

TEACHING KIT

CANADA'S FORESTS

BIODIVERSITY IN A CHANGING WORLD



Volume 9: Biodiversity

Forest Capital of Canada – Celebrating Forest Communities

Established in 1979, the Forest Capital of Canada program highlights the valuable role forests play in the socioeconomic and environmental health of our communities – past, present and future.

Each year the CFA designates a community or region to host a celebration of its forest resources. Traditionally, provincial/territorial forestry associations or other forest agencies invite and relay proposals from communities or regions in their province/territory that demonstrate the capacity to mount a successful 12 to 24-month celebration. Interested communities may also submit proposals directly to the CFA.

National Forest Week

National Forest Week is sponsored across Canada by the CFA and regionally by various provincial/territorial forestry associations, corporations, agencies and individuals.

Established circa 1920 as Forest Fire Prevention Week, the intention was to encourage greater public awareness towards Canada's forests. At the time, there was no apparent shortage of trees for industrial expansion – the greatest threat came from forest fires, due mainly to human causes.

Since then, National Forest Week (as it was renamed in 1967) has evolved to encompass the many and varied human and environmental aspects of Canada's forest resources.

Although special activities are promoted across Canada, National Forest Week remains first and foremost a challenge to individual Canadians to learn more about their forest heritage and support greater recognition of this valuable resource.

National Forest Week is observed annually during the last full week of September, Sunday through Saturday.

How to Participate

- Arrange a tree planting activity at your school; contact: www.treecanada.ca
- Take a walk in a forested area near the school; learn about a forest, close up!
- Identify all the things in your classroom that come from the forest.
- Learn about forest related organizations that demonstrate excellence in sustainable forest land management.
- Have students adopt a tree: care for a newly planted or a neglected tree, and learn about the species.
- Contact your provincial/territorial forestry association for more teaching activities and ideas.

The Forest Capital of Canada 2008 and 2009 Norfolk County, Ontario



St. Williams Forestry Station Centennial Celebration

The Long Point Region Conservation Authority is instrumental in designating significant portions of the landscape as Natural Heritage Woodlands. The Backus Heritage Conservation Area is recognized as a National Historic Site based on the Backus mill dating back to 1798. On the manufacturing side, Townsend Lumber of Courtland is the largest sawmill in Southern Ontario, producing and exporting a wide variety of premium Norfolk County hardwood products.

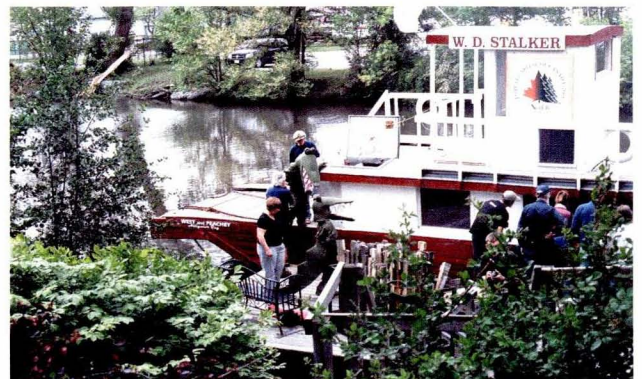
Norfolk County has the largest woodlot owners association in the Province with more than 300 members. Woodlots on average contain 25 or more different tree species. In addition to hundreds of species of shrubs and herbaceous plants, Norfolk County is also home to the greatest number that are rare or endangered in Canada. It is fitting to celebrate Norfolk County's forest biodiversity with the theme of this year's National Forest Week: "Canada's Forests – Biodiversity in a Changing World".

Alligator Steam Warping Tugboat

Norfolk County hugs Lake Erie along Canada's "southern border" and is in the heart of the Carolinian Forest. We might think of this part of our country as being mainly agricultural, or even a manufacturing region. In fact, forests occupy more than 25 percent of the landscape and the resource continues to grow in size and importance, both environmentally and economically.

Norfolk County was designated as the 2008-2009 Forest Capital of Canada (FCC) by the Canadian Forestry Association to help observe the 100th anniversary of the St. Williams Forestry Station—the genesis in 1908 of the scientific approach to tree seedling production and Ontario's forest renewal programs. The two-year long FCC campaign also recognizes the early contribution to the forest industry of the iconic Alligator Steam Warping Tug Boat, built in Simcoe from 1889 until the 1930s.

In today's terms, Norfolk County can boast a robust approach to forestry and the environment. At Port Rowan, the Long Point Bird Observatory under the aegis of Bird Studies Canada monitors and conducts research into local breeding and migratory bird popu-



Contents

Canada's Forests Teaching Kit, Volume 9 explores the importance of biodiversity in Canada's forest and wetland areas, the critical significance of Canada's habitat to all living things, and the vital connections between biodiversity, natural resources and our modern lifestyles.

Canada's Forests: Biodiversity in a Changing World focuses attention on the myriad of species that inhabit Canada's forests in terms of their inherent natural value and their relation to people's health, income, traditions, cultures, recreational pursuits and lifestyle enjoyment.

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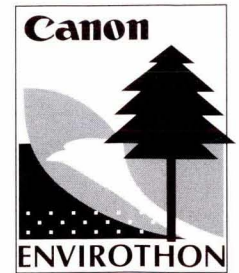
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The lessons contained in this teaching kit are designed to provide young Canadians with a wide variety of learning opportunities in several subject areas. They are suitable for many age levels and every level of ability, from special needs to gifted to ESL (English as a second language). Also contained in this kit, you will find Natural Resources Canada's National Forest Week poster *Canada's Natural Resources, Biodiversity in a Changing World*.

The Canadian Forestry Association, now 108 years old, is dedicated to the wise use and conservation of Canada's forest, water and wildlife resources through enhanced public awareness and education. The Canada's Forests teaching kit series provides educators with the tools to help young people better understand the importance of our forests and the need for them to be managed in a sustainable manner.

In the creation of each teaching kit, every effort is made to provide a balanced perspective among the interests and activities of forest professionals, biologists, landowners, Aboriginal people, rural and urban citizens, various industries and environmental groups in order to meet a common goal: judicious conservation (protection and wise use) of Canada's forest, water and wildlife resources. The Canadian Forestry Association appreciates the thoughtful, dedicated and often-unrecognized ground level management of our forests conducted by professional foresters, biologists, technicians, technologists and everyday people.



Envirothon in Canada

The History of Envirothon in Canada

Many exciting and outstanding environmental education programs and facilities for youth are operating across Canada as a public service. Some of these programs are delivered by companies, others by foundations, and many by environmental non-profit organizations.

Envirothon is one such program and might best be described as the Environmental Academic Olympics for secondary school students.

Embracing Envirothon provides the opportunity for partnerships among like-minded organizations and sponsors that provides mutually beneficial outcomes for the participating organizations, as well as for the youth who are involved in the program.

From its start in Pennsylvania in the late 1970s it has grown into an exciting initiative across the United States and Canada. It culminates annually in a week-long North America-wide competition for teams of five students that have won their respective state, provincial or territorial competitions. This annual competition is known as Canon Envirothon and involves in excess of 50 championship teams.

Nova Scotia, under the auspices of the Nova Scotia Forestry Association, rightfully claims being the first jurisdiction to deliver the program in Canada, and in the past few years they have excelled with First Nations outreach. In 2000 Nova Scotia hosted the first Canon Envirothon competition to be held in Canada. Ontario, under the Ontario Forestry Association, runs the largest program in Canada with well over 100 high school teams competing for the Provincial Championship. Saskatchewan is one

The Challenge of Envirothon in Canada

Envirothon is a hands-on environmental education program for secondary school students. It is an opportunity for young Canadians to take what they've learned in the classroom out there—under the sky, in the forest, at the lake—and with like-minded peers use their skills, senses and creativity, while interacting directly with nature.

Envirothon promotes critical thinking, team building, participatory and hands-on learning, and embraces current environmental issues related to aquatic ecology, forests, soils and wildlife, plus a fifth topic, which changes annually.

of the newest Canadian jurisdictions to climb on board under the wing of Partners for the Saskatchewan River Basin (with support from the Saskatchewan Forestry Association). With only two years of the program under its belt, they are already experiencing growing pains because of the rapid interest and uptake. Quebec, Northwest Territories and Nunavut are yet to become involved in the program.

Although Nova Scotia, Ontario, Manitoba, New Brunswick and Saskatchewan are running highly successful programs, the challenge for Envirothon in Canada is to build strong and successful programs across the entire country so that Envirothon becomes a familiar phrase in Canada.

In many jurisdictions the Envirothon approach has expanded into middle schools to provide an earlier, and even broader approach, to environmental learning, which includes outreach to First Nations and remote northern communities.

This CFA Teaching Kit is geared to providing resources not only useful for those involved in Envirothon, but to all Environmental Education initiatives and classroom activities targeting a broad range of age groups.

Jim Potton
Vice Chair, Canon Envirothon

Jim Potton is also the Co-Chair of the Manitoba Envirothon and a long standing Executive Board Member of the Manitoba Forestry Association.

Envirothon Program

- promotes environmental education-based on teamwork, collaboration and competition
- school-based learning guided by a set of expectations and key references
- combines in-class curriculum and hands-on field experiences

Benefits

- secondary students explore environmental issues with peers, natural resource professionals and community leaders
- students gain valuable knowledge and training in ecology and natural resource management principles and practices
- students get excited about pursuing careers in environmental studies, environmental law, natural sciences and natural resource management
- communities benefit from the involvement of young people in local environmental issues

As part of an Envirothon team, young Canadians participate in fun field-testing competitions, take part in outdoor workshops, find solutions to environmental problems and improve the environment. Envirothon enriches competitors' lives by allowing them to explore the outdoors and test how 'green' they are, ensuring they understand nature's interrelationships, giving them hands-on experience with field testing equipment, and exposing them to education and career opportunities in the field of natural resources.

Winning teams at the provincial level compete at the Canon Envirothon, North America's largest secondary school environmental education competition. Reaching more than 500 000 students across North America annually, Envirothon succeeds in its mission to develop knowledgeable, skilled and dedicated citizens who are willing and prepared to work towards achieving a balance between quality of life and quality of the environment.

However, Envirothon is more than a competition that tests a team's environmental knowledge. A lot of what's fun and interesting about joining an Envirothon team is the camaraderie and friendship that blossoms while learning, exploring and preparing for the big day (Envirothon competition).

The CFA is proud to be the national agency for Envirothon in Canada, and to be working in partnership with conservation groups, forestry associations, educators and natural resource agencies to organize and conduct competitions at the local, regional and provincial levels.

Biodiversity in a Changing World

One exciting way students can learn about biodiversity during the 2008/2009 school-year is by participating in Envirothon. The topic of the Envirothon competition in 2009 is 'Biodiversity in a Changing World.' Registered participants will explore many aspects of this topic, from how biodiversity is defined and how it affects soils, forestry, wildlife and aquatics to the benefits that biodiversity provides and how natural and human-caused events affect biodiversity.

The study of biodiversity is an important part of many exciting careers in forestry, environmental science and management of natural resources. Information on these careers can be found at sites such as www.jobfutures.ca (Government of Canada) and at www.canadianforestry.com (select *Forest Education*, then *The Profession*).

Canadian Envirothon Contacts

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Using This Teaching Kit

This teaching kit is the ninth in the Canada's Forests series, and is designed for nationwide use by classroom educators and youth leaders. It is available in English and French, in print and on-line as a fully word-searchable PDF file.

The CFA is the national organization that represents Envirothon in Canada (see page 2). The CFA works in cooperation with forestry associations, conservation organizations, educators and others that manage Envirothon activities and competitions at the local, regional and provincial/territorial levels.

Biodiversity is the theme of Envirothon in 2009. Through this teaching kit, the CFA hopes to raise awareness of Envirothon in Canada and to encourage increased participation by students in every province and territory.

The activities in this volume are mostly targeted to students in senior elementary and secondary school grades, however there are several lessons that also apply to elementary school students in intermediate grades. Please note that some lessons can be used with more than one age group. The background information provided at the beginning of each lesson relates to the specific topics addressed within them. Supplementary high quality print, video and web-based resources that would augment lessons and activities are also included.

Target Audience

Each province and territory has different specifications for grade levels and sometimes different terminology to describe them (e.g., primary, junior and intermediate versus Levels I, II and III). We have therefore indicated to which broad age range each lesson would apply, in addition to the general topics they address (such as climate change).

Instruction Key



group discussion



Hands-on



Presentation/performance



Writing/recording



Research-based



While the CFA grants permission for the photocopying of this entire publication, the pages marked with the photocopier icon are designed specifically as student worksheets.

Curriculum Links

The lessons are designed to meet the curriculum of many different grades and subjects taught across Canada, such as Science, Geography, Math, Civics and World Issues. Therefore, we have included one broad Expectation/Outcome for each lesson, which describes what students will be demonstrating during the activity. These can easily be adjusted to meet specific curriculum descriptions.

Flexible and Easy-To-Use Activities

To stimulate teacher and student creativity and engagement in the learning process, we have included 'hooks' (attention-grabbing lesson openers) and 'extensions' (further activity ideas).

Accessing Canada's Forests Teaching Kits On-line

You will find volumes 1 to 9 of the Canada's Forests teaching kits on the CFA website www.canadianforestry.com. The kits cover a wide variety of forest-related topics from forest heritage and climate change, to species at risk and water/wetlands. Individual lessons or entire kits can be downloaded and printed at your convenience.

