New Nouveau Brunswick

# FORESTRY/INDUSTRIAL PESTICIDE SAFETY MANUAL

**1st Edition**
**1999**

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**Your Environmental Trust Fund at Work!**

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# Acknowledgements

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The format for this manual is based on the Standard for Pesticide Education, Training and Certification in Canada. Content of this manual is also derived from the Industry Standards and Good practices for Vegetation Management, The Nova Scotia Pesticide Safety Manual, The Ontario Pesticide Education and Licensing Program/Aerial Module and Canadian Forestry Services Fact Sheets.

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# Introduction

Forestry and Industrial pesticide applicators are required to have a base knowledge for a wide range of applications.

The **Forestry** Category includes the application of herbicides, insecticides, fungicides and animal repellents in various settings of forest management.

The **Industrial** Category includes the application of herbicides in areas of roadsides, power lines, right-of-ways, pipelines, rail beds, well sites and equipment yards.

This manual deals only with ground application techniques for forestry and industrial applications. Aerial application is contained in a separate category that has its own manual.

This manual, ***The Forestry/Industrial Pesticide Safety Manual***, in conjunction with the ***General Pesticide Safety Manual***, contains the minimum amount of information that all Forestry and Industrial pesticide applicators must know in order to become a certified pesticide applicator for the Province of New Brunswick.

The ***General Pesticide Safety Manual*** is divided into twelve sections covering the basic pesticide application topics such as legislation, regulations, toxicity and safety as well as the steps and decisions which all applicators have to make in their daily routine on the job.

The ***Forestry/Industrial Pesticide Safety Manual*** focuses on information specific for presented on forestry and industrial settings. Detailed information is presented for New Brunswick's provincial legislation, pest management topics, application technology, safety and professionalism. Applicators wishing to obtain a Pesticide Applicator's Certificate for Forestry and/or Industrial pesticide applications must be aware of the information contained in both this manual and the ***General Pesticide Safety manual*** in order to pass an examination.

Both the ***General Pesticide Safety Manual*** and this manual have been set up to help you prepare for the **Forestry** and/or **Industrial** pesticide applicator certification exam. Read the goals at the beginning of each chapter. This will allow you to recognize the most important points from the chapter. Read each chapter carefully and answer the review questions at the end of the chapter. An appendix at the end of the manual entitled "Answers to Review Questions" will help you obtain and understand the correct answers. These goal, questions and answers have been designed to help you learn the most important points from each chapter.

**Pesticides are not for amateurs. To protect people and the environment, pesticide applicators must be trained professionals!**

# 1 Legislation

**Introduction**

Federal, provincial and municipal governments regulate pesti - cides. Pesticide laws are designed to protect the purchaser, the applicator, the consumer and the environment. As a Pesticide Applicator you should have a good understanding of these laws. Ensure you are familiar with the information in Chapters 4 (Federal Legislation) and 5 (Provincial Legislation) in the ***General Pesticide Safety manual***. Additional information on provincial legislation, specific to forestry and/or industrial pro - grams, is presented in this chapter.

**Goals of the Chapter**

- Understand the process to becoming a Licensed Pesticide Operator for the Province of New Brunswick.
- Understand the process to becoming a Certified Pesticide Applicator for the Province of New Brunswick
- Understand the process for obtaining Pesticide Permits for Forestry/Industrial Applications.

## Provincial Legislation

## Provincial Legislation

The provinces and territories exercise regulation of the sale, use and disposal of pesticides and may attach stricter controls than those administered by the Federal Regulatory Authority Federal and provincial pesticide legislation applies to any person using, selling or disposing of pesticides in New Brunswick.

Pesticides are regulated in New Brunswick under the authority of the *Pesticides Control Act and Regulations*, administered by the Pesticides Management Unit of the New Brunswick Department of the Environment. The provincial Minister of Environment bears responsibility for the *Pesticides Control Act*. This act ensures that pesticides are used, stored and disposed of safely.

If you wish to conduct commercial forestry and/or industrial programs in New Brunswick, your company must meet the following requirements under the Pesticides Control Act and Regulations:

## Operator's Licence

**Your Business must obtain a Pesticide Operator's License.**

This license recognizes the business as one, which is authorized, under the Pesticides Control Act, to provide pesticide application services for fee or reward. An Operator's License is valid for up to one calendar year (most licenses expire December 31 of the year in which they are issued). This license must be renewed annually.

**To apply for a new Operator's License:**

- Complete form "Application for Pesticide Operator's License"
- Submit $100.00 fee
- Submit proof of adequate limited pollution liability insurance (see section on insurance).
- Submit a Contingency Plan (see Chapter 9). Copies of this plan must be sent to your local Fire and Health Departments.

**To renew an Operator's License:**

- Complete the appropriate application forms and submit proof of adequate insurance (see section on insurance)
- Submit $100.00 fee.
- Submit contingency Plan. (See chapter 9). Copies of this plan must be sent to your local Fire and Health Departments.

Typically, a Pesticide Operator would have a pesticide storage area. A Pesticide Storage Area is defined as, "the premises or portion of premises where a non-domestic pesticide is stored, whether on a short term basis and whether sold, offered for supply or supplied at that premises or not."

## Pesticide Storage Areas

**Regulatory Requirements for Pesticide Storage Areas**

The Regulations under the Pesticide Control Act require Operators with a pesticide storage area to ensure that the area has:

- met all federal, provincial and municipal legislation
- a floor impermeable to pesticides stored
- restricted access to authorized personnel only
- signs posted containing the words "Pesticide Storage; authorized persons only; no smoking" and "Entreposage de pesticides; personnes autorisees seulement; interdiction de fumer"
- a contingency plan in place
- been equipped according to the directions of the Director of Pesticides Control (see below)
- met any other terms and/or conditions imposed by the Director of Pesticides Control (see below)

**Requirements for Pesticide Storage Areas Prescribed by the Director**

Operators must ensure that the Pesticide Storage Area is equipped in accordance with the following:

- sufficient lighting
- doors and windows that lock
- a first aid kit, respirator with NIOSH approved pesticide cartridges and protective clothing (eye protection, gloves, coveralls and boots) stored in an accessible location and maintained
- approved fire extinguishers
- appropriate cleanup materials
- been constructed to contain at least 110% volume of product stored
- mechanical ventilation
- no active floor drains

Operators must also ensure that the Pesticide Storage area is:

- used exclusively for the storage of pesticides
- maintained in a clean an orderly manner

**NOTE: Upon written request, the Director may modify some of the requirements listed above.**

## Insurance Requirements

## Insurance Requirements

All holders of a Pesticide Operator 's License must have a Certificate of Insurance. This certificate must indicate:

- Type of Policy:

  Commercial General Liability Policy

  Either occurrence basis or claim – made basis

  Products and/or Completed Operations must be included.

  Pollution Liability Coverage extension must be included (i.e. an addition to the policy that includes coverage for pollution.)

- Recommended Limits: $1,000,000 per occurrence
- Note: There can be no interruption in coverage (cancellation/non-renewal) under this policy except upon thirty days written notice to the Director of Pesticides Control, Department of the Environment, PO Box 6000, Fredericton, NB. E3B 5H1

## Pesticide Applicator Certificates

**All employees handling pesticides must hold Pesticide Applicator Certificates.** Pesticide Applicator Certificates are obtained by successfully completing an appropriate certification program – in this case the **Forestry/Industrial Pesticide Safety Certification Program.** Study material for this program is contained in 2 manuals. They are the ***General Pesticide Safety Manual*** and the ***Forestry/Industrial Pesticide Safety Manual***. The ***General Pesticide Safety Manual*** contains the minimum amount of knowledge that all users of pesticides must know and forms the core for all pesticide applicator programs. The ***Forestry /Industrial Pesticide Safety Manual*** contains specific information on pest management, application technology, legislation and safety procedures for the forestry and industrial sectors. Both manuals are available in English and French at a cost of $25.00 for the ***General Pesticide Safety manual*** and $15.00 for the ***Forestry/Industrial Pesticide Safety manual***.

The Forestry/Industrial Pesticide Safety Certification exam is a 1.5 hour, closed book exam consisting of multiple choice questions, pest identification questions, a calculation section and a label interpretation section. The pass mark for this exam is 75%. Successful candidates receive a **Class C Level 1 (Forestry) and/or Level 2 (Industrial/Right-of-way) Pesticide Applicator's Certificate.**

**To apply for a Pesticide Applicator's Certificate:**

- Complete a certification program
- Complete form "Application for Pesticide Applicator's Certificate"
- Submit $25.00 fee

**To renew a Pesticide Applicator's Certificate:**

- Complete the appropriate application form
- Submit $ 25.00 fee

**To amend a Pesticide Applicator's Certificate:**

- Complete form "Application to Amend a Pesticide Applicator's Certificate"
- Submit $12.50 fee

A holder of a Pesticide Applicator's certificate can apply at any time to amend their certificate. An amendment includes the addition of certification classes and/or levels or changes to the terms and conditions associated with the certificate.

## Pesticide Use Permit

**Your Business must obtain a Pesticide Use Permit**. This permit is a set of operating conditions issued by the Minister of the Environment. The permit will detail which pesticide(s) may be used. Note: Pesticides are specified on the permit both by trade name and their Pest Control Products registration number.

To obtain a permit the applicant must submit to the department a detailed permit application indicating information such as the type of application, the product or products to be used, where in the province the application will take place and the purpose of the application. The application is reviewed and recommendations made to the Minister. When a permit is issued, it contains guidelines (terms, restrictions and conditions) under which an operator/applicator must operate, specific to the type of application.

Monitoring and auditing by departmental staff helps to ensure that pesticide application takes place within permit conditions. These permit conditions are in place to provide additional measures to ensure that if pesticides are to be used, they are used in the safest way possible.

**To apply for a Permit:**

- Complete form "Application for Pesticides Use Permit".
- Submit $100.00 fee

**Note: Permits are not renewed, each application is considered a new application.**

**To amend a Permit:**

- Complete form "Application to Amend a Pesticide Use Permit".
- Submit $50.00 fee (This fee may be waived, depending upon the amendment.)

**Permit Exemptions**

## Permit Exemptions

The following persons are exempt from holding a permit:

a) People or their employees carrying out ground application on their own land or buildings, or land under their direct control.
b) Research or testing on areas of lands less than five hectares in total (for ground application only)

**Types of Pesticide Use Permits**

**Types of Pesticide Use Permits**

In New Brunswick, permits are issued specific to the type of program to be conducted. Forestry and Industrial Permits are described below:

**Forestry:**

Use of pesticides in forest management operation including site preparation, brush control, conifer release, thinning, and insect control.

For both ground and aerial permits, maps or a list of sites must accompany requests with LRIS numbers. Sites must be approved prior to a permit being issued. Additional sites may be added at any time, subject to approval.

**Industrial:**

Use of herbicides for controlling vegetation on industrial areas including power lines, rights-of-ways, railways, equipment yards, bulk storage areas and non-crop land.

For both ground and aerial permits, maps or a list of sites with LRIS numbers must be submitted and approved prior to a permit being issued. Additional sites may be added at any time, subject to approval.

Note: If you wish to conduct a forestry and/or industrial pro - gram by ground on your own land or employer ’s land, you are not required to obtain a Pesticide Operator’s License or Pesticide Use Permit. However, all applicators must hold Pesticide Applicator’s Certificates.

Additional information on pesticide regulations in New Brunswick can be obtained by contacting any member of the Pesticides Management Unit. We can be reached by telephon - ing 1-800-561-4036 (in NB only) or 506-453-7945; by fax at 506-453-2390; or by email at pesticides@gov.nb.ca.

## Review Questions – Chapter 1/Legislation

1. What provincial act is responsible for the regulation of pesticides in New Brunswick?

2. What provincial department is the regulatory agency for pesticide use in New Brunswick?

3. Who requires a Pesticide Operator's (ie. Business) License?

4. Name 4 regulatory requirements for a pesticide storage facility in New Brunswick

5. Is a pesticide operator required to hold a Certificate of Insurance in the Province of New Brunswick?
   True or False

6. What information must be included on a Pesticide Use Permit?

# 2

# Vegetation Management

## Introduction

Vegetation management is utilizing the best method of control for unwanted vegetation by understanding the biology of the plant. Vegetation management can include using prevention, cultural, mechanical, biological and chemical methods. Successful vegetation control starts with proper identification of the weed.

What is a weed? A weed is any plant growing where it is not wanted. This can be in areas where they:

- reduce access and visibility along transportation corridors
- create transmission line hazards
- compete with tree plantations for light, water and nutrients
- interfere with railroads by jamming switches and rotting ties
- reduce the value of lumber stands

## Goals for the Chapter

- Understanding Integrated Vegetation Management.
- Know the methods used for vegetation control in the forestry/industrial sectors.
- Be familiar with the different types of herbicides.
- To review the common weed species in forestry and industrial sites.

## Weed Biology and Identification

### Weed Biology and Identification

The ***General Pesticide Safety Manual*** provides a detailed description of weed life cycles, development stages and plant structures in ***Chapter 24, pages 13-17***. It is essential to understand weed biology in order to apply the best management method to achieve effective control.

Weeds are classified according to their life cycle. **Annuals** are plants that complete their life cycle in one year . **Biennials** are plants that live between one and two years. **Perennials** are plants that may live for many years.

For forestry and industrial vegetation, plants are also classified according to similar structures:

- **Flowering species** produce flowers that develop into seeds. They can be herbaceous (soft stems that die back (fireweed, grass) or woody (hard stems that do not die back during the winter (specked alder, brambles)).
- **Deciduous species** produce leaves that are dropped during the fall and produce seeds through fruits and flowers. These are hardwood species such as birch and maple.
- **Conifers** produce needles or scale-like leaves and produce their seeds in cones. These are the softwood species such as spruce and fir.

## Vegetation Management Methods

**Vegetation Management Methods**

There are many methods of managing vegetation that are suited to specific situations. The management for a particular site depends on the long-term objectives, site characteristics, environmental considerations, landowner and public concerns, adjacent land uses and availability of resources. Often a combination of management techniques are needed. This is called an **integrated vegetation management** (IVM) approach.

An IVM program should be followed when developing a control program for forestry and industrial sites. IVM utilizes a combination of methods to ensure that a successful control program is implemented. It is critical to know the growth habit of the target vegetation and to monitor site characteristics to determine when and how to treat. A long term strategy should be developed to minimize impact on people and the environment. These methods include:

- prevention (sanitation)
- cultural control
- mechanical control
- biological control
- chemical control

Regardless of methods used, all precautions to protect workers and minimize off-target movement must be taken. Weather conditions must be continually assessed during control to ensure chosen methods can be continued without environmental harm.

### Prevention (Sanitation)

**Prevention (Sanitation)**

Prevention is the first step in developing a successful vegetation management program. This would include:

- cleaning machinery before moving between locations to prevent the spread of weed seeds
- using machinery in areas of low infestation before moving to areas of high infestations
- controlling weeds in nearby ditches, fence lines, pathways and roads to reduce the source of re-infestation
- weeding or cultivating target sites regularly to ensure that weed seed production is interrupted
- use certified seed to prevent weed seed infestation

- physical barriers such as ground cover, sheeting and mulching to inhibit weed growth.

## Cultural Control

### Cultural Control

This method utilizes techniques that discourage or prevent weed growth. These methods would include:

- **Site preparation** to improve the site for seeding and planting. This would include clearing debris and controlling weeds prior to planting. This would improve planter access, create well spaced growing sites, remove competing vegetation, increase soil temperatures by opening up the area to the sun and reduce fire hazards.
- **Planting/encouraging species** to complement the area, stabilize the soil and improve aesthetics. An example of a complementary species would be blueberries in a power corridor. Blueberries will not interfere with power lines, will spread quickly, will compete with weed species and are of economic benefit.
- **Seeding after soil disturbance**. Bare ground is an invitation for weed seeds to germinate and spread. If you must have bare ground in areas such as power stations, use a thick layer of crushed rock to discourage weed germination.
- **Planting nurse or companion crops**. A fast growing crop is planted with the desired crop which will out-compete weeds while the desired crop is getting established. It is important that the companion crop can be easily controlled.
- **Increase plants ability to compete against weeds**. This can be accomplished by using good cultural practices such as optimum fertilizer rates and irrigation scheduling.

