A boat on a body of water

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Ocean Motion

**Grade Level:**  4th – 8th

**Explore Chapter:** WHERE IS THE SALISH SEA?

**Time Required:** 12 (50-minute sessions)

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**Aerial view of a land with water and mountains

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**Background for the Teacher**

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In Unit 1, corresponding to chapter 1 of Explore the Salish Sea: A Nature Guide for Kids, “Where is the Salish Sea,” you and your students will build spatial context for the Salish Sea in relation to the one world ocean and investigate oceanography that influences the movement of water and the living and nonliving things in it. This starts with a map.

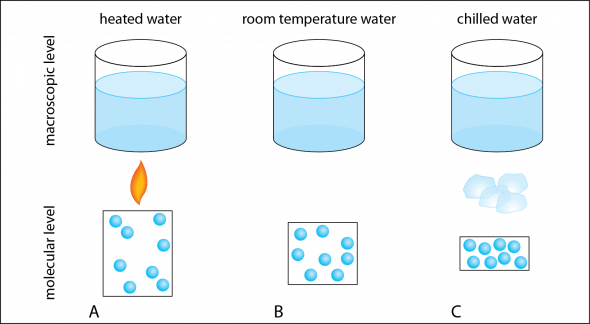
Creating a map of the Salish Sea for your classroom will give your students perspective of where their nature detective work for the southern resident killer whales is happening and of the larger physical processes at work. Going forward, geographic information elements from each chapter can be added to their map. What starts as an outline may eventually include southern resident killer whale travel routes, your own watershed, geologic formations, such as an overlay of the Cordilleron ice sheet or major volcanoes, or locations of eelgrass meadows and salt marshes, harbor seal haul-outs, and salmon-bearing streams. At curriculum’s end it will also show the location of your students’ own Salish Sea Heroes project, where they helped to make the sea a better place for people and wildlife (Unit 8).

A paper wall map is just one option. Esri offers a free license to schools for ArcGIS and ArcMap products to make digital maps. Story maps are webpages that include your map plus images and text to tell a meaningful story about a place. These can be made with Esri’s story map platforms. Both digital web maps and story maps can be made by kids with our easy-to-follow tutorials. No matter what map format you choose, consider making one map for the whole class and allowing a mapping moment in each unit you choose to implement, wherein each Explore Team may contribute one piece of geographic content to tell their story from that chapter of Explore the Salish Sea.

Having your map in place, you and your students will move from being cartographers to oceanographers as you explore the three forces that cause ocean circulation: ***wind, water density differences,*** and ***tides.*** Students will make deeper meaning from these phenomena by considering the effects of ocean currents on the drifters of the ocean, plankton, which they will observe live and then do their best to engineer. All of this will support their investigation of how ocean circulation would influence the directions an oil spill in the shipping lanes would travel and whether it would reach a First Nation’s fishing and gathering sites.

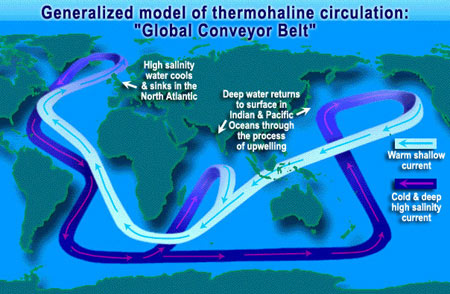
Density differences are the drivers of much of the motion in fluids, including that of our earth’s mantle, atmosphere, and the world ocean. Recall that density is the amount of matter in a given volume. Hence, density units of measurement show mass over volume, such as grams per liter ().

Weird Science: Macroscopic changes in Liquid Water Volume. Images by Byron Inouye. University of Hawaii Manoa.



The particles in warm matter move faster, bump into one another with more force, and spread further apart than those in cooler matter. More matter means more mass, so liquid with higher density sinks in less dense liquid.

This phenomenon is responsible for wind. Uneven heating of Earth’s surface by the sun causes warmer air in some places, which rises, pulling cooler air to fill in the vacant space it leaves closer to the ground. The moving air is wind. And complex, global wind patterns drive surface currents in the ocean, such as the Gulf Stream off the east coast of North America and the Kuroshio Current off the east coast of Japan.



Thermohaline circulation model, showing the general pathway of deep and surface ocean currents as they travel around the globe.

Ocean water is also unevenly heated. It is warmer at the equator and cooler at the poles. Warm water near the equator rises and moves poleward near the surface, cooling as it goes. It is replaced by cold, dense water, which sank at the poles and moved equatorward along the ocean floor, warming along the way. As it goes it gets more unevenly heated and encounters freshwater inputs and geological structures, complicating its pathway.

Adding to the density differences is salinity, or how salty the water is. It can be saltier at the poles when the ocean freezes. Only freshwater turns to ice, leaving salts in the seawater below. This makes the water even more dense there (heavy with salts). Water at the equator evaporates fast, also leaving salts behind, so the ocean is also saltier there but it remains less dense than the deep water moving from the poles below. The ocean current’s pathway is eventually a globe-wide “conveyor belt,” which takes about 1,000 years to complete. This phenomenon is called thermo- (heat) haline (salt) circulation, which your students will model with water, food coloring, ice cubes, and a heat source in a large, clear baking dish.



Model of the tidal bulges on Earth as they are pulled by the gravity of the sun and moon. Image by NOAA.

The final force causing ocean currents is tides. Gravitational pull from the sun and moon pull the ocean water toward their heavenly bodies, causing uneven bulges of water on Earth, one nearest the location of the moon and one on the opposite side due to centrifugal force. As the Earth spins below these bulges, water rushes toward and away from shorelines, causing high or low water levels at regular daily intervals – tides. The closer the earth is to being in a straight line with the moon and sun, the higher (and lower) the tides. These are called spring tides. When the Earth, moon, and sun form a right angle, the bulges are spread out more evenly and tidal exchange is lower. These are called neap tides. In the Salish Sea, there are two high and two low tides of uneven heights every 24 hours and 50 minutes. This is called a semidiurnal tide cycle.

Your students will explore the effects of tides as they consider all that the Coast Salish canoe families have to account for in completing their annual Canoe Journey through the Salish Sea.

Of course, there are extraordinary currents caused by earthquakes below the ocean floor, causing tidal waves, a very different source of ocean motion.

A collage of microscopic images

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Ocean currents impact living things. Plankton, derived from the Greek word, *planktos (*πλαγκτός), are drifting aquatic plants and animals that swim too weakly to counteract currents. These may be as tiny as a virus or bacterium, or nearly as big as a football field, as in the case of some siphonophores.

The plant-like, or phytoplankton, need to remain near the surface to absorb the sunlight that drives photosynthesis (the making of sugar and oxygen from water and carbon dioxide). This means that the animal-like plankton, or zooplankton, that eat them need to remain near the surface, as well.

This need to avoid sinking has led to dramatic and beautiful adaptations for buoyancy amidst these “drifters” (plankton is from the Greek word πλαγκτός (planktos) meaning errant, wanderer, or [drifter (NOAA).](https://oceanservice.noaa.gov/facts/plankton.html)ßßRead this!

