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Freshwater, Saltwater, Estuary? The Port and its Environment

Building on students' existing knowledge about freshwater, saltwater and estuary ecosystems, this project-based lesson asks students to explore the impacts of port activity on the environment. Focusing on the Ports of Prince Rupert, Metro Vancouver, Port Angeles and Portland, students examine how the location of a port determines the nature, type and possible extent of its impacts on the environment in which it operates. This lesson is informed by the big idea of Interconnectedness.

CLASSROOM TIME REQUIRED

2 teacher-directed session of 40-50 minutes; 3-4 sessions for student-led research and activities

LEARNING OBJECTIVES AND OUTCOMES

Students will:

- Examine different ecosystems and the marine and territorial life that they support
- Identify the possible impacts of port infrastructure and activities upon aquatic environments
- Compare the differences between a port primarily located in a freshwater environment, a saltwater environment and a brackish (estuary) water environment with respect to the types of impacts
- Work collaboratively to present research findings accurately and clearly and in an engaging format

MATERIALS REQUIRED

- Map of the Pacific North West (from Portland to Prince Rupert) showing the location of rivers (or Google Earth)
- YouTube video: *The Port of Prince Rupert*
- YouTube Channel: *International Shipping on Canada's West Coast*, Chamber of Shipping of British Columbia
- Slideshow of photos of terminals and infrastructure at the Port of Prince Rupert (see Resources)
- Table of *Primary Port Infrastructure and Human Interventions* (see Attachments below)
- Three tables entitled, *Primary Port Infrastructure*, *Human Interventions and Impacts* (see Attachments below)
- Bloom Ball template (see Attachments below)
- *Port of Prince Rupert 2020 Land Use Management Plan – Key Elements* (see Attachments below)

TECHNOLOGY RESOURCES REQUIRED

- Optional: Google Earth and a computer and projector, or Smart Board
- Internet access for students to conduct independent research

TEACHER PREPARATION

- Set up computer and projector or Smart Board to use Google Earth **or** source a map of the Pacific North West that shows the location of rivers (and other bodies of water).
- Print enough copies of each of the three tables entitled, *Primary Port Infrastructure, Human Interventions and Impacts* for to give to students working in groups of three.
- Become familiar with the locations of the Port of Prince Rupert, Port Metro Vancouver, Port of Port Angeles and the Port of Portland (i.e. the type of aquatic environment their major marine terminals and navigational channels are primarily located adjacent to, or upon).

CRITICAL VOCABULARY (see Glossary for definitions)

Brackish Marine terminals Saltwater

Estuary Navigational channels

Freshwater

LESSON DEVELOPMENT

Activity 1

- Lead the students in a short brainstorming exercise. What images, structures and infrastructure come to mind when the students read or hear the terms “cargo shipping”, “marine terminal” and “port”? Encourage students to draw on their knowledge of the port terminals in Prince Rupert. Record the students’ responses on the board.
- Explain to students that this lesson focuses on the infrastructure and activities of a port and the nature of their impacts on the local environment.
- Using a computer and projector or Smart Board, show the students the table of *Primary Port Infrastructure and Human Interventions*. Talk through the infrastructure concepts with the students and illustrate them with the visual resources (videos and photos) provided with this lesson.

Activity 2

- Group students into pairs or threes and give each group a copy of the three tables entitled, *Primary Port Infrastructure, Human Interventions and Impacts* (see *Attachments* below).
- Explain to the students that they are going to do some independent research in their groups to fill in the information that is missing from the table:
 - Provide a description of each human intervention listed; and
 - Identify the main environmental impacts of each intervention.
- Give students sufficient time to complete their research. (They should just try to identify the most important points and do not, at this stage, need to go into lots of detail.)
- Have the pairs/threes share their findings with another group and edit their table accordingly.

- Ask all groups feed their findings back to the class and, as they do so, record their answers in a master table on the board or flip chart.