Contact Us

To order additional kits, provide feedback or enquire about how to fit lessons into your curriculum needs, please contact the Canadian Forestry Association by calling 1-866-441-4006 or send an email to cfa@canadianforestry.com. We look forward to hearing from you.

Biodiversity: Defining and Measuring

Biodiversity is defined in many ways but has at its root in the word ‘diverse’, which means ‘consisting of different things’ or ‘differing in some way from one another’. Within the context of this kit, biodiversity is simply the variety of life on Earth from invisible microbes to giant whales.

There are several levels of biodiversity, or ways by which it is measured, that include genetic, species, and ecosystem diversity.

Genetic diversity refers to the level of genetic variability that exists within each species. Those with greater genetic variation among individuals may be able to withstand changes or threats in the environment (natural and human-caused)—such as climate change, disease and natural disasters—better than species possessing less genetic variation.

Species diversity is a measure of how many species exist within an area. The more species that exist in an area, the more biodiverse we consider it to be. Losing one or more species can significantly lower a region’s overall biodiversity. According to Hinterland Who’s Who (HWW), a collaboration between the Canadian Wildlife Service and the Canadian Wildlife Federation, remarkably little is known about the Earth’s overall species diversity. This is partly because “most species—and many ecosystems—are a lot smaller than humans” and therefore difficult or inconvenient to study. Wide-scale studies of global species diversity have not yet been completed in many areas. While the estimate of the total number of species on Earth is at least 12 million, it could be as high as 118 million, but only about 1.6 million have been identified so far.

HWW states that the generally accepted number of species in Canada is 71 000 but the actual number may be double that. Only by continuing to study Canada’s ecosystems will we approach the true answer.

Canada has lost some species through extirpation or extinction, but “Because most Canadian species are widely distributed, we have lost relatively few...compared with tropical regions. Since about 1750, Canada has lost the Great Auk, Passenger Pigeon, Labrador Duck, Dawson caribou, sea mink, Banff longnose dace, deepwater cisco, longjaw cisco, and blue walleye” (HWW).

There are currently 556 species at risk in Canada, according to the scientific Committee on the Status of Endangered Wildlife in Canada. The most recent endangered animal species include the wood turtle, the olive-sided flycatcher and Canada’s only freshwater seal, the Harbour Seal *Lac des Loups Marins* subspecies.

“Currently, one in eight of the world’s birds are threatened with global extinction, and of the 428 bird species that regularly breed in Canada, 60 are classified as at risk. One in eight of the world’s plant species are threatened with extinction, and 23 percent of the world’s mammals are at risk” (Nature Canada).

Ecosystem diversity is a measure of how many types of ecosystems exist within a given geographical space. These may include riparian, coastal forest, boreal bog, Arctic tundra, as well as many others.

In terms of where biodiversity is found, the greatest amount in a global sense occurs near the equator and in tropical rainforests, most likely because climatic conditions there are milder and have favoured a large amount of evolutionary diversification compared to areas of the globe where fluctuation of seasonal temperatures is more extreme.

Biodiversity in Canada is therefore greatest in the lower latitudes, and in riparian and protected areas of intact forests and wetlands. Canada’s boreal forest is used by a great diversity of migratory birds as an annual nesting ground.

The biodiversity within Earth’s oceans, in different geographic areas and at various benthic levels, is still largely unknown and in need of extensive further study.

Why is Biodiversity Important?

It is critical to conserve biodiversity because of the many benefits it provides. A wide spectrum of species contribute toward **life-sustaining planetary processes**, such as exchanging oxygen for carbon dioxide in the air, filtering and purifying water, breaking down wastes and toxins, pollinating plants and creating productive soil. In addition, the world's diverse plants and trees provide us with **important medicines**, and there may be many more yet to be discovered.

On the website of the Redpath Museum of McGill University it states that "70 percent of pharmaceuticals now being used come from or are derived from natural products. Three substances that have been produced from the barks of tree species include: aspirin, from willow trees; quinine, which helps prevent malaria and is found in the bark of the quina tree; and taxol, a cancer-fighting drug derived from the bark of the Pacific yew tree."

More than 3000 antibiotics, including penicillin and tetracycline, were originally derived from the world's diverse population of microorganisms. In addition, "doctors use hirudin, a substance discovered in the saliva of leeches, to dissolve dangerous blood clots. Canada's 138 native tree species have at least 40 recorded pharmaceutical or medical uses. In addition they are currently used for production of rayon, cellophane, methyl hydrates, glue, and turpentine" (HWW).

Protecting Earth's plant diversity is also important to **combat global climate change**: "Maintaining the full range of the planet's biodiversity means maintaining the flexibility to respond to unforeseen environmental conditions. For example, many of Canada's native plant species must endure both hot summers and cold winters. These plants may therefore have genetic material that could be used to develop agricultural crops that can withstand greater than normal temperature ranges" (HWW). Many foods eaten

worldwide also come directly from nature's diversity, including wild cranberries, tree syrups, mushrooms, teas, fish, many types of meat, berries and many others.

We also rely on nature's diversity for many decorative plants and trees, and for ceremonial and cultural items such as feathers and sweetgrass. In addition, according to HWW "most Canadians develop a **great aesthetic appreciation of nature as it exists** and do not want to be deprived of it. Canadians of many backgrounds place **spiritual value** on animals, plants, and ecosystems. Canadians do not wish to leave a biologically impoverished Earth to their children and grandchildren. Because natural ecosystems have stood the test of time, we can use them as **models of sustainability**. As long as we conserve them, we can return to them to learn how to refine or reengineer the croplands, managed forests, and industrial fishing areas that we have created, or to find the genes, species, or micro-ecosystems that were left out of the human-designed system because we were ignorant of their importance. Preserving biodiversity will also maintain **our potential as a country** to be creative and productive and will provide opportunities for discovering and developing new foods, medicines, and industrial products." (HWW)

Threats to Biodiversity

There are unfortunately many factors that negatively affect biodiversity. Biodiversity requires habitat, which includes biotic (living) components such as food, mates and the trees and plants that can provide safe areas for evading predators or for nesting grounds. Forest and wetland habitats also provide abiotic (non-living components) such as suitable conditions and materials for reproduction (e.g., sandy soil for turtles to lay eggs), hibernation (e.g., pond bottoms for frogs), and shelter (rocks, water).

When we lose habitat, or the quality of a given habitat degrades, species are at risk of extirpation (extinction in a given area) or complete extinction. Nature Canada is an environmental non-government organization (ENGO) and their website states: "Most scientists agree that **human activity** is causing rapid deterioration in biodiversity. The **loss of critical wildlife habitat**, from expanding human settlements...mining, agriculture and pollution are destroying ecosystems, upsetting nature's balance and driving many species to extinction. For roughly 75 percent of endangered species, the loss and degradation of their habitat is the central cause of their declining numbers."

Invasive species are a major contributing factor to the decline of global biodiversity, since many have no natural predators in their new range, and can adversely affect native plants and animals in a wide variety of ways.

In Canada, invasive alien species include at least 27% of all vascular plants, 181 insects, 24 birds, 26 mammals, 2 reptiles, 4 amphibians, several fungi and molluscs, and 55 freshwater fish. Dutch elm disease, leafy spurge, Japanese knotweed, purple loosestrife, green crab, spiny water flea, gypsy moth, common carp, rainbow trout, starlings, European boar, sea lamprey, Asian longhorned beetle, and emerald ash borer are some of the better-known examples (Canadian Food Inspection Agency). "Of all documented extinctions since 1600, introduced species appear to have played a role in at least half." (University of Michigan)

Illegal poaching, over-hunting and over-fishing (versus sustainable harvest) as well as **pollution of various types** also threaten biodiversity.

Climate Change: A Major Threat to Biodiversity

Climate change is among the most serious environmental challenges facing Earth's biodiversity.

“The problem isn't just that our climate is changing, but also the rate of change. Since the Industrial Revolution in the 1800s, global temperatures have warmed faster than at any other time in the previous 1000 years. As a result, the places that wildlife rely on for survival—habitats—are changing, too... Not all animals are able to adapt quickly... Wildlife populations are linked together in a food web. When smaller animals fail to thrive, there is less food available for the larger animals. Through the web of life, factors that damage one population will eventually have an impact on other populations—even humans. Over the next 100 years, climate change is expected to cause the mean annual temperature in Canada to rise between 5 and 10°C... In Canada, climate change is also likely to bring an increase in the number of days of extreme heat, and extreme weather events such as droughts and heavy rainstorms. Other projected effects include coastline flooding and increased incidence of forest fires.”
(Canadian Wildlife Service, Ontario)

While “many species are expected to move northward” and “trees and other vegetation will colonize new areas, where the climatic conditions are right for their growth needs” (Canadian Wildlife Service, Ontario), “many scientists fear that by the end of next century, perhaps 25 percent of existing species (in Canada and around the globe) will be lost due to such effects of global warming.” (The University of Michigan)

The polar bear is a species often noted as already being adversely affected by global climate change, as well as by pollution and oil and gas development. “Global warming is melting the polar ice caps, robbing polar bears of the ice floes they need to hunt prey.

As the annual sea ice melts, polar bears are forced ashore to spend their summers fasting. If the Arctic ice cap continues to melt earlier and form later, then without food polar bears will become too thin to reproduce and they will become extinct by the end of this century.” (Nature Canada)

Conservation of Biodiversity

All Canadians are the everyday end-users of a large variety of forest-related products. These include wood products such as paper, pencils, furniture, building materials and much more that come from a wide variety of tree species. In both their everyday lives and for special occasions, Canadians use and enjoy many non-timber forest products, such as medicinal plant products and foods from a diverse assortment of forest plant and animal species. This encompasses everything from tree syrups, wild mushrooms, red clover tea and decorative plants to ceremonial feathers, seaweed and fur or meat from trapping, hunting and fishing.

Canadians also use products derived from other forest-based resources, including oil and gas, metals and minerals, and hydro-electricity. Extraction, processing and transportation of these natural resources and production of the associated products can have a significant impact on biodiversity within a given area. However, the continued use and enjoyment of products derived from these resources depends on sustaining biodiversity in natural areas.

A balance must be struck between the interests of many: conservation groups, Aboriginal people, communities whose livelihoods rely on extraction and processing of natural resources, industry stakeholders in the mining, gas and oil sectors, the tourism and forestry industries, those who rely on the products made from forest resources (all Canadians), and the many species (besides humans) for which our forests and wetlands are home. Protecting biodiversity does not mean that we have to stop fishing, farming, logging, manufacturing, processing and building, but it does mean we need to set limits on these activities or perform them in ways that are sustainable and compatible with nature.

At the same time, we must remember that enjoyment of our modern lifestyle is possible because of the people who extract, gather, transport, process and market forest and other natural resources and the associated products. The protection and wise use of our forest resources are inextricably linked to our interdependence on each other, and on those resources.

There are many things we can do to help mitigate the effects of global climate change, in order to reverse the negative impact on biodiversity worldwide. These include simple lifestyle changes like cutting down on energy usage (turning off lights, hanging out laundry to dry, car pooling, etc.), re-using items and packaging, planting trees, becoming actively involved in conservation groups and their associated activities, to name but a few.

To meet Canada's obligations under the Convention on Biological Diversity, the Canadian Biodiversity Strategy was developed in 1995 by federal, provincial and territorial bodies. Each province and territory is responsible for biodiversity conservation within its own jurisdiction. For more information, visit www.cbin.ec.gc.ca

Teaching Resources Relating to Biodiversity

Websites

Canadian Biodiversity <http://canadianbiodiversity.mcgill.ca>

Created by the Redpath Museum at McGill University, this site provides extensive information about biodiversity in Canada, ideal for senior student research projects and teacher background material.

Canadian Biodiversity Information Network – Environment Canada www.cbin.ec.gc.ca

Under *Education and Awareness*, choose *Educators*, *Kids Zone*, *International Biodiversity Day* (for activity ideas and more). This site links to the Canadian Biodiversity Convention Office where you will find information on how Canada is meeting its obligations under the Convention on Biological Diversity.

Environment Canada www.ec.gc.ca

Click on *Nature*, then select *Canadian Wildlife Service* for national wildlife matters, such as habitat protection, species at risk and management of migratory birds. Select *Invasive Species in Canada* for information on both alien and invasive alien species.

Canadian Biodiversity Institute www.schoolgrounds.ca

This organization helps schools “transform their grounds into stimulating, biologically diverse outdoor classrooms” by “developing demonstration sites, providing comprehensive how-to materials, offering expert advice” and more.

The Living by Water Project; several partners, including Nature Canada www.livingbywater.ca

Under *Freshwater*, students can view illustrations on how to transform a typical waterfront property so that it supports greater biodiversity and is more environmentally-friendly (*Give your Shoreline a Makeover*). Under *Co-Existing with Wildlife*, there are many other tips for increasing biodiversity on waterfront properties.

Canon Envirothon www.envirothon.org

Envirothon is an exciting annual competition among state/provincial/territorial teams of secondary school students in grades 9 to 12. Teams demonstrate knowledge of environmental science and natural resource management through hands-on problem-solving activities. There are four testing categories (soils/land use, aquatic ecology, forestry, and wildlife) in addition to a current environmental issue, which in 2009 is biodiversity. Click on *Local Programs* for links to the Envirothon sites (some bilingual).

