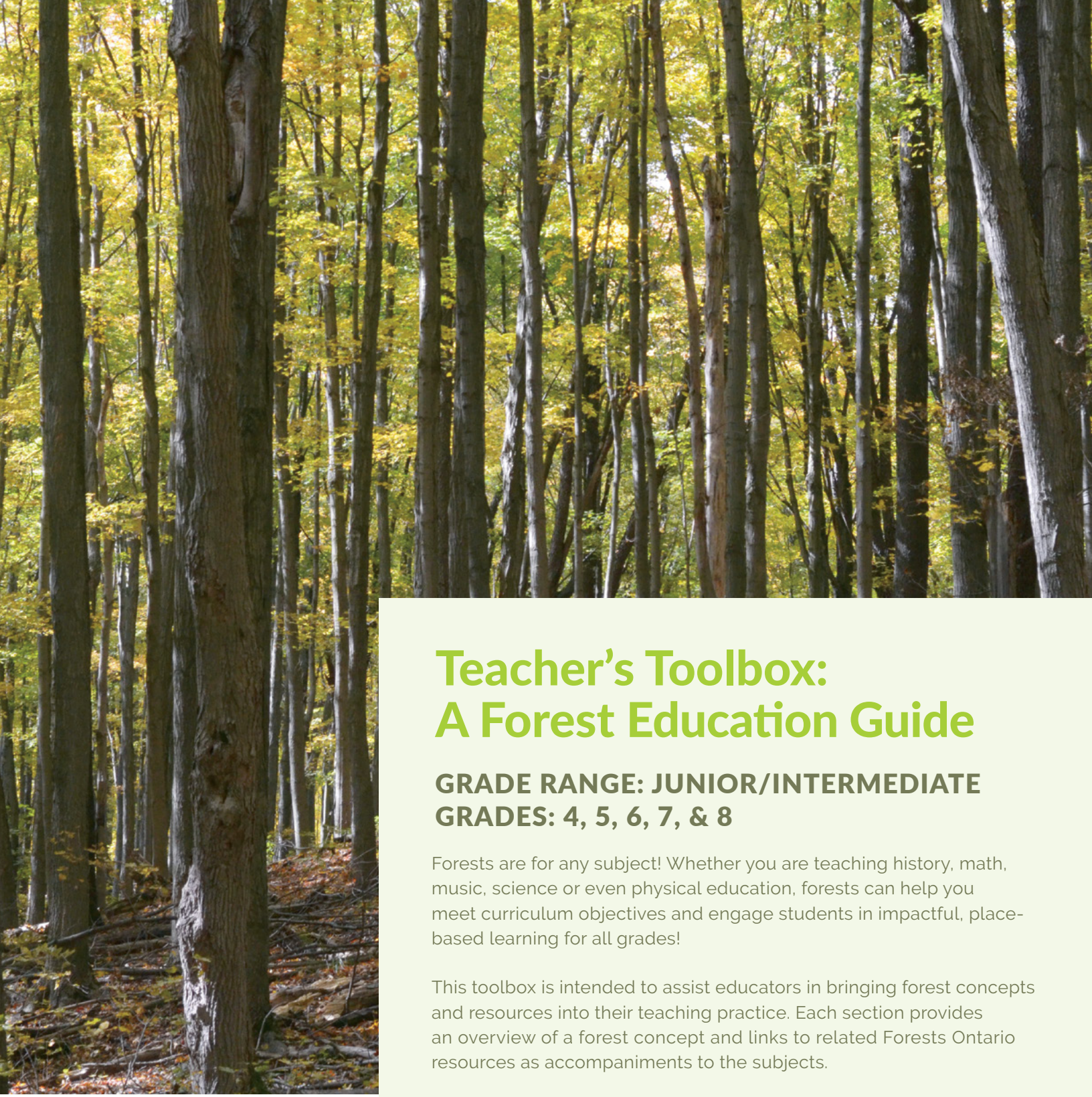


Teacher's Toolbox: A Forest Education Guide

GRADE RANGE: JUNIOR/INTERMEDIATE
GRADES: 4, 5, 6, 7, & 8

Forests are for any subject! Whether you are teaching history, math, music, science or even physical education, forests can help you meet curriculum objectives and engage students in impactful, place-based learning for all grades!

