



IT TAKES A TREE

**A Forest Education Unit
For
Grades 9-12**



The IT TAKES A TREE forest education unit was created to help you and your students learn about the forest, recognize man's interdependence with nature, and explore the basic question, "How shall we use the forest to meet our needs while balancing economic and environmental values?" The unit is a user-friendly, cross-curriculum tool for examining that question.

IT TAKES A TREE is organized into three lessons:

- 1. What is the nature of our forests?**
- 2. What are our needs from and for the forest?**
- 3. How can we meet and protect those needs?**

The unit may be utilized with additional support materials, such as the IT TAKES A TREE video that makes a valuable post-unit reinforcement tool. The unit may also be adapted to suit the needs, skill levels, and time constraints of the individual classroom.

Lesson plans are organized around a teacher outline and include a list of objectives, cross-curricular skills, and vocabulary. Background information for the teacher and discussion material for the classroom are woven into the outline. Student reinforcement activities, a student quiz, and a teacher answer key can be found in the appendix, along with a list of additional resources. These resources have web sites with support materials for further teacher and student enrichment of the topics covered in the unit.

Best wishes in implementing IT TAKES A TREE.

Sincerely,

The Pacific Logging Congress

IT TAKES A TREE



INTRODUCTION

The beauty and majesty of the forest have captured man's imagination since his first walk through primeval woods. Over the course of millennia, forests have adapted to the stresses of nature and to the needs of the human societies living in the shadows of their trees. Through time, they have provided a host of valued gifts, both tangible and intangible.

Before the arrival of Europeans to North America, First Nation Peoples had already been shaping the face of the forest for more than 10,000 years. Trees provided wood for their daily needs. By use of fire, indigenous peoples opened up portions of the forest for establishing villages and for planting crops. Areas cleared for use and by fire made hunting and the harvesting of berries easier and more productive. Opened areas also helped protect native villages from the undetected arrival of their enemies. In the process of using them, First Nation Peoples kept the forests healthy and renewed.

European settlers to North America brought with them new values and new ways of interacting with the forest. Immigrants cleared vast tracts of forestland to plant crops and build towns. They made constant use of these forests, which provided them with building materials, food, and fur. To them, the forests seemed limitless and inexhaustible, a vital source of energy to fuel both their homes and their blossoming societies.

Today we recognize that our forests are not limitless and inexhaustible. They must be wisely managed and protected if we are to continue to draw from their bounty for our increasing needs and still maintain their viability and integrity for future generations. How that is to be accomplished is of concern to foresters, scientists, legislators, and citizens alike. Much time, effort, and thought have gone into the development of contemporary policies and practices to ensure that our growing society can balance its needs for both a healthy economy and a healthy environment. Understanding how the forest functions as an ecological community is the first step. Recognizing our various needs from and for the forest is the second. The third is implementing enlightened management.

LESSON 1

WHAT IS THE NATURE OF OUR FORESTS?



Objectives:

1. To understand forests as ecological communities
2. To understand how trees grow
3. To understand the life cycle of trees and their various stages of development
4. To understand how disturbance factors affect trees and the forest

Skills:

- | | |
|-----------------------|------------------|
| 1. Association | 6. Geography |
| 2. Biology | 7. History |
| 3. Critical reasoning | 8. Language arts |
| 4. Ecology | 9. Math |
| 5. Forestry | |

Vocabulary:

1. **Bark** - the rough outside covering of a woody stem or root
2. **Biota** - the plant or animal life forms in a given area
3. **Cambium** - parallel rows of cells that form new layers of bark and wood
4. **Carbon dioxide** - a colorless, odorless, incombustible gas that is formed during respiration, combustion, and organic decomposition
5. **Ecosystem** - a biological community together with its surrounding air, soil, and water
6. **Ecology** - the study of how plants and animals interact with their environment
7. **Habitat** - the set of ecological requirements that determines where a plant or animal lives
8. **Heartwood** - the hard, nonliving wood at the center of the tree that is more rigid than the living sapwood encircling it
9. **Oxygen** - an element found freely in nature that is needed for humans and animals to be able to breathe and is necessary for combustion
10. **Photosynthesis** - the process of capturing, by means of chlorophyll, energy from the sun to convert water plus carbon dioxide in the air into nutrients for a plant and giving off oxygen into the air
11. **Pioneer species** - a species adapted to colonizing an area quickly
12. **Roots** - the web of tubes and fine hairs that help maintain the tree upright and secure water and soil nutrients
13. **Sapwood** - newly formed wood, lying just outside the cambium, that acts as a major conductor of water and minerals for the tree
14. **Succession** - the predictable replacement, over time, of the species in an area by ones of a different nature
15. **Web of Life** - the network of relationships that interconnect all species of an ecological community



Focus:



Discuss the nature of the forest community

I. What are some types of communities?

- A. Identify the root of the word “ecology”: from the Greek words “oikos” for *house* and “logos” for “*the study of*”. Ask students to speculate about what the “oikos” is in any given community.
- B. Ask for examples of human communities: Earth, nation, province or state, community, family, etc.
- C. Ask for examples of ecological communities: a backyard, a tide pool, a fallen log, a forest, our bodies, etc.
- D. Discuss what elements make up these human and ecological communities: people, trees, flowers, birds, seaweed, shellfish, insects, bacteria, fungi, etc.
- E. Discuss how the various elements of a community interact: what happens to one of them has an effect on the entire community.

II. What are the patterns that all ecological communities share?

- A. Interdependence: the success of the community reflects the success of the individuals in it; the success of the individual depends on the success of the community.
- B. Feedback mechanisms: the individual in a given community adjusts (adapts) to changes in its environment.
- C. Ecological balance: the community changes in response to changes made by individuals within that community, which moves the whole system toward a natural balance.



Discuss how trees grow

I. What are the components of trees, and what functions do they serve the tree?

- A. Outer bark: serves to protect the tree from outside damage
- B. Inner bark: serves to bring the food that is produced in the leaves or needles to the rest of the tree, where it is stored or used for growth
- C. Cambium: a circle of cells which serves to produce new layers of bark and wood each year
 1. These layers of wood are called rings.
 2. One counts the dark rings to tell the age of the tree.
 3. Rings that are far apart indicate ample resources (sunlight, water, nutrients) during the growth period of spring and summer.
 4. Narrow rings indicate a shortage of resources. In the West, the most common shortage is water.
- D. Sapwood: serves as a major conductor of water and minerals for the tree.
- E. Heartwood: serves to give strength to the tree and maintain its upright position