The American Society for Microbiology www.microbeworld.org

To find out more about the vast variety of environments and locations where microbes are found, send your students to *Meet the Microbes*, then *Where They Live*. Under *Resources*, select *Educators* for microbe images, links and *MicrobeWorld Activities*, a collection of 17 hands-on activities designed to help secondary students learn about the microbial world in a fun, active way.

Association of Canadian Educational Resources www.acer-acre.org

This multi-partner organization promotes several environmental monitoring programs in which schools can get involved, under topics such as *Schoolyard Monitoring* and *Climate Change*.

National Geographic www.nationalgeographic.com

Choose *Educators*, then *Classroom Resources*, then *Map Machine*. Under *New Views of the World*, choose *Our Relationship with Nature Trends* then *Ecosystems and Conservation* to investigate worldwide habitat conservation and species data; choose *The Human Condition Trends* then *Human Impact* and *Ecological Footprint* to see our impact on the planet and its biodiversity. Under *Map Machine* and *Featured Places*, choose *Interactive Climate Change Map* to investigate the myriad ways global warming is beginning to impact the world and its biodiversity.

Canadian Species-At-Risk Interactive Activity, Canadian Wildlife Service (Ontario)

www.on.ec.gc.ca/wildlife/sarwheel/ec-sar-flash/index.html

Send students ages 8-14 to this site for a quiz and other interactive picture/text activities on species-at-risk, importance of habitat, the Bald Eagle's comeback and more.

Multiple Canadian partners www.incredibleworld.ca

Students aged 8-16 will enjoy and learn from six short on-line video clips that demonstrate the story of two young people learning about wetland biodiversity and how to conserve it. The site includes galleries, related games and a teacher's guide with lesson plans relating to the story.

World Wildlife Fund www.biodiversity911.org

Includes interactive activities, an on-line exhibit and lots of information for students and teachers.

Ducks Unlimited Education Site www.education.ducks.ca

View many wetland and environmental education resources and programs. Teens can apply for the Great Greenwing Adventure, in which they can be selected and sponsored by DUC to spend a week at Oak Hammock Marsh, MB where they will engage in exciting activities like bird banding, radio telemetry, wilderness survival, camping, canoeing and more.

Hinterland Who's Who – Canadian Wildlife Service and Canadian Wildlife Federation www.hww.ca

This site provides fact sheets on many Canadian species, ideas for conserving wildlife, biodiversity and more.

Ecological Monitoring and Assessment Network www.eman-rese.ca

Environment Canada's EMAN NatureWatch is a blanket organization for citizen-based groups such as Icewatch, Frogwatch, Plantwatch and even Wormwatch. You can use their *Educator Resources* and find out how your students can contribute local-level indicator information, do research and take on-line quizzes.

Global Forest Watch www.globalforestwatch.org

This organization provides reports on various aspects of global biodiversity. Select Interactive Maps to see a given country's protected areas, intact forests and more.

The Atlas of Canada, Natural Resources Canada <http://atlas.gc.ca/site/index.html>

This site provides lesson plans, facts and maps on such topics as climate change, the environment and more.

Green Street www.green-street.ca

This organization connects teachers with accessible, curriculum-linked and affordable programs that are delivered in-school by credible organizations.

Canadian Model Forest Network www.modelforest.net

A program initiated by Natural Resources Canada, this site has information on conservation projects, international model forest partnerships, Aboriginal initiatives, and local level indicators (LLI), which are the heart of the model forests' emphasis on sustainable biodiversity levels, forestry practices and more.

Natural Resources Canada, Canadian Forest Service <http://ecosys.cfl.scf.mcan.gc.ca/accueil-home-eng.asp>

Send students to research the Forest Ecosystems of Canada, some provincial eco-region descriptions. There are also interactive maps and links to many more Canadian forest information sites.

Visit the following sites for many ideas on how your class, school, students and their families can become involved in biodiversity conservation:

Nature Canada: www.naturecanada.ca

Sierra Club of Canada: www.sierraclub.ca

Greenpeace Canada www.greenpeace.ca

Canadian Boreal Initiative: www.borealcanada.ca

Canadian Wildlife Service, Ecological Gifts Program: www.cws-scf.ec.gc.ca/egp-pde/default.asp?lang=en&n=0267F2D5-1

The Nature Conservancy: www.natureconservancy.ca

World Wildlife Fund: www.wwfcanada.org

Canadian Wildlife Federation: www.cwf-fcf.org

The Canadian Parks and Wilderness Society: www.cpaws.ca

Visual

Intimate Strangers: Unseen Life on Earth PBS; four-part series (1999)

A prime-time television introduction to the extremely diverse microbial world. Available on video to educators for \$99 US plus shipping through the Annenberg Foundation: 1-800-LEARNER.

The Hall of Biodiversity (on-line exhibit) African Museum of Natural History www.amnh.org/exhibitions/permanent/biodiversity/

Students will enjoy the Spectrum of Life Exhibit (all life on Earth) and more.

Many biodiversity videos available from Environmental Media (based in South Carolina)

www.envmedia.com/catalog/products/biodiversity.htm

Many free insect posters available from the Canadian Forest Service Bookstore

http://bookstore.cfs.nrcan.gc.ca/home_e.php?test=1 French http://bookstore.cfs.nrcan.gc.ca/home_f.php?test=1

Print

Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity

1995, Environment Canada www.eman-rese.ca/eman/reports/publications/rt_biostrat/intro.html

Canada's Forest Biodiversity: A decade of progress in sustainable management, 2002.

Natural Resources Canada, Canadian Forest Service http://bookstore.cfs.nrcan.gc.ca/detail_e.php?recid=46648

Bionic Bob to the Rescue

BC Ministry of Forests www.for.gov.bc.ca/hfp/biocontrol/downloads/BionicBob.pdf

This 20-page colouring/activity book focuses on invasive plants (download and print).

Alien Invaders

Jane Drake and Ann Love, Tundra Books (2008) ISBN 0887767982

For readers aged 7-9, 56 pages, illustrated. From the Publisher: "From killer toads, feral felines, and brown tree snakes to multiple invaders in Lake Victoria and the Great Lakes, Alien Invaders focuses on wave after wave of invaders that affect our ecosystems and the side-effects of climate change and modern global travel on...endangered species and biodiversity."

The following reviews were provided by BC Southern Interior Forest Educators (www.learnforestry.com):

I Took a Walk Henry Cole (*Greenwillow Books*) ISBN 0-688-15115-9

Children 5-8 will enjoy hunting for the animals found in the bushes, trees and streams; a good introduction to looking carefully at your environment.

A Rain Forest Tree Lorien Kite (*Crabtree Publishing Company*) ISBN 0-7787-0146-8

This book presents plants and animals, such as sloths, monkeys, parrots, tree frogs, and orchids living together in the same South American rain forest tree (for children 8-10).

In the Woods (See, Make and Do) Pamela Hickman (*Formac Publishing*) ISBN 0-88780-412-8

An excellent introduction to forest ecology: nature study activities, information on woodland animals, craft ideas using forest materials, plus safety and conservation tips for hiking in the woods.

There's Dirt in the Forest Kip Anastasiou (*Pacific Educational Press*) ISBN 1-8957-6642-7

This is a great resource book about soil and the forest for children 9-12; includes experiments.

Woodswalk Henry Art and Michael Robbins (*Storey Books*) ISBN 1-58017-452-3

The wonders of the forests revealed, from east to west, spring to winter, and all sorts of details on what you will see, hear and smell when you are exploring the woods. Filled with photographs, drawings and lots of forest facts for upper primary/intermediate students.

Eye Know Tree Penelope Arlon (*Dorling Kindersley*) ISBN 0-7566-1773-1

A new educational book to help middle elementary students discover new facts and learn about the wonders of the forest, how trees grow and the wood products that we use. This book has all sorts of lift-up flaps and fold-out pages with interesting information and beautiful photographs of the forest's living things.

A Log's Life Wendy Pfeffer (*Aladdin Paperbacks*) ISBN 987-104169-3843-7

The life cycle of a tree is portrayed for primary children: a tree becomes a fallen log, accompanied by three-dimensional paper sculptures showcasing the forest ecosystem. Birds, animals and all sorts of insects use the decaying log as it slowly decomposes to become rich, black earth.



Lesson One

Biodiversity and Me

Age range: 14-16

Time: 90 minutes

Subjects: Science, Social Studies

Topics: Biodiversity, Wildlife, Values

Resources: Class handout: *Biodiversity and Me*, scissors, small boxes (such as shoe boxes), objects as described below, glue

Learning Outcome

Students will understand the threats facing biodiversity and the benefits provided by biodiversity by categorizing related phrases and analyzing objects as they relate to biodiversity.

Hook: Objects as Symbols for Values

Explain to students that there are many physical objects that hold meaning for us in terms of our values (what we consider important). Hold up several of the following items and have the class brainstorm the values and connections they could represent, while a student records on the chalkboard: wedding ring (commitment, fidelity), baby shoes (love, family), key (a special place, limited access), dried or fresh flower (romance, someone special), picture of a mountain (achievement, goal), picture of a road (some type of journey), picture of a diamond (wealth, status), etc. Have students think of a few other objects and what values they represent.

Procedure

1 Provide small groups or pairs of students with boxes and a copy of the handout *Biodiversity and Me*. Students are to cut out phrases and sort them into two categories: 1) Threats to biodiversity (glued on the outside of the box) and 2) Benefits of biodiversity (glued on the inside of the box). One phrase, as indicated, glued on the edge and addresses both categories.

2 Students will then receive an assortment of at least five items (ideas below) to place in their 'Biodiversity Boxes.' Explain that each item is a symbol for different aspects of biodiversity and how it is valued. After they have brainstormed their analysis for each item, they will present this to the class as a story. Get them to 'think outside the box' in developing their story.

Item ideas:

- a gardening tool (biodiversity's support of productive soil).
- an empty ASA bottle (biodiversity as it relates to medicines); ASA (acetylsalicylic acid) —also known as aspirin—is derived from willow tree bark.
- blossoms and/or seeds or pictures of them (relates to Earth's diverse pollinators and seed disseminators—insects, birds, mammals etc.).
- a feather, etc. (some cultures gather objects from diverse natural sources for cultural use: e.g., in ceremonies).
- a picture or product label from an unusual fruit or vegetable, preferably unfamiliar or imported) or related product (diverse food products available to us from around the world).
- an empty packages (attached together) from two or more varieties of rice, apples, or another crop (shows genetic biodiversity within closely related species).
- an air filter mask (exchanging oxygen for carbon dioxide in the air).
- an empty water bottle (diverse organisms filter and purify Earth's water—trees, plants, microbes, invertebrates).
- a picture of an industrial smokestack (diverse microbes and invertebrates break down/trap wastes and toxins).
- a picture of people at a wolf howl (biodiversity supports ecotourism).
- a fishing lure (diverse freshwater and marine species are hunted and fished).
- a wood product, such as a pencil (many different species of tree are used for different wood products).
- a picture and the name of an extinct Canadian species (fragile, inherent natural value of biodiversity) the Great Auk, <http://nature.ca/notebooks/english/greatauk.htm> and the Passenger Pigeon, www.passengerpigeon.org are good recognizable examples. Others include the blue walleye, Labrador Duck and deepwater cisco.
- a package from a wild food product (variety of natural foods, part of some family traditions e.g., maple or birch syrup, honey, mushrooms, tea, meat of seal, caribou, moose, deer).
- a picture of a Bald Eagle (overall inherent value of biodiversity; its comeback in Canada is a good biodiversity success story), www.on.ec.gc.ca/wildlife/sarwheel/ec-sar-flash/eagle.html

✦ Extensions

Students can cut out pictures from old magazines to illustrate the phrases on their boxes as part of step one.

Groups can be rewarded with prizes in different categories for their story (e.g., most creative, most educational, most realistic, most dramatic, etc.).

Have a classroom celebration where students bring in and share foods, teas, salves, ceremonial objects, etc. that come from nature's diversity and relate to their various cultures.

✔ Answers

Topics of handout phrases relating to threats TO biodiversity <i>(to be glued on the outside of the biodiversity boxes):</i>	Topics of handout phrases relating to benefits OF biodiversity <i>(to be glued on the inside of the biodiversity boxes):</i>
Antibiotics, medicines, wood products, decorative and ceremonial items, foods, spiritual value, greater assortment of genetic material to draw on to help breed crops that will survive in conditions created by global warming, life-sustaining planetary processes, better opportunities for Canada	Habitat loss, human activity, illegal poaching, over-hunting, pollution, invasive species, climate change – climate effects, climate change – habitat, polar bear

The phrase to be glued on the edge of the box is the large one, which reads: “Canadians enjoy the use of many products...**A balance must be struck** between our needs and desires and the conservation of habitat and biodiversity.”

Biodiversity and Me



Cut out these phrases to be glued on the 'Biodiversity Boxes' provided. Glue factors that negatively affect biodiversity (threats) on the outside of the box and glue factors that are benefits of biodiversity on the inside of the box.

Note that one of the phrases below should be placed on the edge of the box, as it addresses both categories.