This toolbox is intended to assist educators in bringing forest concepts and resources into their teaching practice. Each section provides an overview of a forest concept and links to related Forests Ontario resources as accompaniments to the subjects.

www.forestsontario.ca

FORESTS ONTARIO

Focus on Forests

Tree Bee

Table of Contents

1. FOREST REGIONS 4

2. BIOLOGY OF A TREE 6

3. FOREST ECOSYSTEMS 8

4. FOREST HISTORY 11

5. FOREST MANAGEMENT 13

6. FOREST TOOLS 16

7. CAREERS IN THE FOREST 18

8. CHANGES IN THE FOREST 20

9. GLOSSARY 23

A Message from Forests Ontario

Forests Ontario is pleased to support formal and informal educators in bringing forest education into their teaching practice through the development and delivery of interdisciplinary programs, and a database of free, curriculum-linked resources that are grounded in real-world experiences. Forests Ontario's educational resources and programs empower youth to understand natural ecosystems and develop the skills and knowledge required to become future environmental stewards.

Forest Regions

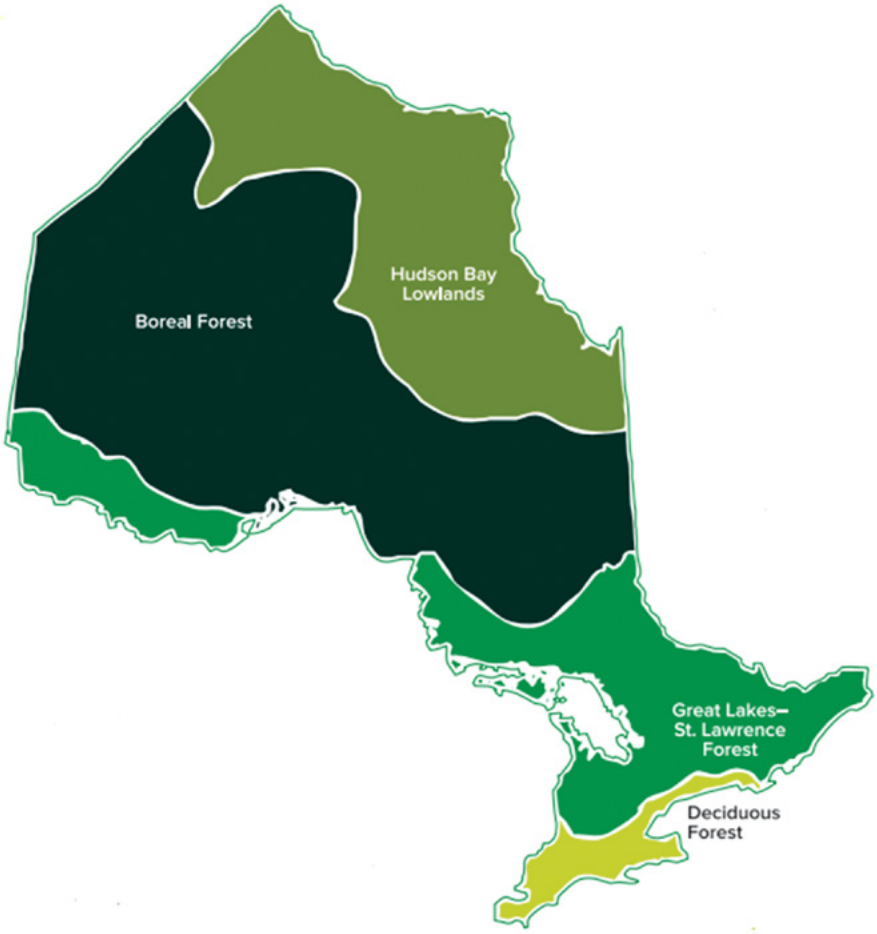
A **forest region** is a major geographic belt or zone characterized by uniformity in physiography and in the composition of dominant tree species. Different forest regions exist because of differences in soil type, topography, climate, and precipitation. While Canada has eight (8) major forest regions, four (4) can be found within Ontario. From north to south they are: Hudson Bay Lowlands, the Boreal, Great Lakes-St. Lawrence and Deciduous. Each forest region has its own characteristic mix of tree species that thrive under certain growing conditions.