*A variety of phytoplankton called diatoms.*

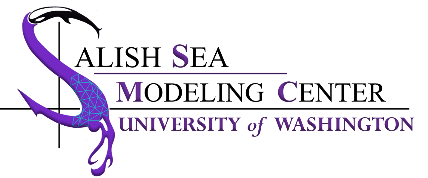
Image by Kathleen Newell, UW School of Oceanography in The Salish Sea (Sasquatch Books)

A close-up of a microscope

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Ocean currents also impact nonliving things, and while our overarching phenomenon is cute, bathtub toys, spilled from a cargo ship, plastics and fossil fuel spills have unwanted and even devastating effects on people and wildlife. Knowing how to predict the spread of spills, using currents, density differences, and time, scientists can help governments and managers to respond quickly and efficiently to slow or stop the spread.



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*Noctiluca, the phytoplankton that* bioluminesces*.* by Emily Bjornsgard.

Lesson 3 synthesizes oceanographic concepts in light of a human issue: oil spills and indigenous food sovereignty. We at SeaDoc Society would like to give many thanks to Lorne Underwood and Chief Harvey Underwood of the Tsawout First Nation for allowing us to use their maps of their fishing and gathering sites. And also to the scientists at Salish Sea Modeling Center, especially Dr. Tarang Khangaonkar. The Salish Sea Model is a sophisticated computer program he and his team developed with Pacific Northwest National Laboratories and the Salish Sea Modeling Center at the University of Washington. It models ocean currents based on multitudes of current, wave, water density, and atmospheric data, gathered by teams of oceanographers over many years. The Salish Sea Model can be used to predict how ocean water will move in the sea at different depths for an endless number of applications. When approached about its use by K12 students, Dr. Khangaonkar and his team modified a version especially for use by kids. Bless their hearts! In lesson 3 you may choose to have your students apply the model to an investigation on the spread of fossil fuel spills to predict whether oil spilled in the shipping lanes between Washington and BC could reach a Gulf Islands First Nation’s fishing and gathering sites. Work with your district’s IT person to follow instructions in Lesson 3 for uploading and utilizing this amazing tool.

Sources

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Further Learning and Classroom Resources

NOAA National Ocean Service. Ocean Facts: Tides and Currents. [https://oceanservice.noaa.gov/facts/oceanfacts-tidescurrents.php Last accessed 2-20-2024](https://oceanservice.noaa.gov/facts/oceanfacts-tidescurrents.php%20Last%20accessed%202-20-2024).

NOAA National Ocean Service. What Are Plankton? <https://oceanservice.noaa.gov/facts/plankton.html> Last accessed 2-22-2024.

Salish Sea Modeling Center. Salish Sea Model <https://ssmc-uw.org/> Last accessed 2-22-2024.

**Unit Overview**

How can we gather and communicate evidence about how humans impact Salish Sea ecosystems?

**Anchoring Phenomenon:** Lummi Nation fed a starving, baby killer whale with live Chinook salmon and SeaDoc Society’s wildlife veterinarian shot her.