Using good cultural practices will ensure that desired crops are competitive with weeds. Choose plant species that grow well in the local environment and soil conditions. In forestry managers look to improve the survival, growth and form of the trees through the use of fertilization and pruning. This is known as **stand tending**. Stand tending uses three methods:

- **Brushing** removes or reduces vegetation that competes

with the crop trees for light, moisture and nutrients.

- **Crop tree release** promotes crop growth to a "free-to-grow" stage by managing vegetation that is overtopping or crowding crop trees.
- **Thinning** reduces the number of crop trees per hectare to allow adequate room to grow to improve diameter growth, form and health of the remaining trees.

## Mechanical Control

**Mechanical Control**

This method utilizes physical control of the weed to disrupt its life cycle. It's often used in areas where chemical control is not appropriate because of:

- environmental considerations such as water courses
- non target species that are present
- weeds that are too advanced or tall for chemical control
- public relations issues such as where burn-out is undesirable or proximity of residential areas/sites

**Mechanical controls include:**

A. Brush mowing

B. Hand slashing

C. Girdling

D. Tree trimming

E. Machine clearing

F. Burning

### A. Mechanical - Brush Mowing

Vehicles with cutter heads are used to mow down smaller trees and brush (less than about 10 cm in diameter). Heavy equip - ment such as crawler tractors, low ground pressure tractors, brush cutters, chipping equipment and mowing attachments are used. This method is useful for site preparation and conifer release (the selective control of non conifer species which will allow the conifers to grow and flourish). Mowing is used where:

- brush is too tall to spray with herbicides
- other methods are not appropriate
- there are few obstacles (rocks, fences, steep slopes)

- off target vegetation is susceptible to herbicides (gardens, planted trees, shelter belts and field crops)

Mowing is more expensive than herbicides but less expensive than hand slashing and trimming. There is also less chance of worker injury than with hand operated power saws. Often mowing is followed up with herbicides to reduce brush re-sprouting. Mowing of sprayed vegetation is also used where burn out may be offensive to the public.

**The negative impacts of mowing are:**

- removes non-target plants, thereby reducing plant competition, wildlife forage and opening up niches for unwanted vegetation
- does not promote colonization of cleared areas with compatible species and usually increases suckering of the non-compatible species
- on wet terrain, disturbance of soils by tires may cause erosion
- rotary blades create safety hazards by throwing rocks and debris long distances
- cut stumps may be hazardous to humans when hidden by low vegetation
- debris may cause a fire hazard
- promotes heavier re-growth of deciduous vegetation
- potential damage to machinery and operator if used on severely sloped or marshy areas

**B. Mechanical - Hand Slashing**

Hand slashing is the removal of brush species using hand operated power saws. Slashing is used where the:

- amount of brush to be controlled is small and mowing would be uneconomical
- trees are too large for mowing and too tall for herbicide application
- brush is inaccessible to mowers

- area is environmentally sensitive

Some of the equipment used for hand slashing are chainsaws, topping saws, chippers, pole pruners, handsaws, climbing gear, axes, brush cutters and wedges.

**The negative impacts of hand slashing are:**

- labor intensive
- increased incidents of worker injuries and accidents
- heavier re-growth (suckering) of deciduous vegetation

### C. Mechanical – Girdling

Girdling is the removal of a strip of bark from around the trunk of the tree. This method effectively controls woody weeds such as alder and birch.

### D. Mechanical - Machine Clearing

Vegetation can be completely cleared by blade, bucket or back-hoe equipment, either on tracks or rubber tires. Crawler tractor clearing is usually used to prepare sites for construction. It is quicker and less expensive than mowing and hand slashing.

It is important that machine clearing is not conducted within 30 meters of open water as it may cause sedimentation. Take note that there may also be legislated requirements regarding machinery's proximity to water. **Consult the New Brunswick Clean Water Act to determine the various requirements for equipment use near water.**

**Negative impacts of machine clearing are similar to brush mowing but also include:**

- environmental impacts
- increased chance of erosion on sloped soils
- not aesthetically pleasing to the public

### E. Mechanical - Tree Trimming

Tree trimming is the selective removal of branches of high value trees to prevent them from growing into unwanted places such as power lines. Trimming is the most expensive means of tree removal due to its very selective control.

It can be hazardous to workers who are trimming trees around power lines or working from an aerial bucket. Ensure that proper safety procedures are followed when working around power lines.

### F. Mechanical - Burning

Controlled burning may be used for site preparation to improve the site for planting. A controlled burning will prevent the build up of large amounts of cut brush that poses a uncontrolled fire hazard during drought conditions.

**Biological Control**

## Biological Control

This is the control of pests through the use of organisms including insect parasites and predators, birds and microorganisms and synthetic compounds that mimic naturally occurring com - pounds. Current use of biologicals in vegetation management is limited but researched is ongoing.

**Living organisms can control vegetation by:**

- grazing a site before weeds go to seed i.e. using sheep for conifer release
- releasing pest specific insects
- encouraging native or naturalized insects/diseases to control weeds

**The negative factors with biological control are:**

- biological research is expensive and long term
- control is a long term process
- control will not be 100% as organisms will not consume their entire food supply

## Chemical Control



Various herbicide methods are used to provide selective or complete control of vegetation. Herbicides are used to treat stumps left after mowing or slashing to reduce suckering. Herbicide use is the least expensive form of vegetation control and provides the least chance of worker injury. **All applicators in New Brunswick are required to have a Pesticide Applicator Certificate.**

Herbicides are a popular method of vegetation management because:

- control can be selective or non selective depending on which product/application technique is used
- selective use may improve habitat for wildlife and promote the growth of compatible species
- there is less re-sprouting of target species than with other brush control
- there is little or no disturbance of the soil
- long term control as compared to other methods

Improper use of herbicides can pose serious environmental problems. There are potential effects on fish or wildlife or contamination of domestic water if improper equipment or application techniques are used. There are also public relations issues surrounding concern about the use of pesticides in the environment. The use of herbicides is a privilege, not a guarantee. Applicators must be certified and conduct their business in a professional manner.

In order to select the most effective herbicide for a given situation, applicators must understand not only the biology of the plant but how the herbicide controls the plant. The following section discusses the various factors of herbicides.

## Types of Herbicides

**Herbicides are classified according to:**

- selectivity
- mode of action
- timing of application
- residual effectiveness

**Herbicide Selectivity:** herbicides control weeds selectively or non selectively. Selective herbicides only control the targeted weed species. Non-selective herbicides control all plants depending on the product chosen.

**Herbicide Mode of Action:** is the method by which the herbicide controls the targeted weed species.

- **Contact herbicides:** kill only the part of the plant that the herbicide comes into contact. There is relatively little movement of the herbicide within the plant. Contact herbicides are effective in controlling annuals but are not effective in controlling perennials as only the top portion of the plant is "burned off" while the underground root structure is not affected. An example of a contact herbicide is Gramoxone.
- **Systemic herbicides:** move (translocate) from the place of contact (above or below ground) throughout the plant. Effects may not show up for several days to several weeks although the plant has stopped growing. Too much herbicide on the leaves may kill the leaf cells too quickly and prevent translocation to the site of action in the plant. An example of a systemic herbicide is Vision.

**Herbicide Timing of Application:** herbicides are also classified according to when they are applied.

- **Pre-plant herbicides** are applied to the soil prior to seeding or transplanting and are usually incorporated into the soil.
- **Pre-emergent herbicides** are applied after seeding of the crop but prior to weed or crop emergence. Pre-emergence may be to prior to germination of either the weed or the crop.
- **Post-emergent herbicides** are applied after the crop and

the weeds have emerged. These herbicides also control established weed species.

**Herbicide Residual Effectiveness:** refers to how long the herbicide remains active in the soil to control weeds over time.

- **Residual herbicides** can remain active for several weeks to several years. Velpar is a residual herbicide.
- **Non-residual herbicides** are quickly broken down in the soil and will not affect weeds germinating after application. They are broken down by microorganisms, sunlight or chemical degradation. Vision is a non-residual herbicide.

### Special Considerations for Residual Herbicides

Residual herbicides remain in the soil for a long period of time. This makes them more susceptible for moving off site through leaching and erosion. Problems that can develop are:

- Damage to trees and shrubs when roots are either in or grow into the treatment area. A buffer zone between the application site and nearby vegetation should be listed on the label. If not, the buffer should be 1/2 times the height of the vegetation.
- Ground water can be contaminated if the treatment site is located in an area with a high water table and coarse gravelly soil.
- Certain desirable plant species will be suppressed by residual herbicides. This limits future use of the area therefore present use of the site must coincide with the length of time that the residual herbicide is active.
- Persistence can vary with product, rate, formulation, concentration, weather and soil conditions.
- Steep slopes should be avoided as this leads to erosion and runoff of the pesticide product. This can be a problem when looking at treatment areas next to roadsides and railways, brooks and ponds.
- When using a residual herbicide, you should develop a site specific plan to ensure no adverse impact to the environment. The site specific plan should include:
    - Soil type, structure, pH

- Proximity to water bodies
- Site drainage patterns
- Surrounding land ownership/use

## Factors Influencing Herbicide Effectiveness

## Factors Influencing Herbicide Effectiveness

There are external factors that must be considered when making decisions regarding effective herbicide application. Ensure that vegetation has been correctly identified before control measures are taken. The following factors can optimize the control of weed species.

- **Shape and Surface of Leaves:** The shape and surface of leaves influence how well herbicides stick to the surface so that it can be absorbed by the plant. Thin upright leaves and hairy or waxy plant surfaces make it difficult for the herbicide to make good contact with the leaf. Surfactants and additives can be added to the spray mix in order to increase the wetting ability of the spray to assist with leaf penetration. Do not add a surfactant if the label does not require it.
- **Weather Conditions:** high temperature, humidity, wind and rain will affect herbicide efficacy. High temperatures and humidity will cause phenoxy herbicides (i.e. Dycleer) to volatilize and drift from the target. Cool temperatures will decrease the rate of plant transpiration which will reduce the movement of systemic herbicides into and within the plant. Wind will cause drift and can move the herbicide off target. Rain may wash the herbicide off the plant before it can be absorbed. Some soil applied herbicides require rain or irrigation after application to carry the herbicide into the root zone.
- **Plant Growth Stage:** The young rapidly growing weed is more susceptible to herbicide control than later growth stages. Systemic herbicides have shorter distances to travel to reach all parts of a young plant. Once plants have reached the flowering stage they are much more resistant to herbicides. Perennial plants are more resistant to herbicides in the later growth stages except at the bud or early flowering stage. At this stage, nutrients are being

translocated down to the roots of the plant in preparation for winter survival. The herbicide will move with the food supply

- **Soil Type:** Soil type affects the rate of herbicides that must be used in order to achieve optimal control. Organic and clay soils bind herbicides to the soil particles which reduces the amount available for weed control. Sandy soils often require lower rates of herbicides because the herbicides are more available to plants. PH of the soil can also affect herbicide activity. Thoroughly reading the pesticide label will assist the applicator to apply the correct rate given the specific soil conditions.
- **Soil Moisture:** Warm moist soils are at their optimum condition for soil applied herbicides.
- **Cultivation:** Cultivating before a herbicide is applied can make the herbicide more or less effective. For instance, cultivating quackgrass several weeks prior to herbicide application will increase control. The long underground rhizomes are broken up and begin to sprout. This ensures that the herbicide will be translocated to the tips of the root system of the new plant. In other instances, breaking up the plant reduces control. Cultivation is usually not applicable to industrial or forestry scenarios except for nurseries and plantations.
- **Resistance:** The number of herbicide resistant plants has increased over the past decade. Resistance develops when the same herbicide or herbicides using the same control pathway are used over a period of time. Those weeds that were not controlled develop offspring that have the same resistant gene. Over time, those species with the resistant gene become the dominant species and will no longer be controlled. There are a number of steps that can be taken to slow down the development of resistance such as rotating different families of herbicides and following label rates. The under and over application of herbicides leads to resistance. Tank mixing different active ingredients may control the plant using different mechanisms of action that will also slow down the development of resistance.
- **Mowing:** If mowing has occurred then herbicide application must be delayed until sufficient suckering or re-growth has occurred.

**The following should be considered when selecting a herbicide program:**

- Treatment objectives (are you doing a site preparation or a brushing operation)
- Herbicide compatibility with the environment
- Timing of application (what season do you want to apply the herbicide)
- Efficacy (which product will work on the species in the treatment site)
- Herbicide costs
- Legal aspects
- Site characteristics
- Selectivity and crop tree resistance
- Practicality of the treatment
- Safety

## Weed Identification

## Weed Identification

The following is a list and description of weeds of significance to the eastern Canadian forestry and industrial sectors.

**Herbaceous Species**

**Herbaceous Species**

**Goldenrod**
***(Solidago spp.)***

**Goldenrod *(Solidago spp.)***

The Maritimes have 16 native goldenrod species that all flower in late summer. Goldenrod prefer dry open habitats and are often found in waste areas, railroads, roadsides and cut-overs. Characteristics of the species include simple and alternative leaves that may be entire or toothed, dull yellow flowers and a distinctive musky odour.

This plant is associated with poor soil conditions and can be controlled by:

- improving soil conditions
- cultivation
- selective herbicides

**Aster *(Aster spp.)***

**Aster**
***(Aster spp.)***

There are approximately 18 species of aster in the Maritimes with most having a perennial life cycle. Identification of asters is easier once the mature plants flower. Characteristics of the species are:

- asters mainly bloom mid-late summer and early fall
- flower heads range from white to deep purple, the disk is red, purple or yellow.
- leaves are alternate, simple and toothed

Like goldenrod, these plants thrive on poor soil conditions. Control measures are the same as for goldenrod.

**Eastern Bracken *(Pteridium aqilinum)***

**Eastern Bracken**
***(Pteridium aqilinum)***

Easten Bracken is probably the most common fern in Atlantic Canadian woodland areas. Eastern bracken is usually found in shaded areas and is spread by spores. The plant has ferns that arise singularly and fronds that are large and coarse.

Eastern Bracken is resistant to most herbicides and can be difficult to control. Contact your forestry specialist for control recommendations for your area.

**Fireweed *(Epilobium angustifolium)***

**Fireweed**
***(Epilobium angustifolium)***

Fireweed is a common weed in clear cut and burnt-over areas. This plant is sometimes confused with purple loosestrife. Fireweed is a tall perennial plant with showy pink-purple flowers. Fireweed seed produces a tuft of white hair which is distinctive when viewed from a distance (unlike purple loosestrife).

Fireweed is a pioneer species and does not generally cause long term problems.

## White Sweet Clover *(Melilotus alba)*

**White Sweet Clover *(Melilotus alba)***

White sweet clover is a biennial plant, reproducing from seed. This tall plant can reach heights of 3 metres and has white, frond-like flowers with very small leaves arranged as three leaflets. This plant is a member of the pea family and develops round or oval pods which contain 1-4 dark coloured seeds.

White sweet clover can be a problem along rail line crossroads and roadways as it grows very tall and restricts visibility for motorists. It is a prolific seeder and spreads rapidly along roadways. It can be very difficult to mow with hand held equipment as the stalks will wrap around blades/chains and jam the equipment. It prefers to grow in a gravelly soils and is a salt tolerant plant.

It can be controlled by selective broadleaf herbicides and its spread can be checked by mechanical mowings before it reaches the seed pod stage.

## Ragweed *(Ambrosia spp.)*

**Ragweed *(Ambrosia spp.)***

Ragweed is an annual plant which usually emerges along roadsides in mid to late June. This weed is usually 30-50 cm in height but may be considerably shorter. The leaves of ragweed are fern like in appearance and the plant may grow with a single stalk or may be bushy in appearance. The tiny green flowers of ragweed form on spikes. Ragweed is a prolific seed producer with one plant producing from 3000-62,000 seeds per year. Ragweed can cause serious health problems for humans due to its high production of pollen. One ragweed plant can produce 8 billion pollen grains in 5 hours and travel over 400 kilometres. This plant is very salt tolerant and is prolific on roadsides.

Mowing is not an effective control measure as ragweed will grow and seed below the cutter bar. Planting a competitive species or implementing a herbicide program will provide control.

