Wildlife/Danger Tree Assessor's Course Workbook

Parks and Recreation Sites Course Module



An initiative of the:
Wildlife Tree Committee of British Columbia
in cooperation with:

WORK SAFE BC
WORKING TO MAKE A DIFFERENCE

Ministry of Forests and Range

BCParks

Ministry of Environment

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PREFACE

Forests, and in particular stands of impressive mature trees, are important parts of the recreational and inspirational experience offered by BC Parks. In a desire to enable visitors to appreciate this experience, park facilities such as interpretive areas, picnic areas and campgrounds have often been placed in proximity to, or even within mature forests. However, as trees age or get injured they become subject to potential for failure. This situation creates immediate conflicts between our mandate to preserve nature or conserve wildlife habitats and our responsibility to provide a safe setting for the visitors we invite into parks and recreation areas.

In response to a recognition that existing (1980) policies and procedures regarding hazard trees were not applied equally across the province, and that there was a need for staff training, a BC Parks Hazard Tree Committee (now the Wildlife Tree Committee) was formed in 1996. The present course was developed to address this need and retains the same technical danger tree assessment procedures recognized as the provincial standard of care by the Wildlife Tree Committee and used in the other provincial danger tree assessment modules. Government staff from the Ministry of Environment (MoE) or contractors must take this course prior to assessing wildlife danger trees in lands managed by MoE. Currently, the primary responsibility for tree assessment in parks and protected areas falls to the Area Supervisor.

In the summer of 1997, the Ministry of Forest (MoF) Recreation Program joined forces with BC Parks in reviewing and endorsing the terms of reference upon which the present course is based. The majority of assessment procedures recommended in this manual for BC Parks sites apply directly to MoF recreation sites. They can also be applied to native tree species found in municipal parks or other wooded areas, such as golf courses and ski hills, and along roads.

Tory Stevens
Natural and Cultural Heritage
Parks Planning and Management Branch
Ministry of Environment

Persons taking this course are NOT certified to assess dangerous trees in Forestry or Wildland Fire Operations.

ACKNOWLEDGEMENTS

Many individuals and organizations have contributed time and expertise to the development of this course, and its subsequent revisions and updates over the years. The Wildlife Tree Committee would like to thank the many people who contributed to the revisions to this workbook.

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CONTENTS

Preface iii
Acknowledgements iv
Contents v
What is the Wildlife Tree Committee of British Columbia? vii
Course Background viii
Goals and Objectives ix
Agenda: Wildlife/Danger Tree Assessor's Course x

Section One: Introduction to Wildlife Trees 1
What is a Wildlife Tree? 3
What Constitutes Good Wildlife Tree Habitat? 7
Wildlife Trees and the Process of Tree Death and Decay 10
Wildlife Tree Classification System for B.C. 14
The Importance of Wildlife Trees 18
Legislation and Policy 22
The Ecological and Economic Significance of Wildlife Tree Users 24
Coarse Woody Debris 30

Section Two: Wildlife/Danger Tree Assessment 33
What is a Dangerous Tree? 35
Determining Tree Danger Rating 37
Step 1A: Determining the level of ground disturbance and visitor exposure 38
Step 1B: Conduct a Site Assessment Overview 42
Step 2: Conduct Tree Assessments 43
Step 3: Make the Appropriate Safety Decision 57
Step 4: Provide Documentation and Communicate Safety Procedures 67

Section Three: Danger Tree Management in Parks and Recreation Sites
Habitat Modification Techniques 72

References and Glossary 77
References 79
Glossary 82

Appendices
1. Some Important Tree Pathogens in B.C. Forests 91
2. Users of Wildlife Trees and Level Of Dependency 99
3. Policy and Regulations 103
4. An Overview Of Legal Considerations 109
5. Danger Tree Assessment Field Data Forms 115
6. Field Procedure Guides 118

WHAT IS THE WILDLIFE TREE COMMITTEE OF BRITISH COLUMBIA

The Wildlife Tree Committee (WTC) is a multi-agency committee composed of representatives from the provincial Ministry of Forests and Range and Ministry of Environment, WorkSafe BC, industry and labour, and public interest groups from across the province. Formed in 1985, the WTC is the advisory body acting on behalf of the three signatory agencies and representing all wildlife tree matters in British Columbia.

The Wildlife Tree Committee mandate is:

To promote the conservation of wildlife trees and associated stand-level biodiversity in a safe and operationally efficient manner, in forest, park and urban environments.

Two major objectives of the WTC are:

- to ensure the maintenance and enhancement of wildlife trees in order to sustain the species dependent on them (about 80 species of vertebrates, or 15% of the province's birds, mammals, and amphibians); and
- to foster cooperation and understanding between the various interest groups.

The WTC believes that managed forests, high standards of worker safety, and maintenance of valuable habitat for wildlife tree-dependent species are mutually compatible if cooperative action is taken to integrate these goals.



COURSE BACKGROUND

This module is intended for those who must assess potentially dangerous trees in parks, recreation sites and park-like settings.

> *Those participants wishing to become qualified assessors should have a minimum of 3 years of practical field experience in forestry or a related field.*

In order to receive a qualifying certificate, students must pass a certifying exam (written and field practical with combined 75% average, including minimum 85% on field practical exam).

The course will be offered on an ongoing basis throughout British Columbia to:

- WorkSafeBC field inspectors;
- Foresters, biologists, arborists, forestry technicians, area supervisors, parks rangers, and others involved in parks and recreation site management and maintenance;
- Park facility operators, and others working in park-like settings.

Certified assessors will be recognized by the WorkSafe BC, Ministry of Forests and Range, and Ministry of Environment.

On successful completion of the 2-day course, the certified assessor will be competent in the following:

- identifying important attributes of wildlife/danger trees;
- assessing trees for their potential as wildlife habitat;
- assessing trees for their failure potential;
- recommending appropriate safety decisions regarding assessed trees.

The Wildlife/Danger Tree Assessor's Certification is valid for a period of 4 years.

COURSE GOALS AND OBJECTIVES

Goals

The goal of the **Wildlife/Danger Tree Assessor's Course** is to present information, practical field experiences and methods for:

- developing wildlife tree and dangerous tree identification procedures;
- retaining selected wildlife tree habitat; and
- maintaining a safe worker and visitor environment.

Objectives

Participants in the ***Wildlife/Danger Tree Assessor's Course*** will be trained to:

- **recognize existing and potential wildlife trees**, identify wildlife tree use, and understand the importance of wildlife trees and how to integrate them into parks and recreation site management; and
- distinguish between safe and dangerous trees, thereby enabling them to **determine tree hazards and related safe work procedures appropriate for dealing with wildlife and danger trees in parks or park-like settings, as well as along roadsides.**

NOTES:

AGENDA
WILDLIFE/DANGER TREE ASSESSOR'S COURSE

(Schedule may vary depending on audience and location of field sites, and instructor needs)

DAY 1

8:00 a.m.	Welcome participants Introduce instructor and participants
8:20 a.m.	Introduction to wildlife trees • what is a wildlife tree? • wildlife tree habitat • pathology of wildlife trees • wildlife tree classification • importance of wildlife trees • ecological significance of wildlife trees
9:45 a.m.	Coffee break
10:00 a.m.	Wildlife/danger tree assessment • what is a dangerous tree • relevant WCB regulations • level of disturbance and exposure • site overview • visual tree inspection • detailed tree assessment • overall tree danger rating • safety procedures
12:00 noon	Lunch
1:00 p.m.	Wildlife/danger tree field assessment—individual trees • participants will assess wildlife/danger trees for hazards, soundness and wildlife habitat value. Participants will carry out practical field identification and determine tree danger ratings and safety procedures for various trees
4:30 p.m.	Adjourn Day 1

DAY 2

8:00 a.m.	Discuss hazard zones; tree marking procedures; management of wildlife/danger trees under various scenarios (along roads, trails, campgrounds); alternate safety procedures for trembling aspen
9:30 a.m.	In field: continued practice with assessing trees in various field scenarios
12:00 p.m.	Lunch in field
12:30 p.m.	Field exam
3:00 p.m.	Return to classroom; written exam
4:30 p.m.	Course concludes

Materials Required

All necessary classroom materials will be supplied by the instructor.

The participant is responsible for providing the following essential items for field exercises:

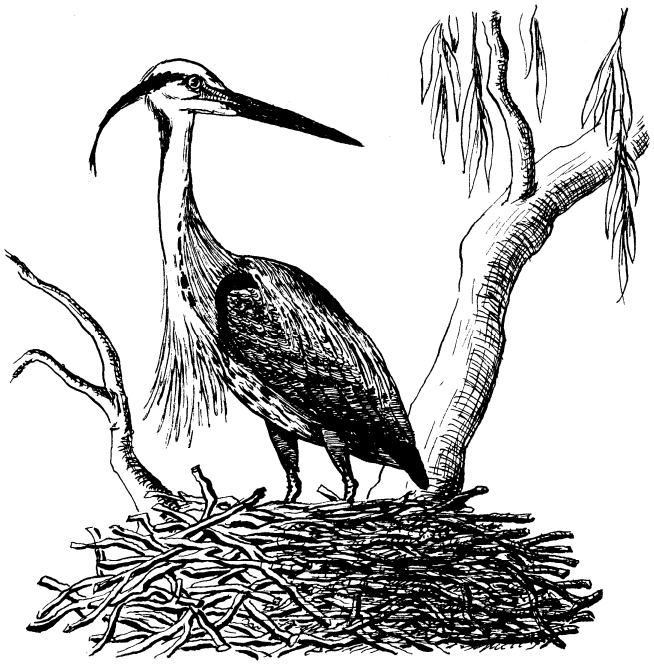
- hardhat (mandatory)
- personal gear, including rain gear (mandatory)
- 6-ring field notebook (mandatory)
- boots with ankle support (mandatory; caulk boots recommended for coastal locations)
- binoculars (recommended)
- clinometer and compass (recommended)
- increment borer (recommended)
- diameter tape (recommended)
- probing instrument (e.g., pocket knife, screwdriver; recommended)

Section One

INTRODUCTION TO WILDLIFE TREES

Learning Objectives

- What is a Wildlife Tree?
- What Constitutes Good Wildlife Tree Habitat?
- Wildlife Trees and the Process of Tree Death and Decay
- Wildlife Tree Classification System
- The Importance of Wildlife Trees
- The Ecological and Economic Significance of Wildlife Tree Users
- Determining Wildlife Tree Value



WHAT IS A WILDLIFE TREE?

Trees in various stages of life, death and decay are important components of the structure and function of all natural forest ecosystems. Wildlife trees are part of this cycle of life and death. They are constantly being formed by biotic and abiotic factors such as insects, fungi, fire and weather.

> ***A wildlife tree is any standing dead or live tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife.***

It can take decades, even centuries, for a tree to complete the cycle of germination, maturation and decay. Careful assessment and conservation of wildlife trees during harvesting and silviculture operations help to ensure continued existence of wildlife trees in managed forests. In a recreational setting, assessment and monitoring can help managers maintain important elements of the natural setting while keeping workers and visitors safe.

The value of any particular tree as wildlife habitat depends on a variety of attributes, including structure, age, condition, abundance, species, geographic location and surrounding habitat features.

Rapid death by fire produces a different kind of wildlife tree than gradual death by insects or disease. Forest health agents such as these create most of the wildlife trees in the forest. Local climate and tree species also influence the way a tree deteriorates and decays.

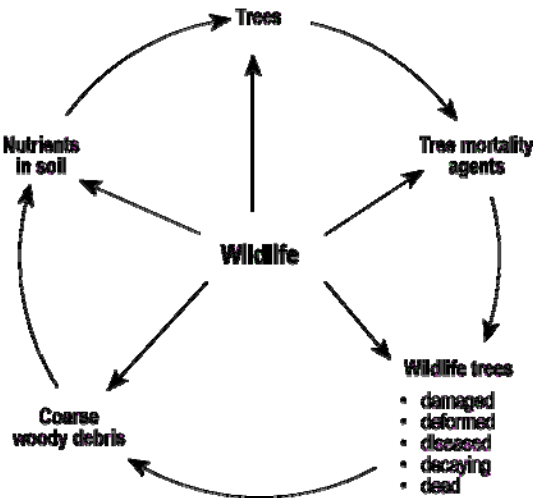
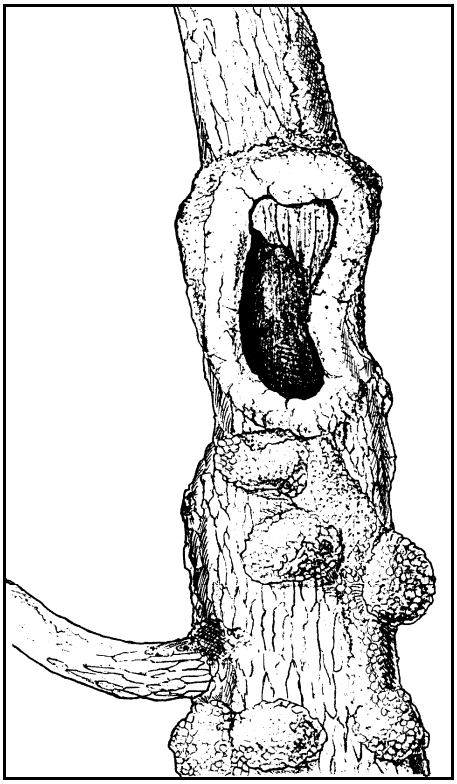


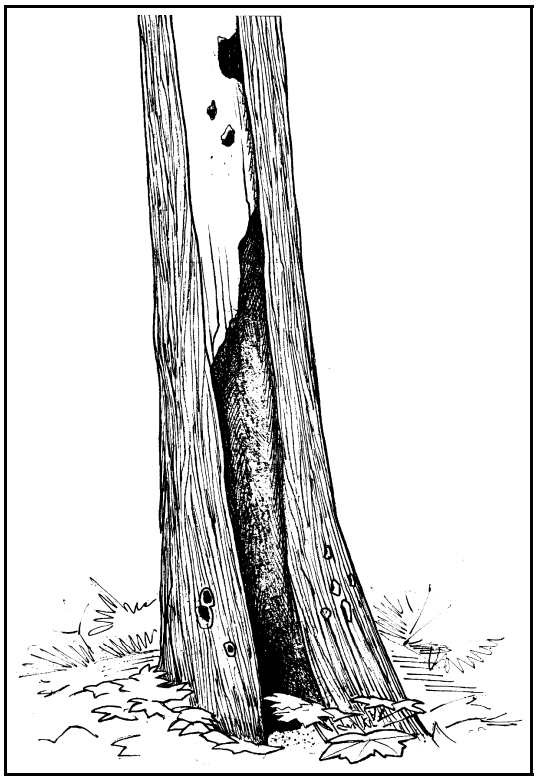
Figure 1. Interaction between wildlife and trees.

There are many habitat features associated with wildlife trees. They are created or caused by influences such as animal excavations, disease, insect attacks, wind, snow and lightning. More than 80 species of vertebrates and countless invertebrates, plants, fungi and bacteria depend on these habitat features for part of their livelihood. Twelve examples of habitat features to be found in wildlife trees are shown on the following pages.

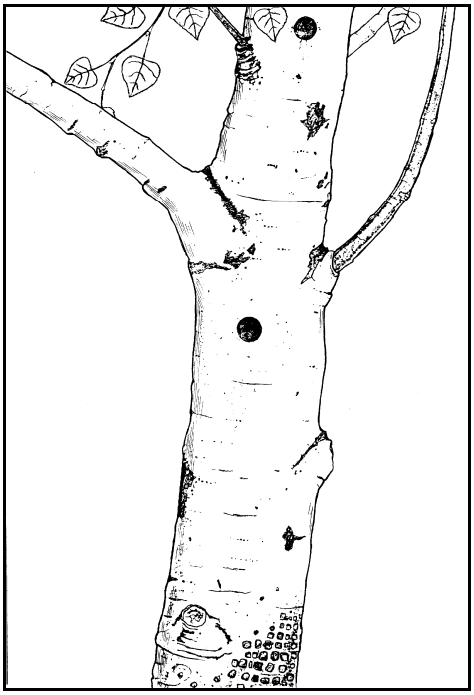
Habitat Features in Wildlife Trees



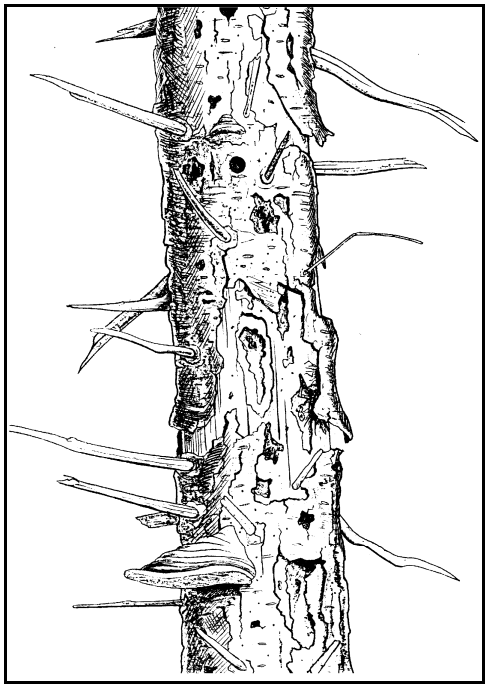
Natural cavity in bigleaf maple.



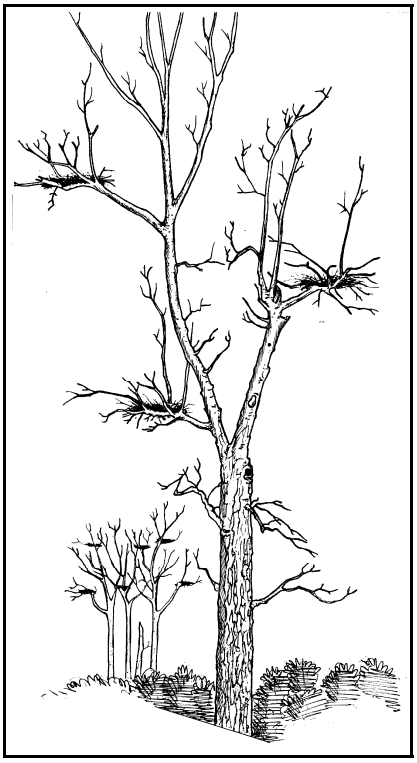
"Chimney effect" in western redcedar (a bat tree).



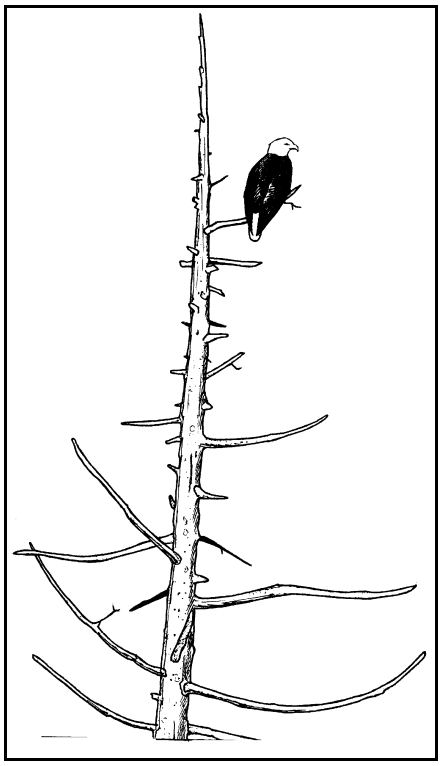
Live hardwood with primary cavity excavation and feeding holes.



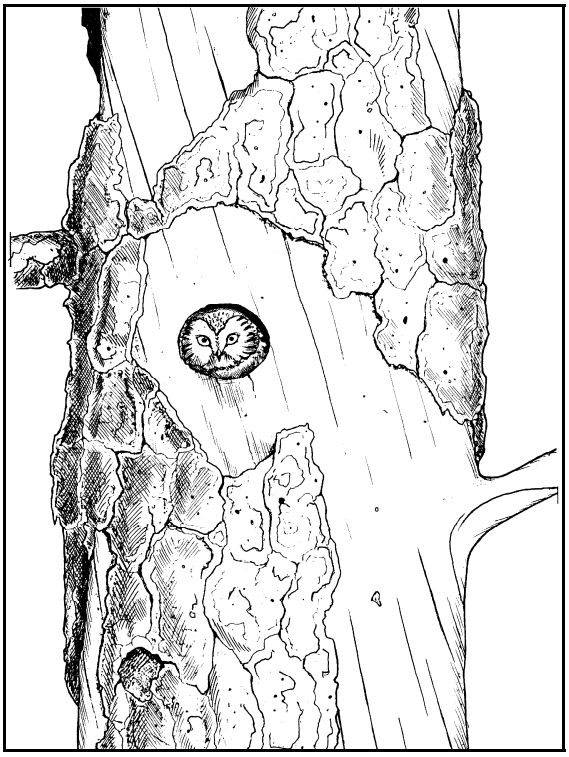
Heart rot and loose bark in grand fir, (used by birds such as Brown Creepers and nuthatches).



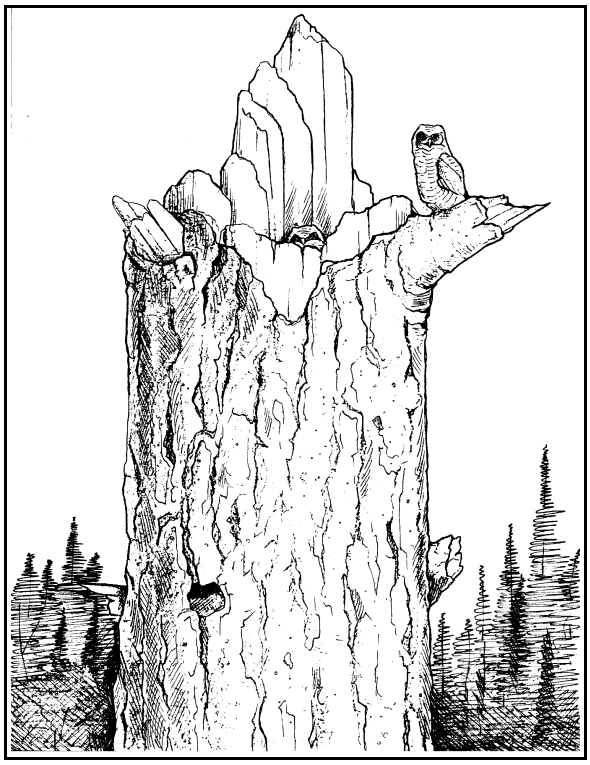
Branching in black cottonwood (nesting for Great Blue Heron).



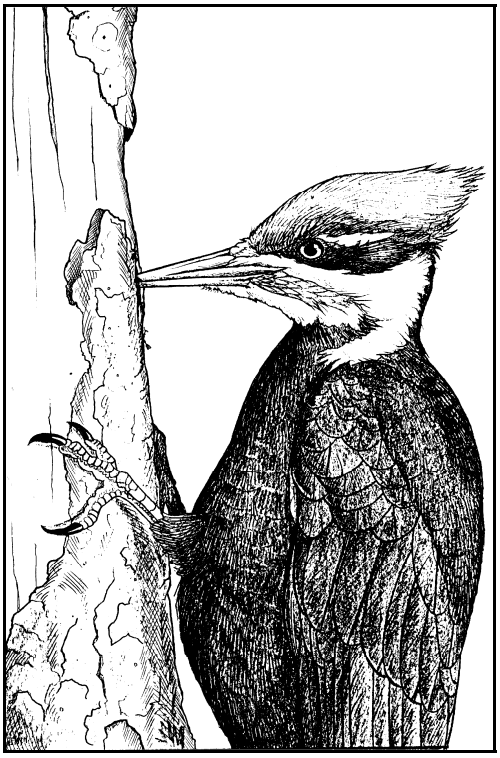
Spike top snag (for perching birds such as Bald Eagle).



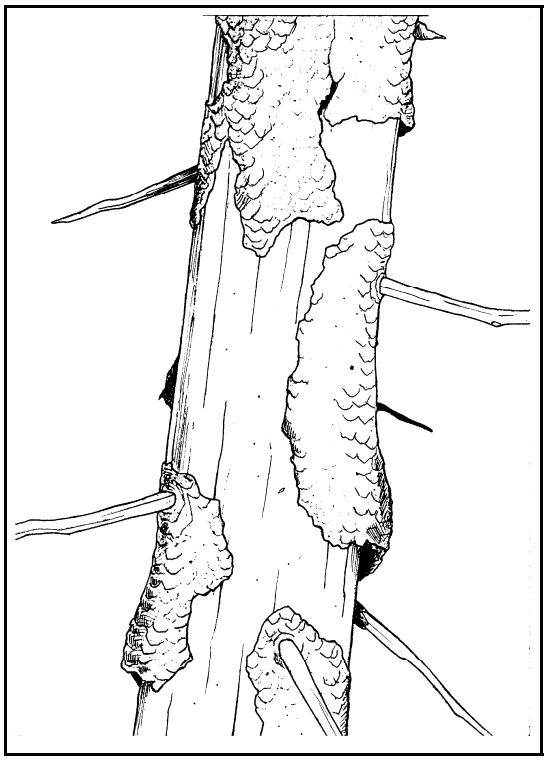
Secondary cavity in ponderosa pine (Saw-whet Owl using old Northern Flicker cavity).



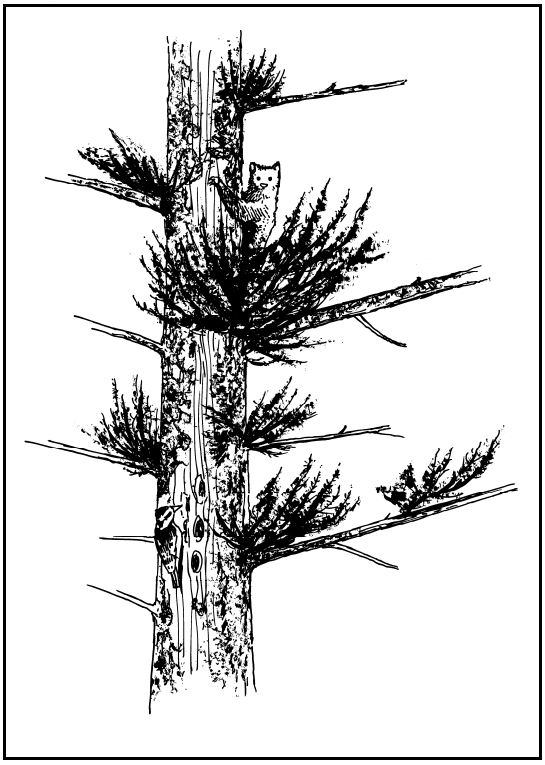
Douglas-fir snag (nesting and perching for owls).



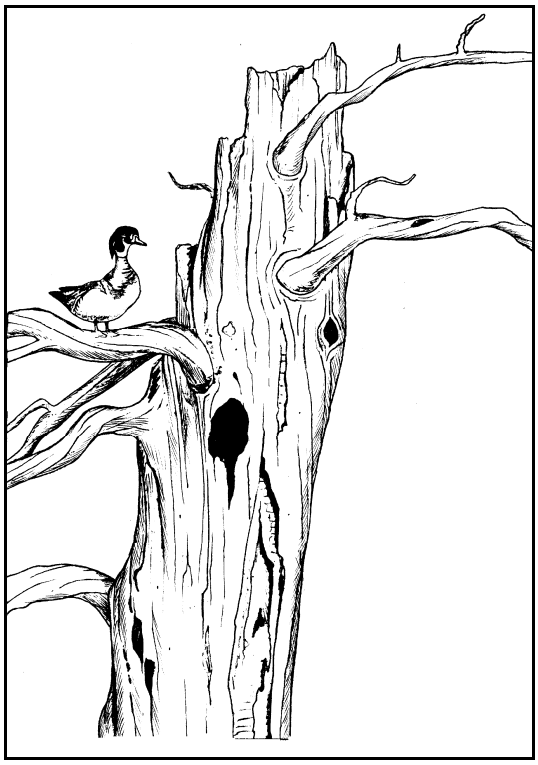
Pileated Woodpecker excavating for insects.



Loose bark suitable for a bat roost.



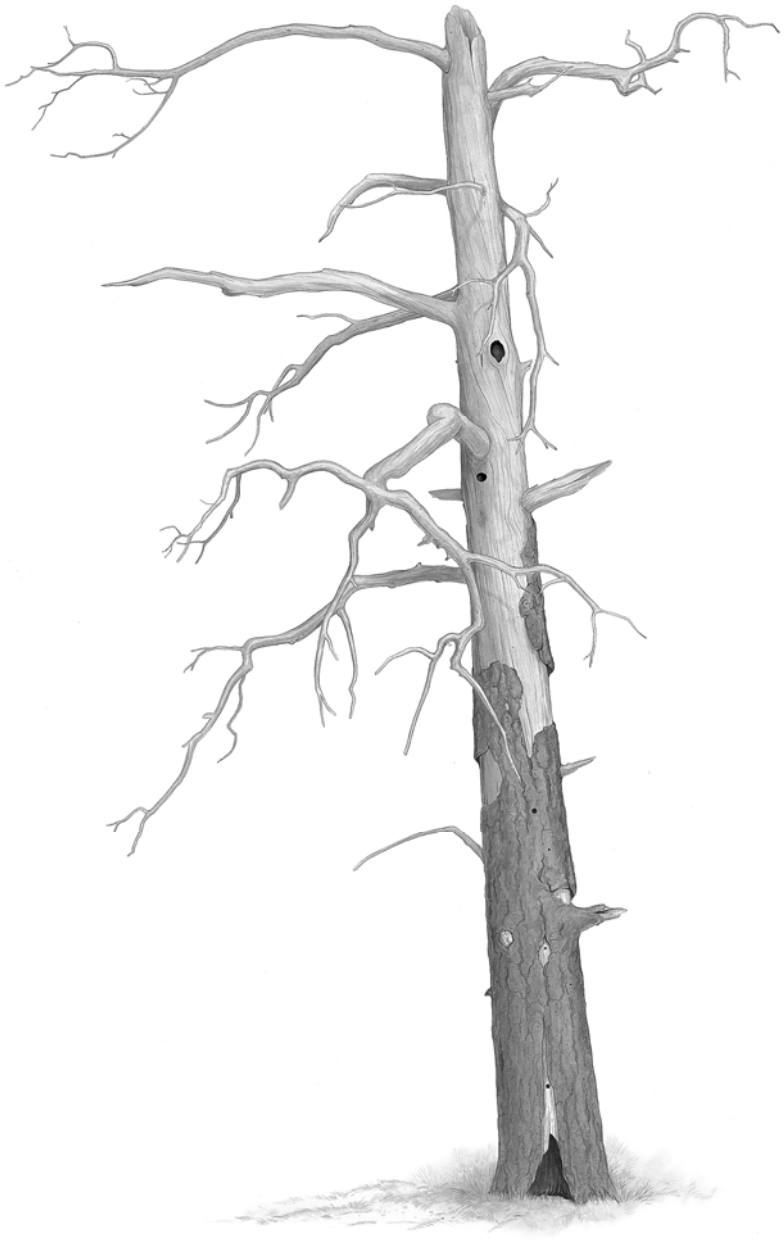
Witches' broom, habitat for marten and other wildlife tree users.



Wood Duck at enlarged cavity in dead ponderosa pine.

WHAT CONSTITUTES GOOD WILDLIFE TREE HABITAT

When considering the needs of wildlife it is important to recognize that all trees are not equal in value. Given the large number of wildlife tree-dependent species and wide range of wildlife uses of these trees, there can be no simple system for determining which trees provide the best habitat for wildlife. The most significant indicators of wildlife tree quality are height and diameter, decay stage, location, distribution and cause of death.



