A picture containing outdoor, colorful, ocean floor

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Tide Out, Table Set

Grade Level: 5

Explore Chapter: Life at the Edges

Time Required: 13 50-min sessions, optional low tide field trip

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An eelgrass meadow is a critical intertidal habitat for many species, including this Pacific spiny lumpsucker! Image by Joe Gaydos

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**Background for the Teacher**

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In Unit 4, corresponding to chapter 4 of Explore the Salish Sea: A Nature Guide for Kids,

Sources

Further Learning and Classroom Resources

**Unit Overview**

How can we as a community address ecological issues in intertidal ecosystems?

**Anchoring Phenomenon:** Magnified view of plump, round oyster larvae next to misshapen oyster larvae

**Design Challenge:** How can we develop evidence-based solutions to climate-related changes in intertidal ecosystems?

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| **Lesson 1 -** 3 days  How can we prepare to go clamming? | **Lesson 2 –** 5 days  How does matter and energy cycle through intertidal ecosystems? | **Lesson 3 –** 8 days  How does carbon cycle through the ocean, land, and atmosphere and affect climate, sea level, and ocean pH? | **Lesson 4** - 3 days  How can we form and communicate evidence-based recommendations to address climate-related intertidal issues? |
| Session 1  What do we wonder about misshapen oyster larvae?  Session 2  What patterns do we notice in  Session 3  Session 4 | Session 1  Session 2  Session 3  Session 4 | Session 1  Session 2  Carry out the investigation.  Session 3  Session 4  Argue using evidence with fellow scientists  Session 5 |  |
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| LEARNING TARGETS LESSON 1: Know that each living organism needs a habitat where it finds food, clean water, shelter, and a place to rear its young.Understand that tides are the rising and falling of the level of the sea as the ocean is pulled by gravitational force toward the moon and, to a lesser extent, the sun.Understand that intertidal life is adapted to extreme physical and biological changes and has structures and behaviors that help it survive in that habitat.Know that shellfish in the Salish Sea are developing deformed and/or under-formed shells. | TEACHER LESSON 1 PREP  • Review unit plan, slide show, and students journal together. Be sure to read all game and activity instructions documents.  • Print Pearls of Wisdom, cut into single ‘pearls’, fold, and place into a large shell or other container.  • Print student journals, 8.5 x 14” paper, booklet fold, color.  Tidepool Survivor  • Print game cards onto cardstock, color, double  sided.  Let’s Go Clamming tide chart activity  • Print or provide online access to the tide charts and lunar calendars for your selected area and month, including a full lunar cycle of tides and moon phases.  Tidal Tango  • Acquire 1 flashlight per Explore Team |
| PERFORMANCE TASKS LESSON 1:   * List the four habitat needs that every living organism has in order to survive. * Model how tides work and what causes tides by using their bodies to represent the moon, sun, Earth, and ocean. * Act out adaptations that tidepool creatures have to survive in such a harsh habitat by using charades. * Discuss possible explanations for the phenomenon occurring in the Salish Sea of native oysters growing deformed (or not being able to grow at all), and form an essential question to investigate this. | TERMS FOR THE TEACHER  **Assessment**- a pre- and post-assessment and formative assessments are available to measure student growth during each unit. The pre- and post- ‘Explore the Salish Sea’ survey should be both taken by the teacher and students and results shared with The SeaDoc Society.  **Games-** games are used to introduce and reinforce concepts through play. Instructions are included.  **Text  Description automatically generatedBackground research**- includes articles, videos, the Explore the Salish Sea book and others.  **Traditional Ecological Knowledge Opportunity (TEK)-** Work with your district’s Tribal or First Nations Liaison, if you have one, to invite a cultural outreach or natural resources employee to visit your class and share what they deem appropriate on the topic of their family history in this place and specifically, how they used traditional ecological knowledge.  **A picture containing text, sign, dark  Description automatically generatedWonder** – a phenomenon, problem, or discrepant event that sparks curiosity in students and initiates the themed exploration for the unit.  **Team Talk** – Explore Team members share with one another. Each student has 1 min to share to ensure equitable opportunity to speak, and to allow students to be heard, who may not speak out in a full-class discussion. The Science Communicator shares out the Team ideas with the class.  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.    **Experiment**- students perform a hands-on investigation.  **Team Read** – The equitable division of a large piece of literature or several types of background information, including articles, videos, webpages, and more, among teammates, each getting summarized individually, and then synthesized in one overall summary. This allows each student to feel that they have contributed an important piece of background research, while accommodating individual ability levels.  **Field Experience** opportunity to make observations outdoors or on a field trip |
| NGSS PERFORMANCE  EXPECTATIONS  Three Dimensions of NGSS  blue=Practice orange=DCI green= Crosscutting Concept  **Grade 5**  [3-LS3-2](https://www.nextgenscience.org/pe/3-ls3-2-heredity-inheritance-and-variation-traits) Use evidence to support the explanation that traits can be influenced by the environment.  [4-LS1-1](https://www.nextgenscience.org/pe/4-ls1-1-molecules-organisms-structures-and-processes)Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior and reproduction.  **Grades 6-8**  [MS-PS2-4](https://www.nextgenscience.org/pe/ms-ps2-4-motion-and-stability-forces-and-interactions) Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.  [MS-ESS1-1](https://www.nextgenscience.org/pe/ms-ess1-1-earths-place-universe) Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. |
| BACKGROUND FOR TEACHERS:  See the [Tide Out Table Set slideshow](https://ucdavis.box.com/s/n4skbu0nx2sok7avf3t5gxl0itocm8k7), slides 1-6  **\*Note on lessons and time:**  Use the lessons and activities herein as you see fit and feel free to modify the plan, journal, and slideshow to fit your teaching needs. For this reason we have left them as Word or PowerPoint files. Just be sure that there is still a logical developmental progression, as described in the  [NGSS Appendix E-Progressions Within the Next Generation Science Standards](https://www.nextgenscience.org/sites/default/files/resource/files/AppendixE-ProgressionswithinNGSS-061617.pdf) |