II. What is the process by which trees grow?

- A. Identify photosynthesis and how it affects the growth of trees.
 1. Indicate the source of the word: from the Greek “photo” for *light*, “syn” for *together*, and “tithenai” to *put*. Discuss in light of other English words that have the same prefixes, suffixes, and roots. How do those words relate to the basic meaning of the original Greek?
 2. Leaves and needles take in carbon dioxide from the air.
 3. Trees use the CO_2 plus H_2O plus the energy in sunlight to make simple sugars, which act as food for the tree.
 4. Trees give off O_2 into the air as a waste product of photosynthesis.
 5. Humans and animals use the oxygen in the air to be able to breathe.
 6. In breathing, animals and people give off carbon dioxide into the air, CO_2 that the trees then utilize for growth, completing the cycle.
- B. Review the concept of competition.
 1. Discuss the differences between competition, which increases productivity, spurs creativity, and benefits society, and unhealthy competition, which physically weakens the individual, affects the morale and goals of the individual, and produces negative social conditions.
 2. Discuss competition among humans: in families, in the classroom, in sports, in the workplace, among nations. When is competition healthy? When is it destructive?
- C. Discuss competition as a vital element in the growth of trees.
 1. How does the need for sunlight, soil nutrients, and water play into competition among trees and other plants?
 2. How does overproduction affect competition in plants, in general?
 3. How does overcrowding affect competition among trees?
 4. What happens to trees and other plants that compete successfully for sun, soil, and water?
 5. What happens to the tree and plants that do not compete successfully?



Discuss the life cycle of trees and their stages of development

I. What are the characteristics of each stage of a tree’s growth?

- A. Seed: the embryonic tree plus the initial nutrients as it first begins to grow. In trees the seed may be found in nuts, fruits, or cones.
- B. Seedling: what sprouts from a seed, the youngest form of tree
- C. Sapling: a young tree
- D. Tree: a woody plant with one main stem or trunk. Trees may be deciduous and lose their leaves in autumn, or they may be evergreen and maintain their leaves for more than a year.



II. What are the life-cycle characteristics of trees?

- A. Seedlings are vulnerable. Animals, such as deer, find them tender and succulent and seek them out for forage. Seedlings are also damaged or destroyed by insects, drought, and competition for sun, nutrients, and water.
- B. Saplings are vigorous growers. Because of this, they do a great deal of photosynthesis. This, in turn, contributes significantly to cleaning the air of greenhouse gases and to replenishing oxygen. A hectare of young trees may consume almost 6725 kg of carbon dioxide and produce over 4483 kg of oxygen in a year.
- C. Adult trees bear cones, fruits, and nuts. As these trees continue to grow, they provide not only new seedlings and clean air, but they also help prevent erosion and cool the air.
- D. Senescent trees lose more wood than they grow. They often have dead tops, dead limbs, and pockets of rot. Like snags, they provide nest sites for hole-nesting birds and mammals.

III. What affects the health of trees?

A. Insect infestations: bark beetles

1. A variety of species of bark beetles attack specific species of trees.
2. Female beetles emerge in spring and early summer, find a vulnerable tree, and bore into the bark to lay their eggs.
3. The larvae eat and tunnel through the cambium layer and may girdle the tree. This cuts off the movement of nutrients and water within the tree and results in its death.
4. When a beetle tries to bore into a healthy tree, sap (pitch) is moving within the tree with a high enough rate of flow to prevent the beetle from succeeding. Unhealthy trees have less sap flow and cannot “pitch out” the beetles.

B. Insect infestations: spruce budworm

1. It is one of the most widely distributed destructive forest insects in North America, attacking a variety of trees.
2. The moths deposit their eggs midsummer in large clusters on the undersides of needles.
3. The eggs hatch in about 10 days. The young larvae spin shelters in which they overwinter.
4. In spring, they emerge and tunnel within the old needles and into unopened buds. The larvae spin loose webs among the needles and eat the new foliage as it emerges, defoliating the tree.
5. Without leaves or needles for photosynthesis, the tree is not able to produce the sugars it needs to survive.

C. Fire and the forest:

1. Over thousands of years, periodic lightning-generated fires acted to clear out underbrush and small trees while only charring the outer bark of larger trees that survived to become healthier in a less crowded area.



2. These natural fires moved along the ground more slowly and burned at lower temperatures than modern wildfires.
3. They opened up small pockets within the forest, allowing browse to grow up for grazing animals such as deer.
4. By destroying stunted and weak trees, they kept insect infestations from reaching epidemic proportions.
5. The raging wildfires typical of modern times are born of accumulated fuels and often climb into the forest canopy. Once in the canopy, fires can kill trees of all ages. Very hot fires expose bare soil, baking the life out of it and making it vulnerable to erosion. All our recognized forest values are compromised by such fires.



Discuss forest succession and how it influences the forest.

I. What is succession?

- A. It is the replacement of the biota of an area by one of a different nature.
- B. Forest succession takes place over very long time intervals, often hundreds of years.
- C. During succession, the plant life is continually changing
 1. New species invade the forest.
 2. Existing species that are able to reproduce persist in the forest.
 3. Existing species that cannot compete for sun, soil, and water do not readily reproduce. Species that do not reproduce die and eventually disappear from the forest.
 4. New species move into areas opened up, replacing species that are dying out.

II. What is the difference between primary and secondary succession?

- A. Primary succession is characterized by initial changes in the forest's physical environment, such as the development of soil.
 1. The weathering of rock and the decomposition of lichens and mosses create new soils.
 2. Soils encourage new species of plant life.
 3. The new biotic community progresses in the absence of catastrophic disturbance.
- B. Secondary succession is the redevelopment of a biota following a catastrophic disturbance.
 1. Catastrophic disturbances destroy the forest but do not destroy the potential for its rapid regrowth.
 2. Secondary succession is characterized by a progression from grasses and forbs to shrubs, open-canopied saplings, close-canopied pole trees, mature trees, and old growth.



Discuss how disturbances affect forest communities.

I. What are some types of disturbances?

- A. Natural disturbances: earthquakes, severe winds, flooding, fire, drought, insect infestation, disease, overgrazing**
- B. Human disturbances: development of an area for housing, farming, or recreation, timber harvest**

II. What are some problems associated with disturbances?

- A. Natural disturbances hold the potential for loss of life and property.**
- B. They increase the risk of soil erosion.**
- C. In the case of wildfires, they may destroy forests rather than merely scorch trees. A total of 1488 fires were reported in British Columbia in the year 2000, and 16,400 hectares were burned.**
- D. Disturbances hold the potential for reduction in the quantity and quality of animal and plant life.**
- E. Disturbances may pollute the air and water.**

III. What are some benefits of disturbance?

- A. Disturbances may act as necessary checks and balances in nature.**
- B. Disturbances reduce numbers and may relieve stress and competition among overcrowded plants.**
- C. Disturbances may clean out diseased and dead trees, that act as reservoirs of insects and disease and as a source of fuel for wildfires.**
- D. Fire allows certain species of plants and trees, such as closed-cone conifers, to release their seeds.**