Activity 3

- Review with the students the characteristics of freshwater, saltwater and brackish (estuary) ecosystems. Ensure that the students understand the types and relative ecological wealth associated with each ecosystem.
- Explain to students that some ports and marine terminals in Canada and around the world are located in freshwater environments, others are saltwater ports, and others are located adjacent to, or near, estuaries and brackish water. Can the students offer any examples?
- Using Google Earth and/or the aerial photos provided with this lesson plan, locate, with the class, the marine terminals at the Port of Prince Rupert and determine the kind of ecosystem (or ecosystems) that they are predominantly built on, or in immediate proximity to. The terminals are:
 - Fairview Container Terminal
 - Pinnacle Pellets (Pinnacle Renewable Energy)
 - Prince Rupert Grain
 - Ridley Terminals Inc.
- Explain to students that you (and they) will return to the Port of Prince Rupert later in this course of study, but that first they are going to examine the characteristics and environmental impacts of some of the other ports in the Pacific Northwest – the table below shows which ports, and the ecosystems that they are predominantly located in, or are in immediate proximity to:

Port	Ecosystem
Port Metro Vancouver (British Columbia)	Brackish Water (Estuary)
Port of Port Angeles (Washington State)	Saltwater
Port of Portland (Oregon)	Freshwater (Columbia River)

- Put students into groups of 3 or 4 and assign each group one of the ports from the table. Explain to students that they will work in their groups to complete the following:
 - Identify the characteristics of port – location, type and relative size of the marine terminals
 - Make informed judgments about what human interventions were likely required in constructing the port terminals and surrounding transportation infrastructure
 - Identify a primary environmental impact of the human interventions that have occurred, and what possible effects on the ecosystem may have occurred, in the absence of mitigation

Students can draw on the information they already have about ecosystems and port infrastructure. They will also need to conduct additional research. To support students' analysis, you may wish to remind them that the size of the marine terminals and transportation infrastructure footprint, the extent of the human interventions and the richness of the ecosystem will all determine the nature and extent of the environmental impacts.

- Tell students that they will be presenting their information as a type of “Bloom Ball”. Explain that a Bloom Ball is created by gluing together 12 circles that contain information important to the topic they are studying. You can share this image of a Bloom Ball to help to convey the concept to the students.

- Tell students that the Bloom Ball gives them lots of opportunity for creative presentation of their findings – images, drawings and maps as well as text can be included. They might wish to use different coloured paper for the different types of information they are finding (i.e. port characteristics; human interventions; environmental impacts).
- Give each group a copy of the Bloom Ball template (see *Attachments* below).
- Give students sufficient classroom and homework time to complete their research and produce their Bloom Ball.
- When the Bloom Balls are finished, hang them in the classroom and have the class examine them. Lead a class discussion about the findings and key learning.

Activity 4

- Bring students back to the port infrastructure in their own community/region. Review the location of four main terminals at the Port of Prince Rupert.
- Identify the natural advantages that the port in Prince Rupert enjoys and the natural constraints that it faces. Ask students to consider the environmental implications of these natural advantages and constraints.

Port of Prince Rupert	
Natural Advantages of Location	Constraints of Location
Good ocean access approach and shipping channels: <ul style="list-style-type: none"> • Deep • Protected from elements by islands 	Shortage of flat land The need for other transportation infrastructure to support port activities

- Review with the students the key elements of the *Port of Prince Rupert 2020 Land Use Management Plan*. (See *Attachments* below for an overview of these that you can share with students. The full document is available on the Prince Rupert Port Authority website.
- With reference to geographical atlases and Google Earth, lead students in the identification of what the future impacts on local ecosystems might be of the Port’s growth plan. Have the students work in pairs to identify the possible impacts, then share their ideas with another pair. Finally, ask the groups of four to share their ideas with the whole class. Record students’ ideas on the board.
- Select two or three of the main impacts identified and have the students, in pairs or small groups, brainstorm ways in which the possible impacts might be mitigated. Have students feed back their ideas to the class and record.