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| **TIME** | **Teacher Guide Lesson 1: Can we go clamming and oystering?** |
| Session 1  1 min  2 min  15 min  17 min  5 min  5 min  5 min | 1. **Provide ‘Pearls of Wisdom’ (inspirational quotes) in a large shell**. Point out the pledge that will be used should you visit a shoreline at low tide, journal p2. 2. Direct students to form **Explore Teams** using the guide on **slide 7** and **journal p3** and rotating roles from the previous unit.   A picture containing text, sign  Description automatically generated   1. Administer Tide Out Table Set  [pre-assessment](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EewRuFTZietFhxVgJzg-rpkBKGZybMF3mGAUZDB9NAsvgg?e=VF5LtN), **slide 8**. 2. A picture containing text, different, same, several     Description automatically generatedDistribute student journals and have students read **Explore the Salish Sea Ch.4,** **Life at the Edge: The Intertidal World, slide 9** (book image) then free-write on **journal p4**. 3. Direct them to highlight or circle unfamiliar vocab words on **journal p5** and add any more they are unsure of from chapter 4. They should define these as they are learned naturally, through repeated exposure throughout the unit. 4. A picture containing text, sign, dark     Description automatically generated**Wonder**: Show **slide 10**. Don’t describe the image, except to share that the oyster larvae on the left are in normal seawater and those on the right are in seawater that’s been changing. Then just let them wonder about what they are seeing. Direct students to journal p6 to write and/or draw what this phenomenon makes them wonder. 5. **Essential question**: Guide the formation of an [essential question](https://www.scholastic.com/teachers/articles/teaching-content/essential-questions/) using what students wondered, **slide 11**. Have students write the essential question on **journal p6**. Subtly guide them toward a question related to local oyster habitat health. |
| Session 2  10 min  30 min  10 min | 1. Hold a ***Team Talk*** to think about how to find clues to what is up with the baby oysters in the Salish Sea, **slide 12**. They may use **journal p 7** to take notes. Have Science Communicators report to the class. Start a mind map to track their thinking, **slide 13**.      1. Ask if the class is ready to do some nature detective work and find their first clues.Let them know that stories are filled with clues! Share the [Gossiping Clams story](https://vimeo.com/216035921) as told by Roger Fernandez. Then let them know that scientific text is also full of clues, but reveals them in a much more direct way. Guide students to the Student Research References (an orange button under Background Research) for Unit 4 in the [Tide Out Table Set webpage.](https://www.juniorseadoctors.com/tideout) Have Teams acquire Oyster Habitat articles and other references and allow 20 min to search for clues and 10 minutes to summarize their research in a [Team Read](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/Eaz1Fx1aHKVEoazfwl5-6EYBeacKwo13H8pCE6aGk92U9g?e=jciLvT) poster. Have the Science Communicators share out any clues they uncovered in their background research. Create/fill in the mind map as they do. 2. Guide students to begin considering what clams and oysters need by introducing ***habitats***. Ask students what every living thing needs in its *habitat* (allow them to intuit the definition with repeated use), have them use their info to fill in the **Have to Have a Habitat** activity, **journal p8**. Afterwards, show **slide 15** and ask the class if they think it’s a good idea to learn all we can about oyster’s habitat, starting with where that is. |
| Session 3  15 min  15 min  15 min | 1. Ask students the meaning of *intertidal* (between tides) and what would be some challenges of living in an intertidal habitat. List answers on the board then introduce the game: 2. [Tidepool Survivor](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ETNTr3UKQ3JFphYi8IK8gCwB310fojOEfqSaFRltvwBgEA?e=sT7vfr), **slides 16-19**, follow game instructions, give Explore Teams five minutes to prepare the charades of their creature and adaptation, filling in **journal p9** as they plan their improv. Give two minutes for each Explore Team to act it out and have the class guess their organism and adaptation. 3. To connect intertidal survival to forces driving the tides, ask students if they’d like to go meet their intertidal neighbors at the seashore. What would they need to know to plan a clamming/oystering trip? Hand out tide charts for your location or tide prediction links for [WA](https://tidesandcurrents.noaa.gov/tide_predictions.html?gid=1415) or [BC](https://www.tides.gc.ca/eng/station?type=0&date=2020%2F05%2F06&sid=7735&tz=PDT&pres=0), **slide 20**. Discuss a date and time for visiting the beach (in person, if possible) and fill out **journal p10**. |
| Session 4 15 min  15 min  20 min  Total:  3 hr 20 min | 1. **Slide 20**, Ask the class: What causes tides? Accept responses. Ask if they have any data at hand that could offer clues to the cause. Some students will likely offer gravity or the moon pulling on the Earth. Hand out a [lunar phase chart](https://www.almanac.com/astronomy/moon/calendar) for the same month as their tide chart. Have students explore a one-month cycle of tides chart vs. a lunar phases chart for the same month. Look for patterns. Notes on **journal p11**. 2. Show slides **21-24**. Have students model tides with their bodies as the Earth, moon, sun, and ocean. Ocean bulges toward moon and sun in the Tidal Tango activity, **journal p12**.      1. Show slides **25-28,** playvideo in slide 28. Hold a whole-class discussion on tides and Have students complete formative assessment, **journal p13**. |