Over 3000 antibiotics used to fight disease are derived from the world's diverse population of micro-organisms.	Many activities, such as hunting, fishing, marketing wild foods and ecotourism provide Canadians with income from biodiversity .
Most scientists agree that human activity is causing loss of biodiversity through loss of critical wildlife habitat and pollution (e.g., expanding human settlement, mining, agriculture, wetland drainage, clearing of native prairie).	Most medicines are derived from Earth's plants, including ASA (aspirin) from willow bark and taxol (fights cancer) from the Pacific yew tree. Hirudin from leech saliva dissolves critical blood clots.
Canada's many tree species provide a wide variety of wood products (e.g., lumber, paper) and lesser known products like rayon, cellophane, methyl hydrates, glue, and turpentine.	Invasive species are a major factor in biodiversity decline, as many of these species have no natural predators in their new homes and can adversely affect native plants and animals (e.g., purple loosestrife).
Illegal poaching threatens the genetic diversity and even the existence of many species (e.g., saguaro cactus, elephants).	We rely on nature's diversity for many decorative plants and trees, and for ceremonial and cultural items such as feathers and sweetgrass.
Pollution threatens biodiversity. Amphibians and reptiles are among the organisms particularly sensitive to many pollutants.	Many foods come from nature's worldwide diversity, including berries, maple syrup, mushrooms, teas, fish, meats, and more.
Many Canadians place spiritual value on living things and the ecosystems in which they live . Many do not want to leave a world lacking in biodiversity for their descendants.	When the climate changes, habitats change too , and not all animals can adapt quickly. Through the web of life, factors that damage one population will eventually impact others.
Over-hunting or over-fishing (versus sustainable practices) has led to the loss of species such as the Great Auk and the Passenger Pigeon.	A myriad of species, including insects and birds help pollinate plants and disseminate seeds in nature and gardens, fields and orchards.
Maintaining biodiversity means a greater assortment of genetic material to draw upon to help breed crops that will survive conditions created by global climate change (e.g., drought, increased temperatures).	Climate change will bring increased temperatures, more days of extreme heat, and extreme weather events such as droughts and heavy rainstorms. This may cause the eventual extinction of many species.
The polar bear is being adversely affected by global climate change (as well as by pollution and oil and gas development). Melting polar ice caps rob polar bears of the ice floes they need to hunt prey, which may ultimately lead to their extinction.	Many species contribute toward life-sustaining planetary processes , such as exchanging oxygen for CO ₂ , filtering and purifying water, breaking down wastes and toxins and creating productive soil.
Preserving biodiversity in Canada means we have better opportunities for developing new foods, medicines, and industrial products.	Canadians enjoy the use of many products from nature's diversity, and many depend directly or indirectly on it for income. Biodiversity, however, is being negatively affected by some human activities (e.g., mining, roads, expanding settlement), which support our modern lifestyles.
When we lose habitat, or the quality of habitat degrades , species are at risk of extirpation (extinct in a given area) or complete extinction.	A balance must be struck between our needs and desires and the conservation of habitat and biodiversity.





Where in the World is Biodiversity?

Age range: 12-14

Time: 60 minutes

Subjects: Science, Geography

Topics: Biodiversity, Climate Change, Threats to Biodiversity

Resources: Class handouts:

Three Canadian Species—Effects of Global Warming and World Map, pencils, coloured pencils

Learning Outcome

Students will first hypothesize about areas where biodiversity is lesser or greater and the predicted effects of climate change on biodiversity, and then discover the answer by using maps.

Hook: How to Hypothesize

Ask students for a definition of 'hypothesis' (to make an educated guess). Have everyone hypothesize about the number of wolverines in Canada. Now, ask the class how they might go about finding the answer (e.g., finding a credible recent book or Internet site, finding an expert, etc.) Share the real estimated number: 15 000-19 000. Students should be familiar with the topic of biodiversity (see background material at the front of this kit). However, **AVOID TELLING THEM** about where biodiversity is greatest (bottom page 3). Tell students that today they are going to hypothesize about where biodiversity is greatest on our planet, and the predicted effects of climate change on some species.

Procedure

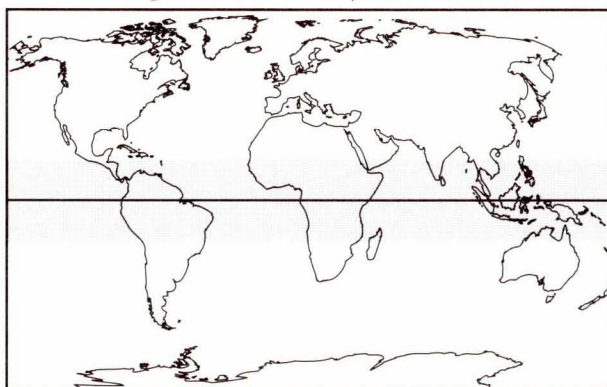
1 Give pairs of students a *World Map* handout. They will hypothesize about where biodiversity is greatest in the world and outline appropriate areas of land in pencil.

2 Show them the answer on the chalkboard or using the answer map as an overhead. Were they close to being correct? Have them add colour. Explain that biodiversity is greatest around the equator because milder climatic conditions there have favoured a large amount of evolutionary diversification compared to areas of the globe where seasonal temperatures fluctuate much more. Biodiversity is somewhat greater below the equator in the southern hemisphere than in the northern because of the Earth's axis in relation to the sun (the southern hemisphere being continuously closer). Biodiversity is greatest in Canada in the lower latitudes and in riparian areas and protected areas of intact forest and wetland; label maps accordingly.

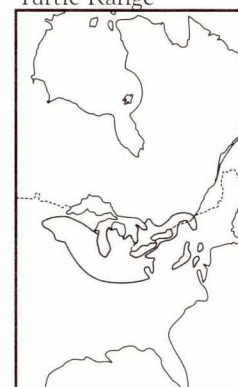
3 Give the students a copy of the handout *Three Canadian Species—Effects of Global Warming*. Discuss the fact that climate change is among the most serious environmental challenges our planet's biodiversity faces today; it is expected to make conditions hotter and drier, result in more extreme weather events and more (see details from *Climate Change* section page 5). Have students predict how global climate change will affect the range of each species by outlining new predicted ranges in pencil. Once they are finished, have them show their maps to a small group or the entire class, explaining their reasoning. Then, show them the answers and discuss. Keep in mind that these answer maps are estimations of how climate change may affect these species in future. It is very difficult to predict how much population numbers may be reduced, how much the range of a species may shrink (some of the southern part of the range being eliminated), and when this may occur. It may even cause complete extinction of some species.

Answers

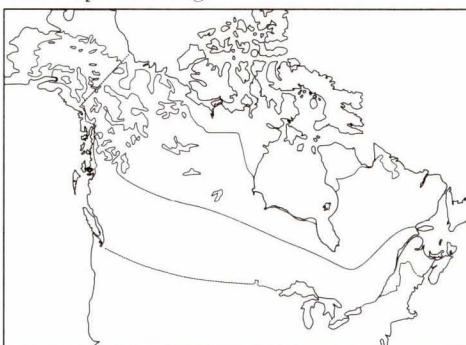
Where is the greatest biodiversity?