Forest Region	Characteristic Tree Species
Hudson Bay Lowlands	Tamarack, black spruce, white birch, dwarf birch, willow
Boreal	White spruce, black spruce, tamarack, balsam fir, jack pine, trembling aspen
Great Lakes-St. Lawrence	Sugar maple, red maple, American beech, red oak, basswood, white elm
Deciduous	Sugar maple, red maple, American beech, red oak, basswood, white elm, tulip tree, white ash, green ash, white pine, black walnut, red cedar, eastern hemlock

Activity

Challenge your students to find your community on a map of the province or country. Once they have completed the task, see if they can translate their findings to a map showing forest regions and identify the forest region.

Figure 1: Forest Regions of Ontario (Ministry of Northern Development, Mines, Natural Resources & Forestry, 2016)

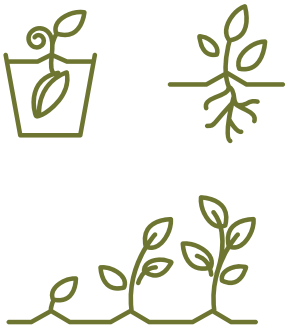


Every forest region contains a different assortment of species that contributes to **biodiversity**. A biodiverse ecosystem provides us with a healthy environment, clean air, productive soils, nutritious food, medicines, and clean water. Human society depends on biodiversity for many necessities.

Forests Ontario Classroom Resources:

- Canada's Arboreal Emblems - Fact Sheet
- Canada's Forest Distribution - Lesson Plan
- Leaf it to Memory - Activity
- Trees at Home - Lesson Plan
- Tree Bee – Web Based Tree Identification Tool
- Success of Tree Seeds - Lesson Plan
- Urban Forests & the Emerald Ash Borer - Lesson Plan and Activity

Biology of a Tree



Canada is home to hundreds of tree species. Greater diversity of species coincides with different environmental elements including water availability, soil type, and climatic factors.

All trees start life as a tiny seed. Given the right conditions, the seed will start to germinate; the tree embryo found in the seed absorbs water and splits the seed coat. First, a tiny root grows and bends downwards into the soil under the influence of gravity. Next, the stem and leaves emerge from the seed coat and push their way through the soil towards open air and sunlight. The seedling then begins to manufacture its own food. Eventually, it grows into a larger tree called a sapling. At a high-level, trees can be classified as **deciduous** or **coniferous**.

When observing a tree in the forest, we often only consider the parts that we see above the ground. While the trunk, branches, and leaves make up a large portion of a tree, we can't forget about an important underground component – the root system! Roots are a vital part of any tree, supplying it with water and nutrients that it needs to grow and thrive. Without adequate growing space or the right environment, a tree will not grow to its full potential.

Activity

Ask your students to draw a tree. Have students share their drawings and observe whether the majority of the group included all parts of a tree or just what is visible above ground. Have a discussion with your students about the role of roots and root structure in impacting tree health.

There are three primary components to a tree, each with specific functions.

Crown
The branches, twigs, and leaves constitute the crown of the tree. The branches and twigs hold the leaves up to receive sunlight, which is vital to food production.