Wildlife Tree Characteristics:

- Greater than 15 m in height preferable
- Greater than 30 cm dbh preferable (interior)
- Greater than 70 cm dbh preferable (coastal)
- Tree classes 2–6 most valuable
- Wind firm, sound root system
- Broken top
- Some large branches
- Some intact bark with space behind loose bark
- Nest cavities, feeding excavations
- Some evidence of decay (visible fungal conks or cankers)

Most valuable wildlife tree species

Because of natural variations in size, growth form and habit, and decay characteristics, some native tree species are inherently more valuable as wildlife trees than others. The following is a **generalized ranking of habitat value** (i.e., 1=most valuable) for some common native tree species. However, this order may vary depending on site- and tree-specific conditions (e.g., presence of pathogens, relative abundance of that tree species or condition of tree in the local area, type of tree damage, location or proximity to other habitats such as riparian areas, etc.).

1. Douglas-fir and western larch
2. ponderosa pine
3. trembling aspen and cottonwood
4. cedars (which have large hollow cavities)
5. hemlocks and true firs (these species have better short-term habitat value)

Height and diameter

Generally, the larger the diameter of a wildlife tree, the greater the variety of species that benefit from it. Most wildlife tree-dependent species prefer tall, larger diameter trees because they offer greater security. A tree with a large trunk provides the potential for a spacious cavity with strong walls. Thick-walled cavities protect their occupants against predators and inclement weather. Large dead trees usually remain standing for many years, providing wildlife habitat for a much longer time than small trees, which fall soon after they die. Large trees are also important for open nesters such as Bald Eagles, Ospreys, and some hawks and owls.

Decay stage

Each stage in the decay process has particular value to certain wildlife species. The earlier the stage of decay, the harder the wood will be. Strong excavators (woodpeckers) usually nest and roost in "hard" trees, while weak excavators (nuthatches, chickadees) prefer "soft" trees. Soft trees also provide the substrate for the numerous species of invertebrates that comprise the food supply of many wildlife species. "Hard" trees that still have branches provide good hunting perches for predatory birds. They also have great future value since most of them, except for those that are fire hardened, will eventually become soft. Fire hardened wildlife trees are not usually suitable for excavating nest holes, but they are often good feeding and perching sites, especially in the first 1–2 years after the fire.

Location

Animals that require dead trees for nesting, denning or feeding usually need live trees nearby for protective cover and foraging habitat. Nest trees of primary cavity excavators (PCEs) are often found at the edge of roads or natural forest openings. The species composition and structure of the surrounding plant community also influence wildlife use of trees. Habitat patch size, distance from high use areas, and adjacency of other specific habitat needs can affect species use. Some wildlife species such as kestrels, flycatchers and bluebirds require trees surrounded by low or early-seral vegetation (grass-forb, shrub-seedling, pole-sapling) that can function as hunting

perches and harbour prey species. Woodpeckers, owls, Vaux's Swifts and others are dependent on the taller tree communities that develop later (young, mature or old-growth). Wildlife trees adjacent to water bodies are important for cavity-nesting ducks, Great Blue Herons, Ospreys, Bald Eagles and Belted Kingfishers. The preferred topographic location of roost trees may vary from season to season.

Distribution and Tree Mortality Agents

Wildlife trees are not evenly distributed throughout the forest. They are usually found in patches corresponding to the unpredictable nature of tree mortality agents such as insects, disease or wildfire. These forest health factors are often interrelated and play important roles in the ecology of wildlife trees. Root diseases, for example, predispose trees to infestations by insects and/or heart rots, thereby creating suitable nesting and feeding habitat for many wildlife species. Similarly, wood-boring beetles or flying insects often attack fire-damaged or fire-killed trees that subsequently become a source of food for woodpeckers, bats and other wildlife tree users.

Determining wildlife tree value

Generally, the following characteristics indicate the relative habitat value of a wildlife tree.

Wildlife Tree Value	Characteristics
HIGH a high value tree has at least two of the characteristics listed in the adjacent column and, where possible, is within the upper 10–15% of the diameter range distribution of trees on the site	• internal decay (heart rot or natural/excavated cavities present) • a sound, firm stem shell • crevices present (loose bark or cracks suitable for bats) • large brooms present • active or recent wildlife use (feeding, nesting, denning) • tree structure suitable for wildlife use (suitable for large nest, hunting perch sites, bear den, etc.) • largest trees for site (height and/or diameter) and veteran trees • locally important wildlife tree species • favourably located for use by wildlife
MEDIUM	• large, stable trees that will likely develop two or more of the above attributes
LOW	• trees not covered by high or medium categories

Note: Under section 34 of the Wildlife Act, no tree with an active nest or the nest of an eagle, peregrine falcon, gyrfalcon, osprey, heron or burrowing owl can be disturbed.

WILDLIFE TREES AND THE PROCESS OF TREE DEATH AND DECAY

Decay and the associated deterioration and death of trees are normal processes that regularly occur within forested ecosystems and are partly responsible for the ever-changing nature of forests. Casual observation may suggest that, aside from obvious factors such as fires and insect attacks, trees die randomly. However, a closer look reveals that tree death is a complex process, involving a vast number of tree mortality agents (see figure 2). The timing and rate of death depend on several factors, including but not limited to:

A. **The tree species**: Some trees, such as hardwoods, often succumb to pathogens at a relatively early age (i.e., 50–60 years).

B. **The location of the tree relative to site and biogeoclimatic zone:** Trees located near the edge of their normal range are less resistant to pest attacks than those situated well within their normal range. Trees located on harsh sites are more easily stressed and hence more susceptible to attacks by various pests.

C. **The age, health and vigor of the host tree**: Trees are most susceptible to injury and attack when they are very young, very old, or otherwise unhealthy or stressed.

D. **The pest species**: Most pests favour certain host tree species and have little or no effect on other species.

E. **The amount or numbers of the pest present and its virulence**: Successful attack resulting in significant injury or death almost always requires that the attacking agent be quite strong and/or numerous in order to overcome the natural defenses of the host tree.

Plants can die either in whole or in part. It is common to see trees with dead tops or branches or roots. Tree death can occur slowly or relatively quickly, as with insect attacks. Different mortality processes produce different types of wildlife trees and change the forest in different ways.



Canker on pine. An obligate pathogen, the canker fungus derives its nutrition by killing host tissue.



White Mottled Rot (Ganoderma applanatum)*, a heart rot fungus common on hardwoods.*

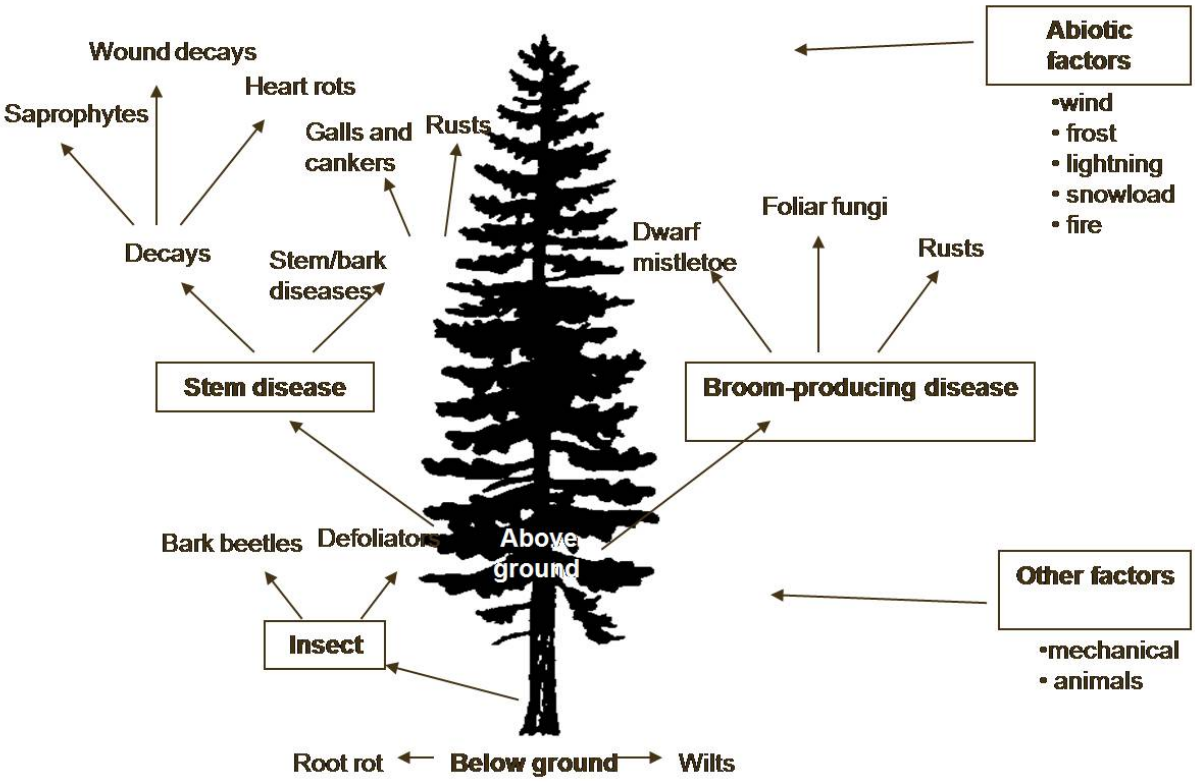


Figure 2. Tree mortality agents.

Simultaneous and Cumulative Pest Attacks

Often several agents simultaneously attack, weaken and ultimately kill a single tree, a small group of trees, or even an entire stand of trees. At other times the mortality agents occur sequentially and act in an additive manner.

One possible scenario of mortality agents acting sequentially begins with a small hatchet wound cut into the base of a western larch tree. This scar is subsequently attacked and infected by a decay organism that causes heart rot. After several years the decay has traveled up the trunk of the tree. A heavy snowfall accompanied by high winds causes the trunk of the tree to break off at the 12-meter point. If there are no live limbs below the breakage, the tree is killed. In this example, mechanical damage, followed by decay, followed by adverse weather conditions, combined to kill the tree.

Significance of Disease and Decay in our Parks

Virtually all natural tree mortality can be attributed to three broad categories: fire, insects and disease (the latter includes losses due to adverse climatic conditions and pollution). The estimated percentages attributable to each of these categories in B.C. are:

Fire	15%
Insects	20%
Disease	65%

We can add the human dimension to these natural processes. Persons working or visiting our parks and recreation sites injure trees, either accidentally or intentionally. Trees can be wounded during the construction of the site (e.g., excavator damage to a tree's roots or scars the stem), or by a vehicle backing into a camping site, or from persons throwing a hatchet into a tree. Each wound on a tree initiates the process of tree death and decay.

These losses are not necessarily negative. What constitutes a healthy forest depends upon one's viewpoint, and definitions of healthy and unhealthy are human perspectives.

Some negative aspects of losses due to decay

1. Weak or unhealthy trees are often knocked over or are broken off by wind or heavy snow. Such events sometimes cause damage to park facilities, homes or power lines, and may result in human injury or death.

2. Dead or dying trees are susceptible to insect attacks and may act as brood trees for small insect populations, allowing them to build up to epidemic levels that subsequently cause widespread forest damage.

Some positive aspects of fungi in our forests

1. Fungi are decomposers. They breakdown organic matter and thereby serve as important agents in nutrient cycling. They also reduce fire hazard by breaking down woody debris.

2. Decay fungi also soften wood, thereby rendering otherwise inhospitable trees more 'user friendly' to many species of birds and animals. Fungi are therefore an important agent in producing and developing what we now refer to as wildlife trees. Host trees with softened heartwood are more vulnerable and accessible to primary excavators, such as large woodpeckers, that create cavities for nesting. Once cavities are created, they are available over many years for other species of birds and animals to use.

3. As the boles of trees continue to decay and break apart over time, woody material falls to the forest floor. This coarse woody debris provides habitat for numerous animals, as well as contributing nutrients to the forest floor.

4. Many fungi, often referred to as ectomycorrhizae or mycorrhizal fungi, live on the outer surface of tree roots and assist trees in absorbing nutrients form the surrounding soil.

Additional information on the distribution, hosts, and identifying characteristics of some of the major tree pathogens in B.C. (fungi, cankers, mistletoe and insects) can be found in Appendix 1.



Blister rust fungus on White pine.

WILDLIFE TREE CLASSIFICATION SYSTEM FOR B.C

The Wildlife/Danger Tree classification system used in B.C. describes each class of wildlife tree in several ways. This includes a simple, general description of each class, a list of the wildlife uses associated with that class, and a summary of the decay characteristics. Although this classification system is based on the decay pattern of thick-barked conifers, such as Douglas-fir and ponderosa pine, it is broadly applicable to all British Columbia native trees (conifers and broad-leaved deciduous).

The deterioration and decay processes occur in various stages, corresponding to the tree classes described below. Conifers can have up to 9 tree classes, whereas deciduous trees have 6 classes, reflecting their accelerated decay and fall-down rates as compared to conifers.

Class 1: These are live, healthy trees with NO structural defects or injuries that have associated decay and which could compromise the structural strength of the tree. Some live trees may show signs of deterioration or slight damage, such as dead branches, sound live forked or secondary tops, or minor physical injuries (e.g., healed-over stem scrapes). In most cases, these DO NOT have associated decay which might compromise the tree's structural strength.

Class 2: These are live trees, but have some VISIBLE EXTERNAL DEFECT which can affect the tree's structural strength or introduce decay. The first stages of deterioration often begin while the tree is still alive. The invasion is led by fungi or wood-boring beetles.

Wildlife trees that are alive or in the early stages of decay attract birds that build large open nests, such as Ospreys, Bald Eagles and Great Blue Herons, or cavity excavators such as woodpeckers.

The presence of the following **defects on LIVE** trees can be used to distinguish Class 2 trees from Class 1 trees:

- Fungal conks and/or internal decay
- Tree cavities
- External stem scars
- Stem cracks/splits (must have associated decay; not a simple dry check)
- Dead tops (including secondary tops and forks)
- Broken tops
- Large dead limbs (>10cm diameter)
- Damaged roots (from disease, fire or mechanical damage)
- Excessive lean (>30%) **AND** damaged/diseased roots or a poor anchoring soil substrate;

  "sweep" is not a lean defect
- Large canker face
- Unusual stem swellings (may indicate hidden decay)
- Insect or fire damage such that tree is likely to die relatively soon (i.e., become a Class 3 tree)



Class 2: showing large hung-up dead limbs

Class 3, 4, and class 5 conifers: The tree has died, and decay begins or continues. Class 3 trees are RECENTLY dead, still bearing their fine branches and twigs, and the bark is "tight". Class 4 trees have lost their fine twigs and only have larger, coarse limbs left, and bark has begun to loosen or shed from parts of the stem. Class 5 trees have usually lost all their limbs but have not yet broken their tops, although their tops may be weakening. Woodpeckers will chisel out nesting cavities, taking advantage of the outer shell of sapwood that protects eggs and nestlings. As time passes, the tree continues to rot and soften.



Class 4: dead tree, with only larger coarse limbs remaining

Class 5 broad-leaved deciduous: This is the tree class for deciduous trees before they fall to the ground as coarse woody debris. By this stage, the sapwood and heartwood are soft, portions of the bole have broken away, and most of the limbs are gone. Class 5 for deciduous trees is roughly equivalent to classes 6–7 for coniferous trees.

Classes 6 and 7

When the tree reaches these stages, weaker excavators, such as nuthatches and chickadees, can make their nest holes in the soft wood. Branches are often broken off, and slabs of bark loosen from the trunk. Decay is advanced in the upper portions of the trunk. The loss of tree limbs creates knot holes and natural cavities, many of which are soon converted into homes by a variety of animals. Over the years, the tree becomes shorter as portions of the top snap off at weak points. Throughout stages 6 and 7, chunks of bark and sapwood are sloughed off and the upper bole of the tree has broken away. Generally up to 1/2 of the original top height of the tree has broken away. Once the softer heartwood is exposed, wildlife trees are used less by woodpeckers and more by other animal species. Class 6 for deciduous trees represents a dead fallen tree.



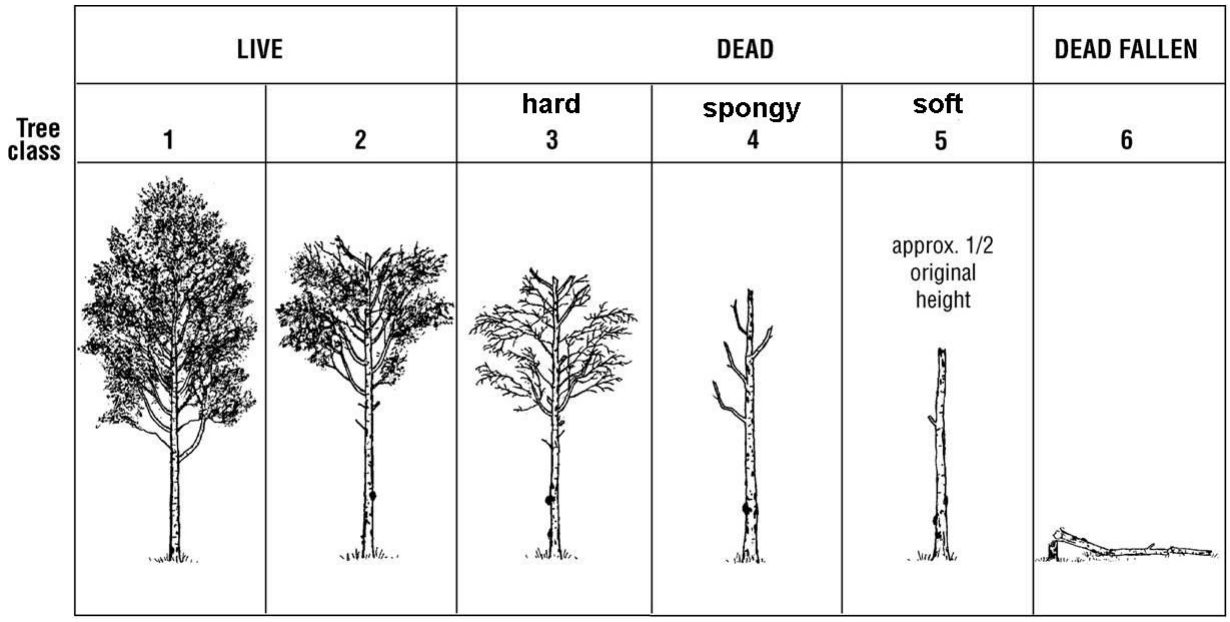
Class 7: soft heartwood, showing numerous nest cavities

Classes 8, 9

In the final phases of tree decay, all the sapwood is gone and the heartwood is completely rotted through. By class 8, only about 1/3 or less of the original tree height remains—the heartwood is highly decayed and is often visible as brown-cubical sloughing fragments. At class 9, the stump and the mound of woody debris that surrounds it become an ideal site for new plant growth, providing a ready supply of moisture and nutrients. It has now become suitable habitat for amphibians, such as the clouded salamander, that require moist, thermally buffered environments.



Class 8



British Columbia's wildlife tree classification system (native broad-leaved deciduous)

British Columbia's wildlife tree classification system (conifers)

	LIVE	DEAD							DEAD FALLEN
		Hard →		Spongy →		Soft			
Tree Class	1	2	3	4	5	6	7	8	9
						approx. 2/3 original height	approx. 1/2 original height	approx. 1/3 original height	
Description	**Live/healthy;** no decay; tree has valuable habitat characteristics such as large, clustered or gnarled branches, or horizontal, thickly moss-covered branches.*	**Live/unhealthy;** internal decay or growth deformities (including insect damage, broken tops); dying tree.*	**Recently dead;** needles or fine twigs are present; bark is tight.	**Dead;** no needles or fine twigs—only coarse limbs present; 50% of branches lost; loose bark.	**Dead;** most branches absent; some internal decay; sapwood decay present; bark shedding; weak top.	**Dead;** no branches or bark; sapwood/ heartwood sloughing from upper bole; decay more advanced.	**Dead;** extensive internal decay; outer shell may be hard; lateral roots usually completely decomposed; hollow or nearly hollow shells.		**Debris;** downed trees or stumps.
Uses and users	Nesting (e.g., Bald Eagle, Great Blue Heron colonies, Marbled Murrelet); feeding; roosting; perching.	Nesting/roosting[1]—strong PCEs[2] (woodpeckers); SCUs[3]; large-limb and platform nests (Ospreys); insect feeders.	Nesting/roosting—strong PCEs; SCUs; bats.	Nesting/roosting—PCEs; SCUs; insect feeders.	Nesting/roosting—weak PCEs (nuthatches, chickadees); SCUs; bats; insect feeders.	Weaker PCEs; SCUs; insect feeders; salamanders; small mammals; hunting perches.	Insect feeders; salamanders; small mammals; hunting perches; occasionally used by weak cavity excavators such as chickadees.		Insect feeders; salamanders; small mammals; drumming logs for grouse; flicker foraging; nutrient source.

1 Large witches' brooms provide nesting/denning habitat for some species (e.g., fisher, squirrels).

2 PCE = primary cavity excavator.

3 SCU = secondary cavity user.

* This classification system does not recognize root disease trees specifically. Such trees become unstable at or before death.

THE IMPORTANCE OF WILDLIFE TREES

Wildlife trees at all stages provide a portion of the life support system for many species of fingi, plants, invertebrates, birds, amphibians, reptiles and mammals. Altogether, 25% of all forest dwelling terrestrial vertebrates in British Columbia depend on dead or deteriorating trees. Some of their uses include nesting, feeding, communication (drumming, marking), roosting, shelter and overwintering.

Some highlights include:

- The largest group of wildlife tree users that we know about is cavity-nesting birds, such as owls, woodpeckers, and some ducks.
  - ~ There are about 19 species of primary cavity-nesting birds in British Columbia.
  - ~ There are about 31 species of secondary cavity-nesting birds in British Columbia.
  - ~ Approximately 18% of the bird species known to breed in British Columbia are cavity nesters.
- More than 30 species of mammals in British Columbia use wildlife trees.
  - ~ Marten often raise their young in tree cavities.
  - ~ Black bears often hibernate in hollow trees.
  - ~ Several kinds of bats roost in tree cavities or behind the loose bark of dead trees.
- Birds of prey, including Bald Eagles, Ospreys and some hawks, use the branches of these trees as perches, and often build their nests in dead or broken-topped trees.
- Woodpeckers, nuthatches and Brown Creepers forage on bark for a variety of insect pests.
- The long list of wildlife tree users includes some rare and endangered birds and mammals.
- In all, there are more than 80 wildlife tree-dependent vertebrates in British Columbia.

Vertebrate wildlife tree users can be divided into five general groups:

1. primary cavity excavators (PCE);
2. secondary cavity users (SCU);
3. open nesters;
4. mammals; and
5. amphibians.

Note: A complete list of wildlife tree-dependent vertebrates and their dependency levels can be found in Appendix 2.

Primary Cavity Excavators

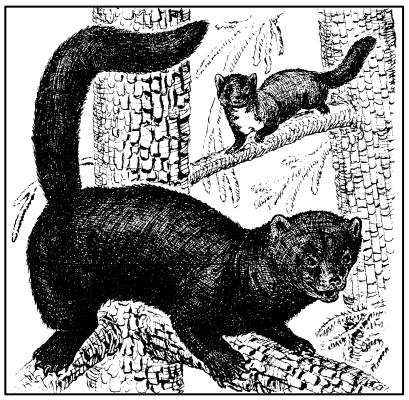
- Primary cavity excavators are adapted to chisel out holes in the decaying wood of trees. They usually make new nest holes each year, leaving the old ones to be used by other wildlife. Woodpeckers and sapsuckers are primary cavity excavators, as are some species of chickadees and nuthatches.
- Primary cavity excavators depend on the availability of dead or defective trees for nesting sites, and often for roosting and foraging sites as well. Cavity excavation and drumming are a part of their communication system, and also play a role in mating. Many of B.C.'s woodpeckers are year-round residents, so trees in which they can excavate thick-walled roosting cavities are an essential part of their winter roosting habitat. B.C.'s four species of chickadees and three species of nuthatches are also year-round residents that use cavities for both nesting sites and winter roosts. Pygmy Nuthatches often roost communally in winter for heat conservation, with up to 150 birds sharing a single roost.



Hairy Woodpecker – a primary cavity excavator.

Secondary Cavity Users

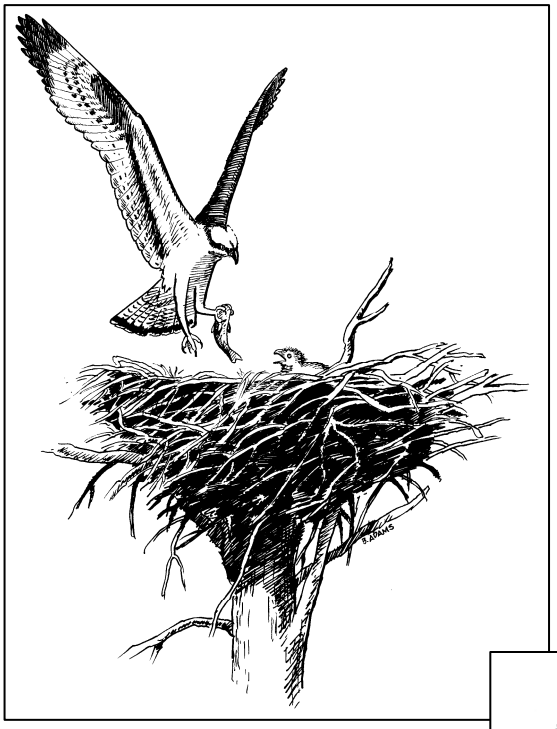
- Secondary cavity users are birds and mammals that cannot excavate their own holes. They raise their young in holes abandoned by primary cavity nesters, or in natural cavities created by decay, loose bark, lost branches and lightning strikes. This group may also use wildlife trees for food storage and temporary shelter. They include small owls, swallows, bluebirds, some ducks, marten, raccoons, flying squirrels, deer mice and bats.



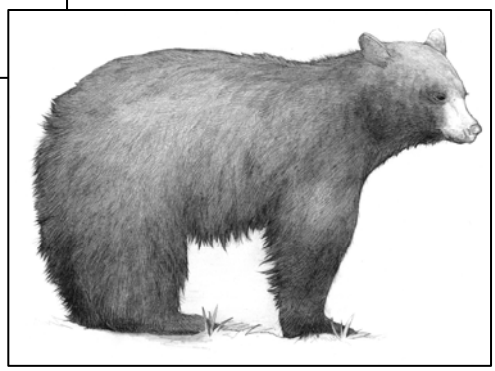
Fisher, which are secondary cavity users, often use wildlife trees to raise their young and for year-round shelter.

Open Nesters

- Cavity-nesting birds are not the only birds that require wildlife trees. Birds that build large, heavy nests in the tops of big trees are called open nesters. Great Blue Herons, Bald Eagles, Ospreys, and the largest hawks and owls depend on large trees that can support their bulky, heavy nests. They do not necessarily require dead or decaying trees, but broken-top, split-top, or flat-crown trees are favoured because of their open, flat structure. Some open nesters depend on wildlife trees for hunting perches. Several open nesters are named as protected species under Section 34 of the *Wildlife Act*.



Osprey – an open nester.



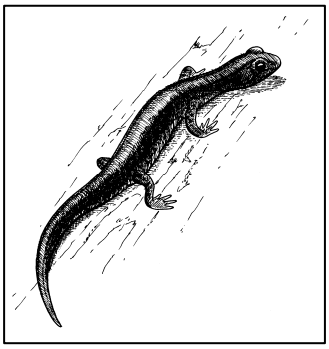
Black bear.

Other Mammals

- Black bears are known to hibernate in hollow trees. The mountain caribou's main winter food is arboreal lichens, which grow on the branches of old and/or dead trees. Marten and fisher den in tree cavities and hollow logs. Bats roost and nurse their young behind loose bark or inside dead, hollow trees. Of all mammals, bats are perhaps the most dependent on wildlife trees.

Amphibians

- Amphibians, including the clouded and western red-backed salamanders, use the soft, moist wood found in highly decayed wildlife trees and fallen logs as shelter, and for laying their eggs.



Western red-backed salamander.

British Columbia's forested landscape offers a rich diversity of flora and fauna, making our parks a strong attraction to visitors from all over the world. We have over 80 different vertebrates that are wildlife tree users. When properly managed, wildlife trees can be safely maintained to provide many years of continued use by wildlife tree users, and at the same time, provide viewing pleasure for the many recreational visitors.

Wildlife/danger tree assessors have an important opportunity to manage wildlife trees for the species dependent upon these trees, both in the immediate and long term. Assessors have the privilege of balancing public safety (discussed in chapter 2) with the conservation of wildlife habitat.

NOTES:

LEGISLATION AND POLICY

The management and protection of certain wildlife species, and the trees they rely upon for survival, are mandated at both the provincial and federal levels of government. In some instances, protection is further guided under municipal bylaws.

Wildlife Act

In British Columbia, Section 34 of the *Wildlife Act* concerns wildlife trees, albeit indirectly. It reads as follows:

"**A person who, except as provided by regulation, possesses, takes, injures, molests or destroys**

- **(a) a bird or its egg,**
- **(b) the nest of an eagle, peregrine falcon, gyrfalcon, osprey, heron or burrowing owl, or**
- **(c) the nest of a bird not referred to in paragraph (b) when the nest is occupied by a bird or its egg**

commits an offence."

Where the nests are located in trees, the Wildlife Act therefore protects the wildlife tree.

Species at Risk Act (SARA)

In Canada, the Federal Government proclaimed the Species at Risk Act (SARA) to legally protect wildlife species at risk, as well as their habitats, on federal lands. SARA makes it an offence under sections 32 and 33 of SARA to disturb or possess individuals, or to alter the residence of the SARA listed species. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent body of experts that identifies and assesses species at risk. When establishing the legal list of species at risk the Federal Government considers COSEWIC's designations on the status of wildlife.

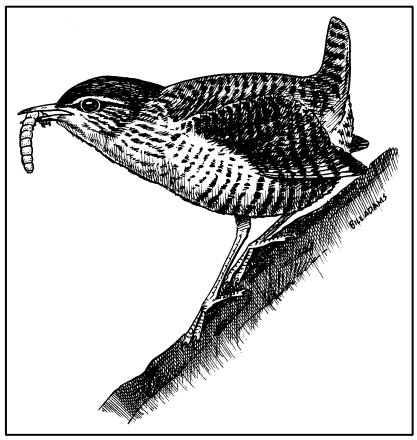
For further information on federal listings, refer to the *Species at Risk Act Public Registry* at: http://www.sararegistry.gc.ca, and to query and search COSEWIC species lists, visit: http://www.cosewic.gc.ca

Identified Wildlife Management Strategy (IWMS)

Identified wildlife is a term given to the species at risk and regionally important wildlife that our provincial government has designated as requiring special management provision under the Forest and Range Practices Act (FRPA). The IWMS provides direction for managing the identified wildlife, with a goal to minimize the effects of forest and range practices on Crown land. For further information on identified wildlife provisions, refer to the IWMS at http:www.env.gov.bc.cz/wld/identified/index .

NOTE:

If a dangerous but high-value wildlife tree poses an unmanageable risk to the safety of persons or facilities (ie, the tree hazard cannot be successfully mitigated by topping, and target cannot be removed), then the duty of care bestowed on the landowner under the *Occupier's Liability Act* supersedes protection of the tree under the *Wildlife Act*. In this case, the tree may be removed and artificial wildlife habitat modification techniques could be used to create a safer substitute wildlife tree nearby (see Section Three). However, if the tree is used by **identified wildlife**, application for permission to alter or remove the hazard must first be sought from the *Permit and Authorization Service Bureau, MoE* before taking action.



Winter Wren feeding on insect pest.

Wildlife Tree Users Under Pressure

Wildlife tree users include more than two-dozen species considered to be red- or blue-listed according to the BC Conservation Data Centre and species listed by COSEWIC. Red-listed species are those being considered for legal designation as endangered or threatened under the *B.C. Wildlife Act*. Blue-listed species are considered vulnerable and/or sensitive and at risk because of low or possibly declining populations. Species may also be placed on the blue list because of inadequate understanding of their status. All other wildlife tree-dependent species are considered of general management concern.

Appendix 3 shows the uses and level of dependency of indigenous wildlife tree users in B.C.