IV. What are pioneer species and how do they compare with other forest trees?

- A. Douglas-fir and redwood are examples of disturbance-dependent species that have evolved over millions of years to seed in quickly in areas opened by disturbances.**
- B. Pioneer species tend to be intolerant, especially in their early years, of the shaded and crowded conditions in the understories of other trees. They tend to grow well only in full sunlight.**
- C. Because pioneer species grow well only in full sunlight, foresters favor growing them by creating openings, clearcuts, that mimic the natural effects of fire. This is called even-age management, because all the trees in an area begin growing at the same time.**
- D. Selective harvest is a means of uneven-aged management that leaves behind a mixture of young trees, more mature trees, and fully mature trees, as well as some open areas. Douglas-fir and redwood do not respond well to uneven-aged management. It does not allow enough sunlight to reach the forest floor. Few seedlings appear, and a vigorous understory of successor species grows instead.**
- E. Other shade-intolerant species, such as ponderosa pine, allow more light to reach the forest floor. Although ponderosa pine is considered a pioneer species, foresters will often selectively harvest it.**
- F. Western hemlock, Western cedar, spruce, and true fir have adapted to shaded and crowded conditions. They invade existing mature forests and eventually become dominant. Shade tolerant species lend themselves to selective harvesting, in which trees are removed based on their health and condition and on potential improvements to stand productivity.**



LESSON 2

WHAT ARE OUR NEEDS FROM AND FOR THE FOREST?

Objectives:

1. To identify the intangible values society derives from the forest
2. To identify what tangible benefits society derives from the forest

Skills:

1. Association
2. Consumer awareness
3. Economics
4. Ecology
5. Language arts
6. Logic
7. Math
8. Natural science
9. Physical science

Vocabulary:

1. *Greenhouse gases*- atmospheric gases that are relatively transparent to short-wave radiation coming into the earth and opaque to long-wave or infrared radiation reflected back from the earth. The most common of these are carbon dioxide and methane. These gases are thought to increase the earth's temperature.
2. *Esthetic*- relating to the beauty of something
3. *Stewardship*- the duties and responsibilities of a steward or caretaker
4. *Natural resources*- those items taken from the land or water that can be used as raw materials by individuals and for the industrial economy
5. *Watershed*- an area from which surface and ground water flows out; the area drained by a river or river system

Focus:



Identify and discuss our forest needs

- I. What are intangible benefits that the forest provides?
 - A. The forest provides esthetic benefits.
 1. Places of beauty and serenity in nature
 2. Places to avoid crowded urban environments
 - B. The forest provides recreational benefits.
 1. Camping, hiking, boating, and swimming, fishing, and skiing areas
 2. Resort areas



C. The forest provides ecological benefits.

- 1. Habitat for hundreds of species of plants, fish, and wildlife**
- 2. Clean water: Rivers and streams usually begin from forested areas.**
- 3. Erosion protection: Tree roots and forest litter hold soil in place.**
- 4. Clean air: Photosynthesis cleans the air of greenhouse gases and replenishes oxygen.**

II. What are the tangible benefits that the forest provides?

A. The forest is the source of a great variety of careers.

- 1. Jobs in the forest industry, foresters, scientists, computer programmers, fellers, heavy equipment operators, truck drivers**
- 2. Jobs in forest-related industries, cabinet makers, construction workers, biomass engineers**
- 3. Jobs in Provincial agencies that regulate and manage public and private forestlands**
- 4. Canada provides 842,000 jobs in forestry, lumber, wood products, pulp, paper, and paperboard.**
- 5. British Columbia's forest industry provides approximately 101,000 direct jobs, 6.5% of the Province's total employment.**
- 6. Canada provides over ten billion dollars in forest-industry-related salaries.**

B. The forest is a source of economic benefit to forest-dependent communities and to the provinces in which they are located.

- 1. The forest industry in British Columbia generates an economic value for Canada of \$17.7 billion annually.**
- 2. The forest industry is a source of tax revenues to provincial, and local governments.**
- 3. Taxes paid by forest-products companies and their employees greatly benefit local communities and are often used for schools and roads in regions where harvesting takes place.**

C. The forest is a source of trees that provide society with lumber, paper, and the over-5,000 forest products we use in our daily lives.

- 1. Wood is practical and healthy for the environment: it is nature's renewable, recyclable, biodegradable resource.**
- 2. Wood is more energy-efficient in buildings: it provides 413 times more insulation than steel, eight times more than concrete, and 2,000 times more than aluminum.**
- 3. North Americans use 0.5 cubic meters of lumber and structural panel products per year and 240 kgs of paper.**
- 4. New residential construction creates the largest demand for lumber, approximately 39% of the softwood lumber demand in 1996.**



LESSON 2

5. **Repair and remodeling of existing homes made up 30% of the total demand for softwood in 1996.**
6. **As our population increases, demands are expected to increase 50% by the year 2020.**
7. **There are over 155 paper mills in Canada. Today, 23 mills are capable of recycling and 62 mills use recovered paper, in whole or in part, as a source of fiber.**
8. **Consumer products that come from trees do not always look like wood or paper.**
 - a. ***Processed tree fibers* produce Rayon and Tencel fabrics.**
 - b. ***Lignin*, the substance that holds tree cells together, is used as a thickener in such varied products as puddings, baby food, pet foods, and cosmetics.**
 - c. ***Tree oils* produce flavorings and fragrances used extensively in foods, beverages, health and beauty aids, and medicines.**
 - d. ***Wood sugars* are used to grow torula yeast, a high-protein, iron-rich additive in many baked goods. Vanillin, a commonly-used, highly fragrant flavoring in cooking and baking, and maple syrup both derive from the wood sugars in trees.**
 - e. ***Cellulose*, the substance that plant cells are made of, comes in several types. It is flavorless and odorless, so it makes a good wrapper for many food products, such as sausages. Cellulose is also used to make as diverse a set of products as hard hats, combs and brushes, luggage, and fishing floats.**
 - f. ***Wood waste*, such as chips, sawdust, and bark, are burned for biomass energy. Sawdust is combined with paraffin to form pressed logs for fireplaces.**

LESSON 3

HOW CAN WE MEET OUR NEEDS FROM AND FOR THE FOREST?