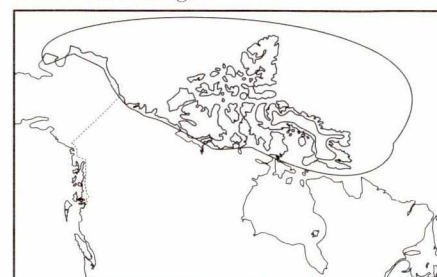
Northern Map
Turtle Range



Black Spruce Range

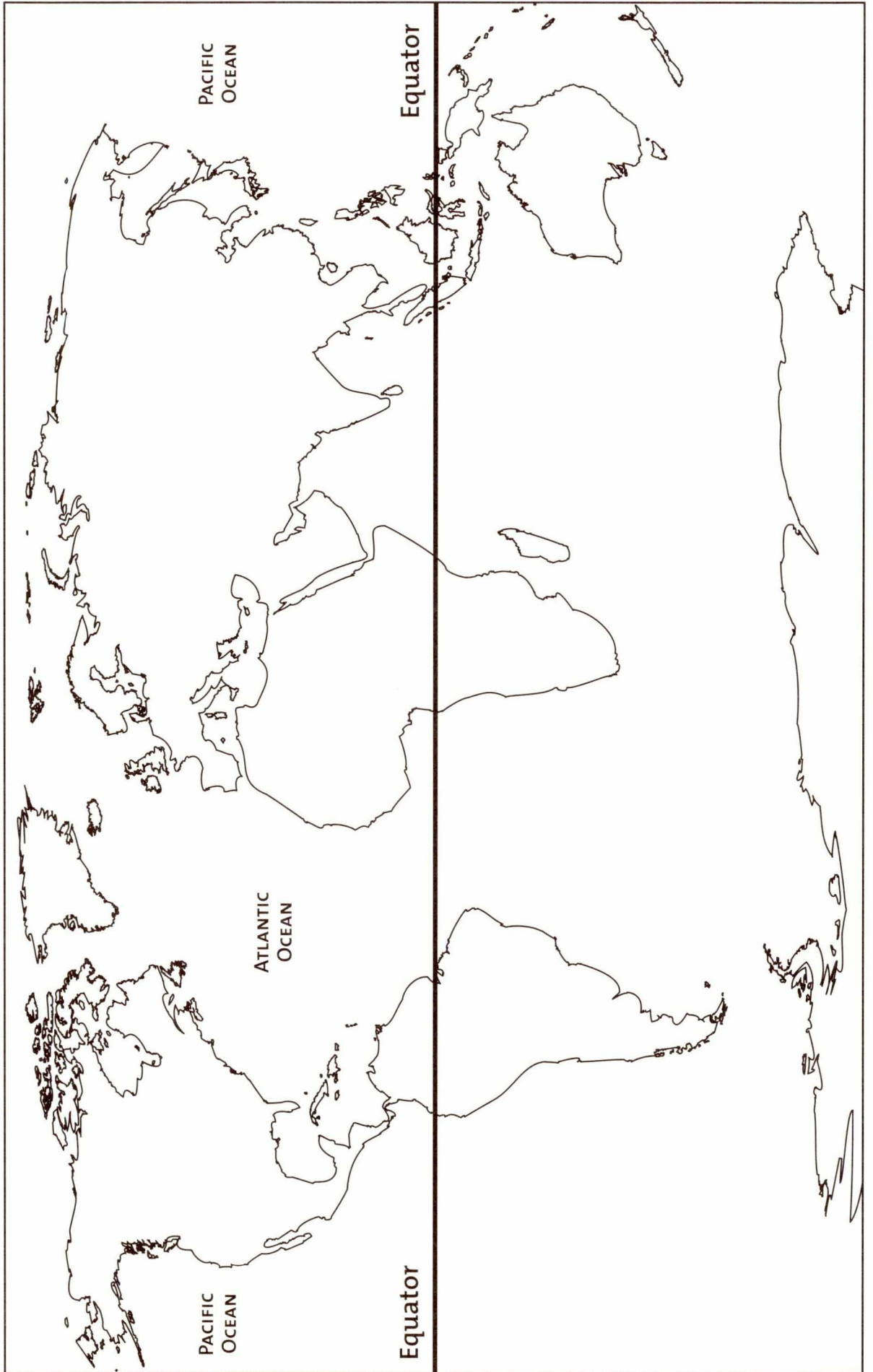


Polar Bear Range

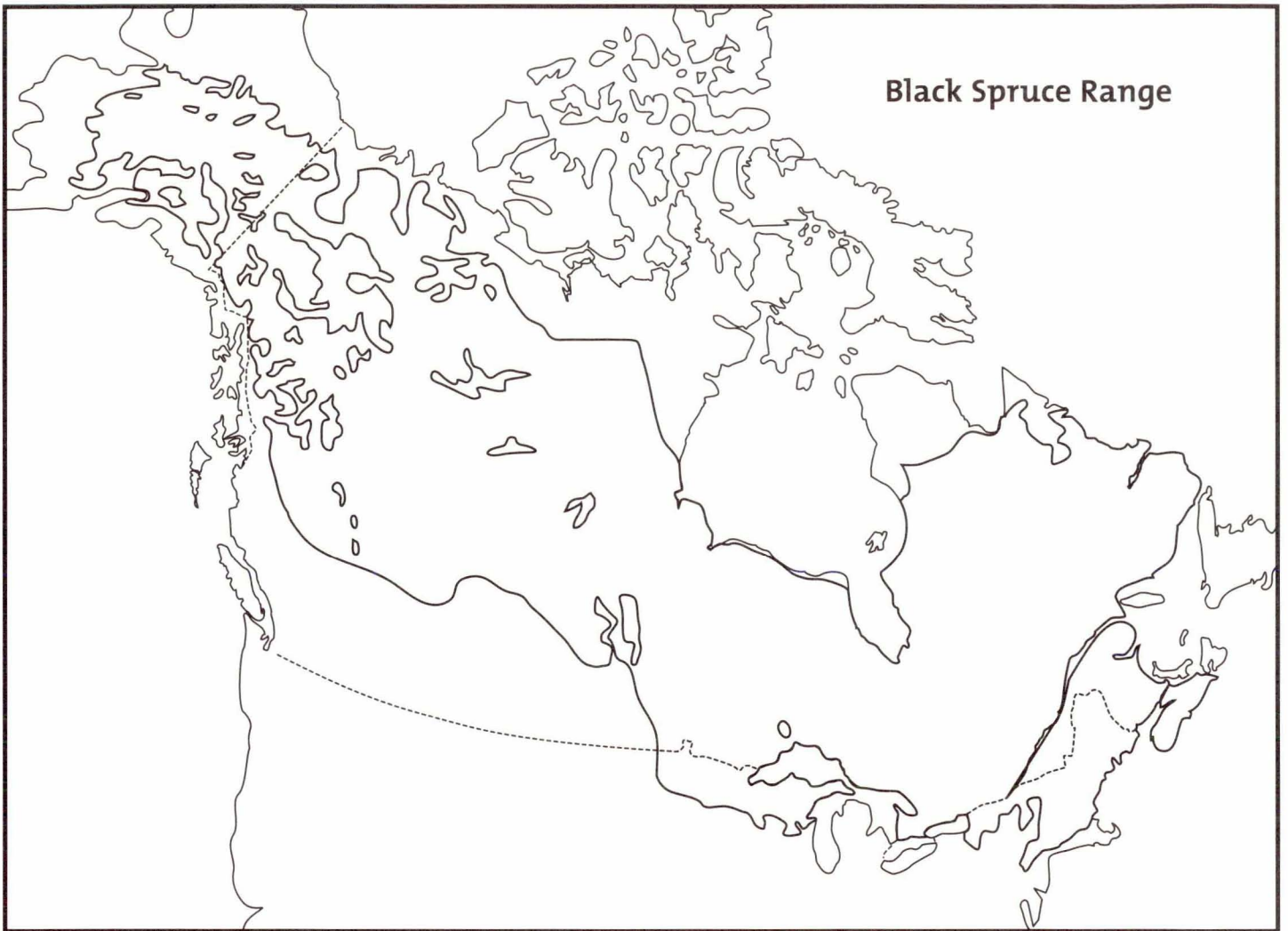




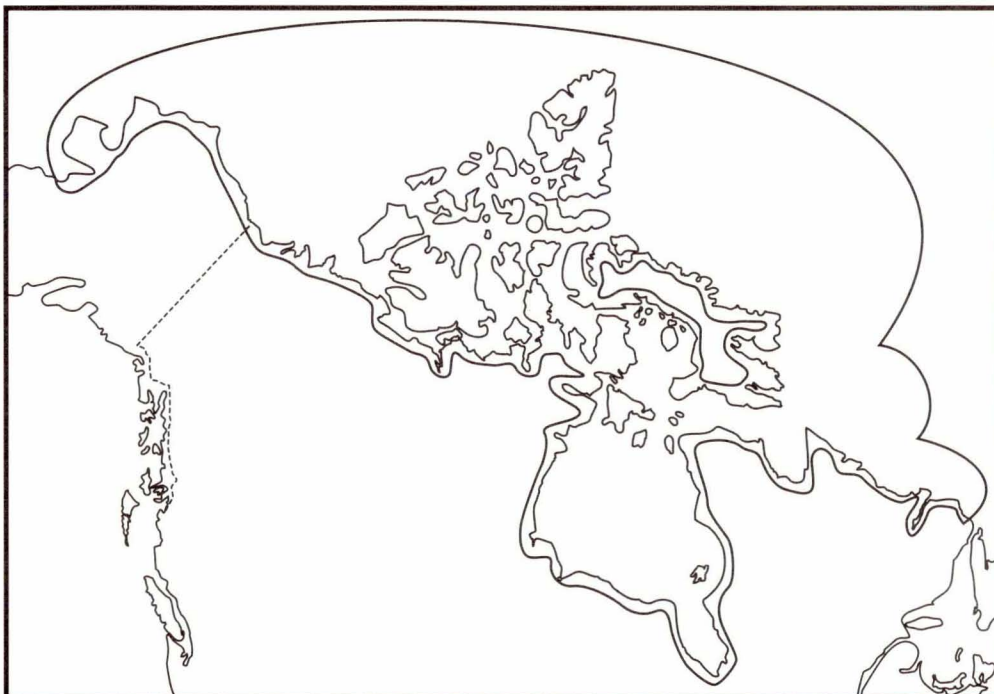
Where in the World is Biodiversity?



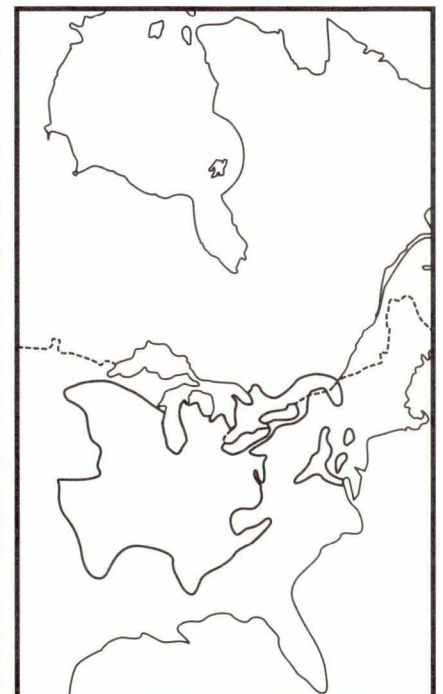
Three Canadian Species—Effects of Global Warming



Polar Bear Range



Northern Map Turtle Range





Billions from Biodiversity

Age range: 10-18

Time: 75 minutes

Subjects: Science, Math

Topics: Biodiversity

Resources: Class handout: *The Wealth Provided by Earth's Biodiversity*, pencils, calculators

Learning Outcome

Students will learn the economic benefits contributed by the world's biodiversity by adding up dollar sums and answering discussion questions. (This activity can be used as a quick introduction to the benefits of biodiversity for secondary students, or as a longer activity for senior grade elementary school students.)

Hook: What's Nature Worth?

Have students contribute short anecdotes about their experiences in a natural setting, such as picking wild berries or catching a fish. Have them brainstorm the 'free' things nature provides, from wildflowers and food to fresh oxygen and purification of water. Lead them to think of other free things that nature provides, such as pollination, animals we have domesticated, the natural areas used for ecotourism, etc. Tell them today we are going to calculate an estimate of the economic benefits contributed by the world's biodiversity.

Procedure

- 1 Give each student a copy of the handout *The Wealth Provided by Earth's Biodiversity*. Have them work through the sheet and take up the answers.

✳ Extensions

Have students illustrate the economic benefits described on the handout with hand-drawn images or pictures cut from magazines.

Have students guess at the number of bacteria in a cubic cm of soil (it's 6 to 10 million). Discuss the fact that large diversity of bacteria, protozoa and other microbes—along with invertebrates such as earthworms, nematodes, millipedes and more—are critical in decomposing organic material and creating soil. They are also critical in purifying and filtering water and retaining or breaking down excess nutrients, toxins, heavy metals and other pollutants.

✔ Answers

1. Individual answer.
2. \$2.928 trillion US (\$2 928 000 000 000). Note that this is in 1997 dollars, so with inflation it's even more in present dollars.
3. Individual answers.
4. Individual answers.
5. The effects of global climate change will cause the Earth to lose more species than is already occurring due to human activity, habitat loss, invasive species, pollution, over-hunting and more. This will reduce the economic benefits biodiversity is able to provide. Our needs and desires as individuals are often at odds with the conservation of biodiversity and habitat, and the 'balance' that is achieved is often controversial. For example, people living on the edge of the rainforest in Brazil need income and food, and will use slash-and-burn techniques if there is no other option. Another example would be the oil sands developments in Alberta; our need/desire for oil and associated projects is the driving factor in these developments, which cause loss of habitat, pollution, etc.

Sources for this Lesson: The estimate calculated by Pimentel and his colleagues is found at many websites, including:

<http://www.sciencedaily.com/releases/1997/12/971211072828.htm>



The Wealth Provided by Earth's Biodiversity

1. The first step in today's activity is to hypothesize what you think the yearly economic benefits provided by biodiversity are equal to in US dollars (which are currently similar to Canadian dollars). Your guess could be in millions, billions or even trillions! _____
2. Now we begin our estimated calculation. As you read the following, underline the dollar amounts.

Let's start with our food. The crops we eat (from vegetables to grains to nuts) have been selectively bred over hundreds or thousands of years from natural wild plants, and some have also been genetically engineered.

The worth of the wild natural crops (raw genetic material) we use today is \$115 billion! Similarly, the livestock animals we breed and consume have also come from nature—from horses, sheep, cows and pigs, to goats, camels, oxen and more. For all these animals, add \$40 billion to your total.

The natural control of pests that attack our forests and crops provided by nature (for example, insects that eat pest insects) is worth \$160 billion. Inherent genetic resistance to disease and pests that exists naturally in our crops and forests (and can be enhanced with breeding and genetic manipulation) is \$86 billion.

The perennial grains that are used or could be used to feed us each year are worth \$170 billion. The pollination and seed dissemination in our forests, fields, gardens and orchards by insects, birds and mammals is equal to a staggering \$200 billion!

The worldwide biotechnology industry, which involves technology based on nature (e.g., biodegradable plastics, biofuels, vaccines) is worth another \$6 billion.

The economic value of fishing, in both marine and freshwater environments, is \$60 billion, hunting is \$25 billion, and seafood is \$82 billion. The value of other wild foods eaten around the world each year, including berries, teas, mushrooms and much more, is worth \$180 billion.

Let's move on to the soil, which is critical for all life on Earth. The formation of soil, which is accomplished by a wide variety of micro-organisms and invertebrates is worth \$25 billion!

The fixation of nitrogen in the soil, which is the critical 'trapping' of nitrogen from the air by micro-organisms into a form that is absorbable to plants, is worth \$90 billion. Waste 'treatment' by nature, which includes the trapping of hazardous pollutants, heavy metals and more in forest and wetland soils is worth an AMAZING \$760 billion. Bioremediation, which is the clean-up of sites contaminated by industrial activities using micro-organisms and natural substances, equals \$121 billion each year.

What about our air? CO₂ sequestration—the capture of carbon dioxide and production of oxygen by plants, trees, ocean algae and more using the sun's energy—is \$135 billion. Now, consider the common items that we use in our schools, homes and workplaces. Wood products from Earth's forests, including lumber, paper, furniture, pencils, cellophane, rayon, glue, turpentine and much more, is worth \$84 billion.



Have you ever gone camping? Ecotourism, which includes birdwatching, wolf howls, canoe trips and much more, equals \$500 billion per year worldwide.

Nature's biodiversity also provides for our health. The website of the Redpath Museum at McGill University in Montreal states that a whopping 70 percent of pharmaceuticals now used come either directly or are derived from nature. For example, ASA or aspirin is made from willow trees, quinine (which helps prevent malaria) is found in quina tree bark and taxol, a cancer-fighting drug, is derived from the bark of the yew tree. Additionally, more than 3000 antibiotics, including penicillin and tetracycline, were originally derived from the world's micro-organism diversity. It is estimated that pharmaceuticals from plants alone are worth \$84 billion annually.

(Source: David Pimentel et al., the College of Agriculture and Life Sciences, Cornell University, 1997)

Total (add up all underlined dollar amounts above): _____

3. How far away from your guess is the total? Are you surprised at the total? Why or why not?
4. How has this activity changed the way you think about how much we depend on Earth's biodiversity?
5. Climate change is one of the greatest threats to biodiversity. Over the next 100 years the average annual temperature in Canada is expected to rise between 5 and 10°C. It is also likely that there will be more days of extreme heat and extreme weather events (such as droughts and heavy rainstorms), coastline flooding and forest fires. Many scientists fear that by end of the next century, as many as 25 percent of existing species in Canada and around the globe will become extinct due to the effects of global climate change. How will these effects impact the economic benefits that biodiversity is now able to provide to us? How do we attempt to strike a balance between our needs and desires (which involve contributions to global climate change) and the conservation of biodiversity and habitat?





Which is More Biodiverse?

Age range: 12-14

Time: 60-75 minutes

Subjects: Science

Topics: Biodiversity, Habitat

Resources: Class handout: *Canadian Forest and Wetland Habitats—Which are More Biodiverse?*, scissors

Learning Outcome

By hypothesis, students will learn why some types of Canadian forest and wetland habitats are more biodiverse than others.

The Value of Natural Spaces and Biodiversity

Discuss with students the different ways we can value a natural place. Lead them to consider that we might value it highly because it is very biodiverse (is home to a great variety of living things). However, it might also feature relatively low amounts of biodiversity but contain rare plants or insects or animals not found anywhere else, or are rare elsewhere. Is it just as valuable? What about the resources that this area may contain, such as timber, precious metals, oil and gas, or non-timber forest products such as wild mushrooms and berries? How do we value it now? What if the area is particularly scenic or holds special cultural, spiritual or sentimental value to certain people? Summarize the various ways this natural area is valued. Stress the point that even preserving biodiversity is critical, but just because a place doesn't have extensive biodiversity doesn't mean it isn't valuable in other ways.

Procedure

1 Give pairs or small groups of students a copy of the handout *Canadian Forest and Wetland Habitats – Which are More Biodiverse?* Read the instructions together and complete the sheet.

2 Provide the answers below, and take up the handout questions.

Extensions

Have students pick three habitat types from the activity and construct a food web for each of these.

Answers (*Thank you to Ducks Unlimited Canada for providing the wetland habitat information*)

Provide students with the following notes on the chalkboard or an overhead:

Least to Most Biodiverse Habitat in terms of species diversity (see page 22):

Arctic Tundra – Even though conditions are harsh, about 1700 plant species live here. Herbivorous mammals include lemmings, voles, caribou, Arctic hares and squirrels, and carnivorous mammals are Arctic fox, wolf and polar bear. Migratory birds include ravens, Snow buntings, falcons, loons, sandpipers, terns, snow birds, and various gull species. Insects include mosquitoes, moths, grasshoppers, blackflies and Arctic bumble bees and some common fish are cod, flatfish, salmon, and trout. Species diversity depends greatly on time of year (migration).