**Design Challenge:** How can we determine what southern resident killer whales need for a healthy habitat?

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| **Lesson 1** - 7 days  5-ESS2  How is the Salish Sea connected with the one world ocean? | **Lesson 2** - 4 days  5-PS2-1  How does ocean circulation affect life? | **Lesson 3** - 4 days  5-ESS3-1  How can we model the spread of an oil spill in the Salish Sea in relation to Coast Salish First Foods? |
| Session 1  Unit orientation – What do we already know about ocean circulation?  Session 2  Where in the one world ocean is the Salish Sea?  Session 3  Where is the world’s water found?  Session 4 - 6  What are the driving forces behind ocean circulation?  Session 7  How do currents in the Salish Sea impact Canoe Journey? | Session 1  In what ways does ocean circulation affect drifting life forms (plankton)?  Session 2  How can we engineer a plankton that will sink slowly?  Session 3  What physical traits enabled the winning plankton design to sink slowly?  Session 4  What other materials are circulated with the ocean water? | Session 1  What and where are Indigenous First Foods in the Salish Sea?  Session 2  How can we use known ocean circulation patterns and the Salish Sea model to model an oil spill in the shipping lanes near Vancouver, BC?  Session 3  How can we use the process of science to determine if an oil spill in the current shipping lanes would impact Coast Salish First Foods?  Session 4  What evidence-based recommendations can we agree to make to decision makers in our community, state, or province on reducing risk of oil spills affecting First Foods?  Session 5  What concepts, core ideas, and science and engineering practices have we learned and what have we discovered through our Ocean Motion research that may help us figure out how to help the southern resident killer whales?  Session 6 -optional  How will we communicate our Western science and indigenous knowledge-based recommendations to local leaders? |
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| **UNIT 1: OCEAN MOTION STORYLINE**  This unit explores both where in the world is the Salish Sea and how its waters circulate with the rest of the world ocean and what that means to communities right here at home. Students’ sense of place is further established through a mapping activity which relates their Salish Sea home to the rest of the world. Next, students will wonder at how a ship load of rubber duckies, spilled during a storm in the Pacific Ocean near China, ended up on various beaches around the world, including here at home. This will guide their formation of an essential question that will drive their research throughout this unit.  In the first lesson, students will orient themselves geographically to the location of the Salish Sea in relation to the one world ocean, establishing that their familiar waterways are connected to the rest of the globe. They will build a model to compare each of the forms water takes in the world to understand the vastness of the water stored in the ocean.  After considering the spilled rubber ducky phenomenon, students will explore the 3 causes of ocean circulation, density differences, tides, and wind, again experiencing the benefits of models as they figure this out.  In Lesson 2, students extend their current knowledge to include impacts of currents on drifting organisms in the sea, plankton. They will have an exploratory introduction to live plankton, then engineer a plankter that has the ability to stay near the surface to access sunlight or food that needs sunlight. This adds concepts of structure and function to those of density differences.  Lesson 3 extends circulation to solution-oriented thinking, as a model of currents in the Salish Sea is used to find out if an oil spill in the shipping lanes could impact indigenous First Foods near the US-Canada border  *Icons in this curriculum are from Microsoft Word Icons or from <ahref="https://www.flaticon.com/free-icons/chemistry" title="chemistry icons">Chemistry icons created by Freepik - Flaticon</a>* | **TERMS FOR THE TEACHER**  A picture containing text, sign  Description automatically generated  **Assessment** – (pre and post) one way to measure student growth over the unit.  **A picture containing object, mirror  Description automatically generated**  **Background research**- includes the Explore the Salish Sea book, articles, videos, games, songs, and expert guests.  A group of white circles on a black background  Description automatically generated**Engineering** – the process of imagining, designing, building, testing, and revising technology solutions that improve life.  Shape  Description automatically generated with low confidence**Essential question** – The overarching question that drives the background research, games, activities, and authentic inquiry for each unit.  Checkbox Checked with solid fill  **Formative Assessment** – opportunity to check for student understanding and misconceptions.  **Games** - games are used to introduce and reinforce concepts through play. Instructions are included.  **Diagram  Description automatically generatedMind Map** – Draw a model with the problem in the center circle and clues to solving it connected to it, grouped by related ideas  **Shape  Description automatically generated with low confidence**Icon  Description automatically generated**Model** – A physical object or mathematical equation that represents an idea, object, process, or system that is difficult to observe directly.  **Process of Science** – Steps scientists take to solve a mystery or problem.  **Text  Description automatically generatedTeam Read** – The division of a large piece of literature among teammates, each part summarized individually, then synthesized by the whole team. This allows each student to contribute an important background research and accommodates individual reading levels.  Group brainstorm with solid fill**Team Talk** –Each student shares with their Explore Team for 1 uninterrupted minute to ensure equitable time and give a voice to students who may not speak out in a full-class discussion. The Science Communicator reports a summary to the class.  **A picture containing text, sign, dark  Description automatically generated**A picture containing icon  Description automatically generated**Tribal Knowledge** - Work with your district’s Tribal or First Nations Liaison, if you have one, to invite a cultural outreach or natural resources employee from a local tribe or First Nation to meet with your class and share *what they deem appropriate* about the topic.  **Wonder** – a phenomenon, problem, or discrepant event that sparks curiosity and initiates exploration | |
| **LEARNING TARGETS LESSON 1:** Know the location and extent of the Salish Sea.Know that ocean water circulates around the globe and vertically.Understand that density is the amount of matter in a given amount of space.Understand that changes in temperature and salinity cause density differences in the ocean.  * Understand that matter contains atoms which are always moving, and their speed is affected by temperature.  Know how density differences cause ocean circulation.   **TEACHING WITH THE 5 E’s FOR A COHERENT STORYLINE – LESSON 1**  ENGAGE activity: Students wonder, discuss, and form a question about the image of rubber duckies, spilled in the NW Pacific, ending up on beaches around the world.  **Practice**: Asking questions  EXPLORE activities: Model wind-driven, tidal, and density-driven ocean circulation.  **Practice:** Obtaining and evaluating information. Developing and using models  EXPLAIN activity: Describe and explain observations of each current model.  **Practice**: Analyzing and interpreting data..  EXTEND activity: Model global ocean circulation watching food move from cold poles to a warm equator and back.  **Practice**: Developing and using models  EVALUATE activity: Compare the models in class to the explanations of ocean circulation by scientists and identify positive and problematic aspects of the class models.  **Practice**: Communicating and Evaluating Information | | **NGSS PERFORMANCE EXPECTATIONS**  blue=Practice orange=DCI green=Crosscutting Concept  GRADE 5   * [5-ESS2-1](https://www.nextgenscience.org/pe/5-ess2-1-earths-systems) Develop a model using an example to describe the ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.   **BRITISH COLUMBIA SCIENCE CURRICULUM**  Grade 5 Big Ideas   * The motion of Earth and the moon cause observable patterns that affect living and non-living systems   Grade 5 Content   * The effects of the relative positions of the sun, moon, and Earth including local First Peoples perspectives * The nature of sustainable practices around BC’s resources * First Peoples knowledge of sustainable practices * First Peoples concepts of interconnectedness in the environment.   If using this content for grades 6-8:   * [MS-ESS2-1](https://www.nextgenscience.org/pe/ms-ess2-1-earths-systems) Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. * [MS-ESS2-4](https://www.nextgenscience.org/pe/ms-ess2-4-earths-systems) Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity. | |
| **TEACHER PREP LESSON 1**   * Review unit plan, student journal, and slideshow together. Revise these as desired and appropriate for your community and ecosystem. * Print student journals on 8.5 x 14” paper, booklet fold, in-color if possible. If you choose to print so each journal page is on a full sheet of 8.5 x 11” paper, change settings in the Word document. It is automatically set to print in booklet fold on 8.5 x 14” paper as is. * Download and print student journals and pre-assessments. * Connect with a community partner who can support a forage fish spawning survey in Lesson 3. Plan ahead for a field trip to conduct the survey. * Invite a visit by an indigenous knowledge holder from the tribe or First Nation upon whose territory your school resides and invite them to share about First Foods and/or Canoe Journey with your class. See suggestions for developing partnerships with local tribes and First Nations in [A Note About Indigenous Knowledge here](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EduRQbyDk-xFnfNuM0wTmTsB_P-RPZ2Qe0bsm-l-FwNamQ?e=RTyU3J). If you are not able to have a visit, review the Children of the Setting Sun Productions video, [Canoe Journey](https://www.youtube.com/watch?v=L5wk7xfkA10&t=1238s) and decide how much you will show your class in session 6. * Familiarize yourself with your choice of tide guide or online app, such as [www.deepzoom.com](http://www.deepzoom.com) * Review unit vocabulary (see student journal pp.5-6) and consider ways you will weave the use of these words naturally through the lessons. Students will return to define them opportunistically as they become familiar through use. * Print, cut, fold, and place [Pearls of Wisdom](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EUfi_5Ugk5JOssbLHzwDAOMBE3_A4wXTa1cMDw78MvCUUw?e=DjKem1) into a shell or other container for students to draw from, if you choose to include this practice of inspiration. * Decide on Explore Teams composition. It works best to have mixed ability groups, where students may contribute their individual strengths to the team and support one another where needed. If you haven’t already, label spots at each table with Explore Team role titles (see student journal p.5). When switching roles, students can rotate seats within their own team or find their new role in their new team. * Print Ocean Motion [pre-assessment](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EQSPd4lhf8lBu5N4AfTLqrcBFfvVRHcd9snkLLohDPJCtA?e=AC03fI) or prepare to administer electronically. * Upload the components for running the Salish Sea Model on your classroom computer/s or in the computer lab. You may need to work with your IT specialist for this task. Practice running the model with various oil spill characteristics, following instructions in Lesson 3. | | |

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| **MATERIALS LESSON 1**   * Internet connection * Audio-visuals equip for slideshow/videos * Printed student journals and pre-assessments * Ocean Motion slideshow   OCEAN WORLD GAME   * Inflatable earth ball, score board with water vs. land   OCEAN MOTION MODEL  **For each Explore Team:**   * 1 clear glass baking dish (9 ½ x 13 inch works well) or similar plastic tray * Water source * Water pitcher for filling baking dish with water * 1 sandwich bag or container full of ice (option to make blue ice, see below) * Heat source, such as a heat lamp or old school lightbulb to heat the water on the "equator. If this isn’t available, hot water with red food coloring may be added to the center of the pan. * Recycled materials (milk cartons, cans, jars) or waterproof clay to model continents and islands * Blue and red food coloring, blue for cold water, red for warm. If possible, make ice cubes with 2 drops of blue food coloring each ahead of time. * Assorted toy sea animals, just for fun (and if anyone has some to lend) * Colored pencils for sketching what happened.   DENSITY AND MOTION ACTIVITY  **For each Explore Team:**   * Blue, green, and red food coloring * 2 identical plastic jars (not beakers) * One note card or playing card (laminated is best, but cardstock paper is fine) * Hot and cold water to fill jars to the brim * Salt to make salt water (2 T per liter)   YOU ARE MY DENSITY GAME (whole class)   * Open space * masking tape to delineate container boundaries on the floor * slow, med, fast music   WIND-GENERATED CURRENT MODEL (each team)   * Clear, plastic or glass bin or baking dish, at least 12” long and 4” deep * Food coloring * Hair dryer   TIDE PREDICTIONS   * Tide guides for local waters or online tide app. | **WEBLINKS LESSON 1**  Pearls of Wisdom  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EUfi_5Ugk5JOssbLHzwDAOMBE3_A4wXTa1cMDw78MvCUUw?e=DjKem1>  Slide show  <https://pacificeductioninstitute.sharepoint.com/:p:/s/Program/ERo8L6oy4ZJEnRI55qBxVNoB5w4ZCTy6c6DEJPyseFw1uA?e=ezOxHJ>  Student journals <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EUv6DgLr7ypLhIClbvx2pj4BkGV3ba3MquVJ4fEle--XnQ?e=6pKYNq>  Ocean Motion Pre-assessment  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EQSPd4lhf8lBu5N4AfTLqrcBFfvVRHcd9snkLLohDPJCtA?e=NgwztB>  Ocean World Game Instructions <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EefeVSSk_ABHloaO0wS8bMQBrDGHtTvhBh8qoAe0-yqzAg?e=ECKXzs>  Why is the Salish Sea So Rich with Life  <https://www.youtube.com/watch?v=XT2htr1-MXY>  Web Map tutorial  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ER0klcq-h6JAtkSLXcAuz7YBe9SAm8DisGsiQ_ytZXLg8A?e=jqyPno>  Story Map Tutorial  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EdmLI7eYWMRPqlhn9VMe36MB3_03Xf1G1-x8tmFffoKfOw?e=CAfgDu>  Essential Question description  <https://www.scholastic.com/teachers/articles/teaching-content/essential-questions/>  Ocean World Game Instructions  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EcA6VSFZ5ghMjFqi_sV_pw8BPYzdfaSiISlKbKEXgpxclA?e=k1ouxd>  Ocean Motion Model Instructions  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EZbiUZm-8n5KiG9uVc73jp4BMm6_oejlJpP6MvcOWkb4mQ?e=lwvm7p>  Density and Motion activity tutorial  <https://www.youtube.com/watch?v=86ChgK38EIA>  Salinity-caused currents video  <https://www.youtube.com/watch?v=uMH2-2nnJGs>  You are my Density game  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EeMJ6b0gq4tFme7wOJIn--gBXf2TwNUw4VTSG-3DeaFeog?e=klhZth>  Deep Zoom Tide and Current app  <https://www.deepzoom.com/>  Children of the Setting Sun Canoe Journey video  <https://www.youtube.com/watch?v=L5wk7xfkA10&t=1238s>  Ocean Conveyor Belt Article  <https://www.nationalgeographic.org/article/ocean-conveyor-belt/5th-grade/>  Team Read template (to draw onto poster paper)  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EQQQbFhgkUpDp3ARAfjnzUwBf2OHVQRjBwDqXR0wOAQn3A?e=nTDEpo> Putting it all together video: Current Events: Crash Course Kids #34.1 <https://www.youtube.com/watch?v=_fcXL61NZS0>  Ocean Density video  <https://www.sciencelearn.org.nz/resources/687-ocean-density> |