Trunk
The trunk is the main stem of the tree. It has two primary functions – to support the crown and to transport food and water throughout the tree. The outer bark on the trunk protects the inside of the tree from injury and from drying out. It also acts as an insulator against cold and heat.

Roots

Roots spread out in the soil in a vast and intricate network, like underground branches. They usually extend as far out from the tree as the crown, if not further. In addition to anchoring the tree to the ground, roots absorb water and nutrients from the soil.

Figure 2: The tree trunk supports the crown and transfer of food and water throughout the tree.

Forests Ontario Classroom Resources:

- Not all Plants are Created Equal - Lesson Plan
- Construct a Tree - Lesson Plan
- Curious About Cones - Lesson Plan
- Seed Secrets - Lesson Plan
- How Trees Grow - Lesson Plan
- Putting Down Roots - Lesson Plan
- Parts of a Tree - Fact Sheet
- Tree Grab Bag - Activity

Forest Ecosystems

Forest ecosystems are more than just a group of trees – they include a community of organisms, both above and below ground as well as abiotic, or non-living, components. In established forests, different canopies form to create a layered effect among the forest. There can be more than one layer formed by trees or shrubs in a forest.

ABOVE GROUND

Super-Canopy Trees
These trees rise high above other trees in the forest and act as a resting place or nesting sites for birds (ex. white pine are distinctive in their super-canopy reach).

Canopy Trees
Mature trees that form a continuous layer of branches and leaves that create shade below.

Cavity Trees and Snags
Cavity trees are living or dead trees with holes; snags are standing dead trees. Both provide important habitat and nesting features for a variety of animals like owls, woodpeckers, bats, and other small mammals.

Understory Trees
Small trees growing beneath the canopy. These trees grow slowly due to the limited sunlight they receive. Some of these species are young canopy tree species, while others are species that thrive in low-light conditions. When gaps form in canopies, sun becomes more available, and many of these trees will grow quickly to fill the space.

Shrubs and Saplings
Low-lying woody plants that grow in the shade of mature canopy trees and in open areas.

Ground Cover
A carpet of different species can be found on the forest floor including mosses, ferns, tree seedlings, flowers, and fungi.

Decaying Wood
Dead trees fall to the ground, but they are not finished their role in the ecosystem. Decaying wood plays an important role in nutrient cycling and providing habitat for wildlife and other plants.

Organic Litter
Along with decaying wood, leaf litter plays an important role in recycling nutrients back into the soil. This layer helps to retain moisture in the soil and provides habitat for a variety of wildlife and other plants.

BELOW GROUND

While we cannot see this part of the forest, it plays one of the most important roles. Large and small roots of trees and plants intertwine themselves throughout the soil. Different soil layers make up soil horizons. The topmost soil layer is comprised of organic material made up of decomposed plants, this is where you will often find fine plant roots. Each year, the forest sheds leaves, twigs, and branches to the forest floor. Through decomposition, these materials break into smaller pieces and eventually become soil.

Figure 3: Trembling aspen (*Populus tremuloides*) is an early successional tree species found across Ontario. It is known for its ability to establish and grow quickly in disturbed areas (Dave Powell, USDA Forest Service (retired), Bugwood.org, no date).

FOREST SUCCESSION

Succession is the natural process of change that occurs in a forest over time as one community of living organisms replaces another.

When a forest is disturbed, it begins to change right away. New plants germinate, grow, and reproduce to successfully inhabit the vacant ecological niche. As the plants increase in size and number, competition and environmental change begin to alter the ecosystem. A new series of plants grow to repeat the cycle of change. The rate of change slows over time as the niche is filled until there appears to be no change. This is the final stage of succession in the ecosystem and is called the climax.

It must be emphasized that forests are dynamic communities that are continually changing at varying rates. Even a climax community is constantly undergoing changes. At any time in the series of changes from the beginning to the climax, a new disturbance may interrupt the process, creating a new beginning.

There are two major forms of succession: **primary succession** and **secondary succession**.