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| **MATERIALS LESSON 1**   * Slideshow * Wi-Fi * Laptop * A/V * Student Journals   Oyster Habitat References   * Oyster video * Oyster fact sheet * Oyster articles 1, 2, and 3 * Team Read template on posters (optional)   Tidepool Survivor   * Tidepool Survivor Instructions * Intertidal organism cards, 1 per Team * Tidepool Survivor challenge cards, 1 per Team * Student journal, p 9 * Space for acting out their organism and challenge   Let’s Go Oystering Tide Chart Activity   * Printed or digital tide chart including a full lunar cycle of tides * Printed or digital lunar cycle chart for the same month as the tide chart   Tidal Tango  For each Explore Team   * One flashlight * Space to roleplay Earth revolving around the sun | **ONLINE RESOURCES LESSON 1**  Tide Out Table Set webpage  <https://www.juniorseadoctors.com/tideout>  Essential Question description  <https://www.scholastic.com/teachers/articles/teaching-content/essential-questions/>  Gossiping Clams story – Suquamish Tribe, told with permission by Roger Fernandez, Lower Elwha S’Klallam Tribe  <https://vimeo.com/216035921>  Team Read Instructions and Template  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/Eaz1Fx1aHKVEoazfwl5-6EYBeacKwo13H8pCE6aGk92U9g?e=UGaPmK>  Tidepool Survivor Instructions  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ETNTr3UKQ3JFphYi8IK8gCwB310fojOEfqSaFRltvwBgEA?e=qjW5mA>  Intertidal organism cards  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ERaAkguhNU1IuOerKosFUK8BDvGfSCY9t_AJ3tMkfnIzSQ?e=eSDS5f>  Tidepool Survivor Challenge Cards (print, double-sided)  <https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EX9YBTpCKG1CrTqArcRareABAFMGpd0-jbMNmBeM_dEEcw?e=RThZdd>  For the teacher: How to Read a Tide Table, REI  <https://www.rei.com/learn/expert-advice/how-to-read-a-tide-table.html>  NOAA Tide Predictions  <https://tidesandcurrents.noaa.gov/tide_predictions.html?gid=1415>  Fisheries and Oceans Canada Tide Predictions  [https://www.tides.gc.ca/eng/station?type=0&date=2020 %2F05%2F06&sid=7735&tz=PDT&pres=0](https://www.tides.gc.ca/eng/station?type=0&date=2020%20%2F05%2F06&sid=7735&tz=PDT&pres=0)  Farmers Almanac lunar phases calendar (print month of choice)  <https://www.almanac.com/astronomy/moon/calendar>  Untamed Science Intertidal Zone video  [https://untamedscience.com/biology/biomes/intertidal-zone-aquatic-biome/#](https://untamedscience.com/biology/biomes/intertidal-zone-aquatic-biome/) |

