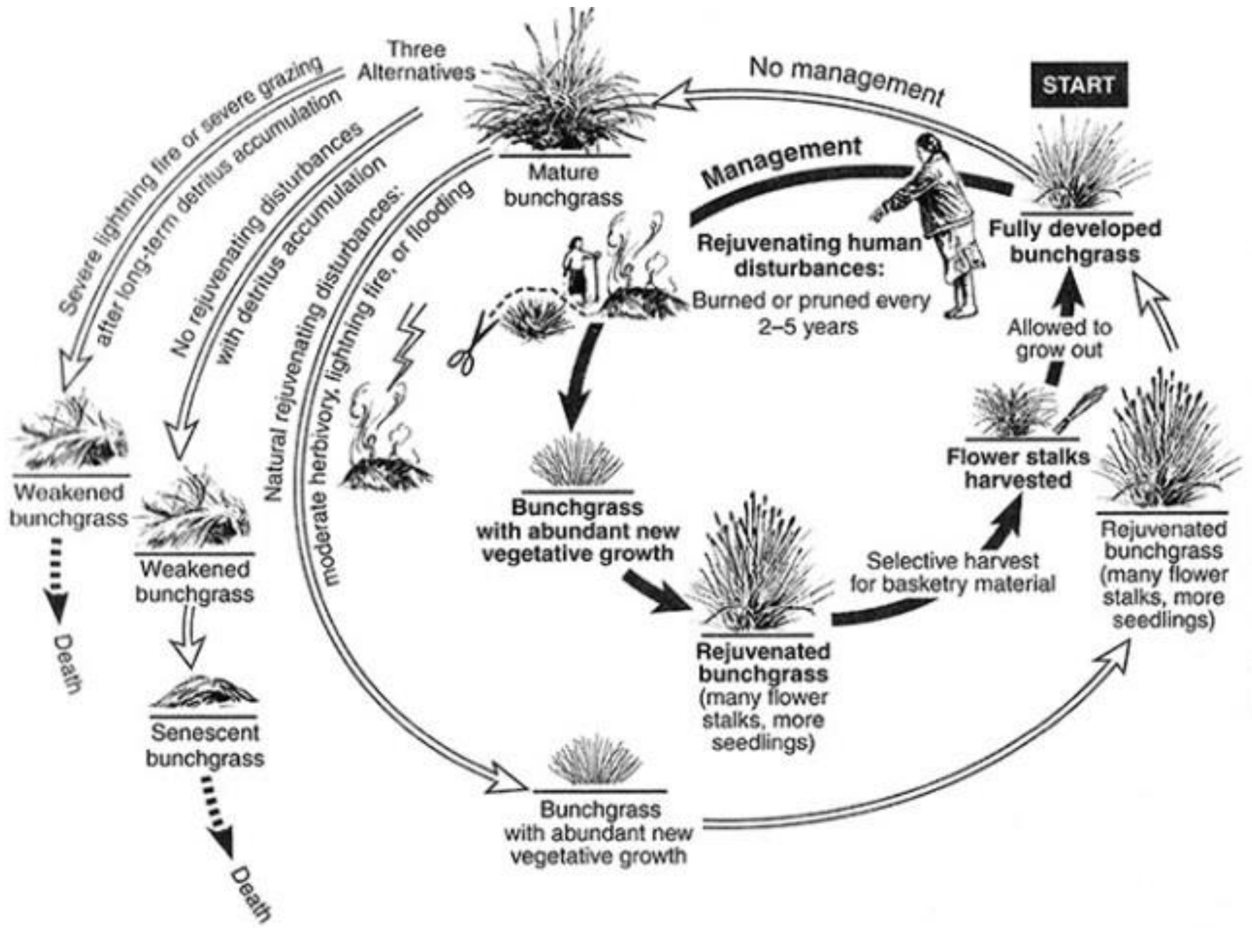

Figure 3 - Indigenous management of bunchgrass, leading to healthier plant development and growth (Anderson, 2005).

Over the past 25 years, integrating Traditional Ecological Knowledge and Western Knowledge has been realized by western entities as a potential optimal vision for natural resource management (Hoagland, 2017). The Wampum Theory (Hoagland, 2017) is the equitable, complementary balance between the western knowledge paradigm and the traditional ecological knowledge paradigm. In additional literature, this theory is referred to as ‘right-way’ science, which is defined as the collaborative process of bringing Indigenous and Western scientific knowledge and methods together to create ethical, productive, and mutually beneficial research (McKemey et al., 2022). This concept is also known as ‘cross-culture’ or ‘two-way’ science (McKemey et al., 2022). Traditional Ecological Knowledge and Western Knowledge both have broad applications in the field of natural resource management (Hoagland, 2017). This is why employing one knowledge system without the other will not lead to successful environmental protection, and instead make environmental situations worse (Hoagland, 2017).

Programs and research about integrating Indigenous Ecological Knowledge into science teaching and learning focus on the equity of learning outcomes from students of non-Western backgrounds, contributions of Indigenous knowledge to the knowledge base of Western Knowledge, environmental concerns in regards to sustainability, and the inclusion of nature philosophy, and the limits of purely Western science (Kim et al., 2017). Western land management is commonly seen as controlling and manipulating the ecosystem directly, and this directly conflicts with cultural values of many indigenous populations (Hoagland, 2017). If completed correctly, the benefits of incorporating Indigenous Ecological Knowledge and Western Knowledge teaching outweigh the costs. Combining knowledge systems can lead to a more holistic understanding of the environment and can lead to discoveries and management practices to promote sustainability (Kimmerer, 2002).

Co-Production and Co-Management Over Integration

Following years of mistreatment, disrespect, and exploitation, educators must work to truly honor and respect traditional knowledge and knowledge bearers. The incorporation of Traditional Ecological Knowledge into Western Knowledge systems has become increasingly common and has been a one-way track. When Traditional Ecological Knowledge is used by scientists and land managers following Western Knowledge paradigms through integration and incorporation it is commonly not ethical or just. Integration of educational models, when done incorrectly, is a continuation of theft, colonization, and broken agreements (Chapman & Schott, 2020).

Incorporating Traditional Ecological Knowledge into current natural resource management plans based in Western Knowledge is not enough, ethical, or just. Commonly proponents of incorporating TK into WK systems pick and choose the knowledge that benefit Western knowledge bases. This incorporation has disproportionately benefitted researchers and their governmental or academic affiliations, not native peoples, or native communities themselves. It is possible to make this one-way track into a two-way track where knowledge co-production is valued, and co-management is essential (Chapman & Schott, 2020). The co-production model was created by Chapman and Schott (2020), and is defined as the process of bringing a plurality of knowledge sources and types together, to address a defined problem and build an integrated or systems-oriented understanding of that problem.

Morality and ethics are also essential to the creation of an educational curriculum that attempts to teach environmental science and climate resilience to Indigenous youth. It is the ethical responsibility of DNR and the scientists who follow the Western Knowledge pedagogy that are creating and teaching this curriculum to make an effort to co-create mutually advantageous curriculum materials while elevating Traditional Ecological Knowledge and considering the normative impacts of Western Knowledge (Chapman & Schott, 2020).

For collaborative efforts, co-production, and co-management to be successful, educators and scientists must focus on challenging the idea that Western Knowledge systems are superior to other knowledge systems (Hou, 2020). As well as unlearning this idea, they also need to focus on the cultural aspects of Traditional Ecological Knowledge and actively seek engagement with traditional knowledge holders to mitigate the potential for exploitation and appropriation (Belldina, 2020).

As an attempt to encompass and highlight both knowledge systems, this curriculum includes knowledge gained from books including *Traditional Ecological Knowledge* by Melissa Nelson and Dan Shilling, *Traditional Ecological Knowledge and Natural Resource Management* by Charles Menzies, and *Braiding Sweetgrass* by Robin Wall-Kimmerer (Kimmerer, 2015; Menzies, 2006; Nelson & Shilling, 2021). This specific pilot program will also include the involvement of Indigenous elders from the Skokomish Tribe. An elder or elders from the community will speak on a topic of their choosing at the beginning of each module. Review of the curriculum and curriculum edits will be supplied by members and employees of the Skokomish Tribe.

Curriculum Building

Curriculum development is completed through five steps: 1) assessing need, 2) planning format and subject ideas with constituents, 3) developing content, 4) pilot program and revision, and 5) curriculum finalization. The work presented here expands on the first three steps. Following the completion of draft curriculum, these will be tested and refined in the final steps. It is likely that through this iterative process, the curriculum will change as it is refined and adapted to various sites throughout Washington waters, and for different perspectives and audiences.