ASSESSMENT

Activity 3

The students’ Bloom Balls may be assessed against a set of appropriate criteria. Early in the process, engage students in the collaborative development of assessment criteria for their Bloom Balls. Criteria could include:

- Presentation – clarity, neatness, creativity
- Detail and comprehensiveness of information included
- Depth of analysis

- Logic of conclusions and links drawn

Activity 4

Informally evaluate students' contributions to the discussion about the possible future environmental impacts, and mitigation thereof, of the growth at the Port of Prince Rupert.

MODIFICATIONS

As a more time efficient approach to the learning material, focus the lesson solely on the Port of Prince Rupert, and apply the Bloom Ball activity to Prince Rupert's marine terminals (Fairview Container Terminal, Pinnacle Renewable Energy, Prince Rupert Grain and Ridley Terminals Inc.).

EXTENSIONS

- Arrange for students' Bloom Balls to be presented and/or displayed at the Port Interpretive Centre at Atlin Terminals.
- Explore further with the marine terminal operators how the possible impacts of the growth of the port in Prince Rupert might be mitigated. Find out what the Port and their tenants are doing now and what they plan to do to reduce or mitigate the environmental impacts of its current and future activities. (Information can also be found in the *Port of Prince Rupert 2020 Land Use Management Plan* and on the Port Authority's website. Also, direct students to the list of online resources for Shipping and the Environment in the *Attachments* below.)

LESSON PLAN RESOURCES

- YouTube video: *The Port of Prince Rupert*
- YouTube Channel: *International Shipping on Canada's West Coast*, Chamber of Shipping of British Columbia
- Slideshow of photos of terminals and infrastructure at the Port of Prince Rupert (see Resources)
- Website of the Port of Port Angeles
- Website of the Port of Portland
- Website of Port Metro Vancouver

ATTACHMENTS (below)

- Table of *Primary Port Infrastructure and Human Interventions*
- 3 tables of *Primary Port Infrastructure, Human Interventions and Impacts*
- Bloom Ball template
- *Port of Prince Rupert 2020 Land Use Management Plan – Key Elements*

Primary Port Infrastructure and Human Interventions

This table lists the basic infrastructure requirements of a port, the ideal characteristics of that infrastructure, and the human interventions to create the ideal characteristics where they do not exist naturally.

Infrastructure	Description	Human Intervention
Nautical Aspects: safe navigational approach and/or channel	Safe and expeditious vessel navigation to, in and from the marine terminal(s): <ul style="list-style-type: none"> - Preparation of the transit movement - Negotiating the port approaches - Approach and mooring to the marine terminal berth 	Shipping lanes for defined channels Installation of lighthouses, or navigation aids such as markers and buoys Tug boats for harbour escort, or vessel berthing activity Dredging to ensure adequate water depth for vessel draft requirements Sufficient air draft to ensure no vessel height restrictions because of bridges and hydro lines
Cargo Unloading: marine terminal (including lifting and loading equipment)	Safe and expeditious cargo unloading from the vessel, movement of cargo around the marine terminal, and to the connecting mode of land transport	Construction of specific types of marine terminals (i.e. container, grain, dry-bulk facilities): <ul style="list-style-type: none"> - Storage yards, - Cargo handling equipment, - Maintenance and office buildings Operating of specific forms of cargo handling machinery Dredging to ensure adequate water depth for vessel draft requirements The provision of a breakwater to ensure adequate wave protection for the vessel The provision of civic utilities (hydroelectricity, sewer, fresh and potable water)
Transportation access on land (road or rail)	Safe and expeditious cargo transport from the marine terminal to the connecting mode of land transport	Construction of access roads, railway yards

Primary Port Infrastructure, Human Interventions and Impacts

Infrastructure	Safe navigational approach and/or channel
Description	
Human Interventions	
Possible Environmental Impacts	