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| LEARNING TARGETS LESSON 2: Know that people, especially Coast Salish people, are interconnected with the Salish Sea ecosystem through food, transportation, and spirituality.Know that organisms are categorized into phylogenetic groups based on the adaptations that they have.Know that energy and matter is transferred from producers to herbivores to predators, and some energy is lost in each transfer through this trophic (food) pyramid.Understand that every living and nonliving organism or resource is connected in an ecosystem. | NGSS ADDRESSED IN LESSON 2  4-LS1-1    Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior and reproduction.  [5-LS2-1](https://www.nextgenscience.org/dci-arrangement/5-ls2-ecosystems-interactions-energy-and-dynamics) Develop a model that describes the movement of matter among plants, animals, decomposers, and the environment.  MS-LS2-1   Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.  MS-LS2-2    Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.  [MS-LS2-3](https://www.nextgenscience.org/dci-arrangement/5-ls2-ecosystems-interactions-energy-and-dynamics) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. |
| PERFORMANCE TASKS LESSON 2:   * Observe clues in native oyster habitat to determine what could be causing the mysterious growth phenomenon. * Demonstrate how Salish Sea organisms in an intertidal habitat are interconnected by building a yarn food web. * Categorize organisms into related groups by using a phylum comparison key. | PREP LESSON 2:  In Lesson 2, students will hunt for more clues to the oyster larvae dilemma by delving into the cycling of energy and matter in the intertidal ecosystem. Here is a chance to discover how other components of the ecosystem interact with oysters and one another. Ecosystem interactions will include ***food chains***, ***food webs,*** and ***trophic (food) pyramids*** to track ***energy transfers***.  Several activities work well at the beach or at an aquarium or marine lab. This is a great time to partner with your [Community Expert](https://www.juniorseadoctors.com/map) to help organize and lead a beach visit. If a field trip is not possible, utilize printed images of marine organisms, such as the Food Web Activity Cards when organism observation is necessary.  Ask your school or district Tribal/First Nations Liaison to invite a TEK-sharer/s to teach about their traditional territory, intertidal First Foods, and why Coast Salish say, **“When the tide is out the table is set**.” Prepare and present gifts to thank these teachers for sharing their people’s knowledge and land. Ask if they would open the field day with their words and/or song. They may suggest a specific beach or come to your school.  **Tidal Tag**  Review instructions, gather play field boundary markers (cones, etc.) and pennies or flags to mark predators, set up the play field.  **Beach Plan**   * Coordinate with your community partner for a low-tide beach field trip, as a class or with independent families. * For whole-class or grade-level trips, arrange for 1 parent chaperone per 1 or 2 Explore Teams. Your students will have selected the best day and time for your trip Print letters home, permission forms, packing lists.   **Alternate Intertidal Activity**   * If you are not able to go to the beach with your class, have them build a beach with art! Provide butcher paper and space for each Explore Team to create a different intertidal ecosystem. Aspects of the beach day station activities may be added to the mural (habitats, zonation, food chains, webs, food pyramids, predator-prey, labeled living (biotic) and nonliving (abiotic) components, phyla and more).   **Beach Day**   * Gather field trip materials (listed in materials list) and review field trip protocols and risk management. * Review the activities for each of the station activities. Gather materials. Print food web activity cards on card stock, color, double sided. Hole punch and attach yarn lanyards for wearing around necks. Stations include: * **Food Web Station Part 1** * **Food Web Station Part 2 Trophic Pyramid** * **Zonation Station Part 1** * **Zonation Station Part 2** * **Classification station Part 1** * **Classification Station Part 2** * **Classification Station Part 3** |

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| TIME | **TEACHER GUIDE LESSON 2: INTERCONNECTED INTERTIDAL** |
| Session 1  5 min  30 min | 1. Share instructions, **slide 29** play [Tidal Tag](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/ES-Lw1L7tf5GmwzX9X6ZGmoBZm48vx1i0D02fmBIv2vffQ?e=tZyHCO) on field or gym. 2. Thank the students for their help in planning a field trip around the tides. Visit the mind map to review the clues to the oyster larvae mystery so far, then have Teams turn and talk about possible culprits based on our current knowledge, **slide 30** (you’ll cross these off as they get ruled out). 3. Ask what students want to find out at the beach\*, have them brainstorm with Explore Teams, **journal p14**. **\***If beach visit not possible, this info can be gathered from your community expert or online data and added to the mural alternative. |
| Session 2  5 min  20 min  5 min  20 min  5 min | 1. Create a class definition of *ecosystem*, **slide 31** and post it in the classroom for reference. 2. Take a virtual tour through five intertidal ecosystems, taking questions or comments of personal stories in those places, **slides 32-39**. **Slide 40** introduces the optional mural project. The mural may be used as part of the beach visit alternative, adding station activity components to the mural. 3. Introduce nature journaling as a way to document beach observations in a personalized, creative way, while still recording key scientific information, **journal p15, slide 41**. If not going to the beach as a class, assign a nature journaling trip to kids with their family at a nearby shoreline or even just their own yard or balcony or window. 4. Walk through beach activities in student journals, noting that the clues they want to find all seem related to how matter and energy cycle through the ecosystem, **slides 42-47, journal pp 16-24.** 5. Distribute permission slips and packing lists. Have students go back and sign the pledge on **journal p2**. |
| Field Trip  Time will vary  20-30  min per  station  20 min  10 min  Total:  1hr 40 min  + trip | 1. Travel to the beach and form a circle to begin the beach day with a message of gratitude, an acknowledgment of whose traditional territory you are sharing, and a reminder of outdoor classroom norms.     Begin the beach day with the TEK talk and/or activity, present thank you gifts to the teacher and give thanks for the gift of being in their traditional territory.   1. Have a station leader divide the beach into three sections, one for each group. Divide students into three groups for stations (keep Explore Teams together, if possible)   STATION 1: STATION 2: STATION 3:  **Food Web Station Zonation Station Classification Station**  journal pp 16-18 journal pp 19-20 journal pp 21-24     1. Gather up and all together play Tidal Tag. 2. Circle up for summary discussion. Ask for observed clues to oyster habitat health based on the four components of habitat. Ask what we may not be able to see that could affect oyster shells. Ask what additional information we may need. Conclude with a formative assessment and a plan to find more clues back in class. |