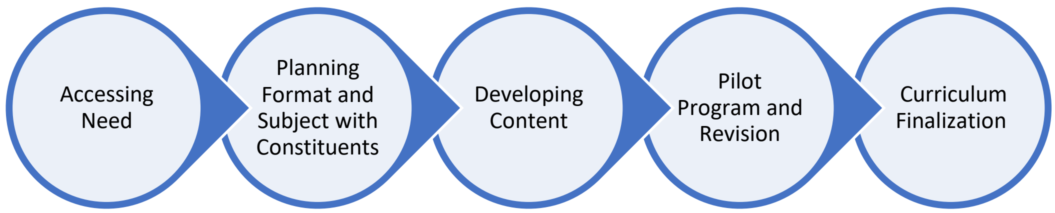

Figure 4 - Steps in developing an educational curriculum.

The curriculum is problem-centered, meaning that learners will be taught to look at a problem and come to a solution (Skyepack Team, 2020). The curriculum addresses the problem, climate change, over 11 modules. Each module was created to cover aquatic assessment and monitoring skills as well as a baseline knowledge of environmental justice and climate action. The creation of every module started with identifying major topics as well as potential engaging field work, discussions, and activities. The feasibility of field work was discussed with constituents and approved activities were identified. After this identification, educational materials were designed to provide baseline knowledge for these activities and goals (Figure 5).

A curriculum outline was created to identify the topics and skills that will be covered in the internship. Appendix B, Curriculum Outline, shows a description of each module along with an introduction to the Skokomish youth internship. The goals and topics covered in this outline were decided based on conversations with constituents including the Skokomish Tribe. This outline has been approved by the Skokomish Tribal Council as well as the Tribe CEO.

Module	Lessons
Module 1: Introduction	• Lesson 1 - Introduction
Module 2: Environmental Justice	• Lesson 1 - Introduction to Environmental Justice • Lesson 2 - History of Environmental Justice • Lesson 3 - Environmental Justice in Our Community • Lesson 4 - Advocating for Environmental Justice
Module 3: Climate Science and Introduction to Measurement Methods and Sensors	• Lesson 1 - Greenhouse Gas Emissions and the Carbon Cycle • Lesson 2 -The Climate Crisis and Climate Action • Lesson 3 - Oberving Climate Effects • Lesson 4 - Vulnerability to Climate Change
Module 4: Nearshore Ecosystem	• Lesson 1 - Estuarine Characteristics • Lesson 2 - Estuaries as Dynamic Systems • Lesson 3 - Estuary Restoration • Lesson 4 - World Building
Module 5: Coastal Stream Systems	• Lesson 1 - Stream Characteristics • Lesson 2 - Seasonal Changes in Stream Characterisitcs • Lesson 3 - Climate Change and Stream Characteristics
Module 6: Aquatic Monitoring Part 1 - Parameters	• Lesson 1 - Physical, Chemical, and Biological Parameters • Lesson 2 - Monitoring at ANeMoNe Sites • Lesson 3 - Field Equipment for Monitoring Physical Parameters • Lesson 4 - Community Science
Module 7: Aquatic Monitoring Part 2 - Time Scales and Error	• Lesson 1 - Time Scales • Lesson 2 - Error, Sensor Maintenance, and Calibration • Lesson 3 - Sensor Use and Deployment • Lesson 4 - Community Meetings
Module 8: Aquatic Monitoring Part 3 - Plants	• Lesson 1 - Plants • Lesson 2 - Climate Change Effects on Plants • Lesson 3 - Monitoring Plant Communities • Lesson 4 - Pathways to Climate Solutions
Module 9: Aquatic Assessment and Monitoring Part 4: Marine Benthic Invertebrates	• Lesson 1 - Marine Benthic Invertebrates • Lesson 2 - Shelled Invertebrates and Climate Change • Lesson 3 - Communicating Science and Climate Decision Making
Module 10: Aquatic Monitoring Part 5 - Shorebirds	• Lesson 1 - Shorebirds and Habitat Types • Lesson 2 - Introduction to Paper Writing and Data Analysis
Module 11: Community Organizing and Climate Action	• Lesson 1 - Community Organizing • Lesson 2 - Examples of Community Movements • Lesson 3 - Presenting Scientific Findings and Observations

Figure 5 - Curriculum Outline

RESULTS

I created a curriculum following the outline and methods above. Here, I will walk the reader through Module 4, Nearshore Ecosystem, with a particular focus on Lesson 1 – Estuarine Characteristics as a curriculum example (Figure 5). Each module is made of multiple lessons, each with a short lesson plan. Materials for Module 4: Lesson 1, can be seen in Appendix B and include PowerPoint slides, activity worksheets, site visit worksheets.

Lesson 1: Estuarine Characteristics. High school students come from a variety of science backgrounds so a review of information essential to understanding field research is provided. Following this lesson, students will be able to define an estuary and identify ecosystem services of estuary systems. They will be able to define a wetland and access estuary and wetland designation public surveys using online resources. They will be able to describe energy flow, explain the role of water, and understand the importance of soils in estuaries. They will be able to define a watershed and explain how activities throughout watersheds can impact estuaries. These topics are covered in a PowerPoint presentation (Appendix B) and include interactive components with the instructor including a quick dive into soil profiles and wetland designations using online resources.

In addition, they will be able to delineate a watershed using StreamStats. Students will learn how to use StreamStats through an activity that is to be completed individually or in small groups (See activity in Appendix B). This activity walks students through basic watershed delineation and prompts students to think about what the delineation tells us prior to a class discussion. Following this activity, a class discussion about the influence of water and watersheds on estuaries is completed.

Through a combination of classroom education, activities, and site visits it is hoped that the learning objectives can be achieved. As a measurement of how the curriculum goals are achieved and measured, a task book was created based on the skills and knowledge covered in the curriculum. The task book covers skills that youth interns are anticipated to master through this curriculum as well as during summer internships with involved groups. This task book focuses on hands-on skills such as water quality sensor use and maintenance, environmental survey protocols, and water sample collection procedures. It also focuses on soft-skills such as defining the climate crisis and climate resilience, listing some principles of community organizing, as well as the skills to contact local representatives. The task book will serve as a reminder of the materials covered throughout the curriculum and will help record skills for use in resume building. The task book, featured in Appendix A, will serve not only as a reminder of tasks learned throughout the internship, but also as a resource for future resume development. From the knowledge gained in Module 4: Lesson 1, students should be able to fulfill multiple pages of the task book.

Module 4 has three other lesson plans: Lesson 2 – Estuaries as Dynamic Systems, Lesson 3 – Estuary Restoration, and Lesson 4 – World Building. Lesson 2, dives into how estuaries are dynamic systems and are continuously in flux. This lesson works to define and describe seasonality, tide series, natural variability, and diurnal cycles. This lesson uses temperature as an example of natural variability and ends with students learning to use a CastAway CTD (conductivity, temperature, depth) sensor in the field to assess a temperature profile in the water column.

Lesson 3, introduces estuary restoration. Starting with defining estuary degradation this lesson focuses on anthropogenic effects and the effects of climate change on estuaries and current restoration practices. Ecosystem services of estuaries are discussed and the effects of estuary degradation on these services are defined. Sources of pollution and restoration practices are introduced. This lesson ends with a local site visit where characteristics of an altered estuary are identified and potential restoration practices are identified.

Lesson 4, teaches the concept of world building. This concept, typically used in science fiction writing, can also be used in building ideas and methods for climate resiliency. This lesson focuses on the activity of students building their ideal worlds. Activity steps involve: 1) Ask ourselves - Who are you? What do you stand for?; 2) Describe our surroundings today. Things that are beautiful, scary, ugly, and uncertain. Describe the laws of society and the values of our cultures; 3) Imagine a world we want to live in. What do we value? How do people treat each other? What is important and what isn’t? What does power look like? What does it smell and feel like?; 4) Debrief - Are there things we can take from our fictional world and bring into our real world? Through discussion this world building activity is then used to identify how to build a healthy estuary. This activity was inspired from ideas presented by Adrienne Maree Brown in her works *Emergent Strategy* and *Holding Change* (Brown, 2017, 2021).

To ensure that the curriculum is achieving its stated goals a survey focusing on learning metrics was created to be distributed at the beginning and end of the curriculum. This survey focuses on knowledge of climate science and aquatic assessment and monitoring, as well as intersectional environmental justice and community building.