For further information on Red- or Blue-listed wildlife in British Columbia, refer to the B.C. Conservation Data Centre at http://srmwww.gov.bc.ca/cdc/

NOTES:

THE ECOLOGICAL AND ECONOMIC SIGNIFICANCE OF WILDLIFE TREE USERS

Wildlife tree-dependent species have a number of ecological roles in B.C. forests. One of the most important and well-documented roles of wildlife tree users is their impact on forest invertebrates and small mammal populations. Each year, B.C. forests are subject to disturbance from a variety of insects and small mammals. Bark beetles (e.g., mountain pine beetle), spruce budworm and Douglas-fir tussock moth are examples of some of the insects most damaging to the forest industry in B.C. Although the relative impact of vertebrate pests on our forests is considered small, some species (e.g., voles, squirrels, rabbits, snowshoe hares and porcupines) can cause significant economic losses under certain conditions.

To identify the prey groups of wildlife tree-dependent species, wildlife tree users can be grouped into "feeding guilds" (Tables 2 and 3) for birds and mammals, respectively. Birds of prey and carnivores feed on a variety of small mammals, some of which eat conifer seeds or damage seedlings and saplings. Bark-foraging birds, foliage-gleaning birds, and aerial-foraging birds feed largely on insects. Differences in bill structure and feeding location result in the partitioning of insect prey types (e.g., defoliators, sucking insects, woody tissue feeders) and life stages (e.g., larvae, pupae, adults) among group members. All 13 wildlife tree-dependent bats are insectivorous.

Visitors to B.C.'s parks are attracted by the many opportunities to observe wildlife, especially wildlife tree users. Wildlife viewing is a growing activity, not only in parks but across the forested landscapes of B.C. The economic and social benefits generated by these opportunities are significant and wildlife tree management should continue to be promoted within the context of parks wherever safety permits.



Defoliators: Spruce budworms.



Woodpecker bark scaling for mountain pine beetle larvae.

Avian wildlife tree user feeding guilds that consume forest insects and small mammals *(adapted from Machmer and Steeger 1995)*

Wildlife Tree User Guild	Guild Members	Predator Example	Prey Example	General Remarks
Birds of prey	eagles[1], hawks[2], falcons[3], owls[4]	Golden Eagle	rabbits, hares, rodents	• rodents, pikas, rabbits and hares are the most common food item of 13 of the 17 species in this group
Bark-foraging birds	sapsuckers[5], woodpeckers[6], Northern Flicker, nuthatches[7], Brown Creeper	White-headed Woodpecker	bark beetles (e.g., mountain pine beetle)	• forest insects make up ≥75% of the diet volume in 11 of the 15 species in this group • 13 of the 15 species are known to eat a variety of *pest* insects
Foliage-gleaning brids	chickadees[8]	Black-capped Chickadee	moths, budworms, loopers, beetles, weevils	• forest insects are the most common food item of the 4 species in this group • all 4 species are known to eat a variety of *pest* insects
Aerial-foraging birds	flycatchers[9], swallows[10], bluebirds[11], Flammulated Owl, Lewis' Woodpecker Vaux's Swift Purple Martin	Violet-green Swallow	beetles (e.g., western pine beetle)	• insects make up ≥75% of the diet volume in 9 of the 10 species in this group • 5 of the 10 species are known to prey on *pest* insects

1 eagles = Bald Eagle, Golden Eagle

2 hawks = Northern Goshawk, Red-tailed Hawk, Swainson's Hawk, Cooper's Hawk

3 falcons = American Kestrel, Merlin

4 owls = Barn Owl, Western Screech-Owl, Great Horned Owl, Northern Hawk Owl, Northern Pygmy-Owl, Spotted Owl, Barred Owl, Boreal Owl, Northern Saw-whet Owl

5 sapsuckers = Yellow-bellied Sapsucker, Red-naped Sapsucker, Red-breasted Sapsucker, Williamson's Sapsucker

6 woodpeckers = Downy Woodpecker, Hairy Woodpecker, White-headed Woodpecker, Three-toed Woodpecker, Black-backed Woodpecker, Pileated Woodpecker

7 nuthatches = Red-breasted Nuthatch, White-breasted Nuthatch, Pygmy Nuthatch

8 chickadees = Black-capped Chickadee, Mountain Chickadee, Boreal Chickadee, Chestnut-backed Chickadee

9 flycatchers = Pacific-slope Flycatcher, Ash-throated Flycatcher

10 swallows = Tree Swallow, Violet-green Swallow

11 bluebirds = Western Bluebird, Mountain Bluebird

Mammalian wildlife tree user guilds that consume forest pests (adapted from Machmer and Steeger 1995)

Wildlife Tree User Guild	Guild Members	Predator Example	Prey Example	General Remarks
Aerial-foraging bats	Myotis spp.[1], Big Brown Bat, Silver-haired Bat, Pallid Bat, Hoary Bat	Big Brown Bat	beetles, moths	• all 13 species in this group are insectivorous • investigations of specific pest species consumed are under way
Terrestrial and arboreal rodents	mice[2], squirrels[3], chipmunks[4], Southern Red-backed Vole, Bushy-tailed Wood Rat	Red Squirrel	moths (e.g., spruce budworm)	• insects comprise part of the diet of at least 6 of 12 species in this group; 4 species are known to consume *pest* insects • fungi is the predominant food for several species
Carnivores	Weasels[5], Marten, Fisher, Ermine, Spotted Skunk, Black Bear, Racoon	Marten	rodents, rabbits, hares	• small to medium-sized mammals (many of which are considered pests) are the first-ranked foods for 5 of 8 species in this group

1 Myotis spp. = California Myotis, Western Small-footed Myotis, Western Long-eared Myotis, Keen's Long-eared Myotis, Little Brown Myotis, Northern Long-eared Myotis, Long-legged Myotis, Yuma Myotis

2 mice = Deer Mouse, Columbia Mouse, Sitka Mouse

3 squirrels = Flying Squirrel, Douglas Squirrel, Red Squirrel

4 chipmunks = Yellow-pine Chipmunk, Least Chipmunk, Red-tailed Chipmunk, Townsend's Chipmunk

5 weasels = Long-tailed Weasel, Least Weasel

Wildlife tree users eat many forest invertebrates and small mammals and affect the level of change incurred by these species. However, this does not tell us whether wildlife tree users can in fact control the abundance of certain pests. Some of the best evidence for this type of control comes from the bark-foraging guild.

Three-toed, Black-backed, and Hairy Woodpeckers eat mainly insects, and in winter they specialize on wood-boring beetle larvae. They use their chisel-shaped bills to drill beneath the bark and then extract the larvae with their unique tongues (Figure 3). Three-toed Woodpeckers show impressive rates of consumption using this feeding technique. During a spruce beetle outbreak, their stomachs contained an average of 915 beetles per bird, with each bird filling its stomach to capacity several times a day. Many studies show that woodpeckers can impact beetle populations; they respond *directly* to beetle outbreaks by including more beetles in their diet and by aggregating in outbreak areas, especially in winter.

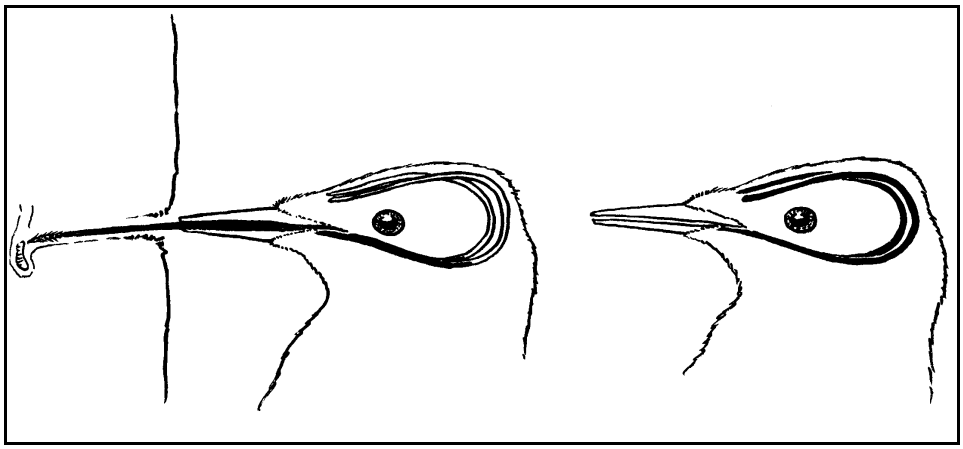


Figure 3. Specialization of woodpecker tongues (adapted from Ehrlich et al. 1988). Most woodpeckers have very long tongues that wrap around the skull when retracted (right). When extended (left), they can probe deep into holes drilled into trees. The tip of the tongue is barbed and coated with sticky saliva to help extract prey.

Woodpeckers also increase beetle mortality *indirectly* through their feeding activities. The process of excavating beneath the bark alters the microhabitat of the beetle larvae, making them more susceptible to temperature extremes, dessication, and attack by parasitic or predaceous insects. Other predators (e.g., Brown Creeper, Red-breasted Nuthatch) are also drawn to "woodpeckered" bark where they can access beetle larvae. Both the direct and indirect effects of woodpecker feeding activity contribute to the biological control of bark- and wood-boring beetles.

In general, cavity-nesting birds play an important role in maintaining some insect species at low levels by delaying the onset of an insect outbreak and accelerating its decline. Their main benefit lies in preventing outbreaks rather than in controlling established outbreaks. The feeding habits of aerial-foraging bats suggest that they too could play a significant role in controlling insects. Maintaining healthy populations of all of these predators makes good biological and economic sense.

Wildlife tree-dependent rodents are thought to impede reforestation. This perception is changing as we learn more about the role these species play in a complex cycle integral to the health of our forests (Figure 4). In the process of feeding, forest rodents disperse spores of mycorrhizae ("fungus-root") which are associations between fungi and the roots of plants. Virtually all commercially-valuable trees in B.C. (e.g., pine, fir, spruce, larch, hemlock) depend on these root-inhabiting fungi to absorb adequate nutrients for growth.

However, in spite of the damage they can cause to commercial tree species in B.C., various forest insects and small mammals are an integral component of forest ecology. The often cyclical relationship between trees, their pathogens, and various insect and small mammal predators is just beginning to be understood.

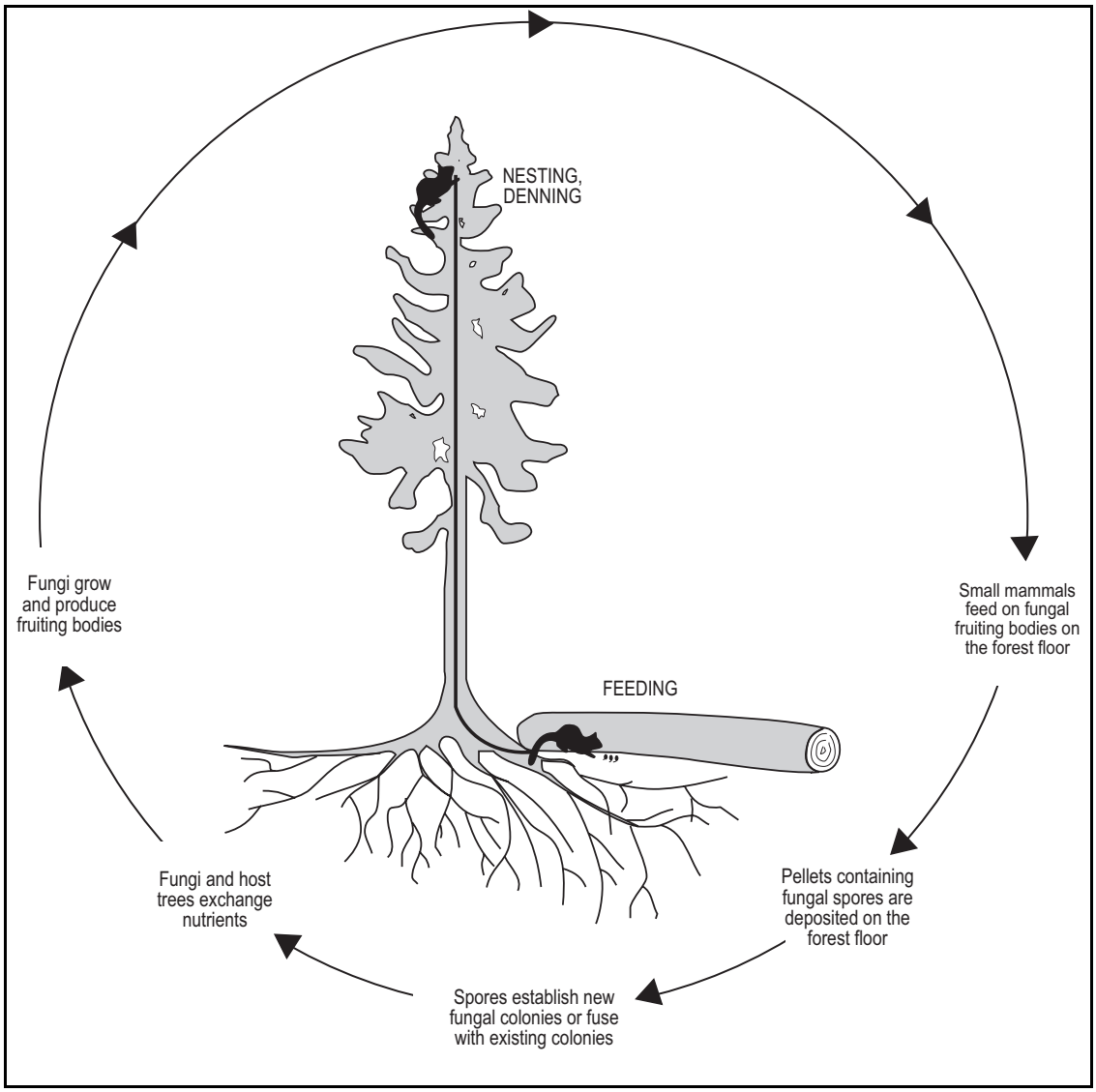


Figure 4. Root-fungus–small mammal interrelationships (adapted from C. Maser 1988).

Some wildlife tree-dependent rodents (e.g., flying squirrel, southern red-backed vole) rely on fungi for food, especially in winter. In turn, those mycorrhizal fungi that produce their fruiting bodies underground rely on small mammals for spore dispersal. Small mammals smell and dig up nutritious fungal fruiting bodies. Once eaten, fungal spores pass through the rodent digestive tract and are excreted into pellets. Spores within these pellets can establish a new fungal colony on a tree root system. By dispersing spores, small mammals act as a critical link in a cycle that promotes the growth and survival of our forests.

Wildlife tree users play a significant role in the transport of other materials within forest ecosystems. Small mammals collect and eat several kilograms of seeds annually. Many seeds are adapted to passage through the digestive tract, and substances contained in rodent pellets (e.g., yeast, nitrogen-fixing bacteria) encourage seedling establishment and growth. In the process of digging, small mammals mix soil layers and improve the properties of the soil for seedling establishment. Ground-foraging birds (e.g., House Finch, Common Grackle) also disperse seeds. Birds and bats are important transporters of nutrients because of their mobility. Bat feces are very rich in nitrogen and contribute to the nutrient content of roost trees and entire forest ecosystems.

Through their excavations, primary cavity excavators provide other wildlife with nesting, roosting and feeding opportunities. Ultimately, they accelerate the rate of tree decomposition and nutrient cycling in forest ecosystems.

NOTES:

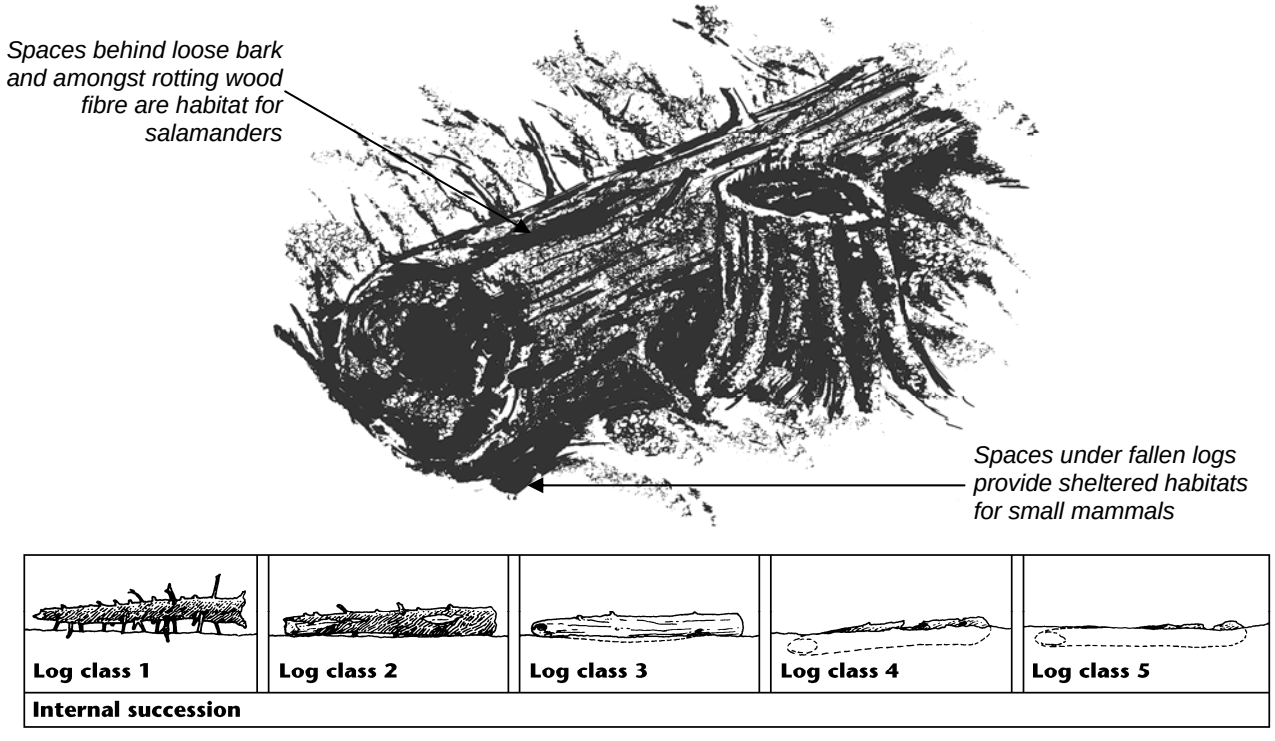
COARSE WOODY DEBRIS

Fallen trees, or other course woody debris (CWD), continue to serve an important role in the forest. Some of the many benefits CWD provides include:

- feeding, breeding, and shelter substrate for many organisms (invertebrates, small mammals, amphibians)
- nutrient source and growing substrates for various bacteria and fungi (including the mycorrhizal fungi that benefit most woody plants), as well as saprophytic plants, lichens and mosses that function in decay, nitrogen production, and other nutrient and moisture cycling
- carbon storage
- erosion control
- buffered microclimates suitable for seedling establishment
- escape cover from predators
- shelter and access routes for small mammals in periods of heavy snow cover.

CWD also shapes and stabilizes stream banks, and in aquatic habitats it increases channel complexity and habitat quality by creating pools and riffles (dispersing stream energy and creating fish habitats). In streams, CWD increases litterfall retention (up to 70%), which is then decomposed by stream organisms.

The decomposition stages for CWD are shown below.



Succession stages of decomposition in logs (source, Bartels et al. 1985).

Recommendations for Managing Coarse Woody Debris

When felling trees or clearing trails, leave some large logs and limbs as wildlife habitat and as a source of forest floor nutrients. In particular, try to leave large logs with heart rot or hollow cavities because these pieces will provide refuge cover for wildlife. Hollow logs are rare and can not be created once a tree has fallen.

General guidelines for managing CWD include:

- Leave a range of piece lengths and diameters.
- Leave a range of decay classes (especially log classes 1–3 and large hollow logs).
- Move CWD away from the trails so that it can decay naturally and with minimal disturbance from public visitors.
- In cleared areas, leave some small debris piles (<1 m high) as habitat for small mammals.
- If woody debris must be chipped, spread the chips thinly (<10 cm deep) on the forest floor to maintain biomass levels on site.
- In traveled or high use areas, slash CWD to the ground (this helps prevent potential injury from suspended logs).
- Balance objectives for coarse woody debris with other management objectives (e.g., fire hazard, back country versus front country).

NOTES:

Section Two

WILDLIFE/DANGER TREE ASSESSMENT

Learning Objectives

- What is a Dangerous Tree?
- Level of Disturbance and Exposure
- Site Assessment Overview
- Visual Tree Inspection
- Detailed Tree Assessment
- Overall Danger Tree Rating
- Safety Procedures
- Hazard Zones
- Documentation and Communication
- Legal Considerations

DANGEROUS TREES IN RECREATION SITES

Trees are an integral component of most parks and recreation sites. Often the very trees that attract visitors also pose risk of failure, especially where there are examples of legacy trees (large and often over-mature trees). Section two covers danger tree management – a systematic process for identifying tree hazards, assessing these hazards to determine their failure potential, and making recommendation about how to manage high risk trees. The guiding principles and goals for managing tree hazards in recreation sites are:

- to ensure public and worker safety,
- to conserve forest and wildlife tree values, and
- to promote tree health and sustainability.

Reasonable care must therefore be exercised to reduce the risk of failure to acceptable levels. The high-risk trees must be identified and the appropriate safety measures implemented to successfully manage the risk of tree failures in parks and recreations sites. Mitigation plans will therefore balance conservation values and visitor safety.

WHAT IS A DANGEROUS TREE

Trees, live or dead, can be dangerous to workers, the public, or park facilities. The following definition of "dangerous tree" in the Occupational Health Safety Regulation (OHS) 26.1 applies:

> **A DANGEROUS TREE**...
>
> *… means a tree (live or dead, regardless of size) that is a hazard to a worker due to:*
>
> *(a) its location or lean,*
>
> *(b) its physical damage,*
>
> *(c) overhead conditions,*
>
> *(d) deterioration of its limbs, stem or root system, or*
>
> *(e) any combination of the conditions in paragraphs (a) to (d).*

With reference to dangerous trees and the work place, Workers' Compensation Board OHS Regulation 26.11 (1) (see also Appendix 3) states: *If it is known or reasonably foreseeable that work will expose a worker to a dangerous tree,(a) the tree must be removed or (b) a risk assessment of the tree must be undertaken.* **This regulation only applies if trees are dangerous AND workers are exposed to that danger**.

One cannot have a dangerous tree unless there is a target. For the purposes of parks and recreation sites, targets are those established trails, camping sites, roads and facilities that are

provided to the visiting public to help them safely enjoy the park or recreation site. Workers responsible for the upkeep and development of the recreation site are also targets.

All trees, whether they are alive or dead, have the potential to be dangerous to people, property or facilities. The danger tree assessment process is based upon the fact that defects are visual indicators that a tree has the potential for failure. However, the process is limited because not all defects can be detected prior to a tree failing. Therefore, successful danger tree management will require a routine and systematic inspection and assessment of trees growing within 1½ tree lengths of targets. The procedures for determining whether a tree is dangerous to workers, to the public, or to park facilities and the appropriate steps and safety procedures for mitigating the hazard, are described in the following sections.

The determination of a tree's danger rating requires an understanding of the hazards inherent in a tree and the level of target exposure to the hazards of the tree. If either the tree hazard or target exposure is eliminated, then there is low risk associated with the tree.

RISK = HAZARD X EXPOSURE

Park Visitor Safety Policy

By virtue of the ***Occupier's Liability Act***, the owner of the park or recreation site has a duty to ensure that all persons and their property are reasonably safe while visiting the developed portion of the park or recreation site. To fulfil their legal responsibility to the public, the owner of a park or recreation site should develop a visitor safety policy that will guide danger tree management. Once a park visitor safety policy is in place, the park or recreation site manager has a legal responsibility (duty of care) to exercise common prudence through an established set of procedures (the standard of care) in operating the park or recreation site.

In addition, the ***Canada Labour Code*** part 2 (124, 125) requires employers to ensure the safety of their workers while performing duties at the work place and to make workers aware of every known or foreseeable safety hazard. Furthermore, employers are to ensure supervisors or managers are adequately trained and informed in such health and safety responsibilities. These responsibilities will ensure that a prescribed program for the prevention of those work site hazards is developed, implemented and monitored as part of an employer's due diligence.

In British Columbia, the standard of care for identifying and assessing dangerous trees that are located within parks or recreation sites is this module of the Wildlife/Danger Tree Assessors Course (WDTAC).

DETERMINING TREE DANGER RATING

The primary goals of tree danger rating are to ensure the safety of people (workers and visitors), property (vehicles, homes), and to protect facilities at the park or recreation site. Assessors must be able to recognize tree hazards, know how to evaluate them, and recommend appropriate safety procedures that will ensure public safety while balancing the conservation values associated with these trees.

Danger tree rating is a systematic process that begins by collecting relevant information about the site, identifies public use patterns, and then identifies tree hazards in relation to targets (people, property or facilities) within the park. Individual tree assessment is only undertaken when there is a risk of failure, whole or part, of a tree that could negatively impact an identified target.

The dangerous tree assessment process is described in 4 main steps:

1. **Determine the level of ground disturbance and visitor exposure** (refer to Tables 1, 1A) and **Conduct a site assessment overview** (refer to Table 2)
2. **Conduct tree assessments** (refer to Tables 3, 4, 4A and 5)
3. **Make the appropriate safety decision** (Safe or Dangerous)
4. **Provide documentation and communicate safety procedures**

This 4-step process is described in the sections that follow. Persons interested in dangerous tree assessment must understand that the processes described herein must be combined with field training and diligent practice.

NOTES:

STEP 1A: Determine the level of ground disturbance and visitor exposure

Not all defects pose an immediate and serious threat to the health and safety of workers and the visiting public. However, various human activities can result in differing levels of disturbance that may eventually be of adequate force (either by striking the tree or causing ground vibration) to dislodge defective trees. Likewise, the longer the duration of exposure to a defective tree, the higher probability that a tree failure will impact the visiting public.

Thresholds for tree defect failure potential have been developed on the basis of disturbance and exposure. The assessor must first determine the level of ground disturbance by workers and rank visitor exposure within the park or recreation site (Refer to table 1 for levels of disturbance). The next step is to utilize the hazard table for the selected level of disturbance (refer to tables 3-5) and assess defects in trees within reach of workers and the public.

Ground disturbance

Various work activities are associated with differing levels of ground vibration and tree disturbance. Activities rated as low disturbance create minimal ground or tree disturbance and as a result, expose workers to very little danger. However, as the level of disturbance increases, the potential risk of a defect being dislodged or failing increases. Consequently, fewer activities are appropriate around potentially dangerous trees under situations of high ground or tree disturbance (e.g., heavy construction equipment).

Visitor exposure

Various human activities can result in differing levels of exposure to potentially dangerous trees. Activities rated as very low disturbance, such as hiking along a trail, have low exposure time to potential hazards (i.e., people are present at a single location for only a brief period). As a result, the visitors are exposed to very little danger. As the use pattern increases there is increased risk of a tree failure, whole or part, impacting the public.

Areas within a park or recreation site need to be stratified to reflect these differences in exposure. Infrequently used areas, or areas of very low traffic volume will expose visitors to very little danger, and require less aggressive danger tree management effort. Where exposure to people and facilities is of long or constant duration (e.g., campgrounds) there is increased danger and the level of care must increase accordingly. Exposure levels must also reflect the differing property values, whether the target is of low value (e.g., firewood shed) or of high value (e.g., permanent building).

Table 1 relates level of disturbance (1 – 4 = "low, medium, high, very high") with various work activities and visitor exposure. Table 1A describes wind speed disturbance equivalencies.

However, some activities such as those involving the use of heavy construction equipment or tree falling can cause significant ground disturbance. Conversely, some locations such as overnight campgrounds, parking lots and buildings have low ground disturbance but high levels

of target exposure. For these sorts of activities and levels of target exposure, the level of risk to people or facilities can be high unless appropriate safety procedures have been implemented.

For many areas within a park or recreation site the level of ground or tree disturbance and the level of target exposure will be very low. Consequently, the potential for tree failure and the risk to people or facilities is also low. In some situations, high rainfall, ice or snow loads and high velocity winds (>40 km/hr) can temporarily affect the danger rating and failure potential for a particular tree (s). This applies particularly to workers in a specific location.

Very low risk (VLR) activities

Some activities result in **negligible levels of ground or tree disturbance, and have low exposure time** to potential tree hazards. Consequently the risk of injury due to tree hazards is very low. Very low risk activities include:

- foot travel and non-motorized travel (walking, hiking, cycling, horseback riding)
- road travel with light vehicles (passenger vehicles, ATV's)
- forest surveys, tree marking

For these situations, workers should keep a "heads-up" awareness of their surroundings and stay away from any obvious overhead tree hazards (e.g., insecurely lodged trees; hanging tops or limbs), and observe standard operating procedures for windspeed work shutdown. For further details, see Table 3.

NO pre-work site inspection is required for the very low risk activities listed above

NOTES:

Table 1. Levels of disturbance for workers and visitors at recreation sites

Wind Speed Equivalency (km/h)	Level of Disturbance*	Example Types of Work Activities	Example of Target & Exposure Levels
<40	1	• Tree planting and brushing • Campsite maintenance • Tree pruning (stems <20 cm dbh) • Use of light-duty machinery (e.g., weed whips, brush saws, lawn mowers, bobcats where there will be no digging which could disturb tree root systems/stability) • Road travel with heavy vehicles (>5500 kg GVWR) on ballasted and PERMANENT roads (a cleared right-of-way) • Trail construction with hand tools • Fire control with hand tools and/or water hoses	• Hiking trails with interpretive signs • Motorized trail use (ATV, snowmobile) • Trail lookouts and viewpoints • Rest stops alongside hiking trails • Wheel chair trails
	2	• Road travel with heavy vehicles (>5500kgGVWR) on non-ballasted, TEMPORARY roads (no clear right-of-way) • Maintenance or construction activities without heavy equipment (e.g., small machines such as "bobcats") • Tree pruning (stems >20 cm dbh) • Spacing or slashing (stems <15 cm dbh) • Tree bucking	• Parking lots (paved or compacted roads) • Day use picnic sites • Public beach/swimming areas • High-use trails (e.g., tour bus groups) • Roadside viewpoints, rest stops • Portable/temporary toilet facilities • Portable/seasonal kiosks • RV sani-stations
40–65	3**	• Tree falling (any tree >15 cm dbh) • Tree yarding (winching or other ground system) • Use of light and intermediate helicopters where workers are exposed to rotor wash (e.g., helipads) • Maintenance or construction activities with heavy equipment (including rubber tire backhoe where digging could affect tree root systems/stability)	• Campgrounds and amenities • Playgrounds • Permanent buildings/facilities
+65	4	• Harvesting operations in structurally damaged stands (e.g., wildfire burns) • Blasting • Use of medium and heavy helicopters where workers are exposed to rotor wash	

* A dangerous tree assessment is only valid for the lowest level of disturbance at which the assessment has been done.

** If trees CANNOT be safely felled and yarded away from adjacent standing trees (i.e., there is a chance that felled or yarded timber will strike adjacent standing "leave trees"), then default to Level 4 disturbance.

Table 1A should be used to determine Level of Disturbance Windspeed Equivalency. This is most useful when there is a need to "bump-up" the LOD rating to a higher value in order to allow work to continue under increasing wind conditions. For example, where an assessment has been conducted for level of disturbance 1 or 2, constant winds or frequent gusts (as opposed to infrequent gusts) that exceed 40 km/h during the work activity render the initial assessment invalid.

Therefore, where working under higher wind conditions, either stop work or reassess the potentially dangerous trees to an appropriate higher level of disturbance (e.g., LOD 3 = 40-65 km/h windspeed).

In addition, trees can initially be assessed at a higher level of disturbance in order to compensate for expected higher winds during the period of work activity, or because the work activity itself may change (e.g., light-duty construction level 2 may be changed to heavy-equipment construction level 3).