Primary succession begins on bare areas that did not previously support vegetation. These may be areas of water, sand, or rock. Primary succession begins with soil building. Soils develop from primitive plants called colonizers reacting with the rock over long periods of time to eventually generate a small amount of soil, which can eventually support larger vegetation. With the accumulation of soil, new plants germinate, grow, and reproduce to being the stages of a new succession.

Secondary succession occurs in areas in which vegetation does grow but have been altered by such external forces as fire, logging, and land clearing. New vegetation can establish on a previously initiated succession that was interrupted by fire. New plants germinate, grow, and reproduce to begin the cycle to the forest stage. Timber harvesting can also lead to secondary succession in a forest.

Forests Ontario Classroom Resources:

- Change in Forest Ecosystems - Lesson Plan
- Exploring Ecosystems - Lesson Plan
- Fire Feelings - Lesson Plan
- Forest Connections - Lesson Plan
- Forest Soils - Lesson Plan
- Invent a Forest Creature - Lesson Plan
- Predicting the Impacts of Change - Lesson Plan
- Stumped - Lesson Plan

Forest History

Canada's landscape contains many qualities that make it ideal for forests and trees. As such, Canada's natural and cultural history is strongly tied to forests and forestry.

Indigenous peoples have long since been stewards of Canada's forests. Since time immemorial, forests have been essential to the livelihood of many First Nations peoples, playing an integral role in ceremony, economic survival, and community sustenance. Many First Nations groups altered the land to better suit their needs through techniques such as slash and burn, which removed trees to make room for agriculture. These practices involved limited removal of wood and had very small impacts on forests. Practices like hunting and foraging were done sustainability, with thanks given to the land. Many First Nations groups still have an intimate and important connection with forests and forest resources across Canada, but more work needs to be done to increase Indigenous governance and stewardship in Canada's forests.

The arrival of European settlers brought more intensive logging practices to Canada's forests. The French were the first of the European settlers to depend on the forest as a source of income. Their dependency was not strictly on timber from the forests but rather the animals inhabiting them, as most of their income came from the fur trade. Wood was still harvested, but at a small scale. It was used primarily for heating, shipping and house building. It wasn't until the early 19th century that Canada's forests began to suffer devastating losses of trees.

The war between Britain and France had cut Britain off from its timber sources along the Baltic Sea therefore, Britain strongly depended on the forests in Canada (then a British colony) as a source of materials for naval shipbuilding. Although pine and oak species were the main harvesting targets, many other species suffered due to the logging practices and techniques used in those times.

The term "logging" refers to the cutting, processing, and removal of trees from a forest. In the early 19th century, this was done manually with crews of loggers. Cut trees would be pulled out of the forest by horses and then hewn (cut and shaped with a small sharp object) usually into square beams. In order to remove these trees, logging roads were established through the forest which **fragmented** the landscape and encouraged people to push deeper into the woods. Most of the cleared areas were then converted into agricultural fields or settlement areas.

Did you know you can look at a forest for signs of the past? Tree rings tell an important history of an area. A tree ring (also known as a "growth ring") is the result of new growth in the vascular cambium. Each ring represents one year in a tree's life, and a tree's age can be measured by counting the number of rings formed in the tree's trunk. This is known as dendrochronology, or telling time using tree rings. The newest ring formed in each tree is adjacent to the bark and represents the most recent growth. Each tree ring has a line between the late wood (dark) which grew at the end of the previous growing year, and the early wood (light) which grew at the start of the year. Tree rings vary in size based on conditions for growth in a season or year. Larger tree rings represent a more productive growing season and smaller ones represent a poorer growing season. Using tree rings, people can determine whether there was a drought, fire, or other severe conditions in any given year in which the tree was alive and growing.

Figure 4: Counting rings is a fun way to determine the age of a tree—each ring is equal to one year!