DISCUSSION

Through the delivery of this curriculum, youth throughout the Salish Sea and Washingtons waters will have the opportunity to discover what is happening to their climate at a local level. Learning the aquatic assessment and monitoring skills to monitor local sites allows youth the agency and the skills to identify local issues and present them to those in power. After completing this curriculum, students will not only be able to identify and research the effects of climate change in their community, but they will also have the skills and agency to identify and ask changes of leaders at local, state, and national levels as well as organize their communities around issues that matter to them.

Next Steps in Curriculum Development and Implementation

This curriculum is a living document subject to change as the material is renewed and the student’s and their communities shift. This is especially true for this draft curriculum that will require iterative refinement early in its implementation based on the location of students, educators, efficiency, cultural shifts, and general betterment.

To complete steps 3 and 4 of the curriculum development process, the educational curriculum will be revised and feedback events will take place and be completed in June of 2022. Educators from throughout the state of Washington will provide feedback on utilization of drafted curriculum materials. For use with Skokomish Tribal Youth the DNR Tribal Liaison as well as the Educational Director for the Skokomish Tribe will amend educational materials as necessary. The educational curriculum will be approved by the Skokomish Tribal Council and the Skokomish Tribe CEO.

Currently the curriculum will be taught by DNR staff, but will be made public once the draft submittal has been reviewed by partner organizations, educators, and the Skokomish Tribe. Once open for public use, the curriculum can be adapted for classroom or internships throughout Western Washington State. The curriculum will be posted in public forums in a Story Map format with connections to Next Generation Science Standards (NGSS) educational learning standards for Washington State. NGSS standards are K-12 science content standards of expectations for what students should know and be able to do (Next Generation Science Standards, 2022). The connections to these standards will allow high school educators to pick and choose and adapt elements of the curriculum that might be beneficial to their current classroom teachings.

As previously mentioned, this curriculum was designed for a specific internship program occurring near the Skokomish Delta ANeMoNe site. It is a goal that this curriculum can be adapted to be run as similar internship programs at other existing ANeMoNe sites (Figure 6).

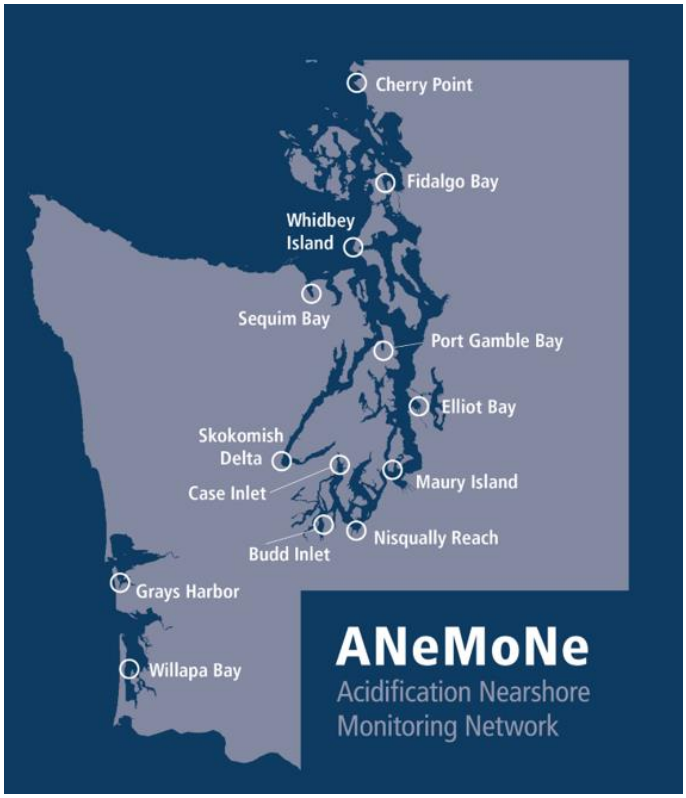

Figure 6 - ANeMoNe program site locations. Curriculum materials can hopefully be adapted to other sites throughout Washington's waters.

Education as a Tool to Fight Climate Change

Climate change is one of the biggest risks to public health, and the stark realities of our changing climate have been confirmed in the events of the past few years. The world temperature is expected to rise by 1.5 ^{o}C by the early 2030s, and global goals and pledges to combat climate change were made at the Glasgow Climate Summit in November of 2021 (IPCC, 2021). These goals are possible if a radical change to rebuild our communities and reevaluate our values take place. Since time immemorial, indigenous nations have stewarded the land in a sustainable manner and have advocated for community growth as well as reciprocal relationships between the planet and people (NDN Collective, 2021).

> **"We should take heart in the fact that people built our oppressive institutions, because it means that people can dismantle them and build something new. People hold the knowledge and technologies to transform society. All we need is moral fortitude and revolutionary courage. Today's extractive systems were created and are upheld by the colonial myths of scarcity, individualism, and the sanctity of free markets. Tomorrow's regenerative systems must be rooted in the Indigenous realities of abundance, community codependency, and deep reciprocal relationships between the planet and its people." – Kaniela Ing (NDN Collective, 2021).**

Community building and community resilience are essential to combating the climate crisis. Resilience measures a community's ability to bounce back and bounce forward - to restore the original pre-disaster state and be able to cope with post-disaster situations and changes (Kais & Islam, 2016). Teaching interns the essentials of community building, environmental justice, community science, and hands-on science skills will increase general community resilience. Community resilience in a changing world relies on thinking about an entire system, including ecological systems, physical infrastructure, and social systems and networks (Wise, 2020). This is one of the many reasons why community education and research are vital parts of developing community resilience to climate change and building career-related skills for youth.

"It cannot be understated that colonialism, the centuries-long effort to dominate other peoples and exert political and economic control over their territories, is the very foundation of the modern-day climate crisis."
– Dr. Rishi Sugla (NDN Collective, 2021)

Climate change is caused by the exploitation and degradation of the planet, people, and cultures (Martinez & Irfan, 2021). Environmental and scientific educational opportunities enhance understanding of current environmental situations, by all people. Historically, education has been used as a tool to make change and build activists, as part of enlightenment. Today's educational system has been infiltrated by capitalism and the priorities of the free market (Van Leeuwen, 2016). Education, when removed from the market-dogma and capitalism, can work to teach resilience and solutions to the climate crisis. Educational programs for youth that focus on building agency and skills for environmental action are essential in building community resilience to the effects of climate change.

CONCLUSION

Developing climate resilience curricula is a harrowing task; it is difficult for scientists, educators, parents, and students. Developing curricula for a government agency to teach Native youth also presents many challenges, and holds the threat of continued colonization, discrimination, mistreatment, and theft, if completed incorrectly. My intention is that the resources I have created do not continue the governmental and Eurocentric colonization of native peoples and native land. The materials created are subject to strict critique and input from a variety of stakeholders, including the Skokomish Tribe.

This curriculum is not a final document; it is intended to be a living document and will continuously need editing throughout the internship with information gathered from assessments, as well continuous input from students, educators, tribal members, and scientists. These materials have been developed to be adapted to other locations throughout Washington's waters. Many of these materials have specific foci on the environment surrounding the Skokomish Delta, but these specifics can easily be edited and amended, to encompass other locations. Even though the curriculum was built as a cohesive year program, individual lessons and modules will be beneficial for use in the classroom setting and for use in educational programming. This curriculum is a broad course in environmental science and its expansion is encouraged to give students a greater understanding of fundamental environmental science concepts.

This educational opportunity for Native youth functions as an afterschool and summer activity to prepare high school students for higher level education or careers in the field of natural resources. This curriculum will be taught in local communities and transportation to sites and other organizations will be provided, allowing this internship to act as a safe and beneficial activity for youth. Educating youth in environmental science is essential, and this must be done with curricula that is co-produced with native nations and community members. To build climate resilient communities, we need community members to be educated in the sciences and this internship is one step in starting to do that.

Environmental education must focus on hope and resilience alongside the realities of our currently changing climate. Youth are experiencing and seeing the negative effects of climate change daily. Communities of color are disproportionately seeing the effects of climate change such as flooding, fires, heatwaves, and deaths (Cuomo, 2011). Focusing on climate doom is not always beneficial when achievable goals seem to be distant and unachievable in the generations to come. Shifting focus to building resilience to an inevitably changing climate can build hope. This curriculum aims to teach resilience and hope during a time of climate disaster.

