

LESSON ONE – Discovering NEPTUNE Canada’s Underwater Laboratories

Overview:	Students will be introduced to NEPTUNE Canada through an interactive slideshow, and will use the information provided to discover three of the active underwater nodes off the West Coast of Vancouver Island.
Duration:	1 classroom session
Objectives: Students will...	<ul style="list-style-type: none"> • be introduced to the NEPTUNE Canada project. • research three of the NEPTUNE node sites (Folger Passage, Barkley Canyon, and Endeavour Ridge), and characterize the undersea habitats found at each site.
Vocabulary:	<p>Tectonic Plate – a large irregularly shaped slab of solid rock that is part of the Earth's surface which moves slowly across the mantle. There are about a dozen major plates that make up the planet’s surface.</p> <p>Plate Tectonics – the theory that the surface of the Earth consists of approximately a dozen large plates that are continually moving.</p> <p>Juan de Fuca Plate – one small plate (200,000 sq km) that is very important to British Columbia. This plate is sandwiched between the North American Plate and the Pacific Plate.</p> <p>Mid-Ocean Ridge – the active underwater ridge that runs along the bottom in the middle of oceans.</p> <p>Habitat – the physical space where a certain species lives. A species of plant or animal can only live in a habitat where its survival needs are met.</p> <p>NEPTUNE Canada – is the world’s largest cable-linked seafloor observatory, with an 800 km network of electro-optic cable on the seabed over the northern part of the Juan de Fuca tectonic plate.</p> <p>Seafloor “Observatories” or Nodes - NEPTUNE Canada (North-East Pacific Time-Series Underwater Networked Experiments) is a new way of studying the ocean. The cable network features five seafloor “laboratories”, or nodes. Through these nodes, land-based scientists control and monitor sampling instruments, video cameras and remotely operated vehicles as they collect data from the ocean surface to under the seafloor.</p>

¹ Definitions are from NEPTUNE Canada (www.neptunecanada.ca) and B.C. Science Probe 7 (Nelson)

The key words provided are integral to this lesson plan. If the Earth Sciences topics (eg. Tectonic Plates) have not already been covered in your class, you will need to teach the material prior to the NEPTUNE Canada introduction.

British Columbia PLO's:

- Grade 7 Science Life Science: Ecosystems
- Grade 7 Science Earth and Space Science: Earth's Crust

Background Information:

1. NEPTUNE Canada

Our Earth is covered by about 70% water, and beneath the surface of the ocean, there is a fascinating world of submerged mountain chains, erupting volcanoes and life forms that can thrive thousands of metres below sea level. The oceans have remained largely unexplored and we may know more about our moon, than we do about our own oceans.

The vastness of our oceans and their ever-changing nature make them both intriguing and challenging to understand. NEPTUNE Canada has made a technological leap that will bring us one giant step closer to understanding our oceans. By laying cables across the ocean floor to connect undersea ocean observatories, NEPTUNE Canada provides a window into the ocean where there was not one before. The undersea observatories allow scientists, teachers, students and the general public to expand their current knowledge of marine life, geology, and oceanic processes across an entire tectonic plate, from the continental shelf to the deep sea. Real-time access to information will transform the way we study the ocean and the Earth's crust.

2. Introducing the Undersea Laboratories

NEPTUNE Canada observatories are located on the seabed over the northern part of the Juan de Fuca tectonic plate, a 200,000 square kilometer region in the northeast Pacific off the coasts of British Columbia, Washington and Oregon. The observatories will allow us to monitor and research a diversity of ocean ecosystems, including abyssal plains, canyons, rifts, methane gas seeps, and hydrothermal hot vent communities.

The five nodes are located inshore at *Folger Passage*, on the slope site of *Ocean Drilling Program 889*, at the northern edge of *Barkley Canyon*, at the *mid-plate ODP 1027* site, and at the ocean spreading, active venting site along the *Endeavour Mid-Ocean Ridge*.

The five laboratories will focus on five distinct scientific themes; the structure and seismic behaviour of the ocean crust, seabed chemistry and geology, ocean climate change and its effects on marine life at all depths, the diversity of deep sea ecosystems, and engineering and computational research.

In the following lesson plan, we will explore the characteristics of three of the five nodes, including Folger Passage Node (pinnacle only), Barkley Canyon Node, and Endeavour Mid-Ocean Ridge Node.

Folger Passage Node

Folger Passage is located near the entrance to Barkley Sound, not far from the Bamfield Marine Sciences Centre. Folger Passage has two study sites, one on the seafloor and another located near the

tip of a pinnacle that reaches up to a depth of 20 meters. We will be exploring the exciting and dynamic shallow pinnacle site which is exposed to huge ocean waves. It displays patterns and processes of the near-shore zone, and is connected to the continental shelf.