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| TIME | TEACHER GUIDE LESSON 1: WHERE IS THE SALISH SEA IN THE ONE WORLD OCEAN? |
| Session 1  1 min  1 min  18 min  20 min  6 min | UNIT ORIENTATION   1. Have a student draw and read a [pearl of wisdom](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EUfi_5Ugk5JOssbLHzwDAOMBE3_A4wXTa1cMDw78MvCUUw?e=nIBVBr) (inspirational quote) from a shell. 2. Introduce Unit 1, Ocean Motion, **slide 7,** and ask students if we may be able to help the orcas if we learn some knowledge of the people who respected them as relatives for thousands of years and of the oceanographers who use the process of science and engineering to understand how ocean works? Share that both these ways of knowing require teamwork, so it’s time to form new ***Explore Teams***. Pass out **student journals,** have students write their names on the front, then form teams, **slide 8, journal p2**, rotating roles from the previous unit. 3. Have students read and sign the Seashore Stewardship Pledge, **journal p3** in preparation for working with plankton. Administer the [Ocean Motion pre-assessment](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EQSPd4lhf8lBu5N4AfTLqrcBFfvVRHcd9snkLLohDPJCtA?e=EYUGxc), **slide 9**. 4. Distribute Explore the Salish Sea books and read **Ch.1** Where is the Salish Sea?, **slide 10**, then free-write/draw on **journal p4**. 5. Ask students to highlight or circle unfamiliar vocabulary words on **journal p5** and add any more words they are unsure of from the chapter. Let students know to come back and define these as they discover their meanings through the unit. |
| Session 2  2 min  30 min  23 min | GEOGRAPHY EXTENSION   1. Remind students of their overarching essential question from the Task Force unit, which is likely related to: How can we help the southern resident killer whales? Ask if it would help to know where in the world ocean their study area is and how to find out. They will likely suggest a map. Suggest that we make a map where we can post our clues and track our progress, like a detective on a case. In fact, let’s make 2 kinds of maps. 2. Ask students what types of Information can be shared with a map besides locations of water and land. Ask them to brainstorm using **journal p6**.      1. Show **slide 11,** using presenter notes, and then charge students with a mission to **map the Salish Sea** as a class, **slides 12 and 13**. This may be done by projecting a Salish Sea map onto butcher paper on the wall and tracing its outline, creating an electronic [web map](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ER0klcq-h6JAtkSLXcAuz7YBe9SAm8DisGsiQ_ytZXLg8A?e=QVJkxZ)\*, or another method you choose together.   This is a good place to start your optional [***Salish Sea story maps\****,](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EbaAvRLP40xOkn-RDCU3a2oBXdl69Jf1KEndvNlVOLKRtA?e=twboob) as individuals, Explore Teams, or as a whole class with each team contributing a page of content per Explore the Salish Sea chapter as you go. These can be added to alongside or instead of your paper map and will result in an ideal science communication tool to share student learning and projects.  \* [Esri offers a free license](https://www.esri.com/en-us/industries/education/schools/schools-mapping-software-bundle) to schools for ArcGIS and ArcMap products. See weblinks for instructions. |
| Session 3  10 min  15 min  3 min | ENGAGE   1. Ask the class what we already know about the ocean (ie. its effects on weather, climate, food, oxygen, shipping, fun…). List their current thoughts onto a poster paper in a format of your choice, such as a **Mind Map** and save. 2. Play the [Ocean World Game](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EefeVSSk_ABHloaO0wS8bMQBrDGHtTvhBh8qoAe0-yqzAg?e=hZp43j), **slide 14**, for 10 or so minutes and guide a brief discussion on the results. Take-away: the ocean covers ~70% or over 2/3 of the Earth.   Checkbox Checked with solid fill   1. Give an [exit ticket](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EaZOrhO3zbVPtyn14uF_GmAB-BF-gzpR_BXd66VhJigBgA?e=eD1vYn) of your choice, looking for knowledge of the Salish Sea’s location and connection to the world ocean and how much of Earth is covered by ocean. |