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APPENDICES

APPENDIX A

INTERNSHIP TASKBOOK

Climate Resiliency Youth Internship

Task Book

APPENDIX B

CURRICULUM OUTLINE

INTERNSHIP CURRICULUM OUTLINE

This internship program is intended to expose high school youth to the fundamentals of climate science through hands-on experience with scientific monitoring instruments and field data collection. Interns will learn how climate effects can be monitored in the marine nearshore and freshwater streams that feed their Skokomish River Delta. They will receive an education in environmental science, environmental justice, targeted skill training, mentorship, and employment opportunities. They will document the skills they master in a task book to be utilized in building their individual resumes. The resources and residents of the Skokomish watershed are extraordinarily vulnerable to the consequences of extreme weather and climate disaster. By encouraging climate literacy and skill development, we hope to empower the Skokomish youth and equip them with the skills they'll need to further engage in climate solution actions in their community.

The goals of this program are to provide interns with hands-on training in measuring and assessing a range of different types of environmental sensors. They will learn methods for conducting field and biological surveys as well as how to record and manage data. Interns will participate in ANeMoNe field visits for sensor maintenance and data collection. They will gain experience using and sharing environmental data with their community. Through measurements and observations documented in field visits, interns will share their knowledge with natural resource managers to highlight climate change threats to the local coastal stream-estuarine system. They will learn different tools for public engagement so they are empowered to present and discuss potential climate solution actions with their local community members. Interns will be mentored in building application-ready resumes that identify skills gained through the internship experience.

Below is an outline of the education modules included in this internship. Each module will require several in-person meetings to be completed over a 2–4-week period.

Module 1. Introduction

- Describe the ‘why’ of establishing ANeMoNe. Broadly introduce potential effects of climate change relevant to Skokomish Delta.
- Introduce role of community science.
- Show slides of ANeMoNe map and images of site guardians participating in collecting data and maintaining sensors- point out gear people need for the field.
- Focus on Skokomish Delta. Encourage interns to share their knowledge of the natural and cultural history, status and changes to the system. Learn organizational framework to document this essential contextual information.
- Introduce the basic principles of environmental justice and encourage interns to relate these principles to the history and current status of Skokomish River and Estuary social-ecological system.
- Supplement their current understanding with scientific information that influences monitoring design.
- Hand out field gear (waders, boots, jackets, gloves)
- Visit Skokomish Delta and stream site(s) and ask interns to identify and describe different habitat characteristics they’re familiar with.

Module 2. Environmental Justice

- Introduction to the concept of environmental justice and environmental racism
- History of environmental justice – with a highlight of environmental justice issues in Washington State and surrounding the Skokomish Delta
- Examples of success in the fight for environmental justice and how native communities have always been at the forefront of this movement
- Ways to move toward an environmentally just society

Module 3. Climate Science and Introduction to Measurement Methods and Sensors

- Greenhouse gas emissions & carbon cycle
- Carbon flow through stream, estuarine, coastal habitats (food web)
- How and what can be monitored to observe climate effects.
- Introduce water quality hand-held sensors (YSI multi meter) for discrete sampling of temperature, conductivity, dissolved oxygen.
- Use YSI in solutions of different temp, conductivity and dissolved oxygen
- Discuss other information that should be collected for these measurements to be meaningful.
- Familiarize with other gear needed to collect meaningful data (GPS, device to measure water depth, watch, clipboard, pencil, iPad)
- Visit stream site(s)/delta or both sites to practice using YSI multimeter and recording readings in the field.
- Elaborate on the fundamentals of environmental justice. Consider the influence of environmental (in)justice on Skokomish Delta vulnerability to effects of climate change.

Module 4. Nearshore Ecosystem

- Estuarine characteristics, energy flow and ecosystem function.
    - water quality from sediment surface to top of water column
    - water depth and beach elevation
    - sediment type and quality
    - intertidal and upper subtidal benthic organisms
    - fish, birds, mammals
- How estuarine characteristics change seasonally, with tide series, with diurnal cycle.
- Measuring characteristics that have natural variability in time and place.
- Discuss water quality changes with depth- particularly temperature and how this drives circulation
- Introduce hand-held, side-cast CTD for profile sampling
- Visit Skokomish Delta site and conduct sampling.
- Discuss the idea of ‘world building’ and ‘local building’ in regards to the climate crisis. Imagine what our world could look like. Imagine what the Skokomish River Estuary could look like. What changes would we make? What would we embrace? What are some pathways to begin realization of these changes locally?

Module 5. Coastal Stream Systems

- Stream characteristics
    - water depth and flow rate
    - elevation and bank slope
    - substrate and woody debris
    - riparian vegetation
    - fish, birds, mammals
- Seasonal changes in stream characteristics
- How climate changes effect stream characteristics
- Stream sampling - meter tape for measuring width, stream gauge to measure depth, flow meter, temperature, sediment type and riparian vegetation. Discuss how community scientists would expand the data collection possibilities.
- Discuss what future decisions about uses and changes to Skokomish River- Estuary system could be informed by scientific monitoring data.
- Introduction to principals of community organizing.

Module 6. Monitoring the Aquatic Environment - Part 1: Parameters
- Physical, chemical and biological sampling.
- Describe the physical, chemical and biological monitoring conducted at ANeMoNe sites.
- Focus on physical parameters: water elevation, sediment, and beach slope
- Equipment used for monitoring these (stream gauge, pressure sensor, laser & stadia rod, grab and core sediment samplers and measurement methods)
- Visit Skok Delta stadia rod and laser for elevation measurements, collect sediment (cores & grab) samples
- Learn different approaches and methods for community engagement.

Module 7. Monitoring the Aquatic Environment - Part 2: Time Scales and Error
- Discuss time scales of environmental change (e.g. daily, long-term, episodic) and how to monitor to capture change at these different scales.
- Discrete (point) sampling and continuous monitoring.
- Compare continuous, autonomous, logging monitoring sensors to hand-held point measurement sensors.
- Focus on chemistry parameters-water quality sensors
- Introduce HOBO temp/pH logging sensor and point temp/pH probe
- Visit Skokomish Delta and/or stream site and use both continuous (with phone app) and point pH sensor.
- Demonstrate how only through participation of community scientists can relevant data at multiple scales be collected.
- Sensor maintenance –probes, biofouling, batteries, corrosion.
- Sensor calibration- demonstrate calibration with 2 HOBO pH sensor
- Data recording methods (clipboard, waterproof paper, ipad, logging and telemetric sensors).
- Information to record when collecting data and deploying sensors
- Sensor use and deployment methods (mount logging sensors, buoys, sample off boats

- Deploy sensor cages at Skok Delta- making sure sensor cages are deployed in correct habitat (E vs B), a log of
- Discuss different types of community meetings.
- Learn from interns about community meeting types among Skokomish tribe and local residents.

Module 8. Monitoring the Aquatic Environment - Part 3: Plants
- Role of plants in carbon cycle
- Plants providing habitat
- Diurnal and seasonal changes in plant growth and productivity
- Climate change effects on riparian and submerged plants.
- Measure density, distribution and size of riparian plants along stream-Tree DBH, densiometer.
- Measure density, distribution and size of eelgrass in estuary- quadrat, stem counts, plant morphology
- Discuss changes already observed in local aquatic vegetation attributed to a warming climate.
- Consider urgency to identify climate solutions (what changes are likely on what time scales)
- Learn how climate policy is made at various levels of government.
- Introduce how the public can comment on federal, state and local government decision making processes.
- Learn about public engagement in Skokomish tribal government decision making on climate change policy and planning.

Module 9. Monitoring the Aquatic Environment - Part 5: Marine Benthic Invertebrates
- Detrital and filter feeders in carbon cycle
- Shelled invertebrates and climate change
- Eelgrass buffering capacity
- Outplant shellfish inside and outside of eelgrass and measure growth rates – construct mesh predator enclosures, measure juvenile shellfish outplant in different environments and monitor growth rates.
- Discuss the importance of tribal decision making in implementing climate solutions.
- Discuss the role local government representatives in prioritizing climate actions. Identify local representatives and how to contact them.

Module 10. Monitoring the Aquatic Environment - Part 5: Shorebirds
- Role of shorebirds in carbon cycle
- Migrating vs. resident birds
- Use of shore habitats types and sub-types (vegetated versus bared tide flat, upper beach, water's edge, open water).
- Conduct scan and focal follow of shorebirds in eelgrass versus bare habitat at Skokomish Delta.

Module 11. Community Organizing and Climate Action

- Introduction to community organizing
- Community organizing in native cultures and examples of success of community organizing
- Tribal speaker
- Present findings and community needs to local representatives. This can look like a formal presentation, a letter, report, or other forms of media.

