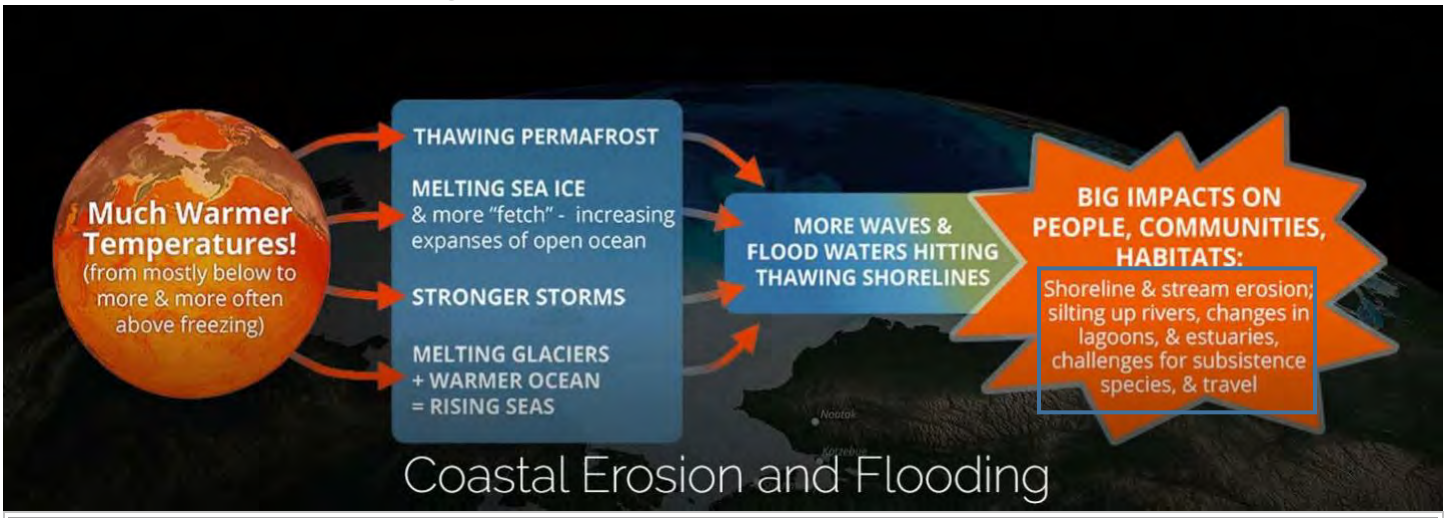
Alaska Seas and Watersheds

An Alaska Sea Grant K–12 Education Program

Coastal Erosion Project: Monitoring & Solving Community Problems Along Alaska Coasts
High School (Grades 9-10) Unit



Unit Description & Teacher Background

Global warming is accelerating the rate of weathering and erosion in Arctic and Western Alaska, as more waves and flood waters hit tundra shorelines where permafrost is thawing. This is creating challenging problems for rural communities along Alaska's coastal areas and along rivers. Glacial melt rates are accelerating for the majority of glaciers along Alaska's southern and southeastern coast, adding more silt to streams and estuaries.

This unit introduces students to the processes of weathering and erosion and the effects of rapid erosion resulting from warmer air and ocean temperatures, melting glaciers, the loss of sea ice close to shore to buffer ocean wave action, stronger storms and higher storm surges, and thawing permafrost shorelines. The labs and other learning activities in this unit will help students better understand the role of four main erosion agents - water, ice, wind, and gravity - and the ways in which human activities and other natural factors can add to or reduce the effect of these erosion agents on landscapes and shorelines. Students apply what they learned in making recommendations in a community erosion mitigation plan and plan an investigation to be carried out to contribute observations and/or data that are relevant to the problem.

Many Alaska communities have developed Erosion Hazard Mitigation Action Plans that characterize the vulnerability of the community erosion and flooding and list potential actions to slow erosion rates to protect critical infrastructure. Check for your community on the map in the Resources section and/or contact a local community official, planner, or tribal environmental specialist for tribal governments to find your community's plan for use by your students as a starting point for understanding local problems and possible solutions.