Prairie Grassland (TEMPERATE – North America) – Almost all grass species, but few trees (cottonwood, oak, willow), grow in river valleys, and a few hundred species of flowers grow among the grasses (asters, blazing stars, coneflowers, goldenrods, sunflowers, clovers, psoraleas, and wild indigos). Animals found here include wolves, prairie dogs, rabbits, deer, mice, coyotes, foxes, skunks, blackbirds, grouse, meadowlarks, quail, sparrows, hawks, owls, snakes, grasshoppers, leafhoppers, and spiders.

Mature Boreal Forest – May be less biodiverse than younger forests, but some species are dependent on mature forest conditions. It is the last step before renewal, by harvest or fire or pest attack (insect or fungus, etc.). As trees in the forest break down, species such as mushrooms flourish.

Edge of Prairie/Forest – Biodiversity is greater where habitats overlap because species from each habitat are found here (also known as the 'edge effect').

Recently Harvested Boreal Forest – As new growth comes up after a cut or replant many plants, bugs, birds and mammals move in. A similar effect is seen after forest wildfires or prescribed burns (controlled, deliberately set fires used to meet forest land management objectives) occur. (Note that this type of habitat could be more biodiverse than a bog or fen.)

Bogs – these “nutrient-poor” ecosystems are not as productive as marshes, swamps or fens. Their low productivity is reflected by the smaller number of species that live in them. However, bog plants are unique because they have adapted to the acidic, nutrient-

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poor soils. Some wildflowers and insects are only found in bogs. Carnivorous plants, such as the pitcher plant and sundews, get their nutrients from insects they trap in their specialized leaves. Sphagnum moss forms the vegetative mat in most bogs, which sometimes floats on the surface. Trees, if present, are usually black spruce or tamarack, which grow slowly. Common shrub species include Labrador tea, leatherleaf, cranberry and laurel. Bogs provide habitat for weasels, foxes, owls and a variety of mice, voles and shrews. Many songbirds inhabit bogs (e.g., Whitethroated sparrow, Wilson's warbler). Moose often feed along the edge of bogs.

Fens – Occur in slightly acidic or alkaline water and are more productive than bogs. Predominately featuring sedges—grass-like plants with triangular stems. Many rare wildflowers including orchids require the unique chemistry found in fens in order to grow. Trees, if present in fens, are usually cedar or tamarack.

Swamps – Wooded swamps provide important habitat for many types of plants and animals. White-tailed deer use dense coniferous swamps for winter cover. Other animals that depend on swamps include hawks and owls, rabbits and hares, raccoons, coyotes and wolves, black bears and a wide variety of songbirds. Wood ducks and Hooded mergansers often nest in hollow trees in swamps.

Marshes – Most biodiverse of all wetlands. In all ecosystems, plant life forms the base of the food chain. In marshes, this base is exceptionally large (including emergents such as cattail and bulrush, floating species such as water lily and submergents like coontail) so more food is available for more insects, amphibians and reptiles, fish, birds and mammals. The warm shallow waters provide spawning grounds for minnows, sunfish, bass, pike, and muskellunge and a multitude of crustaceans and shellfish. Birds (many migrating) that use marshes include ducks (Canvasback, Mallard, Blue-winged teal, Scaup, Redheads, Goldeneye), osprey, rails, bitterns and kingfishers. Muskrat and mink, etc. feed on the wide variety of baby birds, amphibians etc.

NOTE: Remind students that the number of species is only one way of measuring biodiversity in a given area. See page 3 for more.

Answers to Handout Questions

1. & 2. Individual answers.
3. Southern habitats tend to have more biodiversity (i.e., a marsh 500 km south of another marsh may feature species that cannot survive in the northern climate). Alien invasive species such as purple loosestrife and Asian long-horned beetles are also factors in biodiversity decline, as many of these species have no natural predators in their new home and can adversely affect native plants and animals in many ways. Alien species, especially in southern Canada, can add to the biodiversity of the area in terms of number of species present, but create conditions detrimental to the normal flora and fauna. Illegal poaching and pollution can also threaten species diversity in a given location.
4. Habitat loss due to human activity and expanding human presence and global climate change are two of the greatest threats to biodiversity. Over the next 100 years, average annual temperatures in Canada are expected to rise between 5 and 10°C. There will likely be more days of extreme heat, and extreme weather events such as droughts and heavy rainstorms. Many scientists fear that by end of the next century, as many as 25 percent of species around the globe will become extinct due to the effects of global warming.

Canadian Forest and Wetland Habitats— Which are More Biodiverse?



Cut out the following descriptions and read them carefully. Can you categorize them in any way? What clues do they contain that might indicate which are more biodiverse (home to a greater variety of animals, plants, insects, microbes) than others? Place them across your desk in order of estimated least (left) to most (right) biodiversity.

<p>MARSHES</p> <p>Marshes are wetlands that usually feature open water up to 2 metres deep, with lush vegetation growing along the shorelines in and out of the water.</p>	<p>MATURE BOREAL FOREST</p> <p>Most trees are old, and provide a high canopy that blocks a great deal of sunlight. A shrubby understorey may exist.</p>	<p>MATURE BOREAL FOREST</p> <p>Most trees are old, and provide a high canopy that blocks a great deal of sunlight. A shrubby understorey may exist.</p>
<p>PRAIRIE GRASSLAND (TEMPERATE – North America)</p> <p>The dominant vegetation is grasses (shrubs or trees usually restricted to river valleys etc.).</p> <p>The soil found here is deep and nutrient-rich, resulting from the growth and decay of deep, many-branched grass roots. The rotted roots also retain the soil in place.</p>	<p>EDGE OF PRAIRIE/FOREST</p> <p>At the ‘edge’ of two habitats, in this case Prairie grasslands and forest, the habitats actually overlap so that organisms from each habitat are present. This is known as the ‘edge effect.’</p>	<p>BOGS</p> <p>More common in Canada’s northern boreal forest regions, bogs are highly acidic wetlands that occur on thick organic ‘peaty’ soil. Bogs are ‘old’ wetlands, occurring where water circulation is poor. Most of the nutrients that enter a bog come directly from rainwater, and not from the runoff from adjoining uplands, lakes, or rivers.</p>
<p>RECENTLY HARVESTED BOREAL FOREST</p> <p>After trees are cut in a given area, new plant and tree growth flourish due to the abundance of sunlight and space to grow; inviting other forms of life to follow. (By law, all trees harvested in Canada must be replaced.)</p>	<p>SWAMPS</p> <p>Swamps are wetlands dominated by water-tolerant shrubs or trees like alder, maple and ash. Swamps can feature hardwood trees growing with “wet feet” or, in the case of cedar swamps, can have water just below ground level.</p>	<p>ARCTIC TUNDRA</p> <p>This habitat is known for its barren scenic landscapes, extremely low temperatures, small amounts of precipitation (desert-like), poor nutrients and short growing season. Dead organic material functions as the main source of nutrients.</p>

Questions

1. Write down the headings of your arrangement of the least to most biodiverse habitat type.
2. Riparian areas (areas containing freshwater, such as ponds, rivers, lakes and streams) are more biodiverse because water and shorelines naturally support a great variety of organisms. Does this affect the way you have arranged your habitat types? Write down your new order of arrangement if you now wish to change it.
3. You will now take notes from your teacher regarding the correct arrangement. Describe how your arrangement differs from the answer. What are three principles you have learned in this activity that relate to biodiversity? (e.g., riparian areas are generally more biodiverse than areas without water)
4. Besides water, what are three other factors that affect biodiversity found in a given habitat? (Think about latitude, species that don’t belong, human activities, etc.)



Climate Change and More: The Future of Biodiversity



Lesson Five

Age range: 15-18 years

Time: 60 minutes

Subjects: Science

Topics: Biodiversity, Climate Change

Resources: Class handout: *Climate Change and More: The Future of Biodiversity*

Learning Outcomes

Students will understand the importance of biodiversity in terms of human health, food production, economies and more by hypothesizing about several natural areas, one where biodiversity is protected, one where it is not, and one where climate change has a significant impact.

Hook: Forks in the Road

Ask students to describe situations where we make choices that set us on a path towards a certain outcome, good or bad. Choices made every day can have long-term consequences. For example, students choose to work hard at school for years so that they will be able to achieve high marks in senior classes and have the widest range of possibilities for scholarships and post-secondary education options. Similarly, our choices relating to land use and the environment have consequences. Tell students that today they are going to look at three possible futures for one large area of land, and the consequences of how these choices affect biodiversity.

Procedure

- 1 Ensure that students are familiar with the concept of biodiversity, its benefits and importance. See background material at the start of this kit. You could also use the activity “Billions from Biodiversity”.
- 2 Divide students into groups, distribute the handout and review it. The tract of land described at the top is given three futures as described in the chart. For each future, students must now consider whether each biodiversity benefit listed along the left side of the chart (e.g., O₂-CO₂ exchange by plants and trees) will be sustained (same) or be affected negatively (go down).
- 3 Circulate among students as they fill out the table and discuss their answers when complete.

Answers

Future 1 – In general, all biodiversity benefits go down. However, ask students to list some of the other benefits provided by these developments (e.g., short term and long term jobs, community stability, products for all Canadians to use as we enjoy modern lifestyles, products for export, etc.). Discuss the trade-offs we make on a daily basis with regard to support of our lifestyles and conservation of biodiversity in a given area.

Future 2 – In general, all biodiversity benefits stay the same.

Future 3 – Life-sustaining processes will all be affected negatively if global warming leads to droughts and general drying of a given area. Some species will be simply unable to survive. The soil and wetland microbes and invertebrates will diminish, and reductions in water purification, trapping of toxins, and organic matter breakdown (soil creation) will occur. Income from listed sources will also most likely go down. In terms of the ‘Social and Ecological’ impacts, while the recreational, cultural, and spiritual values of the area may not necessarily decrease, the drier conditions and extirpated species may cause this to occur. The value of maintaining biodiversity levels will be negatively affected, as will the value of using intact ecosystems as models in the future.

Extensions

Measure biodiversity levels (in terms of a number of given species for example) at a local site. Make some changes to promote biodiversity (such as planting vegetation, and trees), and measure how biodiversity levels change in the following years.

Climate Change and More: The Future of Biodiversity



Land area description: This large tract of land within Canada's boreal forest contains many natural resources, from precious metals and oil and gas reserves to timber and non-timber forest products. Local people valued the land in a variety of different ways, including recreation, spiritual aspects, culture, income and more.

<p>Biodiversity Benefits</p>	<p>Future 1 – Several oil and gas, human settlement and mining developments proceed on the land. They are completed after due process and consultation with all stakeholders. This process put the focus on what areas would be conserved first and then on how much and what kind of developments would be allowed.</p>	<p>Future 2 – Land is essentially conserved. It is set aside for certain low-impact uses, such as hunting and ecotourism, subject to regular review. Certain sensitive areas important in an ecological or cultural sense are set aside for permanent protection.</p>	<p>Future 3 – Land is conserved as in Future 2, but affected by global climate change. Over time, certain tree, plant and animal species become extirpated (extinct in this area) or may only be able to survive northward. Annual temperatures may increase by 5-10°C. There are more days of extreme heat, and extreme weather events such as droughts and heavy rainstorms.</p>
<p>Life-sustaining Processes</p> <ul style="list-style-type: none"> • O₂-CO₂ exchange by plants and trees: Natural purification of water • Natural break down and trapping of wastes/toxins by trees, plants, wetlands, microbes and more • Breaking down organic matter to create productive soil 	<p>Same or Down?</p>	<p>Same or Down?</p>	<p>Same or Down?</p>
<p>Income</p> <ul style="list-style-type: none"> • Trapping, guiding hunting and fishing trips, ecotourism, etc. • Potential discovery of medicinal plants, trees and microbes • Non-timber forest products such as foods, craft materials, etc. 	<p>Same or Down?</p>	<p>Same or Down?</p>	<p>Same or Down?</p>
<p>Social and Ecological</p> <ul style="list-style-type: none"> • Recreational value of area • Cultural value of area • Spiritual value of area • Value of maintaining biodiversity level for the next generation • Value of using intact ecosystems as models in the future 	<p>Same or Down?</p>	<p>Same or Down?</p>	<p>Same or Down?</p>





Sustaining Biodiversity

Age range: 14-18

Time: 60 minutes

Subjects: Science, Math

Topics: Biodiversity, Sustainable Harvesting, Interactions

Resources: Class handout: *Sustaining Biodiversity—How and Why?*, calculators, pencils

Learning Outcomes

Students will understand the importance of a given species to the continued existence of biodiversity and how it can be maintained through sustainable harvesting (hunting or fishing). Students should be familiar with the concept of biodiversity (see background material at the front of this kit and other activities).