APPENDIX C

MODULE 4: LESSON PLANS

Lesson Plan

Module 4: Lesson 1: Estuarine Characteristics, energy flow and ecosystem function (Site Specific: Skokomish Delta) (3 Classes)
Date:

Learning Objectives

Students will be able to….

- Define an estuary and identify ecosystem services of estuary systems
- Define wetlands and what wetlands look like in Western Washington
    - Access estuary/wetland designation public surveys
- Explain estuary energy flow and general ecosystem function
- Explain the role of water in estuaries and the importance of soil and soil composition
    - Define a watershed and how activities throughout watersheds impact estuaries
    - Delineate watershed through stream stats
    - Access information about soil profiles in their local estuary
- Identify intertidal and upper subtidal benthic organisms as well as fish, birds, and mammals that rely on estuaries

Summary of Tasks and Activities

- Group Discussion: What ecosystem services do estuaries provide? What does your local estuary provide?
- Activity: Delineate a watershed using StreamStats
- Group Discussion: What role do humans play in estuaries?
- Site Visit: Local estuary – Identify mammals, birds, and benthic organisms. Identify estuarine habitat characteristics, identify soil type
    - As homework or in the next class have students work to identify the four organisms they described at the site

Materials/Equipment

- PowerPoint
- Writing materials and white board for discussions
- Site visit materials: Waders, binoculars, raingear, gopros, ipads, etc

References

Notes

Lesson Plan

Module 4: Lesson 2: Estuaries as Dynamic Systems (Castaway CTD) (2 Classes)
Date:

Learning Objectives

Students will be able to….

- Explain the natural changes in estuaries with seasonality, tide series, and diurnal cycle
- Describe methods of measuring characteristics that have natural variability in time and space
- Describe water quality changes with depth – a highlight on temperature
- Use a Castaway CTD for water profile sampling

Summary of Tasks and Activities

- PowerPoint Presentation
- Site Visit: Local estuary – Prepare for site visit by checking tide series. Discuss and investigate changes that occur due to seasonality, tide series, and diurnal cycle. Use Castaway CTD to collect water profile data and discuss data upon return

Materials/Equipment

- PowerPoint
- Writing materials and white board for discussions
- Site visit materials: Waders, binoculars, raingear, gopros, ipads, etc

References

Notes

Lesson Plan

Module 4: Lesson 3: Estuary Restoration (Site Specific: Skokomish Delta) (3 Classes)
Date:

Learning Objectives

Students will be able to….

- Describe what causes estuary degradation and what ecosystem characteristics and services are changed when an estuary becomes degraded
- Identify methods and timeline of estuary restoration
- Identify the differences between restored estuaries and unaltered estuaries
- Describe history of the degradation and restoration of local site (Skokomish Delta)

Summary of Tasks and Activities

- Discussion – What do we know about the Skokomish Delta? What are some environmental impacts on the Skokomish Delta?
- Watch short Skokomish Delta restoration video
- Group Discussion – Why did this restoration effort take place? What evidence of ecosystem degradation do we know of?
- Site visit to the Skokomish Delta
    - Identify characteristics of an altered estuary
    - Identify restoration methods and efforts at the local site
    - Discuss what these restoration efforts have already achieved as well as what they can achieve
    - Discuss what has been lost despite these restoration efforts
    - Dig and discuss a soil profile

Materials/Equipment

- Powerpoint Slides
- Writing materials and white board for discussions
- Site visit materials: Waders, binoculars, raingear, gopros, ipads, etc

References

Notes

Lesson Plan

Module 4: Lesson 4: World Building – Rebuilding our Community and Estuary (1 Class)
Date:

Learning Objectives

Students will be able to….

- Define the concept of world building
- Imagine a community with a healthy estuary and identify the steps it would take to get there
- Identify steps that have already occurred and specifics that can be done now at the local site and surrounding community

Summary of Tasks and Activities

- PowerPoint Slides
- Handout: World Building – How would you build your world?
- Group Discussion: What do our worlds look like?
- Group Brainstorm: How would we rebuild our local estuary? What has been done? What can we do?

Materials/Equipment

- PowerPoint Slides
- Writing materials and white board for discussions
- Handouts for world building activity

References

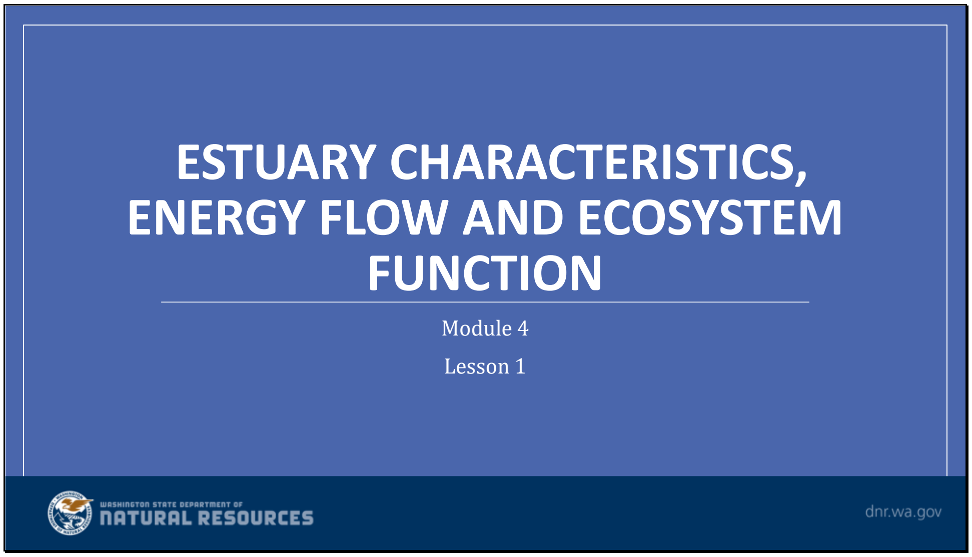
Notes

APPENDIX D

MODULE 4: LESSON 1

Module 4: Lesson 1: Slides

Slide 1



Slide 2

Slide 3

What is an estuary?

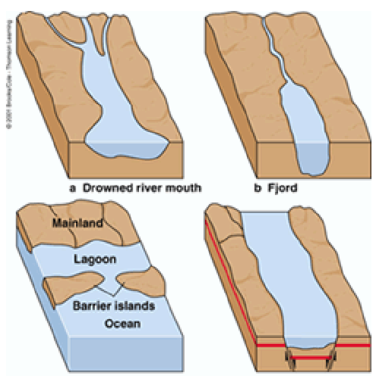
Estuary – where a freshwater river or stream meets the ocean

- When freshwater and seawater combine, the water becomes brackish or slightly salty
- Water continuously circulates into and out of an estuary
  - In estuaries water level and salinity increase and decrease with the tides as well as with seasons and storms

Slide 4

Types of Estuaries

A. Coastal Plain Estuaries (drowned river mouth)
B. Fjord Estuaries
C. Bar-built Estuaries
D. Tectonic Estuaries

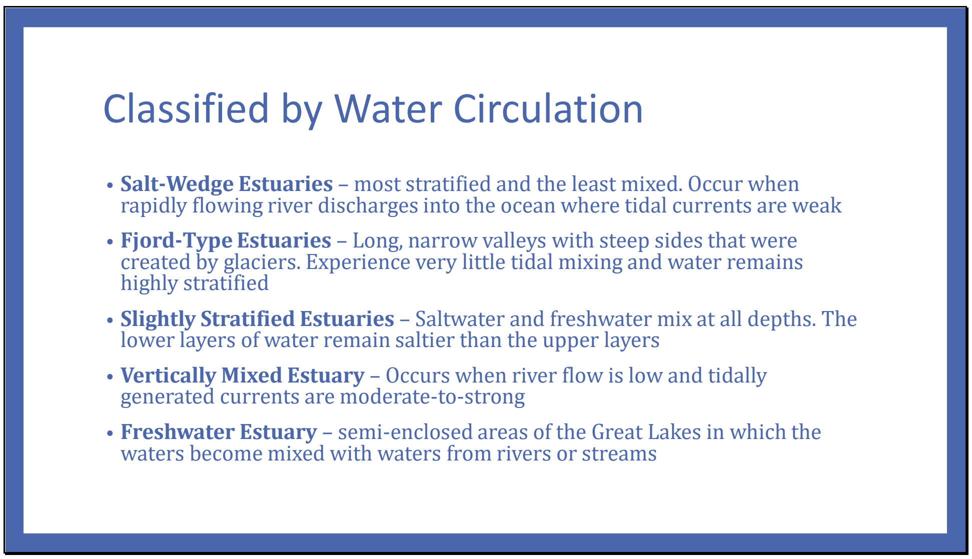


- Coastal Plain Estuaries are created when sea levels rise and fill an existing river valley
- Tectonic Estuaries are formed though tectonic activity and are due to the shifting and rifting of the Earth's crust.

