CANADA'S AMAZING NEPTUNE PROJECT

Introduction

Download the mp3 of this Introduction at newsinreview.cbclearning.ca.

Focus

This *News in Review* story focuses on the launch of NEPTUNE Canada, a high-tech ocean observatory off the coast of Vancouver Island. NEPTUNE's 800 kilometres of fibre optic cable, along with a number of sophisticated underwater instruments, could change the way the world studies its oceans.

Acknowledgement

News in Review would like to acknowledge the support and assistance of NEPTUNE Canada in the development of this story. Visit the NEPTUNE Canada Web site for further information on this amazing project at http://neptunecanada.ca.

Many Canadians look to the skies and wonder about the vast unexplored expanse called space. However, there is another vast unexplored expanse right here on Earth—the world's oceans. Consider these facts: over 70 per cent of Earth is covered by water, and every second breath we take comes from oxygen generated by our oceans. Water is such an important resource one has to wonder why more hasn't been invested in studying the mysteries of the deep blue sea.

Canada is solidifying its reputation as an international leader in ocean research and exploration. The University of Victoria—working in conjunction with 12 universities across Canada and partners in government and the private sector—officially launched NEPTUNE Canada near the end of 2009. NEPTUNE Canada is a sophisticated ocean observatory that is hooked up to the Internet via fibre optic cable. The cable stretches 800 kilometres in a strategic loop across the Juan de Fuca tectonic plate off the Pacific coast of Vancouver Island. All the data gathered at five research hubs are fed back to NEPTUNE Canada's shore station in Port Alberni and then transmitted via high bandwidth to the archiving centre at the University of Victoria where they are shared with the world over the World Wide Web.

Both academic and amateur researchers from anywhere in the world can log onto the NEPTUNE site and create an account free of charge. They can then interact with NEPTUNE's data to make observations and discoveries. This means that a person conducting PhD research on biodiversity in Guelph, Ontario, or a Grade 11 science student in Paris, France, can participate in ocean research without having to head out onto the rugged waters off the coast of British Columbia.

The launch of NEPTUNE has put Canada in a position to provide researchers from a range of sciences (geology, biology, physics, chemistry) and from around the world with the opportunity to access real-time continuous data online to study and better understand things like climate change, ocean health, marine ecosystems, ocean-floor mineral deposits, and hydrocarbons from anywhere in the world. NEPTUNE will also provide invaluable data for the study of underwater volcanic processes and submarine earthquakes and tsunamis.

NEPTUNE's slogan maintains that they are "Transforming Ocean Science." It appears that the generosity of NEPTUNE's data-sharing agenda, as well as the ingenuity of its observatory system, could see this transformation become a reality. Many nations have expressed interest in constructing NEPTUNE-style research facilities in the not-too-distant future.

To Consider

1. Identify two ways that NEPTUNE is transforming ocean science.

2. How are discoveries made off the west coast of Vancouver Island relevant to someone living in another part of the world?

CANADA'S AMAZING NEPTUNE PROJECT

Video Review

Definition
NEPTUNE is an acronym that stands for **N**orth-**E**ast **P**acific **T**ime-series **U**ndersea **N**etworked **E**xperiments.

Pre-viewing Questions

With a partner or in a small group read and discuss the following questions.

1. Traditionally, scientists have studied the world's oceans by going out on marine expeditions with sophisticated instruments. Imagine if there could be permanent study labs on the ocean floor. Why would permanent ocean labs be more effective than ongoing marine expeditions?

2. If scientists were able to build permanent labs on the ocean floor in a variety of locations, where should they be located? Explain your answer.

3. Imagine that scientists could remotely access information from permanent ocean labs. Should the people who build the labs be paid for use of their labs? Why or why not?

Viewing Questions

Write your responses to the following questions in the spaces provided.

1. What does Mairi Best mean when she says that she is being asked to build "the marine space station"?

2. Why does Kim Juniper say that we had better start to understand what is going on in our oceans or we're going to be in big trouble soon?

3. a) Describe NEPTUNE Canada.

   b) How much is the project expected to cost?