Objectives:

1. To understand the role that enlightened management plays in keeping the forest healthy, protected, and productive
2. To understand the role of environmental stewardship in sustaining our forests
3. To understand the role of the consumer in forest stewardship

Skills:

- | | |
|----------------------|-----------------------|
| 1. Association | 6. Economics |
| 2. Critical thinking | 7. Consumer awareness |
| 3. Biology | 8. Language arts |
| 4. Horticulture | 9. Math |
| 5. Ecology | 10. Social science |

Vocabulary:

1. **Biomass harvesting**- removal and chipping of small trees, usually as part of forest thinning. Chips may be used for paper or other products or burned to generate electricity.
2. **Controlled burns**- fires purposely set to burn off excess fuels or undesirable vegetation under conditions that allow the course and severity of the fire to be controlled
3. **Downed logs**- the trunks of dead trees that have fallen to the forest floor
4. **Forest practices codes**- provincial laws dictating the conditions under which forestry companies may harvest trees and manage lands and water
5. **Fuel load**- the weight of all combustible material on a hectare of land
6. **Multiple-use public forests**- forests owned by government that are designated for recreation, grazing, wildlife habitat, mining, harvesting, and watershed protection
7. **Natural regeneration**- the regrowth of areas of forests without human intervention
8. **Old-growth forests**- forests in which the dominant trees are large and show signs of age and in which there are many standing and fallen dead trees
9. **Reforestation**- the replanting of seedlings to regrow areas of the forest that may have been harvested or destroyed by a natural disaster
10. **Riparian area**- the area bordering a river, stream, pond, or lake
11. **Salvage logging**- removal of dead or dying trees killed by disease, insect attack, fire, or competition with other trees
12. **Snags**- dead trees that have not yet decayed to the point of falling over



Focus:



Discuss the various aspects of enlightened forest management

I. How did enlightened forest management evolve?

- A. Just over 2/3 of British Columbia and just under half of Canada is forested.
- B. Ninety-five percent of British Columbia is Crown land (owned by the public).
- C. In 1871, when the colony of British Columbia entered Confederation, it was vested with ownership of, and jurisdiction over, all lands which had not been granted to private interests.
- D. In 1885, Banff was established as Canada's first national park
- E. In 1909, the Royal Commission of Inquiry was established to explore conservation issues.
- F. In 1912, the first forest act was passed, introducing early conservation methods.
- G. In 1995, the Forest Practices Code was passed to support British Columbia's commitment to sustainable forestry.

II. How do we identify and manage our special and unique forests?

- A. Protected public forests: No harvesting is allowed.
 1. Over 11.7 million hectares of forest land in British Columbia are set aside as part of Canada's national wilderness, national parks, and protected old growth, close to 13% of the Province's total land base.
 2. Canada has over 12 million hectares of old growth forest within its provincial and state park boundaries.
- B. Multiple-use public forests: limited and closely regulated use.
 1. Recreation: By law, access to and use of public recreation areas must be part of forest management and planning for provincial forestlands. Roads built by forest-resource companies provide access to camp sites, ski areas, and trailheads. Cross-country skiing and snowmobiling are enjoyed in many younger, reforested areas.
 2. Grazing of commercial stock, harvesting, and mining: These activities are allowed under guidelines that mandate that harvest and growth be balanced.
 3. Watershed: The water that feeds into rural and urban water systems from the forest via natural creeks, streams, and rivers. Responsible forest management techniques, such as erosion control, as well as adherence to forest practices codes, assure that those waters will be protected and maintained pure and clear for public use.



C. Privately owned commercial forestlands: Sustainable harvesting takes place

- 1. Forest are managed and strictly regulated for production and environmental protection**
- 2. In the last decade and a half, forest-products companies have spent more than \$100 million on wildlife and environmental research to enable them to meet the needs for wildlife and habitat.**
- 3. The process of developing and maintaining oversight in compliance with provincial, and federal regulations represents a tremendous commitment on the part of foresters, scientists, forest companies, and government agencies to maintain the quality of our natural resources. Millions of dollars and manpower hours go into the regulatory process each year.**

III. What role does management play in forest health and sustainability?

- A. In British Columbia, the annual loss to pests is about 14 million cubic meters.**
- B. Trees stressed by overcrowding, old age, and drought are vulnerable to insects, fire, and disease.**
 - 1. Overcrowding results in intense competition for sun, soil, and water.**
 - 2. An average 30-meter tree has about 200,000 leaves that during a growing season take up about 50,000 liters of water from the soil. Drought conditions compromise the ability of the tree to take up enough water to meet its needs.**
- C. Selective thinning of weakened trees provides room between healthy trees and increases their access to sun, soil, and water for growth.**

IV. What influence does secondary succession have on the management of forests?

- A. Harvest planning should reflect whether the dominant tree species is a shade-intolerant pioneer species or a shade-tolerant successor species.**
- B. The type of harvesting done for a particular area usually has this pattern in mind. The size and pattern of the harvest are determined by the ability of the new crop of trees to occupy the site and to grow successfully.**
 - 1. Light partial cuts: This type of harvest favors shade-tolerant species, especially those already established in the understory.**
 - 2. Moderately-heavy partial cuts and the harvesting of small groups of trees: These two methods of selective harvesting favor mid-tolerant species by creating small holes in the forest canopy similar in size to those that would be formed by cool fires, small-scale windthrows, or the deaths of overmature dominant trees.**
 - 3. Clearcutting: This type of harvest removes all the trees in a limited area to simulate the effects of catastrophic disturbances such as fire or windthrow. A larger open area such as this favors pioneer species.**

**V. How does enlightened management make use of sustainable forestry?**

- A. Sustainable forestry is the management of all forest resources to maintain them in the ecosystem. Reforestation and resource protection are the keys to sustainability.**
- B. Reforestation may be accomplished by means of natural regeneration.**
 - 1. Some conifers, like redwoods, grow fast by sprouting new trees from stumps. Like other conifers, they also produce seedlings from seeds expelled from their cones.**
 - 2. Hardwoods also grow naturally from stumps, as well as from roots, nuts, and seeds.**
 - 3. In moister coastal areas, where growing conditions are less demanding, natural regeneration from seed can be sufficient to reforest harvested or naturally disturbed areas.**
- C. Reforestation may be accomplished by means of nursery-raised seedlings.**
 - 1. Cones are collected and seeds gleaned from only the finest trees, those that are straight, fast growing, and disease resistant.**
 - 2. Trees have evolved to adapt to their local environments. Since a seed moved some distance from the parent tree or into a different environment would grow poorly, the replanting of nursery-grown seedlings is done with plants of the same species, taken from the approximate area where harvesting took place.**
 - 3. Seedlings are usually 1-2 years-old by the time they are replanted into harvested areas. This allows them greater resilience for survival because of their size. It also allows them to grow faster because of their longer, well-established root system.**
 - 4. Improvements in genetics and planting technology now allow for almost 95% success in survival of nursery seedlings.**
- D. Inventory of forest lands to assess sustainability**
 - 1. The British Columbia Ministry of Forests inventories every five years in order to set new harvest rates. This review takes into account new growth and yield information, changes in management practices, and land use decisions which may affect the size of the harvestable land base. Depending on the combined effect of these and other factors, the sustainable harvest rate may increase or decrease.**
 - 2. Inventories tell how much has been harvested and how much new wood has grown.**



Discuss the diverse aspects of environmental stewardship.