- Bar-Built Estuaries are when a bay is protected from the ocean by a sandbar or barrier island
- Fjord estuaries are a type of estuary created by glaciers. They occur when the ocean fills a deep valley that was carved by glaciers.

What type of estuary is the Puget Sound? …Fjord Estuary!

Slide 5

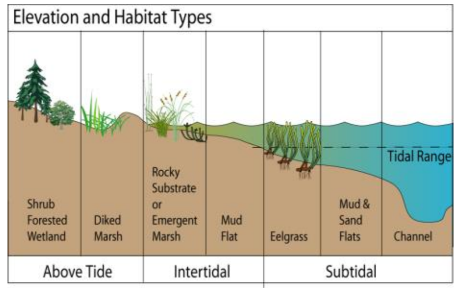


Puget Sound is classified as a fjord in terms of geology but is classified as a slightly stratified estuary when classified by water circulation.

Slide 6

Common Estuary Habitats

- Oyster beds
- Kelp forests
- Rocky and soft shorelines
- Submerged aquatic vegetation (eelgrass beds)
- Coastal marshes
- Mangrove forests
- Deepwater swamps and riverine forests
- Mud flats
- Tidal Streams
- Barrier Beaches
- Salt Marshes



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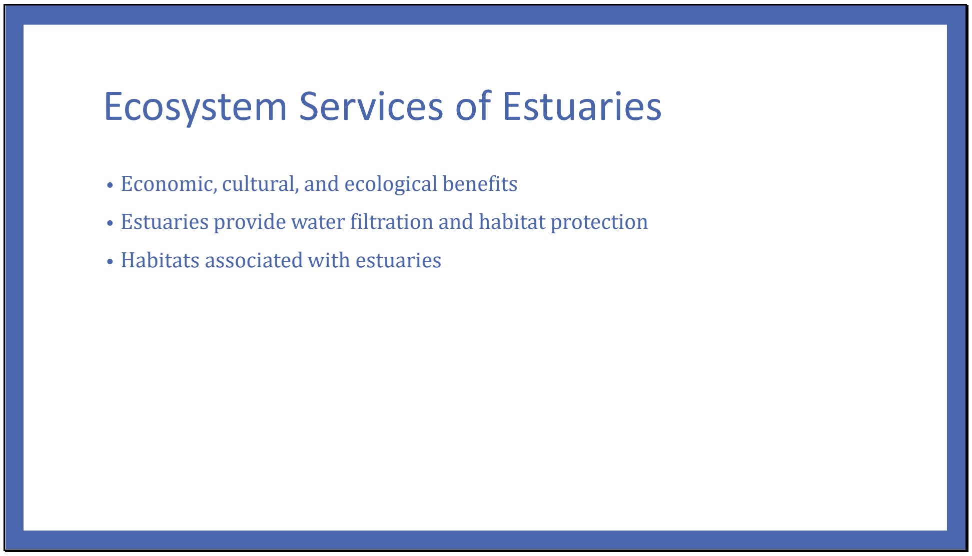
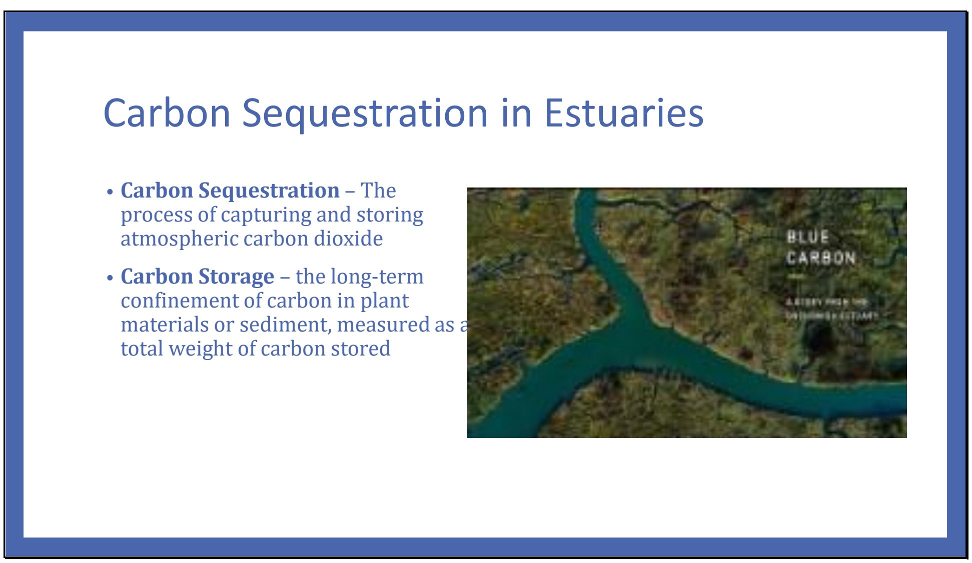
Ecosystem Services

- Ecosystem services are the benefits that nature provides to people
- Some examples of ecosystem services include:
  - **Provisioning Services** - the provision of food, fresh water, fuel, fiber, and other goods
  - **Regulating Services** – climate, water, and disease regulation as well as pollination
  - **Supporting Services** – soil formation and nutrient cycling
  - **Cultural Services** – educational, aesthetic, and cultural heritage values as well as recreation and tourism

Slide 8



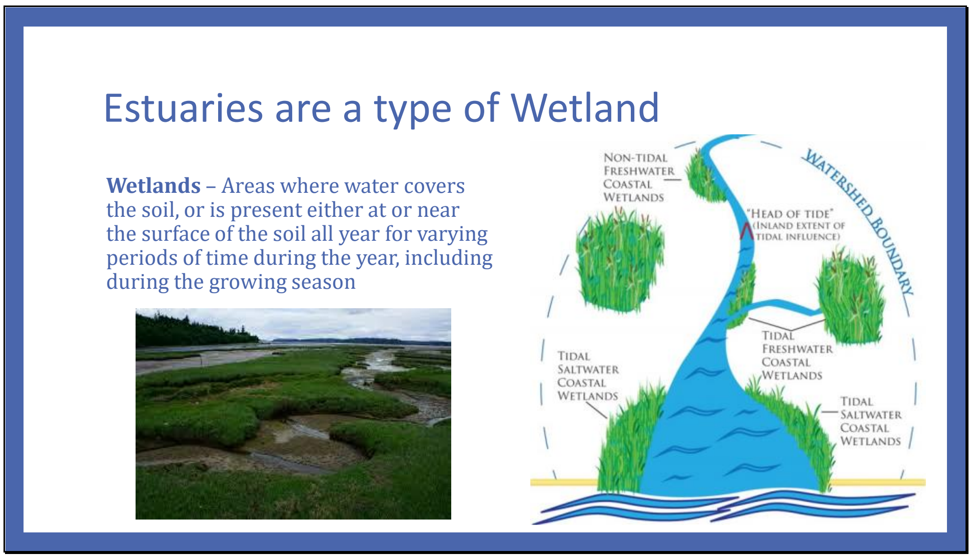
Slide 9



Carbon sequestration is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

- Current studies suggest that mangroves and coastal wetlands annual sequester carbon at a rate ten times greater than mature tropical forests.
- They also store three to five times more carbon per equivalent area than tropical forests.
- Most of the carbon is stored in the soil in coastal estuaries

Slide 10



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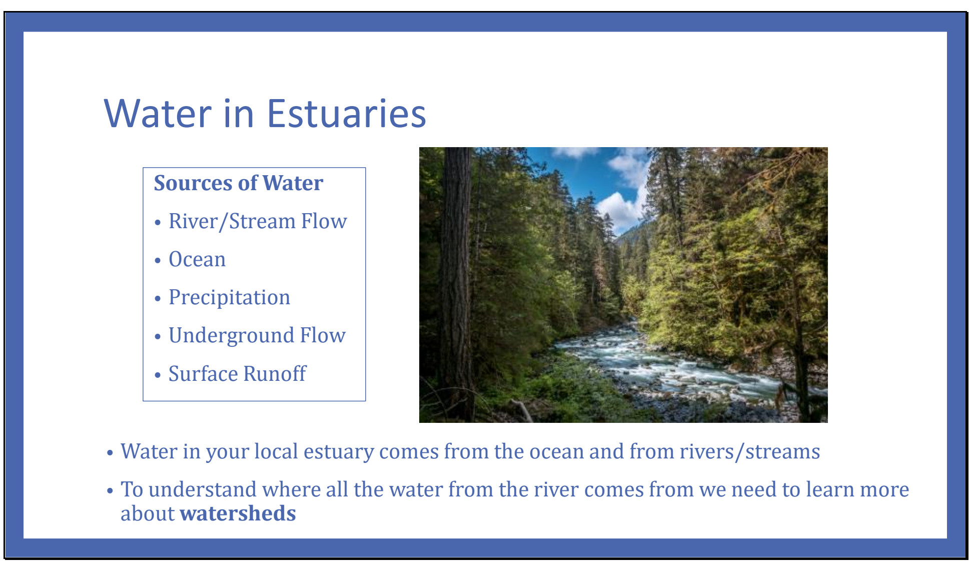

Discussion: Where does the water come from in your local estuary?