Did you know . . .
Forty per cent of Earth's people live within 100 kilometres of the sea, and the issue of ocean wellness is beginning to take on increasing importance in deliberations regarding climate change. NEPTUNE, and whatever other projects it inspires, will become a key player in providing information that shows humanity how profoundly connected we are to the sea.

4. What role did the voyage of the M.V. Thompson play in laying the groundwork for NEPTUNE Canada?

5. How many species have been discovered in Earth's oceans? How many do some people estimate are actually present in Earth's oceans?

6. What do ocean scientists study when they visit Endeavour Ridge?

7. Why is Kim Juniper surprised that life is able to thrive in the volcanic areas of Endeavour Ridge?

8. What does Juniper mean when he says that life at the bottom of Endeavour Ridge is "an ecosystem that is not dependent on solar energy"?

9. Name some of the things that NEPTUNE hopes to study.

10. How long is the line of fibre optic cable stretching from Port Alberni out into the Pacific Ocean?

11. Why did ocean scientists pick the coast of Vancouver Island as the location for NEPTUNE Canada's research?

12. What is the name of NEPTUNE's rover? What is the rover's job?

13. What difficult decision does NEPTUNE's staff need to make when some of their instruments fail once they are installed?

Post-viewing Questions

1. The price tag on NEPTUNE is $100-million to build and $8- to $10-million a year to operate. Is the project too expensive, or do you think the information NEPTUNE will provide is worth the cost?

2. A paradigm shift is a radical and unexpected change in the way things are done. How does NEPTUNE represent a paradigm shift in the world of ocean science?

CANADA'S AMAZING NEPTUNE PROJECT

YV *Transforming Ocean Science*

Did you know . . .
VENUS was the first cabled underwater observatory built by the University of Victoria. If features 44 kilometres of fibre optic cable connecting instruments in Saanich Inlet and the Strait of Georgia to researchers using the Internet.

The emergence of NEPTUNE Canada as a global leader in ocean research is a story of vision, planning, ingenuity, innovation, perseverance, and collaboration. The rationale behind the use of so many descriptors to describe the efforts of the University of Victoria (UVic) to bring NEPTUNE online will become clear to you in a moment.

The NEPTUNE story began in the mid 1990s with a team of visionary ocean scientists from the United States who were frustrated with the way marine research was being conducted. Traditionally researchers hoped that government and university funding grants would allow for marine expeditions for a limited period of time scattered sporadically over the course of a given year. Even if researchers could scrounge up the money, things like the weather and sea conditions would often scuttle an expedition before it could get out of port.

Then, around the turn of the millennium, these visionaries began to put a dream into action with the idea of a permanent ocean science observatory located on the sea floor that was hardwired to a shore station. In 2000, scientists in Canada and the U.S. agreed to work together on the NEPTUNE project and to seek funding in their respective countries. Within a few short years, Canadian ocean scientists received funding for VENUS (the Victoria Experimental Network Under the Sea), a coastal cabled ocean observatory between Victoria and Vancouver, British Columbia. After several years of careful planning and preparation, VENUS launched in 2006.

VENUS

What makes VENUS unique is that it is located in two different scientifically interesting coastal settings. One is a glacially carved fiord setting in the Saanich Inlet and the other is in the Strait of Georgia, a very busy human-use corridor between Vancouver and Victoria that is impacted by the Fraser River delta. VENUS provides three research hubs, including one where more than 50 instruments powered by undersea nodes feed a constant stream of data to the UVic database. The instrument readings travel from their respective locations along 44 kilometres of fibre optic cable straight onto the Internet for anyone in the world to use.

NEPTUNE

Following the success of VENUS the installation of NEPTUNE (North-East Pacific Time-series Undersea Networked Experiments) was not far behind. While VENUS covers a significant and important smaller coastal system, NEPTUNE is a huge network that extends from the west coast of Vancouver Island out into the sea. In fact, 800 kilometres of fibre optic cable stretch out in a massive circle from the base station in Port Alberni into the Pacific Ocean. Five 13-tonne nodes feed power to over 400 instruments and sensors located in water ranging in depth from 100 metres along the coast to 2 660 metres out in the deeper ocean.