- I. What are forest practices laws and how do they perform a stewardship role?**
 - A. Forest practices laws vary from region to region in western North America, but they share the common goal of ensuring that all land managers harvest trees in an environmentally sound manner.**
 - B. Many forest practices acts provide rules and guidelines for responsible harvesting of public and private lands and for the maintenance of forests to enhance ecological stewardship.**
 - 1. The Provincial Chief Forester sets the rate of cut on timber harvesting practices.**
 - 2. Endangered species protections prohibit harvesting of trees and other activities that harm threatened species or their habitats.**
 - 3. The Environmental Protection Act provides government regulation by means of the environmental impact statements of activities that hold potential for affecting the environment.**
 - 4. British Columbia's Forest Practices Code, for example, requires that a registered professional forester develop a comprehensive timber harvest plan before harvesting can take place on publically owned forest lands.**
 - 5. These timber harvest plans must be approved by various agencies, such as the Ministry of Environment, Lands and Parks, Ministry of Forests, and Department of Fisheries and Oceans.**
 - C. Forest-practices regulations usually require a series of inspections of harvest areas. These include:**
 - 1. Pre-inspection of conditions on land about to be harvested.**
 - 2. In-progress inspection to insure that regulations are being met.**
 - 3. Completion inspection to verify that all aspects of the harvest have been accomplished according to regulations.**
 - 4. Because forest practices acts require that a given area be reforested soon after harvest, a stocking inspection, an erosion-control inspection, and a maintenance inspection may follow if reforestation is not to be implemented immediately.**
 - D. Timber harvests are strictly regulated and cover not only broad-based environmental issues, such as animal and plant habitat protection, but also smaller details, such as clean-up of the areas involved. For example:**
 - 1. The use and sizes of clearcuts are tightly controlled and vary by province and the type of species being harvested.**
 - 2. Protection from damage is provided for the trees and habitats remaining after harvest. For example, trees need to be felled away from streams and riparian areas.**
 - 3. Limitations exist on the types of equipment used in certain locations. Harvest equipment, for example, may not disturb streams and riparian areas.**
 - 4. Provisions are made for clearing debris created by the harvest.**

**II. How are streams protected so that fish and wildlife needs are assured?**

- A. Debris and sediment are kept out of streams to protect forest watersheds.**
 - 1. Monitoring the construction and maintenance of access roads avoids erosion.**
 - 2. Excess sediment can harm spawning beds, and large amounts of silt released after spawning can smother eggs that have been deposited by fish in stream beds.**
- B. Water temperatures are kept cool to protect fish.**
 - 1. Maintaining trees along the riparian buffer zone regulates water temperature.**
 - 2. Riparian trees also provide food by way of insects that drop from overhanging leaves.**
- C. Riparian buffer zones along streams are kept to protect plant life and the unique habitats that they provide for wildlife.**
 - 1. As trees die alongside the stream, they create standing dead snags for insects and wildlife.**
 - 2. When a tree decays, it falls into the stream, creating a natural dam. These dams slow the water and allow gravel to collect, forming spawning beds and resting areas for fish.**

III. How are forest-access roads built and maintained to protect against erosion?

- A. Access roads are located in areas with minimal erosion risks.**
- B. These roads are constructed to be as narrow as possible**
- C. Water runoff control is planned for in road construction**
- D. Landings, the places where logs are loaded onto trucks, are required to be as small as possible to keep the amount of bare soil to a minimum.**
- E. Skid roads, used to drag logs to the landing areas, are kept to a minimum.**
- F. In British Columbia, after harvesting in an area, roads are either semi-permanently or permanently deactivated. Cross-ditches and water bars are put in place to divert water off the roads and into natural drainages.**
- G. Forest practices rules require regular maintenance of access roads to avoid problems of blocked drainage culverts and to repair water diversion structures.**

IV. What provisions are made to protect wildlife habitat?

- A. What is wildlife habitat?**
 - 1. Wildlife habitats are places with the ecological qualities that allow animals to forage, find shelter and safety from predators, and reproduce and rear young.**
 - 2. Species may require different types of habitat to fulfill these separate basic needs.**
 - 3. The greater the diversity of habitats within a forest, the greater the number of animal species that will be found there.**
- B. How do foresters, operating under forest-practices laws, manage for wildlife diversity?**
 - 1. They promote a diversity of habitats, including, patches of different ages and sizes of forests, mixtures of mature trees, grassy meadows, and younger stands**



2. They create “edges”, places where one habitat borders another habitat, where different successional stages meet. The greater the contrast at these edges, the greater the likelihood that adjoining habitats support the needs of different wildlife species.
3. They leave dying trees and snags that serve wildlife needs by providing nesting and resting areas in cavities and broken tops, lookout perches, and insects that live in the rotting wood and bark.
4. They leave dead and rotting logs on the ground. These stumps, root wads, bark, limbs, and logs have an increased moisture content that provides certain species with the cool, moist microhabitats that they require. Dead wood is a source of nitrogen fixation by bacteria and is often a site of regeneration of young trees.
5. They protect riparian areas by leaving buffers, up to 50 meters wide, alongside streams.

V. How is reforestation achieved?

- A. Reforestation methods vary, depending on the location and type of trees being replanted.
- B. All forest-practices acts require the successful reforestation of harvested lands. This may require repeated replanting if the first reforestation efforts fail.



Discuss personal responsibility in forest stewardship.

I. What efforts of “quiet stewardship” can citizens make to take personal responsibility for their use of the forest and its many gifts?

- A. Practice fire safety when traveling through or making use of the forest and its recreational facilities.
- B. Keep the forest clean of debris and litter from camping and recreational activities.
- C. Follow posted rules and regulations for the use of public forest lands.

II. What consumer choices can be made to reduce the stress on our natural resources?

- A. Choose products made from renewable resources, whenever practical, and ease the drain on natural resources that cannot be replenished.
- B. Choose to buy products that can be reused, whenever practical, and reduce the amount of consumable goods going into landfills.
- C. Choose items that are recyclable and biodegradable. This makes for responsible use of our natural resources, conserves energy, and reduces the amount of material going into landfills. For recycling to be a success, there must be a demand for recycled products.
- D. Recognize that an increasing population generates a comparable increase in demand for goods and use of our natural resources.
- E. Recognize that to meet many of our ecological and economic needs, now and into the future,

IT TAKES A TREE.

LESSON 1: REVIEW



1. All members of a community share in *the web of life*. What happens to one individual can affect what happens to the entire community, and what happens to the community affects individuals. On a separate piece of paper, show how this interdependence might work in the following situation:

The garbage collectors of your town, Happy Valley, want a raise in pay and have been negotiating for weeks with Mayor I. M. Stubborn. Nothing has been resolved, and the workers have decided to strike. What happens to the workers, the town, your neighborhood, the rat population, the hospital, and the mayor before the issue is finally resolved? Make a flow chart with arrows from one event bubble to the next to show the chain of events.