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WATERSHEDS

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What is a Watershed?

- **Watershed** – The drainage basin where all precipitation on the surface or below ground, drains into a single river or lake on the way to the ocean or an endorheic basin (lake with no outlet such as the Great Salt Lake)

Additional Vocabulary:
•**Precipitation**: Any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface.
•**Watershed**: The drainage basin where all precipitation (snow and rain) on the surface or below ground, drains into a single river or lake on the way to the ocean or to an endorheic basin.
•**Basin**: A catchment area where water drains into a depression.
•**Infiltration**: The seeping of surface water into the soil and down into the aquifer through the porous spaces between rock particles.
•**Aquifer**: Underground water flow formed by the infiltration of precipitation from the surface. It flows through a permeable substrate and is contained by impermeable layers below it. They are often the source for springs, where the topography drops below the elevation of the water table.
•**Water Table**: The horizontal depth of the top of the aquifer. Where the surface elevation drops below the water table elevation, surface water in the form of lake.
•**Permeable Layer**: Surfaces that contain pores or spaces which liquids can pass through and into.
•**Impermeable Layer**: Surfaces that lack pores or spaces and do not allow liquids to penetrate.
•**Springs**: A place where water comes from below ground to run on the surface. Often these are the headwaters from streams.
•**Seeps**: A place where groundwater percolates to the surface or through cracks in the strata. They can form small wetlands that trickle into streams.
•**Groundwater**: Water that collects or flows beneath the Earth's surface, filling the porous spaces in soil, sediment, and rocks. Groundwater originates from rain and from melting snow and ice and is the source of water for aquifers, springs, and wells. The upper surface of groundwater is the water table.
•**Substrate**: An underlying layer.

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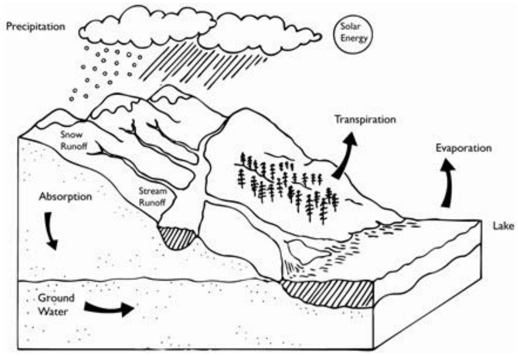
Dimensions of a Watershed

- Precipitation
- Network of surface streams and mouth
- Groundwater



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Outline Local Watershed

- On the map outline what you think is the Skokomish Watershed. This includes all stream tributaries, headwaters, and glacier melt that will end up in the Skokomish Watershed.
- **Watershed Delineation** – Drawing lines on a map to identify a watershed's boundaries

As a group use StreamStats to delineate the Skokomish River Watershed based on USGS data https://streamstats.usgs.gov/ss/

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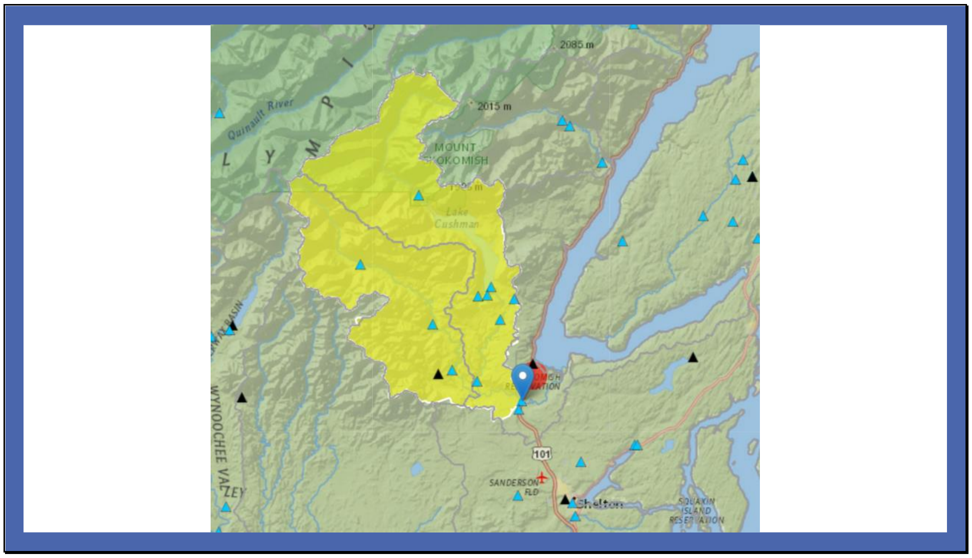

Have each individual or team pick another location and delineate the watershed for that location using StreamStats. Use the worksheet titled ‘StreamStats Activity’.

Discussion:
What does the delineation of your watershed tell us?

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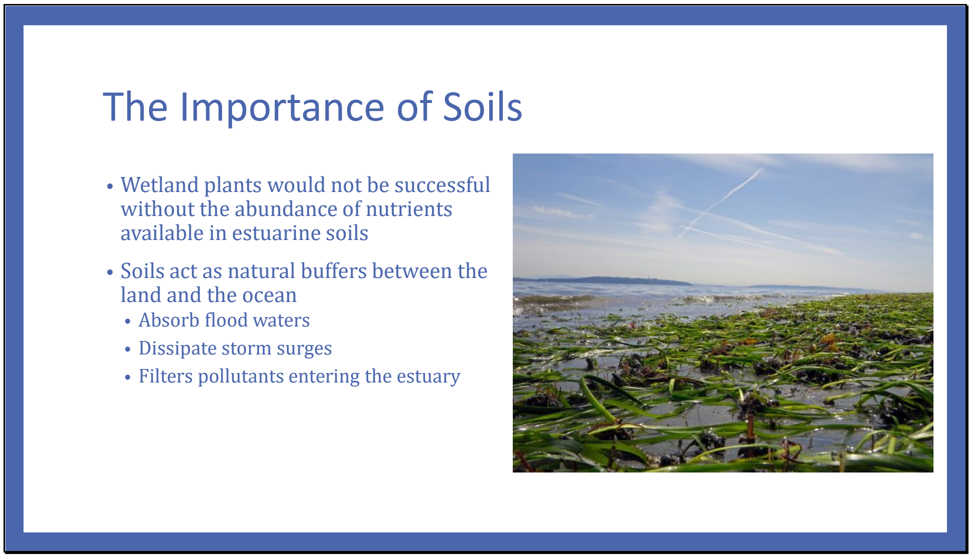

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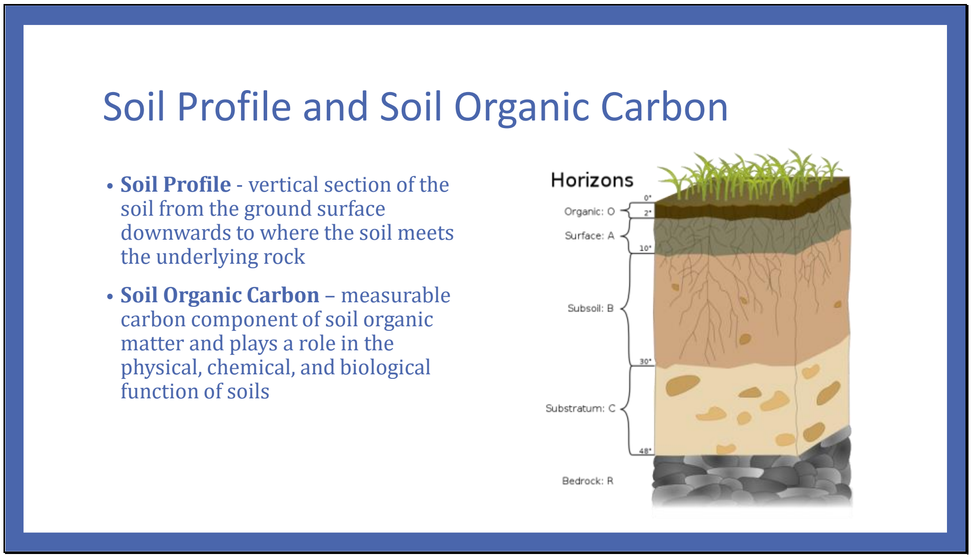