Table 1A. Influence of wind speed on level of disturbance

Wind Speed (km/h)	Description	Level of Disturbance Equivalency
0–40	light breeze (dust and loose paper raised; small branches move) to fresh breeze (small trees sway; tops of large trees sway)	1 – 2
40–65	strong breeze (small branches fly in the air; whole tree in motion; resistance felt when walking against wind)	3
65+	gale (branches broken off trees; walking impeded)	4

NOTES:

STEP 1B: Conduct a Site Assessment Overview

Prior to going out to the field, review all available information relevant to the site (e.g., safety policy, operating procedures, air photos, forest cover maps, past tree assessment reports, history of tree failures, development plans for the site, visitor use patterns, etc.). Divide the site into areas (strata) having differing management needs, levels of disturbance and exposure.

Once on site, confirm your stratification. Review the following site/stand factors during a walk through of the site, prior to individual tree inspection. The site overview provides a context for inspection of individual trees (i.e. it will identify overall site problems such as damaged stands or root rot). **Information and site/stand indicators found in the site overview** (see data card, appendix 5) **can provide clues about the condition and potential danger of individual trees.**

Table 2. Site Assessment Overview (for all tree species)

Site/Stand Factors	Hazard Indicators/Influences
Stand history and condition	• evidence of past tree failure • disturbance history (natural or human-caused, including wildfire damage; age, condition and location of mechanically harvested "stubs") • general age, condition and density • tree species composition • evidence of root and/or stem diseases
Common rain, snow and ice conditions	• high snow or ice loading • high rain fall periods
Flooding	• high water table • evidence of water damaged/decayed roots • area prone to flooding
Windthrow potential	• topography • prevailing winds • evidence of significant windthrow • area of high or recent exposure • stems with height/diameter ratio >100 (i.e., very tall, slender stems) • saturated soils • shallow soils • restricted rooting depth • fine textured soils
Crown condition	• stress cone crop • thinning foliage • chlorosis • rounded crown • small live crown (<20% of tree height)
Resinosis	• higher than normal stem or basal pitch flow
Tree lean	• trees recently leaning due to windstorm, root damage, shifting root mat or other causes
Additional site-specific factors	• based on local knowledge (e.g., soil or slope instability)

STEP 2 : Conduct Tree Assessments

A tree is potentially dangerous if it has defects in its top, branches, stemwood or root system. The degree of hazard will vary with the size of the tree, type and location of the defect, tree species, and nature of the target or work activity. All trees within 1½ tree lengths of targets (work areas, facilities, and public use areas) are therefore candidates requiring tree assessment. Tree assessment is divided into visual inspection and detailed assessment, in order of increasing rigour of testing and examinations.

Tree Hazards

Tree hazards can be separated into three categories: top and branch defects, stemwood defects, and root and butt defects. The dangerous tree assessment process requires that assessors identify tree hazards and know how to recognize, evaluate and manage all types of hazards.

> Tables 3–5 provide a summary of tree hazards associated with live or dead trees. On the following two pages are diagrams of each major tree hazard. Abbreviated codes are given for recording the presence of these tree hazards.

Visual Tree Inspection

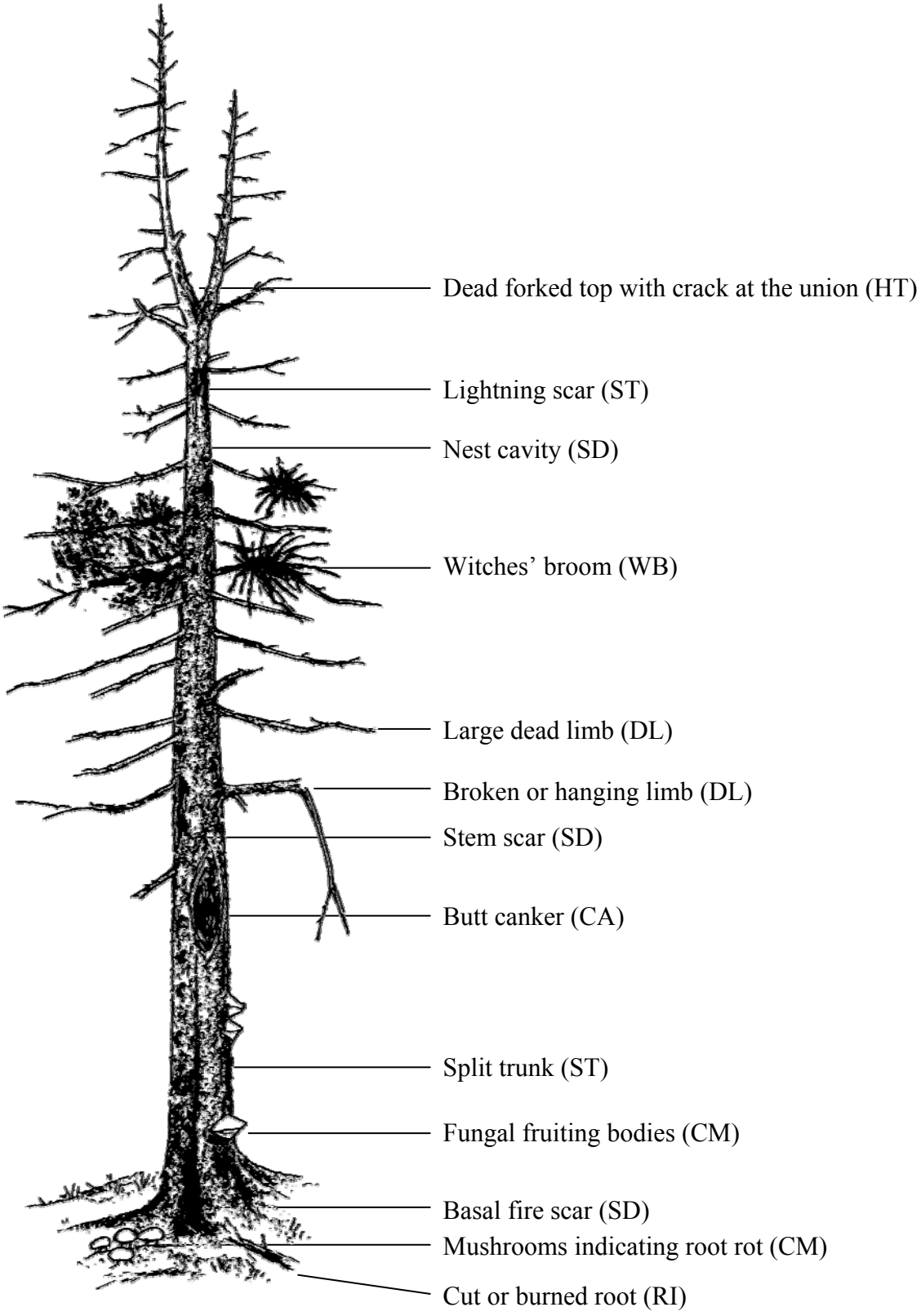
The determination of tree safety/danger is generally a visual process. Careful observation of hazards can usually result in the determination of an individual tree's failure potential and resultant safety decision within several minutes. However, where visual inspection identifies questionable root stability or shell thickness and where the results of the visual inspection are inconclusive, a detailed assessment involving root probing and/or stem sampling will be necessary.

Identify and describe any visible defects on trees where there is target exposure. Use the Danger Tree Assessment Field Data card to record the tree defects and hazards, wildlife habitat value information, soundness, and other details that will guide the management decisions for the tree. For each tree, refer to the defect descriptions in tables 3-5, and record whether the defect is safe (**S**) or dangerous (**D**), or questionable and requires a detailed assessment (**?**). It is important to record the presence and condition of each defect when recommending that a safe tree be monitored for decline.

Assessors must review trees from different vantages to reduce the possibility of missing defects obscured by poor lighting, vegetation or other obstacles. To properly evaluate defects high in the canopy of trees, assessors are advised to use binoculars. Remember that weather conditions may also impair ones ability to detect and evaluate defects.

> A tree can be declared as dangerous after the visual inspection. The presence of one or more dangerous tree defects, rooting problems or a hazardous lean will result in the tree receiving a dangerous (D) rating.

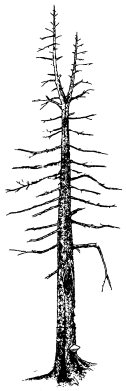
Common Dangerous Tree Indicators



Eight Generalized Tree Defects That Influence Tree Failure

(for further description, see Tables 3–5)

Dead limbs (DL)

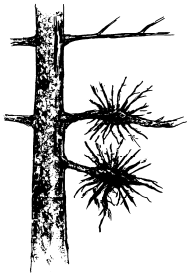


Hazardous tops (HT)

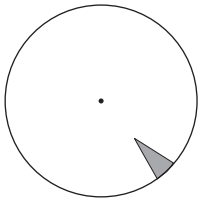




Witches' broom (WB)



Split trunk (ST)





Stem damage (scarring or butt rot) (SD)

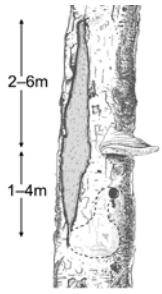


Butt and stem cankers (CA)



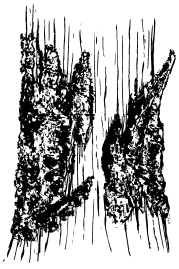
Fungal fruiting bodies (conks and mushrooms) (CM)





Heart rot decay column extending above and below conk. Distances indicated are a general rule of thumb. Note the circular woodpecker nest cavity below the conk (drawing not to scale).

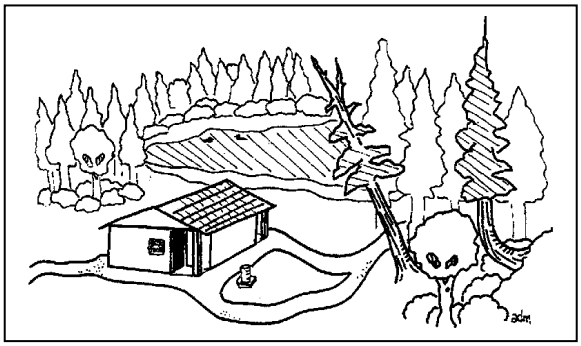
Thick sloughing bark (SB)



Tree Lean and **Root Inspection** must also be evaluated as part of the Visual Inspection Process. Specific failure potential criteria for Tree Lean and Root Inspection are described in Tables 3–5.

Tree Lean

Tree lean may be recent or long-standing. Long-standing lean trees have often subsequently grown a vertical top in the time since the lean occurred. Live leaning trees develop tension and compression wood at stress points, to aid in support. They also develop a reinforced root system, where disturbed, to compensate for prior damage. Unless the roots are disturbed further or decay is present, the potential for failure of long-standing leaning trees is low, and such trees need not be considered a hazard.

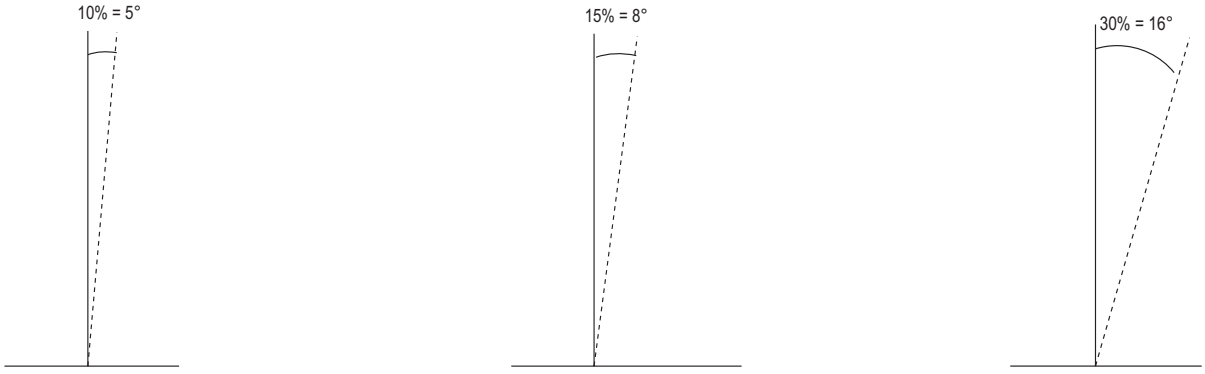


Hazard rating for leaning trees

For Class 1-3 trees, a lean >15% toward targets can be tolerated if there are NO rooting or instability problems. To make the assessment complete, the assessor must look for evidence of tree instability (i.e., shallow soils and lifting or damaged roots, root disease indicators, and time since lean). The amount of acceptable lean will therefore be a site-specific decision.

For Class 4-8 trees, however, the lean threshold is reduced. A lean >10% toward targets can be tolerated, but only if there are NO rooting and stability problems; otherwise these trees would be rated dangerous.

The hazard rating for lean is recorded as either S (safe) or D (dangerous). If you wish to monitor tree lean, record the amount of lean and the direction of lean relative to targets. For example, a tree with a safe lean of 10% towards a target can be recorded as –10S (the negative sign reflects the lean is towards the target and the S that the lean is safe; use a positive sign when the lean is away from the target).



Recently-leaning trees are tilted over their entire length. Since there is no evidence of reinforcement of the root system or bole wood, assessors must assume potential hazard. Assessors should also identify other rooting problems such as shallow roots or substrate, damaged or decayed roots, lifted roots, root disease indicators, or history of windthrow.



Sweep is defined as the curvature or distortion of the stem, and is often associated with competition for sunlight, snowpack and steep slope conditions. Sweep should not be confused with lean. Sweep has no decay or soundness significance and is not a hazard indicator. Beware of situations where a tree has had to grow up and around a fallen log. In this case the assessor must evaluate the stem to determine if there is damage and internal decay that may be obscured by the remnant log.



Slope is an important determinant of the direction of falling, and how far and with what force a tree will roll or slide after falling. Wildlife/danger trees falling on steep slopes may travel farther than the length of the tree. Slope angle must be evaluated site-specifically, but in general steep slopes are considered to be >30% inclined.

Detailed Tree Assessment

The detailed tree assessment is more rigorous than the visual inspection, and uses diagnostic tests to explore the extent of observed weakness or decay associated with a tree defect. Stem increment boring, drilling or sounding and root probing/drilling techniques will be employed. The detailed assessment may involve:

1. Stem sampling to measure the average stemwood shell thickness, and/or
2. Root probing to determine root condition.

It is important to note that the results of the detailed tree assessment (e.g., actual sound stemwood shell thickness) can, in some cases, override the dangerous tree criteria for visual inspections of a particular tree defect. For example, the assessor could determine the extent of decay due to an isolated conk on a live tree by increment-boring the affected area rather than simply defaulting to a dangerous rating.

In circumstances where visual inspection identifies questionable root stability or shell thickness and where the assessor wishes to retain the tree, a detailed assessment is required. The mandate to protect the conservation values in parks may warrant the extra time required to conduct detailed assessments. This is especially true when visually obscure defects are encountered on trees having high wildlife habitat value or trees that are intrinsically important to the visitor attractiveness for the park or recreation site (e.g., culturally significant, veteran, or legacy trees).

Remember: A detailed assessment is required when:

- the visual inspection is inconclusive as to the safety of a tree; and
- the tree is planned for retention where there is target exposure.

Stemwood Condition (only if required for Detailed Tree Assessment)

The relative thickness of either the outer shell or inner core of the tree in proportion to the tree's diameter provides an indication of the "columnar" strength. When the thickness of the shell or core of sound wood is insufficient for a tree's diameter, the failure potential can be said to be high. At least three cores should be taken from stems >40 cm dsh (diameter at sample height – usually at stump height, which is approximately 30 cm above ground on the high side of the tree), to ensure that the required stem thickness is present. Look for signs of decay or weakness and bore the stem adjacent to those areas.

Trees that have both heartwood decay and external scars that suggest an incomplete cylinder of sound stem wood will usually be rated as unsound. **If the stem is determined to be unsound, the tree is rated as dangerous, and there is no need to proceed with a test of root condition.**

> Trees with a sound average stemwood thickness <30% of the tree radius have a high failure potential (unsound) and are rated as Dangerous for stem condition.

NOTE: Sound wood is any wood that is firm, with no evidence of "punkiness." The wood is usually fairly light and uniform in colour, and growth rings are distinct. An increment core remains intact—it has a smooth texture and usually snaps when broken, and doesn't dent under fingernail pressure.

Caution: In certain dead trees in Classes 3–7 (especially white and ponderosa pine), the sapwood often deteriorates more quickly than the heartwood. The unsound sapwood must be discounted when determining the required stem thickness.

NOTES:

The procedure for determining required stemwood thickness (RST) compared to actual stemwood thickness (AST) is as follows:

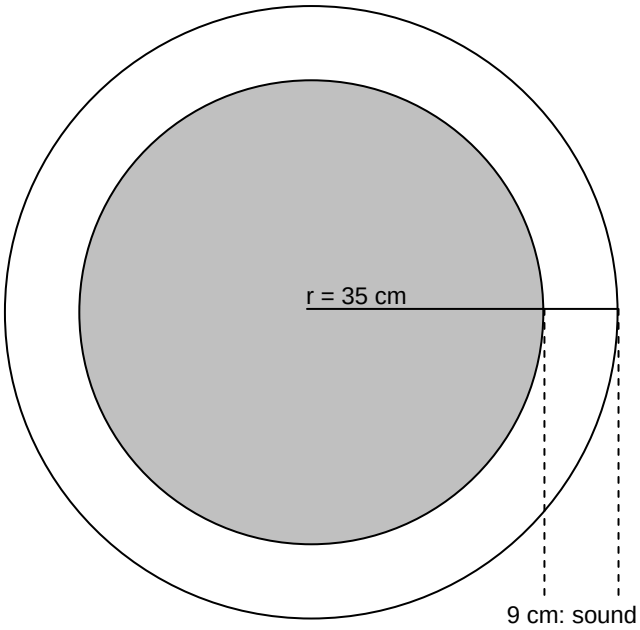
1. Measure diameter at sample (dsh), either at 30 cm above ground level (stump height) or at a specific position of weakness on the bole. This measurement is made outside the bark. For thick-barked Douglas-fir, ponderosa pine, western larch and cottonwood, a deduction for bark thickness should be made to determine the actual diameter of the stem. Most other tree species have relatively thin bark and do not need a deduction for bark thickness. An assessor, however, may make bark thickness deductions any time it is appropriate.
2. Divide diameter inside bark by 2 to determine the stem's radius.
3. Multiply the radius by 0.3 to determine required stemwood thickness (RST). The RST is 30% of the tree radius (RST = radius X 0.30).
4. Bore tree at sample height or where the stem was measured (average of two or more borings may be required) to determine the tree's actual solid stemwood thickness (AST).
5. Compare RST with AST. If the AST is equal to or greater than (≥) the RST, the stemwood condition is considered sound (S). If the AST is less than (<) the RST, the stemwood condition is dangerous (D).

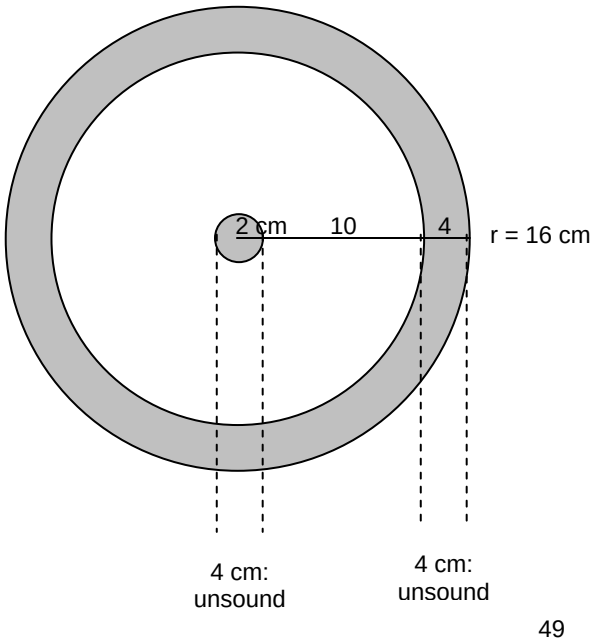
Example 1: tree with extensive heartrot

1. DSH = 70 cm
2. 70 cm ÷ 2 = 35 cm radius
3. 35 cm x 0.3 = 10.5 cm = RST. The required stem thickness (RST) of this tree is 10.5 cm.
4. A core from this tree shows that the outer shell of sound wood (actual stem thickness or AST) is only 9 cm.
5. 9 cm AST <10.5 cm RST, therefore the stemwood condition of this tree is rated as dangerous (D).

Example 2: tree with saprot decay and some inner heartrot

1. DSH = 32 cm
2. 32 cm ÷ 2 = 16 cm radius
3. 16 cm x 0.3 = 4.8 cm= RST. The required stem thickness (RST) of this tree is 4.8 cm.
4. A core from this tree shows an unsound outer shell of 4 cm, and an unsound central core of 4 cm, with 10 cm of sound wood in between. The actual stem thickness (AST) is 10 cm.
5. 10 cm AST > 4.8 cm RST, therefore the stemwood condition of this tree is rated as safe (S).



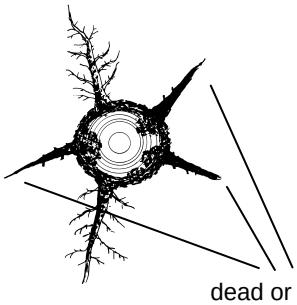


Root Condition (only if required for Detailed Tree Assessment)

Root condition is assessed at the root collar (as close to the ground as possible) using an increment borer or appropriate sharp probing instrument.

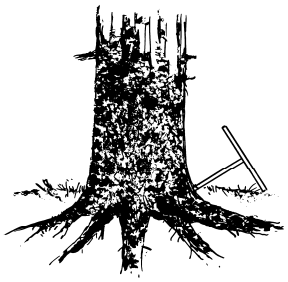
First, count the number of major lateral roots. Increment cores should then be taken until >50% of the major lateral roots are shown either to have advanced decay (>50% of the root's diameter is decayed) or be free from decay (Example 1). Borings or probing is made into the lateral roots at a downward angle of ≈45° (Example 2). Root excavation and chopping into the roots may cause unnecessary damage and destabilize the tree, thus this practice should be avoided.

Example 1:



This tree has 5 major lateral roots. Cores were taken until it was found that 3 roots had advanced decay. The tree receives a high failure potential rating for root condition.

Example 2:



Core probes should be made at a 45° angle into the major lateral roots to assess root soundness. If possible, check the underside of the roots for any decay.

NOTE:
In general, trees have a high failure potential when **>50% of lateral roots have decayed more than 50% through; or when >50% of the root system has been mechanically disturbed, damaged or burned through.** Damaged root condition should not be confused with roots having the soil duff layer scraped or burned away, merely **exposing** the roots but not actually damaging them. For visual root inspection criteria, refer to Tables 3 - 5 for **the corresponding Level of Disturbance** (e.g., LOD 3 uses >25% root damage as the visual inspection criteria for danger rating).

- Trees on shallow soils over bedrock or hardpan, or with high water tables, will have shallow root systems. Also look for root pull and cracked or lifting soil mats. These will become more hazardous over time and should be examined carefully before work activities begin.
- Trees growing in or near areas where root disease is present are likely to be infected as well. Watch for stand openings associated with uprooted trees, standing trees with thin or discoloured crown foliage, and fruiting bodies of root disease-causing fungi near the base of trees.

Dangerous Tree Criteria

The failure potential thresholds for each defect have been summarized by levels of disturbance tables (see Tables 3 –5). The assessor simply evaluates the tree defects observed against the criteria described within the applicable disturbance table.

Table 3 describes the **4 significant tree hazards that indicate a high failure potential and therefore a DANGEROUS rating for LEVEL 1 disturbance and exposure** — lesser hazards (as described in Tables 4–5) can be rated Safe for level 1 activities. In most cases a site assessment overview **conducted by a qualified person** will be sufficient to identify the significant tree hazards at level 1.

Table 3. Danger Tree Assessment Process for Level 1 Disturbance Activities: Significant Hazard Indicators

D = dangerous	D if tree has one or more of the following significant tree hazard indicators that are at risk of imminent failure: • Insecurely lodged trees or insecure hang-ups: i) Insecurely lodged trees (a tipped tree that is likely to shake free of the support trees and fall to the ground); or ii) Dislodged but hung-up limbs or tops (consider size and height above ground) at risk of shifting free during light winds or other tree motion • highly unstable tree: Examples: i) >50% tree cross-sectional area damaged or decayed; or ii) Spongy snags with heart rot conks along the majority of the length of the stem (e.g., class 5-6 conifers or class 4 deciduous) or soft snags (e.g., class 7-8 conifers or class 5 deciduous); or iii) >50% lateral roots damaged or with advanced decay • recent lean toward work area AND decayed root system (>50% of roots have advanced decay) or damaged and lifting anchoring soil layer (consider soil conditions and anchoring)
S = safe	all other trees

The **qualified person must be sufficiently experienced and/or trained to be able to recognize and ensure workers avoid exposure to the above significant hazards**. Crews should be instructed to keep a "heads-up" for any of the significant hazards and to stay away (generally greater than 1.5 defect lengths) from any trees showing these hazards. **However, any trees that the qualified person determines or suspects to be dangerous must be dealt with as follows BEFORE any workers enter that area:**

- have tree(s) or hazardous parts removed
- flag a no-work HAZARD ZONE of appropriate size and shape around tree(s) and instruct workers to stay out of this area (generally 1.5 defect lengths in size).

NOTE: Work crews must also observe wind speed conditions. After winds exceed 40 km/h, crews cannot be near any trees which might be suspect unless they have first been rated as safe by a **certified danger tree assessor** for the equivalent wind speed rating (see Table 1A).

Structurally damaged sites

A structurally damaged site is one that contains trees that have been severely and extensively damaged to the extent that a qualified person decides there is an undue risk of tree failure in the stand or site (e.g., site clean-up following extensive windthrow).

If work is required WITHIN 1.5 defect lengths of locations which are known or likely to contain defective, structurally damaged trees, then a qualified person must assess the work area PRIOR to work commencing in order to identify any trees which are dangerous and to implement the appropriate safety procedures.

NOTES:

NOTE

Tree defect descriptors that indicate a DANGEROUS tree rating are summarized in Tables 4 and 4A. Use these tables to determine which trees are rated dangerous for levels 2 and 3 disturbance activities respectively. Table 5 describes the only types of trees that are safe for retention in level 4 disturbance activities. The defects described in these tables are those that would likely cause injury if they were to fail. Therefore, consider the size of the defect and its height above ground.

Table 4. Dangerous Tree Criteria for Level 2 Disturbance Activities

NOTE: Any tree defects as described in the boxes below will be rated as DANGEROUS for level 2 disturbance. Trees with lesser defects can be rated SAFE for level 2—care should be taken not to brush these trees and to fall and yard away if possible.

Defect Category	Species Group			
	Douglas-fir, larch, pines, spruces	Western redcedar, yellow cedar	Hemlock, true firs	Broad-leaved deciduous
Hazardous top (HT)	• Class 2 to 5 trees: Defective Top (any size; e.g., secondary top) where structural weakness is evident; OR • Class 4 and 5 trees: defective top (e.g., secondary top) >30% of tree height	Class 2 to 5 trees: Defective Top (any size; e.g., secondary top) where structural weakness is evident	• Class 2 to 5 trees: Defective Top (any size; e.g., secondary top) where structural weakness is evident; OR • Class 4 and 5 trees: defective top (e.g., secondary top) >20% of tree height	▪ Class 2 to 5 trees: Defective Top (any size) as a fork, co-dominant or multiple stem where structural weakness is evident; OR ▪ Where a dead top is >20% of the tree height
Dead limbs (DL)	• Dead limbs >10 cm diameter with structural weakness • Hung-up limbs	• Dead limbs >15 cm diameter with structural weakness • Hung-up limbs	• Dead limbs >10 cm diameter with structural weakness • Hung-up limbs	• Dead limbs >10 cm diameter (including "scaffold branching") with structural weakness • Hung-up limbs
Witches' broom (WB)	Brooms >1 m diameter on dead branches with evidence of decay, cracking or failure (dead branches and brooms may be on the ground)	n/a	Brooms >1 m diameter on dead branches with evidence of decay, cracking or failure (dead branches and brooms may be on the ground)	n/a
Split trunk (ST) (includes frost, lightning, wind-induced and impact-induced cracks)	Crack or split >2 cm wide extending >25% of tree diameter into stem AND evidence of advanced decay in surrounding stemwood	Crack or split >2 cm wide extending >50% of tree diameter into stem AND evidence of advanced decay in surrounding stemwood	Crack or split >2 cm wide extending >25% of tree diameter into stem AND evidence of advanced decay in surrounding stemwood	Crack or split >2 cm wide extending 25% of tree diameter into stem AND evidence of advanced decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire damage, machine damage, animal damage or butt rot)	>25% of tree cross-sectional area damaged, burned, scarred or fractured	>50% of tree cross-sectional area damaged, burned, scarred or fractured	>25% of tree cross-sectional area damaged, burned, scarred or fractured	>25% of tree cross-sectional area damaged, burned, scarred or fractured
Thick sloughing bark or sloughing sapwood (SB) (bark applicable to Douglas-fir, larch, ponderosa pine and cottonwood >50 cm dbh)	Class 6–8 trees: Large pieces of bark or sapwood separated and sloughing from bole of tree*	• Bark n/a • Long slabs of sloughing sapwood hanging from bole of tree	n/a	Class 5 trees: Large pieces of bark separated and sloughing from bole of tree
Butt and stem cankers (CA)	>50% of butt or stem circumference as a perennial canker face	n/a	n/a	>50% of butt or stem circumference as a canker face on a dead tree
Fungal fruiting bodies (CM) ** (conks and mushrooms)	• Any heartrot fungus present Exception: For veteran and dominant trees, if *Phellinus pini* conks present BUT NO other visible defects/damage to stem that allow oxygen exchange (e.g., broken top, scarring, nest cavity, etc.) = SAFE; • Sap-rotting fungi present on any tree <30 cm dbh where saprot depthis >5 cm	n/a	• Any heartrot fungus present • Sap-rotting fungi present on any tree <30 cm dbh where saprot depth is >5 cm	• Any heartrot fungus present Exception: P. tremulae on live trembling aspen, apply alternate safe work procedures; • Sap-rotting fungi present on any trees <30 cm dbh where saprot depth is >5 cm
Tree lean (for class 1–3 trees)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Tree lean (for class 4–8 trees)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Root inspection	Occurrence of any of the following: root pull; lifting root mat; visible decay or damage to roots affects >50% of lateral roots	Occurrence of any of the following; root pull; lifting root mat; visible decay or damage to roots affects >50% of lateral roots	Occurrence of any of the following: root pull; lifting root mat; visible decay or damage to roots affects >50% of lateral roots	Occurrence of any of the following: root pull, lifting root mat; visible decay or damage to roots affects >50% of lateral roots.
Average stemwood shell thickness (for Detailed Tree Assessment)	Average sound stemwood shell thickness <30% of tree radius	Average sound stemwood shell thickness <30% of tree radius	Average sound stemwood shell thickness <30% of tree radius	Average sound stemwood shell thickness <30% of tree radius

* In Douglas-fir and ponderosa pine, treat thick sloughing sapwood according to the bark failure potential criteria

Table 4A. Dangerous Tree Criteria for Level 3 Disturbance Activities

NOTE: Any tree defects as described in the boxes below will be rated as DANGEROUS for level 3 disturbance. Trees with lesser defects can be rated SAFE for level 3—care should be taken not to brush these trees and to fall and yard away if possible.