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| Session 4  **(60 min session)**  15 min  10 min  5 min  20 min  10 min | ENGAGE continued   1. Group brainstorm with solid fill**Wonder**: Show **slide 15**, explaining the “friendly floatie” spill using presenter notes. Have students consider silently, then share out what they observed/thought. Repeat with **slide 16**, a sailboat running down a boundary between two colors of sea water and **slide 17**, a turquoise Hood Canal. Encourage students to write or draw a picture about what they wondered, **journal p. 7** Hold a **Team Talk, slide 18** then invite Science Communicators to share what each team wondered. Establish whether students have enough evidence to conclude that ocean water does not sit still. Add “Ocean water moves” to the class **Mind Map**. 2. Shape     Description automatically generated with low confidenceGuide the formation of an [Essential Question](https://www.scholastic.com/teachers/articles/teaching-content/essential-questions/), using what students wondered. Subtly guide their question to relate to what these three images have in common or how ocean water moves. It could even be what makes ocean water different colors. Any of these will be figured out with nature detective work in this unit. Have students write the class’ essential question on **journal p7**.   EXPLORE   1. Revisit the different water colors near the Fraser River mouth, **slide 19,** and ask who wants to start figuring out this mystery. Show **slide 20** and take some suggestions for what information this map is showing. Tell them that the map is one type of **model.** Ask if students would like to create a physical model to figure out what makes the ocean move. Have students brainstorm all of the forces they believe move the ocean water.      1. WIND-DRIVEN CURRENTS Wind is likely one idea. Ask how they might test out if wind can cause currents, given bins of water, food dye, and hair dryers, **journal p8**. Allow Explore Teams to try various ways of figuring out the answer, including observing other teams who figured it out. 2. Allow time to make sense of observations and add to the class mind map, ie. “Wind moves water at the ocean surface.” |
| Session 5  20 min  10 min  10 min  10 min | EXPLORE  DENSITY-DRIVEN CURRENTS   1. Group brainstorm with solid fillTell the class we have an ocean current mystery to figure out, with another model! Guide Can density cause ocean currents on **journal p9**. Try this yourself first! Use [this tutorial](https://www.youtube.com/watch?v=86ChgK38EIA) to do so. Present a demonstration for the whole class first, without revealing what is in each jar. Then allow students to experiment with warm (red) vs. cold (blue) water and salt (green) vs. fresh (blue) water. After clean-up, hold another **Team Talk, slide 20** to discuss density and its effects on water movement, called currents, then write notes on their observations on **journal p10.** Show this video on salinity-caused currents to wrap up the session. 2. Play the [You are my Density game](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EZ632VYfUmBIlXY_hO_hOm4BbcMyB78z5DDi-nPllTB7hA?e=qxSrPv), debrief, then ask students to add to explanations of how temperature and salts act as density changers on **journal p10**. 3. Show **slides 21 and 22** and watch [MooMoo Math’s video](https://www.youtube.com/watch?v=uMH2-2nnJGs) in **slide 23**, then allow time for sense-making of the graphics on **journal p. 11**. Ask students to think-pair-share their thoughts on density, temperature, and water currents.   Checkbox Checked with solid fill   1. Show **slide 24** and use **journal p12** as a formative assessment. |

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| Session 6  10 min  Time varies and may need a whole session  10 min  30 min | EXTEND  TIDE-DRIVEN CURRENTS   1. Group brainstorm with solid fillShow **slide 25** and ask Explore Teams to have a Team Talk on what they would need to consider about ocean motion if they were going to paddle across the sea in a canoe. Discuss teams’ ideas. 2. A picture containing icon     Description automatically generatedIntroduce Canoe Journey. If possible, invite a knowledge sharer from a local tribal canoe family to teach your students in person or via Zoom about Canoe Journey. If that is not possible, show the [Canoe Journey video](https://www.youtube.com/watch?v=L5wk7xfkA10&t=1238s) in **slide 26** by Children of the Setting Sun Productions.      1. Give a brief overview of the cause of tides using **slides 27-31**. Take time for students to model centrifugal force involved in tides with their bodies at **slide 29**. 2. A picture containing icon     Description automatically generatedDistribute tide guides or allow access to [tide and current predictions online](https://www.deepzoom.com/) and challenge Explore Teams to determine the safest and easiest day and time in late July to make a canoe journey from a launch site nearest their school to Tsawout First Nation on Vancouver Island, **journal p13**. |
| Session 7  60 min session  20 min  25 min  15 min | Text  Description automatically generatedEVALUATE   1. It’s time to compare what we have figured out with what other scientists have to share about what sets the ocean I nmotion, **slide 32**. Describe how scientists find out what others have learned from their research by reading what they’ve published or shared in presentations. Distribute a poster paper with the Team Read template to each team and hold a [Team Read](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EQQQbFhgkUpDp3ARAfjnzUwBf2OHVQRjBwDqXR0wOAQn3A?e=IPZTnB) of the print or digital version of the [Ocean Conveyor Belt article](https://www.nationalgeographic.org/encyclopedia/ocean-conveyor-belt/)**, slide 33.** Then show the Interview with an Oceanographer, **slide 34.** Short discussion: How does this information support or refute what we have discovered so far about ocean circulation? 2. Follow the  [Ocean Motion Model instructions,](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EZbiUZm-8n5KiG9uVc73jp4BMm6_oejlJpP6MvcOWkb4mQ?e=pkyLZc) to model ocean circulation. Use one interactive demo for the whole class or provide materials for each Explore Team. Add objects to represent continents and wind (hair dryer) for complexity. Prompt students to record their observations on **journal p14**.   Group brainstorm with solid fill   1. Checkbox Checked with solid fillInvite Explore Teams to have a **Team Talk** to make sense of and evaluate what they observed in the Ocean Motion model, including the benefits, drawbacks, and improvements they would make to the model as a representation of the whole ocean, recording notes on **journal p15**. Show **slide 35** and ask that Science Communicators share a summary of their team’s model evaluations with the class. |

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| **LEARNING TARGETS LESSON 2** Know that density determines where objects, including plankton, will sit in the water column.Know that buoyancy is an object’s ability to float in liquid depending on how dense the liquid is.Realize that plankton depend on buoyancy to be at the depth that provides the right amount of light for their survival.  * Understand that science and the Engineering Design Process can be used to develop the best solution(s) to a problem and should be communicated with others. * Know that the lack of water circulation can support plankton blooms.   **TEACHING WITH THE 5 E’s FOR A COHERENT STORYLINE – LESSON 2**  ENGAGE activity: Students observe living plankton and wonder how they avoid sinking away from the sunlit surface waters.  **Practice**: Asking questions  EXPLORE activities: Students engineer a plankter to enter into the Great Plankton Race.  **Practice:** Designing solutions, Developing models.  EXPLAIN activity: Students evaluate what types of body structures supported the slowest sinking rates.  **Practice:** Evaluating and communicating information, Constructing explanations.  EXTEND activity: Read and discuss a scientific article on how water circulation affects plankton “blooms” in the Salish Sea.  **Practice**: Developing and using models  EVALUATE activity: Draw.  **Practice**: Communicating and Evaluating Information | **NGSS PERFORMANCE EXPECTATIONS**.  [5-PS2-1](https://www.nextgenscience.org/pe/5-ps2-1-motion-and-stability-forces-and-interactions) Support an argument that the gravitational force exerted by Earth on objects is directed down.  [3-5-ETS1-1](https://www.nextgenscience.org/pe/3-5-ets1-1-engineering-design) Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.  [3-5-ETS1-3](https://www.nextgenscience.org/pe/3-5-ets1-3-engineering-design) Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.  **If using this content for grades 4 or 6-8:**  [MS-ETS1-2](https://www.nextgenscience.org/pe/ms-ets1-2-engineering-design) Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.  [MS-ETS1-4](https://www.nextgenscience.org/pe/ms-ets1-4-engineering-design) Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. |