Soil organic carbon is slow to accumulate and is one of the most challenging aspects and most important factors of wetland restoration (which we will touch on in a later module)

Use SoilWeb (https://casoilresource.lawr.ucdavis.edu/gmap/) to display and discuss soil profiles in a local estuary

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ESTUARY ECOSYSTEM

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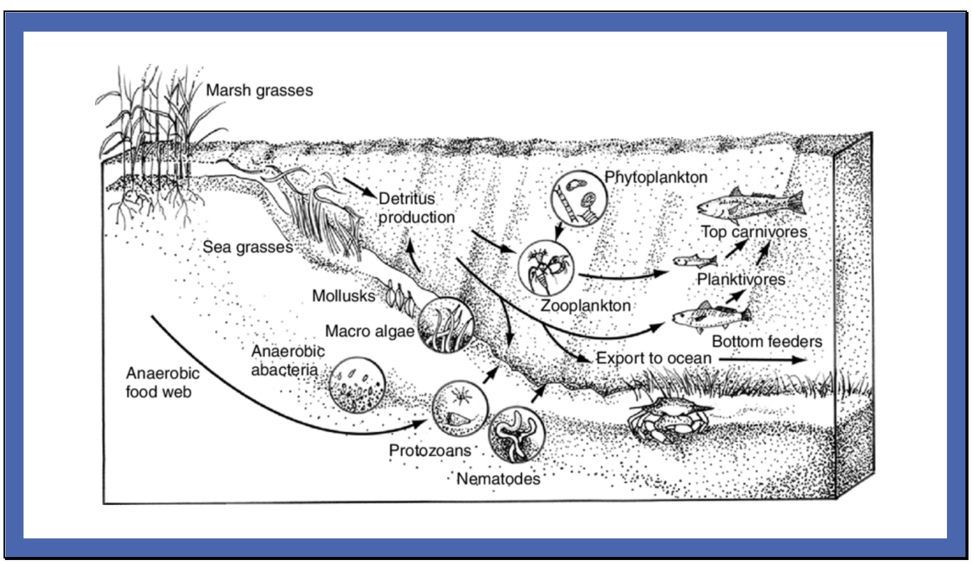

Estuary Food Web

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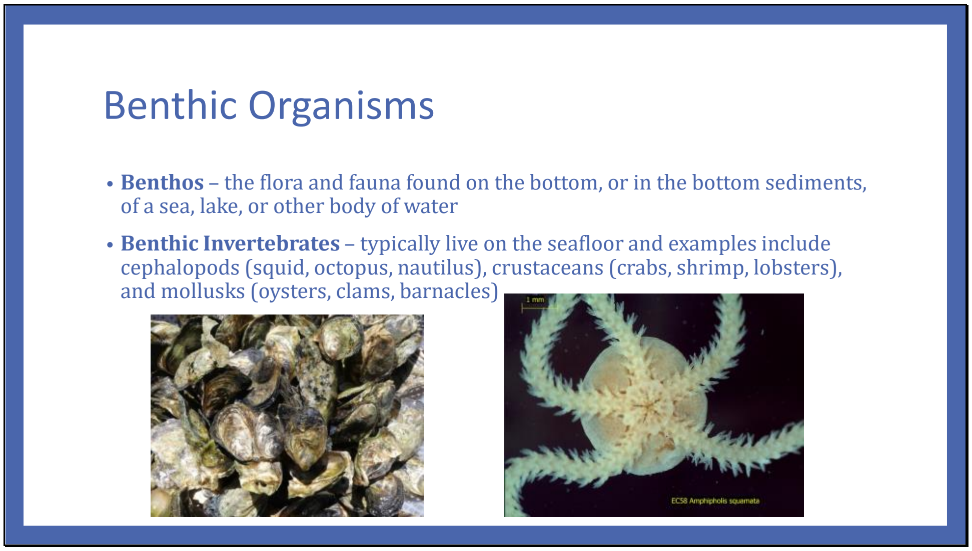

Left image – Olympia oysters
Right image – brittle star

For a deep dive into identification of benthic organisms in the Salish Sea:
https://www.eopugetsound.org/articles/benthic-invertebrates-puget-sound

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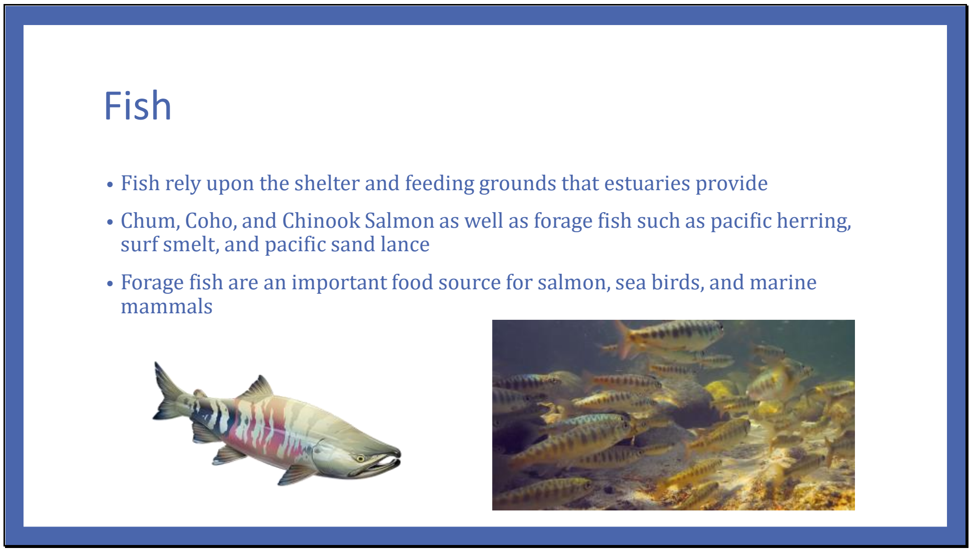

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For more bird identification resources: https://pugetsoundestuarium.org/bird-species-list/

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ANY OTHER SPECIES THAT ARE IMPORTANT TO THE ESTUARINE ECOSYSTEM?

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Humans and Estuaries

- First human civilizations were founded along estuaries due to their productivity and fertile soil

Salish Sea

- Native Nations who have stewarded the Salish Sea since time immemorial have lived and continue to live on the bounty of estuaries

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FIELD: SITE VISIT

INTRODUCTION TO STREAMSTATS

StreamStats allows us to delineate streams at a location of our choice. Think of a location on a specific stream or river and follow the steps below to delineate the stream from a certain location.

1) Go to the website: https://streamstats.usgs.gov/ss/
2) Click on the three lines in the upper left corner
3) Zoom in on the map to a stream that you would like to delineate. Make sure to zoom to level 8 or greater (the zoom level is stated on the bottom left section of the map 'Zoom Level: ___')
4) Select 'Washington'
5) Zoom in further to the stream you would like to delineate. You must zoom to level 15 or greater. You will start to see blue boxy lines where the streams are.
6) Click 'Delineate' and use your mouse to select a blue box at the point you want to delineate.
7) Wait for the tool to process
8) You should see a yellow shape indicating your delineation

What does the yellow shape tell us?

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____

____

____

____

What does it mean to delineate a watershed?

____

____

____

Do activities or resource use anywhere in yellow shape effect water at your chosen point? If they do, how so? What activities might affect water at your chosen point?

____

____

____

____

SITE VISIT: ESTUARINE CHARACTERISTICS

Draw a food web of organisms you have seen so far at the local site. You may use the back of this sheet if additional space is needed.

What are some ecosystem services of this site?

____
____
____

Where does the water come from at this site?

____
____

Take photos of 4 organisms you have not previously identified. Describe these four organisms and draw their details in each of the boxes below.