**Coltsfoot (*Tussilago farfara)***

**Coltsfoot (*Tussilago farfara)***

Coltsfoot is an unusual perennial plant in that its flowers appear before its leaves, usually late April to early May. Its bright yellow flowers and seed heads are similar to dandelion. Coltsfoot leaves emerge in clumps and are green with a greyish wooly underside.

Coltsfoot can spread over 3 metres in one season by underground rhizomes and is extremely difficult to control. Consult your forestry or agricultural representative for specific control measures on this plant.

## Control of Herbaceous Species

**Control of Herbaceous Species**

Many of the herbaceous species that pose a problem to the forestry and industrial industries are perennials that reproduce from underground structures. This would require a control program that depletes the root reserves, out-competes the weed or uses a systemic herbicide. An ongoing mowing program would reduce the root reserves by forcing the plant to use its resources from its roots to produce its vegetative structures. This would require targeting mowing during the bud stage and may have to be done more than once a season. Complete control would be difficult to achieve using this measure. Another method would be to plant a competitive species.

A herbicide program using a selective systemic herbicide may provide excellent control. The following is a list of active ingredients that can be used for vegetation control. Please check labels for specific recommendations.

| | | |
|---|---|---|
| diuron | dicamba/2,4-D | amitrole |
| bromacil | chlorsulfuron | glyphosate |
| bromacil/diuron | triclopyr | clopyralid |
| 2,4-D | imazapyr | |

**Ensure you meet all the requirements under the Pesticides Control Act before using any of the above products. See Chapter 1 – Legislation for details.**

Woody Species

## Speckled Alder *(Alnus rugosa)*

**Speckled Alder *(Alnus rugosa)***

There are 30 species of alder but only three occur in the Maritimes. The most common is speckled alder (Alnus rugosa). Alders are pioneer species that occur in areas that are reverting back to forest. They can be found along roadsides, ditches and open areas. The following are characteristics of the species.

- Alternate oval shaped leaves that are a dull dark green, coarsely textured, slightly hairy (depending on species), uneven and sharply toothed edges.
- Bow shaped stems that are found in clumps that spread laterally from the base. They can reach a height of six meters. Older alders may have a 10 cm diameter but taper or branch to a smaller diameter. The exposed surface of cut stumps turn orange.
- Flowers hang from the ends of twigs in small bunches until spring. They develop into oval dark brown cones that may remain on the branch for more than one year.

Alders are nitrogren fixers which mean they can convert nitrogen from the atmosphere into nitrates. This can make alders a good choice for planting as a competitive species as they will improve the fertility of nutrient poor land. They also provide good wildlife stands for rabbits and birds.

## Red Osier Dogwood *(Cornus stolonifera)*

**Red Osier Dogwood *(Cornus stolonifera)***

The dogwood family includes over 50 different species of which 5 are found in the Maritimes. The red dogwood is a common weed. The wood is very hard but doesn't reach a commercially valuable size. The following are characteristics of the species.

- Leaves have five to seven pairs of prominent veins that follow the leaf shape. This is a distinct characteristic for the dogwoods. Leaves are opposite, dark green on top, lighter underneath and slightly fuzzy.
- The red dogwood seldom reaches three meters and has a bushy appearance. The bark is lime green in the summer

and red in the winter. The bark is dotted with small white oval markings.

- Small white flower clusters are flat topped, bloom in June and produce white-blue berries produced by September.

**Red-Berried Elder *(Sambucus pubens)***

## Red-Berried Elder *(Sambucus pubens)*

Two common elder species found in the Maritimes are common and red-berried elder. Elders are the only shrub that have opposite pinnate leaves (leaflets arranged along each side of a common stalk). The following are characteristics of the species.

- Leaves are opposite and pinnate with five to seven leaflets. The leaves are sharply toothed, dark green on top and light green with fuzz underneath.
- Stems are found in clusters that spread from the base and may reach a height of three meters. The bark is brown and covered with "warts".
- Oval or pyramid-shaped clusters of creamy-white flowers bloom in May. Brilliant red berries are produced in mid-July.

**Serviceberry *(Amelanchier spp.)***

## Serviceberry *(Amelanchier spp.)*

There are 20 species of Serviceberry. They are shrubs and trees are also known as shadbush, juneberry or saskatoonberry. The easiest way to identify serviceberry is that they are often the first shrub to bloom in the spring. The following are characteristics of the species.

- Leaves vary in shape with most being rounded at the base. They are alternate, toothed and can be as small as four cm and as big as 20 cm.
- Stems are light grey and streaked with dark vertical lines. The wood is hard, heavy, tough and close-grained. The heartwood is dark reddish-brown and the sapwood is pale. Thin winter twigs are coated with a white film.
- Flowers are white and produce edible fruit in July. Fruit are round, reddish-purple and topped with five small dried up flower parts.

## Willow *(Salix spp.)*

**Willow *(Salix spp.)***

Willows flower early in the spring which is the easiest time for identification because catkins (dry scaly unisexual spikes) are still present. Catkins do not droop as they do with other tree species. The following are characteristics of the species.

- Willows have long alternate narrow pointed leaves.
- Sizes range from knee-high shrubs to tall trees. Stems may grow singularly or in clumps. The wood is light colored and tough.
- Willows flower as fuzzy catkins in May or June.Tiny seeds are released, spread by the wind and can begin germination within hours of landing on the ground.
- Twigs are slender and yellowish with crescent shaped buds.

## Poplar *(Populus spp.)*

**Poplar *(Populus spp.)***

Poplars and aspens are also included in the willow family which flower very early in the spring. Aspen have smooth buds while poplar buds are finely hairy. The following are characteristics of the species.

- The flowers are surrounded by a deeply toothed or lobed bract.
- Catkins are produced in the early spring with the seed maturing before leaves fully expand.

## Maple *(Acer spp.)*

**Maple *(Acer spp.)***

Maples are one of the most abundant tree species in Canadian deciduous forests. The two most common species in Eastern Canada are sugar and red maple.

**Sugar Maple** *(Acer saccharum)* flowers from late April to early June. They have bark that is smooth and grey.

**Red Maple** *(Acer rubrum)* is often seen as a shrub in poorly drained or clear cut sites. The leaves are thick and leathery with serrated margins.

**Birch *(Betula spp.)***

**Birch *(Betula spp.)***

Birch has 50 species in the northern hemisphere with yellow and white birch being the most common in the Maritimes.

**Yellow Birch** *(Betula alleghaniensis)* has broad oval shaped pointed leaves. Stems are shiny brown with small white mark - ings that smell like wintergreen when broken. Birch is often a dominant species in deciduous forests.

**White Birch** *(Betula papyrifera)* has a variable leaf shape and bark color. Its'distinct papery white bark makes it easy to iden - tify. It is scattered in our forests but often germinates into a pure stand after a fire.

**Beech *(Fagus spp.)***

**Beech *(Fagus spp.)***

There are 10 species that can be found in the northern hemi - sphere with one species found in the Maritimes (F. grandifolia). The following are characteristics for this species.

- Leaves are toothed with points at the end of each vein.
- Fruit is a sharply three angled nut with one seed.
- Beech is severely affected by the Nectria beech canker.

**Kalmia *(Kalmia angustifolia)***

**Kalmia *(Kalmia angustifolia)***

Kalmia, also known as sheep laurel and lambkill, are shrubby type plants that are usually found as large infestations. This plants common name is derived from the fact that kalmia is toxic to sheep. The following are characteristics of the species.

- Flowers are showy and rose or pale pink in color and are arranged in clusters and flower from late May to early July.
- Leaves are opposite with in-rolled margins and powdery-white under sides.
- The plant has an interesting appearance in that the flowers grow along the stalk, not at the top.

## Brambles

### Brambles

Brambles include red raspberry *(Rugus idaeus)* and smooth blackberry *(Rubus canadensis)*. Both of these species are common on roadsides, deforested land, rocky ground, clearings and on the edges of woods.

**Red Raspberry** has canes that range from bristly to nearly smooth. The leaves are divided into 3-5 leaflets, which are white beneath. Raspberry flowers in July as small inconspicuous clusters and produces edible fruit.

**Smooth blackberry** has canes that are smooth or have only scattered, straight prickles. The leaves are divided into five leaflets, the terminal one on a long stalk. It flowers in June and July with ten to twenty showy flowers and produces edible fruit.

Brambles represent a species with conflicting perceptions. Although the general public view brambles as a food source that derives economic benefit, brambles are a serious weed species in the forestry and industrial sectors.

## Control of Woody Species

### Control of Woody Species

One of the problems with woody species in forestry and industrial areas is that they sucker after they are cut. Suckering occurs when the parent stem of a shrub or tree is cut and numerous small stems grow from the parent root system. In many cases, cutting encourages suckering and growth.

A program using mechanical control methods must be done on a regular basis to ensure that species that spread through suckering are kept controlled. An integrated management program using a variety of methods ensures that effective long term control is achieved. A foliar or basal bark spray program often controls the entire plant because the herbicide is moved throughout, killing all parts of the plant. Suckering does not occur.

The following is an overview of active ingredients that can be used for vegetation control. Check labels for specific recom - mendations.

| | | |
|---|---|---|
| 2,4-D | dicamba/2,4-D | fosamine ammomium |
| dichlorprop/2,4-D | picloram/2,4-D | imazpyr |
| triclopyr | glyphosate | |

**Ensure you meet all the requirements under the Pesticides Control Act before using any of the above products. See Chapter 1 – Legislation for details.**

## Review Questions –
## Chapter 2 / Vegetation Management

1. List the factors that influence herbicide activity.

2. Define a contact herbicide.

3. List four vegetation management techniques.

4. What is integrated vegetation management?

5. What are the environmental considerations when using residual herbicides?

# 3

# Insect Management

## Introduction

**Insects** are a group of animals that have 6 legs, an exterior skeleton and three body sections (head, thorax and abdomen) in the adult stage. Many adults have wings.

**Mites** are members of a group of animals that include spiders and ticks. They also have an exterior skeleton but are extremely small (0.1 – 1mm in length), are wingless, generally have eight legs and one main body section.

There are over 50,000 species of insects and mites in Canada. Most of these are considered to be beneficials that help to control insect pests or contribute to forestry production. These beneficials should be protected because of their importance to sound forestry practices. They include lady beetles, ants, bees, click beetles and many more.

There are only a few insect species that cause significant economic damage, especially within the forestry community. Insects that become pests can be native or introduced species.

Often **native insects** that become pests are present in low numbers until conditions are right for the populations to expand rapidly. In such cases, they may multiply so fast that natural predators such as birds, predator insects and diseases cannot contain the population levels. After several years their natural controls increase and reduce the pest population to low levels once again. The increase and decrease of outbreak are called cyclic attacks.

**Introduced species** may expand rapidly because they have been transported from other geographical areas into new locations that may not have their natural enemies to contain them.

The ***General Pesticide Safety Manual*** gives a description of the insect body characteristics, mouthparts, reproduction and development and the cycle of metamorphosis. This information is very valuable in understanding how insects reproduce, develop and at what stages they are the most likely to do damage. This information is found in Chapter 24, pages 1-10 of ***The General Pesticide Safety Manual.***

## Goals for the Chapter

- Be familiar with the stages of insect growth.
- Know the general categories for insect pests.
- Be familiar with the factors influencing insecticide efficacy.
- Review the common insect pests of forestry/industrial sectors.

## Insect Life Cycles

## Insect Life Cycles

An insect's life cycle consists of a series of events from egg through to adult. Knowledge of this development and reproduction can be used to apply control measures at times when pest species are most susceptible and is essential for the selection of effective control procedures.

Most insect reproduction results from sexual fertilization. Some exceptions exist whereby reproduction can occur without mating (aphids). A few insects give birth to live young (aphids); however in most cases the life cycle begins with the egg.

Eggs may be deposited individually or in masses in the soil or on trees and plants, animals or structures. Temperature, humidity and light conditions influence the time and success of the hatch. When an insect hatches from the egg, it begins to feed and grow until its skin restricts its growth. The animal then sheds its skin – called molting- and a new skin is formed. The last growth stage is the reproductive adult.

The common stages of insect growth are:

- egg
- larva
- nymph
- pupa
- adult

As mentioned above, eggs may be deposited individually or in clumps. **Larva** are soft bodied in appearance (caterpillars, loopers, grubs) and look nothing like the adult. **Nymphs** are similar in appearance to the adult but are wingless and lack reproductive organs. **Pupa** is a non-feeding stage during which a complete change of shape occurs. The **adult** insect is reproductive and winged.

The most effective time for control is during the early part of development – young nymph or larva. As the insect gets older and larger it inflicts more damage and is more difficult to control.

## Insect Damage

**Insect Damage**

Up to this point we have looked at insect biology. The following paragraphs will group insect pests according to the damage they inflict.

Insect pests can usually be placed in one of six general categories for forestry. These include woody tissue feeders, defoliators, sucking insects, cone and seed insects, gall insects and root pests.

**Woody Tissue Feeders:** These insect pests, otherwise known as stem/stalk borers, cause damage by weakening the plant, preventing adequate movement of water and nutrients between the parts of the plant and damaging valuable lumber. The most damaging woody tissue feeder are bark beetles that cause very high losses to mature and over mature stands. These insects bore through the bark of trees and chew out tunnels in which they lay their eggs. Some trees try to "drown" out the beetles

**Woody Tissue Feeders**

with a heavy flow of pitch that is evident on the bark. Bark beetles can also introduce a fungus that penetrates the inner bark and sapwood, cutting off the flow of nutrients.

**Management techniques for woody tissue feeders are:**

- schedule harvesting to remove stand before it over matures
- proper sanitation ie. prompt pickup of cut trees, clean logging, removal of high stumps and materials along roads
- use of trap trees
- injecting systemic insecticides in trap trees.

## Defoliators

**Defoliators:** One of the more obvious forms of insect damage is the eating of leaf tissue. Most defoliators are native species and their damage is cyclical. Defoliators can cause massive damage to forest ecosystems and may reach epidemic proportions. Defoliators will do the majority of damage during the larval stage. Examples of defoliators are spruce budworm and hemlock looper.

Control of defoliators can be very difficult. Management techniques can include:

- early detection
- protection of the conifer stand until infestation has declined
- use of an insecticide early in the outbreak

## Cone and Seed Insects

**Cone and Seed Insects:** As the name implies, these insects develop and feed in the interior of seed and fruit of plants and trees. These insects cause the majority of damage in the larval stage where they feed on the seed cones, reducing seed production. Examples of internal feeders are seed chalcids and cone worms.

Management techniques for cone and seed insects center around insecticide applications to penetrate into the cones and seeds. They are often applied with air blast sprayers.

## Sucking Insects

**Sucking Insects:** These insects have adapted mouthparts that are able to suck the juices from plants. Plant damage includes curling and stunting of leaves and stems, chlorotic mottling, needle drop and wilt caused by reduced water movement and dead areas caused by the injection of toxins by the pest during feeding. Life cycles of most sucking insects are complex and require alternate hosts for completion of their life cycle. Examples of sucking insects are aphids and scales.

Management of sucking insects is very difficult.

**Gall Insects:** There are many insects that form galls and in some situations these galls can become part of an IPM program for weed species. In forestry however gall species are pests in spruce. Six generations are usually required to complete the two- year life cycle. Larvae bore into the tree shoots and form cells. The gall is formed when tissue swells around the larval cells. Examples of gall insects are the spruce gall midge and the spruce gall agelgid.

## Gall Insects

**Root Feeders:** Plant roots are host to many underground feeding insects with many of these being beneficials. Damage occurs when insect pests feed directly on root tissue in populations to cause stress to the tree. Root feeders often do the most damage in tree nurseries when saplings are tender and vulnerable. Examples of root feeders are white grubs and weevils.

## Root Feeders

## Insect Management in Forestry

Insect management strategies include various integrated pest management techniques. These would include:

- attempted eradication
- suppression of an insect epidemic
- protection of trees while an epidemic runs its course
- harvest of damaged trees
- use of trap trees to prevent infestation of an entire stand by sacrificing a few

These pest management techniques may involve the use of biologicals, cultural, mechanical and chemical methods of control. Pesticides for insect management will include insecticides, miticides and nematicides.

Insect Management in Forestry

## Insecticides and Miticides

The use of insecticides and miticides are only one method of pest control and should be used in a way that minimizes the negative impact on beneficial insects and the environment. Insecticides and mitacides are often described according to how they work (mode of action). The following is a list of pesticide categories.