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| **TEACHER PREP LESSON 2**  **Plankton Observation**  In this section, if possible, you will work with live plankton. We suggest reaching out to a [community partner in your area](http://www.juniorseadoctors.org/map) to guide a plankton-gathering adventure (totally fun!) or ask them about procuring live plankton for your class. Plankton viewing may also be done remotely through a community partner if a trip or visit is not possible. Of course, another option is to gather plankton as a class with your own or a borrowed or student-made plankton net. If your students have access to a dock or boat and you have the extra time to devote to this lesson, students may enjoy constructing their own plankton nets and using them to gather plankton. These do not catch as many plankton as an official net. Find instructions and materials for [plankton net construction here](chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https:/coast.noaa.gov/data/estuaries/pdf/catching-plankton-resources.pdf).  To keep plankton alive while storing for more than a few hours, provide refrigeration and aeration, if possible. An air stone and motor for a home aquarium works well for aeration.  Print 1 phytoplankton and 1 zooplankton ID guide per Explore Team or each pair of students. In color and laminated, if possible (they will get wet). These can also be displayed overhead if printing is not an option. Keep these for future use.  **The Great Plankton Race**  Gather craft supplies listed in  [instructions](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EQFhsb4VlStDuJ1kfa9fCiEB5N7o0KVb2kut3OnuGGrnYQ?e=dOeMmB).  *Shooting star outlineSustainability star – repurpose materials that would otherwise be headed for a landfill!*  Set up a large, clear aquarium or other container in a central location.  Fill with water nearly to the top.  Provide a stopwatch or stopwatch function on a cell phone.  Prepare a class data table for race results, including Plankton Name and Sinking Speed as the column headings.  **Scientific Article Review**  Print plankton article, dividing equitably amongst Explore Team members or plan to have students read in digital format.  Create 1 Team Read poster template per team  Provide a set of colored markers for each team |

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| **MATERIALS LESSON 2**  PLANKTON OBSERVATION:   * Bucket * Seawater, live plankton-collect yourself (you will need a plankton net and a jar with a lid) or reach out to an organization on the [www.juniorseadoctors.com](http://www.juniorseadoctors.com) map of marine experts near you. * Dissecting scopes or magnifying glasses * Petri dishes or small, clear containers * Plastic pipettes (first choice), syringes, turkey baster, or spoons for transferring plankton to dishes * [zooplankton](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EUZEKvRimgtHuakEpdB75AUBY4-aiMqtUwoA0ROcjYkO0A?e=JHDYWl) and [phytoplankton](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/Efj6noPV4uNJt5GOkvY6rzIBjshLgAqJisll4iPKLwv6Hg?e=WfgUWO) ID guides * Optional: aerator for the plankton bucket, refrigerator for the plankton sample(s)   THE GREAT PLANKTON RACE   * 10-gallon Aquaria or buckets – 1 per class * ½ gallon plastic bins, 1 per Explore Team * Craft materials from which to build plankton, such as corks, plastic bottle lids, paper clips, toothpicks, feathers, packing peanuts, pipe cleaners (Idea: if feasible, do a beach clean-up and build plankton out of the plastic trash) * Stopwatch (cell phone stopwatch is fine) * Scoreboard or Google Sheet for results   SCIENTIFIC ARTICLE REVIEW   * Plankton article, dividing equitably amongst Explore Team members or in digital format. * 1 Team Read poster template per team * Colored markers set for each team | **WEBLINKS LESSON 2**  **Slide show**  <https://pacificeductioninstitute.sharepoint.com/:p:/s/Program/ERo8L6oy4ZJEnRI55qBxVNoB5w4ZCTy6c6DEJPyseFw1uA?e=Ysahxq>  **Estuary Experts Map**  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EXJNMlYfk7xJqL5B5FUK0hgBcMjf_wDUNAck576P_liLuA?e=KTzv5d>  **How to Collect a Plankton Sample video**  <https://www.youtube.com/watch?v=CGq4i832yS4>  **How to construct plankton nets instructions** (copy and paste all of the following into your browser):  Chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://coast.noaa.gov/data/estuaries/pdf/catching-plankton-resources.pdf    **Plankton ID guides**  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EW9CSvejKGZKoTeuWlp9xeQBkQiU0gwi0WbTWxr5gmznCw?e=jCjDwI>  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/Efj6noPV4uNJt5GOkvY6rzIBjshLgAqJisll4iPKLwv6Hg?e=WfgUWO>  **The Great Plankton Race Activity Instructions and materials**  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EQFhsb4VlStDuJ1kfa9fCiEB5N7o0KVb2kut3OnuGGrnYQ?e=BgyiYy>  **Plankton article**  <https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EU6EYFHQ_FlPuygqjEa1PDYBePShIFGqYkmLnOwoT4toWg?e=AhLJae> |

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| TIME | TEACHER GUIDE LESSON 2: HOW DOES OCEAN CIRCULATION AFFECT LIVING BEINGS? |
| Session 1  15 min  35 min | ENGAGE   1. Show students the phenomenon in **slide 36** again and ask who is ready to figure this out. Take a few suggestions of what ocean currents might do to tiny plants and animals. Introduce plankton and the problem with buoyancy using **slides 37-44**. 2. Guide the plankton observation lab, Friend a Plankter, **following journal p16**, using the plankton from a community partner or gathered by your class (notes in prep). |
| Session 2  5 min  45 min | EXPLORE   1. Using the students’ density knowledge, introduce the concept of buoyancy using **slide 45** as it pertains to plankton’s need to be near the surface. Ask what type of density they would need compared to the water to achieve this? If they can’t float, what kinds of structures would help slow their sinking?   A group of white circles on a black background  Description automatically generated   1. Challenge students to use the engineering design process on **slide 46** and **journal p17** to design, construct, test, and redesign, etc. a model plankter with neutral buoyancy just below the surface. Emphasize the term model and compare and contrast the model of a plankter with the model of the ocean. Ask that they describe briefly or draw its creation, summarize its testing, then draw an improved design in the circles provided on **journal pp 18-19**. |
| Session 3  10 min  10 min  15 min  5 min | EXPLORE continued   1. Use **slides 47-48** to introduce the buoyant force and neutral buoyancy. 2. A group of white circles on a black background     Description automatically generatedUrge students to write notes they consider important to improve their model design for a neutrally-buoyant or at least slow-sinking plankter. Ask students to draw their improved plankter model design on **journal p19**, then add arrows indicating buoyant force pushing upward and gravitational force pushing downward. 3. Give race instructions, **slide 49**. Hold the Great Plankton Race in a 10 gal or bigger aquarium of water, racing 5-6 plankton at a time. Chief Scientists place the plankton at the surface, Lab Techs run the stopwatches and Research Associates record results. Have students record results and reflect on **journal p20**.   Group brainstorm with solid fill  EXPLAIN   1. Hold a **Team Talk** to make sense of the race results, then share explanations with the whole class. |
| Session 4  30 min  10 min  10 min | **Text  Description automatically generated** EXTEND   1. Investigate previous scientific research through a **Team Read of** [this scientific article](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EU6EYFHQ_FlPuygqjEa1PDYBePShIFGqYkmLnOwoT4toWg?e=y56JyS) on what affects plankton and the entire food web in the Salish Sea, **slide 50**.     Checkbox Checked with solid fill EVALUATE   1. Have students draw their own diagrams of how ocean circulation affects phytoplankton and zooplankton in the Salish Sea, including symbols to represent currents, freshwater, sunlight, and nutrients.   Group brainstorm with solid fill   1. If you are moving on to Lesson 3: Fossil Fuels and First Foods Investigation, hold a Team Talk here to gauge Explore Team interest and curiosity.   Guiding questions are:  1. What, in addition to plankton, does ocean circulation move and spread in the sea?  2. How would ocean circulation affect oil accidentally spilled in the sea?  3.Using your knowledge of ocean circulation, is it possible to predict where the oil would travel?  Ask Science Communicators to share their Team’s ideas with the class. Leave it at the idea stage for now. |