The objectives for Folger Passage are: to identify the factors that control how much sea life is present; to understand the effects that marine processes have on fish and marine mammals; and to provide learning opportunities for the public, students and researchers, many of whom will be working and studying at the nearby Bamfield Marine Sciences Centre (NEPTUNE Canada Newsletter, 2008).

Barkley Canyon Node

Seaward from the Folger Passage node, the Barkley Canyon Node is located on the continental slope where the continental shelf drops off towards the abyss. A deep trench is formed where the Juan de Fuca plate dives under (submerges) the North American plate. Canyons are typically sites of underwater landslides as well as movement of sediment, organic material and nutrients to the deep ocean. They are also the location where methane and sulfide rich fluids seep out of the ocean floor creating a unique environment with creatures new to science.

There is a huge diversity of environmental settings within the Barkley Canyon locality, each of which has intriguing and exciting elements for various aspects of scientific investigation. An upwelling zone at the head of the canyon supports plankton blooms and an active shelf fishery. The cold-seep fauna in the Barkley Canyon methane hydrate zone gives us an opportunity to study and observe an unusual and specialized ecosystem.

The Barkley Canyon node allows us to study changes in biological and chemical activity associated with nutrient and sediment transport through the canyon to the deep sea.

Endeavour Mid-Ocean Ridge Node

The Endeavour Mid-Ocean Ridge node is part of the Juan de Fuca volcanic ridge where tectonic plates are spreading apart and new seafloor is being formed by volcanic eruptions. Hot springs, known as hydrothermal vents, are frequently found along these spreading ridges. Four major vent fields are known, and they are spread over a 2-3 kilometer distance. The vent sites are located at depths of 2600 meters, and are characterized by large chimney-like structures with extensive venting of chemicals, minerals, and fluids at temperatures reaching over 300°C.

The Endeavour Hydrothermal Vent area is a hotbed of biological activity. Black-Smokers, the chimney-like structures, spew out super-heated water and nasty chemicals and are amazingly surrounded by an entire ecosystem that thrives in this extreme environment. Animal densities can be up to half a million creatures living per square meter around the chimney structures. Research has shown that the Endeavour Hydrothermal vents are home to 12 species that exist nowhere else on Earth. In 2003, the Endeavour Hydrothermal Vents were designated as the first Marine Protected Area under the Oceans Act.

The Endeavour Mid-Ocean Ridge node allows us to quantify the complex interaction among volcanic, tectonic, hydrothermal and biological processes where new volcanic seafloor is created at the western edge of the Juan de Fuca plate. The region has been intensively investigated for more than 20 years, and the NEPTUNE Canada node site will help continue this research as well as allow the use of real-time monitoring for new and exciting research.

Materials:

Option 1 - Fill-in-the-Blank during slideshow presentation, no internet required

- Computer and projector set up in classroom for PowerPoint presentation.
- *Discover NEPTUNE Canada* PowerPoint Slideshow. Download from S.O.L.E. Website For Teachers.
- copies of the *Discover NEPTUNE Canada* Fill-in-the-Blank Worksheet, one per student. Download as Word document from S.O.L.E. Website - For Teachers.

OR

Option 2 - Web-Quest Worksheet using computers with internet access – one per student or pair

- copies of the *Discovering NEPTUNE Canada - WebQuest Worksheet*, one per student. Download from S.O.L.E. Website - For Teachers.
- Computer access, preferably one per student or pair of students.

Extension Activities

- copies of *Discovering NEPTUNE Canada - Mapping Worksheet*, one copy for each student. Download from S.O.L.E. Website - For Teachers.
- copies of *Latitude and Longitude Made Easy*, one copy for each student. Download from S.O.L.E. Website - For Teachers.
- poster or large mural paper, markers, crayons, or paints.

Procedure:

Option 1:

1. Ensure that the students understand the Earth Sciences key words outlined above. Having the vocabulary list on the board or as individual handouts for reference during the lesson will be very helpful.
2. Using the PowerPoint slideshow provided on the S.O.L.E. Website, introduce NEPTUNE Canada to your students. You will need to have a computer that is loaded with PowerPoint connected to a LCD projector at the front of the classroom in order to present the slideshow. There are notes written at the bottom of each slide to aid you in your presentation. If you do not have access to a projector, you can print out the PowerPoint slides onto overheads or handouts, or alternatively, have each student individually access the PowerPoint presentation from the website.
3. Task the students to complete the *Discovering NEPTUNE Canada - Fill-in-the-Blank-Worksheet*. They will be able to determine the words needed to fill in the blanks as you are presenting the slideshow. Ensure the students are engaged and following along by asking questions of them during the presentation. You may want to stop after each Node section to allow the students to catch up and fill in any blanks they may have missed.
4. When the slideshow is finished and the worksheets are complete, lead a discussion with your class about the three underwater Nodes that they have learned about. Divide the class into

three smaller discussion groups, assigning one group to each Node site. Encourage the students to visualize the underwater habitat, predicting what kinds of organisms might live there and how life might feel for those organisms:

- What do you visualize the underwater habitat to look like at the Node?
 - Can you predict what kinds of organisms might live in this habitat?
 - What do you think life might feel like for those organisms (temperature, light, colour, currents, pressure)?
5. Each group should then present what they have discussed about their assigned Node site to the rest of the class.
 6. Leave the students with a couple of follow-up questions that can be answered as a class, or individually as reflection topics in their journal or notebook.
 - How do you think the NEPTUNE Canada Node sites could assist you and your peers to learn about underwater ecosystems and geology?
 - Can you think of other ways in which technology has been used to explore unknown environments?