- **Contact pesticides** must come in contact with the pest to be effective. They can be applied to the pest or on vegetation that the pest touches. Some contact insecticides have a residual effect and can kill insects for some time after they are applied.
- **Systemic pesticides** enter plants/trees and flow in the sap. Insects that suck on the sap are killed. Some pesticide products are both contact and systemic.
- **Suffocating insecticides** clog the breathing system of the pest and may also effect egg survival. They are usually in an oil formulation.
- **Growth regulators** act like the organism's own hormones. They affect normal development and the pest dies before it becomes an adult or before it can reproduce.
- **Attractants** are chemicals which may attract female insects for egg laying or attract male insects to artificial female traps.
- **Microbial pesticides** contain microbes (tiny organisms such as bacteria). They are sprayed on trees and are poisonous only to selective insects. After they are eaten, the microbe, or a poison the microbe produces kills the insect.
- **Fumigants** are pesticides that work in a gaseous form. They may be used to control pests in enclosed spaces or in soil.
- **Desiccants** are inert powders that kill crawling insects by lacerating their bodies thereby drying them out.
- **Sticky pastes** are placed on traps to attract pests. Attractants or colours are often used to lure the insect to the trap where they are physically trapped.

## Factors Influencing Insecticide Efficacy



There are external factors that must be considered when mak - ing decisions regarding effective insecticide application. It can not be overstated that the pest is correctly identified before any control measures take place. The following factors can optimize the control of identified insect pests.

- **Timing of Application:** Insects should be at the optimum growth stage for effective control. For many insects this is during the early larval or nymphal stages. The older and larger the insect the less likely it is to achieve effective control. The eggs and pupal stages are not generally effected by most pesticide applications so timing of control measures must fit into the susceptible growth stages. Control of the early life stages of insects is effective in preventing or suppressing current feeding damage. Control of the adult stage reduces subsequent generation numbers.
- **Weather Conditions:** Temperature, humidity and rain can alter the effectiveness of pesticides directly as well as effect the activity of the pest and it's susceptibility to pesticides. The pesticide label will contain statements regarding use for specific weather conditions. Read the pesticide label thoroughly.

- **Resistance:** Heavy reliance on chemical control methods has led to the development of pesticide resistance in insects. A pest that is resistant to one product may be resistant to other products with a similar mode of action. If a pesticide is not working the insect pest may have developed a resistance to it. The applicator can slow the development of resistance to a chemical pesticide by:

    - Using a non-chemical control method
    - Using pesticides only when required
    - Alternating pesticides from different chemical families
    - Developing an integrated pest management strategy

**The following is a list and description of insect pests of significance to Eastern Canadian Forests. The information has been taken directly from Forestry Canada fact sheets. Forestry specialists should be consulted regarding specific**

**pesticide recommendations and for other control measures. A list of resource agencies is listed in the back of this manual to assist applicators.**

## Spruce Budworm *(Choristoneura fumiferana)*

### Spruce Budworm *(Choristoneura fumiferana)*

The spruce budworm is one of the most destructive insects of coniferous species. In the Atlantic region it is a primary pest for balsam fir but it also attacks blue spruce, white spruce, red spruce and hemlock.

During outbreaks the larvae may destroy most or all of the new foliage and sometimes all the buds and shoots. Trees will put out new growth the next year and will recover unless the attack is severe for three or more years, in which case, many balsam fir trees may be stunted, have dead tops or have died completely. Small trees are seldom killed unless growing under large trees.

#### Life History

The adult is a dull, grayish-brown moth about 16mm long. In the last half of July, the adults mate and the females lay their eggs on the needles of the host tree in groups of 15 to 50, in rows which overlap each other . The eggs are light green and hatch in about ten days. The young larvae crawl into the crevices on the twigs and branches where they spin a small, silken case, or hibernaculum, in which they remain dormant until spring. About the time the buds begin to swell, the larvae emerge from their cases and start feeding, mining the needled or buds. When fully grown (mid to end of June) the caterpillar can be found in a thin web on the foliage; it is about 25mm long and pale brown with light spots. It transforms into a brown pupa within the web and about 10 days later the moth emerges to lay the eggs for the next generation.

#### Control

Spraying the trees with an insecticide can control the spruce budworm. It is desirable to kill the larvae before they cause noticeable defoliation. This is not easy because the small larvae feed mostly inside the buds and shoots where they are protect - ed from insecticides. Therefore timing of the insecticide appli - cation is critical. Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being controlled.

**Yellowheaded Spruce Sawfly** *(Pikonema alaskensis (Roh.))*

The yellowheaded spruce sawfly occurs in many parts of North America. It feeds on white, red, black, Norway, Colorado blue, and Engelmann spruces. The young larvae feed only on the new or current year 's foliage, but when they are almost full-grown, they will feed on older needles. Young trees growing in open areas and in plantations and hedges are most severely attacked. Persistent infestations will hinder growth development and greatly affect tree appearance. Trees may even be killed outright after two years or more of severe defoliation, especially when the sawfly outbreak coincides with drought periods even of short duration. Damaging outbreaks seldom occur in stands with a closed canopy.

**Life History**

The insect over winters in the larval stage within a dark brown capsule-shaped cocoon in the ground. Pupation occurs after the ground warms in the spring and adults emerge early in June. The adult is a four-winged fly about 12 mm long. The female lays its eggs singly in shallow slits made by its ovipositor near the base of the new needles or in the shoot itself, when the shoot is about 25 mm long. The eggs hatch about 10 days later and the young larvae start feeding in colonies on the new needles. The larvae become full-grown about mid-July when they drop from the trees, crawl into the ground, and spin their cocoons. The mature larva is about 20 mm long with a chestnut-brown head and dark green body with fine grayish strips on the back and sides.

**Control**

Parasites, predators and disease are important factors in regulating the yellowheaded spruce sawfly. Often, however, they are inadequate to protect trees and control measures must be used. The larvae are difficult to detect at first; any may cause considerable defoliation before being noticed. Spruce trees should therefore be watched closely for the appearance of small larvae from the middle of June until early August. If only a few colonies are present, the shoots bearing the larvae may be cut off and destroyed. On small, infested ornamentals, a vigorous shaking will likely dislodge the larvae which can then be destroyed on the ground. If larvae are numerous, the trees should be sprayed with an insecticide before the larvae cause serious defoliation, usually about 10 days after shedding of the

bud caps. Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being controlled.

## Eastern Hemlock Looper

*(Lambdina fiscellaria fis - cellaria (Guen.))*

**Eastern Hemlock Looper**
**(***Lambdina fiscellaria fiscellaria (Guen.))*

The eastern hemlock looper is found throughout most of the range of hemlock and balsam fir in North America. In Eastern Canada, it is an important pest in mature and over-mature for - est stand in which these hosts predominate. A peculiar feature of looper epidemics is their link with specific conditions of the environment, especially evident in the fact that most outbreaks have been recorded in fir stands located on islands or in regions bordering lakes and rivers. The insect is of particular concern in Newfoundland where in association with two other serious for- est pests, balsam woolly aphid and spruce budworm, it threat - ens a large portion of that province's chief pulpwood species. Large epidemics have also developed in coastal regions of Quebec. Severe but smaller infestations also occur periodical - ly in many areas throughout Prince Edward Island and Nova Scotia. Although mortality may not directly result from these infestations, there is a significant decrease in tree growth and vigor making the stands more vulnerable to other insect and disease attacks.

Hemlock looper outbreaks flare up suddenly and extensive feeding can kill the trees in only one year . The larvae normal- ly feed on fir and hemlock, but they will also attack many other conifers and a wide variety of hardwoods during heavy infesta- tions. Infestations may last up to 6 years, but severe outbreaks generally do not persist longer than 3 years in one area. They seldom end gradually but are typically marked by a sudden col- lapse in population from one year to the next.

**Life History**

The adults start emerging from cocoons early in September and are active until mid-October. The front wings of the creamy tan to grey moths are marked with two transverse, wavy, narrow lines; the hind wings have a single line. Eggs are laid individ - ually or in small groups of two or three on the branches, twigs, and tree trunks where they overwinter. They hatch in mid-June

and the larvae migrate to developing foliage. The larvae feed wastefully and needles are rarely entirely consumed. Because the damaged needles dry out and turn brown before dropping, browning of foliage is a noticeable feature of a hemlock looper outbreak from mid-July to mid-August. The young caterpillars are dark grey with black transverse bands; older larvae, about 32 mm long when full-grown, are yellow to dark brown with both head and body speckled with black. Pupation takes place during August either on the host tree or within the ground debris.

**Control**

Consult your forestry specialist for specific control of this insect pest. Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being controlled.

**Tent Caterpillars (***Malacosoma disstria Hbn.)*

**Tent Caterpillars** *(Malacosoma disstria Hbn.)*

Two species of tent caterpillars occur in the Maritime Provinces. The **forest tent caterpillar** feeds on poplar, oak, apple, and many other kinds of trees. The poplar known as trembling aspen is preferred, and large areas of forests containing this tree are often completely stripped. Because these caterpillars are early-season feeders, a second, reduced crop of leaves will be produced. Repeated defoliation over an extended period of 3 to 4 years, although they will not kill trees directly, will weaken and make them vulnerable to wood boring insects and diseases. Forest tent caterpillar infestations can pose a direct threat to local economies if they persist for a number of years in tourists regions, where campers remember them from a ruined picnic or a bad camping experience. Because of their tendency to migrate in large numbers in search of new foliage or of places suitable for spinning cocoons, they will from time to time create a sense of panic in inhabited areas close to poplar woods, as migrating larvae may literally cover the sides of buildings. During severe epidemics they have been know to stop cars and trains, because the roadway and the rails become slippery from crushed caterpillars.

The **eastern tent caterpillar** feeds chiefly on wild cherry and apple and is the only species which forms a “tent”.

**Life History**

The eggs are laid in masses of 100 to 350, each mass encircling a twig. The mass is coated with a dark glue-like substance. The eggs hatch in late April or early May, about the time the buds of aspen begin to burst. The larvae (caterpillars) feed in colonies and when not feeding they congregate on the tree trunks or branches. The full-grown caterpillar is about 50 mm long and is black with a conspicuous row of irregular cream-colored spots along the back and many bluish markings on the sides. The body is sparsely covered with light brown hairs. The cocoon is usually spun within a curled leaf, and is composed of several layers of yellowish white silk. The adults generally emerge between 1 July and 10 August. After mating, the females lay their eggs, which remain on the trees over winter . The adults have a wing expanse of about 30 mm. They are buff brown with two darker oblique lines near the middle of the forewings.

**Control**

Consult your forestry specialist for specific control of this insect pest. Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being controlled.

## Balsam Fir Sawfly

*(Neodiprion abietis (Harr.))*

**Balsam Fir Sawfly** *(Neodiprion abietis (Harr.))*

The balsam fir sawfly,is a native species with a wide distribu - tion in Canada and the United States. Its preferred host is bal - sam fir but it may feed on spruce also. Injury is caused by the larvae feeding on the mature foliage. Prolonged severe infesta- tions can kill trees. However, the trees are usually not killed but radial growth is reduced and the trees may be weakened mak - ing them more subject to attack by other organisms.

**Life History**

The insect overwinters in the egg stage and hatches in June. The larvae, which feed in colonies on the old needles, complete their development in late August. The head is black and the body is dull green, marked with darker longitudinal stripes

(Figure). After the last molt, when the larvae are about 20 mm long, the color fades considerably. At this time, they spin reddish brown cocoons among the needles on the twigs and in the litter on the ground. The adults emerge in early September and, soon afterward, the female lays her eggs in slits in the needles with her sawlike ovipositor.

**Control**

Spraying with an insecticide can kill the balsam fir sawfly . Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being controlled.

**Whitemarked Tussock Moth** *(Orgyia leucostigma (J.E.Smith))*

**Whitemarked Tussock Moth** *(Orgyia leucostigma (J.E.Smith))*

This native insect occurs periodically in large numbers. Primarily it is a pest of broad-leaved trees, but, when numbers are high, it also attacks evergreen species such as fir, spruce, and larch, and may cause severe damage to Christmas trees. Its food preferences may vary from time to time and in different places. Sometimes when trees are severely defoliated the caterpillars migrate to gardens or fruit trees and feed on almost every green crop, often invading summer residences in the process of migrating.

Moderate to severe infestation of this defoliator has occurred in the past over extensive areas exceeding 500,000 hectares (1,235,000 acres). In New Brunswick it have been found mainly in Westmorland and Albert counties, while in Nova Scotia the infested counties have been Cumberland, Colchester, Lunenburg, Hants and Halifax. In both provinces, defoliation is most evident on balsam fir, tamarack, and hardwoods, but field crops can also be affected.

**Life History**

The caterpillar is characterized by a red head, two long black tufts of hair on each side of the head and one near its hind end, and four greyish brush-like tufts and two bright red spots on its back.

The eggs hatch in late June or early July. The caterpillars feed for about 6 weeks growing to about 38 mm long. They spin loose grey cocoons within which they transform to pupae. Greyish moths emerge about 2 weeks later. The males are winged and the females are wingless. The female lays its eggs on or near the cocoon. The insect overwinters as an egg on branches, crevices of buildings, or wherever the fully grown caterpillar crawled to spin its cocoon.

**Control**

Tussock moth outbreaks normally last from 2 to 4 years and are usually brought under control by natural factors, mainly by a virus-induced disease in the caterpillars. However, to prevent serious damage, it is occasionally necessary to initiate control procedures in Christmas tree plantations and on certain ornamentals as soon as an infestation is detected and before the caterpillars become too large. Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being controlled.

**Balsam Twig Aphid**
**(***Mindarus abietinus(Kock))*

**Balsam Twig Aphid** *(Mindarus abietinus (Kock))*

The balsam twig aphid feeds on the new shoots and needles of balsam fir causing the ends of the shoots to twist and the needles to curl. Severe infestations give the foliage a ruffled appearance. Trees growing in the open are more susceptible to attack than those in closed stands. Severe infestations occur every 4 or 5 years in the Maritimes and become obvious in late June when many fir shoots are covered with a sticky "woolly" substance. The insect is usually of little economic importance as it seldom damages forest trees. It does, however, sometimes greatly lower the quality of Christmas trees.

**Life History**

The insect has three and sometimes four generations between early May and mid-June; throughout the rest of the year, it is in the egg stage. The nymphs of the first generation, developing from the overwintering eggs, are small (2 mm long) and wingless. They feed around the bud, mostly on the old needles, and do little or no damage. They occur in small numbers and are not often noticed. However, each adult produces 40 to 60 offspring (nymphs) mostly in early June.

The second and third generation aphids suck the juice from the

new needles and cause permanent deformation: the second is the peak generation. The young aphids secrete masses of waxy wool and large quantities of 'honey-dew'(Fib. B) which makes the shoot 'woolly' and sticky. The aphids mature in the second half of June as winged but wool-free adults about 3 mm long. After flying to other balsam fir trees, each adult produces about 10 living young.
The fourth generation consists of males and females. They are minute (1 mm or smaller), wingless, and lightly 'woolly'. They conceal themselves in the shoots, feed lightly, and become adults about 1 week after birth. Each female lays one or two black eggs around the buds and covers them with white wax scales. These eggs hatch in May the next year.

**Control**

Consult your forestry specialist for specific control of this insect pest. Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being controlled.

**Balsam Shootboring Sawfly** *(Pleroneura brunneicornis)*

## Balsam Shootboring Sawfly (*Pleroneura brunneicornis)*

The balsam shootboring sawfly has been reported from Alberta to Nova Scotia and south of the Great Lakes. The larvae bore into and kill the new shoots of balsam fir, causing damage similar to that caused by late spring frost. Although damage is often conspicuous, no associated tree mortality has been reported.

**Life Habitats and History**

The adults emerge in the spring and eggs are inserted singly into the tightly packed needle clusters shortly after the bud scales have dropped. Feeding larvae have been found burrowing into shoots from about mid-May to early July. The whitish larva, about 6 mm long when full grown, drops to the ground and spins a cocoon, inside which it overwinters as either a larva or a pupa. In Ontario it appears that this insect spends full year in a cocoon in the ground, since feeding larvae are abundant only every second year in any one locality.