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| **LEARNING TARGETS LESSON 3** Know that the process of science can provide clues to help solve mysteries and problems or explain how things work.  * Understand that computer models are based on actual measurements of the natural world and can help us protect wildlife and people. * Know that we can use critical thinking to construct explanations about phenomena and back them up with evidence. * Understand that communicating scientific investigation results is how science is brought to the people to inform decisions that make a difference for helping people and wildlife to have a better life.   **TEACHING WITH THE 5 E’s FOR A COHERENT STORYLINE – LESSON 3**  ENGAGE activity: Students learn traditional knowledge about First Foods.  **Practice**: Obtaining information  EXPLORE activities: Read informational text and view an interactive storymap about food sovereignty or shipping oil in the Salish Sea. Investigate, using a hydrodynamic model, whether an oil spill will spread to indigenous fishing and gathering sites.  **Practices:** Every Science and Engineering Practice is engaged in here.  EXPLAIN activity: Get CERIAs Forum.  **Practice:** Evaluating and communicating information, Constructing explanations. Arguing with evidence.  EXTEND activity: Share how the Salish Sea Model may be used in other applications.  **Practice**: Developing and using models  EVALUATE activity: Ocean Motion assessment.  **Practice**: Communicating and Evaluating Information | **NGSS PERFORMANCE EXPECTATIONS**.   * [5-ESS3-1](https://www.nextgenscience.org/dci-arrangement/5-ess3-earth-and-human-activity) Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.   **If using this content for grades 4 or 6-8:**   * [MS-LS2-2](https://www.nextgenscience.org/pe/ms-ls2-2-ecosystems-interactions-energy-and-dynamics) Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. * [MS-ESS3-3](https://www.nextgenscience.org/pe/ms-ess3-3-earth-and-human-activity) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment * [MS-ESS3-4](https://www.nextgenscience.org/pe/ms-ess3-4-earth-and-human-activity) Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth’s systems. |

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| **TEACHER PREP LESSON 3**  **Introduction to First Foods**   * Work with your district’s Tribal or First Nations Liaison, if possible, to invite a cultural outreach or natural resources knowledge keeper to share what they deem appropriate on the topic of ocean currents, or First Foods, and concerns for their health in relation to shipping fossil fuels through their territories. * Consider and prepare a thank you gift for this guest with your students. * Create [Team Read templates](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EQQQbFhgkUpDp3ARAfjnzUwBf2OHVQRjBwDqXR0wOAQn3A?e=JIPcaD) on poster paper, 1 per Explore Team. Pre-read the [Salish Current article](https://salish-current.org/2021/03/12/rescue-tug-stationed-in-islands-is-best-bet-to-avoid-oil-spills-in-san-juan-gulf-waters-study-says/) on oil spill preparedness and decide how best to divide it between or within Explore Teams. Print the article for students to read or plan to have them access it online.   **Guiding the Process of Science**  Icon  Description automatically generated   * Review the UC Museum of Paleontology’s [Understanding Science website](https://undsci.berkeley.edu/for-educators/prepare-and-plan/teaching-tips/) and [How Science Works](https://undsci.berkeley.edu/interactive/#/intro/1) interactive flow chart. You will guide your students through part of the scientific process here and all you need for support is shared in these resources. For more guiding the process of science, visit our [online training](http://www.explorethesalishseatraining.org). * Gain permissions from your district to download the \*[Salish Sea Model](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ERwronWaO9dFg6eyMoVAWv8Bg5WefRCEkd11_0GOxNervA?e=EAFZ55) program and practice modelling an oil spill following instructions in the link. * Practice running the Salish Sea Model for an oil spill in the shipping lanes between Vancouver, BC and the Strait of Juan de Fuca with your choice of variables (type of fuel, volume of fuel spilled, date, time)   \***The Salish Sea Model** was adapted for use in this curriculum by its creator, Dr. Tarang Khangaonkar of Pacific Northwest National Laboratories and University of Washington’s Salish Sea Modeling Center. It is a model developed for shipping corporations and government agencies and based on thousands of hours of many scientists measuring tides, currents, and water densities, and then programming this model to simulate how water circulates in the Salish Sea and how specific types of fossil fuels would circulate and spread here. SeaDoc Society extends deep gratitude to Dr. Khangaonkar and his team of brilliant scientists for the use of this model. It supports our goal of bringing real science to students.  **Assessment**   * Make KWL charts and the class Mind Map accessible for completing * Print [Ocean Motion post-assessment](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EbYaqV7vaI1BoSzTBg1gTsUBSEextt1JiO_cDmFk0MHxlA?e=ubdQz3) 1 per student |

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| **MATERIALS LESSON 3**   * Gift for Indigenous knowledge sharer * Slide deck * Explore the Salish Sea: A Nature Guide for Kids books * KWL chart for each student * Mind Map for adding clues and building schema * Salish Sea Model, uploaded to your computer and student computers (if possible – not essential) * Ocean Motion Post-assessment | **WEBLINKS LESSON 3**  **Slide show**  <https://pacificeductioninstitute.sharepoint.com/:p:/s/Program/ERo8L6oy4ZJEnRI55qBxVNoB5w4ZCTy6c6DEJPyseFw1uA?e=BlW4B9>  **How Science Works Process of Science website** (explore this whole site, it is AWESOME!)  <https://undsci.berkeley.edu/article/howscienceworks_01>  **How Science Works Web Interactive**  <https://undsci.berkeley.edu/interactive/#/intro/1>  **Salish Sea Model Instructions for Teachers**  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EbaAvRLP40xOkn-RDCU3a2oBXdl69Jf1KEndvNlVOLKRtA?e=OQvzRR>  **Salish Sea Modeling Center**  <https://www.pugetsoundinstitute.org/salish-sea-modeling-center/>  **Salish Sea Model Data Portal** <https://www.pnnl.gov/projects/salish-sea-model/data-portal>  **Salish Sea Model file for download**  <https://www.pnnl.gov/sites/default/files/media/file/SSM-GNOME_July_2014.zip>  **Map of Tsawout First Nation Fishing Sites**  <https://pacificeductioninstitute.sharepoint.com/:i:/s/Program/Eeuw79CFZupBgZPsJvt-aEMBRYOgYDRwlX6Eh0cZ1jxQmw?e=YVA3qZ>  **Map of Tsawout First Nation Gathering Sites**  <https://pacificeductioninstitute.sharepoint.com/:i:/s/Program/EQkA2Qmtws1CmAhoIOMGY5ABZ40R6PTwtUsfu_-l3uZqww?e=L1oCco>  **Avoiding oil spills article (online)**  <https://salish-current.org/2021/03/12/rescue-tug-stationed-in-islands-is-best-bet-to-avoid-oil-spills-in-san-juan-gulf-waters-study-says/>  **Avoiding oil spills article pdf**  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/Ea9Am0cCnGhHjG5ebCQm_SEB_EoXTkKPI_aHnxpV_U-CoQ?e=AcMQOl>  **Oil spills and Indigenous food sovereignty article**  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/Ea9Am0cCnGhHjG5ebCQm_SEB_EoXTkKPI_aHnxpV_U-CoQ?e=QFS3M2>  Weigh Anchor interactive video storymap by The Globe and Mail  <https://www.theglobeandmail.com/news/british-columbia/kinder-morgan-trans-mountain-pipeline-bc-coast/article35043172/>  **Oceanographer careers website**  <https://oceanservice.noaa.gov/facts/oceanographer.html>  **Inspiring hope article: Boyan Slat of the Netherlands starts Ocean Cleanup at 18 and is now cleaning the Great Pacific Garbage Patch** <https://www.usatoday.com/story/news/world/2021/10/29/great-pacific-garbage-patch-ocean-cleanup-nets-63000-pounds-trash/6138815001/> |