Hook: Sustainable Practices

Ask students what sustainability means to them (e.g., being able to sustain a practice or process over the long-term). Have them list some practices in our forests (harvesting trees, wild mushrooms or wild rice; hunting and fishing, birdwatching, etc.) and describe how the practice can be conducted in both a sustainable and non-sustainable ways. For example, sustainable forestry includes planning and preparation (taking into account a number of factors such as average tree age, species-at-risk, etc.); replanting trees as you harvest them (the law in Canada); harvesting trees in such a way as to mimic natural disturbances, such as forest fires; and keeping the impact of logging activities to a minimum. Tell students that today they are going to discover how important a given species is to overall biodiversity and how sustainable harvesting practices can help to keep its population stable.

Procedure and Answers

- 1 Give the students a copy of the handout *Sustaining Biodiversity—How and Why?* and go over Step 1. The material for Step 1 can be photocopied from a website such as Hinterland Who's Who – The Beaver (<http://www.hww.ca/hww2.asp?id=82>)
- 2 Predators that might catch a beaver are bears, wolves, foxes or birds of prey. Beaver ponds are highly productive wetlands supporting high levels of biodiversity (see Lesson 4). The harvest of trees (e.g. poplar, willow) by beavers promotes new growth, which supports a diverse number of species.
- 3 Go over Step 2 and allow them to answer it. Tell them we will get into the assumptions we are making in a few minutes.
- 4 Give them the answer: Harvesting 15 beaver a year leaves the population at five, which produce three young each (15 young), bringing the population back up to 20.
- 5 Go through Steps 3 and 4 together as a class. In discussing Step 4, following are the answers.

Answers, Step 4 a) Female. No. b) One year. No, because it's two. c) Pregnant, healthy, sexually mature. No, some will be males, sexually immature, etc. d) We are assuming that these things will have no effect on the population in question. The reality could be quite different. e) Extremely cold temperatures could kill off some beavers. Disease is a possibility. However, habitat loss from human activity and settlement and the conditions created by global climate change are a much bigger threat to beavers other species worldwide. Habitat loss is straightforward. If there is no suitable habitat, there will be no beavers. Climate change is expected to bring a rise in average Canadian temperatures of 5-10C in the next 100 years, along with more days of extreme heat, more extreme weather events (droughts and heavy rainstorms) as well as more coastline flooding and more forest fires. All these factors will have an impact on the beaver and all other species on Earth.

Note that if no beaver mortality were to occur, beaver may explode in numbers, and overharvest poplar (less food for them than available) and cause damage by flooding roads, cropland, etc. as they dam up culverts, streams, etc

- 6 Have students work together on Steps 5, 6 and 7. In discussing Step 5, following are the answers: It is hard to say. Given all the assumptions that we are using, and all the possible factors that may affect beaver populations, the answer might be one animal every few years. Answer, Step 6) Sustainable practices involve high levels of complexity. For a good answer to Step 7), see background section "Why is Biodiversity Important?" (page 4).

Extensions

Have a local wildlife biologist, forester, farmer or person from a similar discipline come into your class and speak about biodiversity and the sustainable practices he/she uses in order to conserve it.



Sustaining Biodiversity—How and Why?

1. Your animal is the beaver (*Castor canadensis*). Using the material provided by your teacher, make notes on this animal's description, habitat, unique characteristics, range, feeding, breeding and conservation.

Now that you are familiar with this animal, explain how this species supports overall biodiversity in the forest and wetland areas where it lives? For example, name two predators that might eat a beaver if they could catch one. What do beaver ponds support in terms of biodiversity of species? How does the beavers' harvest of trees affect biodiversity?

2. Now we will figure out how many beavers can be 'harvested' from a given large forest and wetland area so that the number left can sustain the population at the same level. In this particular forest area, there are 20 beavers and we will assume each beaver produces three young per year (other assumptions will be discussed later).
3. What strategies did you use to solve the problem? (e.g., trial and error, equation). What worked best?
4. Let's look at the assumptions that we are using in this activity, in addition to assuming each beaver has three young every year:
 - a) Of which gender are we assuming all beavers to be, or at least the beavers not harvested each year to be? Is this reasonable?
 - b) How many years are we assuming it takes for a beaver to mature sexually (able to have offspring)? Is this reasonable?
 - c) What are we assuming about all five surviving beavers at the end of the season? Is this reasonable?
 - d) What are we assuming about how disease or extreme temperatures or global climate change conditions, such as drought, could adversely affect the population? Is this logical?
 - e) How will the conditions listed in d) likely affect beaver populations?
5. After carefully considering all these assumptions (and how far-fetched they are!), what do you now consider a reasonable yearly harvest for sustaining this beaver population and all the corresponding biodiversity it supports?
6. What have you learned about the complexity of sustainability?
7. Why is biodiversity valuable? Explain at least five ways the diversity of plants, trees, microbes, mammals, insects, birds and other living things on Earth are important for our daily survival and wellbeing. Consider all aspects of our daily lives!



We Meet Again: Reintroduction of Species at Risk



Lesson Seven

Age range: 14-18 years

Time: 3-4 classes

Subjects: Science

Topics: Species-at-Risk, Wildlife Management, Climate Change

Resources: Class handout: *Re-introduction of Species—A Complex Issue*, access to the Internet for research

Learning Outcomes

Students will understand the importance of habitat and biodiversity interdependence (e.g., the relationship between predators and prey) by researching why species become extirpated, why they're chosen for reintroduction, how species are generally reintroduced and the reintroduction and monitoring of a given species (accounting for the current and projected effects of climate change).

Hook: Two Examples of Species Reintroductions

Download and show the following video clips from PBS (about 7 minutes each), and use Activity 3 discussion questions: http://www.pbs.org/americanfieldguide/teachers/native_species/native_species_unit.html#.

Video clip **Return of the Wolf** is found under Activity 1: Extinction and Endangered Species: What Can You Do? and clip **Re-establishing Bighorn Sheep in Oregon** is under Activity 3 The Reintroduction of Bighorn Sheep. These excellent clips (accompanied by transcripts of the text) demonstrate why animals become extirpated and the social, political, economic, ecological and logistical complexities of capturing and reintroducing animals in a former area of their natural range.

Procedure

- 1 Divide students into groups, give the students a copy of the handout *Re-introduction of Species—A Complex Issue* and review it.
- 2 Students will now research their topics using computers and present their findings to the class.

Extensions

Now that they are familiar with all facets of reintroduction, students could plan the reintroduction of a species whose range once included your geographic area. (Alternatively, this could be a species that is endangered that you can pretend is extirpated.)

Have students share tips for helping species-at-risk as a class. For ideas see page 26 of *Conserving Borderline Species*: http://library.fws.gov/Pubs/borderline_species01.pdf



Reintroduction of Species: A Complex Issue

In many parts of the world, native species have been driven completely out of areas of their former range because of habitat loss, human presence, pollution, invasive species and over-hunting and illegal poaching. This is called extirpation, which means the species is extinct in certain areas. Climate change is expected to cause the extirpation and extinction of many species, even as many as 25 percent of the world's species, in the next 100-200 years.

Over the past several decades, species have been successfully reintroduced to former areas of their range in many parts of the globe. This doesn't mean, however, that the process goes completely smoothly or didn't have failures in early attempts. Species reintroduction, especially for a predatory carnivore such as the wolf, or hungry large herbivores such as elk, is rife with social, political, economic, ecological and logistical complexities where the viewpoints of different groups of people can be significantly at odds with others.

In your research, keep in mind that some websites are operated by groups with a specific agenda (e.g., environmental groups who want to see the species re-established no matter what the objections, or landowner groups who may want to stop the species reintroduction no matter the perspective of others). As always in your research, use a variety of reliable up-to-date, balanced sources of information (academic, government, well known and established organizations) and document with detailed references from where you obtained the information on the issues below.

For your assigned species from the list below, address the following issues:

1. Economic – Are costs of the reintroduction project given? Is there debate about how the money could have been better spent? Will reintroducing this species potentially threaten or boost anyone's income? Who is being paid to handle the reintroduction and monitoring?
2. Social – Who are the stakeholders with a legitimate perspective in this species reintroduction (e.g., farmers, landowners, conservationists, ecotourism operators, politicians, wildlife biologists, everyday citizens, etc.) Describe their viewpoints on the benefits and/or detractions of reintroducing this species.
3. Political – Is there strong political support for this reintroduction? Was that always the case? Why? Is the cooperation of multiple government levels required? Is the cooperation of other countries required? Remember that a successful politician always takes into consideration the voting power of various groups.
4. Ecological – What are the reasons why this species became extirpated? Where is its original range? How did this species originally fit into the ecosystem? (e.g., what did it eat, what ate it, what were its competitors, etc.) How did its absence affect the ecosystem and how will its reintroduction do so?
5. Logistical – How is the species collected and transported? What are the problems and precautions taken? What treatments are typically given and/or measurements taken? What does the release and monitoring involve? How does climate change affect the species now and how will it do so in the future?

Some reintroduced species in Canada and elsewhere (with links to get you started) include:

Elk, ON - www.bancroftontario.ca/elk/index.html or www.trentu.ca/newsevents/newsreleases_070312elk.php

Sea otters, BC - www.dfo-mpo.gc.ca/csas/Csas/status/2007/SAR-AS2007_031_E.pdf (also reintroduced in Washington State)
<http://wdfw.wa.gov/wlm/research/papers/seaotter/survey/index.htm>

Swift fox, AB & SK - www.srd.gov.ab.ca/fishwildlife/status/pdf/swfox.pdf

Wild turkeys, ON - www.mnr.gov.on.ca/mnr/csb/news/2004/dec08nr_04.html

Atlantic salmon, Lake Ontario www.mnr.gov.on.ca/MNR/csb/news/2006/oct27nr_06.html

Wolves, Montana, Idaho & Yellowstone Park www.yellowstoneparknet.com/wildlife/wolf_reintroduction.php

Bighorn sheep, Oregon & Idaho www.fs.fed.us/hellscanyon/life_and_the_land/wildlife/bighorn-sheep.shtml

Lynx, Colorado www.colostate.edu/Dept/coopunit/research-lynxnew.html

Fishers, Washington (proposed) http://wdfw.wa.gov/wlm/research/papers/fisher/fisher_reintroduction_assessment.htm

American burying beetle, various US sites http://ecos.fws.gov/docs/recovery_plans/1991/910927.pdf

European beaver, Scotland www.scotsbeavers.org/

Black-footed ferret, various US sites http://library.fws.gov/Pubs/borderline_species01.pdf

Lord Howe Island phasmid (large insect), Australia <http://www.fnpw.com.au/enews3/lhiPhasmid.htm>

Trumpeter swans, various North American sites http://news.nationalgeographic.com/news/2003/07/0724_030724_tvbirddata.html





Invasive Invasion

Age range: 9-13

Time: 60 minutes

Subjects: Science

Topics: Invasive Species, Spread, Prevention

Resources: Class handouts: *Invasive Species: Terms and Issues* and *Invasive Species Charades Game Pieces*

Learning Outcomes

Students will understand the impact of invasive species on biodiversity by doing a match-up and acting out the various ways to prevent the spread of invasive species.

Hook: Aliens All Around Us

Ask students if they can name a species that lives in Canada but didn't originate here (e.g., pigeons, starlings, purple loosestrife, zebra mussel, gypsy moth, sea lamprey, carp, Dutch Elm disease etc.). Discuss the various ways these alien invasive species can have a severe negative effect on native species, sometimes wiping them out of an entire area (e.g., they out-compete and out-reproduce native species; interbreed (hybridize) with them; over-consume them as predators or herbivores; are diseases or spread diseases; parasitize native species, negatively alter habitat). Tell students today they are going to teach each other about how these species are spread and what we can do to help.

Procedure and Answers

- 1 Distribute copies of the two handouts *Invasive Species: Terms and Issues* and *Invasive Species Charades Game Phrases*. Complete the first handout, and take it up with the class.
- 2 Have students form teams of four or five people and match them with another team to compete against. Give each competing pair of teams a container with the cut-out phrases from the charades handout; the appropriate team player will select a phrase from this container when it is his or her turn. There are ten phrases, five per team.
- 3 Explain that each phrase will demonstrate something we can all do to prevent the spread of alien invasive species. Each team is timed for how long it takes their team to guess the answers demonstrated by each player during each turn. (You may want to put a maximum limit of a few minutes for each turn.) The winning team is the one that took the least amount of time to guess their phrases.
- 4 As each clue is guessed, have the demonstrating student read it out and have all students copy it down.

Extensions

Students could each research an invasive species in Canada, how it came to be introduced, its effects, how it is being controlled, etc. to manage established and spreading invaders through eradication, containment and control.