**Control**

Control measurers have not been required for the balsam shoot-boring sawfly. However, in the event that they become neces - sary, a systemic type of insecticide would perhaps be most appropriate, since the larvae are concealed feeders. Read the pesticide label thoroughly before applying – use products according to label directions for the specific pests being con - trolled.

## Review Questions –
## Chapter 3 / Insect Management

1. What are the common stages of insect growth?

2. What stage(s) are the most susceptible for control insect pests?

3. Defoliators do the majority of damage in the larval stage.
   True False

4. Contact pesticides must:
   a) Come in contact with pest to be effective.
   b) Come in contact with tree to be effective
   c) Come in contact with the leaves to be effective
   d) Come in contact with the pest or on the vegetation that the pest is in contact with.
   e) A and d.

5. Growth regulators act as the organism's own hormones.
   True False

# 4 Disease Management

**Introduction**

Controlling plant diseases is as difficult as controlling animal diseases. Curing a disease is rare so the emphasis must be put on preventing the disease or minimizing its occurrence.

A plant disease is any harmful condition that alters a plant's growth, appearance or function. Diseases are caused by microorganisms (**pathogens**). Diseases caused by microorganisms are called **infectious diseases**. Pathogens include fungi, bacteria, viruses and nematodes. They are spread by:

- weather such as wind and rain, dust storms
- insects, snails, slugs and earthworms
- birds and people
- contaminated soil, equipment and tools
- nursery grafts and vegetative propagation
- infected seed
- irrigation water

Plant pathogens are parasites that live and feed on the host plant. In order for a disease to develop, a pathogen must be present, the host plant must be susceptible and the environmental conditions must be favorable.

Environmental stress also causes disease like symptoms. It is important to note similar symptoms may also be caused by insect or herbicide damage; therefore correct identification of the cause of the symptoms is necessary for effective diagnosis

and treatment. Pesticide applications can assist with disease management by decreasing the presence of some diseases and protect host plants from the risk of infection.

## Environmental Stress

### Environmental Stress

Unfavorable environmental conditions which stress plants and cause abnormal growth or disease-like symptoms include extremes of light, temperature, water or nutrients. Plants weakened by environmental stress (sometimes called non-infectious disease) are more likely to be infected so recognizing stress factors will help to prevent invasion by infectious diseases. Examples of stresses that cause disease symptoms include:

- Damage from frost, snow or ice
- Prolonged flooding on the forest floor
- Drought
- Nutrient deficiencies or excesses

Disease caused by environmental stress cannot be spread like infectious diseases.

## Goals for the Chapter

Understand the effects of disease on forests.

- Be familiar with common disease organisms.
- Know how fungicides/bactericides/nematicides work.
- Review common diseases that may impact forests.

## Types of Microorganisms

### Types of Microorganisms

**Fungi** are the largest group of organisms that cause plant diseases. Fungi feed on living or decaying organisms. Fungi include molds, mushrooms, and rusts. Most fungi reproduce by tiny spores. When these spores germinate, they usually produce threadlike filaments that can infest the host, absorb nutrients, and give off toxins that cause diseases symptoms. Movement of infected plants, plant parts and soil can also spread the fungus.

**Disease symptoms caused by fungi include:**

- cankers
- galls
- leaf spots
- rots
- rusts
- wilts

The life cycles of many fungi follow a similar sequence. The following is a typical example of the sequence:

- The fungi stay on a diseased leaf over winter . As the weather becomes warmer in spring, the fungus becomes active and produces spores. The spores are released into the environment and are moved by wind and water. These spores land on healthy leaves of a plant. If environmental conditions are poor for germination, the spores may die, be washed off by rain, or remain dormant.
- If environmental conditions are good, the fungal spores will germinate. The fungal spore is most vulnerable to fungicides just after germination. Infection begins when the fungus enters plant tissues. Inside the plant the fungus is protected and difficult to control. A systemic fungicide may control the disease if applied before the infection is too severe. When the plant responds to an infection by growing abnormally, it is said to be diseased. Some disease symptoms that may be caused by fungi include cankers, dieback, galls, leaf spots, rots, rusts and wilts.

**Bacteria** are one-celled organisms that can only be seen with a microscope. Bacteria can cause major plant diseases. They usually enter a plant through natural openings or wounds. Under favorable conditions, bacteria reproduce very quickly , using the plant as a source of food. Bacteria are spread by wind and rain or by contact with animals or equipment. Some blights, galls and rots are caused by bacteria.

**Viruses** are sub-cellular particles that can only grow within host cells. They cannot be seen with an ordinary microscope. Viruses cause diseases that often reduce plant vigor and crop yields. Viruses reproduce only when they are in living cells. Viruses can be spread by mechanical means (i.e. during pruning or harvesting), in propagation material, (seeds, tubers, and other plant parts) or by vectors (i.e. insects, mite, nematodes, fungi).

Mosaics, ringspot and leaf roll are examples of diseases caused by viruses. No pesticides are available to control viruses directly but may be used to control virus vectors.

**Nematodes** are small thread-like worms which may feed on plant roots, stems and leaves. They can affect the movement of water and nutrients in a plant. They also create wounds that may allow fungi or bacteria to enter. Nematodes multiply by producing eggs. Symptoms that may be caused by nematodes are:

- wilting
- stunting
- lack of vigor
- growth deformities

## Approaches to Disease Management

## Approaches to Disease Management

The following three conditions must be present for a infections disease to develop:

- a disease causing organism (pathogen)
- a host susceptible to the disease
- an environment favorable to the disease organisms and/or unfavorable to the host

Taking away or changing any one of these three conditions will control the disease. For example, a disease problem can be prevented by keeping the organisms out of an area, using strains of plants that are resistant or not affected by the disease, reducing the population of disease causing organisms, or by manipulating the environment to favor the host, but not the disease organism.

Diseases are responsible for significant timber loss in forestry through a reduction in growth and seed production or destruction of susceptible species. The best approach to disease management is prevention. Foresters need to implement strategies to prevent unacceptable damage levels in the future. Good management practices would include:

- selecting disease tolerant species
- site preparation
- stump and root extraction
- harvest scheduling
- pruning and spacing operations

Pesticide use for disease management is not the first line of defense. Cultural and manual methods of disease control are favored. However, when pesticides are required it is important to understand how they are used and the diseases they control.

## Chemical Control

Chemical Control

Pesticide products used to control diseases are known as **fungicides, bactericides and nematicides**. These products are often described according to how they work (mode of action). Fungicides are used to prevent or eradicate diseases caused by fungi. Bactericides are used to control bacteria. Nematicides are used to control nematodes that help to spread disease.

### Fungicides

Fungicides

**Protectant fungicides** provide a protective film of fungicide on or around the host to prevent fungal spores from germinating. Protectant fungicides must be applied before the fungi reach the infective stage. After the plant is infected the fungicide normally will not kill the fungi inside the plant but it can protect the plant from further infection. New plant growth that appears after treatment is not protected: therefore, re-application is required. Protectants can be applied to seed, foliage, flowers, fruit or to roots. Most fungicides used in control programs are protectant fungicides.

**Eradicant fungicides** kill fungal organisms that have infected, but have not become well established within the plant. Eradicant fungicides have limited value for fungi that are well established within plants. Only a few fungicides are eradicants.

**Systemic fungicides** are not common. They are absorbed by plants and move within them. They may act as protectants, eradicants or both. Once inside the plant, systemics move to new areas of plant growth.

**Factors Influencing Fungicide Efficacy**

## Factors Influencing Fungicide Efficacy

The following is a list of factors affecting how well fungicides will work. It is essential that the disease be correctly identified before any treatment measures take place.

- **Timing of Application:** To be effective, the fungicide should control the fungus before or during the infection period.
- **Fungus Life Cycle and Weather:** The frequency of applications varies depending on the type of fungus, the fungicide, and the weather. If the fungus has a short life cycle and there are good conditions for its growth it can have many infection periods and many applications may be needed. Rain, rate of plant growth, and type of fungicide also affect the frequency of treatments. If the fungicide is washed off, if new leaves grow or if the fungicide breaks down quickly, applications may need to be repeated. Read the pesticide label thoroughly to understand how weather conditions and fungus life cycle will be affected by the product.

- **Resistance:** Disease organisms are resistant to certain fungicides or groups of fungicides. They may develop resistance after repeated applications of the same fungicide.

### Bactericides



Bactericides kill bacteria on contact and act as a protectant barrier. Timing of application, the amount of bacteria present and the weather will affect the efficacy of the product.

### Nematicides



Nematicides are applied as granular or liquid formulations and control nematodes as either contact or systemic products. Nematicides move through the soil in gas form or in soil water.

## Disease Identification



The following is a list and description of diseases of significance to Eastern Canadian Forests. The information has been taken directly from a Canadian Forest Publication entitled ***"Tree Diseases of Eastern Canada"***. Forestry Specialists should be consulted regarding specific pesticide recommendations and for other control measures. A list of resource agencies is listed in the back of this manual to assist applicators.
It should be noted that with the exception of plantations and nurseries, emphasis is placed on prevention of disease rather than control due to the economics involved with control, the limited number of products and the difficulty in applying them on a large scale.

## Needle Cast (*Lirula nervata* (Darker) Darker*)*



**Host:** Exclusively balsam fir.

**Distribution:** Widely distributed throughout eastern Canada.

**Effects on host:** Infection results in loss of needles; heavy infection degrades Christmas trees and causes growth reduction.

**Identifying features:** Infected needles are brown. The fruiting body appears as a black line running the entire length of the needle along the underside of the midrib, with a narrow slit that opens up when the needle is wet, exposing a milky, shiny surface. A thin, more or less continuous, superficial line appears on the middle of the upper side of the needle. Infected needles may fall after spores are released but often persist for the rest of the year.

**Life History:** The spores produced in the fruiting body the previous year mature in the last spring or early summer. The lips of the fruiting body open in wet weather, and the spores are discharged and carried to new needles by wind or raindrops. The spore germinates and enters the needle, and new infection results. Infected needles turn yellowish, then brown. The fruiting bodies develop in the late summer of the first year after infection and release the spores in the spring of the second year

**Control:** Fungicides applied at the time of spore discharge provide adequate protection, but spraying should be considered only for high-value plantations or ornamental trees, and only if fruiting bodies are abundant from previous infection.

**Witches'-Broom of Blueberry**
*(Pucciniastrum goeppertianum* **(Kuhn) Kleb.***)*

**Witches'-Broom of Blueberry**
*(Pucciniastrum goeppertianum* **(Kuhn) Kleb.***)*

**Hosts:** Balsam fir, with blueberry as the alternate host.

**Distribution:** Occurs throughout eastern Canada.

**Effects on hosts:** On balsam fir, the infected needles shrivel up and drop prematurely. When infection is heavy, the loss of foliage may result in growth loss, particularly on young trees. With Christmas trees, infection may result in a reduction in grade and consequently significant economic loss.

**Identifying features:** On balsam fir, small, orange-yellow blisters develop in early summer on the undersides of current-year needles on both sides of the main vein. The infected needles turn yellow, then brown, and finally dry up and fall.

**Life History:** This fungus over winters as a resting spore in the bark of infected blueberry shoots. The bark is sloughed off in the spring, and the resting spores produce the spores that infect the new needles of balsam fir. In about two weeks time, another type of spore develops in small white sacks on the undersides of the needles. These spores are orange-yellow in color and infect only the newly expanded blueberry shoots. The year following infection, a witches'-broom is formed as a result of a proliferation of swollen ranches. Witches'-broom is perennial.

**Control:** When both hosts have commercial value, a choice is necessary. One of the hosts must be eliminated from the area, or chemical control can be used. Herbicides to destroy broomed blueberry or fungicides applied to balsam fir just after bud break are probably adequate.

**Additional Information:** A similar needle rust fungus, *Pucciniastrum epilobii Otth*, alternates between balsam fir and fireweed *(Epilobium sp.)*. The life cycle of the fireweed rust fungus differs from that of *P. goeppertianum* in that it has a spore type on the alternate host that infects other alternate host plants. In some open areas where fireweed abounds, damage to balsam fir by this rust exceeds that caused by the blueberry rust. Infection by *P. epilobii* occurs somewhat earlier in the summer, and the same tree may be infected by both fungi. Elimination of fireweed in and around Christmas tree areas is recommended as a control method for *P. epilobii.*

Other needle rust fungi, which produce white instead of orange-yellow spores on balsam fir, also occur in eastern Canada. These are species of *Uredinopsis* and *Milesia*, with various ferns serving as alternate species.

## Sirococcus Shoot Blight *(Sirococcus conigenus* (DC.) P. Cannon & Minter)

**Sirococcus Shoot Blight** *(Sirococcus conigenus* (DC.) P. Cannon & Minter)

**Hosts:** Mainly red pine and black and white spruce, rarely jack pine and blue, Norway, and red spruce.

**Distribution:** Widely distributed on red pine and the cone of white spruce in the Maritime provinces and on red pine in northwestern and central Ontario. Common on black spruce in the Laurentides Provincial Park in Quebec and has been found on spruce in a nursery in Prince Edward Island.

**Effects on hosts:** The disease kills only the current year 's shoots. Repeated attacks have a current year's shoots. Repeated attacks have a cumulative effect, resulting first in stunted growth, then the tree succumbing to the disease. Seedlings, especially container-grown seedlings, die quickly; older, larger trees die after several successive years of severe attack.

**Identifying features:** On pine, needles on infected shoots wilt, collapse at the base, and bend sharply downward, giving the shoot a drooped appearance. Needles may stay on the tree for up to 2 years and undergo color changes from reddish to finally bleached straw brown. Small black fruiting bodies form at the base of infected needles, often only under the bundle sheath. Infected shoots may appear anywhere on affected trees, although lower branch infection, not to be confused with natural shading, is more common.

On spruce, the entire shoot droops, and damage appears similar to that caused by late frost.

**Life History:** Spores ooze out of the small black fruiting bodies in wet periods during the growing season and are carried by wind or splashed to healthy shoots by rain. Infected shoots die within 4-6 weeks. Fruiting bodies develop on newly killed needles, on cone scales, or occasionally on the dead shoot tips. The spread of the disease is usually slow, but it can intensify rapidly on infected trees. Young trees under or near infected large over-story trees are very vulnerable, as are trees in plantations with intermingling crowns. There is evidence that the fungus is seed-borne in spruce, which creates special problems for nurseries.

**Control:** Removal and destruction of infected shoots on ornamental trees as soon as practical, but not later than bud break, are recommended. Removal of old over-story trees in and around nurseries, plantations, and new regeneration, preferably coupled with pruning, should reduce new infections. Fungicide treatment is practical only in nurseries.

## Spruce Needle Rust *(Chrysomyxa ledi* **(Alb. & Schwein.) de Bary and** *Chrysomyxa ledicola* **(Peck) Lagerh.***)*



**Hosts:** Mainly black, red and white spruce; the alternate host is Labrador tea.

**Distribution:** Found throughout the range of its host in eastern Canada.

**Effects on hosts:** These two species of fungi infect the current year's needles and are responsible for most of the spruce needle rust in eastern Canada. The infected needles die, and the resulting defoliation, if severe, probably affects tree growth. Extensive stands of spruce with severe defoliation have been reported, but usually the amount of rust does not remain high for consecutive years. Normally, a considerable amount of healthy, older foliage remains and is able to sustain the trees. The rust fungi occasionally infect cones.

**Identifying features:** The white pustules and the orange to yellow spores that develop in them are evident on infected spruce foliage in midsummer and are the most conspicuous stage of the disease. The spores of *C. ledicola* are considerably larger than those of *C.ledi,* but the fungi are indistinguishable on spruce in the field.

*Chrysomyxa ledicola* is distinct on Labrador tea because it is the only rust fungus that fruits on the upper surface of the leaf. On Labrador tea, the rust fungi fruit on the foliage produced in the previous year.

**Life History:** Both rust fungi over winter in the foliage of Labrador tea. In the spring, a spore stage develops that spreads the disease to other Labrador tea plants. Because this stage occurs every spring, the disease can persist on the alternate host in the absence of spruce. The reverse is not true, as both hosts are required for successful infection of spruce. In the early summer, a different spore stage develops on Labrador tea, and these spores spread the disease to the spruce host. Infection on spruce first appears as small reddish dots in which small fruiting bodies soon develop. These fruiting bodies produce spores

involved in fertilization. Later, white pustules are formed under which the orange to yellow spores develop. Once these spores mature, a white cover tears open, and the spores are released; they are then carried by wind and rain splash to Labrador tea, where they initiate infection. These spores usually mature in the mid- to late summer.