Defect Category	Species Group			
	Douglas-fir, larch, pines, spruces	Western redcedar, yellow cedar	Hemlock, true firs	Broad-leaved deciduous
Hazardous top (HT)	• Class 2 to 5 trees: Defective Top (any size; e.g., secondary top) where structural weakness is evident; OR • Class 4 and 5 trees: defective top (e.g., secondary top) >30% of tree height	• Class 2 to 5 trees: Defective Top (any size; e.g., secondary top) where structural weakness is evident	• Class 2 to 5 trees: Defective Top (any size; e.g., secondary top) where structural weakness is evident; OR • Class 4 and 5 trees: defective top (e.g., secondary top) >20% of tree height	• Class 2 to 5 trees: Defective Top (any size) in the form of a fork, co-dominant or multiple stem where structural weakness is evident; OR ▪ Where dead top >20% of tree height
Dead limbs (DL)	• Dead limbs >10 cm diameter with structural weakness • Cracked, decayed, broken or hung-up limbs	• Dead limbs >15 cm diameter with structural weakness • Cracked, decayed, broken or hung-up limbs	• Dead limbs >10 cm diameter with structural weakness • Cracked, decayed, broken or hung-up limbs	• Dead limbs >10 cm diameter with structural weakness • Cracked, decayed, broken or hung-up limbs
Witches' broom (WB)	Brooms >1 m diameter on live or dead branches AND evidence of decay, cracking or failure	n/a	Brooms >1 m diameter on live or dead branches AND evidence of decay, cracking or failure	n/a
Split trunk (ST) (includes frost, lightning, wind-induced and impact-induced cracks)	Crack or split >2 cm wide extending >25% of tree diameter into stem AND evidence of decay in surrounding stemwood	Class 2 and 3 trees: Crack or split >2 cm wide extending >50% of tree diameter into stem AND evidence of decay in surrounding stemwood Class 4–8 trees: Crack or split >2 cm wide extending >25% of tree diameter into stem AND evidence of decay in surrounding stemwood	Crack or split >2 cm wide extending >25% of tree diameter into stem AND evidence of decay in surrounding stemwood	Crack or split >2 cm wide extending >25% of tree diameter into stem AND evidence of decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire damage, machine damage, animal damage or butt rot)	• >25% of tree cross-sectional area damaged, burned, scarred or fractured	Class 2 and 3 trees: >50% of tree cross-sectional area damaged, burned, scarred or fractured Class 4–8 trees: >25% of tree cross-sectional area damaged, burned, scarred or fractured	• >25% of tree cross-sectional area damaged, burned, scarred or fractured	• >25% of tree cross-sectional area damaged, burned, scarred or fractured
Thick sloughing bark or sloughing sapwood (SB) (bark applicable to Douglas-fir, larch, ponderosa pine and cottonwood >50 cm dbh)	Large pieces of bark or sapwood separated and sloughing from bole of tree	Bark n/a • Long slabs of sapwood hanging from bole of tree	n/a	Large pieces of bark separated and sloughing from bole of tree
Butt and stem cankers (CA)	>50% of butt or stem circumference as a perennial canker face *	n/a	n/a	• >20% of butt or stem circumference as a perennial canker face* • >50% of butt or stem circumference as a canker face on a dead tree
Fungal fruiting bodies (CM) ** (conks and mushrooms)	• Any heart rot fungi present Exception: For veteran and dominant trees, if *Phellinus pini* conks present but no other defects or damage to stem that allow oxygen exchange (e.g., scars, broken top, nest cavity) = SAFE • Sap-rotting fungi on trees <30 cm dbh where saprot depth is >3 cm	n/a	• Any heartrot fungi present ; OR • Sap-rotting fungi present on trees <60 cm dbh where saprot depth is >6 cm	• Any heartrot fungi present Exception: P. tremulae on live trembling aspen, apply alternate safe work procedures; OR • Sap-rotting fungi present on trees <60 cm dbh where saprot depth is >6 cm
Tree lean (for class 1–3 trees)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	• Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope) • For candelabra-branched trees, where candelabras are predominantly on lean side of tree—lean >10% toward target/work area and tree has rooting problems	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Tree lean (for class 4–8 trees)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Root inspection	Occurrence of any of the following: root pull or lifting root mat; visible damage or decay to roots affects >25% of lateral roots	Occurrence of any of the following: root pull or lifting root mat; visible damage or decay to roots affects >25% of lateral roots	Occurrence of any of the following: root pull or lifting root mat; visible damage or decay to roots affects >25% of lateral roots	Occurrence of any of the following: root pull or lifting root mat; visible damage or decay to roots affects >25% of lateral roots.
Average stemwood shell thickness (for Detailed Tree Assessment)	Average sound stemwood shell thickness <30% of tree radius	Average sound stemwood shell thickness <30% of tree radius	Average sound stemwood shell thickness <30% of tree radius	Average sound stemwood shell thickness <30% of tree radius

Additional Notes Relevant to Table 4 and Table 4a

Structural Weakness

Structural weakness includes decay, cracking, breakage, embedded (included) bark or cracking at forks or multiple stem unions, presence of conks, stem scars with decay, swollen stems from mistletoe (goiter), and woodpecker cavities.

Nest Cavities

Nest cavities themselves (which are usually circular in shape) should be considered as stem damage and is an **indication of internal decay**. Some trees with nest cavities will have sufficient sound shell in this section of the tree, but this will vary with tree species and size, type of decay pathogen present, and other factors (e.g., other tree damage, site moisture, species of excavating bird, etc.). Assessors must therefore practice due diligence when evaluating trees containing cavity nests – these valuable wildlife trees warrant a thorough assessment before concluding with the tree assessment.

Perennial Cankers

Perennial cankers are generally circular to lens-shaped cankers that can persist for years, and slowly expand at about the same rate as the radial growth of the affected live tree. They gradually take on a sunken appearance as tissues under the dead cambium do not grow along with the surrounding wood. They are sometimes called "exploding cankers."

Identity of Wood Decay Fungi

If the identity of wood decay fungus cannot be determined (e.g., saprot or heartrot), then default to Dangerous rating.

- When ***Phellinus pini*** is present (see the exception note for the Douglas-fir, larch, pine, spruce conifer group) and the stem has structural damage such as a broken top or scarring that allow oxygen exchange or other stress indicators (e.g., resinosis, damaged roots), **OR** if there are conks distributed along the bole length, then default to Dangerous rating.
- With class 2 Aspen, when ***Phellinus tremulae*** is present, alternate safe work procedures can be used. This requires the assessor to peform a site review and to sample a selection of the trees in an attempt to determine what combination of defects results in failures at the site, and to use this criteria to define dangerous trees. If you do not see many broken or snapped aspen, conclude that **LIVE** standing aspen with NO OTHER DAMAGE other than visible conks, can be declared "Safe" to work around during the period of the work activity

If there is an isolated heart-rot conk on a live tree, the assessor can conduct a detailed assessment in vicinity of this conk to determine whether there is sufficient sound stemwood thickness to override the default dangerous rating. Such trees would then be monitored for decline and appearance of multiple conks (an indication that heart-rot has advanced and compromises stem wood strength). Refer to Appendix 1 for more detailed information about wood decay fungi, or consult reference resources that aid in recognizing fungi.

Table 5. Danger Tree Assessment Process for Level 4 Disturbance Activities

When conducting level 4 disturbance assessments, only the following 4 types of trees are rated safe. All other trees will be rated Dangerous for level 4 activities.

Level 4 disturbance

S = Safe
if tree is one of the following:

- class 1 tree (all species)
- class 2 trees with NO structural defects (all species) (usually wind- or snow-snapped green trees, very light fire scorching).
- class 2 cedars with LOW failure potential defects (refer to table at right)
- class 3 conifers with NO structural defects (tree recently killed by insects, climate or light intensity fire—these will have no structural damage or decay)

D = Dangerous all other trees
(fall tree; create a no-work zone; or remove hazardous parts)

Any leave tree that is damaged during the work activity must be reassessed if work is to continue within reach of the tree.

CLASS 2 CEDAR TREES ARE SAFE IF THEY FIT THE FOLLOWING CRITERIA:

Defect Category	Western Redcedar, Yellow-cedar Low Failure Potential
Hazardous top (HT)	Defective Top (e.g. secondary top, spike) <30% of tree height with no evidence of decay, cracking, failure or other structural weakness
Dead limbs (DL)	Dead limbs (no size limit) with no evidence of decay, cracking or failure
Split trunk (ST) (includes frost, lightning and wind-induced cracks; does not include dry checking)	Crack or split >2 cm wide extending <50% of tree diameter into stem; no evidence of decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire damage, machine damage, animal damage or butt rot)	<50% of tree cross-sectional area damaged, scarred or fractured with no evidence of decay in remaining stemwood
Tree lean (TL)	Lean <30% (16°) toward target/work area and tree has no rooting problems
Lean — candelabra branched trees (where candelabras are predominantly on lean side of tree)	Lean <10% (5°) toward target/work area and tree has no rooting problems
Root inspection (RI)	No visible problems: no root pull or lifting root mat. Any visible structural damage to roots only affects <25% of lateral roots (remaining roots undamaged)
Average stemwood shell thickness (for Detailed Tree Assessment if required)	Total sound stemwood shell thickness >30% of tree radius

STEP 3: Make the Appropriate Safety Decision

After the initial visual inspection (checking for hazards/defects and site conditions such as lifting root mats) and, if needed, after the more detailed tree assessment (checking stemwood and root soundness) a safety procedure can be prescribed for a tree or trees.

Generally, the trees having moderate to high wildlife tree habitat value, cultural importance, or outstanding conservation value will affect the safety procedure decision (e.g., removal of the target versus the removal of the tree). Refer back to Section 1 for information on habitat value.

Wildlife Tree Value, as well as other values (e.g., heritage, cultural or archaeological significance, rare tree species, etc) should be factored into mitigation strategies for dangerous trees. On the field data card, record the values related to the tree. Where wildlife use is observed, record the type of use by selecting from the following codes:

CN – Cavity Nest	**F** – Feeding
P – Perch tree	**ON** – Open nest
M – Mark tree	**D** - Den
Other – bats, roost	

The distance to the nearest target should also be recorded on the field data card to guide safety decisions for trees or groups of trees. Assessors should also take note of the magnitude of impact a dangerous tree will have to the recreation site (e.g., whether the tree affects one or multiple camping sites). This information can help the management team prioritize resources and consider the use of tree modification techniques to manage trees with high conservation values.

Safety Procedures (for "suspect" trees that have been assessed)

To demonstrate due diligence, ensure your field data card is completed accurately. Record a hyphen where defects are absent or where assessments were not required (e.g., if the detailed assessment was not required). Use a "?" to indicate where the visual assessment of a defect was inconclusive and you performed a detailed assessment to make the final determination (e.g., increment drilling was needed to confirm solid shell thickness).

On the field data card, select the safety procedure that you recommend be applied to the tree(s). The following options are recommended. It is your duty to recommend the appropriate safety procedure based upon your tree and site assessment. Treatment or implementation is the responsibility of the management team.

For trees rated as Safe (S), consider the following management procedures:

- record tree as **S**: tree is safe for activities and exposure, retain tree—no removal or modification necessary (may affix a tag, paint or flagging as appropriate)
- record tree as **M**: monitor the tree with low-risk defects (useful when there is concern about future tree failure and there is target exposure)
- record tree as **R**: recommendation that the tree with low-risk defects be treated now while the tree is safe to mitigate (because to delay until the tree reaches a dangerous state will be problematic, especially when there is exposure to a permanent target)

For trees rated as Dangerous (D), consider the following procedures:

- dangerous; tree risk is high, fall tree
- dangerous; remove the dangerous part(s) of the tree
- install temporary flagged hazard zone; usually a temporary work area, or awaiting opportunity to treat the tree and need to temporarily prevent exposure to workers and visitors
- modify target or facility; to prevent exposure to the tree, move the amenities that attract visitors, or modify access routes, or simply move the facility
- record tree as Dangerous (may affix tag, paint or flagging if marking is required for work activity or site)
- map the location of hazard zones and trees recorded as Dangerous.

Overall Danger Rating

Any tree that receives a D-rating for visible defects, lean, stemwood and/or root condition automatically receives a D-rating for overall danger rating and a mitigation plan is required.

REMEMBER

When prescribing safety procedures, consider the level of target exposure. Where there is no or very low exposure, then the risk is also very low, regardless of the nature of the tree hazard. It is NOT appropriate for assessors to select "Safe / Monitor" for trees with dangerous defects.

Summary of Assessment Requirements

All **work** activities EXCEPT those defined as "very low risk" require a pre-work inspection by a qualified person to determine if there are any trees that might endanger workers. A summary of activity level assessment requirements is shown below.

- **Very Low Risk (VLR) Activities**—No pre-work site inspection is required.

- **Level 1 Disturbance Activities**—A pre-work inspection by a qualified person is required. If trees with significant tree hazards (see Table 3) are observed, the appropriate safety procedures must be taken BEFORE work activities begin.

- **Level 2, 3 or 4 Disturbance Activities**—A pre-work inspection by a qualified person is required. If "suspect" trees (see Table 4, 4A, 5) are identified by a qualified person, then **further assessment by a certified danger tree assessor** is required and the appropriate safety procedures must be taken BEFORE work activities begin.

Dangerous Trees Along Roadsides

Vehicle travel along established roads is considered a Very Low, Level 1 or Level 2 disturbance (see Table 1). Consequently, inspection/assessment and subsequent removal or modification of trees alongside roads must be determined on a site-specific basis. Look for the three significant hazard indicators (see Table 3) that result in a Dangerous rating for trees along traveled (and ballasted) roads.

The location of the tree relative to the roadway and its surroundings will affect whether a tree is dangerous to travelers. If trees are leaning towards the road, but because of the distance or presence of intervening large, live trees, the tree cannot reach the road, then there is no exposure and therefore no risk to road users. However, factors such as excessive lean (generally >15%), whether the tree is live or dead, tree condition (tree class, stemwood soundness), rooting conditions (root health and soundness, soil depth and moisture), distance from the road, slope toward the road, and wind exposure all determine whether trees along roads should be removed or modified.

Frequency of Road Assessments

In general, roads should be inspected for dangerous trees on a regular basis. The frequency of inspection will be determined by the level of use as well as other site-specific factors (e.g., areas prone to windthrow or root disease, occurrence of major storm events).

- In most cases, an annual or biannual inspection for tree hazards will be sufficient, but resource managers familiar with the area should determine the frequency.

- Under most circumstances, the visual tree inspection process will be adequate for road inspections; however, some trees may require a detailed assessment.

Alternate Safe Work Procedure for Decay Defects on Live Trembling Aspen

Rationale

Trembling aspen (*Populus tremuloides*) is one of the most common deciduous trees occuring throughout most of interior British Columbia. Where it occurs, it is perhaps the most valuable wildlife tree for cavity excavating birds because of its propensity to develop heart rot decay as a live tree, relatively soon in its life span. In most cases this heart rot is caused by the fungi *Phellinus tremulae*, which is restricted to the heartwood of the tree and is often successfully compartmentalized by the tree. Consequently, depending on the diameter and vigour of the tree, the internal decay is restricted to the heartwood, with the tree developing a sound outer shell of later heartwood and sapwood. The result is a live tree which can often exhibit numerous fruiting bodies of *P. tremulae* (brownish-gray conks are usually visible just below branch stubs), yet have enough sound outer wood in the stem cross-section to provide columnar strength to the bole of the tree (i.e., the minimum required shell thickness is $\geq$ 30% of the tree radius). Trees in this condition make excellent nest sites for cavity excavating birds, and while they are still alive, often do not suffer stem breakage.

Related Danger Tree Assessment Guidelines

According to the tree failure criteria described in this course, the presence of "... any heart rot fungi" found on broad-leaved deciduous trees results in a "Dangerous" rating for those trees, under Level 2-4 work activities. Most mature aspen have *P. tremulae* conks or blind conks - this means that these trees would automatically get a "D" rating if there is exposure to workers (except for Level 1 work activities). In some areas of the province where aspen is abundant, this may mean that an undue number of live and/or minimally damaged aspen would be rated "D" for Level 2-4 work activities - this would result in an unnecessary amount of tree felling and subsequent fuel loading in these situations, as well as a loss of valuable wildlife habitat. An alternate job safety procedure is recommended for aspen, as follows.

Alternate Job Safety Procedure for Trembling Aspen (applicable to Level 2-4 work activities)

1. **Conduct a site assessment overview** in order to determine the general size and condition of aspen in the work area
2. **Look for visible conks and blind conks** on tree trunks (blind conks usually seen as rough textured, blackish swellings at the base of branch stubs)
3. **Look for aspen trees that have broken or snapped**. If trees have sufficient decay to be a safety hazard (i.e., they have insufficient sound shell), then it is very likely that you will observe some broken and snapped trees, and trees with extensive woodpecker nest holes along the trunk.
4. If you do not see many broken or snapped aspen (with or without fire damage), then conclude that **LIVE** standing aspen with NO OTHER DAMAGE other than visible conks, can be declared "Safe" to work around during the period of the work activity.
5. **Document your observations** of aspen based on the site assessment overview
6. **Determine and document marking procedures** for aspen. If live aspen with conks are generally not breaking in the stand, then you will likely NOT have to mark aspen which have visible conks, but no other damage
7. The above 6 steps **ONLY apply to LIVE aspen** with visible conks or blind conks, **AND** which do NOT have other damage. Trees with other damage (e.g., fire scarring, dead tops, damaged roots, etc.) must be assessed according to Tables 3-5 and dealt with accordingly.

Hazard Areas (HA)

Hazard areas are flagged or barricaded areas where no person shall enter except to remove specific tree hazards. In most park and recreation site applications, hazard areas will usually be areas flagged temporarily until work activities are completed in an adjacent area. The hazard area may also be used to protect workers and visitors in situations where the danger tree or parts thereof have not yet been removed. This zone must include all the area on the ground that could be reached by any dislodged portion of the tree were it to fail. The following guidelines apply to the use of hazard areas:

- Hazard areas will take into account the nature of the hazard and the lean of the tree.
- On steep ground, the hazard area will be extended downhill to protect workers and visitors.
- Hazard areas can be adjusted in size depending on the size of surrounding live timber (e.g., a small danger tree surrounded by much larger trees that "shield" the adjacent area have a HA radius less than 1.5 defect lengths).
- A kick-back area should be included for semicircular hazard areas. The size and shape of this area is determined by tree lean, condition and form (branching).

> **NOTE:** HAZARD AREAS are generally 1.5 times the defect length. This length can be modified (larger or smaller) depending on site-specific conditions such as slope or size of surrounding trees.

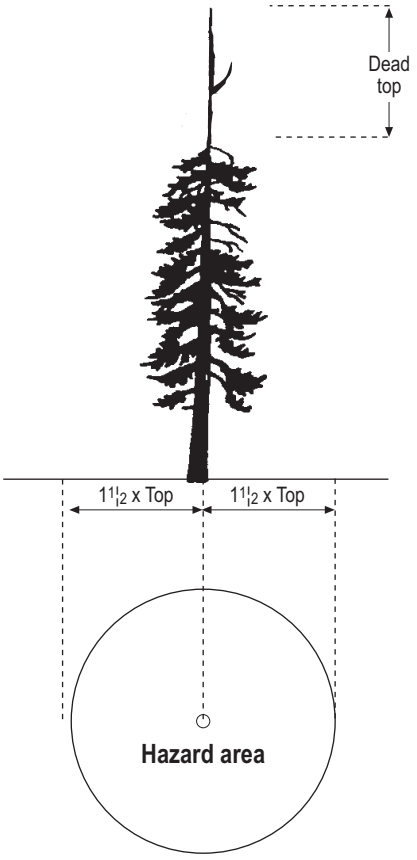
The most common types of hazard areas are illustrated on the following pages.

NOTES:

A. Sound tree, no lean, hazardous top, flat ground

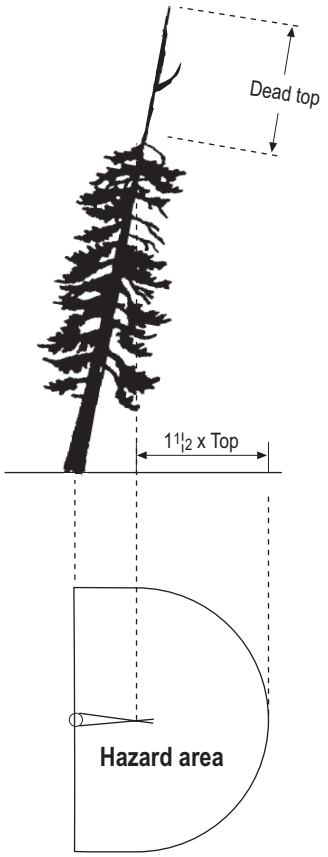
1. Determine the length of top that might dislodge.
2. Add ½ of this length, to get a 1½ top length distance.

This distance is the radius of the hazard area.



B. Sound tree with lean, hazardous top, flat ground

1. Determine the length of top that might dislodge.
2. Add ½ of this length, to get a 1½ top length distance.
3. Determine from the lean how far from the base of the tree the top might land.

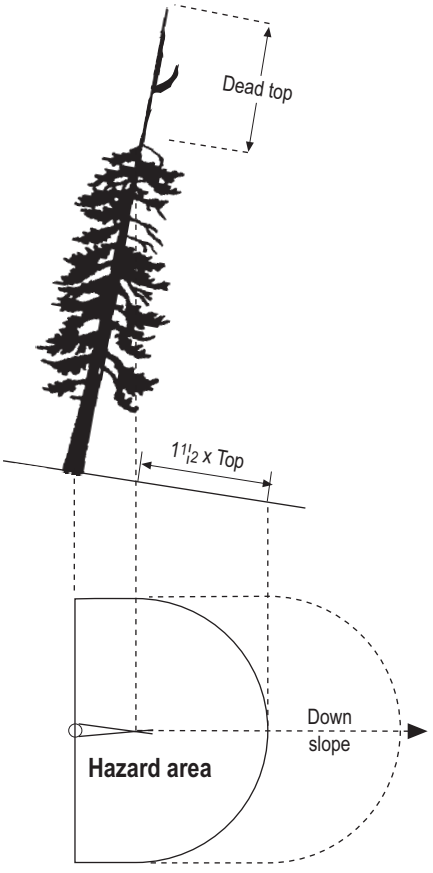


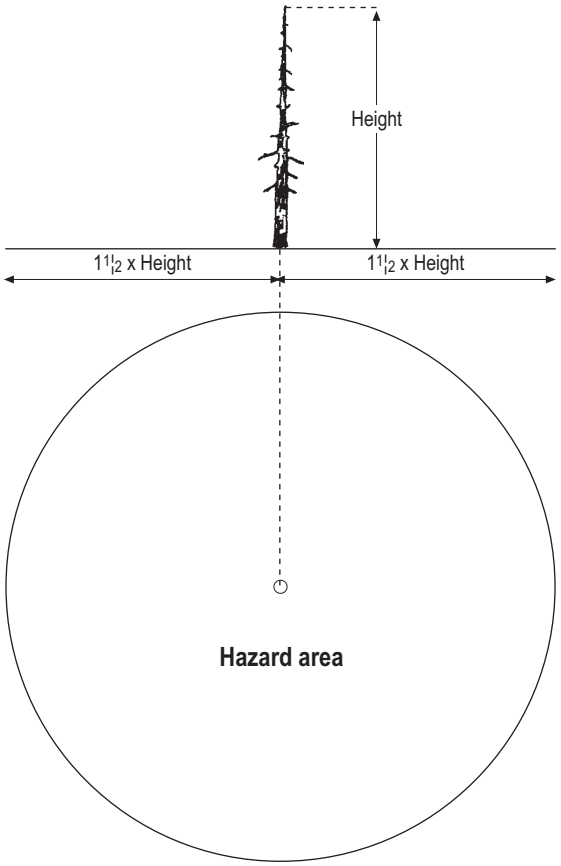
C. Sound tree with lean, hazardous top, on slope

1. Determine the length of top that might dislodge.
2. Add ½ of this length, to get a 1½ top length distance (horizontal distance from tree).
3. From the lean, determine how far from the base of the tree the top might land.
4. On slopes >30%, extend the hazard area downslope. This distance must be determined on a site-specific basis.

D. Unsound or hazardous tree, no lean, flat ground

1. Measure the height of the tree.
2. The hazard area is a circle around the tree, with a radius of up to 1½ times the height.



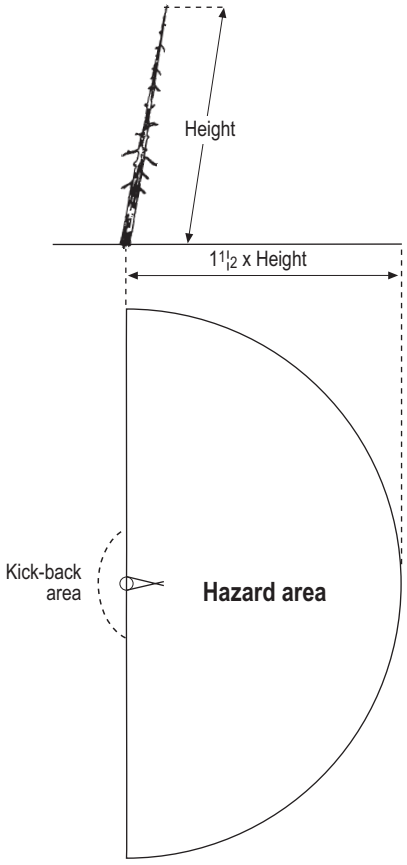


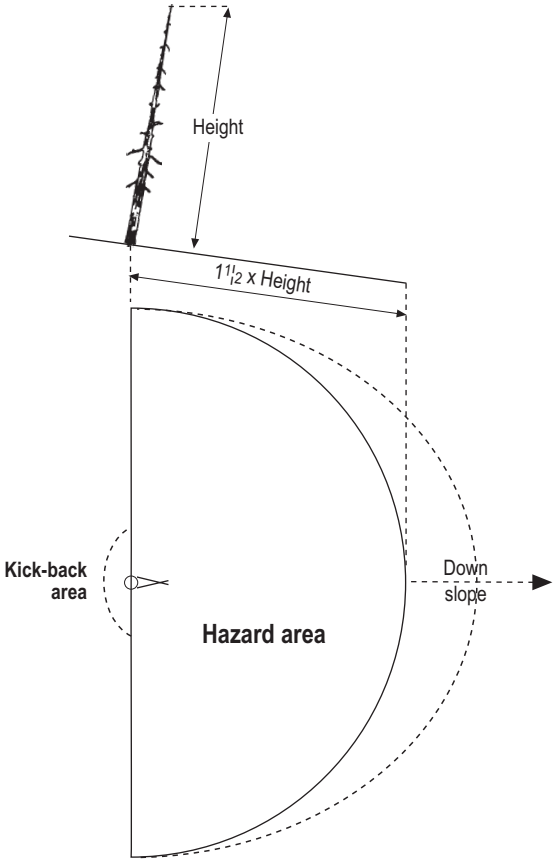
E. Unsound or hazardous tree, with lean, flat ground

1. Measure the height of the tree.
2. Add ½ of this length to get a 1½ tree length hazard area.

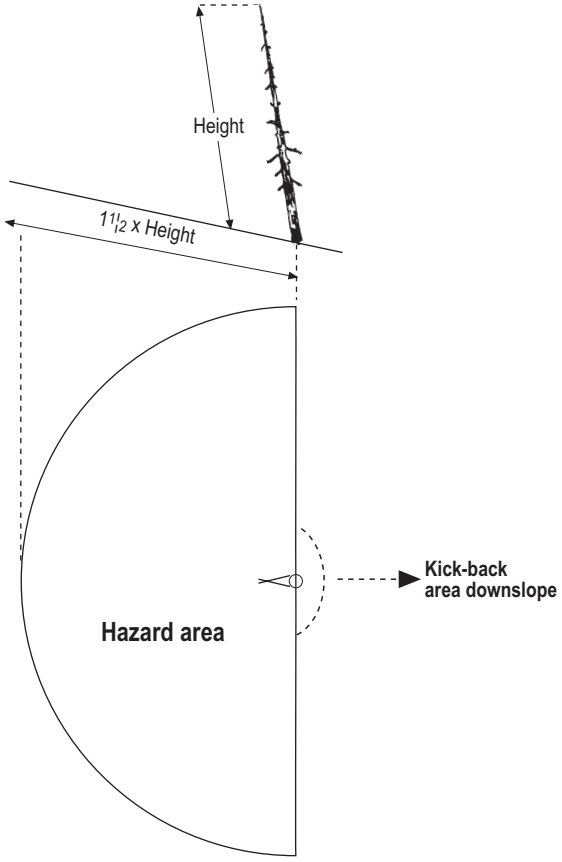
F. Unsound or hazardous tree, with lean, on slope

1. Measure the height of the tree.
2. The hazard area is a half-circle extending up to 90° on each side of the lean, with a radius of 1½ times the height of the tree.
3. On slopes >30%, extend the hazard area downslope. This distance must be determined on a site-specific basis.
4. Trees on a >30% slope need to be carefully assessed for their wildlife tree value, as the hazard area will take up a large part of the treatment area.





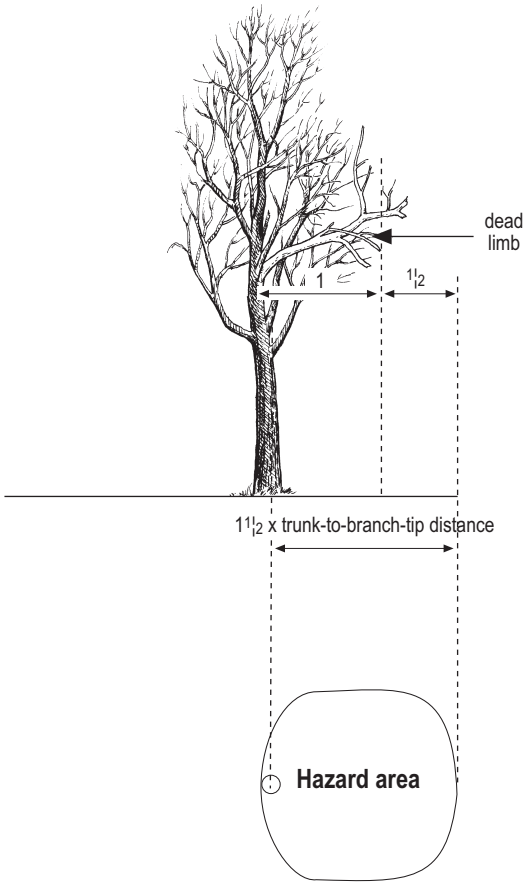
5. Where the tree slopes uphill, the hazard area should be 1½ times the tree height going upslope.
6. Where the tree slopes uphill, depending on the slope of the hill, a kick back area will be added on a site-specific basis.



G. Deciduous, sound tree, no lean, defective branches

1. Determine the length of defective limbs that might dislodge.
2. Add ½ of this length to get a 1½ limb length distance.

The 1½ limb length distance must be calculated for all defective limbs on the tree.

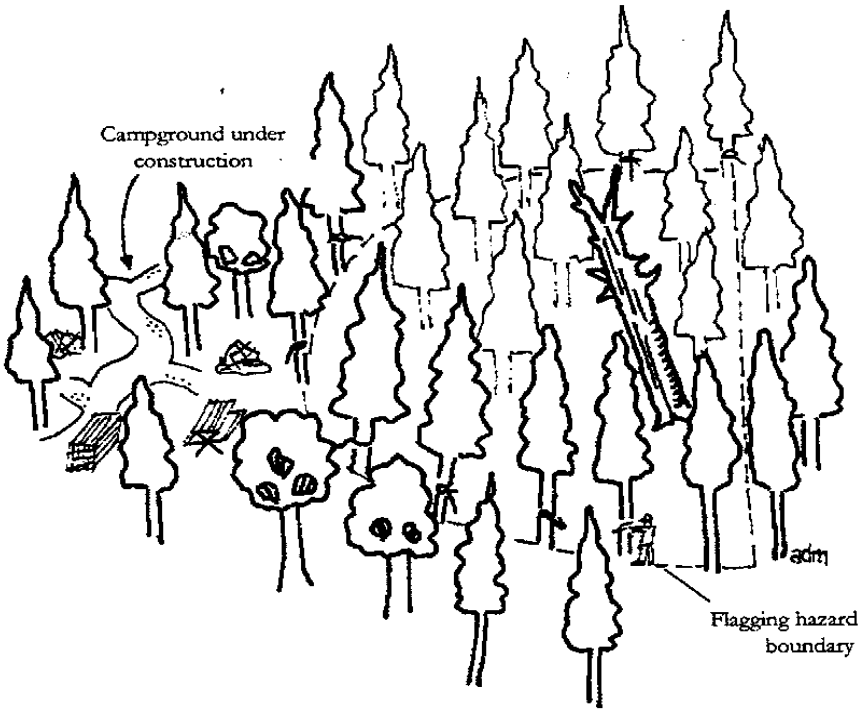


Flagging Hazard Areas

It is recommended that the assessor use standardized yellow barricade tape with bold black letters reading **HAZARD AREA**, or any other tape that is easily identifiable to indicate a hazard zone.