Resources:

Map of Alaska communities with Climate Action Plans and/or Hazard Mitigation Plans. (2018)

Map with Maximum Documented Annual Erosion Rates for Alaska Communities. The highest rates occurred in

Newtok (-63 feet), Hooper Bay (-37 feet), Kaktovik (-28 feet), Utqiagvik (-27 feet), and Port Heiden (-22 feet).

Links to community-based erosion and flooding monitoring sites near Alaska communities

Background Information on Buffers and Their Use in Arctic Environments

The "What's Changing and Why? section on the AdaptAlaska.org website has links to overviews and resources for teaching about the big picture of global climate change and of climate change in Alaska, and for engaging your students in a specific community issue related to Coastal Erosion and Flooding. A number of opportunities exist for your students to collect, analyze, and report environmental data by participating in research projects as citizen scientists or in community-based environmental monitoring programs (Community and erosion scientist contacts for North Slope and Bristol Bay communities are included in the Measuring a Beach Profile lesson plan.)

One-page summary of the concept and science of erosion with a time-lapse video of Drew Point (Beaufort Sea coastline) coastal erosion http://www.geography4kids.com/files/land_erosion.html

Unit Teaching Strategies

Unit activities are aligned with Alaska science, science literacy, and cultural standards. The unit provides guidance for supporting your students in the development and implementation of a science/STEM project focused on erosion problems around your community. The teaching strategy is based on project-based learning (PBL) which involves situating concepts within a series of high interest student learning tasks. Students find PBL investigations engaging because there are obvious connections between the classroom and the real world. The focus is on problems that plague society today without defined solutions. In most rural Alaska school districts, the emphasis is also on place-based, culturally responsive learning about environmental problems relevant to your students and their community.

PBL instruction is typically started by posing a compelling question. An open-ended process to develop that question provides maximum “ownership” by your students, but in science/STEM education, your guidance can provide direction for your students to become involved in on-going scientific research and community efforts, much of which is focused on the impacts of rapid climate change. This unit has been designed to guide students in addressing erosion threats to your community posed and contributing to your community’s environmental monitoring and problem-solving efforts.

Acknowledgements: This unit was initially developed for the North Slope Borough School District 9th grade North Slope Science course and then adapted for use statewide through the AdaptAlaska.org website with the support of a capacity-building grant from the Gulf of Mexico Oil Spill Research Program.

Alaska State Standards

AK: Cultural Standards

A. Culturally-knowledgeable students are well grounded in the cultural heritage and traditions of their community.

1. They assume responsibility for their role in relation to the wellbeing of the cultural community and their life-long obligations as a community member;

B. Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life.

4. They identify appropriate forms of technology and anticipate the consequences of their use for improving the quality of life in the community.

E. Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them.

2. They understand the ecology and geography of the bioregion they inhabit;

Alaska State Science Standards (NGSS)

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS2-5

HS-PS2-2. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-3

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HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable

problems that can be solved through engineering. HS-ETS1-2

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

Science & Engineering Practices	Disciplinary Core Idea	Cross-Cutting Concepts
Planning and carrying out investigations Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Constructing explanations (for science) and designing solutions (for engineering)** Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations	**ESS2: Earth's Systems** **ESS2.C: The Roles of Water in Earth's Surface Processes** The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5) **PS2: Motion and Stability: Forces and Interactions** **PS2.A: Forces and Motion** If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2) **ETS1: Engineering Design** **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (HSETS1-2) (secondary to HS-PS2-3)	**Stability and Change – For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.** Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. **Structure and Function – The way an object is shaped or structured determines many of its properties and functions.** The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. **Cause and Effect**: **Mechanism and Prediction – Events have causes, sometimes simple, sometimes multifaceted**. Systems can be designed to cause a desired effect

ELA AND MATHEMATICS STANDARDS

AK: 6-12 Literacy in History/Social Studies, Science, and Technical Subjects (2012)
AK: Grades 9-10

Reading: Science & Technical Subjects
KEY IDEAS AND DETAILS
RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Writing
TEXT TYPES AND PURPOSES
WHST.9-10.1.a-e Write arguments focused on discipline-specific content.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

PRODUCTION AND DISTRIBUTION OF WRITING
WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

RESEARCH TO BUILD AND PRESENT KNOWLEDGE
WHST.9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

Topical Understandings and Essential Questions

TU #1: Erosion is a geological process that can change the Earth's physical appearance abruptly or over an extended period of time.
EQ #1: In what ways does erosion change the physical appearance on the landscape around our community?
EQ #2: What types of erosion are most common here?
EQ #3: What factors affect the rate of weathering and erosion here?