2. “What goes around, comes around.” You have probably heard this saying used to imply that those who do wrong eventually get their punishment. This old adage can be seen as an affirmation of feedback mechanisms in human society. The same thing applies to the biological community: a change in one component cycles through the community until it reestablishes balance. Read the following account of the dynamics going on in one forest community and then answer the questions that follow.

Gushing Waters, a stream that runs through the Harmony Forest, brings lots of briskly flowing water to Wildwood Bend. Along the banks of the stream at this point, aspen and willows grow thickly. They shade the stream and provide a riparian buffer along both sides, protecting fish and providing habitat for many animals. Beavers migrate into this area. Beavers use aspen and willows for all their habitat needs, food, building materials for dams and shelter, and a safe place to rear their young. At Wildwood Bend, they cut down many trees to build their lodges and dams. As the beaver lodges grow, more beavers occupy the area and dam up Gushing Waters, forming deep pools that overbank and flood the area. The expanding pond provides more room for beaver lodges, but building these requires more wood than is now available along the banks of the pond. Since the beavers have used most of the preferred trees near the pond, they have to go farther away to get their wood, making them vulnerable to predators. With the increase in the availability of beavers as prey, predators spend more time in the area. Beavers have a harder and harder time getting the wood they need, and more and more die from predation. The survivors eventually decide to leave the area for better habitat.

- a. How do the predators respond when the beavers leave for better habitat?
- b. What happens to the lodges when the beavers leave?
- c. What happens to the beaver dams and the stream?
- d. What happens to the riparian area, including the aspen and willows?
- e. Will beavers ever return to Wildwood Bend? When?

LESSON 1: REVIEW



- 3. Disturbances act as checks and balances on communities. While they hold potential for problems, they also contribute some benefits. Answer the questions below that deal with disturbances in the forest.**
- Using fire as a prime example of a forest disturbance, what are some of the benefits to the forest that fire provides?
 - What are pioneer species of trees, and what is their connection to forest disturbance?
 - What two methods do foresters use to mimic the beneficial effects of fire?
 - What is a “fuel load” and how does it relate to forest disturbances?
- 4. Succession, the replacement of the plant and animal life in an area by one of a different nature, occurs over the course of time, often over hundreds of years. Enlightened forest management makes use of patterns of succession to orchestrate the types of harvesting and reforestation practices that will be used in a given area of forest. Answer the following questions that relate to succession:**
- How does shade-tolerance affect the secondary succession of tree species?
 - What are successor species of trees? How do they differ from pioneer species? Give an example of each.
- 5. The parts of a tree serve different functions. Indicate the function of the following:**
- Outer bark
 - Inner bark
 - Cambium
 - Sapwood
 - Heartwood
- 6. A tree that is healthy and growing vigorously is less vulnerable to insects, fire, and disease. How do the following affect forest health?**
- Overcrowding of trees in an area
 - Bark beetles
 - Spruce budworm

LESSON 2: REVIEW



1. Society looks upon the forest as a source of esthetic pleasure, a place of recreation, and a source of ecological benefits. Society also depends on the forest to meet economic needs.

- a. What are four major ecological benefits of forests?
- b. What economic needs does the forest meet?

2. Use the information in the table below to answer the questions that follow.

Year	1940	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040
Population (in millions)	11.5	13.6	18.2	21.5	24.8	28.0	31.0	33.3	35.3	41.2	42.9

- a. This table displays the recorded and projected-future population of Canada. Draw a graph showing the increase in population for the period.
- b. Calculate the percent increase of the population between 2000 and 2040.
- c. If each person in Canada uses, on average, 0.53 cubic meters of wood and 340 kilograms of paper a year (the equivalent of one 30-meter tree 0.46 meters in diameter), calculate how many cubic meters of lumber and kilograms of paper will be used in 2020.
- d. If, on average, seventy-seven trees, with an average height of 30 meters, grow on a hectare of forest land, how much land needs to be harvested to provide wood and paper for the population in 2040?
- e. Assuming that forests are harvested on a sustainable basis and that the average tree takes 60 years to grow to harvest size, how many hectares of land would need to be committed to timber production to meet the needs of a population equal to the one in 2040?

LESSON 3: REVIEW



1. Many laws have been passed to meet our need to insure ecological stewardship of the forest. Some of these are state laws; others are national. All of them are meant to regulate this valued resource.

- a. In the United States' Wilderness Act of 1964, what did legislators have in mind when they included the phrase, “...an area where earth and its community of life are untrammelled by man,...”? Are there such places?
- b. What major pieces of legislation impact forest use and management in your area?
- c. In terms of harvesting trees, how are parks and wilderness areas different from multiple-use forests? How are public multiple-use forests different from private forests?

2. Enlightened management is vital to the protection and productivity of our forests, both public and private. It forms the blueprint of how forests are to be used and which techniques are to be employed to keep the forest healthy and vigorous now and into the future. Answer the following questions about enlightened management:

- a. What is sustainable forestry?
- b. What is the difference between natural regeneration and reforestation? What role does each play in good forest management?
- c. Monitoring the volume of wood grown and harvested is essential to enlightened management. The table below shows data and projections for the volume of wood (in millions of cubic meters) grown in and removed from forests along the Pacific coast.

Year	1952	1962	1970	1976	1986	1991	2000	2010	2020	2030	2040
Growth	57.2	69.2	82.3	89.9	107.0	103.1	107.4	109.3	117.6	123.3	124.0
Harvest	98.7	99.5	114.4	114.0	114.9	98.0	70.0	69.7	74.3	78.5	84.7

Using the information in the table,

1. Calculate the percent of harvest that growth formed for each year in the table.
2. On graph paper, draw x and y axes representing time and volume. Graph the annual growth and harvest over time.
3. Describe the trends in the two lines shown in your graph. Estimate when growth and harvest were exactly balanced.
4. List three possible reasons for the trend in harvest.

LESSON 3: REVIEW



- 3. Wildlife habitat protection is rigorously monitored on both public and private forest lands. Various pieces of legislation mandate how harvesting activities must proceed in order to meet these needs.**
 - a. What are the three most basic habitat needs that wildlife share in common?
 - b. What is meant by “habitat diversity”?
 - c. What forces create habitat diversity in forests?
 - d. The greater the habitat diversity, the greater the number of species of wildlife will be found in an area. Why?
 - e. What are riparian areas? Why are they considered so valuable as wildlife habitat?
 - f. In addition to broad-based rules concerning the protection of wildlife, what are some of the rules that govern protection of riparian areas.