Ocean scientists are able to conduct experiments along the coast at Folger Passage as well as gather data from the edge of the Juan de Fuca tectonic plate at NEPTUNE's Endeavour site. All this can be done remotely from anywhere in

Did you know . . .
Gas hydrates—natural gas and water frozen together into a solid substance—are common in arctic permafrost regions and in sediments in the ocean's deep waters. Research is now underway to better understand the issues around this vast, untapped resource: how natural gas hydrates form, where they are located, and how they could be used as a future source of natural gas.

the world via the Internet. NEPTUNE is really in its infancy; it came online only in December 2009. Ocean scientists are just starting to see NEPTUNE's true potential, and plans are underway in different jurisdictions around the world to build similar cabled networks.

Ocean Networks Canada

The ingenuity and innovation behind the scientific success of VENUS and NEPTUNE are complemented by the equally creative leadership work of Ocean Networks Canada (ONC), which it put into place in 2007 to help build and sustain Canada's world leadership in ocean science and technology.

Experienced university researchers have seen many projects disintegrate due to unproductive rivalries and poor planning.

ONC works as the umbrella organization that keeps VENUS and NEPTUNE on track and provides leadership and support to ensure these observatories bring maximum economic and social benefits to Canada and its international partners. In other words, both projects can function independently while focusing on their research objectives.

Ocean Networks Centre for Enterprise and Engagement

To complement the work of ONC, Ocean Networks Centre for Enterprise and Engagement (ONCEE) was founded in the spring of 2009. ONCEE's mandate is to work with governments and businesses to highlight the economic benefits of VENUS and NEPTUNE. Both projects are so unique that politicians and business people might need some guidance in realizing the true benefits of what these ocean observation systems have to offer. For example, NEPTUNE is equipped with seismic moitoring equipment and can detect oceanic earthquakes and corresponding tsunamis. Governments would be very interested in this critical public safety information.

NEPTUNE is also studying things like natural gas hydrates which, if handled correctly, could prove to be a source of energy in the future. This is obviously of interest to businesses, as humans continue to consume more and more of Earth's energy resources.

The whole point of explaining the overall organization behind VENUS and NEPTUNE is to demonstrate that things don't just happen because someone has a good idea. Progress happens because a good idea is combined with planning and perseverance. If the Canadian and British Columbia governments, scientists, and technological partners hadn't been willing to bring VENUS and NEPTUNE to life through creativity and hard work, Canada would not be the international leader in ocean science that it has become. Just 10 years after its conception, both projects are living up to their mandate and are transforming ocean science.

Source: Ocean Networks Canada – www.oceannetworks.ca

To Consider

1. How is VENUS different from NEPTUNE? Provide at least three differences.
2. Why is ONC so important in maintaining the success of VENUS and NEPTUNE?
3. What is the mandate of ONCEE?
4. This section uses a number of descriptors in its opening sentence to describe NEPTUNE. Do you think these descriptors accurately describe NEPTUNE Canada?

CANADA'S AMAZING NEPTUNE PROJECT
NEPTUNE Canada: A Snapshot

What is NEPTUNE?

NEPTUNE stands for North-East Pacific Time-series Undersea Networked Experiments. The separate parts of this acronym are explained below:

North-**E**ast **P**acific: This identifies the project's location off the coast of Vancouver Island, British Columbia, in the northeastern part of the Pacific Ocean.

Time-series: NEPTUNE will provide on-demand, real-time information for researchers for at least the next 25 years.

Undersea: NEPTUNE's instruments will take up permanent residence in the north-east Pacific Ocean operating at depths ranging from just under 20 metres to just over 2 600 metres.

Networked: 800 kilometres of fibre optic cable connect to a series of nodes stretching from the Port Alberni shore station out to the edge of the Juan de Fuca tectonic plate. The nodes deliver the power and manage the data from the over 400 instruments and sensors spread out like tentacles at NEPTUNE's five locations.

Experiments: In an act of remarkable scientific generosity, NEPTUNE has agreed to provide unfettered access to its undersea observatory. This means that innumerable scientific experiments can occur simultaneously via the NEPTUNE network.

