
Northwest Passage: Then and Now - Teacher Guide

Setting the Stage

Students will learn about some of the early explorations of the Northwest Passage and how the changing sea ice extent has prompted new explorations of this region to transport goods from one region of the Northern Hemisphere to another.



Map of the Northwest Passage. Credit: www.serc.carlton.edu

Lesson Overview

This lesson plan was adapted in part from material from the Northwest Passage exercise from On the Cutting Edge available at:

https://serc.carleton.edu/sp/library/google_earth/examples/northwest_passage.html.

- *Activity 1 – Engage (30 minutes) Moving Goods in the Northern Hemisphere*
Students will read a short text on the Northwest Passage.
- *Activity 2 – Explore (50 minutes) Contemporary Northwest Passages*
Students explore the Arctic using Google Earth Pro, and read a series of articles on changing sea ice extent.
- *Activity 3 – Explain (20 minutes) Arctic Sea Ice Today - Causes and Effects*
Students participate in a whole-class discussion about their findings, and consider the possible effects of reduced sea ice in the Arctic



- *Activity 4 – Evaluate (20 minutes) Transporting Oil Today* Students use their experiences from the lesson to create and present a solution for moving oil from the Arctic region to other regions around the world

Instructional Overview	
Grade Level	Middle School
Instructional Time	120 minutes
Standards Alignment	NGSS: DCIS: MS-ESS2.C: MS-ESS2.D SEPs: Analyzing and Interpreting Data; constructing Explanations and Designing; Engaging in Argument from Evidence CCCs: Cause and Effect
Lesson Phenomenon	<ul style="list-style-type: none"> • A reduction in Arctic sea ice is creating new transportation routes
Driving Question	<ul style="list-style-type: none"> • Why is the Northwest Passage important? • How and why has access changed in the recent past?
Learning Goals	<ul style="list-style-type: none"> • Use datasets displayed in Google Earth Pro to identify trends in Arctic sea ice extent. • Create evidence-based arguments for changing sea ice extent. • Discuss the economic implications for the loss of sea ice in the Arctic.
Materials	<ul style="list-style-type: none"> • This lesson requires access to a computer lab for Activity 2. Each computer needs to have the Google Earth Pro desktop application installed, and there should be enough computers so that no more than one or two students are seated at each computer. • Student handout • Summative grading rubric obtained from: http://rubistar.4teachers.org/index.php?screen=ShowRubric&rubric_id=1525075&
Material Preparation	<ul style="list-style-type: none"> • Google Earth Pro may need to be installed on each computer in the computer lab that will be used for this lesson. The time to download and install this application on each computer is expected to be 5-10 minutes, depending on CPU, memory, and speed of network connectivity on each computer. <p>Note: If this is the first time students are using Google Earth Pro, they will need a bit of scaffolding to navigate the capabilities of the program before starting Activity 2 in this lesson that requires its use.</p>



Instructional Strategies	Prerequisite Skills: Prior to this lesson students should have a basic understanding of the mechanisms of climate change. This short video from National Geographic video (3:03) entitled Global Warming 101 , could be used as a review before beginning the lesson.
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	Lesson Resources
Activity 1	<ul style="list-style-type: none"> Text: Northwest Passage: https://en.wikipedia.org/wiki/Northwest_Passage
Activity 2	<ul style="list-style-type: none"> Tool: Google Earth Pro https://www.google.com/earth/versions/#earth-pro Page: Arctic Sea Ice News & Analysis https://nsidc.org/arcticseaicenews/ Data: NSIDC Data on Google Earth https://nsidc.org/data/google_earth Text: Arctic becomes an island as ice melts https://www.telegraph.co.uk/news/earth/earthnews/3350631/Arctic-becomes-an-island-as-ice-melts.html Text: A Chilling Possibility https://science.nasa.gov/science-news/science-at-nasa/2004/05mar_arctic Text: Why is Arctic Sea Ice Melting Faster than Predicted? https://www.sciencedaily.com/releases/2008/04/080407132120.htm
Activity 3	<ul style="list-style-type: none"> Video: What is a current? https://oceanservice.noaa.gov/facts/current.html
Activity 4	Locate a recent article that provides the current status of the issue of the Alaskan Pipeline vs. transporting the oil via ships.



Activity 1 (Engage)

Moving Goods in the Northern Hemisphere (30 minutes)

Activity 1

Brainstorm with students on the variety of modes of transportation used to get their goods to their stores. Use this list to ask them to apply it to goods moving around the globe, and which would be the most efficient. Finally, show them a map of the Arctic region, and ask them what the most direct pathways are to moving resources from one country to another. They may not consider the climate of the polar regions at this point, or the fact that sea ice impedes the movement of ships through this region.

Mention this:

Some of the trips were harrowing and are sure to pique student interest. Of particular importance in the context of natural resources found in an Earth science curriculum, the Northwest Passage was considered for use to transport oil in the late 1960s. Ultimately, however, this route was deemed to be too costly and the Alaska Pipeline was constructed instead.