Forests Ontario Classroom Resources:

- Dendro Discs - Lesson Plan
- Life History of a Tree - Lesson Plan
- Back in My Day... - Lesson Plan
- Old Trees, Old Tales (Jr.) - Lesson Plan

Forest Management

Forest management consists of an established process that occurs in sequence and is repeated at set intervals. Tree harvesting is only one part of forest management, but it attracts the most attention because is causes the most visible change to a forests structure.

Forest Management Steps:

1. **Commitment**
   - Forest owners and managers develop policies that outline the degree of their commitment to sustain a forest and practice long-term forest management.
2. **Public Participation**
   - General concerns about forest management and activities and their impacts are raised on a regular basis. Public participation in the planning stages of forest management has been adapted in many provinces. Most of these concerns are raised by individuals or organizations in local communities, which may include foresters, engineers, trappers, recreational users, and many more.
   - Governments are increasing supports available to further engage Indigenous communities in the forestry sector through consultation, employment, and business development.
3. **Planning**
   - Forest management plans are prepared based on a province's Forest Management Planning Manual. Most of these include:
     i. An updated description and inventory of the proposed area and long-term activities (usually 15-25 years) along with the objectives, goals, and values that are to be met in a specific time.
     ii. A summary of the management strategy and how the objectives will be met.
     iii. Work schedules providing activities, dates, and locations to meet the objectives and management plan.

Figure 5: Areas of Concern (AOC) are discussed early in the forest management planning process and mapped to ensure their protection.

- The fundamental part of a forest management plan is to determine the annual allowable cut (AAC), or how much timber can be harvested per year. The AAC is determined based on a forests' growth over a full rotation, about 80 years, and must take into consideration the productivity, capacity, regeneration, and nature of the forest. The AAC is re-assessed at each periodic revision as outlined in the management plan, and will vary based on the depletion or re-growth of the forest.

4. **Implementation and Assessment of the Plan**

- There are four important steps in the implementation of a forest management plan:

    i. **Access** – There must be access to the forest for any activity to take place, most commonly by road. Planning the type and location of access is crucial and involves looking at the cost, potential environmental impacts, and effects on value of the site and potential future uses of the access, among other concerns.

    ii. **Harvest** – Once there is access to the forest, the removal of timber begins. There are four main systems of harvesting trees: seed tree, shelterwood, selection, and clear-cutting. The choice for any system is based on how suitable it is for a given location and scenario, and there are many variables of each system. The most important thing is to choose a system that meets the objectives of the forest management plan.

    iii. **Regeneration** – The most important part of any management plan is to re-establish a harvested area with new trees. This is accomplished either by tree planting or natural seeding. For successful regeneration to occur, the planting sites and seeds must be prepared. Preparation can involve creating suitable conditions on the forest floor for regeneration and varies by location and harvesting system.

    iv. **Maintenance** – The forested area must be maintained and protected in order to promote forest health and meet the objectives of the plan. Usually, thinning (the removal of unwanted trees and plants) occurs to promote growth of healthier or more desirable trees, and to reduce competition within the stand.

Figure 6: Harvesting occurs using one of four systems: seed tree, shelterwood, selection, and clear-cutting.

Forests Ontario Resources:

- A Fine Balance - Lesson Plan
- Cutting Styles - Lesson Plan
- Forestry Terms Wordsearch - Activity
- Forest Values - Lesson Plan
- Glossary of Forest Management Terms

Forest Tools

Understanding the local ecosystem informs the choices practitioners make in forest management. One important way to achieve this understanding is by taking detailed forest measurements to get a picture of what planning and management activities need to be completed through a forest inventory. Forest inventories focus on collecting several crucial pieces of information including tree species, age, height, and density. Rather than measure each tree within a stand, a portion of the stand (sample unit) is sampled, the information collected in the sampled area is then expanded to reflect the entire the stand. This information is collected using a number of forestry tools and techniques, some of which are discussed in this section.

Figure 7: Forest practitioners use a variety of tools to collect data so that they can make informed, responsible planning decisions.