Answers

Q, J, N, M, I, L, B, A, P, C, F, H, D, E, G, O, K



Invasive Species—Terms and Issues

- _____ Of the roughly 5000 known plant species in Canada, this many are known to be alien invasive species.
- _____ An alien invasive species is defined as...
- _____ This invasive moth feeds on the leaves of many trees.
- _____ This aquatic invasive species feeds on fish as a large parasite in both fresh and salt water.
- _____ This disease has attacked trees all over North America.
- _____ We should all be sure to check out our _____ , vehicle _____ and _____ when we move from one wilderness area to the next.
- _____ When out hiking and camping, make sure NOT to do this.
- _____ This alien invader mussel shares its name with striped horse-like African mammals.
- _____ These two birds from Europe are now common in Canada, and cause several problems for native birds.
- _____ Term used to describe when some alien species are able to interbreed with a native species, reducing the native population and its genetic diversity.
- _____ This brightly coloured invasive weed that chokes out native plants is still legal to be sold in stores in much of Canada!
- _____ If you recognize a population of invasive plants, animals, fungi, fish or any other kind, you should report your finding to the landowner or a government official.
- _____ Alien species often out-compete and out-reproduce native species, taking over _____ , _____ , _____ and _____ .
- _____ Other alien species harm native populations by _____ them.
- _____ Some alien invaders harm native species by _____ the environment in a negative way.
- _____ A bad way to combat invasive species is to volunteer at your local park or other wildlife area to help remove invasive species, and help educate others about the threat.
- _____ Invasive species have a very negative effect on our planet's _____

- A. Zebra mussels
- B. Collect wild plants, trees, flowers etc.
- C. hybridization
- D. space, water, food, other resources
- E. eating
- F. purple loosestrife
- G. altering
- H. true
- I. Chestnut blight
- J. A species not natural to the area, which is having a negative effect on local species.
- K. biodiversity (the variety of living things found in a given natural area).
- L. boots, tires, other gear
- M. sea lamprey
- N. gypsy moth
- O. false
- P. pigeons and starlings
- Q. 500



Name: _____ Date: _____



Preventing the Spread of Invasive Species— Charades Game Phrases

Find out what invasive species are present in your area and how to identify them so you can help prevent their spread. (Hint: demonstrate looking at a book or at the computer, then walking out in the ‘woods’ and pointing to an invasive species).

Report any infestations you may come across (in packing crates, your garden, the wild or anywhere else). (Hint: demonstrate finding an invasive species in your garden (being shocked) and then getting on the ‘phone’ to let the authorities know).

Avoid weed infested areas by staying on designated trails and roads. (Hint: place a short ‘trail’ on the floor using classroom materials and stay on the trail).

Clean all recreation gear, clothing and shoes before leaving an area to avoid carrying any seeds to the next site you visit (Hint: Demonstrate ‘hiking’ and then checking your clothing, shoes, tent, etc. and cleaning them of weed seeds).

Do not collect flowers, plants or wild animals. They could be invasive aliens. (Hint: demonstrate looking at and sniffing pretty wild flowers, but leaving them alone and walking on).

When horseback riding in different areas, remove seeds from animals by brushing them thoroughly, cleaning their hooves and tack before transporting. (Hint: Get down from your ‘horse,’ brush the animal, clean the hooves and saddle etc. of weed seeds).

When boating in different waters, blow out your intakes and scrub your boat and trailer thoroughly. (Hint: Get out of your ‘boat,’ blow out the intakes of your motor and scrub the boat and trailer).

Buy only non-invasive and/or native species at your garden centre. (Hint: Walk into a garden centre and choose a non-invasive plant (label it with a piece of paper) and take it to the check-out with your purse or wallet).

Don’t release aquarium fish and plants, live bait or other animals into the wild. (Hint: After going fishing, take your ‘bait bucket’ home instead of dumping it in the water. You may want to stop your invisible friend from dumping the ‘bucket!’).

Join with others to do a clean-up of invasive weeds or another species from a local wilderness area (Hint: Demonstrate joining with others by waving hello, shaking hands, etc. and then pulling out weeds together).



Biodiversity: Getting the Message Out



Lesson Nine

Age range: 14-18

Time: 60-120 minutes

Subjects: Science, Visual Arts

Topics: Biodiversity, Benefits

Resources: Paper, pencils, coloured pencils and markers

Learning Outcomes

Students will understand the importance of biodiversity by creating a t-shirt design and slogan.

Hook: National and International Agreements

Discuss elements of a successful t-shirt design and slogan. The words should be catchy, and the design should be relatively uncomplicated, yet make good use of detail and colour.

Procedure

Divide students into pairs or groups and let them know that their task today is to develop a t-shirt design and slogan that effectively communicate the importance of biodiversity (e.g., “Biodiversity – it matters!”). The design should include illustrations or icons that reflect the various benefits biodiversity provides.

For example, students could consider what images represent the following benefits of diversity, and how these images can work together in an overall design:

- diverse insect species (flies, wasps, moths) as well as bird and animal pollinators and seed distributors, help our wild areas, crops, orchards and gardens grow.
- biodiverse micro-organisms and invertebrates in forests and wetlands contribute to productive soil.
- biodiverse microbes and invertebrates in forests and wetlands filter the planet’s water and trap harmful toxins.
- thousands of species of plants, trees and ocean algae trap carbon and emit oxygen.
- the world’s tree biodiversity provides all sorts of products from lumber to paper to turpentine.
- biodiversity provides direct food sources (seal meat, caribou, moose, venison, freshwater and marine fish, seafood, wild mushrooms, birch and maple syrups, teas, berries, etc.)
- from nature’s biodiversity comes the genetic basis for our present-day crops and domestic animals.
- biodiversity provides items for cultural celebrations and everyday use (feathers, bone, fur, sweetgrass).
- biodiversity contributes to human health (e.g., medicines from trees and plants, over 3000 antibiotics from micro-organisms).
- biodiversity provides for recreation (e.g., fishing, hunting, bird-watching, hiking, canoeing, mountain biking).
- biodiversity provides direct and indirect income (ecotourism, harvest of wild foods, medicinal plants, trapping, etc.)
- biodiversity is integral for the spiritual renewal of many people.
- existing biodiverse ecosystems provide models of sustainability and genetic resources that we can use in future to improve our food, create products, develop medicines and cope with global climate change (e.g., drought resistant crops).

Extension

Students could have the ‘winning’ class design transferred to t-shirts to sell as a fundraiser for a local conservation project or organization.

T-shirts with the winning design could be given as incentives to individuals for special Earth Day accomplishments or conservation-related school activities throughout the year.

Glossary

carbon sink: a place where carbon is accumulating, such as forests (which convert carbon dioxide from the air into carbon-containing sugars and plant fibre).

climate change: an on-going process of large-scale and long-term weather changes due to planetary warming or cooling which may involve many unpredictable effects.

conservation: the study, protection, sustainable utilization, restoration and enhancement of natural resources with a long-term perspective.

COSEWIC: the Committee on the Status of Endangered Wildlife in Canada, an independent volunteer group of experts funded by the government which conducts research and provides recommendations about at-risk species for the government to use when updating SARA.

deforestation: clearing an area of forest for another long-term use, such as golf courses, parking lots, buildings, and roads.

ecotourism: nature-related activities in which people engage while visiting an area that may or may not cost money, e.g., wolf howls, viewing polar bears, bird-watching, hiking, camping, canoe trips.

forest fragmentation: the process of breaking up a once-intact forest into fragments, usually as a result of agriculture, mining, pipelines, roads and other developments.

habitat: the arrangement of food, water, shelter and space in a given area.

intact forest: forest that does not contain roads or other developments.

invasive species: plants, animals and micro-organisms that, when introduced outside of their natural past or present distribution, spread and cause serious and often irreversible damage to native ecosystems, economy and society.

management: careful planning and decision-making based on science that goes into the wise use and conservation of natural resources such as forests, water and wildlife. This could include protected areas, policies for use and harvest levels.

native species: a species normally found in an area.

non-renewable resources: naturally occurring assets such as oil and minerals that exist in finite amounts.

organism: any living thing.

renewable resources: naturally recurring assets including wood, water, fish, plants and wildlife.

riparian zone: a distinct area between land and water (excluding ocean) featuring specific types of vegetation. Trees and plants here are important for wildlife habitat and food, sediment control and prevention of erosion.

SARA: Canada's Species at Risk Act.

species-at-risk: a species identified by COSEWIC that is of special concern, threatened, endangered (facing imminent extinction) or extirpated (extinct in certain areas of previous inhabitation).

stakeholder: a person or organization with an investment and concern in a particular item or endeavour; stakeholders wish to be included in the sharing of information and contribute to decision-making.

sustainable: used to describe practices that allow for controlled consumption so that a renewable resource remains at basically the same level for the benefit of future generations.

wetland: a distinct low area of habitat that is wet to varying degrees during the course of a year and over a number of years that has characteristic soils and aquatic vegetation; includes swamps, bogs, fens and marshes. Spruce bogs are very common in Canada's boreal forest.

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Canada's Forests Teaching Kit

Funding Partners

Canadian Boreal Initiative

The Canadian Boreal Initiative was created in response to both opportunities and threats facing Canada's boreal region. Based in Ottawa, the CBI brings together a wide range of conservation organizations, First Nations, industry leaders and others to create new solutions for boreal conservation and sustainable development. It supports scientific research to advance thinking on conservation-based planning for the boreal region, and acts as a catalyst by supporting a variety of on-the-ground efforts across the boreal forest by conservation groups, First Nations and others.

In 2003, the CBI convened the Boreal Leadership Council, an extraordinary group of conservation organizations, First Nations and resource companies. In concert with members of the Council, the CBI created and launched the Boreal Forest Conservation Framework – a vision for the protection and sustainable development of Canada's entire boreal ecosystem.

Canadian Forest Service

The Canadian Forest Service, one of five sectors of Natural Resources Canada, works to ensure that Canada's forest resources are used wisely by advancing the science and policy that assists forest managers in practising sustainable development. Canada is steward of more than one-third of the world's boreal forest, one-fifth of the world's temperate rainforest, and one-tenth of the total global forest cover. This is a responsibility the Canadian Forest Service takes to heart. Its innovative programs, policies, science and technology are key to Canada's global leadership and critical to safeguarding the environmental, economic, and social values that Canadians place on their forests – now and for the future.

Canadian Model Forest Network

The Canadian Model Forest Network (CMFN) consists of 14 model forest sites across Canada. Each local level site involves numerous partners who work towards sustainable landscape management. Partners include, forest companies, Aboriginal communities, private citizens, parks, environmental groups, governments and universities. Beyond strengthening alliances between Model Forests, the CMFN works to raise the profile of Model Forests in Canada and supports and coordinates national initiatives relevant to all Model Forests. The CMFN also works as a liaison between Canada's Model Forests and the International Model Forest Network.

Ducks Unlimited Canada

Ducks Unlimited Canada (DUC) is a national, private, nonprofit organization and is known as Canada's Conservation Company. DUC has been committed to wetland conservation for more than 67 years and has positively influenced nearly 25 million hectares of habitat in 7139 locations across Canada. Despite this, wetland loss continues across Canada. As much as 70 percent of Canada's original wetlands have been lost in some areas of the country. DUC's conservation efforts take many forms. On-the-ground work is guided by the wetland and environmental research of DUC's scientists. DUC works to change policy in favour of wetland and habitat conservation. DUC also delivers wetland and environmental education programs to teach Canadians about wetlands and the need to conserve them. As a non-profit organization, DUC relies on the support of over 150 000 Canadians from across the country. DUC's 8200 dedicated volunteers work very hard to help DUC in achieving its conservation mission and vision.

Forest Products Association of Canada

The Forest Products Association of Canada (FPAC) is the voice of Canada's wood, pulp, and paper producers nationally and internationally in government, trade, and environmental affairs. Canada's forest industry represents 3 percent of Canada's gross domestic product (GDP) and exports \$45 billion annually. The industry is one of Canada's largest employers, operating in hundreds of Canadian communities and providing over 900 000 direct and indirect jobs across the country. With the help of member companies, FPAC designs programs to promote Canada's leadership in trade and economic matters, sustainable forest management and environmental stewardship.

Louisiana-Pacific Canada Ltd.

Louisiana-Pacific Canada Ltd. is a premiere supplier of building products, delivering innovative, high quality commodity and specialty products to retail, wholesale, homebuilding and industrial customers. LP operates 31 mills (20 in the United States, 10 in Canada and one in Chile) and has more than 6000 employees.

LP was founded in 1972 as a spin-off of Georgia-Pacific Corporation and became an independent corporation on January 5, 1973. Building on a strong presence in lumber and plywood, LP pioneered the U.S. production of oriented strand board (OSB) panels in 1982. Today, LP is the world's largest producer of OSB, which continues to replace plywood in residential

building. Other products manufactured by LP include LP WeatherBest composite decking, LP SmartSide composite siding and Engineered Wood Products, including LVL and LP I-joists.

LP's centralized Technology Center in Franklin, TN is designed to rapidly turn new concepts into new products.

The facility also focuses on improving product quality and raw material utilization in the manufacturing process.

LP is traded publicly on the New York Stock Exchange under the LPX ticker symbol. Net sales in 2004 reached \$2.8 billion.

LP is dedicated to investing in communities where our employees live and work. The company provides funding, product and volunteers to support public schools and nonprofit organizations. Contributions are focused in areas of shelter, education, social services and the environment.

Ontario Ministry of Natural Resources (OMNR) - Forests Division

The Forests Division of the Ontario Ministry of Natural Resources is committed to sustainable forest management - healthy forests providing balanced environmental, social and economic benefits now and for the future. Ontario is a recognized world leader in its forest programs and practices. We are committed to managing Ontario's forests in a sustainable manner. The expert support and advice provided to forest users will ensure the wise use of Ontario's forests for generations to come.

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For many years the Canadian Forest Service of Natural Resources Canada has been a strong supporter of the Canadian Forestry Association, working with it on projects of mutual interest and benefit. In addition to providing a substantial share of the CFA's annual core funding, CFS provides scientific expertise and guidance to products such as the Canada's Forests teaching kit series. While the CFA remains an independent arms-length organization, its mission dovetails with the objective of the CFS to develop and showcase Canada's world-leading advances in forest science and forestry practices.

Supporting Forest Education



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