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| **MATERIALS LESSON 2**  Tidal Tag   * Open space for running * 6 cones or other boundary markers for play field * 3 pennies or flags to identify the predators   Food Web Station I activity Food Web   * Intertidal Food Web Activity Instructions * Intertidal Food Web cards, printed, folded, hole-punched, yarn or other lanyards attached * Ball of yarn * Plush toy top predator (killer whale works well)   Food Web Station II activity Trophic Pyramid   * Salish Sea Wildlife Guides, 1 per student (come free with Junior SeaDoctor membership, also free) * Other intertidal ID guides (see Salish Sea School’s or Periwinkle Press’ EZ ID)   Zonation Station I and II   * Instructions with Zone Key * Salish Sea Wildlife Guides   Classification Station I   * Magnifying glasses, 1 per pair of students * Colored pencils   Classification Station II   * 8 Phylum cards on colored paper, laminated * 8-12 plastic bins or buckets for temporarily holding sea life * (replace each organism to where it was found after each group)   Classification Station III   * Salish Sea Wildlife Guides * Adoption Certificates, 1 per student (award back at school) | **ONLINE RESOURCES LESSON 2** Tidal Tag<https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/ES-Lw1L7tf5GmwzX9X6ZGmoBZm48vx1i0D02fmBIv2vffQ?e=tZyHCO> Fulford Harbor, BC Clam garden video by Swinomish Indian Tribal Community  <https://www.youtube.com/watch?v=9dDesE4u07U&t=6s> Intertidal Food Web Activity<https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EYWDJ0C8dC5GqwrBAvC2QN0B54kANm1dF5FzGRxNJmNXag?e=hg9l2l>Intertidal Food Web cards<https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ERaAkguhNU1IuOerKosFUK8BDvGfSCY9t_AJ3tMkfnIzSQ?e=8H9aCL>Zonation Station Instruction card with Zone key [Zonation Station Instructions.docx](https://pacificeductioninstitute.sharepoint.com/:w:/s/Program/EVdTM2CiPkxAgwXS6lTHja4BQboDdg5FUS2xPbFCS4sXzg?e=OvToiU) Intertidal ID Guide by Salish Sea School (with photos)[https://media.wix.com/ugd/739787\_aa3502e2f5a14386982 aa45d95329010.pdf](https://media.wix.com/ugd/739787_aa3502e2f5a14386982aa45d95329010.pdf)Intertidal ID Guide by Periwinkle Press<https://soundwaterstewards.org/ezidweb/ezid_cards/periwinkle.htm>Classification Station Instruction cardClassification extension videos by UW Friday Harbor Labs studentsPhylum Comparison Key<https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EWxsICLAtA9LnvRAwY1aV1YBoLKzO81nGxqMa09K_ysV4A?e=sPdT2n>Invertebrate Adoption Certificate template<https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/ERIhASjYZk1GphB10xtKFQEBX8k6WkO3ut13aZKGMeLiNw?e=fSBTXr>Extension beach activity: Bioblitz instructions (modify to simplify or go whole-hog)<https://www.nationalgeographic.org/projects/bioblitz/> |
| RISK MANAGEMENT:   * Play games in a safe area where students in the obstacle course will avoid tripping hazards or a hard fall. * **For Field Trip**: * Provide 1-2 adult chaperones per Explore Team. * Review Outdoor Classroom rules. * Review proper and safe tool use. * Carry first aid kit and meds for children who need them. * Ensure children AND adults come with safe footwear, raingear, sunscreen, lunches or snacks, and reusable FULL water bottles for hydration. * Have the site scouted for potential hazards. * If on docks or slippery surfaces near deep water, bring or borrow enough life vests for students. |  |