Option 2:

1. Ensure that the students understand the Earth Sciences key words outlined above. Having the vocabulary list on the board or as individual handouts for reference during the lesson will be very helpful.
2. Set the students up on computers with internet access (individually or with a partner), and give the students a brief orientation to the S.O.L.E. Website. The “Dynamic Earth” pages are great for general information about geology and ecology of deep sea life, while the “Deep Sea Science” pages are where the students will find the information needed to complete the Web-Quest Worksheet.
3. Three of the five NEPTUNE Canada underwater laboratories (“Nodes”) have been chosen for our study of undersea ecosystems. Using the *Discovering NEPTUNE Canada - WebQuest Worksheet* provided (one worksheet per student or pair), task the students to go on a search for information on the three Node sites. Encourage them to use all the resources provided, including video clips, photos, animations, and website links.
4. Get the students to complete the worksheet, filling in as much information as possible on the location, habitat characteristics, and research questions being asked at each of the underwater laboratories we are studying (Folger Passage, Barkley Canyon, Endeavour Ridge).
7. When the Web-Quest Worksheet is complete, lead a discussion with your class about the three underwater Nodes that they have learned about. Divide the class into three smaller discussion groups, assigning one group to each Node site. Encourage the students to visualize the underwater habitat, predicting what kinds of organisms might live there and how life might feel for those organisms:

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9. Leave the students with a couple of follow-up questions that can be answered as a class, or individually as reflection topics in their journal or notebook.
- How do you think the NEPTUNE Canada Node sites could assist you and your peers to learn about underwater ecosystems and geology?
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Discussion:

To be discussed in small groups after worksheet is complete:

- Briefly go over with each other what you have discovered during the class about the Location, Habitat Description, and Research at the Node site your group has been assigned.
- What do you visualize each of the underwater habitats to look like?
- Can you predict what kinds of organisms might live in each of the habitats?
- What do you think life might feel like at each of the sites (temperature, light, colour, currents, pressure etc.)?

To be discussed as a class, or answered as reflection topics in personal journals:

- How do you think the NEPTUNE Canada Node sites could assist you and your peers to learn about underwater ecosystems and geology?
- Can you think of other ways in which technology has been used to explore unknown environments?

Extension Activities and Resources:

Social Studies Mapping Activity:

- As an extension activity that is cross-curricular with Social Studies, get the students to plot each of the three node sites on the Mapping Worksheet provided. The Node locations should be placed on the map using the latitude and longitude found, and should be labeled using a legend, symbols, or different colours. Have a large map on display for the classroom, which can include information such as node locations and characteristics of each site (downloadable version from NEPTUNE Canada can be printed in colour).
- If your students are unfamiliar with plotting latitude and longitude, allow the students time to read over the *Latitude and Longitude Made Easy* handout as an introduction to geographical mapping.
- For a fun activity to introduce latitude and longitude, check out this website:
<http://www.helium.com/items/962556-teaching-tips-how-to-teach-latitude-and-longitude>

Visual Arts Mural Activity:

- Have each group create a mural depicting the underwater habitat they discovered during this lesson. Encourage them to work together to represent the unique characteristics of the Node site, and include their visualizations of the organisms that may live in the habitat. You can use large poster paper or bristol board, markers, crayons, paints, and any other art supplies you may have available.
- The murals will be great for the students to use as a reference throughout the rest of the S.O.L.E. curriculum. You may even be able to use the murals to represent the habitat in the food webs created in Lesson Three!

Further Resources:

- Allow students some computer time to explore both the NEPTUNE Canada website (<http://www.neptunecanada.ca/>), as well as the Dive and Discover site (<http://www.divediscover.whoi.edu/>). Both sites have interesting and interactive activities as well as information regarding deep-sea science.
- To give students a good visual representation of the depth of the ocean at some of the sites we are exploring, you could adapt this short lesson plan posted on the Dive and Discover website: <http://www.divediscover.whoi.edu/expedition12/activities/depth/index.html>

References:

B.C. Science PROBE 7 Textbook, Nelson (2005)

Dive and Discover (Wood's Hole Oceanographic Institute): <http://divediscover.whoi.edu/>

NEPTUNE Canada: <http://www.neptunecanada.ca/dev> (in progress)
<http://www.neptunecanada.ca> (up to date, not as student-friendly)

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Wood's Hole Oceanographic Institute: <http://www.whoi.edu/>