Both rust species can be found together on the same spruce host and even in adjacent pustules on the same needle.

**Control:** Chemical control of this disease on spruce does not seem necessary. Nurseries should not be located near swampy locations that typically contain considerable amounts of labrador tea.

## Review Questions –
## Chapter 4 / Disease Management

1. Name the environmental stresses that may cause disease symptoms in forests.

2. Name four pathogens that cause disease in trees.

3. What is a protectant fungicide?

4. List the factors influencing fungicide efficacy.

5. Name three good management practices for disease control.

# 5 Vertebrate Management

## Introduction

Vertebrate (animals with a backbone) pests in an industrial or forestry setting can include rodents, rabbits, skunks, porcupines, deer, squirrels, bear and birds.

Forestry vertebrate pests cause problems by damaging young rootstock and shoots, destroying the bark on desirable tree species and damaging trees by tearing off cones or branches.

Industrial vertebrate pests inadvertently cause safety problems by their presence on roadways, rail lines and power corridors

**Goals for the Chapter**

- Become familiar with the vertebrate species that can cause damage to the forestry/industrial sectors.
- Understand the issues involved with a vertebrate control program.

## Assessing Damage

### Assessing Damage

Like all other pest management categories it is important to identify your pest before you can implement a control program. Small pests like mice and squirrels usually tend to affect smaller trees while larger animals such as porcupine, bear and deer will damage larger species. The majority of damage by vertebrate pests occurs over the winter months when food sources are scarce. The subsequent damage may not be seen until the following summer. Deciduous species will fail to leaf out or drop/ colour their leaves early. Conifer damage may be more dramatic with the injured tree turning red as the needles die off.

Inspection of damaged trees will show injury to the bark with scratches, scraps and teeth marks visible in many cases. Nursery stock may have a layer of bark girdled by hungry **rodents**, thus effectively killing the tree. **Deer** will damage tender nursery stock by chewing off new shoot growth. **Squirrel** damage rarely kills trees but may cause multiple leaders to form from damage done to twigs. **Birds** such as woodpeckers, sapsuckers and grosbeaks will also damage trees at localized points and severe damage is possible but not common. **Porcupine** and **beaver** are the most active in the late fall/ early winter and can cause an impressive amount of damage to the bark with beavers usually cutting down entire trees for food, shelters and dam building.

## Vertebrate Behavior

### Vertebrate Behavior

As with other pest categories it is important to identify the correct pest before an effective control program can be carried out. The biology and behavior of the pest must be understood. Effective control will depend on:

- population density
- mobility of the pest
- habitat of the pest
- availability of food
- predators of the pest

*It is important to note that many of the species, which cause damage in Forestry and Industrial settings, provide enjoyment and recreational opportunities for photographers, hunters, artists and naturalists. A control program to destroy these creatures to prevent further damage must be carefully weighed against the benefits they create by being in the wild.* Keeping that in mind the following general controls are discussed.

## Vertebrate Control

Vertebrate Control

In nursery settings **mouse** control begins by having good weed control. By removing long grass and tall broadleaf plants from around trees, the habitat enjoyed by these rodents is destroyed. Tree screens are also effective which will reduce damage from other rodents and **rabbits**. Hunting rabbits also provides effective control. Hunting and trapping can also be effective for deer, **bear** and **beaver**. Animal repellents may be used but are of limited effectiveness dependent on specific settings. Poison baits are registered for some vertebrate pests but caution must be exercised with this form of control. The danger is that bait may affect a non-target wildlife species, a domestic animal or humans if improperly used. **Squirrel** damage seems to be random and usually does not occur in the same area two years in a row. Understanding this behaviour can determine if control measures are necessary. Birds such as **sapsuckers** and **grosbeaks** may be controlled by the use of automatic noisemakers or by hanging aluminum plates or metallic ribbons in the affected trees. Rubber snakes hanging in trees have been reported to be successful.

**The control measures chosen will depend on:**

- the legal status of the control measure
- the cost of the controls
- the effectiveness of the control

Legislation for the protection of wildlife may prevent the destruction of some pests or may require special permits for their control. Shooting, trapping and the use of pesticides may be limited to specific times of year or specific locations. **Check with federal, provincial and municipal authorities before using any control measure for vertebrate pests.**

## Review Questions –
## Chapter 5 / Vertebrate Management

1. When do vertebrates do most of their damage?

2. What must be considered when implementing an effective control program?

3. Who must be contacted before initiating a vertebrate control program?

# 6 Environmental Impact

## Introduction

Forestry/Industrial pest management programs occur in areas that are valuable for wildlife and recreation. The public is con - cerned that pesticide use will result in the loss of resources, both now and in the future. It is essential that pesticide applicators carefully manage their programs so that the pests are controlled and the environment is protected. Both land and aquatic impacts must be considered.

**Goals for the Chapter**

- Know how forestry and industrial pesticide programs can harm wildlife and recreation areas.
- Be familiar with procedures to protect the environment from pesticides.

## Aquatic Impact

**Aquatic Impact**

Aquatic organisms can be harmed both directly and indirectly through incorrect pesticide applications and spills. Direct harm is the obvious effects from contamination of habitat.
Indirect harm results from:

- The reduction of food supply through loss of food organisms or stream side vegetation.
- Loss of vegetation canopy over streams. Canopy is essential for temperature regulation, food supply and fish cover.

Water sources can be protected from pesticides through the use

of **buffer zones**. Buffer zones are areas that are left in their natural state to protect neighbouring habitats. Buffer zones are important because they:

- Catch spray drift or run-off that minimizes toxic hazards to aquatic habitats.
- Prevent damage to streamside vegetation.

Buffer zone width will vary depending on terrain, forest cover, method of application and the pesticide used. Check with the New Brunswick Department of Environment regarding specific buffer zone requirements and guidelines.

## Land Impact

## Land Impact

Wildlife habitat and recreation activities can be adversely affected by incorrect pesticide application. Like aquatic impact harm may be direct or indirect. Direct harm is the obvious effects from contamination of habitat such as insecticide toxicity on birds and their young when nesting. Indirect harm results from:

- Insecticides altering bird behavior
- Insecticides removing food source insects and pollinators
- Loss of habitat that is essential for food, shelter, nesting, dens, hunting perches and foraging sites.

Recreation sites such as snowmobile, hiking and ski trails, berry picking sites and waterways can be lost or irreparably damaged by pesticide misuse. Applicators must identify forest or right-of-way use and must protect these areas as required through permits or guidelines. Check with the New Brunswick Department of Environment regarding specific buffer zone requirements and guidelines.

**Land resources can be protected by:**

- Practicing an IPM program
- Conducting site visits prior to application
- Setting aside certain areas of treatment blocks for wildlife forage
- Choosing selective methods of application to protect non-target organisms and minimize the effect on browse vegetation
- Working with wildlife habitat staff to develop a site specific management plan.

## Review Questions –
## Chapter 6 / Environmental Impact

1. Why are buffer zones important?

2. How can land resources be protected from pesticide contamination?

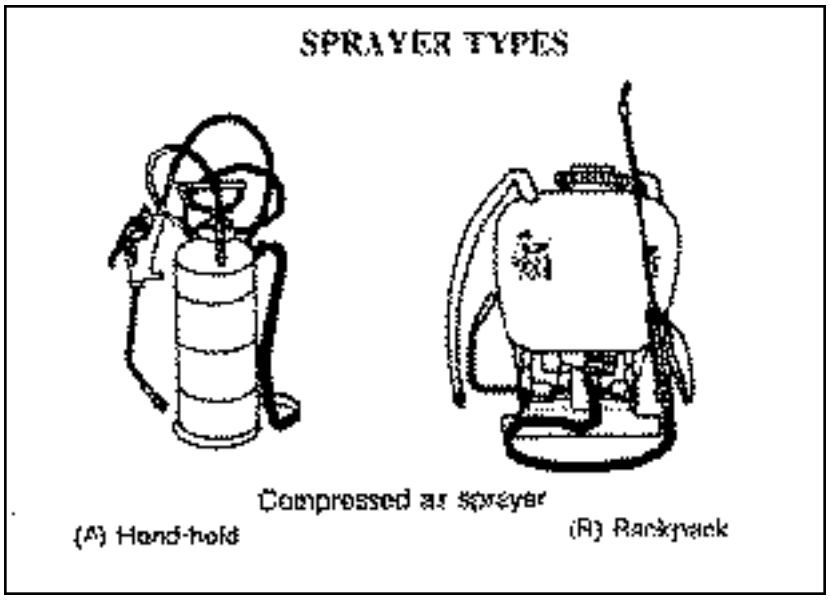
3. How can aquatic organisms be harmed through incorrect pesticide use?

# 7

# Application Technology

## Introduction

Pesticide application is one method of control that may be used in an integrated pest management program. Pesticide applications must use techniques and equipment that will not only achieve successful control but are also cost effective and environmentally sound. The technique and equipment chosen must ensure thorough coverage of the target species, that the correct amount of pesticide is applied and that drift is reduced. Choosing inappropriate techniques will not control the pest, waste time, increase costs and may have an adverse impact on the environment. Proper pesticide application requires knowledge and skill of application technique, equipment and calibration.



## Goals for the Chapter

- Be familiar with application techniques used in the forestry/industrial sectors.
- Learn about application equipment used in the forestry/industrial sectors.
- Learn how to select nozzle types for particular applications.
- Learn how to calculate treatment area for pesticide application.

## Application Techniques

### Application Techniques

Pesticides must be applied when the target species are at their most susceptible stage of growth while the non-target species are at their most resistant stage of growth. This will decrease the possibility of non-target damage.

Most pesticide applications in the forestry and industrial sectors use herbicides. Diseases and insects are generally controlled by non-chemical methods such as selective harvesting and biological control methods. Large insect populations that are cyclic, such as defoliators, are treated with insecticides. If an insecticide or fungicide is used, foliar and aerial applications are the two most common types of application. Most of the equipment that is described in the application equipment section can be used for all types of pesticides. Since herbicides are used most frequently, techniques and equipment will mainly be described in vegetation management terms.

**Application techniques for vegetation management include:**

- Foliar application
    a) Bud break spray
    b) Early foliar spray
    c) Late foliar spray
    d) Fall spray

- Basal bark application
- Cut surface application
    a) Stump treatment
    b) Trunk wound application
    c) Tree injection
- Soil application
- Aerial application
- Tree growth retardation

## Foliar application

**Foliar application** is the application of a pesticide spray mix to leaves and stems. Pesticides can be applied with truck-mounted boom and boomless systems, helicopter or fixed wing aircraft, compressed air sprayers and hand held spray guns.

**Advantages of foliar application are that they are:**

- the most cost effective method of control
- the most time efficient method of control

**Disadvantages of foliar application are that they:**

- require complete coverage
- can create a drift hazard
- are the most publicly visible form of pesticide control

**There are several timings for foliar applications:**

a) **Bud break or dormant sprays** are used in the late winter or early spring prior to when buds break to form leaves. Herbicides are absorbed through the bark of the brush. Conifers are resistant to herbicides at this stage. Dormant sprays are often used where foliar application was not com - pleted in the previous season or where off-target plants could be harmed by drift. Pesticides can be applied with oil or water carriers. There are some environmental concerns with dormant sprays because they use oil carriers.

b) **Early foliar sprays** are used in the late spring when most young vegetation is susceptible to herbicides. This is not an effective time for conifer release as the conifers can be dam- aged.

c) **Late foliar sprays** are used in mid to late summer . This application can be less effective on brush species as they are more resistant as they get larger. Once conifer growth has stopped and buds have formed, conifer resistance to herbi - cides increases. A water carrier is often used.

d) **Fall sprays** are used in the late summer to late fall. This application can be very effective on brush and perennial herbaceous species. Herbicides are translocated down to the root system along with food reserves in preparation for the winter. It is not effective on species that have ceased growth. Conifers are generally resistant to herbicides at this time.

## Basal bark application

**Basal bark application** is the application of a herbicide solu - tion on the base of stems from a height of approximately 0.5 meters to ground level, on root collars and on exposed roots. Control is most successful when stems are less than 10 cm in diameter.

**The advantages of basal bark application are:**

- Treatment can be carried out any time of the year (most effective in late summer).
- It is highly selective since only target plants are treated.

**The disadvantages of basal bark treatment are:**

- Environmental concerns because of the oil carriers used to penetrate the bark.
- This method is very labor intensive.

There are three variations to basal bark applications that include one-sided low volume, thin line and stream line applications.

## Cut surface application

**Cut surface application** is the application of herbicides to the cambium layer of the woody species. The cambium layer is the tissue between the wood and the bark. This layer carries water and nutrients to all parts of the plant. Applying a herbicide to this layer will ensure that herbicides are carried to the stems, foliage and roots. The advantages and disadvantages of cut sur- face applications depend upon the method used. The following is a description of three methods of cut surface application:

a) **Stump treatment** is the application of a herbicide to cut stems or stumps of trees immediately after mowing or hand slashing to prevent suckering. The application is made to the

outer 2.5 cm of the cambium layer of the cut stump. There is specialized equipment available such as the **sprout-less applicator®** that cuts and applies the herbicide in one operation.

**The advantages of stump treatment are:**

- It is highly selective as only target plants are treated
- The non oil solution reduces environmental impact

**The disadvantages of stump treatment are:**

- Time consuming
- Labour intensive
- Can produce inconsistent results especially when treatment is made during heavy sap flow in the spring or when stumps have been left for several days before application

b) **Trunk wound application (hack and squirt)** consists of making a cut in woody plants and applying herbicides to the cut. Herbicides can also be injected into trees with hypo-hatchets, squirt bottles or basal injections by making a 45 ( angle cut through the bark at waist height. The label will indicate the number of notches (frills) that are required for the tree diameter. This type of application is used mainly to control species that sucker and where unwanted species are located on the edges of open areas. Control is variable for some species during heavy sap flow in the spring i.e. maples. Trunk wound applications are successful with trees or shrubs that have stems that are 5 cm in diameter or larger .

**The advantages of trunk wound application are:**

- It is highly selective as only target plants are treated
- The non oil solution reduces environmental impact

**The disadvantages of trunk wound application are:**

- Time consuming
- Labour intensive
- Can produce inconsistent results especially when treatment is made during heavy sap flow in the spring

c) **Tree injection** uses a system where a capsule that contains a systemic herbicide is injected into the bark. It is used mainly on woody species in forestry and on right-of-ways. Another technique is drilling holes into the trunk and inserting a probe into the trunk. The probe dispenses the herbicide.

**Advantages of tree injection are:**

- minimal herbicide exposure to the worker and the environment
- highly selective
- can be done in the fall or winter months.

**Disadvantage of tree injection is that:**

- it requires several months for the effects to become visible.

## Soil application

**Soil application** is the application of soil active herbicides that are taken up by roots. These herbicides are applied directly to soil and may require moisture to become activated. Caution with this procedure is that pesticides should not be applied to frozen ground or on sloped terrain as the herbicide may move off-target. Wettable powders and liquid formulations are applied as a spray application. Soil application is often done using a hand held boom that is sprayed to treat individual spots (site preparation, conifer release) or by low-pressure boom sprayers as a broadcast over a large area (nurseries).

Granular formulations are dispensed by granular application equipment. Small amounts can be spread by hand around the base of the tree or broadcast by hand or mechanical spreader. Do not apply on sloped terrain. Rainfall or irrigation dissolves the granules which causes them to release the herbicide into the root zone. Soil applied herbicides are often residual so special consideration is essential when developing this type of control program to minimize off-site movement.

**The advantages of soil treatment are:**

- Provides residual control
- Can apply with small equipment to do a small area

**The disadvantages of soil treatment are:**

- May move off-site due to its residual properties
- Not suitable for sloped or gravelly terrain

**Aerial application** is the application of pesticides by helicop - ters and fixed wing aircraft. Aerial application can be used to apply pesticides to large areas that are not as easily accessible by land due to terrain or other conditions. For some circum - stances aerial application may be a more efficient method of application. See the ***Aerial Application Pesticide Safety Manual*** for additional information.