TU #2: Natural processes, including human activities, can cause and affect the rate of erosion.
EQ #1: What natural processes result in erosion around our community?
EQ #2: What human activities result in increased rates of erosion around our community?
EQ #3: How have changes in seasonal sea ice patterns and permafrost thaw rates affected the rate of coastal erosion?

TU #3: People can engineer solutions to mitigate the effects of erosion in places where it threatens important community facilities.
EQ #1: What additional scientific information is needed to develop solutions to community erosion problems?
EQ #2: What are best solutions for community erosion problems?

Language Arts/Literacy in Science (subject area)
TU#1: Effective researchers must be able to express their findings in a credible and accurate manner in order to persuade the public to act upon their research.
EQ#1: What makes an argument effective so that the leaders in my community will be able to use the scientific information to take the appropriate action to alleviate erosion concerns for my community?

Knowledge

Student will know...

- water, ice, wind, and gravity are agents of erosion.
- seasonal sea ice close to shore can buffer (i.e., reduce the rate) of weathering and erosion of northern coastlines.
- human activities, including human-caused global warming, have accelerated the rate of erosion along Alaska coastlines
- people can engineer short-term solutions to slow erosion rates.

Skills

Students will be able to...

- recognize the results of erosion around their community.
- plan and conduct investigations of how the properties of water and other factors contribute to erosion.
- apply scientific and engineering ideas to design and evaluate how natural and engineered buffers reduce the force on waves and winds colliding with shoreline.
- make effective arguments about solutions to a local erosion threat or problem.

Learning Plan

Learning Experiences

Teacher Preparation:
Read the Teacher Background information about buffers. Find an aerial photo or map of your community and contact your local government to find out if there is a local erosion hazard and mitigation plan for your community. (See map of communities with plans in the Teacher Background section.)

Obtain the materials needed for the labs as described in the Resources section.

Make copies of hand-outs, as needed, for Learning Experiences, and pre-view PowerPoint presentations. Review the Teacher Background information on buffers before showing the PowerPoint in Week 3 on Potential Solutions to Erosion.

WEEK 1: Preparation: Make several copies of the aerial photo or map of your community for student work in small groups. If you can find this online on your community or borough planning department website, you can project it onto a whiteboard.

Students share observations, interview community members, and hear from an expert, then develop criteria and set priorities for finding solutions to erosion problems in their community.
Guiding Question: What impact does erosion have on our community, culture, and subsistence activities?

Introductory Activity

1. Ask students for definitions of erosion, then pass out the 1-1Vocabulary List for this unit. Read the definition for erosion as "the processes by which natural agents remove rocks, soil, and sand from one location on the Earths' surface and move it to a different location."
2. Brainstorm what those agents might be: (*wind and water in various forms of runoff from the land, flowing water in streams and rivers, moving glaciers or sea ice, ocean currents and tides*). Discuss the role of gravity as agent that influences how and where erosion happens and where eroded materials are carried and eventually deposited.

Ask: Do human activities cause erosion? What can we do to slow down erosion by water or wind?

Issue Concept Mapping Activity

1. Show the class the aerial map of your community or project the map on a white board. (Re-size the screen image if needed to show the entire aerial photo.)
2. Students work together in small groups to develop a concept map by responding to a series of questions and develop a concept map. Divide the class into small groups, give each group a large piece of paper (e.g., flip chart paper) and markers, and pass out the 1-2 Local Erosion Problems Concept Map Worksheet to each group.
3. After students have completed their concept maps, give each recorder a different-colored dry-erase marker. They will come up to the white board and use their marker to put a dot on the map at the location where the observations in their group's concept map were made and add the number as the reference.

Leave this map on the board during the rest of the unit if you can. If not, be sure to take a picture of the mapped observations!