Once the size of the hazard zone area has been calculated by the assessor, the area should be flagged at sufficient intervals so that the workers or the visiting public will always be able to see the hazard area boundary from any position along its perimeter. **No person is allowed to enter this area EXCEPT to remove a specific tree hazard**.

Hazard areas should be "dismantled" (i.e., flagging removed) when there is no further exposure to a tree hazard because the hazard has been removed, or there is no target exposure (people or facilities are now out of reach of the hazard).



STEP 4: Provide documentation and communicate safety procedures

As part of fulfilling occupier's duty of care, it is extremely important that a well documented, thought-out plan, process and decision are followed in the implementation of any danger tree management policy and program.

Once operational procedures and activities are in place to fulfill management policy and regulations, and these have been translated into an action plan, then those operational activities must be documented and meet accepted standards of care (use the Danger Tree Assessment Field Data cards to record tree information).

> All documentation must be retained on file and be retrievable

Minimum documentation must include:

- Assessor's name
- Date and location of assessment
- Level of disturbance and exposure
- Marking procedures (i.e., flagging or tags) used for assessed trees, assessed areas and hazard areas
- Locations of assessed trees and completed assessed areas
- Locations of hazard areas
- Use field cards if necessary to provide documentation on individual tree assessments

Reassessment of Trees

Trees assessed and recorded as SAFE must be reassessed if, prior to the work activity commencing, **an intervening winter or major disturbance event has occurred, or if the level of disturbance has changed from the original assessment** (e.g., level 1 routine maintenance becomes level 3 heavy equipment construction).

Frequency of Site Assessments

Park and recreation sites should be inspected for tree hazards on a regular basis. The frequency of inspection will depend on the level of use/exposure (e.g., high use or low use), proximity and type of target (e.g., trail, facility) and the level of disturbance (e.g., very low, such as hiking, or high such as construction within heavy equipment).

Thus, assessment frequency will be determined on a site-by-site basis, and will likely vary seasonally (i.e., with changes in weather and visitor use patterns) and with changes in levels of site disturbance, facilities development, target exposure, and other factors (e.g., tree or stand damage resulting from forest pathogens, fire, flooding, or human-caused injury).

Infrequent Site Inspections

In general, low-use/low target exposure areas such as low-use trails will require infrequent inspections (perhaps every **2-3 years**, usually after the winter season, or more frequently given knowledge of local site conditions).

Periodic Site Inspections

Relatively low-use facilities such as backcountry campsites will require infrequent inspections, but if person or property is required to remain in a particular location (e.g., place their tent or cook in a defined space; stop at a viewing platform), then the level of target exposure increases. In these locations the frequency of inspection should be **annual** (e.g., in the spring, following the winter season and prior to peak summer season use; or more frequently given knowledge of local site conditions) or after major weather events.

Frequent Site Inspections

Areas such as campgrounds, visitor centers, public viewing sites, parking lots, and other buildings, facilities or locations which have high use and/or high target exposure, will require regular, more frequent inspections and assessment for dangerous trees. Again, this will vary site-specifically but could be **biannual** (i.e., every 6 months, spring or autumn) or **annual**. Resource managers who are familiar with the site and local area can make this decision. Timing of the assessments must permit time for implementing mitigation actions with minimal conflict (e.g., try not to schedule tree removals during active nesting seasons).

Timing to Implement Operational Procedures

Once a particular site or individual tree(s) has been identified as dangerous and has been recommended for treatment, then this recommendation must be followed up as soon as possible with the appropriate action (e.g., fell tree or remove hazardous parts).

A case for liability may exist where the land owner/manager knew of a tree danger but took no action to abate it. However, as with all other aspects, the courts would review the circumstances and determine what was reasonable and what a similar person in similar circumstances ought to have done (Dunster and Murray 1977).

Posting Signs

It is NOT safe to assume that posting signs that warn of site or individual tree hazards is a reasonable standard of care, and that this will eliminate the potential for liability. However, placing signs can be considered to be a prudent precaution. Assessment of a tree as dangerous must be followed up as soon as possible by appropriate safety measures.

Policy and Regulations in Developed Areas

There are various policies and regulations pertinent to the management of hazards associated with trees in parks and recreation sites. All of these provide some level of policy direction and/or technical guidance concerning the management of dangerous trees. As such, they also imply a duty of care on behalf of the land owner (e.g., the provincial Crown; regional municipality). The following policies and regulations relate to dangerous tree management in British Columbia:

Occupiers Liability Act

- Establishes a duty of care upon the land owner (e.g., the Crown) or someone acting on behalf of the owner (e.g., park manager or staff) concerning activities and facilities that occur on that land. Consequently, the land owner would be expected to meet a certain standard of care with respect to hazards or unreasonable risks which may affect the use of said land by the public or workers.

Canada Labour Code

- Establishes the due diligence of employers or supervisors acting on behalf of the employer (e.g., park manager or supervisor) concerning the health and safety of workers at their work place (e.g., while conducting routine site maintenance or giving nature tours). Consequently, the employer is expected to meet a certain standard of care with respect to identifying hazards and training employees to recognize hazards and how to avoid exposure to such dangers.

Memorandum of Understanding (MOU) Concerning Wildlife and Danger Trees (2002)

- Memorandum signed by BC Ministry of Forests, Ministry of Environment, and Workers Compensation Board. The main intent of the MOU is to agree that the "…three agencies will work together for the common purpose of developing, maintaining, and managing the natural wildlife habitat of standing green, dying or dead trees in forestry operations in a safe manner for the best interest of the citizens of British Columbia".

BC Parks Conservation Program Policies

These policies affect the management of vegetation within provincial parks. The specific policy concerning ecosystem manipulation of vegetation states that "Deliberate manipulation of vegetation may occur in parks and ecological reserves under special circumstances".

The following is the policy direction for Danger Trees:

- BC Parks' managers will conduct an on-going tree hazard monitoring program consisting of inspection, hazard rating, and recommended actions.

- Successional stage and ecosystem health will be considered when assessing hazard trees and developing mitigation options.

- Hazard trees may be removed from areas with known risk to visitor and worker safety, especially within intensive use zones and along high-use corridors.

- If removal or modification of hazard trees threatens high conservation values, visitor use patterns may be altered to eliminate the need for such actions

- Although contractors may be assessing the condition of trees and recommending mitigation, the ultimate decision for cutting or modifying a wildlife/danger tree lies with Park managers

- Tree management decisions will be based on worker safety and risk management strategies for visitor safety, balanced with the responsibility to manage the resource for conservation values

- Conservation of viable, natural vegetation ecosystems in B.C.'s parks and ecological reserves will always take precedence over their use by people

- Permanent or temporary closures of selected areas are appropriate management strategies for reducing or eliminating undesirable impacts of human use on critical vegetation features

- Endangered, threatened and vulnerable species whose habitats occur in parks and ecological reserves will receive high priority management attention, with an emphasis on protection

Workers' Compensation Board Occupational Health and Safety Regulation *(section 26.11.1)*

This regulation is relevant to employed or contracted persons working in forested areas. It states, "If it is known or reasonably foreseeable that work will expose a worker to a dangerous tree, the tree must be felled".

The options available to comply with this regulation are to fall the dangerous tree, undertake a risk assessment and remove the dangerous defect(s) or prevent exposure to the dangers (e.g., move or close the facility, modify access and activities to lower LOD criteria).

NOTES:

Summary of Legal Aspects

(Adapted from Dunster and Murray 1997: see Appendix 4 for further detail)

No organization will ever have enough resources (money and staff time) to inspect every tree that might fall and cause damage. However, a duty of care and standards to carry out this duty does exist. Thus, the park or recreation site manager must ensure a reasonable level of safety within the park, and that the standard of care required to achieve this is equal to or better than what is commonly accepted in similar situations. The policies and procedures must be clearly defined and properly implemented. A standard of perfection is unreasonable and not likely to be upheld by the courts.

There are a number of terms that are relevant to the management of dangerous trees. These include:

- Duty of care – a legal responsibility of the land owner or someone acting on their behalf. The duty of care invokes a certain standard of conduct (called "standard of care") in operating the park or recreation site. Duty of care may be established by various Acts and policies (e.g., Occupiers Liability Act, BC Parks Conservation Program Policies).

- Standard of Care – is a combination of elements or practices accepted as correct according to established procedures at an accepted level of standards. Once a policy has been established, then the park or recreation site manager has a legal responsibility (duty of care) to exercise common prudence through an established set of procedures (the standard of care) in operating the park or recreation site.

  In Shuswap Provincial Park, information pamphlets are passed out to the public highlighting areas of the park and conditions under which tree hazards may exist. The Park also has an active hazard tree management program that documents problem areas and trees, and recommends and implements appropriate action steps. This process represents a reasonable standard of care in danger tree management.

- Negligence – the failure to assume a duty of care and reasonable standard of care. As a result of breach of the duty of care, (failure to meet accepted standards of care) persons or property have sustained damage.

- Liability – liability has to be proven, usually by showing that some sort of negligence was involved. Generally, liability hinges on whether or not there was a duty of care to be exercised, and if so, whether or not it was negligently implemented.

For example, as a public land owner if you are aware of a particular tree hazard, but did not take any steps to abate the hazard, then you were likely negligent in meeting your duty of care and can be found liable.

Section Three

DANGER TREE MANAGEMENT IN PARKS AND RECREATION SITES

Learning Objectives:

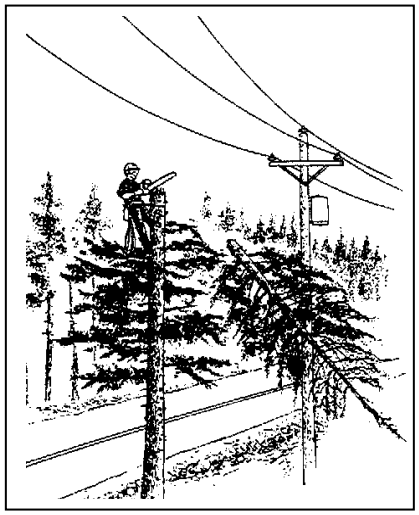
- Habitat Modification Techniques

HABITAT MODIFICATION TECHNIQUES

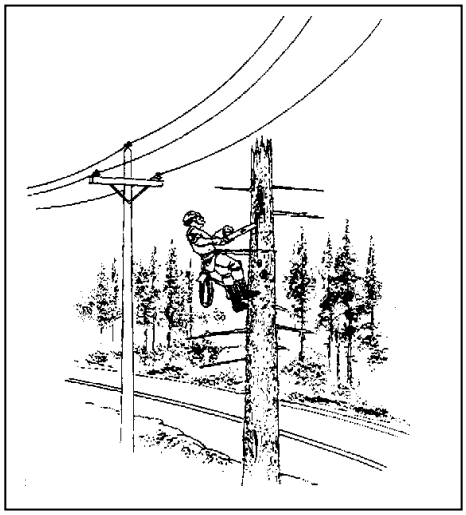
In many situations it will be desirable to remove the hazardous portion of the tree, while still maintaining the rest of the tree intact for wildlife habitat. In this context, trees with wildlife tree-like attributes such as broken tops, decayed heartwood, and artificial cavities can be created using various techniques. These techniques have value under specific applications and can be viewed as methods for enhancing or restoring wildlife tree habitat.

Tree Topping

- Tree topping should be employed in situations where removal of the tree is not desirable, and where the installation of a hazard area around the tree to protect facilities or the work area from aerial hazards (e.g.; a large spiked top or large dead limbs on a class 2 tree) is not appropriate.
- Healthy class 1 trees (trees with no visible external defects) can also be topped to stimulate natural breakage and promote snag recruitment. This is especially important in even-aged stands with little or no structural diversity.
- Trees should be "jagged topped" to stimulate natural breakage, thereby facilitating weathering and decay processes.
- Only highly experienced and trained personnel should climb and top trees.
- Each tree must be assessed for safety concerns by personnel who are experienced and trained in danger tree assessment, tree climbing and topping.



Removing the hazardous portion of a tree along a road and powerline. Tree can be "jagged-topped" with a chainsaw.



Creating feeding cavity starts in a tree where a hazardous top was removed.

Nest boxes and Cavity Construction

- Artificial nest boxes can provide suitable nesting structures for a variety of hole-nesting birds. This is especially true for areas with a shortage of natural cavities.
- When installing nest boxes, it is essential to place the box in the appropriate habitat for the intended species. This includes nest height (e.g., for predator avoidance) and nest location (e.g., proximity to water for cavity-nesting ducks).
- Proper nest box construction is required to ensure use of the box by the intended species. Accurate species-specific hole size (diameter) and shape (e.g., circular, flattened oval) will usually limit use of the box to the intended species.
- "Cavity starts" for feeding, nesting and roosting can be constructed in trees, using a chainsaw. This requires knowledge of the habitat needs of the species in question (e.g., size, shape and location of the nest hole for flying squirrels), and an experienced tree climber/chainsaw operator.



Creating an artificial nest hole with an accompanying faceplate for use by cavity nesting ducks or owls.

Fungal Inoculations

- Inoculation of live trees with native wood decay fungi in order to promote heart rot has excellent potential as a wildlife tree creation tool. Inoculated trees usually maintain good growth and form, and pose few worker safety problems. Inoculation is potentially useful in restoring or enhancing habitats where there may be a lack of suitable wildlife trees and stand structure (e.g., riparian management areas, damaged ecosystems, and immature forest stands). Preliminary results from U.S. studies have shown development of internal decay and subsequent uses by wildlife within 5-10 years.
- However, fungal pathogens are tree species specific and area specific. Detailed knowledge of inoculation procedures is required for this technique to become broadly successful (including choice of fungal species and injection parameters and procedures). The Ministry of Forests regional pathologists should be consulted if this method of treatment is being considered.



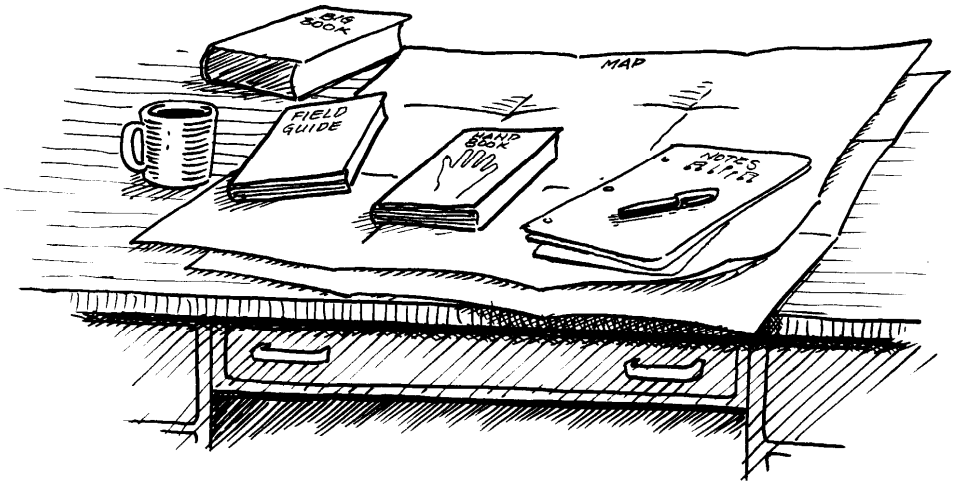


Inoculation tubes placed in live trees for insertion of fungal inoculums (Photos courtesy of T. Manning)

Timing of Modifications

- If possible (i.e., within timeline to implement safety procedures), perform wildlife tree modifications outside of the breeding/nesting period (i.e., May-July) for most wildlife tree users. Consequently, the recommended periods for performing tree modifications are in March-April (i.e., after winter storms) or in autumn (September- November).

REFERENCES AND GLOSSARY



REFERENCES

Allen, E., D. Morrison and G.Wallis. 1996. Common Tree Diseases of British Columbia. Can. For. Serv., Victoria, B.C. 178 pp. To order free copy, call (250) 363-0600 – CFS office

Backhouse, F. and J.D. Lousier. 1991. Silviculture systems research: wildlife tree problem analysis. A report prepared for Silviculture Branch, Min. For. Victoria B.C.

Bartels, R.J., R.L. Knight and G. Schaefer. 1985. Dead and down woody material. *In* E.R. Brown (ed.), Management of wildlife and fish habitats in forests of western Oregon and Washington. USDA For. Serv., Pac. NW Reg. Publication No. R-6-F&WL-192. 1985: 171–186.

British Columbia Ministry of Environment, Lands and Parks and Forestry Canada. Tree hazards in recreation sites in British Columbia. Management guidelines. Joint Report No. 13. Reprinted March 1992.

Brown, E.R. (tech. editor). 1985a. Management of wildlife and fish habitats in forests of western Oregon and Washington: Part 1 - Chapter narratives. USDA For. Serv., Pac. NW Reg. Publication No. R6-F&WL-192-1985.

Brown, E.R. (tech. ed.). 1985b. Management of wildlife and fish habitats in forests of western Oregon and Washington: Part 2 - Appendices. USDA For. Serv., Pac. NW Reg. Publication No. R6-F&WL-192-1985.

Bull, E.L. 1977. Specialized habitat requirements of birds: snag management, old growth, and riparian habitat. PNW-64.

Bull, E.L., J.W. Thomas, and K. Horn. 1986. Snag management on national forests in the Pacific Northwest — 1984. West. J. Appl. For. 1(2):41–43.

Bunnell, F.L., B. Booth, and A.C.M. Farr. Bald eagles. Brochure. Outdoor Canada, Wildlife Habitat Canada, World Wildlife Fund and B.C. Environment, Victoria, B.C. Copies available from B.C. Environment.

Campbell, W.R., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The Birds of British Columbia - Volumes 1 and 2. Royal B.C. Museum, Victoria, B.C.

Campbell, W.R., K.H. Morgan, and C. Palmateer. 1988. Species notes for selected birds. Vol. 2 *In*: A.P. Harcombe (tech. editor) Wildlife Habitat Handbooks for the Southern Interior Ecoprovince. Min. Envir. and Min. For., Victoria, B.C.

Cannings, R.A. and A.P. Harcombe (editors). 1990. The vertebrates of British Columbia: scientific and English names. Royal B.C. Museum Heritage Record No. 20; Wildlife Rep. No. R24. Min. Mun. Affairs, Rec. and Culture and Min. Envir., Victoria, B.C.

Cline, S.P., A.B. Berg, and H.M. Wight. 1980. Snag characteristics and dynamics in Douglas-fir forests, western Oregon. J. Wildl. Manage. 44(4):773–786.

Cowan, I.M. and C.J. Guiget. 1965. The Mammals of British Columbia. B.C. Prov. Museum, Victoria, B.C.

Dunster, J.A. and S.M. Murray. 1997. Arboriculture and the law in Canada. Intl. Soc. Arboriculture, Savoy, Ill.

Ehrlich, P., D. Dobkin, and D. Wheye, 1988. The Birder's Handbook: A Field Guide to the Natural History of North American Birds. Simon & Schuster/Fireside Books, New York, N.Y.

Fenger, M., T. Manning, J. Cooper, S. Guy, P. Bradford. 2006. Wildlife & Trees in British Columbia. Lone Pine Publishing. Vancouver, BC.

Finck, K.E., P. Humphreys, and G.V. Hawkins. Field guide to pests of managed forests in British Columbia. Min. For. and For. Can. Joint publication No. 16.

Fischer, W.C. and B.R. McClelland. 1983. A cavity-nesting bird bibliography — including related titles on forest snags, fire, insects, disease, and decay. USDA For. Serv., Gen. Tech. Rep. INT-140, Intermtn. For. and Range Exp. Stn.,

Frissell. S. 1984. The impact of firewood cutting on hole-nesting birds. West. Wildlands. (4):28-30.

Glinski, R.L., T.G. Grubb, and L.A. Forbis. 1983. Snag use by selected raptors. pp. 130-133 *In*: Snag habitat management: proceedings of the symposium. USDA For. Serv., Gen. Tech. Rep. RM-99, Rocky Mtn. For. and Range Exp. Stn.

Green, D.M. and R.W. Campbell. 1984. Amphibians of British Columbia. B.C. Prov. Museum Handbk. No. 45. Victoria, B.C.

Harvey, R.D. and P.F. Hessburd. 1992. Long range planning for developed sites in the Pacific Northwest: the context of hazard tree management. USDA For. Serv., Pac. NW Region, FPR-TP039-92.

Keisker, D.G. 1987. Nest tree selection by primary cavity-nesting birds in south-central British Columbia. B.C. Min. Envir. and Parks, Wildlife Rep. No. R-13.

Klinka, K., R.E. Carter, and M.C. Feller. 1990. Cutting old-growth forests in British Columbia: ecological considerations for forest regeneration. Northwest Environ. J. 6: 221–242.

Machmer, M.M. and C. Steeger. 1995. The ecological roles of wildlife tree users in forest ecosystems. Land Management Handbook 35. Min. For. , Victoria.

Maser, C. 1988. The redesigned forest. R.E. Miles, San Pedro, CA.

Mattheck, C. and Breloer, H. 1994. The Body Language of Trees. London. HMSO.

Matheny, N. and J. Clark. 1991. Evaluation of hazard trees in urban areas. Int. Soc. Arboric., Urbana, Ill.

Matthews, J.D. 1989. Silviculture systems. Clarendon Press, Oxford.

Nagorsen, D. W. and R.M. Brigham. 1993. Bats of British Columbia. Royal British Columbia Museum Handbook. Vol. 1. The mammals of British Columbia. UBC Press, Vancouver, B.C.

Neitro, W.A., R.W. Mannan, D. Taylor, V.W. Binkley, B.G. Marcot, F.F. Wagner, and S.P. Cline. 1985. Snags. pp. 129–169 *In*: Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington. Part 1 — Chapter Narratives. Browne, E.R. (tech. editor). USDA For. Serv., R6-F&WL-192- 185, Pac. NW Reg.

Pokorny, J.D. 2003. Urban Tree Risk Management: A community guide to program design and implementation. NA-TP-03-03. St. Paul, Minnesota: USDA For. Service.

Shigo, A.L. 1979. Tree Decay: An expanded concept. Agricultural Inform Bulletin No. 419. New Hampshire: USDA For. Services.

Stevens, V. 1997. The ecological role of coarse woody debris: an overview of the ecological importance of CWD in BC forests. Res.Br., B.C. Min. For., Victoria, B.C. Work Pap. 30.

Stevens, V. and S. Lofts. 1988. Species notes for mammals. Vol. 1 *In*: Wildlife habitat handbooks for the Southern Interior Ecoprovince. A.P. Harcombe (tech. editor). Min. Envir. and Min. For., Victoria, B.C.

Thomas, J.W., R.G. Anderson, C. Maser, and E.L. Bull. 1979. Snags. pp. 60-77 *In*: Wildlife Habitats in Managed Forests: The Blue Mountains of Oregon and Washington. USDA For. Serv. Handbk. 553.

Wagener, W.W. 1963. Judging hazard from native trees in California recreational areas: a guide for professional foresters. USDA For. Serv. Res. Paper PSW-P1.

Wildlife Branch. 1990. Managing wildlife to 2001: a discussion paper. B.C. Min. Envir., Lands and Parks, Victoria, B.C.

Wildlife Tree Committee of British Columbia. 1993. A bibliography on wildlife trees for British Columbia with annotations and abstracts. B.C. Wildlife Tree Committee and B.C. Min. Envir. Victoria, B.C.

Workers' Compensation Board of British Columbia (WCB). 1998. Occupational health and safety regulation, Parts 20–23. April 1998. Richmond, B.C.

Zarnowitz, J.E. and D.A. Manual. 1985. The effects of forest management on cavity-nesting birds in northwestern Washington. J. Wildl. Manage. 49(1):255-263.

GLOSSARY

For the purposes of this text, the following terms and definitions will be used:

biogeoclimatic subzone	A representative class of ecosystem under the influence of the same regional climate. It is associated with a distinct climax (or near-climax) group of plants. For example, the Sub-Boreal Spruce Moist Cool (SBSmk) subzone is characterized by a hybrid spruce-huckleberry-highbush cranberry plant association.
biological diversity	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including genes, species, ecosystems, and the evolutionary and functional processes that link them.
blind conk	Sometimes called swollen knots; are significant indicators of decay. They typically appear as pronounced swellings around knots, and are the result of the tree attempting to heal over an old conk. Often the affected knot and new conk is partially covered by sound wood, which is implied by the term "blind" conk.
canker	Dead portion of the cambium and bark on a branch or the main stem. Cankers can be raised or sunken and are sometimes surrounded by a raised lip of tissue.
certified danger tree assessor	Someone who has passed one or more of the Wildlife/ Danger Tree Assessor's course modules sponsored by the Wildlife Tree Committee of B.C., and who holds a valid certificate, dated since November 1998, which signifies this designation. Certification is valid for four years.
chlorotic	Yellowing of normally green foliage tissue due to lack of chlorophyll. Usually indicates poor growing conditions or some sort of tree stress (e.g., root disease).
coarse woody debris (CWD)	Fallen trees or logs, and parts of trees on the forest floor at least 7.5 cm in diameter. CWD provides habitat for various small mammals, salamanders and numerous invertebrates. As it decays, it provides nutrients back to the forest soil.
conk	The fruiting body of a wood decay fungus; bracket-like or reclined or flat on the host or ground, but not a mushroom. Usually woody or leathery in texture.

dangerous tree	Means a tree that is a hazard to a worker due to its location or lean, its physical damage, overhead conditions, deterioration of its limbs, stem or root system, or any combination of these conditions.
defect length	The length of the dangerous defect on a tree; this could be the dangerous dead limb, or hazard top (i.e., the segment above an observed weakness), or the entire tree (i.e., the whole tree is at risk of failure because of root problems, lean or insufficient stem thickness).
dominant trees	The tallest trees of the main forest canopy layer.
embedded (included) bark	Bark that is pushed inside a developing branch or stem crotch, usually causing visible cracking and a weakened structure.
environmentally sensitive area (ESA)	An area with potentially fragile or unstable soils that may deteriorate unacceptably after forest harvesting, or one of high value for non-timber resources such as fisheries, wildlife, water and recreation.
forest activity	Any activity that requires workers to be in the field where they may be in the vicinity of living or dead trees.
guild	A group of species with similar behaviours and similar ecological requirements (e.g., cavity-nesting ducks).
habitat	A specific kind of living space or environment that provides at least minimal conditions for one organism to live, or for a group to appear together.
hazard area (HA)	A flagged area where no worker shall enter except to remove hazards. Workers will be informed about hazard areas prior to commencement of work on site. The size of HA's are 1.5 times the defect length. This length can be modified (larger or smaller) depending on site-specific conditions
hazardous top	A suspect or defective top section (live or dead) of a tree that may be hazardous because of visible structural weakness, especially if there is evidence of decay or cracking. The defect length is defined by the point of visible stem deformation (stem swelling or goiter, spike, multi-tops or candelabra, fork, kink or other such deformity) or stem damage that makes the top prone to failure.
live cull	A live tree with some visible external defect such as a broken, dead, or forked top, split or scarred trunk, or fungal conks.
live Class 1 tree	A living, growing tree with good vigour, no structural problems, and no visible signs of disease or decay.

old growth	A forest that contains live and dead trees of various sizes, species composition, and age class structure that are part of a slowly changing but dynamic ecosystem. The age at which forests develop the specific structural attributes that characterize old growth will vary widely according to forest type, climate, site characteristics and disturbance regime. Old growth is typically distinguished from younger stands by several of the following attributes: large trees for species and site; wide variation in tree sizes and spacing; accumulations of large, dead standing and fallen trees; multiple canopy layers; canopy gaps and understory patchiness; decadence in the form of broken or deformed tops or boles; and root decay.
pathogen	A living organism that incites disease in a host.
pre-harvest	Prior to harvesting activity.
qualified person	A person experienced in the specified work activity and who, by reason of education, training, experience or a combination thereof, is able to recognize and evaluate hazards associated with trees, with due regard for the anticipated work activity and possible disturbance of the tree(s).
raptor	A bird of prey such as an eagle, hawk, falcon or owl.
recruitment	Wildlife tree management strategy of retaining standing live or dead trees that will become future wildlife trees.
Regeneration cu) (reproduction method)	The manner in which a stand is cut to ensure the establishment of a replacement stand of a desired composition, vigour and structure within a certain time limit.
reserve	The retention of various number of unharvested (reserved) trees, distributed either uniformly or in groups for purposes other than regeneration. Some of these purposes include wildlife habitat, biological diversity, and aesthetics. Reserves can be used with any silvicultural system. For purposes of wildlife tree management, a reserve can range in size from a single, outstanding wildlife tree, to a patch containing many wildlife trees on several hectares.
resinosis	An abnormal flow of resin or pitch from conifers, often from the base or lower stem. Resinosis can indicate the presence of tree pathogens or damage.
riparian area	The land bordering a river, stream, lake, reservoir, pond, wetland or spring. Riparian areas typically exemplify a rich and diverse vegetative mosaic reflecting the influence of available surface water.

riparian management zone (RMZ)	That area located adjacent to a stream, wetland or lake of a width determined in accordance with the *Riparian Management Guidebook*.
rust	A disease caused by infection with one of the rust fungi, often producing yellow to orange spores at some point during the infection.
saprot fungi	A general group of fungal organisms which decay in the outer sapwood layer of trees. Saprots tend to be more commonly found on dead trees. Because of their shallow depth of penetration (2 cm – 5 cm is usual), they generally only contribute to tree structural failure on small diameter dead trees (e.g., <30 cm dbh).
scaffold branching	Multiple stem and branch attachments characteristic of some deciduous trees. They consist of a system of co-dominant branches and lack a central leader.
secondary top	A growth leader on a tree which usually forms after the breakage or die-back of the original tree top. Secondary tops (live or dead) can occur as single leaders, forks or multiple tops. They may be hazardous, especially if there is **evidence of decay or cracking at the point of the original top breakage**.
seral stage	One of a chain of successional ecological stages leading to a climax plant community. For example, an early seral stage could be a new stand with fire origin, a mid-seral stage could be a mixed hardwood/conifer forest, and a late seral stage could be a mature or old-growth forest.
silviculture prescription (or Site Plan - SP)	A planning system for collecting site-specific field data and developing forest management prescriptions before harvesting is allowed to take place.
silvicultural system	A cycle of activities by which a forest stand, or group of trees, is harvested, regenerated and tended over time. These activities include harvesting, site preparation, reforestation and stand tending.
sloughing	Starting to separate and eventually falling or breaking away from the tree trunk.
spike top	The pointed **dead tip of a living tree** from which most of the needles and branches have fallen off. The length of this "spike-shaped" dead tip is variable and can sometimes be up to 1/3 or more of the tree height for species such as cedars. This top dieback may be caused by insects, disease, or climatic factors.

stand level	The level of forest management at which a relatively homogeneous land unit can be managed under a single prescription, or a set of treatments, to meet well-defined objectives.
stand-level structural attributes	Components of a forest stand (including living and dead standing trees, canopy architecture and fallen dead trees) which together determine stand structure.
Stand management prescription	A document to describe activities to be carried out on a free-growing site to ensure the activities are planned and implemented to maintain or enhance inherent productivity of the site; to ensure resource values including biological diversity are identified and accommodated; and to set out a series of stand management activities capable of meeting the stated management objectives.
stratification	Dividing or organizing an area, such as a campground, into distinct units based on site-specific factors such as visitor use, vegetation type or physiographic relief.
structurally damaged stand	A stand of trees which has been severely and extensively damaged, to the extent that a qualified person decides there is an undue risk of tree failure in the stand or site.
stub	An artificially-created wildlife tree, mechanically cut from a class 1, 2 or 3 tree.
suppression	Reduced tree growth and vigor due to excessive competition for light, moisture and nutrients.
suspect tree	Suspect trees are *any live or dead tree with a visible defect which could cause failure of the tree, either whole or in part, for the applicable level of disturbance*. Suspect trees require a visual inspection as well as a site assessment by a qualified person or a certified danger tree assessor, in order to determine whether they are dangerous for a particular level of disturbance/type of work activity.
uneven-aged management	A silvicultural system designed to create, maintain and regenerate an uneven-aged stand structure (a stand of trees consisting of three or more age classes). Single tree and group are uneven-aged silvicultural systems.
veteran tree	A tree which is significantly older (usually 150 years of age or greater) than the trees of the main forest canopy. The tree may have survived one or more fires as evidenced by fire scars. Veteran trees are usually isolated in distribution and often extend well above the main tree canopy. Because of their large size, they usually provide valuable wildlife tree habitat for many decades.

wildlife tree	A standing dead or live tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife.
Wildlife Tree Committee	A committee organized in 1985 to find ways of maintaining wildlife tree habitat in timber harvesting and silviculture operations, without endangering the safety of forest workers.
Workplace	Includes all locations where a worker is or is likely to be engaged in work activities.
Xylem	Vascular tissue throughout which most of the water and nutrients are conducted from the roots to other parts of the plant.