Clinometer
Scaling a tree or cutting it down may be the most accurate way to measure its height but it is far from the most practical. However, using a clinometer, which measures angles and distances, and little trigonometry you can get a good estimate of a tree's height without needing to leave the ground!

Activity

Don't have access to a clinometer? Try making your own to determine the height of a tree using our "How Tall is that Tree" activity sheet with your class!

Increment Borer
Every year, a tree grows a new layer of wood. By looking at a cross-section of a tree, you can count the rings (or annual growth layers) to determine a tree's age. An increment borer is a tool that drills a small hole into a living tree and removes a cross section of wood tissue for analysis.

Prism
A prism is a tool that is used to determine the basal area of a forest. Basal area describes the average amount of space occupied by trees in one hectare of forested land. It is closely related to volume and is a factor in determining the future development of the forest. Prisms are advanced tools used in forestry that determine what is and is not within the basal area.

Diameter at Breast Height (DBH), Diameter Tape & Calipers
Diameter at Breast Height (DBH) is the standard technique for determining the diameter of a tree. The tree is measured at approximately 1.37 m from its base. There are two tools which are used to measure DBH – diameter tape (also known as d-tape) or calipers. These tools are already calibrated to give the user the diameter of a tree with no calculations required. Understanding the diameter of a tree helps to determine wood volume by giving one part of a calculation for volume of a cylinder.

Forests Ontario Classroom Resources:

- Circle and Cylinder GeomeTREE - Lesson Plan
- How Tall is that Tree - Activity
- Reaching New Heights - Lesson Plan
- Tree Sampling - Lesson Plan

Forest Careers

A career in the forest sector can be anything from working in the field, to operating machinery, to working as a lab technician on expanding wood products. There is a growing diversity of careers which is expanding annually—the possibilities are endless!

Forests, if well-managed, are a renewable resource and contribute to Canada's economic, cultural, and social wellbeing. Low levels of enrollment into post-secondary forestry programs, combined with a high rate of retirement within the forest sector, means there has never been a higher demand for forest professionals.

Figure 8: There is a wide variety of forest careers available, from on the ground operations to forest management planning and innovation.

Forest sector professionals understand the connections that people have with the natural environment and all it has to offer. These connections are linked to forests, ecology, wildlife, pest control, timber harvesting, non-timber wood products, and forest regeneration, to name a few. Since the forest sector is very interdisciplinary, it invites a wide range of individuals with an even wider range of skills to work together to promote healthy forests. Examples of forest sector careers include:

- Registered Professional Forester
- Forest Technician
- Biologist
- GIS Analyst or Technician
- Tree Marker
- Conservation Officer
- Environmental Engineer
- Arborist
- Forest Fire Fighter
- Tree Planter
- Park Warden
- Logging Equipment Operator
- Chemical or Material Engineer
- And much more!

Activity

Ask your students to write out a list of their skills. Based on these skills, have students identify a forest career which suits them. Have them develop a poster which promotes their selected forest career. Ask the class to find other forest careers that they feel would work well with their skills, attributes, and interests. Have students discuss how various forest careers are linked.

Forests Ontario Classroom Resources:

- Forest Career Chart - Fact Sheet
- Forest Folks - Lesson Plan

Changes In The Forest

To the casual observer, forests can appear to be a stable and unchanging part of the landscape. However, forests are dynamic ecosystems that are consistently undergoing change.

While change is generally gradual, there are some external stressors that can cause rapid and dramatic alterations to forest ecosystems and composition. Two major sources of stress to forest ecosystem function and health include climate change and invasive species.

Climate Change
Climate change is already having a significant effect on forest ecosystems and cycles. As temperatures and weather patterns change, so too will forest composition. Species that adapt best to new climate conditions and disturbance regimes will succeed and dictate the transformation of forests. In some instances, forests may convert to different land types, such as grasslands.