Extensions:
Customized Google Maps. If students have access to a computer or a phone, they can view their community in Google maps, both as a "street map" or in "satellite view," and zoom in to see detail. If they have access to a gmail account and Google drive, they can add to the map using the pull-down menu in the upper left-hand corner of the map description. The can make contributions by adding flags to locations, and attaching images and links to the flagged locations. See: instructions on creating a customized Google map, if needed. Customized Google maps can be saved and shared by sending the link to the saved map to you.

Creating a Story Map: Students can use Story Map on the ESRI website to create a digital story that combines text, photos, and map locations for the high priority erosion problem areas. You can sign up for a free class ArcGIS account and get started here.
Example of a story map with observations related to coastal erosion in Utqiaġvik. (In the online version of the story map, clicking on each arrow will bring up the story for the selected point on the map.)

4. Homework assignment: Assign students the task of interviewing at least one parent, grandparent, or other adult in the community about the changes they have seen and any erosion problems they have observed. If you haven't already done so, discuss interview strategies with the students:
- Be friendly, respectful, and polite.
- Explain the purpose of the interview, about how long the interview will take, and how the information will be used.
- Be a good listener.

- Allow the speaker plenty of time to answer a question.
- If the person seems to be getting off topic, listen carefully to what they may be trying to tell you. They may be telling a story in answer to your question.
- After you have finished asking all your questions, ask them if there is anything else they might want to tell you.
- Ask permission before you take photos. If they have historical photos they are willing to loan you, be sure to return them after the unit is over or as soon as you scan them if they give you permission.
- Ask for information about when older photos were taken. The time of year can make a large difference in making comparisons.

5. Students report out and add the evidence of erosion described during the interviews to their numbered list and the map. If they have access to computers, they can search for historical photos of the local area.

Developing Criteria Activity

1. Students review the map. First In small groups, and then as a class, they develop criteria for the highest priority erosion problems in their community. [Examples of criteria: threats to facilities related to important community needs (e.g., clean drinking water, sewage disposal, waste disposal, threats to important travel routes or boat launch areas for hunting or fishing, archaeological sites]
2. After students have compiled their class list of criteria, help them brainstorm and map the critical facilities in their community that might be threatened by erosion. .Ask the students what facilities and community needs should be added to their list of criteria and mapped.
3. Invite one or more community experts into the classroom to discuss priorities in terms of erosion threats to the community. This could be someone who is responsible for road or community building maintenance for your community or an Elder or other long-term resident who can add their own observations to the map.

4. **Setting Priorities Activity:** Students use the criteria they developed to review the observations of local erosion problems on their map and set priorities.

    1) Write the list of criteria on the board (e.g., facility that meets an important community need, vulnerability to erosion, important travel route, etc.).
    2) Based on this list, ask students which of the places on the map where the students or the people they interviewed have observed evidence of erosion should be a high priority for finding a solution to the erosion problem.
    3) Model arguing from evidence, for example: “The water treatment plant should be a high priority for finding a solution to erosion control because we all need clean water, it’s close to the bluff edge, and Joe observed that the sand bags in the berm that’s protecting the cliff next to the treatment plant were washing out during the last storm.” Encourage discussion to add additional evidence or disagree that it’s a high priority based on evidence.
    4) Place sticky notes on the map in the areas students agree are the high priorities.

WEEK 2: Students gain knowledge about erosion processes through readings and lab activities.
Guiding Question: What causes erosion? What factors influence the rate of erosion?
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Teacher-Generated Notes about Types of Erosion
Give students the Teacher Notes about Types of Erosion. Provide direct instruction by reading through the notes with your class. You will be using vocabulary words for this unit, so you may need to pause to review the definitions as you use them.

PowerPoint Presentation

1. Show students **Part 1** of the 2PP Types of Erosion PowerPoint and reinforce vocabulary word definitions and concepts from the Teacher Notes about each type. Emphasize that the same factors cause erosion all over the world, but the pattern of which factors cause the most erosion can be unique in a region like the Arctic.
2. Use the images in **Part 2** of the **2PP Types of Erosion** PowerPoint as a quiz to check student understanding. Have students to write down their answers as you show the slides, then show the images again and discuss their answers as a class. If there is disagreement, ask for justifications for the different answers.
3. Divide students into pairs or small groups to identify and argue from evidence which of the four erosion agents have been important in shaping local river or coastal or river shorelines.