- 4. Consumer understanding of how the forest functions as an ecological community and awareness of the demand by society for forest products should serve to promote enlightened stewardship of forest lands.**
 - a. What is enlightened management? What are its two component parts?
 - b. What are the driving forces behind the increase in consumer demand for wood and wood products? Which of these exerts the most pressure on our natural resources?
 - c. What are the three “Rs” of consumer ecological responsibility?
 - d. What are some wise consumer choices that illustrate personal forest stewardship?

A. Short-answer questions. Write your answers on a separate sheet of paper or on the back of this page, as instructed.

1. How did First Nation Peoples influence forests in North America prior to European settlement? Give examples to support your answer.
2. What are the functions of the following parts of a tree:
 - a. cambium
 - b. heartwood
 - c. sapwood?
3. What is the most common way to determine the age of a tree?
4. What life-history information can we get if the rings of a tree are narrow? are far apart?
5. How do bark beetles affect the health of a tree?
6. Why does defoliation affect tree growth?
7. What is lignin? What function does it serve a tree? How is it used by humans?
8. What is a natural resource?

B. Multiple-choice questions

9. The stump of a 45-centimeter-diameter tree has 50 rings. The innermost 30 are wide; the outermost 20 are narrow. The most likely explanation for this is
 - a. The inner 30 rings are heartwood. The outer 20 are sapwood.
 - b. The climate changed from a wet period to a period of drought.
 - c. The tree grew in an open area at first. As the forest developed around it, competition slowed growth.
 - d. An insect attack defoliated the tree 20 years before it was cut.
 - e. Either A or D.
10. Which of the following is *not* true of an old-growth forest?
 - a. It has not burned recently.
 - b. It has a lot of dead trees.
 - c. The diversity of tree species is less than in a young forest.
 - d. It consumes as much oxygen as it produces.
 - e. The net growth of wood exceeds 3 cubic meters per hectare.

QUIZ

NAME _____

11. Douglas-fir often dominates old coastal forests because
 - a. it is shade tolerant and replaces early succession trees when those die.
 - b. it is not killed by fire.
 - c. it reseeds disturbed areas and grows fast.
 - d. it outcompetes and dominates other species during early succession.
 - e. both c and d.

12. The number of kilograms of paper used per person each year in Canada is
 - a. less than 90 kilograms.
 - b. 90 - 136 kilograms.
 - c. 136 - 181 kilograms.
 - d. 181 - 227 kilograms.
 - e. over 227 kilograms.

13. Forest practices acts in British Columbia apply to
 - a. public multiple-use forests.
 - b. public parks and reserves.
 - c. private industrial forests.
 - d. private nonindustrial forests.
 - e. both c and d.

14. Which of the following has no effect on the diversity of wildlife species in a forested area?
 - a. The presence of snags.
 - b. The amount of forest edge.
 - c. The mixture of stand ages.
 - d. The amount of riparian vegetation.
 - e. The number of pools in the area's streams.

C. Sentence completion questions

15. The atmospheric gas taken up by trees during photosynthesis to form sugar is _____.
16. A young, vigorously growing tree is called a _____.
17. The process by which a disturbed area regrows into a mature forest is called _____.
18. A common disturbance-dependent species of tree is _____.
19. _____ are produced from sawdust and paraffin.
20. The provincial environmental law that has the most impact on managing forest wildlife habitat is _____.
21. The two major qualities of streams that foresters seek to maintain are _____ and _____.
22. The vegetation bordering a stream is known as the _____ zone.
23. The three major methods of ecological stewardship are _____, _____, and _____.
24. The two elements that must be balanced for sustainability of our forests are _____ and _____.

LESSON REVIEWS: TEACHER ANSWER KEY

Lesson 1:

1. Student answers can be reviewed as a flow chart on the board or on an overhead, done as a list in cascading order with arrows showing the feedback from event to event, or discussed orally with the students as you do the assignment together. Answers may vary. Below is one scenario.
 - a. Arbitration with the mayor is unsuccessful.
 - b. Workers strike.
 - c. No garbage is picked up.
 - d. Garbage starts to pile up, rot, and smell.
 - e. People call the mayor to complain, including your parents.
 - f. Dogs knock over the garbage containers, rip into the bags, and strew garbage all over the lawns.
 - g. People call and complain to the mayor.
 - h. The mayor has to call out extra animal control officers, which costs the city more money.
 - i. Rats get into the garbage. The rats carry fleas which get onto dogs and cats hunting them.
 - j. Fleas are vectors for a disease, such as bubonic plague.
 - k. More animal control officers are needed to cope with sick dogs and cats.
 - l. Hospitals start seeing people with illnesses related to improper sanitation.
 - m. Doctors and vets call the mayor.
 - n. The mayor's street gets picketed and garbage is dumped on his law.
 - o. The mayor's wife forces him to call for a return to the bargaining table.
 - p. The mayor agrees to a raise in pay and benefits.
 - q. The strike ends and garbage is once more collected.
2. The stream
 - a. Predators rearranged their hunting patterns to concentrate on the beaver pond. Once the beaver are hunted out or leave the area, predators leave the area and return to their original prey.
 - b. Over time, the lodges weather and come apart. Pieces of wood are washed downstream to become piles of driftwood and perhaps form new habitats for fish or other mammals.
 - c. Abandoned beaver dams fall apart. Water levels drop dramatically, and the stream returns to its original banks.
 - d. The riparian area dries out, encouraging new growth of aspen and willows. These grow rapidly in the full sunlight.
 - e. Over time, as conditions revert back to favorable habitat, beavers return to recolonize the area. The cycle begins again.
3. a. The benefits of fire: It opens the forest for regeneration of pioneer species. It clears out fuels, lessening the likelihood of catastrophic fire in the future. It allows fire-dependent species of trees to open cones and reseed. It cleans out dead and dying trees infested with disease or insects. It lessens competition among trees, allowing the trees that survive to grow more rapidly.
 - b. Pioneer species of trees are ones that come into an area opened by disturbance. They colonize it quickly to become the dominant species in that area.
 - c. Selective harvesting and clear-cut harvesting
 - d. The fuel load is the accumulation of combustible plant material in the forest. The greater it is, the more likely that a fire will get from the ground to the canopy and out of control.

- 4.a. Shade tolerant species grow beneath other trees and form an understory of small trees. When the first trees to form the forest canopy age and die, they are replaced by trees from this shade-tolerant understory.
- b. Successor species of trees are adapted to the shaded and crowded conditions of the understory of an existing mature forest. They eventually replace it as the canopy species die. Pioneer species come into an area opened by disturbance and usually do not tolerate shade.
- 5.a. Outer bark protects the living part of the tree from damage.
- b. Inner bark brings food produced in the leaves (needles) to the rest of the tree.
- c. Cambium is the layer of cells that produces new bark and wood.
- d. Sapwood is the major conductor of water and minerals for the tree.
- e. Heartwood gives strength to the tree and keeps it upright.
- 6.a. Overcrowding increases competition for sun, nutrients, and water. It stresses trees, making them more vulnerable to insects, disease, and fire.
- b. Bark beetles bore into the tree to lay their eggs. They and their larvae can girdle the tree, impairing its ability to transport water and nutrients from one part of the tree to another.
- c. Spruce budworm moths lay eggs that hatch the following spring. The larvae eat the new foliage and may defoliate the tree. Without sufficient leaves, the tree cannot grow and may die.