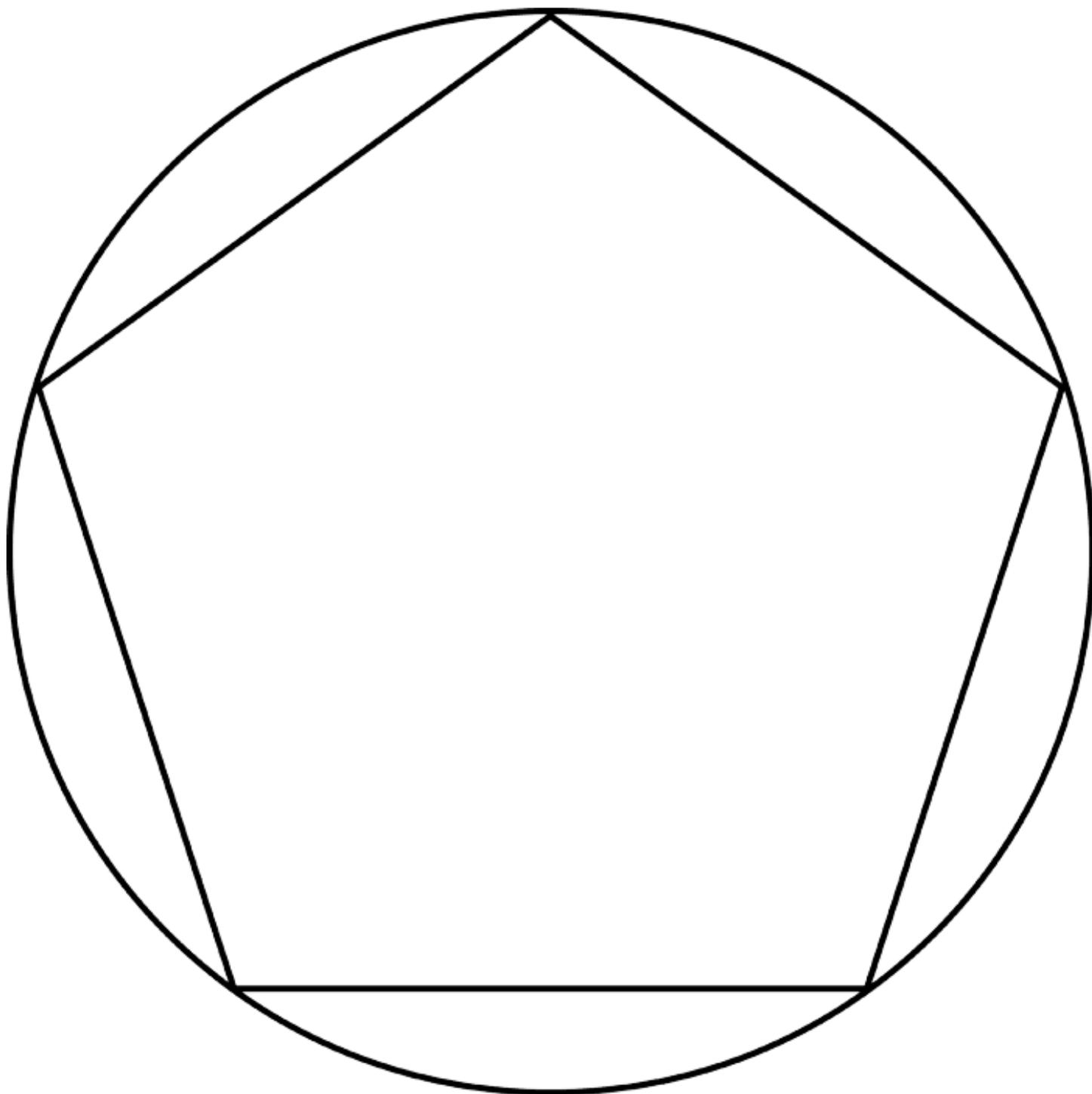
Primary Port Infrastructure, Human Interventions and Impacts

Infrastructure	Marine terminal (including lifting and loading equipment)
Description	
Human Interventions	
Possible Environmental Impacts	

Primary Port Infrastructure, Human Interventions and Impacts

Infrastructure	Transportation access on land (road or rail)
Description	
Human Interventions	
Possible Environmental Impacts	

Bloom Ball Template



Port of Prince Rupert 2020 Land Use Management Plan – Key Elements

Future planning for Port lands and infrastructure anticipates several initiatives, including:

- Expansion of the Fairview Container Terminal
- Development of a new potash bulk commodity terminal on Ridley Island;
- Provision for other bulk terminals on Ridley Island;
- A general cargo terminal on Ridley Island;
- A new short sea shipping terminal;
- Redevelopment of Inner Harbour terminals for light industrial commodities; and
- A logistics industrial park (export and import), as well as a general marine industrial park.