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| **LEARNING TARGETS LESSON 3** Understand that changing a chemical component of the sea affects other living and nonliving components.Know that our behaviors as human species impact the health of wildlife and their ecosystems.Understand that adding more carbon to the atmosphere adds carbon to the sea.Understand that increased carbon in the sea makes it hard for animals and phytoplankton to make shells due to chemical changes in their environment that affect their shells.Know how to share evidence-based recommendations with others for solving ecological problems. | **NGSS ADDRESSED IN LESSON 3**  5-ESS3-1    Obtain and combine information about ways individual communities use science ideas to protect Earth’s resources and environment.  [MS-PS1-2](https://www.nextgenscience.org/pe/ms-ps1-2-matter-and-its-interactions) Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.  [5-PS1-4](https://www.nextgenscience.org/pe/5-ps1-4-matter-and-its-interactions). Conduct an investigation to determine whether the mixing of two or more substances results in new substances  MS-LS2-4   Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.  MS-ESS3-3    Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. |
| **PERFORMANCE TASKS LESSON 3**   * Draw a carbon cycle taking place in the Salish Sea. * Track how carbon moves through living and nonliving organisms and resources in an environment by performing a nutrient-cycling activity. * Perform a research project to determine ecosystem health for oysters and other marine life by testing the acidity (pH) of local ocean waters. * Compare findings of their oyster research project with peers and support their findings with experimental data. * Give at least one evidence-based recommendation to solve the oyster dilemma. | **PREP LESSON 3**  Here your students’ clue-finding will lead to the discovery that every biotic (living) thing contains carbon. This is a great time to introduce ***nutrient cycling***, with carbon as the star.  This starts with tracking down the ingredients of their own favorite foods and following them through their bodies and into the air, and then into water. Students will compare water after adding regular air, exhaled air, pond plants, or yeast to figure out what carbon concentration does to the acidity of the water.  After all this experimentation and observation, students will be forming some ideas about the balance of carbon in living organisms, air, and water. This is the perfect time to clear misconceptions about carbon cycling. Doing so by pairing your intermediate students with primary buddies to read the book, *Living Sunlight*, is a super-fun and meaningful way to do so, while boosting leadership and confidence in your students and bonding in your school community.  Finally, if you are interested, work with your community partner to support an authentic investigation into the acidity of your local beaches, following the process of science. This will begin with your students defining a question they can test by gathering environmental data. It can range from meeting at the beach to run water quality tests with a scientist to testing water samples they’ve provide you in the classroom, or just analyzing pH (acidity) data collected in nearby waters to determine if they are safe for oyster larvae. At any rate, collect all pH data in a central location and graph it to inspire a meaningful Get CERIAs discussion on whether your local waters can support oysters and, if not, what should be done about that and who should hear their science-based recommendations.  **Tracking Carbon in Food Webs**   * Review instructions in the unit plan and background info in the slideshow, order BTB indicator solution (bromothymol blue) from a scientific distributor, such as Fisher Scientific, Flinn Scientific, Carolina, or another. * Order aquatic plants at the same time or collect them from a local pond, stream, or lake. Keep them submerged in water in a container open to the air and in sunlight until ready to use. * Invite parent helpers ahead of time for wet labs, 1 per Team, if possible * Prepare a bin or tray of all investigation supplies for each Explore Team. * Prepare yeast culture: 1-2 hrs before: mix 1 oz of active dry yeast with 4 oz warm water. Let sit in open air. This will provide yeast for 32 samples. * Plan where to place pond plant samples in the sunlight (or lamp light) and dark during the investigation.   **Acidity of local waters intertidal research project**   * Plan with community partner for collection locations that best fit your class question. Plan field visit with students or to have community partners collect water samples or data for your investigation. * Review scientific process and Get CERIAs protocol. * Distribute water collection containers and water quality test kits, including pH, or just pH test strips. * Establish sources of sea water for pH testing. * For all investigations, establish safety rules for working with chemicals and glass and for safe field work. |