From the Wikipedia page:

“The Northwest Passage is a sea route through the Arctic Ocean, along the northern coast of North America via waterways amidst the Canadian Arctic Archipelago, connecting the Atlantic and Pacific Oceans. The various islands of the archipelago are separated from one another and the Canadian mainland by a series of Arctic waterways collectively known as the Northwest Passages or Northwestern Passages.

Sought by explorers for centuries as a possible trade route, it was first navigated by Roald Amundsen in 1903–1906. Until 2009, the Arctic pack ice prevented regular marine shipping throughout most of the year, but climate change has reduced the pack ice, and this Arctic shrinkage made the waterways more navigable. However, the contested sovereignty claims over the waters may complicate future shipping through the region: The Canadian government considers the Northwestern Passages part of Canadian Internal Waters, but the United States and various European countries maintain they are an international strait or transit passage, allowing free and unencumbered passage.”



Next, direct students to the Wikipedia page for the [Northwest Passage](#), pair-up the students, and assign each pair of students a different Northwest expedition to explore. Allow 15 minutes for them to read and prepare to report out their findings. They may gather notes on the Student Handout or in their science notebooks. Ask students to report out while pointing to the pathways for the expeditions on a globe. Mention to students that in the next activity they will explore contemporary pathways and how climate change is opening up the region for commerce.

Formative Assessment Feedback:

Circulate the room and evaluate students understanding based on conversations and interactions.



Activity 2 (Explore)

Contemporary Northwest Passages (50 minutes)

Activity 2.1

Review the functions of Google Earth Pro, and then allow students to orient themselves to the location and historic routes through the Northwest Passage. Students should be encouraged to explore on their own during this stage of the lesson with the teacher only providing guidance as necessary. Students should record responses in their science notebooks or on the Student Handout.

Start Google Earth Pro and choose the Google Earth Ruler tool. Select the Path tab.

1. How long is the shortest route by ship, in kilometers, between Germany and Japan that does not go through the Arctic Ocean? Hint: this route passes through the [Suez Canal](#).
2. How long is the shortest route by ship, in kilometers, between northern Alaska and New York City that does not go through the Arctic Ocean? Hint: this route passes through the [Panama Canal](#).

Activity 2.2

Examine the [Arctic Sea Ice News and Analysis](#) page of the National Snow and Ice Data Center (NSDIC).

3. What seasonal and long-term trends in Arctic sea ice extent are of note in this report?
4. In what month is Arctic sea ice extent typically at its minimum? Explain why this occurs in terms of seasonal cycles.
5. What was the average Arctic sea ice extent (in millions of square kilometers) in mid-September from 1979 to 2000?
6. What was the Arctic sea ice extent (in millions of square kilometers) in the middle of this past September?



Activity 2.3

Go to [NSIDC Data on Google Earth](#), and open Sea Ice Minimum and Maximum Extents, 1979 to 2019 in Google Earth Pro.

7. Choose the September radio button in the Places pane for the interval of years that is indicated. Gradually drag the time slider at the top of the 3D Viewer from left to right. The display may flicker as each image loads, so give this time to occur. What is the trend in sea ice extent for September? For what year do you notice the greatest change in ice extent from the previous year?

Activity 2.4

Read the following news article from 2008: [Arctic becomes an island as ice melts](#).

8. What historic event in the Arctic has been revealed by satellite images?
9. Taking this into account, how long is the shortest route by ship, in kilometers, between Germany and Japan?
10. Taking the same event into account again, how long is the shortest route by ship, in kilometers, between northern Alaska and New York City?

Activity 2.5

Read the following article from 2004: [A Chilling Possibility](#).

11. How could melting of Arctic sea ice lead to climate change in eastern North America and Western Europe?

Activity 2.6

Read the following article from 2008: [Why Is Arctic Sea Ice Melting Faster Than Predicted?](#)
[NOAA Probing Arctic Pollution](#).

12. What factors may be causing the Arctic sea ice to melt so quickly?
13. What are some positive effects of the changes in Arctic sea ice?



14. What are some negative effects of the changes in Arctic sea ice?

Activity 2.7

Locate a recent (past 3 years) article on the state of Arctic sea ice, and report on your findings here.

- Title of Article:
- Date of Publication:
- Claim and evidence presented in the article:

Formative Assessment Feedback:

Provide written feedback on their questions to help guide their understanding and help the teacher assess the level of understanding of individual students and the class as a whole.



Activity 3 (Explanation)

Arctic Sea Ice Today - Causes and Effects (20 minutes)

Activity 3

The teacher will lead a class discussion of the findings of the students during the exploration component of the lesson. The following guiding questions may be used to prompt discussion and should be used as a formative assessment at the end of the class period:

- How could you use a globe and a lamp to model the seasonal changes in the extent of the sea ice? Do these seasonal changes and our model explain all of the melting occurring in the Arctic? Explain your thinking citing examples from your investigation.
- Based on the investigation today, how has climate change impacted the sea ice extent in the Arctic? What are the economic and global climate implications caused by melting sea ice?
- Should scientific funding be contributed to further study of climate change and the condition of the Polar Ice Caps and sea extent? Why?
- Explain in detail how this melting might affect the Earth's ecological/systems balance?
- What might happen to our weather, climate, sea levels, or coastal ecosystems? Make predictions about what you think the greatest changes will be, if any. (Teacher may want to lead students in developing a concept map of the ideas that students have in order to help students understand the interconnectedness of earth systems).