Shipping and the Environment – Online Research Resources

Australian Marine Environment Protection Association – industry sponsored association providing educational resources about shipping and the environment; corporate sponsors include Shipping Australia Ltd., ANL Container Line Ltd. and Shell Tankers Australia Ltd.

Clean Shipping Coalition – a global international environmental organization that focuses exclusively on shipping issues; promotes policies aimed at the protection and restoration of the marine and atmospheric environment that are consistent with the safe operation of ships, sustainable development, social and economic justice, and human health.

Environmental Defense – non-profit organization that leads a variety of environmental campaigns, including Oceans Alive, an all-encompassing effort to maintain the health of the oceans.

Environmental Ship Index – is a voluntary system designed to improve the environmental performance of sea going vessels. The Environmental Ship Index (ESI) identifies seagoing ships that perform better in reducing air emissions than required by the current emission standards of the International Maritime Organization.

Fisheries and Oceans Canada - Understanding the three oceans that surround Canada, as well as Canada's waterways and aquatic resources, is crucial if you want to ensure their sustainability – the challenge that scientists at Fisheries and Oceans Canada face each day.

Green Marine - Green Marine is a joint Canada-U.S. initiative aimed at implementing a marine industry environmental program throughout North America. Founded in 2007 by the major marine industry associations in both Canada and the U.S., Green Marine has rapidly gained a reputation for credibility and transparency, and for challenging participant companies to improve their environmental performance beyond regulatory compliance.

Institute for Coastal Research - at Vancouver Island University is made up of a team of people working to further understanding of the cultural, economic, environmental and social dynamics of the B.C. coast through collaborative research, creative exploration, dialogue, engagement and education. In doing so, we try to help guide human activities to bring the greatest good to coastal communities and ecosystems.

International Maritime Organization – United Nations body responsible for the safety of ships and seafarers and protection of the marine environment.

International Tanker Owners Pollution Federation Ltd. – non-profit organization established on behalf of the world's shipowners to promote an effective response to marine spills of oil, chemicals and other hazardous substances.

Oceana – international organization focused solely on ocean conservation; believes in the importance of science in identifying problems and solutions.

Transport Canada – Marine (Safety and Environment)

Pacific North Coast Integrated Management Area (PNCIMA) – aims to ensure a healthy, safe, and prosperous ocean area by engaging all interested parties in the collaborative development and implementation of an integrated management plan.

United Nations Atlas of the Oceans – The UN Atlas of the Oceans is an Internet portal providing information relevant to the sustainable development of the oceans. It is designed for policy-makers who need to become familiar with ocean issues and for scientists, students and resource managers who need access to databases and approaches to sustainability. The UN Atlas can also provide the ocean industry and stakeholders with pertinent information on ocean matters.

World Ocean Council - brings together the diverse ocean business community to collaborate on stewardship of the seas. This unique coalition is working to improve ocean science in support of safe and sustainable operations, educate the public and stakeholders about the role of responsible companies in addressing environmental concerns, more effectively engage in ocean policy and planning, and develop science-based solutions to cross-cutting environmental challenges that cannot be solved by one company or industry, such as: invasive species, ocean noise, marine mammal impacts, marine debris, the Arctic, and others. The WOC is engaging a wide range of ocean industries, including: shipping, oil and gas, fisheries, aquaculture, tourism, renewable energy (wind, wave, tidal), ports, dredging, cables and pipelines, carbon capture and storage, as well as the maritime legal, financial and insurance communities, and others.