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| TIME | **TEACHER GUIDE LESSON 3: SHELLFISH AND CARBON** |
| Session 1  5 min  15 min  10 min  10 min | 1. Treasure Map outlineRelish some memories from the beach or field day, **slide 49**. Post clues found to the class Mind Map. Use the food web activity they did to segue to nutrients cycling through producers, consumers, and decomposers. Ask students where these nutrients were before they entered living things, then ask if they are ready to wonder   **A close up of a sign  Description automatically generated**   1. Demo CO2 dissolving into the sea at the sea-atmosphere interface, following this [Khan Academy](https://www.khanacademy.org/partner-content/exploratorium-ddp/exploratorium-chemistry/ocean-acidification/v/ocean-acidification-intro) example. Do not explain. Reveal that it is baking soda+ vinegar in the cup and sea water + BTB or cabbage juice indicator in the beaker. BTB and cabbage juice change color with changes in **pH**, **slide 50**. Invite students to describe their observations on **journal p25**. Leave this phenomenon here in the wonder phase for now. Ask students to help you figure it out with clues throughout the lesson. 2. Ask students what their favorite food is and have students write its two main ingredients on **journal p26**. Reveal what carbs are made of, **slide 50.** Review that a food chain shows the transfer of matter and energy from producer to primary then secondary consumers, **slide 51**. Have them draw food chains of ingredients in their favorite food from the sun, plants, animals (if included) to their bodies **journal p26**. Ex. Pizza: sunà wheatàme, sunàgrassàcowàmilkàme 3. Hand out sugar cookies or fruit to enjoy. Ask: Where does the carbon go after eating the cookies? After cookies have been eaten, invite students to ***dance*** when you play the KidzBop video, **slide 52**. Ask them to consider why the body increases the breathing rate, what it needs more and less of that is contained in the breath and write the forms food takes when it exits. Review states of matter (solid, liquid, or gas). Ask what state the carbon was in when it entered and what state it was in when it exited the lungs. Ask students to complete the remainder of **journal p26.** |
| Session 2  50 min | 1. Offer students an opportunity to be trackers, carbon trackers. Challenge them to track carbon through the ecosystem in three ways. Present the Explore It Question, **journal p27** then invite them to share their current ideas in words and/or a diagram there. “Where do you find carbon in the ecosystem? How does it move through different parts of the ecosystem?” 2. Show the procedure and data table, **journal pp 28-29**. 3. Demonstrate how to use materials safely for each step, such as how to operate a syringe or turkey baster to bubble air in the water without sucking up the solution and blowing air gently with the straw, warning of the danger of sucking it in. Require gloves and goggles to work with chemicals. Have them follow instructions to track carbon between living things and water and air. Invite Lab Techs to procure the materials for the experiment and begin to explore! 4. Ask Lab Techs to manage oversee clean up of materials, then return materials to the designated storage. 5. Invite all students to reflect on their observations in the Discussion on journal p30 then revisit and revise their initial ideas of how carbon cycles through the ecosystem on **journal p31**. |
| Session 3  30 min  20 min | 1. Invite kids to the carpet for story time. Read *Living Sunlight* or play its accompanying video of the authors reading it aloud. Best yet, plan to have your students read it to primary student buddies and complete its accompanying carbon cycling packet. Find the f[ree, printable packet online](https://thesunlightseries.files.wordpress.com/2017/09/living_sunlight_printables_3_5.pdf) for filling in and coloring. Show **slides 54-55** to further visualize the human and plant components of the carbon cycle. Ask students if respiration is the only source of carbon in the atmosphere and water. 2. Ask students to draw a carbon cycle in the Salish Sea, including a producer, consumer, fossil fuels underground, and fossil fuels being burned in industry and transportation on **journal p32**. Afterward, show **slide 56** to compare what they figured out to another way of organizing the carbon cycle. Make sure they know there is not one right way and that this is to compare their discoveries with other scientists. |
| Session 4  5 min  5 min  40 min | 1. Treasure Map outlineReturn to the phenomenon that began this lesson, the seawater and BTB (or cabbage juice) demo. Ask students to hold a Team Talk to put what they know about the carbon cycle together to figure out what was happening in the jar. Invite each Science Communicator to share out to the class. 2. Ask if this could be related to the initial Wonder at the beginning of this unit, the misshapen oyster larvae. Add to the class mind map. Show **slides 56-62** to introduce the term ocean acidification – the decrease in pH of seawater with an increase in dissolved CO2. Be clear that it does not mean the ocean is acidic (less than 7 on the pH scale), but that excess CO2 is now causing the pH to drop below what it was historically, especially here in the Salish Sea. Shellfish struggle to form shell with lowered pH. Ask them, how did that CO2 get into the water? 3. Have students navigate to [How Science Works online](https://undsci.berkeley.edu/interactive/#/intro/1) or **journal p33** to track the steps they’ve taken to solving the oyster larva mystery to date. Ask them if they have gathered enough background information to run a scientific investigation to answer their Essential Question. Tell them scientists gather all the info they can from other scientists investigation results before running an investigation. Hold a Team Read, guiding students to available science articles about carbon in the ocean (in the orange Student Research References button at [www.juniorseadoctors.org/tideout](http://www.juniorseadoctors.org/tideout)). |
| Session 5  50 min | 1. **Put Science to Work**: For tips on how to support students with research question development, visit our [online training,](https://www.explorethesalishseatraining.org/) Module 1, Guiding the Process of Science. Their question may be about whether local water is safe for oysters and clams, which will require the class, you, or a community partner to collect at least three water samples from each selected beach site. Guide pH of Local Waters Investigation, **journal p34-39.** Modify to fit their research question.Test pH in three replicate samples from one field site. Provide a Google Sheet or other spreadsheet or a paper data table for teams to enter their data. 2. Create graph in the Google Sheet as a graphing exercise or do it for your class. Give them time to consider patterns in the graph. Save the graph to display it in the next session, while students write Discussions and fill in their Get CERIAs forms. |
| Session 6  20 min  30 min | 1. Guide student’s Discussion-writing **journal pp37-39** and [Get CERIAS](https://ucdavis.box.com/s/aempaobtykxel2p1waxeg18fcpkqvwjx) forms **journal p40** 2. **Science Communication**: Guide [Get CERIAs](https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EbvGHQk4kcNHnGdgxtXfcJUBHBJBafq19bA6L2RS2HJsig?e=nASdwh) to argue using evidence either before or after having them write their conclusions/discussion. Celebrate unit with intertidal snacks (seaweed), and a Hope Matters film fest [film 1](https://www.youtube.com/watch?v=F2LRC7mMres&feature=youtu.be), [film 2](https://www.youtube.com/watch?v=Vzn5XO_GYL0). |
| Session 7  30 min  20 min  **Total:**  **5 hours** | 1. *Optional:*If creating a cohesive Salish Sea Map throughout the Explore the Salish Sea curriculum, have students draw and label a tidepool creature they found interesting from the unit and add it onto the map where that creature lives (paper map) or add an intertidal page to their Esri story map. 2. Administer post-assessment. Stamp student journals. Celebrate – this was a big exploration! |