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| TIME | TEACHER GUIDE LESSON 3: FOSSIL FUELS AND FIRST FOODS |
| Session 1  6 min  30min    14 min | Group brainstorm with solid fill ENGAGE   1. Show **slide 51** and have students turn to **p.1** in their ***Explore the Salish Sea*** books. Hold a Team Talk about what the Musqueam First Nations peoples were doing in their canoes in that photograph and why. 2. A picture containing icon     Description automatically generatedIf possible, invite an Indigenous knowledge sharer to introduce the concept of First Foods and their importance to Coast Salish health and well-being. Sharing foods, such as seaweed, smoked salmon, and clams is even better, carefully considering gathering regulations and allergies in your class. Present a gift to your visitor at the end of their visit. Note: extend the time accordingly on this activity if you have a visitor and move the Team Read to Session 2.   If learning from the local indigenous community is not possible, introduce First Foods using **slides 52-54** and share foods as you are able. Ask students to consider ways that ocean circulation can affect First Foods in both positive and negative ways, especially considering the concerns of the Musqueam about increased oil shipping.     1. Group brainstorm with solid fillShow **slide 55** and invite students to gather all the clues they can from the maps of Tsawout (pronounced *tsay out*) First Nation fishing and gathering sites on **journal pp.21-22**. What do these maps show? How is this related to the photo of the Musqueam people, Tsawout neighbors across the strait, in the book? Give 2-3 minutes to explore maps and then hold a Team Talk to summarize what team members discovered from the maps. Ask Science Communicators to share out for each team. |
| Session 2  20 min  10 min  15 min    5 min | EXPLORE   1. **Text     Description automatically generatedA picture containing object, mirror     Description automatically generated**Ask students to share what they’ve heard about increased shipping of oil in the Salish Sea. Give students an experience of being on a tug, towing an oil tanker through the shipping lanes in the [Weigh Anchor video/storymap.](https://www.theglobeandmail.com/news/british-columbia/kinder-morgan-trans-mountain-pipeline-bc-coast/article35043172/)  Introduce recent articles that can help us understand more. Invite half of the Explore Teams to conduct a [**Team Read**](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EQQQbFhgkUpDp3ARAfjnzUwBf2OHVQRjBwDqXR0wOAQn3A?e=hexnIJ) of [this Salish Current article](https://salish-current.org/2021/03/12/rescue-tug-stationed-in-islands-is-best-bet-to-avoid-oil-spills-in-san-juan-gulf-waters-study-says/). And the other half, the [Jonasson et al. food sovereignty article](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/Ea9Am0cCnGhHjG5ebCQm_SEB_EoXTkKPI_aHnxpV_U-CoQ?e=a6mEGV). Hand out printed articles or direct students to the orange button in the [Ocean Motion unit page](http://www.juniorseadoctors.com/oceanmotion) to read it online. 2. Have each student fill in a Know, Want to Know, Learned (KWL) chart about how ocean currents would move oil spilled in the shipping lanes near Vancouver, BC, **journal p23**.  |  |  |  |  | | --- | --- | --- | --- | | **KNOW examples**   * There will be increased shipping of oil after the Trans Mountain pipeline is completed and more shipping of everything else should the Robert Banks shipping terminal expansion be approved. * Coast Salish peoples depend on First Foods from the sea. * We have the locations of Tsawout First Nation’s First Foods sites. | **WANT TO KNOW examples**   * Will an oil spill reach Tsawout First Foods? * Where should an oil spill response tug be positioned to prevent it? | **LEARNED**   * ? |  |     Now that we have clues and a question, it is time to put science to work, **slide 56.**   1. Scientists at the Salish Sea Modelling Center created a computer model that predicts the spread of an oil spill, based on thousands of measurements of actual Salish Sea tides, currents, estuarine flow rates, and how all of these react with different fossil fuels in the water. Demonstrate the the [Salish Sea Model](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EbaAvRLP40xOkn-RDCU3a2oBXdl69Jf1KEndvNlVOLKRtA?e=XEctlK) and let students watch a spill spread. Let them know they will have access to this model themselves. Ask students if it could help prevent a disaster with oil and First Foods. Once they have seen the model in action, ask how they can use the process of science so they have the power to figure out if a spill in the shipping lanes could reach Tsawout fishing and gathering grounds. 2. Icon     Description automatically generatedDisplay the [**How Science Works Flowchart**](https://undsci.berkeley.edu/article/scienceflowchart) **slide 57** and have students view their **own** online or on **journal p24**. Give a minute to familiarize. Let them know that this is a model of the steps scientists take when solving mysteries or problems. Is it a straight line process? No. It is a circuitous route through many, often revisited steps of curiosity, design, exploration and discovery. Ask where in the process of science we already are with the issue of Salish Sea circulation, oil shipping, and First Foods. Give a moment to consider then take a few suggestions. Point out that they’ve already begun their own, real scientific research! Let them know next session, they will put it to work. |
| Session 3  10 min  10 min  30 min | EXPLORE continued   1. Icon     Description automatically generatedHave students consider the research questions on **journal p.25** then come up with a title that summarizes the study. In future units, students will create their own research question and identify its variables. For this first research endeavor, these are provided.   Icon  Description automatically generated   1. Now that Explore Teams are equipped with background information, they are ready to form their hypotheses, **slide 58, journal p23**. 2. Icon     Description automatically generatedGuide students in planning an investigation using **journal p26** and the [Salish Sea Model](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EbaAvRLP40xOkn-RDCU3a2oBXdl69Jf1KEndvNlVOLKRtA?e=XEctlK) to simulate an oil spill in the location of their choice, **slide 51.** Students may modify the existing procedure, if desired. Let them run the model and record results, **slide 60**, **journal pp 26-27**. |
| Session 4  20 min  20 min  10 min | EXPLIcon  Description automatically generatedAIN   1. Guide students through the [Get CERIAs](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ETMHqXrdXfRGssNWQMt4blABXr5QGdRfuGv6q2rI7IHHvA?e=NXbSrZ) form to analyze the results, **slide 61**, **journal p 28**.   A picture containing sign, dark  Description automatically generated   1. Hold your [Get CERIAs Forum.](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ETMHqXrdXfRGssNWQMt4blABXr5QGdRfuGv6q2rI7IHHvA?e=NXbSrZ), following the guidelines in the link. 2. Let students know that many careers can support the kind of investigations we have done in this unit of study. Share oceanography career types, **slide 62**. |
| Session 5  15 min  20 min  10 min | EVALUATE   1. Complete the KWL chart, **journal p23**, filling in the **Learned** column with students. Add to the class mind map any clues that may help us figure out how to help the southern resident orcas with what we learned.   A picture containing text, sign  Description automatically generated   1. Administer the [Ocean Motion post-assessment](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EbYaqV7vaI1BoSzTBg1gTsUBSEextt1JiO_cDmFk0MHxlA?e=7J9h8c), **slide 63**. 2. Group brainstorm with solid fillHold one last Team Talk to decide how to share your discoveries with your school or broader community. You may just inspire local leaders to help heal the sea. 3. Give stamps to celebrate |
| Optional  time  varies | COMMUNICATE   1. A picture containing sign, dark     Description automatically generatedPlan and carry out your science communication event (symposium, poster display, song, webpage, social media post, letter to tribal community leaders, or…?).   \*Do this now or save for after you’ve completed all of your chosen units of Explore the Salish Sea, including your Salish Sea Heroes Project. |