Lesson 2:

- 1.a. Animal habitat, clean air, clean water, and prevention of erosion
- b. Jobs, economic benefits and taxes, lumber, paper, and other wood products
- 2.a. Graph
- b. $\frac{\text{population in 2000}}{\text{population in 2040}} = 120\% \text{ minus } 100\% = 20\%$
- c.

307 million	307 million
<u>x 0.53 cubic meters</u>	<u>x 340.5 kilograms</u>
162.71 million cubic meters	104,533.5 million kilograms
- d. $\frac{327 \text{ million people}}{77 \text{ trees/hectare}} = 4.3 \text{ million hectares/year}$
- e. 4.3 million hectares/year X 60 years = 654 million hectares

Lesson 3:

- 1.a. It is that the effect of man upon the forest will not be felt. Are there such places? Some think not. It may be a matter of degree rather than kind.
- b. In British Columbia, the Forest Practices Code.
- c. No harvesting is allowed in parks and wilderness areas. Harvesting must be balanced against other uses in multiple-use forests. Private forests allow harvesting according to legal regulations.

- 2. a. Sustainable forestry is the balance of growth and harvest.**
- b. Natural regeneration is the growth of new trees by natural means, such as stump sprouting. Reforestation is the planting of nursery-grown seedlings.**
- c.1. Percent of harvest: sample calculation**
- $$\frac{1952 \times 57.2}{98.7} = .58 \times 100 = 58\%$$
- c.2. Graph**
- c.3. The trends indicate that the growth of wood increased continuously throughout the interval except for a dip between 1986 and 1991. Harvest grew through 1970, declined from 1986 to 2010, and then grew again until 2040.**
- c.4. Demand may have peaked in 1986. There may have been a decline in trees of harvestable size. Regulatory controls on harvesting may have increased.**
- 3. a. Places to forage, places for protection, places to rear young**
- b. Habitat diversity is the variety of different forest structures available to animals.**
- c. Most habitat diversity is caused by variation in topography, moisture, and soils. Human and natural disturbances amplify this normal variation.**
- d. Species requirements are more likely to be met in an area with a variety of habitats. In addition, those species that require more than one kind of habitat are more likely to be satisfied in a complex landscape.**
- e. Harvesting is excluded from riparian areas, and restrictions exist on the operation of heavy equipment near water. Trees must be felled away from streams.**
- 4. a. Enlightened management is taking care of the forest in ways that show awareness of how the forest functions as an ecological community. It seeks to balance ecological and economic needs from and for the forest.**
- b. The driving forces are increased population and increased per capita wealth.**
- c. Renew, reuse, recycle.**
- d. Consumers can choose products made from renewable resources. They can reuse materials, instead of discarding them. They can use recyclable materials.**

QUIZ: TEACHER ANSWER KEY

A. Short answer questions:

1. **First Nation Peoples removed trees to form permanent settlements and for wood for their daily needs. Their largest impact was through the setting of fires. This removed undergrowth and created a more open forest. They did this to increase their own protection and attract species of game animals to better forage.**
- 2.a. **Cambium is the layer of dividing cells that produces new bark and wood.**
 - b. **Heartwood is the core of dead cells that gives the tree structural strength.**
 - c. **Sapwood is the layer of living cells that transports water and nutrients throughout the tree.**
3. **Count the dark rings.**
4. **Narrow rings reveal years of water stress caused by drought or crowding. Wide rings are years of abundant water, nutrients, and sunlight.**
5. **Bark beetles may girdle a tree and kill it.**
6. **Photosynthesis takes place in the leaves. If the leaves are removed, the tree cannot grow. If the removal is severe enough or repeated, the tree will die.**
7. **Lignin is the substance in wood that holds cells together. It is used as a thickener in forest products.**
8. **A natural resource is an item taken from the land or water that can be used by individuals or as a raw material for the industrial economy.**

B. Multiple choice questions:

9. **c**
10. **e**
11. **e**
12. **e**
13. **e**
14. **e**

C. Sentence completion:

15. **Carbon dioxide**
16. **Sapling**
17. **Secondary succession**
18. **Douglas-fir or redwood**
19. **Pressed logs (for the fireplace)**
20. **The Fish and Wildlife Act**
21. **Low temperature and little sediment**
22. **Riparian**
23. **Renew, recycle, reuse**
24. **Economic concerns, ecological concerns**

ADDITIONAL RESOURCES

American Forest and Paper Association -- www.afandpa.com

A Tree for Each American

Quick Facts about America's Forest & Paper Industry

American Forests -- www.amfor.org

California Forest Products Commission -- www.calforests.org

California Foundation for Agriculture in the Classroom -- www.cfaitc.org

Natural Resources Fact Sheet: Forest Resources

Forest Alliance of British Columbia -- www.forest.org

The Forest Foundation -- www.calforest.org/foundation

We Care for the Forests: booklet (grades 7-adult)

Our Forests Forever: education unit (grades K-6)

A Walk in the Woods: activity book (grades K-6)

Un Paseo Por El Bosque: A Walk in the Woods Spanish edition (grades K-6)

Los Bosques de California: Spanish information booklet (grades 7-adult)

Arboleda: newsletter/lesson plans for educators

Video Lending Library Catalog

Stewards of the Land: traditional and non-traditional forest-related careers

Forestinformation.com

Places to Get Free Trees

Forest Products Association of Canada -- www.cppa.ca

(formerly Canadian Pulp and Paper Association)

Forest Stewardship Council (International) -- www.fsc.org/int

Incense Cedar Institute -- www.pencils.com

The Pencil Kit: information packet for teachers and students

Oregon Forest Resource Institute -- www.oregonforests.org

Pacific Logging Congress -- www.pacificloggingcongress.com

It Takes a Tree: brochure (grades 9-adult)

It Takes a Tree: video (grades 7-adult)

Project Learning Tree -- www.plt.org

Environmental Education Activity Guide

Society of American Foresters -- www.safnet.org

Temperate Forest Foundation -- www.forestinfo.org

Circle of Life: video

Dynamic Forest: video

Miracle Resource: video

Tree People -- www.generationearth.com

U.S. Forest Service -- www.fs.fed.us

Washington Forest Products Association -- www.wfpa.org

Western Wood Products Association -- www.wwpa.org