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| **MATERIALS LESSON 3**  Tracking Carbon Through Life Exploration  For the class:   * Sugar cookies or fruit for each * High energy dance song * Bromothymol Blue (BTB) indicator. Cabbage juice indicator will work if BTB is not available. * Yeast * Sugar * Sprigs of live pond plants, collected from a local pond or ordered from a science supply lab. Elodea works well. Keep them submerged in water.   For each Explore Team:   * 1 jar of yeast culture * 1 container of sugar with a tiny scoop * 2-3 dropper bottles of BTB to share * 1 timer or cell phone with timer function   For each student:   * Clear container (test tube, Erlenmeyer flask, beaker, or baby food jar) containing about 50 mL of water * Large, plastic syringe or turkey baster * 1 biodegradable or reusable drinking straw * 1 plastic pipette (wash and reuse)   Story Time   * *Living Sunlight* book(s) by Penny Chisholm and Molly Bang. This book is the first of a series, tracking carbon through the ecosystem. The whole series is remarkable. * Extension: pair 5th graders with 1st or 2nd grade buddies. Have them read the book aloud to them and complete its accompanying worksheet packets together afterward.   Ocean acidification model demo   * 500 mL beaker * Paper cup * Baking soda * Vinegar * BTB * Seawater   pH Investigation   * Seawater from marine sources nearby * Seawater samples x 3 per group * Plastic pipettes x 3 per group * Beaker for waste x 1 per group * 250 mL Erlenmeyer flasks x 1 per group * pH sensor, test kits or test strips with color chart   RISK MANAGEMENT:   * Play games in a safe area where vision-blocked students or those in the obstacle course will avoid tripping hazards or a hard fall. * Use goggles and gloves when working with the BTB. Stress avoiding sucking in on the straw when breathing into the BTB solution. BTB may cause stomach irritation and nausea. In case of ingestion, rinse mouth with water and get medical attention. | **ONLINE RESOURCES LESSON 3** Review of Photosynthesis for teacher video byTED Ed[https://www.youtube.com/watch?time\_continue=234 &v=eo5XndJaz-Y&feature=emb\_logo](https://www.youtube.com/watch?time_continue=234%20%20%20%20%20&v=eo5XndJaz-Y&feature=emb_logo)Carbon Cycle background for teacher by cK-12[https://flexbooks.ck12.org/cbook/ck-12-middle-school- life-science-2.0/section/12.22/primary/lesson/the- carbon-cycle-ms-ls](https://flexbooks.ck12.org/cbook/ck-12-middle-school-%20%20%20%20%20%20life-science-2.0/section/12.22/primary/lesson/the-%20%20%20carbon-cycle-ms-ls)Living Sunlight printable worksheets, WordPress[https://thesunlightseries.files.wordpress.com/2017/09/ living\_sunlight\_printables\_3\_5.pdf](https://thesunlightseries.files.wordpress.com/2017/09/%20living_sunlight_printables_3_5.pdf)Carbon Cycle Game by Jennifer Ceven (adapted from Project Wet, The Incredible Journey)<https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EenvhNLaWZNFrycb4b8QslMB0qLnxq0auKyYR8sS8t-Jrw?e=mqxZZf>Making cabbage juice indicator (for teacher or as an extension)[https://www.carolina.com/teacher-resources/ Interactive/red-cabbage-guice-homemade-ph-indicator/tr10851.tr](https://www.carolina.com/teacher-resources/%20%20%20%20%20Interactive/red-cabbage-guice-homemade-ph-indicator/tr10851.tr)Ocean acidification demo:[https://www.khanacademy.org/partner-content/exploratorium-ddp/exploratorium-chemistry/ocean-acidification/v/ocean-acidification -intro](https://www.khanacademy.org/partner-content/exploratorium-ddp/exploratorium-chemistry/ocean-acidification/v/ocean-acidification%20%20%20%20%20%20%20%20%20%20%20%20%20-intro)Process of Science:<https://undsci.berkeley.edu/interactive/#/intro/1>Background resources for student-led research project:(store these in a shared folder for student-access)NOAA PMEL OA and Oysters video[https://www.pmel.noaa.gov/co2/story/Ocean+ Acidification's+impact+on+oysters+and+other+shellfish](https://www.pmel.noaa.gov/co2/story/Ocean+%20Acidification's+impact+on+oysters+and+other+shellfish)ScienceNews for Students articlesChemistry Explainer: Ocean acidification[https://www.sciencenewsforstudents.org/article/ explainer-ocean-acidification](https://www.sciencenewsforstudents.org/article/%20%20%20explainer-ocean-acidification)Shell-shocked: Emerging impacts of our acidifyingseas[https://www.sciencenewsforstudents.org/article/shell- shocked-emerging-impacts-ocean-acidification](https://www.sciencenewsforstudents.org/article/shell-%20%20%20%20%20%20%20%20%20%20%20%20shocked-emerging-impacts-ocean-acidification)Ocean acidification may ground swimming skates[https://www.sciencenewsforstudents.org/article/ ocean-acidification-may-ground-swimming-skates](https://www.sciencenewsforstudents.org/article/%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20ocean-acidification-may-ground-swimming-skates)CO2 emissions will hit a record high globally in 2018[https://www.sciencenewsforstudents.org/article/carbon- dioxide-emissions-will-hit-record-high-globally-2018](https://www.sciencenewsforstudents.org/article/carbon-%20%20%20%20%20%20%20%20%20%20dioxide-emissions-will-hit-record-high-globally-2018)Get CERIAs Form and Forum Instructions<https://pacificeductioninstitute.sharepoint.com/:b:/s/Program/EbvGHQk4kcNHnGdgxtXfcJUBHBJBafq19bA6L2RS2HJsig?e=VxmQDL>Conclude with hope! Intertidal Film Fest linksTidepools! By Bob Turner[https://www.youtube.com/watch?v=F2LRC7mMres& feature=youtu.be](https://www.youtube.com/watch?v=F2LRC7mMres&%20feature=youtu.be)Blue carbon by Restore America’s Estuaries<https://www.youtube.com/watch?v=Vzn5XO_GYL0> |