**Aerial Application**

**Tree growth retardants** work by impeding the growth of the tree without killing it. It is a method that requires little inter - vention once it is in place but as of yet this method is not reg - istered for commercial use in Canada.

**Tree growth retardants**

## Application Equipment

**Application Equipment**

A wide variety of equipment is available for applying pesticides in the forestry and industrial sectors. This equipment can range from hand-held applicators, large tractor or truck mounted sprayers to rough terrain vehicles. The decision for selecting the most appropriate equipment is based on the size and type of area to be treated, the type of pest, the pesticide formulation and applicator accuracy.

Whether the sprayer is a small 3-point hitch truck mounted unit or a large tractor drawn unit, there are basic similarities in the component parts and their interaction. Every sprayer has three basic systems that work together to spray pesticides on the tar - get. The three basic systems consist of **supply, control** and **delivery**. All equipment must be well designed, safe for the workers and the environment and meet Canadian Standards. Please refer to the ***General Pesticide Safety Manual, Chapter 18*** for details on sprayer components.

The following section discuses commonly used nozzles and equipment used for forestry and industrial applications.

## Nozzle Selection

Nozzle information is detailed in the ***General Pesticide Safety Manual, Chapter 18***. This chapter discusses nozzle types, flow rates, spray angles, overlaps and spray patterns. Nozzles may be selected for such uses as drift reduction, banding, soil incorporation or boomless operation. The three most common nozzle types that are used for forestry/industrial sectors are flat fan, off center and hollow cone. The following section discusses various nozzles that are used for forestry and industrial applications. Pesticide Labels may also provide information regarding nozzle selection.

**High volume nozzles** are mainly used for boomless spray systems but can be attached to the ends of booms to increase the spray swath. Off-center, cluster and solid stream nozzles are the three most common types of nozzles used for roadsides, embankments, fence lines, etc.

- **Off-center nozzles** produce a wide spray that is off to one side of the nozzle. These nozzles are often mounted on the side of a truck for roadside spray operations.
- **Cluster nozzles** can be used on boom and boomless sprays as well on the end of handguns. They are often combined in clusters of 2 to 5 nozzles in a boomless system and direct the spray up and out. An adjuvant must be used with these nozzles so that when air and spray are mixed they form foam that is visible to the applicator. **Boomjet nozzles** are a combination of a center-discharge and 2 or more off-center discharge fan nozzles. The spray droplets vary in size from very small to very large. Drift management is essential when using these nozzles. **Large deflector nozzles**, anther type of cluster nozzle, spray swaths up to 20 meters wide from a single nozzle. Cluster type nozzles often require 50% overlap. **Accutrol nozzles** are designed to be used in combination with a spray adjuvant. The nozzles draw in air and mixes it with the spray to form a foamy mixture that is visible to the operator.
- **Solid stream nozzles** are used with hand held gun-sprayers to spray tall or distant targets.

**Low-pressure flat fan nozzles** are designed for low pressures of 100 kPa to produce larger droplets. Although the pattern and output is similar to a standard flat fan nozzle, drift hazard is reduced. Flat fan nozzles are generally used for herbicide applications. Some examples are: **narrow band nozzles** are used for basal bark applications, **tapered flat fan** that are used in an overlapping spray pattern and **even flat fan** that are used for banding applications.

**Flooding fan nozzles** enable the boom to be placed only 30 cm above the target vegetation and produce a wide spray swath. Although these nozzles produce less drift than standard flat fans, they also produce an inferior pattern. **Raindrop nozzles** produce larger droplets than standard flat fans, which also reduces drift potential. **Hollow cone nozzles** produce fine spray droplets that are often used for insecticides and fungicides to allow the spray to penetrate the canopy.

**Controlled droplet applicators** uses disc movement in the nozzle body to reduce the spray into droplets rather than through mechanical means as in other nozzle types. The two common types of nozzles are the **radiarc®**, which uses a vibrating disc and the **direct-a-spray®**, which uses a spinning disc.

**Disc-core nozzles** produce a hollow cone pattern and are used in aerial applications.

**Thru-valve boom and microfoil boom nozzles** are also used for aerial applications. They produce a consistent droplet size that allows the volume of spray at the outside of the swath to be equal to the spray volume in the center of the swath. Overlap is not required. This reduces drift because the smaller droplets are not produced on the outside of the swath.

## Compressed Air Sprayers

Equipment Selection

### Compressed Air Sprayers

Compressed air sprayers are best for spot treating areas that are inaccessible to larger equipment or for small pest infestations. They usually have a tank capacity of 5-25 liters, are carried by a strap over the shoulder and use hand operated pumps. The pressure in the tank is reduced as the tank is emptied, however there are models available that have constant-pressure. Suction draws pesticide from the tank and forces is out with the air flow Other models utilize $CO^2$ cylinders to provide pressure. There are two basic types of compressed air sprayers:

- **Hand Sprayers** are small sprayers that are used to apply small quantities of pesticides, spot treatments and hard to spray areas. The advantages with these sprayers are that they are economical, easy to use, clean and store. The disadvantages are that pressure and output rate fluctuate and there is not enough agitation to keep wettable powders in suspension.
- **Backpack Sprayers** are similar to a hand sprayer but have a self-contained unit (tank and pump) that is carried on the applicator's back. A mechanical agitator plate may be attached to the pump plunger to keep pesticides mixed in solution. Backpack sprayers can be equipped with a small boom with several nozzles or a boomless wand with a nozzle or a cluster of nozzles at the end. A mist blower can also be used as a backpack.

**Advantages of using a backpack are:**

- Can selectively control vegetation
- Can access small areas
- Versatile in its applications

**Disadvantages of using a backpack are:**

- Labor intensive and costly
- Difficult to control tall vegetation
- Physically challenging to the applicator in areas of rough terrain

## Boom Sprayers

These larger sprayers are used when the application can be made from a tractor or truck mounted boom. Arm booms are available for roadside and ditch spraying. One end of the arm shaft is mounted on either the front, side or the back of the truck with a nozzle or nozzle cluster at the end of the boom. They are not widely used in forestry as the terrain is often too rough to keep the booms stable. Hand booms and adjustable spray guns can be operated from a truck or tractor mounted power spray equipment to spray stump and basal sprays or to spray tall vegetation. They can deliver a range of spray output from a fine mist to a narrow coarse stream. **Spray gun nozzles** wet surfaces thoroughly. Different spray guns operate at different pressures between 30-800 psi.

- **Low-pressure sprayers** are designed to distribute liquid spray solution over large areas. They deliver a low to moderate volume of spray (100-650 liters/ha) and are usually mounted on tractors or trucks. Some models are self-propelled.

  **The advantages of low-pressure sprayers are:**
  - medium to large tanks
  - lower cost than high pressure sprayers
  - versatile

  **The disadvantage of a low-pressure sprayer is:**
  - the low pressure limits pesticide penetration and reach.

- **High-pressure sprayers** are hydraulic sprayers that can spray through dense foliage and to tops of tall trees. They deliver larger volumes of spray of 200-5500 liters/ha with pressure ranges of 1000-2700 kPa. They are usually mounted on tractors, trailers, and trucks or are self-propelled. They may utilize a hose and handgun for use in spraying trees.

  **The advantages of high-pressure sprayers are that:**
  - they provide good penetration and coverage
  - are well built and long lasting

**Disadvantages of high-pressure sprayers are:**

- the high cost of equipment
- the need for large amounts of water, power and fuel
- that the high pressure produces fine droplets which may drift

## Boomless Sprayers

## Boomless Sprayers

These sprayers generally use cluster nozzles for spraying road-sides, ditch banks, utility lines, etc. Boomless sprayers are easier to maneuver over rough ground and are less expensive than boom sprayers. Often this sprayer can spray a swath between 6-10 meters. It is usually mounted on a 4 wheel drive power wagon, skidder or caterpillar-type tractor.

One disadvantage with the boomless sprayers is that it is difficult to control drift due to the fine spray pattern. Shrouds for booms are available to reduce droplet drift and allow spraying during windy weather. They can reduce droplet drift to less than one percent but have some disadvantages:

- applicator cannot see the nozzles
- difficult to calibrate nozzle tips
- difficult to clean under some models
- possible buildup and runoff of some herbicides

- **Low-pressure boomless sprayers** have a central nozzle cluster that produces a horizontal spray pattern that is similar to the swath pattern made by a boom sprayer These sprayers are useful in irregular shaped areas because they can move through narrow places and avoid trees and other obstacles. Some of these sprayers are equipped with a hose and hand held gun nozzle for applications in small or hard to reach areas. The **radiarc® sprayer** applies pesticides while providing drift control through low volume applications. It can apply spray to both sides, one side or to the rear of the sprayer vehicle. **Power hose sprayers** consist of a hose and a single nozzle of durable construction which is usually stored on a reel mounted

system. It can be used for spraying selective spots by pulling the hose and nozzle for as far as the length of the hose will allow. Staff are needed to operate the pump, the spray nozzle and lift and move the hose.

- **Mist blowers** produce concentrated sprays in a fine mist at low volumes per hectare. The pesticide is carried in the air stream instead of liquid. These sprayers usually have the same components as low or high-pressure sprayers but also utilize a high-speed fan. The air blast separates the drops of pesticide into fine droplets and carries them to the target. This sprayer can be useful in swamps, under power lines, over rough ground, for stand tending or in seed cone nurseries. Most are trailer mounted but may be tractor mounted. A backpack mist blower can be used to spray small areas and can be used for brush up to 10 meters tall. A **cannon® airblast sprayer** can shoot spray up to 25-30 meters in height due to the high output fan (125 miles/hour). The advantages of a mist blower are the good penetration at high or low volumes under low pump pressures. The disadvantages are the high cost of the equipment, high power and fuel use, high drift hazard, use of concentrated pesticides and hard to spray small target areas.

- **Ultra low volume (ULV) sprayers** utilize pesticide concentrates without dilutents. They may be hand held or mounted on either ground equipment or aircraft. The advantages of ULV sprayers are that since no dilutent is required it decreases time and labor, eliminates the need to find water sources and provides for equal control with less pesticide. The disadvantages with these sprayers are that they do not provide thorough coverage, there are hazards of using high concentrations, there is a chance of over dosage and there are only a few pesticides registered for ULV use.

## Aerial Sprayers

## Aerial Sprayers

The use of helicopters and fixed wing aircraft that are equipped with a spraying system are another method of pesticide application. Helicopters are more expensive than fixed wing but require no runway and fly better in low visibility. For more information on aerial spraying consult the ***Aerial Application Pesticide Safety Manual.***

## Granular Applicators

## Granular Applicators

These applicators are usually broadcast seed sowers, fertilizer spreaders or airguns. The broadcast method applies the granules over the entire site. The banding method applies granules in narrow bands only over the area being controlled. A typical hand spreader has a rotating plate powered by a hand crank for spreading the granules and is carried by a shoulder sling strap. It has adjustable openings to obtain different rates. Some granular herbicides are applied to brush by hand. Pails and scoops are used by each member of a crew to dispense the pesticide. There is usually a crawler tractor that hauls the bags of pesticides.

## Other Equipment

## Other Equipment

Research in application technology is ongoing as the industry continues to require better, more cost effective, environmentally sound and efficient equipment. Several other types of equipment that are currently being used in the industry are:

- **Hypo-hatchet®** is a hand held unit that is a "hatchet" attached to a hose and a small mixing tank. It works as a tree injector using a chisel head hatchet. After the chisel head has been inserted into the bark, the herbicide is delivered to the cambium layer by a lever that is activated to dispense the herbicide. A measured amount of herbicide is delivered with each hit of the axe to the stem or trunk. The number of hits depends on the size of the brush. Check label recommendations.

- **Sprout-Less applicator®** has a small herbicide reservoir that attaches to the bottom of a brush saw . A pump and a dispensing system are activated during the brush cutting action of the saw. Brush is cut and sprayed at essentially the same time for improved herbicide translocation through the cambium layer. It is very selective and does not produce drift.

- **Crusher/sprayer unit®** utilizes a larger rough terrain vehicle with a heavy steel drum in front of the vehicle that crushes the vegetation. The sprayer unit is located at the rear of the vehicle. The brush is crushed and sprayed at essentially the same time. This improves herbicide translocation.

## Equipment Calibration



It is essential that whatever equipment be chosen for pesticide application should be properly calibrated. Calibration ensures that the correct amount of pesticide is being applied at the proper speed and correct height above the target species. A properly calibrated sprayer will increase pest control, decrease damage to non-target species, reduce pesticide costs, save time (no need to retreat) and reduce the potential for environmental risks.

Please refer to the ***General Pesticide Safety Manual Chapter 19*** for equipment calibration for various types of application equipment. One type of equipment not mentioned in that chapter is the **hack and squirt applicator.** It is essential that the squirt device apply the correct amount of herbicide per notch. Calculate the total pesticide required per stem diameter and density of stems per hectare to determine the amount of spray mix that will be required.

## Environmental Considerations when using Sprayer Equipment

**Spray Drift** – before beginning a spray application program, evaluate weather conditions to assess the potential for spray drift. Consider:

- **Air and ground temperature** – high temperatures increase pesticide volatility, reduces pesticide effectiveness and may create a temperature inversion. A temperature inversion occurs when air at ground level is cooler and more stable than air above the ground. This prevents very fine spray droplets from settling which allows them to move off target.
- **Relative humidity** – high temperature and low relative humidity increases pesticide volatility.
- **Wind speed and direction** – increased wind speed increases drift. No wind conditions may also cause drift as the very fine droplets do not settle which allows them to move off target.
- **Impending weather conditions** – if the forecast is calling for rain within several hours of the spray application, reschedule application.

Reduce the potential for spray drift by spraying under favorable weather conditions, choosing suitable application equipment and technique, pesticide formulations and using drift control agents.

**Water quality** - temperature, sediment, pH and presence of salts in the water that is mixed with pesticides may affect its performance. For example, the active ingredient of some pesticides are adversely affected when the water is alkaline. The rate at which pesticide breakdown occurs also depends on the length of time the pesticide spray mix is left in the tank and the amount of organic material in the water. Silt and organic material can also affect the mechanics of the spray equipment such as premature pump wear and plugging of screens and nozzles.

## Pesticide Use Calculations

Once the sprayer has been properly calibrated, the applicator must be able to accurately determine the amount of pesticide that will be required for the application. Please refer to the ***General Pesticide Safety Manual Chapter 20*** on how to determine pesticide calculations for granular and liquid pesticides.

## Conversions

Although labels use the Metric system (hectares and liters), some pesticide applicators are still using the Imperial system (acres and gallons); therefore it is important to know how to convert from the Imperial system. The conversions listed below will provide simple changes to the Metric system:

**Liters/hectare = ____ gallons/acre x 11.23**
10 gallons/ acre x 11.24 = 112.3 liters/ha

**$m^2$ = ___ $ft^2$ x 0.093**
You are spraying an area 90 ft x 120 ft = 10,800 $ft^2$ x 0.093 = 1,004.4 $m^2$

**Hectare = ___ $m^2$ x 10,000 $m^2$**
1,004.4 $m^2$ x 10,000 $m^2$ = 0.10 hectare

**Hectare = ____acre x 0.405**
5 acres x 0.405 = 2.025 hectares

### Area Measurements

To determine how much pesticide will be needed to do a job, the area to be treated must be measured. If the area is a rectangle, circle or triangle, simple formulae may be used. Determining the area of an irregularly shaped site is more difficult.

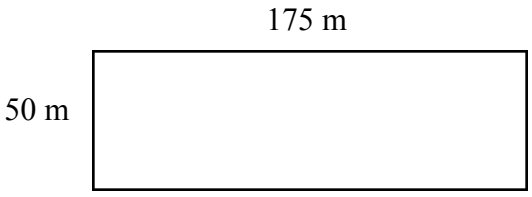
The following examples will help in determining the area of both regularly and irregularly shaped surfaces.

## Regularly Shaped Areas

### Rectangles

The area of a rectangle is found by multiplying the length (L) by the width (W).

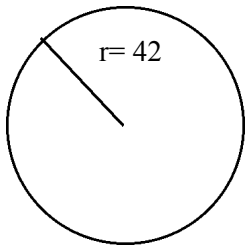
Example: **Area = Length x Width**
=175 m x 50 m = 8,750 $m^2$




### Circles

The area of a circle is the radius (one-half the diameter) squared and then multiplied by 3.14.