Ask: What's unique about the local environment that influences the types of erosion that occur here more often? How have human activities influenced erosion to either speed it up or slow it down?

Students must provide evidence for their answers and present their findings (in writing) to the class.

Read an Article
Students read a portion of the article **2-2 *Collapsing Coastlines***.

Extension: Students can read the article **2-3 *Chunks of Northern Coast Fall into the Sea*** about a study of erosion rates around Drew Point, which have been the highest measured along the Alaska Arctic coast. In 2016 a 5.5-mile stretch of coastline receded72 feet. A link to a time-lapse video of erosion at this location is in the Resources section.)

LAB ACTIVITIES
See the Resources section for a list of materials needed and preparation for each lab. Before starting the lab activities, Introduce or review the definition and concept of a buffer.

1. Lab 2A Factors Affecting the Role of Erosion**.**

Pass out copies of the **Lab 2A Student Worksheet** (at the end of the lesson plan file)**.** The lab set-up and results are shown in photos in the lesson plan.

2. Lab 2B Wave Tank Lab Lesson Plan
After the lab, or if you don't have the materials or time for this lab, show the wave tank video (link in the Resources section below) (12 mins.)This is an excellent demonstration of how engineers use a wave machine to design and test structures that influence what happens when wave energy collides with the structure and the shore.(HS-PS2-3)

3. Lab 2C Stream Table Lesson Plan
Reinforce student understanding that the **s**tream table is a type of model and student skills in use of the model to make inferences about the role of flowing water to pick up, move and deposit sediment. (HS-ESS2-3)
You can also show the 8-minute **video: Erosion Lab** (link in the Resource section). This demonstrates sandy beach erosion by waves, stream erosion, and the influence of rocks and trees on land in slowing erosion rates. The video provides prompts for students to draw their predictions before water is added.

WEEK 3: Students research and evaluate engineered solutions to erosion problems

PowerPoint Presentation - Buffers and Other Engineered Solutions
Review the information in the article "Buffers and their Use in Arctic Environments."

Ask: Do you think this type of buffer can stop erosion? And the PowerPoint presentation **PP 3 Potential Solutions to Shoreline Erosion in Arctic Environments** to see if they are relevant to your community. If not, give the students time to research solutions that are relevant.

If you choose to show the PowerPoint, ask students to identify what is serving as a buffer in the images and to explain how it influences what happens to the energy of incoming waves. List their answers on the board.

Ask: Do you think this type of buffer can stop erosion? (*Buffers and erosion control structures are usually designed to slow the rate of erosion in particular places by absorbing the brunt of the energy from the water or re-directing it. The materials that make up the buffer will eventually weather and erode and re-directed hydraulic energy may cause the erosion rate to increase somewhere else. The sustainability of green infrastructure depends on whether plants can become established and the root strength is sufficient to withstand erosion forces year-round.)*

Guide the discussion to compare and contrast the different types of buffers, including sea ice, in relation to factors they observed in their community or during the lab activities that affect the amount and rate of erosion, including wind speed and direction, wave pattern, wave direction and height, the type of materials used to construct or plant a buffer, slope of a beach, river ice jams, etc.

Research:
1.Students read an article 3-1 How One Alaskan Community is Attempting to Adapt to Climate Change about how people have responded to thawing permafrost and coastal erosion in Wainwright and Kaktovik. They complete 3-2

Student Worksheet Community Adaptation to Climate Change which asks them questions answered in the article.

Extension: Students watch the video Moving Meshik.(9 ½ mins.)

2. Students review their community's erosion mitigation action plan. If your community doesn't have one, you can invite someone into the classroom who is responsible for responding to flood events and erosion problems (e.g., someone responsible for Public Works or Emergency Response,

Evaluation Task #1: Develop an erosion mitigation plan for your community. (See below for a more detailed task description.)

Solutions Concept Mapping Activity:

1. Hand out the example of a student concept map related to a local erosion problem: 3-3 Concept Map: Solutions to Problems Related to Sea Level Rise.
2. Have students work in groups to develop their own concept map on a large piece of paper (e.g., from a flip chart) of potential solutions to erosion problems in their community, starting with the solutions people tried in Wainwright that might work in their community, the mitigation measures recommended for their community in your community's hazard mitigation plan, the types of buffers and other solutions they saw in the PowerPoint presentation, and any other solutions they know are being tried or will be tried to slow down erosion in the high priority areas around their community. After the groups have finished their work, bring them together to develop a class concept map that includes all of the possible solutions.