APPENDICES

APPENDIX 1. Some Important Tree Pathogens in B.C. Forests

Although there are thousands of different types of fungi present in the forest, only some cause decay. Of these, only a few are significant with respect to the development of wildlife trees. The most prevalent decay fungi relative to wildlife trees in British Columbia are listed below, alphabetically by disease name. Maps are also provided, showing the distribution of many of these species, as well as the distribution of core insect pathogens.

Mainly conifers

Disease name:	**Brown Crumbly Rot**
Organism name:	*Fomitopsis pinicola*
Common name of organism:	Red Belt Fungus
Hosts:	Many coniferous and deciduous species.
Characteristics useful for identification:	Perennial fruiting bodies hoof-shaped or shelved, brown-black with a red-brown margin. Pore surface white-cream.
Disease name:	**Brown Cubical Butt and Pocket Rot of Ceda**r
Organism name:	*Postia sericeomollis*
Hosts:	Most conifers, most importantly western redcedar.
Characteristics useful for identification:	No reliable external indicators, fruiting bodies are thin and crust-like but very rare. Use an increment borer to check for decay.
Disease name:	**Brown Cubical Butt Rot**
Organism name:	*Phaeolus schweinitzii*
Common name of organism:	Velvet Top Fungus
Hosts:	Most conifers.
Characteristics useful for identification:	Stalked, annual fruiting bodies with brown, velvety tops that are up to 20 cm in diameter are found near the base of infected trees. In advanced decay the wood breaks into large red-brown cubes.
Disease name:	**Brown Cubical Rot**
Organism name:	*Laetiporus conifericola (formerly: L. sulphureus)*
Common name of organism:	Sulphur Fungus
Hosts:	Many coniferous and deciduous hosts.
Characteristics useful for identification:	Annual bracket-like fruiting bodies, bright yellow-orange in colour.

Disease name:	**White Trunk Rot of Conifers**
Organism name:	*Phellinus hartigii*
Common name of organism:	
Hosts:	Western hemlock, amabilis and subalpine fir, Douglas-fir.
Characteristics useful for identification:	Perennial, velvet fruiting bodies; hoof-shaped on stems, commonly along the underside of branches.
Disease name:	**Brown Stringy Trunk Rot**
Organism name:	*Echinodontium tinctorium*
Common name of organism:	Indian paint fungus
Hosts:	Most importantly Hw and true firs, also other conifers.
Characteristics useful for identification:	Distinctive perennial fruiting bodies with tooth- like pore layer, usually associated with branch stubs.
Disease name:	**Brown Trunk Rot**
Organism name:	*Fomitopsis officinalis*
Common name of organism:	Quinine Fungus
Hosts:	Most commonly Lw, also on most other conifers.
Characteristics useful for identification:	Hard, perennial fruiting bodies, hoof-shaped to long and pendulous. Thick, white mycelial felts often associated with advanced decay.
Disease name:	**Red Ring Rot**
Organism name:	*Phellinus pini*
Hosts:	Most conifers.
Characteristics useful for identification:	Hard, brown, perennial fruiting bodies, generally bracket-like, are associated with branch stubs. Decayed wood is red stained with distinctive white-pockets.

Mainly hardwoods

Disease name:	**Aspen Trunk Rot**
Organism name:	*Phellinus tremulae*
Hosts:	Only on aspen.
Characteristics useful for identification:	Perennial fruiting bodies are hard, woody and triangular-shaped.Upper surface is gray-black and rough. The lower surface is brown.

Disease name:	**Hardwood Trunk Rot**
Organism name:	*Phellinus igniarius*
Hosts:	Many deciduous tree species.
Characteristics useful for identification:	Perennial fruiting bodies are hard, woody and hoof shaped. The upper surface is gray-black and rough. The lower surface is brown, generally at a 90° angle to the stem.

Disease name:	**White Mottled Rot**
Organism name:	*Ganoderma applanatum*
Common name of organism:	Varnish conk
Hosts:	Most hardwoods.
Characteristics useful for identification:	Perennial fruiting bodies are hard, leathery, flat and plate-like. The upper surface is brown. The lower surface is white, turning brown when bruised or marked.

Disease name:	**White Spongy Trunk Rot**
Organism name:	*Fomes fomentarius*
Hosts:	Mainly birch, also other hardwoods.
Characteristics useful for identification:	Perennial fruiting bodies are hard, grey-brown and hoof-shaped. The pore layer is generally at a 90° angle to the stem.

Major Root Diseases

Disease name:	**Annosus Root and Butt Rot**
Organism name:	*Heterobasidion annosum*
Hosts:	Many coniferous and deciduous species. In B.C., mainly Hw.
Characteristics useful for identification:	Fruiting bodies are rare, but when present will be found on the underside of stems and roots of windthrown trees. Wood in advanced state of decay is white and stringy with black flecks running parallel to the grain

Disease name:	**Black Stain Root Disease**
Organism name:	*Leptographium wageneri*
Hosts:	Mainly Fd, Pl, also Pw, Se, Sw, and Hw.
Characteristics useful for identification:	Reduced leader and branch growth, discoloured foliage. A purple-black stain is present in portions of annual rings in roots and up into the stem.

Disease name:	**Armillaria Root Rot**
Organism name:	*Armillaria ostoyae*
Hosts:	Attacks all tree species; cedars and white pine tend to be more resistant.
Characteristics useful for identification:	Causes diagnostic crown symptoms (reduced leader grown, foliage discoloration and thinning). Rosin may exude from bark on lower bole. Whitish mycelial fans may be seen under the bark, showing resinosis. Fruiting bodies (mushrooms) occur around the base of infected trees and stumps. They are cream- to brown-coloured with a 5–10 cm-wide cap and distinct ring on the stem. Dead and diseased trees usually occur in disease centres which appear as openings in the canopy.
Disease name:	**Laminated Root Rot**
Organism name:	*Phellinus weirii*
Hosts:	Fd, Sx, hemlocks and true firs; a separate "form" occurs as a butt rot on Cw.
Characteristics useful for identification:	Infected trees often grouped in "disease centres." Standing infected trees have thinning, yellow foliage with reduced leader growth. Look for windthrown trees with "root balls" (lateral roots have characteristic laminated decay and are broken fairly close to stems).
Disease name:	**Tomentosus Root Rot**
Organism name:	*Inonotus tomentosus*
Hosts:	Mainly Sx, also other conifers.
Characteristics useful for identification:	Stalked fruiting bodies, ≈ 10 cm in diameter, with velvety upper surface on ground near infected trees. Small longitudinal pits in decayed wood give it a honeycombed appearance.

All of the above fungi have unique 'conks' or fruiting bodies which, with some practice, can be easily recognized and identified. However, fruiting bodies are not always present and visible. These conks occur on the bole or trunk of the tree and their presence, size, and frequency of occurrence can be good indicators of the amount of decay present in the host tree. Identifying the various types of conks and their associated fungi helps in identification and classification of both present and potential wildlife trees.

For example, a tree infected with *Fomitopsis officinalis* with one conk present would likely be a very good wildlife tree and could be expected to persist for several years. On the other hand, a tree infected with one *Fomitopsis pinicola* conk would likely be a poor wildlife tree because it would probably have extensive heart rot and would not remain standing for long. Depending on its location, it could be a hazardous wildlife tree and would most likely not be worth saving.



Ganoderma applanatum

Laetiporus conifericola



Root Disease

Root diseases are caused by fungi that kill the living parts and decay the woody parts of tree roots. Decay in the root system can advance several metres up the trunk. All root diseases produce similar symptoms—thin, yellowish (chlorotic) foliage, reduced growth, and distress cone crops (cones that are smaller than normal but perhaps more numerous). The severity of the symptoms depends on the disease organism, the species and size of the tree, and the proportion of the root system affected. Root disease fungi will eventually weaken the host tree, making it susceptible to bark beetles and saprophytic decay fungi. Root systems weakened by disease can make trees unstable.

Cankers and Rusts

Fungi that cause cankers (an area of dead tissue marked by a flattened surface on the trunk) and rusts are two types of pathogens that can eventually girdle trees. The mortality rate depends on the species of fungus and the size of the host: small diameter trees are killed more easily. If no root pathogens or decay are present, the roots are generally stable. Aspen, poplars, lodgepole pine and white pine are the species most susceptible to stem or bark diseases. Pines attacked by stem rusts attract squirrels which chew the margins of the infections, resulting in resin flow.

Heart Rots



Phellinus pini

Heart rot fungi may enter a tree through branch stubs, branchlet scars, or other wounds. As heartwood decays it becomes more easily excavated by primary cavity excavators. The sapwood remains intact, leaving a hard outer shell that protects nest cavities. The most common heart rot fungi are *Phellinus pini* (red ring rot) and *Fomitopsis pinicola* (brown crumbly rot) affecting many conifer species, *Echinodontium tinctorium* (Indian paint fungus) affecting hemlock and true firs, and *Phellinus tremulae* which affects aspen.

Living trees with heart rot are not prone to windthrow because the fungus does not usually attack the roots. Trees displaying several conks (fruiting bodies) are usually extensively decayed and are susceptible to breakage. However, the proliferation of fruiting bodies varies within the fungus. A lack of visible conks does not indicate a lack of heart rot.



Echinodontium tinctorium



Phellinus tremulae

Wound Decays

Wound decay fungi are specialized fungi that invade freshly scarred trees where there is localized killing of tissue. Basal scars are often colonized by such fungi, sometimes resulting in a hollow at the tree base. Some wound decay fungi are able to progress beyond the wound site and cause heart or sap rot, but they usually do not kill the tree.

Scars, broken tops, frost cracks, forks and crooks are decay indicators because they mark exposed sapwood that can serve as an entry point for decay fungi. Decay indicators are generally more reliable in conifers than in hardwoods. Decayed trees are prone to breakage, particularly at the site of infection and colonization. The larger or older the wound, the more susceptible to breakage the tree is likely to be.

Saprophytes

Strict saprophytes, which can only colonize dead wood, cause decay in fallen logs and standing dead trees. Such fungi usually follow other organisms in the successional pathway and are effective competitors for woody substrates. Trees killed by repeated attacks by defoliators or bark beetles are susceptible to wood borers, secondary bark beetles (those that infest only severely stressed or dead trees), and saprophytic fungi. Decay by saprophytic fungi usually results in a soft outer shell, and decayed trees are prone to losing tops or large branches in wind or when subject to ground vibration. Whether there is more external decay (sap rot) or internal decay (heart rot) depends on what types of fungi become established and where the infection starts. For example, a tree that has a broken top before or shortly after death is more likely to be infected with heart rot than is a tree that remains intact. Dead trees continue to be decayed by saprophytes until they finally collapse.

Witches' Brooms

Dwarf mistletoes are parasitic plants that absorb mineral nutrients, water and carbohydrates from the host. Their presence is marked by witches' brooms and sometimes by swollen cankers on branches or the main stem. Western hemlock, larch, lodgepole pine and Douglas-fir mistletoe produce large, heavy brooms. Although dwarf mistletoes are not usually the primary cause of tree death, they often make host trees more vulnerable to other pathogens. Needle-cast fungi and some species of rust fungi also cause brooming symptoms. Witches' brooms may provide an entry point for decay fungi and may reduce the vigor of host trees. Large brooms and infected branches are prone to breakage.

Large brooms may provide habitat for some species of wildlife. The brooms provide excellent shelter, hiding cover from predators, and good nesting sites. Several research studies have shown that the numbers and varieties of bird species present in stands that were heavily infected by dwarf mistletoe were significantly higher than in uninfected stands.

Several species of mammals, including flying squirrels, marten and fisher, also use brooms. One research study showed that fisher often sleep in dead or live brooms caused by spruce broom rust. (For breeding, fisher prefer to nest in old centre-rotted Douglas-firs, spruce or cottonwoods).

On the other hand, mistletoe is responsible for significant levels of mortality and growth reduction in managed forests. Live trees (Classes 1 and 2) with mistletoe brooms within 20 metres of regenerating commercial forest trees should be carefully managed.

> Death and decay are dynamic processes, but they do not necessarily occur rapidly. Trees may take decades to die and even longer to become decayed enough to be useful to some species of wildlife. Pathogens and trees in various stages of death and decay are important natural components of forest ecosystems.

The Process of Tree Decay

Tree decay is a complex process, about which we still have a lot to learn. While there are several theories concerning decay and its various stages, the scenario outlined below is presented as a reasonable case for what the process could be like.

Stages of Tree Decay

1. The host tree is wounded, with the wound providing a weakened area and hence a suitable infection site for an invading pathogen. The wound might be a broken branch stub, a broken top, a frost crack, or other area on the butt or bole of the tree where the bark has been removed.
2. The exposed wood becomes infected through the successful attack and subsequent establishment of a pathogen. Once established, the pathogen develops microscopic hyphal threads that penetrate between the cell walls of the wood. These threads secrete enzymes that condition and weaken the wood for further hyphal development. As the wood and cell walls weaken and the hyphae continue to grow, they invade the cells and obtain even more nutrients from them.
3. After the pathogen has become well established, a brown, reddish-brown or black stain may appear in the wood. This stain further conditions the wood for subsequent growth and development of the pathogen; in advanced stages it is often a diagnostic tool in identifying the disease. In fact, the common names of some decay fungi are derived from the distinctive color and pattern of stain they impart to the wood.
4. After several years, some triggering mechanism occurs and fungal hyphae, which may now form felts, fans or strands within the wood of the tree, produce fruiting bodies or 'conks' which grow on the branch, branch stubs or on the bole of the tree. Most of the conks associated with the pathogens listed in Table 1 are perennial, persisting for many years and often growing very large. The more numerous the conks and the larger their size, the more decay one can expect to find in the tree. Each conk and associated decay is different. Conks of some decay fungi (e.g., *Fomitopsis cajanderi)* may mean only a little rot is present. The presence of others (e.g., *Fomitopsis pinicola)* means that the host tree is likely already dead.
5. In the advanced stages of decay, the pathogen that originally killed the host tree may fade out, while a secondary pathogen becomes established, overtaking and displacing the primary pathogen.

APPENDIX 2. Users of Wildlife Trees and Level Of Dependency

Dependency	Use
1 High	R Reproduction
2 Common	F Feeding
3 Occasional	S Shelter
	^ Artificial

Key

SCU	Secondary cavity user
PCE	Primary cavity excavator
1R	Highly dependent on wildlife trees for reproduction
1R^	Highly dependent on wildlife trees for reproduction, but may use artificial structures when available
IF	Highly dependent on wildlife trees for feeding
1S	Highly dependent on wildlife trees for other needs, such as shelter
1S^	Highly dependent on wildlife trees for other needs, such as shelter, but may use artificial structures when available
2R	Commonly uses wildlife trees for reproduction, but also uses alternative natural sites and/or artificial structures (moderately dependent)
2F	Commonly uses wildlife trees for feeding (moderately dependent)
2S	Commonly uses wildlife trees for other needs, such as shelter (moderately dependent)
3R	Occasionally uses wildlife trees for reproduction (non-dependent)
3S	Occasionally uses wildlife trees for other needs, such as shelter (non-dependent)

NOTE: Cavities used by any of the species may be natural cavities or vacated woodpecker holes.

Species	Wildlife Tree Users	Dependency Level
Amphibians		
Clouded salamander	lays eggs in rotting wood; feeding site; shelter	2RFS
Aquatic Birds		
Great Blue Heron	open nest on large tree limbs	2R
Wood Duck	Secondary Cavity User (SCU)	1R^
Barrow's Goldeneye	SCU	1R^
Common Goldeneye	SCU	1R^
Bufflehead	SCU	1R^
Common Merganser	SCU	2R
Hooded Merganser	SCU	1R^
Marbled Murrelet	SCU (old growth/coniferous, if large live trees are wildlife trees)	2R
Birds of Prey		
Bald Eagle	open nest on large tree limbs; hunting perch; roost	2RS
Cooper's Hawk	open nest in live trees, in crotch near main trunk	3R
Northern Goshawk	hunting perch; nest in largest tree in the stand line	3R
Red-tailed Hawk	hunting perch; nest in large trees, often dead tops	2R
Osprey	open nest on large tree stump and limbs; lookout & feeding perch	1R^2FS
American Kestrel	SCU; hunting perch	1R^3F
Great Horned Owl	SCU; nest in broken treetop; hunting perch	2RF
Barred Owl	SCU; nest in broken treetop and large limbs; winter roost	1R2S
Spotted Owl	SCU; winter roost (cavity)	1R
Western Screech-Owl	SCU; winter roost (cavity)	1R^2S
Flammulated Owl	SCU	1RS
Northern Pygmy-Owl	SCU; winter roost	1R2S
Northern Saw-whet Owl	SCU; winter roost	1R2S
Northern Hawk Owl	SCU; nest in broken treetop; hunting perch; winter roost (cavity)	2RFS
Boreal Owl	SCU; winter roost	1R2S

Species	Wildlife Tree Users	Dependency Level
Woodpeckers		
Lewis' Woodpecker	Primary Cavity Excavator (PCE) & roost – soft wood; hawking perch; foraging	1RS2F
Yellow-bellied Sapsucker	PCE & roost – live trees, sound and soft wood; foraging	1RS
Red-naped Sapsucker	PCE & roost – live trees, sound and soft wood; foraging	1RS
Red-breasted Sapsucker	PCE & roost – live trees, sound and soft wood; foraging	1RS
Williamson's Sapsucker	PCE & roost – sound wood; foraging	1RS
Downy Woodpecker	PCE & roost – soft wood; foraging	1RS
Hairy Woodpecker	PCE & roost – sound or soft wood; foraging	1RS2F
White-headed Woodpecker	PCE & roost – sound or soft wood; foraging	1RS2F
Three-toed Woodpecker	PCE & roost – sound or soft wood; foraging	1RFS
Black-backed Woodpecker	PCE & roost – sound or soft wood; foraging	1RFS
Northern Flicker	PCE & roost – soft wood; foraging	1RS
Pileated Woodpecker	PCE & roost – sound wood; foraging	1RFS
Insectivorous perching birds		
Vaux's Swift	SCU	1R1S
Tree Swallow	SCU	1R^3S
Violet-green Swallow	SCU	2R^3S
Black-capped Chickadee	PCE – soft wood; opportunistic SCU; foraging; winter roost (cavity)	1R^S
Mountain Chickadee	PCE – soft wood; opportunistic SCU; foraging; winter roost (cavity)	1R^S
Boreal Chickadee	PCE – soft wood; opportunistic SCU; foraging; winter roost (cavity)	1RS
Chestnut-backed Chickadee	PCE – soft wood; opportunistic SCU; foraging; winter roost (cavity)	1R^S
Red-breasted Nuthatch	PCE – soft wood; occasional SCU; foraging; winter roost (cavity)	1RS
White-breasted Nuthatch	PCE – soft wood; opportunistic SCU; foraging; winter roost (cavity)	1R^S
Pygmy Nuthatch	PCE – soft wood; opportunistic SCU; foraging; winter roost (cavity)	1R^S
Brown Creeper	SCU (behind bark); foraging	1RS
Western Bluebird	SCU; hawking perch	1R^
Mountain Bluebird	SCU; hawking perch	1R^

Species	Wildlife Tree Users	Dependency Level
Bats		
California Myotis	nursery/day roost in cavities and behind bark	2RS
Western Long-eared Myotis	nursery and day roost in cavities and behind bark	2RS
Keen's Long-eared Myotis	nursery and day roost in cavities and behind bark	2RS
Little Brown Myotis	nursery and day roost in cavities and behind bark	3RS
Northern Long-eared Myotis	nursery and day roost behind bark	2RS
Long-legged Myotis	nursery and day roost in cavities and behind bark	2RS
Yuma Myotis	nursery and day roost in cavities and behind bark	2RS
Hoary Bat	day roost in cavities	3S
Silver-haired Bat	nursery, day roost, and hibernation site in cavities and behind bark	1RS
Big Brown Bat	nursery and day roost in cavities	3R2S
Townsend's Big-eared Bat	unknown	–
Pallid Bat	day roost in cavities	3S
Rodents		
Bushy-tailed Woodrat	nest, summer and winter dens in cavities	3RS
Keen's Mouse	nests in cavity or behind bark; summer and winter dens in cavities	2RS
Northern Flying Squirrel	nest, summer and winter dens in cavities; cavities used as feeding stations	1RS3F
Chipmunks	nest and summer den in cavities	3RS
Douglas' Squirrel	nest, summer and winter dens in cavities; cavities used as feeding stations	2RS/3F
Red Squirrel	nest, summer and winter dens in cavities; cavities used as feeding stations	2RS/3F
Weasel Family		
Marten	nest, summer and winter dens in cavities	2RS
Fisher	nest, summer and winter dens in cavities	1R 2S
Ermine	nest and summer den in cavities	3RS
Other Mammals		
Raccoon	nest, summer and winter dens in cavities	2RS
Black Bear	hibernates in hollow trees and standing dead trees	2RS
Caribou	feeds on arboreal lichens on old trees and standing dead trees	2F

APPENDIX 3. Policy and Regulations

BC Parks Conservation Program Policies: Vegetation Management

The following is a summary of excerpted definitions, sections and clauses most pertinent to the management of dangerous trees and hazards in BC Parks.

Hazard Tree

"A tree with defects in roots, stem, or branches, located in a place which, when failure occurs, could cause personal injury and/or property damage"

Old Growth

"A forest contains live and dead trees of various sizes, species composition and age class structure that are part of a slowly changing but dynamic ecosystem. Old growth forests typically contain accumulations of large size dead standing and fallen trees; multiple canopy layers; canopy gaps and understory patchiness; decadence in the form of broken tops or boles and root decay".

BC Parks Conservation Program Policies: Blowdown Management

BC Parks' primary responsibility in low down management, after the protection of life and property, is to maintain natural ecosystems within parks and ecological reserves.

Upon occurrence, blow down will be assessed in relation to high risk factors including visitor safety, recreational values, and risk of insect infestation.

Blowdown will be removed where it obstructs traffic and/or poses a safety risk in high-use areas, or significantly impacts on established recreational use of an area.

BC Parks Conservation Program Policies: Management of Special Features

Management priority will be given to special or unique vegetation communities, rare, threatened, and endangered species.

Outstanding Specimens, Historic Landscapes, and Culturally Modified Vegetation

Exceptional trees and stands of old growth will be managed with a high degree of protection emphasis.

To conserve scarce old-growth forests and to ensure public safety, BC Parks will not develop campgrounds, visitor centres, interpretation centres, picnic sites, parking lots, in old-growth forest stands.

BC Parks Conservation Program Policies: Ecosystem Manipulation of Vegetation

Deliberate manipulation of vegetation may occur in parks and ecological reserves under special circumstances.

Hazard Trees

- BC Parks managers will conduct an on-going tree hazard monitoring program consisting of inspection, hazard rating, and recommended actions.
- Consider successional stage and ecosystem health when assessing hazard trees and developing mitigation options.
- Hazard trees may be removed from areas with known risk to visitor and worker safety, especially within intensive use zones and along high use corridors.
- If removal or modification of hazard trees threatens high conservation values, visitor use patterns may be altered to eliminate the need for such actions.

Occupiers Liability Act (Ch. 337)

In this Act, "occupier" means a person who has responsibility for, and control over, the condition of premises, the activities conducted on those premises and the persons allowed to enter those premises. The Act determines the care that an occupier is required to show toward persons entering on the premises (ie., the Park or recreation site) in respect of dangers to them, or to their property on the premises. An occupier of premises therefore owes a duty to take that care in all the circumstances of the case it is reasonable to se that a person, and his property, on the premises will be reasonably safe in using the premises. This duty of care applies in relation to the condition of the premises, activities on the premises; or conduct of third parties on the premises.

Species at Risk Act (SARA)

SARA provides immediate protection to listed species, making it an offence in sections 32 and 33 to:

- kill, harm, harass, capture or take an individual of a listed species that is extirpated, endangered or threatened;
- possess, collect, buy, sell or trade an individual of a listed species that is extirpated, endangered or threatened, or its part or derivative;
- damage or destroy the residence of one or more individuals of a listed endangered or threatened species or of a listed extirpated species if a recovery strategy has recommended its reintroduction.

The federal government has responsibility for:

- federal lands (such as national parks, Department of National Defense, Reserve lands, and most of the 3 Territories)
- aquatic species, and
- migratory birds covered by the *Migratory Birds Convention Act, 1994.*

Workers' Compensation Board Occupational Health and Safety Regulation

Part 26: Forestry Operations and Similar Activities, Section 11: Dangerous Trees

(1) If it is known or reasonably foreseeable that work will expose a worker to a dangerous tree,

a) the tree must be felled, or

b) a risk assessment of the tree must be undertaken by a person who has completed a training program acceptable to the Board.

(2) If a risk assessment under subsection (1) determines that a tree poses a risk to a worker, the recommendations made in the risk assessment for eliminating or minimizing the risk must be implemented before the work referred to in that subsection starts.

(3) Despite subsections (1) and (2), if work in a forestry operation is to be carried out in an area that has more than 500 dangerous trees per hectare, the Board may approve a request to work without felling or assessing all the dangerous trees, if before the work starts,

(a) a person who has completed a training program acceptable to the Board conducts a risk assessment of a representative sample of the dangerous trees, and

(b) any recommendations made in the risk assessment for eliminating or minimizing the risks are implemented.

RED-listed Wildlife Tree Users: Endangered/Threatened Species

Northern Goshawk (coastal *laingi* subspecies)
Spotted Owl
Western Screech-Owl (*macfarlanei* subspecies)
Williamson's Sapsucker (*nataliae* subspecies)
White-headed Woodpecker
Marbled Murrelet
Pallid Bat
Keen's Long-eared Myotis (bat)
Red-tailed Chipmunk (*ruficaudus* subspecies)
Least Chipmunk (*selkirki* subspecies)
Ermine (*haidarum* subspecies)
Long-tailed Weasel (*altifrontalis* subspecies)
Fisher
Mountain Caribou (southern population)

Note:

The subspecies listed on this page have limited ranges in specific regions of the province. For example, the Blue-listed *emmonsii* subspecies of black bear occurs only in extreme NW British Columbia.

BLUE-listed Wildlife Tree Users: Vulnerable/Sensitive Species

Great Blue Heron
Barn Owl
Flammulated Owl
Northern Pygmy-Owl (*swarthi* subspecies)
Northern Saw-Whet Owl (QCI *brooksi* subspecies)
Western Screech-Owl (*kennicotii* subspecies)
Lewis's Woodpecker
Williamson's Sapsucker (*thyroideus* subspecies)
Hairy Woodpecker (QCI *picoideus* subspecies)
Fringed Myotis (bat)
Northern Long-eared Myotis (bat)
Western Small-footed Myotis (bat)
Spotted Bat
Townsend's Big-eared Bat
Least Chipmunk (*oreocetes* subspecies)
Red-tailed Chipmunk (*simulans* subspecies)
Ermine (*anguinae* subspecies)
Black Bear (*emmonsii* subspecies)



Great Blue Heron nesting in a suitable wildlife tree.

For further information on Red- or Blue-listed wildlife in British Columbia, contact the B.C. Conservation Data Centre in Victoria (see *http://srmwww.gov.bc.ca/cdc/access.html*)

Guidebooks Containing Reference to Wildlife Trees

Stand Management Prescription Guidebook

Forest Practices Code Guidebooks

- Biodiversity Guidebook
- Defoliator Management Guidebook
- Dwarf Mistletoe Management Guidebook
- Forest Development Plan Guidebook
- Forest Road Engineering Guidebook
- Green up Guidebook
- Lake Classification and Lakeshore Management Guidebook: Kamloops Forest
- Lake Classification and Lakeshore Management Guidebook: Nelson Forest
- Lake Classification and Lakeshore Management Guidebook: Prince George
- Logging Plan Guidebook
- Pruning Guidebook
- Riparian Management Area Guidebook
- Silviculture Prescription Guidebook
- Silviculture Surveys Guidebook
- Site Preparation Guidebook
- Spacing Guidebook

See the WTC website at www.for.gov.bc.ca/hfp/wlt/ for links to Ministry of Forests and Range, and Ministry of Environment policies and regulations which may be relevant to the management of wildlife trees.

Appendix 4. An Overview Of Legal Considerations

Prepared by Julian Dunster[1]

Legal Basics[2]

Creating and managing parks of any kind to ensure safety requires planning and management skills. The degree of safety depends upon the issue involved, and the level of risk that one is prepared to assume. For example, safety issues associated with theft of personal property from parked cars differs from the safety of park users on trails, which in turn differs from the safety issues associated with the safety of people playing in an open grassed area. However, all of these safety issues involve fundamental principles.

While absolute safety is impossible to guarantee in most instances, it is possible to plan and implement certain fundamental steps to attempt to ensure a basic level of safety. Car parks can be designed with high visibility at all times of day; trails can be built to certain minimum standards to eliminate the most obvious and immediate hazards; and playing fields can be built and maintained so that they are reasonably safe for most users.

For park managers it is very important to remember that a park is a place where people are invited to come, for whatever reason. That is, the very act of being a park implies that the area is open for use and enjoyment by the public, typically with few if any predetermined conditions, other than the usual things like park here, keep dogs on a leash, please stay on the trails and so on, and no qualifications as to who may or may not enter the park.

The very act of inviting people into these places called "parks" places what is called a duty of care on the owner of the park. A duty of care is defined in Black (1990) as:

> *A human action which is exactly conformable to the laws which require us to obey them. Legal or moral obligation. An obligation that one has by law or contract. Obligation to conform to legal standard of reasonable conduct in light of apparent risk. An obligation, recognized by the law, requiring actor to conform to certain standard of conduct for protection of others against unreasonable risks.*

The fact that a duty of care exists merely means that the owner has a legal responsibility. Translating that legal responsibility into actions requires an additional step, legally termed the standard of care. Black (1990) defines the standard of care as:

> *That degree of care which a reasonably prudent person should exercise in same or similar circumstances. If a person's conduct falls below such standard, he may be liable in damages for injuries or damages resulting from his conduct.*

And how do we know what a standard is? Well Black (1990) defines that as:

> *Stability, general recognition, and conformity to established practice. A type, model, or combination of elements accepted as correct or perfect. A measure or rule applicable in legal cases such as "standard of care" tort actions.*

It is crucial to understand the general implications of these aspects. The standard of care determines how the duty of care is measured. In a court action, the judge has to determine who has the duty (responsibility) of care, what level of care that person might ordinarily be expected to exercise, and how. Thus, if accepted practice for car park designs is well established, and one particular park uses a much lower standard, then an action involving the lower standard might well succeed if it can be proved that the park owner did not do what was ordinary, or typically reasonable in similar circumstances.