Visiting NEPTUNE

Close your eyes and imagine you are taking a ride along the ocean floor in order to visit NEPTUNE Canada, here's what you would find:

• Folger Passage (17–100 metres below the ocean surface)
Initially you will travel from the shore station at Port Alberni and begin your submarine expedition beneath the sea in Barkley Sound. The first stop on your journey will be the Folger Passage research area. In this zone, you will find two arrays of instruments—one set on the seafloor 95 metres deep, and another on a rock pinnacle 17 metres below the ocean's surface. The instruments plug into a 13-tonne node that powers the equipment and receives and transmits data. The Folger Passage site examines biodiversity and marine life on the continental shelf.

• ODP 889 (1 260 metres below the ocean surface)
Next you will travel along the continental shelf, departing the relative comfort of Folger Passage, moving to the mid-point of the continental slope 1 260 metres below the ocean's surface. Eventually you will encounter another research hub, marking your arrival at ODP 889. The instruments that branch off the node are designed to measure seismic events, monitor gas hydrate distribution, and look for areas where the slope has collapsed.

• Endeavour (2 300 metres below the ocean surface)
Continuing your voyage you will travel out into the deep sea and visit the research site at Endeavour Mid-Ocean Ridge. NEPTUNE ocean scientists see this as one of the most exciting places to study. Endeavour Ridge is located about 300 kilometres from the British Columbia coast and has been a place of intense study since the mid 1980s.

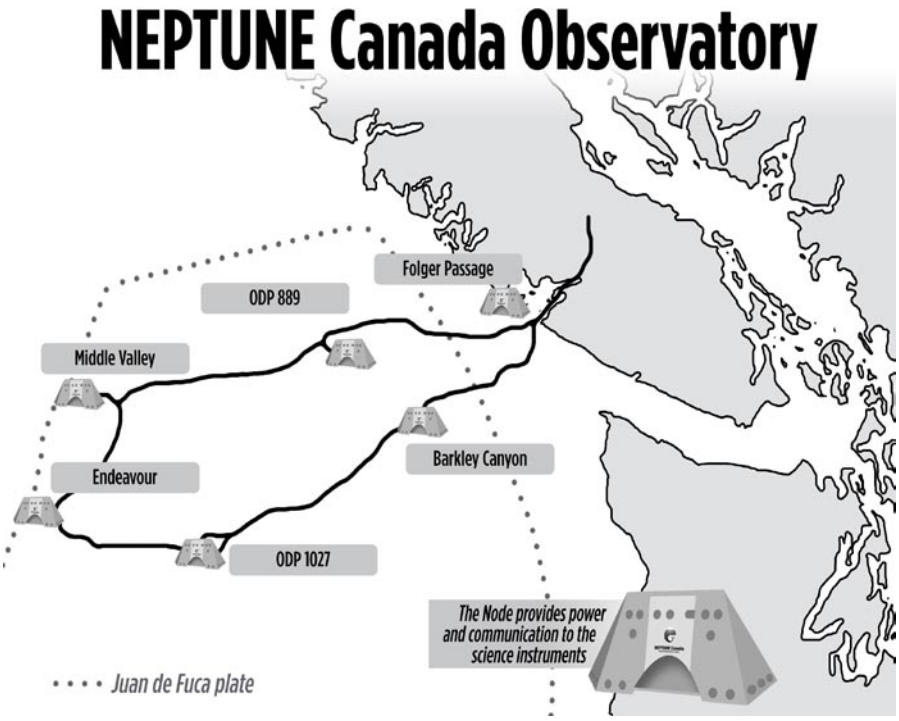
Quote
"It's like landing on another planet, constantly disturbed by volcanic activity. No light ever reaches these depths. Crushing pressure and extreme temperature near these black smokers make it one of the most unwelcoming places on Earth."
— Frédéric Zalac, CBC reporter, describing Endeavour Ridge

You will find instruments located on the expanding boundary between the Juan de Fuca and Pacific tectonic plates that features hydrothermal vents. A hydrothermal vent forms when fissures open on the seafloor, causing the release of hot, mineral-rich water. Researchers at the Endeavour site study this hydrothermal vent activity as well as earthquakes and tectonic processes.

• ODP 1027 (2 660 metres below the ocean surface)
After you visit Endeavour Ridge you will make your way back toward land, winding up in the middle of the abyssal plain. ODP 1027 (Ocean Drilling Program drill hole) is at the mid-point of the Juan de Fuca tectonic plate at a depth of 2 660 metres deep. Instruments that branch off this node take measurements related to temperature and pressure. They also provide earthquake- and tsunami-detection readings.