Note: The teacher may want to use animated global models such as those found at <https://oceanservice.noaa.gov/facts/current.html> to remind students of concepts such as global ocean currents.

Formative Assessment Feedback:

At the end of the “explain” portion of the lesson, students will answer one of the prompts in a well-developed paragraph. Assess and provide feedback to evaluate student understanding as well as to promote writing across the content areas.



Activity 4 (Elaboration and Extension)

Transporting Oil Today (20 minutes)

Activity 4

Students or pairs of students will begin work on this extension activity in class and will complete it as a homework assignment.

You are an engineer working for a company that currently extracts oil from the North Slope Oil Fields in Alaska. Your company is realizing that with the changing conditions of the sea ice in the Northwest Passage that it may be economical to transport oil via ship rather than to continue using the Alaska Pipeline, which is expensive to maintain as it ages.

Your assignment is to determine whether it is viable to use the Northwest Passage as a transport route. For full credit you will include your findings in the following areas:

- Based on data from your investigation, what months will it be possible to use the passage?
- Describe in detail (with diagrams) what would be necessary to explore possible routes in terms of people and equipment.
- Describe how your company would mitigate the potential environmental threat of an oil spill like the one that occurred in the Gulf of Mexico in 2010 or with the Exxon Valdez in Prince William Sound, Alaska in 1989.
- Summarize the shortest and most economical routes for your company. Also, outline alternative routes for your shipping in the event that your shortest route is blocked by ice.
- What do you predict will be the long-term outlook for using the passage as a practical (ice-free) passage to transport oil for your company?

Prepare a short (three detailed paragraphs) summary of your findings that explains to the company leadership whether you recommend using the Northwest Passage as a transport route. Back your findings with scientific evidence found during your investigations in this lesson.

Report your findings using presentation software (ex: Microsoft Powerpoint or Google Slides) to be shared at a stakeholders meeting. Be sure to include maps and graphics to support your solutions.



Provide a deadline to complete the assignment, and allow class time for each student or pairs of students to present their solutions. Follow this with a class discussion weighing the merits of the solutions, and building consensus for a “best solution.”

Summative (Extend) Assessment Rubric:

The following rubric will be used to evaluate presentations and will be provided to students prior to the start of the project.

Category	4	3	2	1
Use of Class Time	Used time well during each class period. Focused on getting the project done. Never distracted others.	Used time well during each class period. Usually focused on getting the project done and never distracted others.	Used some of the time well during each class period. There was some focus on getting the project done but occasionally distracted others.	Did not use class time to focus on the project OR often distracted others.

Content Accuracy	Information is thorough and covers all relevant facts relating to the topic.	Information is accurate and facts are displayed on the poster. Most relevant facts are covered with few areas left unresearched.	Information is generally accurate with some questionable facts. Gaps are left in several areas related to the topic.	Facts are questionable about accuracy. Gaps are left in many areas related to the topic.
Knowledge Gained	Student can accurately answer all questions related to facts in the presentation and processes used to create the poster. He/She has made strong connections and included numerous thoughtful explanations.	Student can accurately answer most questions related to facts in the presentation and processes used to create the presentation. He/She has made some connections and included several thoughtful explanations.	Student can accurately answer about 75% of questions related to facts in the presentation and processes used to create the presentation. He/She has made connections and/or included some explanations.	Student appears to have insufficient knowledge about the facts or processes used in the presentation. He/She did not make sufficient connections or include needed explanations.

Mechanics	Capitalization and punctuation are correct throughout the presentation.	There are only a few errors in capitalization or punctuation.	There are several errors in capitalization or punctuation.	Errors in capitalization or punctuation are numerous.
Grammar	There are no grammatical mistakes in the presentation.	Grammatical mistakes in the presentation are minimal.	There are several grammatical mistakes in the presentation.	There are numerous grammatical mistakes in the presentation.
Graphics - Originality	Several of the graphics used in the presentation reflect an exceptional degree of student creativity in their creation and/or display.	One or two of the graphics used in the presentation reflect student creativity in their creation and/or display.	The graphics are made by the student, but are based on the designs or ideas of others.	No graphics made by the student are included.

Graphics - Clarity	Graphics are all in focus and the content easily viewed and identified from 8 ft. away.	Most graphics are in focus and the content easily viewed and identified from 8 ft. away.	Most graphics are in focus and the content is easily viewed from close proximity.	Many graphics are not clear or are too small.
Graphics - Relevance	All graphics are related to the topic and make it easier to understand. All borrowed graphics have a source citation.	All graphics are related to the topic and most make it easier to understand. All borrowed graphics have a source citation.	All graphics relate to the topic. Most borrowed graphics have a source citation.	Graphics do not relate to the topic OR several borrowed graphics do not have a source citation.