Duty and Standard of Care

So, a park manager or other park staff, acting on behalf of the owner (which can be public or private) has a legal responsibility (the duty of care) to exercise common prudence (the standard according to established practice) in operating the park.

Negligence and Liability

Clearly, the main concern for a park manager is that the park be maintained in a safe condition, and that the park owners avoid liability for any accidents. In the event that a court action is launched against a park owner, the person suing has to prove that the owner is in fact responsible, or liable for the damage alleged. Liability has to be proved, usually by showing that some form of negligence was involved. In order to prove negligence several aspects must be established. Firstly there must be proof that a duty of care existed. Then, it must be shown that this duty of care has been breached in some way, and that as a result of this breach (failure to meet accepted standards of care), damage (usually property or physical injury) resulted.

Establishing liability then determines who pays for the damage claimed and how much. Generally, liability hinges on whether or not there was a duty of care to be exercised, and if so, whether or not it was negligently implemented. Note that there is a difference between the person who directly causes a problem (an act of commission) and a person who fails to prevent or undertake actions to remove a problem ((an act of omission).

Across Canada the legislation governing parks varies and may be affected by an Occupiers Liability Act, as well as by other provincial and Federal legislation. However, in all cases it is safe to assume that the park owner (typically the Crown, a municipality or, other local government) does have a duty of care and is expected to meet a certain standard of care.

Dealing With Trees

When dealing with trees in parks, many of the issues considered by the courts will be similar to other safety issues. The fact that trees are involved may be less important than the manner in which the trees were dealt with. Park managers should be aware of the legal aspects noted above and systematically devise policy and procedures for each park area in their jurisdiction. While it is impossible to discuss all of the legal niceties in this section, it is important to appreciate the legal implication of a policy decision as opposed to operational activities. Following a British court ruling in 1978 known as Anns v. Merton London Borough Council, it has been established law in Canada that there is a difference between events which emanate from policy decisions, and those which arise out of operational activities. In essence, the courts have ruled that policy decisions may limit or eliminate any duty of care, while operational decisions which are the actual implementation of a policy decision are not restricted. For example, it is clearly recognised that it is unreasonable to expect a standard of perfection in dealing with identifiable hazards such as falling rocks and trees. No organization will even have enough staff time and budgets to inspect every single tree or rock that might possibly fall and cause damage. But suppose a policy is created that states something along the lines of "to the extent allowed by the budgets available, trees and rocks capable of causing damage will be inspected periodically". Once this is translated into an annual action plan – that is, operational activities that fulfill the policy requirement – then those operational activities must meet accepted standards of care.

For example, there are two very high profile Supreme Court of Canada cases involving trees on public roads (Just 1989, and Swinammer 1992), which address these very issues. In both cases it was argued that a policy decision was involved and that liability was thus restricted. For those interested in these aspects, these two cases merit scrutiny because they have had profound implications for highway authorities across Canada.

While there appear to have been very few Canadian court cases involving falling trees in parks[3], the principles likely to be involved are quite clear. In the absence of well-defined court cases, the following guidelines are suggested[4].

General Guidelines

1. Recognize and accept that you have a duty of care to ensure public safety.

2. Consider the levels of risk you are willing to accept in one or more places within the park.

3. Draw up a policy statement that addresses the recognition of the risks and how you will deal with them.

4. Based on the policy statement, draw up a set of operational procedures that will be implemented as a means of assessing and mitigating risks. This document will be extremely important in all of your park activities. It dictates the standards of care you are implementing, and that you will have to justify in the event of a court action against you.

The first three steps should be straightforward. Clearly areas of high public usage will also have higher risk since there are people present there more often. Remote trails are less likely to be heavily used than playing fields, for example. So at a relatively simple level, broad risk categories can be established, and these might serve as a first step for assessment and mitigation.

The operational activities need to establish areas of risk, such as car parks, trails, lookouts, fishing areas and so on and then draw up a plan that will assess each area to establish some sense of what exists currently, its condition now, its potential in future years, and what actions have been taken at the time of each assessment.

In a heavily used regional park, where people visit all year round, it would be reasonable to require at least an annual inspection of the most heavily used areas such as trails and car parks. For a provincial park, having a network of trails leading into the backcountry, a similar level of assessment might be reasonable. For the more remote trails, perhaps only used by a small percentage of visitors, then it may be reasonable to have a longer interval between inspection, perhaps a five year assessment interval. And, for the really remote back country areas, it may be quite reasonable to have no assessment procedures in place on the basis that this is the wild area and the user is entirely responsible for any and all conditions encountered.

In all cases, once you have established that an area is to be assessed, then you must employ qualified personnel to undertake the assessment, and they in turn should clearly and carefully document what they assessed, what they found, and what, if any, actions are recommended.

Timing to Implement Operational Procedures

Note that once a tree has been identified as a hazard, and has been recommended for treatment (for example removal of the whole tree, conversion to a wildlife tree, removal of dead branches), then this recommendation must be followed up as soon as possible with action. There are court cases where the owners have been found liable for damages because they knew of a problem, and took no action to abate it (for example Hayes v. Davis 1991). It should be noted that there are also cases where components of a park have failed and caused damage to neighbouring property, the classic case in that regard being Leakey v. Nat. Trust for Places of Historic Interest or Natural Beauty (1980).

As a park manager you have a duty of care to ensure public safety, so high priority should be given to abating identified hazards as soon as possible. As with all other aspects, the courts would review the circumstances and determine what was "reasonable" and what a similar person in similar circumstances ought to have done.

Determining the acceptable levels of risk in any one situation is not easy. The safest approach is to be sure the standards you employ are reasonable, and are as good as or better than contemporary standards used elsewhere. That means that you must know what these other standards in use are, and your staff must also be aware of them and qualified to implement them. Training in hazard tree identification is very important, and as with other aspects, should be documented so that it can be shown you have taken all reasonable steps to ensure safety.

Signs

Many people believe that placing a sign at the entrance to a park, advising the public that they use the park at their own risk, will eliminate the potential for liability. There seems to be little basis for reliance on this approach. While it can be argued that the public was notified, it might also be argued that a) any one person did not see the sign, b) they say the sign but did not (or could not) read it, c) they read the sign but did not appreciate its true meaning, or d) they read and appreciated its meaning, but had a reasonable right to believe that the park would be safe since it was still open to them. Others might argue that the very act of placing such a sign is an admission of guilt, since it implies that the owners have recognised that hazardous conditions do indeed exist. Placing the sign might also be construed as a prudent precaution.

Summary

It comes back to the fundamental principle that the park owner has a duty of care to ensure a reasonable level of safety within the park, and that the standard of care required to achieve this reasonable level of safety must be sufficient to equal or be better than what is commonly accepted in similar situations. The policy and operational procedures in place must be clearly defined and properly implemented. A standard of perfection is unreasonable and not likely to be upheld by the courts.

If all of these aspects are carefully considered, then it should be relatively simple to have a safe park with safe trees.

Cases Cited

Anns v. Merton London Borough Council, (1978) A.C. 728, (1977) 2 W.L.R. 1024, (1977) 2 All E.R. 492 (H.L.).

Hayes v. Davis, (1990) B.C.W.L.D. 345; stay of execution granted (1989) B.C.W.L.D. 2542 (C.A.); affirmed (1991) 54 B.C.L.R. (2d) 350, (1991) 4 W.W.R. 678, (1991) B.C.W.L.D. 965 (C.A.); leave to appeal to S.C.C. dismissed (1991) 58 B.C.L.R. (2d) xxxiv, (1991) 6 W.W.R. lxvii, (1991) 6 B.C.A.C. 159n, (1991) 13 W.A.C. 159n, (1991)136 N.R. 238n (S.C.C.).

Just v. British Columbia, (1989) 2 S.C.R. 1228, 41 B.C.L.R. (2d)350, (1989) 64 D.L.R. (4^{th}) 689, (1990) 1 W.W.R. 385, 1 C.C.L.T. (2d) 1, 18 M.V.R. (2d) 1; affirming 10 B.C.L.R. (2d) 223, (1987) 2 W.W.R. 231, 40 C.C.L.T. 160 (C.A.); affirming 64 B.C.L.R. 349, (1985) 5 W.W.R. 570, 34 M.V.R. 124 (S.C.).

Leakey v. Nat. Trust for Places of Historic Interest or Natural Beauty, (1980) 1Q.B. 485, (1980) 2 W.L.R. 65, (1980) 1 All E.R. 17 (C.A.); affirming (1978) Q.B. 849, (1978) 3 All E.R. 234.

Swinamer v. Nova Scotia (Attorney-General) (1994), 19 C.C.L.T. (2d) 233, 2 M.V.R. (3d) 80, 163 N.R. 291, (1994) 1 S.C.R. 445, 129 N.S.R. (2d) 321, 362 A.P.P. 321, 112 D.L.R. (4^{th}) 18, 20 Admin. L.R. (2d) 39; affg. (1992) 35 M.V.R. (2d)191, 10 C.C.L.T. (2d) 207, 108 N.S.R. (2d) 254, 294 A.P.R. 254 (S.C.-A.D.); reversing (1991), 6 C.C.L.T. (2d)270, 101 NS.R. (2d) 333, 275 A.P.R. 333 (T.D.).

References Cited

Black, H.C. 1990. Black's Law Dictionary. 6th Ed. St. Paul, Minnesota: West Publishing Co.

Footnotes

1. Dr. Julian Dunster (Dunster & Assoc. Environmental Consultants Ltd.) is a professional forester, professional planner, and ISA certified arborist based on Bowen Island, B.C. Much of the following material has been extracted from Dunster, J.A., and S.M. Murray. 1997. Arboriculture and the Law in Canada. Savoy: International Society of Arboriculture. Distributed in Canada by Neville Crosby Inc., Vancouver, B.C.

2. The material presented here is an overview of the legal implications and is not intended as absolute legal advice. The author is not a lawyer and makes no representation as such. The legal implications discussed here may change as case law changes. Persons wishing to obtain more detailed legal advice should retain the services of a lawyer.

3. In searching for court cases for the book Arboriculture and the Law in Canada, several instances of people being injured by trees falling in parks were noted, but all seem to have been settled out of court and no court cases were found that had gone right through the trial process.

4. These are based on the author's experience in park planning, court cases, and the materials discussed in Arboriculture and the Law in Canada. Readers interested in learning more details should consult the book, which explains the Canadian case law in considerable detail.

APPENDIX 5. DANGER TREE ASSESSMENT FIELD DATA FORMS (SAMPLE)

DANGER TREE ASSESSMENT FIELD DATA – PARKS

Assessor's Name: Joe Doneit

Date: Y/M/D Date of assessment

Park or Rec Site: BC PARKS

Location: Somewhere, BC

Certificate #

Map Attached:

Type of Facility: YEAR ROUND CAMPGROUND

Target Description: CAMPING SITES, AMENITIES (showers, toilets, woodsheds)

Type of Activity: Camping, day-use picnicing, trail riding (bikes)

Level of Disturbance (LOD): 3

				LOD = 1			*LOD = 2, 3 or 4*																*Tree Comments*					*Management Action*				
				From Table 3			From Table 4 or 4A or 5										Detailed Assessment															
							Tree Defects (S = defects rated safe; D = defects rated dangerous; / = absent; ? = needs detailed assessment)																									
Tree #	Species	Tree Class	Tree Height (m)	Insecurely lodged or hung up limbs/tops =D	Highly unstable tree =D	Recent lean with unstable roots = D	HT	DL	WB	ST	SD	SB	CA	CM	TL	RI	DSH (cm)	RST (radius x 0.3)	AST (cm)	Stem (S or D)	Roots (S or D)	Overall Rating (S or D)	Wildlife Tree Value	Wildlife Uses (CN, F, P, ON, M, Other)	Recreational Attraction(Y/N)	Heritage Feature (Y/N)	Distance to Target (m)	Safe / Monitor Tree	Dangerous - Fall Tree	Dangerous - Modify	Dangerous - Move Target	Action and date completed yy/mm/dd
1	Fd	4	35				S	D	-	-	?	-	-	?	5	S	80	12	18	S	-	D	H	CN	N	N	5			X		
2	Pl	4	22				S	S	-	-	S	-	-	S	0	S	42	-	-	-	-	S	L	F	N	N	10	S				
3	Fd	6	18				-	S	-	-	?	-	-	-	0	S	34	5.1	5.3	S	-	S	H	CN	N	N	12	M				

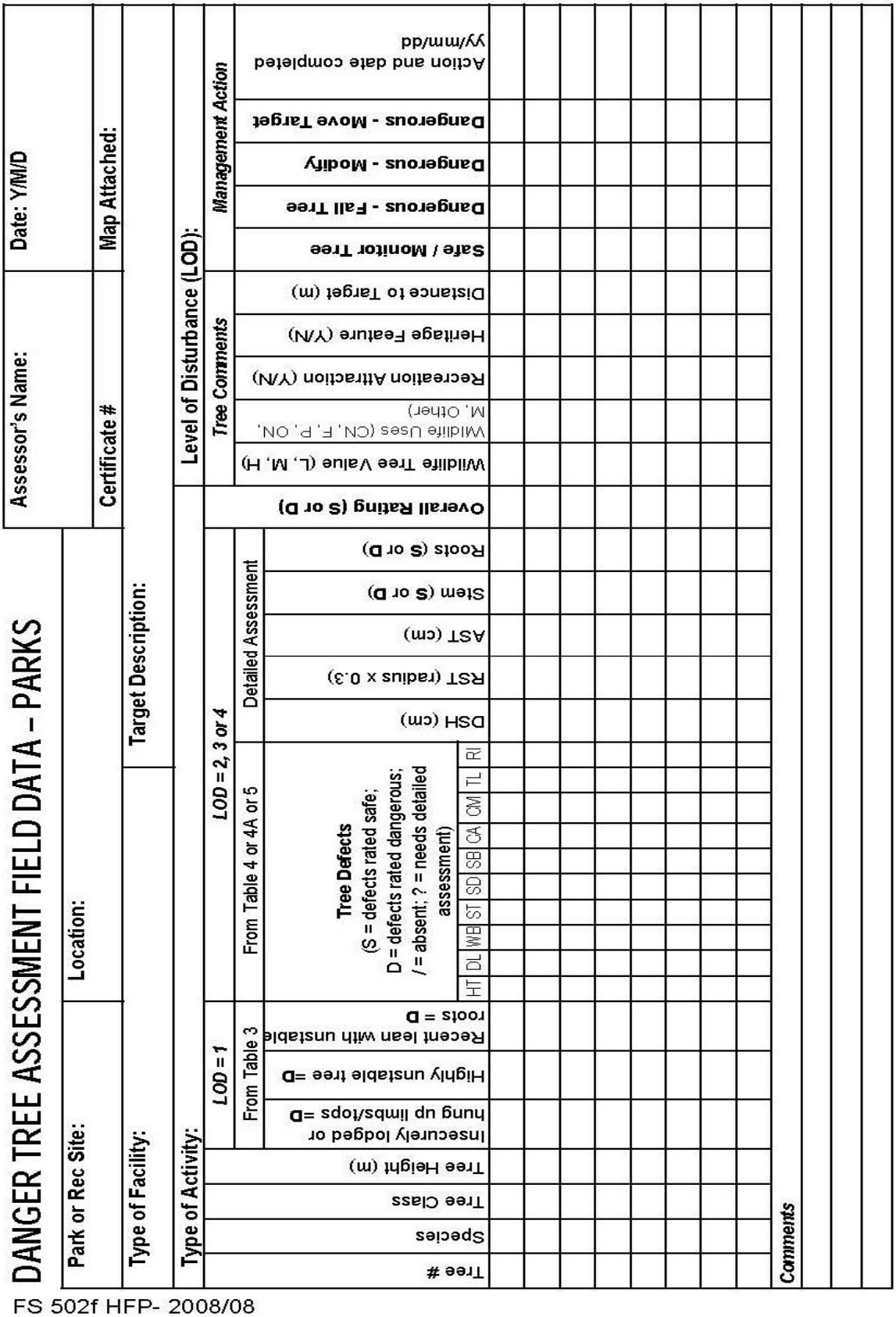
Comments: *WT#1 has a hanging DL at 20m; CN at 10m and below the p. Pini conk - climbed and drilled to get AST; remove DL with bucket truck*

WT#2 has MPB feeding; saprot fruiting bodies just appearing - safe to retain

WT#3 has SD and associated decay - AST barely exceeds RST; monitor decline; active nest and PCE feeding observed

FS 502f - Aug 2008

Appendix 5. DANGER TREE ASSESSMENT FIELD DATA FORM (BLANK)



FS 502f HFP- 2008/08

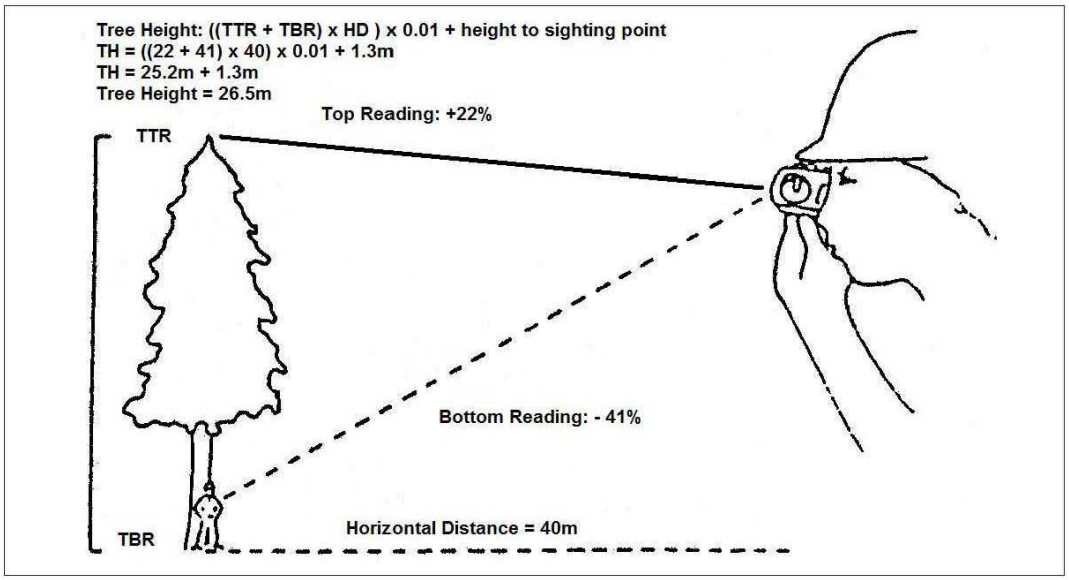
Appendix 5. DANGER TREE ASSESSMENT FIELD DATA FORM (SITE OVERVIEW)

Site Assessment Overview Summary			Date (mm/dd/yy):
Location:	Tenure Holder:		Tenure:
Stratum Identification:	Operation:	Assessor's Name:	
Forestry activity and LOD:		Planned start-up and end dates:	
Stratum conditions (Describe leave trees - species, sizes, condition, ages and density distribution):			
WT management objectives (Describe constraints to NWZ, WT retention):			

Stand Density and Site History	**Site Hazards**	**Common Tree Pathogens/Cause of Failure (List factors and severity/frequency)**
Disturbance year	Bluffs/cliffs/sink holes	
Disturbance type	Gorges/streams/gullies	
Recent tree failure(s)	Rock talus/scree	
Past tree failure(s)	Steep/unstable terrain	
Fire intensity (L,M,H)	Recent edge/tree exposures	
Tree retention pattern - even clumps irregular	Snow/ice/fog	
Retention tree density (L, M, H)	Windthrow risk	
Tree species mix	Shallow/saturated soils	
Tree age (dom/co-dom)	Stand decadence	
Prevailing wind direction	Other:	
Wildlife tree use (L, M, H)		
Mitigation Strategies	**Constraints**	**Communication**
Falling/machine clearing/blasting	Wind speed criteria	Evacuation routes
NWZ criteria	Weather	Refuge area
Tree modification	Seasonal issues	Road use control

Appendix 6. FIELD PROCEDURE GUIDES

Measuring Tree Heights



The most common tool for measuring tree height is the Suunto clinometer. The 'clino' works on a pendulum principle and measures the angles to the top and to the base of the tree.

When these measurements are combined with a measured distance to the tree, the height of the tree can be calculated.

The Suunto makes it possible for you to estimate tree height based on two quick readings of the slope lines from your eye to the top and bottom of the tree.

To use the Suunto, hold it to your right eye and watch the internal movable scale, while looking at the target tree with your left eye. Tilt the instrument until you can see the top of the tree, and read the right hand side of the scale (in %). Make note of the reading, then tilt the instrument to the 'base' of the tree (actually, at dbh) and record the reading. Measure the horizontal distance you are from the tree, then calculate the tree height according to the following formula:

Tree height = (TTR + TBR) x HD x .01

where TTR = Tree top reading (%)

TBR = Tree bottom reading (%) *

HD = Horizontal distance from tree **

* Tree bottom readings are usually a negative %; ignore the negative sign and add the bottom % measurement to the top % measurement. In cases where you are looking uphill to sight both the top and bottom of the tree, and both % readings are positive, subtract the tree bottom % reading from the tree top % reading.

** Remember to derive the horizontal distance using slope tables.

SLOPE CORRECTION TABLE

To get horizontal distance, multiply slope distance by this factor.

Percent Slope (%)	Factor	Percent Slope (%)	Factor	Percent Slope (%)	Factor	Percent Slope (%)	Factor
1	1	26	0.968	51	0.891	76	0.796
2	1	27	0.965	52	0.887	77	0.792
3	1	28	0.963	53	0.884	78	0.789
4	0.999	29	0.960	54	0.880	79	0.785
5	0.999	30	0.958	55	0.876	80	0.781
6	0.998	31	0.955	56	0.873	81	0.777
7	0.998	32	0.952	57	0.869	82	0.773
8	0.997	33	0.950	58	0.865	83	0.769
9	0.996	34	0.947	59	0.861	84	0.766
10	0.995	35	0.944	60	0.857	85	0.762
11	0.994	36	0.941	61	0.854	86	0.758
12	0.993	37	0.938	62	0.850	87	0.754
13	0.992	38	0.935	63	0.846	88	0.751
14	0.99	39	0.932	64	0.842	89	0.747
15	0.989	40	0.928	65	0.838	90	0.743
16	0.987	41	0.925	66	0.835	91	0.740
17	0.986	42	0.922	67	0.831	92	0.736
18	0.984	43	0.919	68	0.827	93	0.732
19	0.982	44	0.915	69	0.823	94	0.729
20	0.981	45	0.912	70	0.819	95	0.725
21	0.979	46	0.908	71	0.815	96	0.721
22	0.977	47	0.905	72	0.812	97	0.718
23	0.975	48	0.902	73	0.808	98	0.714
24	0.972	49	0.898	74	0.804	99	0.711
25	0.97	50	0.894	75	0.800	100	0.707

Source: BC Ministry of Forests and Range, Forest Practices Branch. Aug. 9, 2005. How to Determine Site Index in Silviculture.

Increment Boring: Field Methods



Increment boring is performed to:

- determine the age of standing trees;
- measure the tree growth rate;
- check for tree defects in stems and roots;
- check chemical penetration of treated wood products;
- test the condition of wooden structures

Your primary field tool will be the increment borer. They are manufactured by several companies (e.g., Haglof, Suunto, Timberline, Mattson), but all contain the same three components (from top to bottom): a handle, a bit, and a core retriever (extractor). They are sold in various bit lengths ranging from 4" to 28" ($100 to $500 US). The components nest together for easy packing. When in use, the bit is inserted into the handle and twisted into the tree (always keep the extractor out of the bit and in a safe place while coring).



The tip of the increment borer is threaded to help pull the hollow bit into the tree. Thread styles on the bit may vary from 2 to 3 thread types. The sharpened surface of the leading edge MUST be protected from damage at all times. The consequences of a dull bit are varied and can range from mild to extreme. A severely nicked or damaged bit can not be re-sharpened and must be replaced. At $75 to $400 per bit, it is best to be careful! The diameter of the core of wood is determined by the inside diameter of the opening of the threaded end of the bit and may range from 5.0 mm to 12.0 mm.



Assemble the coring tool by inserting the bit into the handle and closing the locking mechanism. BE SURE TO REMOVE THE EXTRACTOR!

To begin coring, hold the bit just behind the threads and lean into the borer to provide as much body pressure as possible. Slowly turn the bit until the threads have become fully engaged.



After the threads have engaged, you may step back from the increment borer and in a clockwise motion, turn the handle. The bit will proceed into the tree and should be held at a 90 degree angle. Hardwoods (e.g., oak) will require a considerable use of strength and energy. DO NOT EXTEND THE HANDLE TO GAIN LEVERAGE OR USE A POWER DRILL!

If you hit a rot pocket (you will know immediately because

of the ease of turning), back out immediately or else your bit may be incredibly difficult to remove (the threads do not engage in reverse unless they already have a bite in the wood).

Your goal is to core the tree slightly past the pith (center) of the stem. To gauge your depth at any given time, you can hold the extractor up to the side of the tree (it is the same length as the bit and will inform you of your progress).





When the proper depth has been achieved, back the bit out one full turn, then insert the extractor with the edges turned upside down (∩) into the hollow increment corer bit, at a slight angle applying upward pressure. Insert the extractor to its full length (depending upon the species, this may require that you apply some pressure with the heel of your hand near the end). NEVER drive the extractor in with a hammer or other implement.

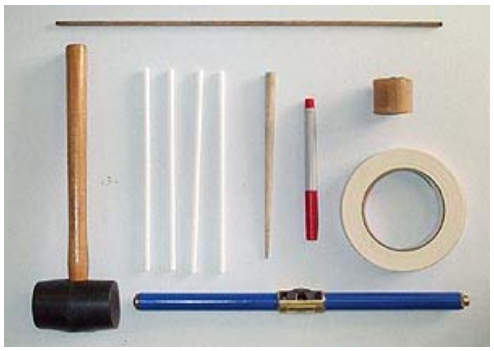


Then turn handle ½ turn backwards, causing the extractor edges to point up (∪). SLOWLY withdraw the extractor from the increment handle and you should retrieve an intact core with the serrated tip holding it in place. Remove your borer from the tree as soon as possible to prevent it from being "frozen" in the tree. Current wisdom suggests that the hole you left will scar over quickly and no attempt should be made to treat or plug the hole with any type of substance or object. Just leave it be. If you experience twisting or breaking of the cores, try cleaning and oiling the borer bit (inside and out). Some follow this practice every few cores to reduce core problems.



Immediately place the core into a paper drinking straw, seal the ends, and mark the straw with the sample ID

number (this should code to your field data sheets that contain additional information about the tree and site). Be sure not to loose any pieces. If the core breaks, maintain the order of the pieces in the straw. Store the straws in a protective container while in the field (such as a map tube).



Shown here is a collection of basic field tools you will need. They include the INCREMENT BORER, PAPER STRAWS (for core storage), INDELIBLE MARKER PEN, MASKING TAPE (for joining two or more straws together for long cores), BEESWAX (to rub on borer tip to facilitate boring), 2 WOODEN DOWEL RODS and a RUBBER MALLET (to free pieces of wood that may become entrapped in borer bit--this is a pretty common occurrence). A wooden golf tee works well for dislodging material at the tip of the borer bit.



You should always keep a cleaning kit within easy reach (field or lab). Use a cleaning rod designed for .22 caliber rifles with a plastic tip insert that holds either some steel wool or a small cotton pad (both of which should be soaked in WD-40 or equivalent spray lubricant and rust preventative). All bits should be sprayed with WD-40 inside and out prior to storage and minimally after every day of use. Cleaning the bits after every few trees to ensure untwisted & unbroken increment cores is a good idea. Store and transport the bit inside the handle with a plastic cap over its end.

Source: WDTAC – Ministry of Transportation and Highways. 2003.

British Columbia Tree Code List

NATIVE CONIFERS

Cedar	Thuja	C
western redcedar	*T. plicata*	Cw
Cypress	Chamaecyparis	Y
yellow-cedar	*C. nootkatensis*	Yc
Douglas-fir	Pseudotsuga	F
Douglas-fir	*P. menziesii*	Fd
coastal Douglas-fir	*P. menziesii* var. *menziesii*	Fdc
interior Douglas-fir	*P. menziesii* var. *glauca*	Fdi
Fir (Balsam)	Abies	B
amabilis fir	*A. amabilis*	Ba
grand fir	*A. grandis*	Bg
subalpine fir	*A. lasiocarpa*	Bl
Hemlock	Tsuga	H
mountain hemlock	*T. mertensiana*	Hm
western hemlock	*T. heterophylla*	Hw
mountain x western hemlock hybrid	*T. mertensiana* x *heterophylla*	Hxm
Juniper	Juniperus	J
Rocky Mtn. juniper	*J. scopulorum*	Jr
Larch	Larix	L
alpine larch	*L. lyallii*	La
tamarack	*L. laricina*	Lt
western larch	*L. occidentalis*	Lw
Pine	Pinus	P
jack pine	*P. banksiana*	Pj
limber pine	*P. flexilis*	Pf
lodgepole pine	*P. contorta*	Pl
lodgepole pine	*P. contorta* var. *latifolia*	Pli
lodgepole x jack pine hybrid	*P.* x *murraybanksiana*	Pxj
ponderosa pine	*P. ponderosa*	Py
shore pine	*P. contorta* var. *contorta*	Plc
western white pine	*P. monticola*	Pw
whitebark pine	*P. albicaulis*	Pa
Spruce	Picea	S
black spruce	*P. mariana*	Sb
Engelmann spruce	*P. engelmannii*	Se
Sitka spruce	*P. sitchensis*	Ss
white spruce	*P. glauca*	Sw
spruce hybrid	*Picea cross*	Sx
Engelmann x white	*P. engelmannii* x *glauca*	Sxw
Sitka x white	*P.* x *lutzii*	Sxl
Sitka x unknown hybrid	*P. sitchensis* x ?	Sxs
Yew	Taxus	T
western yew	*T. brevifolia*	Tw

NATIVE HARDWOODS

Alder	Alnus	D
red alder	*A. rubra*	Dr
Apple	Malus	U
Pacific crab apple	*M. fusca*	Up
Arbutus	Arbutus	R
Arbutus	*A. menziesii*	Ra
Aspen, Cottonwood, or Poplar	Populus	A
poplar	*P. balsamifera*	Ac
balsam poplar	*P. b.* ssp. *balsamifera*	Acb
black cottonwood	*P. b.* ssp. *trichocarpa*	Act
hybrid poplars	*P.* spp.	Ax
trembling aspen	*P. tremuloides*	At
Birch	Betula	E
Alaska paper birch	*B. neoalaskana*	Ea
Alaska x paper birch hybrid	*B.* x *winteri*	Exp
paper birch	*B. papyrifera*	Ep
water birch	*B. occidentalis*	Ew
Cascara	Rhamnus	K
cascara	*R. purshiana*	Kc
Cherry	Prunus	V
bitter cherry	*P. emarginata*	Vb
choke cherry	*P. virginiana*	Vv
pin cherry	*P. pensylvanica*	Vp
Dogwood	Cornus	G
Pacific dogwood	*C. nuttallii*	Gp
Maple	Acer	M
bigleaf maple	*A. macrophyllum*	Mb
vine maple	*A. circinatum*	Mv
Oak	Quercus	Q
Garry oak	*Q. garryana*	Qg
Willow	Salix	W
Bebb's willow	*S. bebbiana*	Wb
Pacific willow	*S. lucida*	Wp
peachleaf willow	*S. amygdaloides*	Wa
pussy willow	*S. discolor*	Wd
Scouler's willow	*S. scouleriana*	Ws
Sitka willow	*S. sitchensis*	Wt

UNKNOWNS

Unknown	X
Unknown conifer	Xc
Unknown hardwood	Xh

OTHERS

Other tree, not on list	Z
Other conifer	Zc
Other hardwood	Zh