• Barkley Canyon (400-653 metres below the ocean surface)
You are almost home. Your final stop will be at Barkley Canyon, where you will find a lively ecosystem consisting of fish, marine mammals, and plankton. One of the technological strengths of this NEPTUNE research area is a mobile instrument platform called the Vertical Profiler System (VPS). The base of the VPS is situated on the sea floor. A tethered float can be raised and lowered from the platform via a winch, which allows scientists to measure activity from the sea floor 400 metres down up to the ocean surface. The VPS facilitates the monitoring of things like temperature, salinity, plankton and fish clusters, and marine mammal movement. Gas (methane) hydrate deposits outcrop in the walls of the canyon, and NEPTUNE is deploying a rover, like an all-terrain vehicle, hosting many instruments controlled through a powered tether to investigate how such deposits are formed.

Source: NEPTUNE Canada – http://neptunecanada.ca



Activity

Visit the NEPTUNE Web site (http://neptunecanada.ca) and click on the links to the five locations listed above. Make a list of instruments used at each location and the research being conducted at each site. Create a chart that shows the information you were able to discover.

CANADA'S AMAZING NEPTUNE PROJECT
NEPTUNE and the Global Ocean

Quote
"Right now we have something in the order of 200 000 to 300 000 species that have been encountered in the ocean. Some people estimate there are six million or more species in the deep sea." — Kim Juniper, oceanographer, University of Victoria

Did you know . . .
NEPTUNE Canada is considered to be one of four groundbreaking science initiatives in Canada. NEPTUNE joins Canadian Light Source at University of Saskatchewan, Triumf at the University of British Columbia, and the Sudbury Neutrino Observatory.

To say that NEPTUNE Canada is studying a tiny portion of the Pacific Ocean is a bit misleading. Increasingly scientists are referring to the global ocean—an amalgam of Earth's five oceans—because of the way ocean currents interconnect. In reality, what happens in the Pacific Ocean has an effect on the Arctic and the Atlantic oceans as well. In other words, all oceans really connect into one global ocean.

Based on this premise, consider the following:

- the global ocean contains 80 per cent of all life on Earth, most of which remains undiscovered
- close to 250 000 marine species have been identified
- the global ocean contains 97 per cent of Earth's water
- ocean scientists have only managed to study five per cent of the deep sea
- every second breath a human takes comes from oxygen generated from the part the ocean plays in the oxygen-carbon cycle

The Impact of Climate Change

We often associate climate change with the circulation of polluted air. However, the air we breathe is actually intricately linked to the global ocean. The climate change facts are clear: the last 25 years have featured the warmest years on record, with the world's average surface temperature increasing by 0.7° C over the past 100 years. Experts predict a further one to six degree rise in the next century. The warming of the air is contributing to the warming of the oceans, which is causing some wild weather patterns. Of even more concern is that the addition of carbon dioxide into the atmosphere is being transferred to the oceans, causing acidification. Climate change has become a major global concern—and the health of the global ocean has risen to paramount importance.

Canada's Role

With the world's largest coastline, Canada has a significant interest in becoming a global leader in ocean research. VENUS and NEPTUNE are evidence that Canada is taking this role seriously, with both projects being described as the most innovative ocean observatories in the world. Meanwhile, Canadian ocean scientists know that the ocean is our greatest ally in the climate change struggle. While human activity has led to a 25 per cent increase in carbon dioxide in the air, the ocean continues to protect us by absorbing almost half of that amount.

How long this will remain the case is unclear, and the increasing ocean acidification and its effects on many species is a growing concern. What is clear is the fact that NEPTUNE in particular can provide a snapshot into the behaviour, health, and future of the global ocean. A study in gas hydrates at Barkley Canyon can lead to hypotheses that have global implications. Ocean warming trends measured by instruments at ODP 889 can serve as a predictor for other temperature changes in the global ocean. And long-term ecosystem analysis by NEPTUNE's vertical profiler system at Barkley Canyon can certainly provide vital information regarding the health of species living in the global ocean.