The productivity of forests will vary (either increase of decrease) depending on the rates of tree growth and mortality, as well as the forest region. Many forested areas will experience a decrease in productivity, which may result in habitat loss or a migration of species, usually northwards or higher in elevation. Other regions will go through something called "novel climate," which means tree species that are already poorly adapted to climate change will experience even more stress.

Forest-dependent communities will experience the impact of changes in forest regions most acutely, specifically in changes to timber supply and other non-timber forest product values. Both the quantity and quality of desired tree species may be affected, putting many forest-dependent communities at risk.

In addition to the above impacts, forest operations may be time-limited with changes in season length. Shorter winters mean less time for harvesting operations in Canada. Aside from economic losses in forest value, climate change can lead to increased fire activity in Canada's forests. It is estimated that annual burned areas will approximately double by the end of the century.

Invasive Species

Invasive species are threatening our forests now more than ever. Global trade has made the introduction of pests and plants into new ecosystems and areas even easier. While there are protection mechanisms to prevent introduction (Canadian Food Inspection Agency), invasive species are still entering forests and pose an immense threat to ecosystem stability and resources.

Figure 9: Emerald Ash Borer (EAB) are an invasive species first reported in Ontario in 2002. Immature EAB feed on the inner bark of ash trees creating structures called galleries which disrupt the transfer of nutrients between roots and leaves, eventually killing the host tree.

An invasive species is an organism (animal, bacterium, fungus, or plant) introduced to an area outside of its natural range that creates a negative impact on its new environment. Theses impacts can be social, economic, environmental, or a combination of all three. Invasiveness refers more to the behaviour of an organism than its origins. Invasive species are commonly associated with the terms “non-native”, “alien”, or “introduced”; however, given the right influence of events, native species can become overpopulated and have similar negative impacts.

Alteration and destruction of natural landscapes can lead to ecosystem stress, making these areas more sensitive and prone to invasion. Invasive species are a serious threat to biodiversity, second only to habitat loss. The introduction of extra competition to a natural landscape increases pressure on native species, which can result in the invasive species outcompeting native ones. Given the right set of conditions, invasive species can eliminate native species in an area in a matter of years. A lack of predators can help to boost invasive species populations, speeding up this process.

Invasive species have direct impacts on the economy, with costs from the loss of production in the agricultural and forest sectors, as well as costs associated with their management. The presence of invasive species can also negatively impact other sectors such as recreation and tourism. The costs relating to invasive species are not always direct and make take years to fully emerge.

Activity

Split the class into groups and have them develop an invasive species of their own. The invasive species must compete with and/or negatively impact a tree species. Have each group draw their invasive species and provide information about its life cycle, its negative effects on the environment, and define its characteristics.

Forests Ontario Classroom Resources:

- Alien Invaders - Lesson Plan
- Invasive Species Wordsearch - Activity
- The Heat is On - Lesson Plan
- Urban Forests and Emerald Ash Borer - Lesson Plan

Glossary

Biodiversity	Biological diversity: Refers to the diversity of life on earth and includes every living organism (trees, flowering plants, insects, fish, birds, mammals, etc.).
Coniferous	Cone-bearing trees: Also known as evergreens that have needle or scale-like leaves.
Deciduous	Trees or shrubs that drop/shed their leaves seasonally, usually at the end of the growing season in the fall.
Forest Management	Involves not only producing raw material from forests sustainably, but also maintaining the many other values of the forest (eg. wildlife habitat, water and soil resources, and recreational opportunities).
Forest region	A geographic area or zone characterized by similar climate/ weather, landscape features, and composition of tree species.
Fragmentation	The division of habitat into small, isolated pockets.
Succession	A series of gradual and complex changes in an ecosystem.
Primary Succession	Occurs in bare areas that did not have earlier vegetation (eg. a beach, bare volcanic soil).
Secondary Succession	Occurs in areas where plants already grow but have been disturbed by some outside force (eg. after a storm, fire, etc.).

Notes