Developing Criteria and Applying the Criteria to Solution Options.

1. Students brainstorm another list of criteria that might be used to determine if what was tried was successful in mitigating erosion impacts or threats to your community. (e.g., cost, how long it will prevent or slow erosion, whether it will work in the Arctic, evidence of failure in your community, etc.)
2. Give students time to brainstorm other solutions, including Internet research on any other options. Divide them into small groups and have each group think through pros and cons of the different methods in relation to the criteria the class developed as a successful solution. The 3-4 Mitigation Planning Graphic Organizer and Example is an example of a way for your students to organize the review of different options against their criteria. You can use this as an example or adapt it for your students.
3. Students work in groups on the first GRASPS task to develop a mitigation plan presentation.

WEEK 4.
Students make class presentations for the first Evaluation Task.

Evaluation Task #2 (See below for more detailed task description).
Guiding questions: How can we collect more observations and data about erosion around our community? Can we help protect our community from erosion threats?

1. Students plan an investigation to collect more observations and data during the last two weeks of spring semester. As an engagement activity, you can show them the Coastal Erosion Story Map on the Barrow Area Information Database (BAID) website about the types of technology and scientific methods for measuring and monitoring coastal erosion rates.
2. Examples of the types and methods for collecting and communicating student data and observations are provided in the task description, including researching historical photos to compare with current photos of the same place, taking an "erosion and erosion control" tour of the community to update a Story or Google Map, measuring and plotting a beach profile using the Coastal Erosion Monitoring Field Trip Activity, and inviting scientists who study erosion to make a classroom presentation in person or via Skype or Zoom. See the Resources section for additional resources for setting up a shoreline monitoring site and monitoring erosion along with contacts for students to contribute data to on-going community volunteer monitoring program for specific beach transect locations near many Alaska coastal communities.

Evaluation

Checking for Understanding (Ungraded)

1. Student answers to questions posed throughout the lessons, labs, and activities.
2. Discussion of teacher-generated class notes and PowerPoint presentations (Student misunderstandings about the notes or vocabulary should be addressed by other students or by the teacher during class discussions.)
3. Student examples of erosion they have observed around their community (Issue Concept Mapping in Week 1.
4. Student participation in interviews with other community members about erosion in their community.

Other Evidence (Graded)

- Answers to the 2PP Types of Erosion PowerPoint quiz (provided in the notes section below each PowerPoint slide)
- Answers to Lab 2A Student Worksheet and discussion questions for labs
- Quiz Answers
- Student Worksheet Answers to Community Adaptation to Climate Change (science literacy skills)

Erosion Quiz
Erosion Quiz Answers

Evaluative Criteria

1. Accuracy and completeness of student answers to quizzes and worksheets.
2. Rubrics for evaluation tasks (See Evaluation section.)

This project-based unit involves small group interactions, classroom synthesis activities, and a final product that is a team effort. Evaluation of individual performance will require observation on the quantity and quality of contributions to group products in addition to the above

Summative Evaluation

Task #1. Developing a Community Mitigation Plan for Erosion
Summative: Project: Group
Your team has been asked to make a presentation to a group of village or city planners charged with recommending solutions to erosion problems facing your community. You will present a mitigation plan based on the evidence of erosion in specific places that the class has compiled on the map or story map of your community, the criteria set for determining the highest priorities for action soon, and your evaluation of possible solutions, including ones already in place. Provide your scientific reasoning about how what you recommend will influence the rate of erosion.

Task #2. Investigation of an Erosion Problem in Your Community
Formative: Project: Group
Your project team will plan an investigation to collect more observations and data and explain how this investigation will contribute information necessary to understanding and developing solutions to community erosion problems. Examples: finding historical photos to compare with photos of what the same place is like now, designing an “erosion and erosion control” tour of the community and updating a Story or Google Map, measuring a beach profile on a local beach to establish a current baseline to measure the rate of future erosion (See the Coastal Erosion Monitoring Field Trip), inviting a scientist who studies erosion to answer questions you have in person in your classroom or via Skype or Zoom.