NEPTUNE promises to provide state-of-the-art research covering the following areas over the next 25 years and beyond:

- undersea volcanic processes
- earthquakes and tsunamis
- minerals, metals, and hydrocarbons
- ocean-atmosphere interactions
- climate change
- greenhouse gas cycling in the ocean
- marine ecosystems
- long-term changes in ocean productivity
- marine mammals
- fish stocks
- pollution and toxic blooms

How can advanced research in any of these areas be anything but good for humanity?

Source: NEPTUNE Canada – http://neptunecanada.ca

To Consider

1. What is meant by the expression *global ocean*?
2. Why is it in Canada's best interest to become a leader in ocean science research?
3. How has Canada positioned itself to be a leader in ocean science research?
4. Rank the research areas listed at the end of this section from most important to least important. Explain the rationale behind your top ranking and bottom ranking.

CANADA'S AMAZING NEPTUNE PROJECT
Activity: Web Site Exploration

Activity Choices
You have a choice between two different activities. Review both options and select the one that best suits your learning style. Both options involve a writing task.

- Activity 1 is an exercise in following instructions and navigating a Web site.
- Activity 2 is more open-ended but also involves exploring a Web site.

Activity 1: Become an Ocean Scientist
Step One: Log on
Go to the NEPTUNE Canada Web site (www.neptunecanada.ca) and create an account. You will need a valid e-mail address to register.

Once you have registered, go to the home page and click on DATA EXPLORER. Once you get to this page, you will need to register again since this is a separate application. Use the same username and password.

Step Two: Play Ocean Scientist
Once you are logged onto NEPTUNE's Ocean 2.0 program, you'll see a list of instrument headings and the DATA SEARCH instructions. Review the data search instructions and then start playing with the data.

Here's an example:

1. Go to the TEMPERATURE SENSOR option and click on the A.G.O. TEMPERATURE PROBES. A screen will pop up that shows you an illustration of the probe and a map showing where the probes are deployed. Click on the picture and the map for a closer look. Make note of where the probes are deployed.

2. Next click on MORE INFO. Work your way through the tabs and make special note of the NAMEPLATE and HISTORY information. The NAMEPLATE will tell you what the probe is measuring. Keep in mind that a lot of the information will not mean much to you since you are not an actual ocean scientist—but it is fun to look at nonetheless.

3. Now it's time to play with the NEPTUNE instruments.

   a) You'll see a START DATE and END DATE option. Click on the calendars and pick a one-week period to study.

   b) Next click on ***any two temperature probes*** (for example, 6957-T1, 6958-T2) in the TIME SERIES SCALAR PLOT column. These reports generate relatively quickly, and that's why we are selecting them.

   c) Next, click on the GENERATE RESULTS button. Either download the results onto your computer or click on the document and take a look at what you created. Once again, the data aren't going to mean much to you unless you have a background in ocean science, but at the very least you are getting an idea of how ocean scientists gather their information.

You will also get an idea of how cold or warm the water is based on your knowledge of temperatures.

Feel free to keep playing with the data and the NEPTUNE instruments.

Final Task

When you are finished exploring, write a 150–300 word reflection of what you discovered when you visited the NEPTUNE Canada Web site and played the role of ocean scientist. Be sure to comment on what you found interesting and surprising.

Activity 2: NEPTUNE Canada Scavenger Hunt

Step one: Visit NEPTUNE Canada

Go to the NEPTUNE Canada Web site (www.neptunecanada.ca).

Step Two: Find the Info

Navigate the site and find the following information:

1. NEPTUNE is an acronym for . . .
2. NEPTUNE's slogan is . . .
3. Name five (5) things that NEPTUNE studies.
4. NEPTUNE is located on which tectonic plate?
5. The five NEPTUNE node locations are . . .
6. The deepest NEPTUNE node is located how many metres below the ocean surface?
7. NEPTUNE's sister project is called . . .
8. NEPTUNE runs under the umbrella of which organization?
9. The university that runs NEPTUNE is . . .
10. NEPTUNE's shore station is located in which city?
11. Name five (5) types of instruments that NEPTUNE uses.
12. DMAS stands for . . .

Final Task

Use the information you gathered to write a 150–300 word news report on how NEPTUNE Canada is transforming ocean science.