Rubrics for Evaluation Tasks
Rubric: Community Erosion Mitigation Plan
Rubric: Planning an Investigation

The evaluative criteria can be expanded to evaluate technology, science literacy, and teamwork skills (e.g., collaboration, creativity, etc.)

Resources and Preparation Materials

Lab 2A Factors Affecting the Rate of Erosion Lab:
Preparation: Review the instructions on the Student Worksheet and photos of to see the lab set-up**.** Use the food coloring to dye the sand before the lab.
Materials: Sand (and/or other types of soil or gravel (materials you collected in the fall),food coloring (to dye the sand),Styrofoam plates (one for each pair or group of students),Dice or monopoly hotel to represent a house, plastic cups, water

Lab 2A Extension: This lab provides students other opportunities to observe the effect of differences in wind speed and the type of materials on the rate of weathering and erosion.
Preparation: Review the instructions on the Student Worksheet and photos to see the lab set-up.
Materials:

Lab 2B Stream Table Lab:

D-I-Y Stream Table Design #1
Materials:4 disposable baking pans 9" X 11"X 3" (e.g., lasagna pans),scissors ,coffee filters, Duct tape, plastic drinking straw, hole punch, anail,2-liter bottle,3 Yard sticks or rigid wood supports at least 1/4" thick, a stack of books about 5" tall ,large pan to catch water, sand or dirt (e.g., potting soil), enough to fill the stream table to a depth of one inch;
For a demo by a teacher that shows how to put this together in about 9 mins., watch https://www.youtube.com/watch?v=X0xTSNASGv8

D-I-Y Stream Table Design #2.
Materials: 2 Rubber tubes (one for water entering, one for exiting), 2 5-gallon buckets (one for water going into-table, one to catch water leaving table), a support for one bucket to establish a siphon, sand or ground nut shells for water to flow through, clamp to change water flow through entering tube, towels to dry hands, and other wet surfaces. , 5 Gallons of Water (re-useable). See the lesson plan for how this is set up.

For use in the stream table: Add fake plants, rocks, toys, and other cool things to use as: "dams" "erosion control structures." Optional: Kleenex® tissues (single and multiple layers), tooth picks, crushed ice cubes, sources of both warm and cold water, small wood chips, cat litter, or mulch (absorbent material). See the Lesson Plan to see the descriptions of how these materials can be used in the demonstration.

Interactive Erosion Lab Video: https://www.youtube.com/watch?v=ZNJe6hrdL3M

Lab 2C Wave Tank
Materials/group:2 Aluminum baking pans (1 long and narrow pan can be substituted), sand, water, ruler or meter stick, stiff piece of plastic or wood big enough to fit across short end of the pans, Duct tape (optional),Tin snips (optional),Silicon caulking (optional)

Video demonstrating use of a wave tank to test engineered solutions to erosion:
https://www.youtube.com/watch?v=3yNoy4H2Z-o

Solutions Concept Mapping Activity: Concept mapping activities adapted from "Out of the Box Responses Student Worksheet," Activity 2, UNITE US *Facing the Future* curriculum. UAF Geophysical Institute, 2012.

Other Resources:
Community-based methods for monitoring coastal erosion. By Buzard, R.M., Overbeck, J.R., and Maio, C.V. Alaska Division of Geological and Geophysical Surveys. DGGS IC 84. May 2019

Video demonstrating how volunteers in Maine measure beach profiles using Emery rods to survey a beach profile to help monitor beach erosion:https://www.youtube.com/watch?v=NaF7Pq2HkxA&feature=c4-overview&list=UU0wajJ67o5YTuxaRjZGX8eA

Barrow Area Information Database (BAID) website. Web apps include an Imagery Time Viewer that allows students to compare change over time by using a slider that juxtaposes images from different time periods and the Coastal Erosion Viewer. The site also has a Coastal Monitoring Story Map about technology and scientific methods for measuring and monitoring erosion.

Understanding and Evaluating Erosion Problems**.** Alaska Department of Commerce, Community and Economic Development. Good source of graphics and explanations about sources of energy in erosion, factors that increase or accelerate it, and erosion problems caused by human activities, including those that control erosion in one place but increase or accelerate it in another.