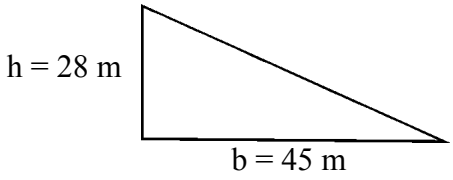
Example: **Area = radius$^2$ x 3.14**
=(42 x 42) x 3.14 = 5,538.96 $m^2$




### Triangles

The area of a triangle is one-half the base (b) multiplied by the height (h).

Example: **Area = b x h ÷ 2**
=(45 x 28)÷ 2 = 630 $m^2$



**Irregularly Shaped Areas**

Irregularly shaped areas often can be reduced to a combination of rectangles, circles, and triangles. Calculate the area of each and add them together to obtain the total area.

Example:

b = 15 m
h = 15 m
L = 40 m
W = 48 m
$L_1$ = 38 m
$W_1$ = 21 m

**Area = (b x h ÷ 2) + (L x W) + (L1 x W1)**

(15 x 15) ÷ 2 = 112.5
40 x 48 = 1,920
38 x 21 = 798
112.5 + 1,920 + 798 = 2,830.5 $m^2$

Another way is to establish a line down the middle of the property for the length, and then measure from side to side at several points along this line.

Areas with very irregular shape require more side to side measurements. The average of the side measurements can be used as the width. The area is then calculated as a rectangle.

Example: ab = 60 m
c = 23 m
d = 10 m
e = 25 m
f = 19 m
g = 28 m

**Area = (ab) x (c+d+e+f+g) ÷ 5)**
=60 x (23 + 10 + 25 + 19 + 28) ÷ 5) =1,260 $m^2$

A third method is to convert the area into a circle. From a cen-

ter point, measure distance to the edge of the area in 10 to 20 increments. Average these measurements to find the average radius. Then calculate the area, using the formula for a circle.

Example: **1. Radius = $\frac{a+b+c+d+e+f+g+h+I+j+k+l}{12}$**

**a = 10**
**b = 12**
**c = 16**
**d = 15**
**e = 11**
**f = 12**
**g = 10**
**h = 9**
**I = 13**
**j = 12**
**k = 13**
**l = 16**

**1. Radius= $\frac{10+12+16+15+11+12+10+9+13+12+13+16}{12}$**

**= 12.42**

**2. Area = radius$^2$ x 3.14**
**= (12.42 x 12.42) x 3.14**
**= 484.1 m$^2$**

## Review Questions –
## Chapter 7 / Application Technology

1. List the types of foliar application.

2. Describe a basal bark application.

3. Tree growth retardants are widely used in the industrial sec - tor. True False

4. List two types of compressed air sprayers.

5. What are two disadvantages of using a shroud for a boomless sprayer?

6. Describe a hypo-hatchet.

7. What are the advantages of high pressure boom sprayers.

# 8

# Safety

## Introduction

Pesticide application requires more than knowledge of equipment and application techniques. It also requires managers and applicators to develop and follow polices that prevent accidents from occurring. This would include accidents to the applicator and to the environment. Safety policies must include responsibilities of all involved, procedures for personal protection, health monitoring, site application monitoring, training in pesticide application and record keeping. Pesticide safety is discussed in detail in the General Pesticide Safety Manual, Chapters 11-16. It includes information on safety precautions, handling, mixing and loading, disposal, storage and record keeping.

**Goals for the Chapter**

- Understand what a pesticide management plan should include.
- Identify hazards, other than pesticides, that may be present at the work site.

### Planning

**Planning**

Environmentally sound planning will assist in reducing pesticide accidents. Pest management should control target species while minimizing off-target effects. The first step is to carefully plan the pesticide application program. These steps would include:

1. **Pre- application functions** are those activities that need to occur prior to application to ensure that the application is legal, safe and effective. These functions would include:

   - Pre application meeting that will discuss application details, legal requirements, hazards, sensitive areas and emergency response plants.
   - Work site surveys and maps to plan sensitive areas and mark hazards.
   - Develop a management plan that includes application decisions, crew supervision guidelines (chain of command, spot checks to ensure safe working conditions), job scheduling,

2. **Safety planning** is essential ensuring that the work environment is safe for the crews. This would include developing a:

   a) **Safety policy** - companies involved in pest management activities must develop policies that ensure they are committed to employee safety . These policies must include company and staff responsibilities, procedures and employee training in pesticide application and safe use.

   b) **Hazard assessment** - hazards in target sites must be determined. These may include terrain, weather, man-made, traffic or strenuous physical hazards. Uneven terrain may lead to pesticide accidents through the loss of vehicle control. High wind conditions and open area sites may lead to a drift probability. There may be man-made hazards such as overhead power lines where equipment may become entangled that may not only lead to pesticide accidents but serious personal injury. Reduce traffic hazard by wearing high visibility vests, using signs and flaggers and following provincial traffic safety regulations

   **Applicators must be trained to:**

   - identify and mark hazards
   - use appropriate protective equipment
   - follow safe work procedures
   - be certified when working within the safe limits or approach of energized power lines

c) **Equipment hazards** - pesticide accidents may lead to exposure of both the applicator and the environ - ment through improper protection and procedures during mixing and loading, application and mainte - nance. Equipment hazards also include powered and mobile equipment, power tools and hand tools.

**Applicators must protect themselves and others in the following ways:**

- Being fully trained and certified in the use of the equipment.
- Follow manufacturers guidelines
- Properly maintain equipment
- Wear appropriate personal protective equipment
- Pay attention
- Keep unauthorized people away from job site

3. **Application scheduling** - determine the best time to conduct the program. Other than targeting times when the weather is favorable, there are other factors that need to be considered to reduce the possibility for a pesticide accident. For exam - ple, a roadside application must consider the level of traffic activity and schedule around peak times.

4. **Temporary Storage** – the nature of many forestry/industrial applications often require that a temporary storage location be established. Regulations for permanent storage relate to temporary storage. Transport trailers or vehicles may be used for temporary storage. If portable trailers are used, natural ventilation may be relied upon provided all containers are tightly sealed.

## Review Questions –
## Chapter 8 / Safety

1 Identify hazards that may be present at the application site.

2. List the pre application functions.

3. How can applicators protect themselves and others from equipment hazards?

4. Temporary storages do not need to meet provincial regula - tions.

True False

# 9 Contingency Planning

## Introduction

Vegetation managers and Foresters should develop complete response programs for possible emergencies in the field, office and storage facilities. A pesticide spill or fire may never happen, but if it does, will you be ready? Contingency planning will:

- Protect your employees
- Prevent an emergency from becoming a major disaster
- Protect the community
- Protect your business
- Keep environmental damage to a minimum
- Build confidence with your neighbours

**Licensed pesticide operators in New Brunswick are required to have a contingency plan under the Pesticides Control Act and Regulations [see Chapter 1 – Legislation].**

**Goals for the Chapter**

- To understand the need for contingency planning.
- Understand how to develop a contingency plan.

## Emergency Response Program

### Emergency Response Program

A major part of contingency planning involves having an emergency response program.

Emergency Response Programs save lives, property and money. Emergency response planning ensures applicators are prepared to handle emergencies and often results in prevention of emergencies because applicators learn to spot and control hazardous conditions before they cause serious problems. Planning also ensures vegetation management and forestry companies are properly equipped to handle emergencies.

**An Emergency Response Planning Program should contain the following features:**

- Facility Emergency Plans
- Field Emergency Plans
- Emergency Services, Supplies and Equipment
- Training
- Emergency Notification

The Canadian Vegetation Management Association has developed an Emergency Response Checklist for pesticide applicators. The following information is based on this checklist.

## Facility Emergency Plans

### Facility Emergency Plans

Facilities include all stationary sites such as offices, storage and sheds. A facility plan will use all pertinent information about the site including physical layout of building, equipment, dangerous goods, supplies and staff.

**Facility information should include:**

- An overview map of the site and surrounding areas including access roads, main shutoffs for gas, electricity outlets, pesticide storage(s) and contents, fire protection equipment, perimeter fencing and distances to important buildings. Construction materials should also be noted.
- A map sketch of existing drainage for controlling runoff of contaminants. All nearby ditches, culverts, underground drains, steams, brooks and rivers should be noted. Use

arrows to indicate drainage direction. If possible, indicate where and how water runoff may be blocked by dykes and dams. Include lists of dyking materials and whether land-moving equipment is available on site.

- A list of surrounding neighbours and land use (residences, commercial operations, farms, etc.) and include the number of occupants in the area.
- Planned evacuation routes.

*** Please refer to the "Emergency Response Plan: Worksite Layout" at the end of this chapter.**

**List all potential emergencies for each site. Determine what actions would be required for each scenario**. These would include the following:

- Calling the fire department, ambulance, hospital and police.
- Notifying appropriate government departments and other emergency services.
- Notifying management
- Notifying next-of-kin for seriously injured applicator
- Notifying media
- Maintaining an up to date log of the scenario as it unfolds including who has been contacted and what their communications were to you.

Also determine who is responsible for each of these emergency procedures.

**Develop an inventory of post-emergency procedures including:**

- Company and government reports
- Insurance claims
- Company and government investigations of emergencies.
- Cleanup and resumption of work

Assign responsibility for each of these procedures.

**List a full inventory of emergency equipment.** Include the manufacturer, date of purchase, operating instructions, renewal dates (for fire extinguishers and oxygen tanks) and date last used.

**A telephone directory of all local and provincial emergency services and government contacts**. Please refer to the emergency contact list at the end of the chapter.

**Compile copies of Material Safety Data Sheets (MSDS) for each of the pesticide products being used.**

**Note: All of the above material should be compiled in a single manual and copies made available to all staff. Copies of the plans should also be given to each emergency response organization or Department that would be involved in emergency response.**

**Field Emergency Plans**

## Field Emergency Plans

Field emergency plans (site-specific plans) should include as much of the same information as facility emergency plans as possible and:

a. **Maps** of the work sites marked with private and public boundaries, residences and other dwellings, water sources and vegetation.

b. **Telephone numbers** of emergency services closest to the site.

As well, all company vehicles and private vehicles used on the job should be equipped with communication devices (e.g.mobile telephones, 2-way radios), a copy of emergency plans and emergency equipment relevant to the job site and hazards.

## Emergency Services, Supplies and Equipment

Emergency services, supplies and equipment are recommended for every work site as described below.

### First Aid

Requirements for emergency first aid services, supplies and equipment are based on the number of applicators per shift on a specific site, the type of work being done and the location of the work. Forestry and Industrial companies must follow provincial regulations regarding Occupational Health and Safety requirements. These regulations vary in each province – companies that do work in more than one province need to be aware of these variations.

#### First Aid Services and Staff

Readers should refer to provincial occupational health and safety regulations for specific requirements. One or more applicators may have to be certified as a First Aid Attendant, Safety Coordinator, First Aider I, First Aider II, Paramedic or Nurse.

#### First Aid Rooms

For large operations, first aid rooms may be required. Provincial occupational health and safety regulations define the contents of first aid room and who must have them.

#### First Aid Kits and Supplies

Check provincial first aid regulations for a description of the contents of first aid kits. Contents are based on the number of people in a work crew and the specific work being done. In addition, the following materials should be available at facilities and to work crews that handle chemicals or pesticides.

- clean water, soap and towels for washing
- clean water for drinking
- syrup of ipecac (available from drug stores) to induce vomiting **only if recommended by the provincial poison control centre and the pesticide label**

- activated charcoal (available from drug stores) to absorb ingested pesticides when either vomiting must not be induced or after inducing vomiting, when it is recommended
- impervious gloves for the person who administers first aid
- Material Safety Data Sheets (MSDS) for any products controlled under WHMIS. MSDS can be obtained from the company that sells the product or the manufacturer that makes the product.

**Emergency Conveyance**

Applicators must have access to emergency conveyance, either through local ambulance service or by an emergency con - veyance on the work site. An emergency conveyance must be large enough to accommodate a stretcher and passenger inside the vehicle. Check provincial occupational health and safety regulations for further specifications.

**Eyewash and Shower Facilities**

Wherever there is a possibility an applicator will be splashed with pesticides or other harmful substances, wash facilities must be immediately available. As a minimum, a container of clean water should be on hand at field sites, and eyewash facil - ities and a deluge shower should be available at mixing and loading facilities.

**Respiratory Protective Equipment**

Respiratory protective equipment must be readily available wherever applicators may be exposed to airborne contaminants in excess of the occupational exposure limits defined in provin - cial occupational health and safety regulations.

### Spill Cleanup Equipment

Adequate cleanup equipment must be available for use at all work sites where chemicals and pesticides are stored, mixed, loaded and handled. Equipment should include:

- personal protective equipment (gloves, boots, waterproof apron, coveralls, eye protection and respiratory protective equipment)
- absorbent material such as sand, activated charcoal, vermiculite, dry coarse clay, kitty litter or commercial absorbent
- neutralizing material such as hydrated lime or activated charcoal
- long-handled brooms
- shovels
- waste container with lid
- blank labels to identify contents of waste containers

**On trucks, the following cleanup equipment should be available:**

- personal protective equipment
- absorbent material
- shovel
- empty container with lid for transferring ruptured pesticide containers or pesticide-contaminated materials
- blank labels for identifying contents of waste containers

***Some Canadian companies dealing with Forestry Equipment provide "Spill Kits". See the sources reference at the end of this manual for more information.**

### Firefighting Equipment

Firefighting equipment should be available at all work sites and include:

- water supplies (in buildings)
- multi-purpose (ABC agent) fire extinguishers with spare cartridges
- shovels and pails
- backpack pumps
- fire blankets (in case an applicator's clothing is ignited)

Firefighting equipment required by provincial fire codes must be readily accessible and properly maintained at work sites. Firefighting equipment may also be required in vehicles as defined by provincial forestry acts. At the minimum, vehicles should carry 5 lb. extinguishers and mobile equipment should carry 10 lb. extinguishers.

The equipment should be readily accessible and maintained according to a schedule. A log should be kept of inspections and repairs. Pressure gauges on all portable extinguishers and the seals on all cartridge extinguishers should be inspected at least every three months. If low pressure or damage seals are found, the extinguishers should be repaired or replaced immediately.

The only time, other than for an emergency, fire equipment should be removed from its assigned location is for maintenance. If the equipment is to be removed for longer than a few hours, replacement equipment should be available.

**Training**

## Training

Applicators should be trained in the various emergency procedures developed for their work areas, including:

- first aid - first aid training requirements are discussed under Emergency Services, Supplies and Equipment
- firefighting - all applicators should be trained in firefighting techniques and equipment for their work areas
- cold weather survival - applicators should be trained to recognize and protect themselves from the dangers of cold weather, specifically:
    - hypothermia, a condition in which the core temperature of the body falls below the normal 37°C. Hypothermia can develop rapidly as a result of falling in cold water or slowly from working in wet, windy conditions.
    - wind chill, which is the combined chilling effect of wind and temperature on humans. A wind chill factor can result from even a relatively gentle wind. For example, a temperature of 5°C combined with a 20 km/h wind lowers the temperature below freezing.

- hot weather survival - applicators should be trained to recognize and treat hyperthermia (heat stress)
- WHMIS - applicators must be trained to handle any products on their work site that are covered by WHMIS. Applicators must also be trained in the emergency procedures for each product as described on product labels and MSDSs.

## Emergency Notification

**Emergency Notification**

Each emergency requires different notification procedures. Whenever an emergency notification call is made, the caller should be able to provide details on:

- location and type of emergency
- pesticides, equipment and other materials involved in the emergency
- presence of injuries and fatalities
- threat to surrounding areas

Applicators should be trained in proper notification procedures. Complete lists of emergency services, government agencies and company contacts should be:

- included in each copy of emergency response plans
- posted in conspicuous locations at work sites (near telephones)
- posted in company vehicles and private vehicles used for company business

These lists should be updated periodically and re-issued any - time changes are made.

***An emergency response program can protect you, your appli - cators, your neighbourhood and your environment from an emergency turning into a major disaster. Contingency plan - ning saves time, money and lives. Be prepared.***

## Review Questions –
## Chapter 9 / Contingency Planning

1. List the five features that an emergency response program should have.

2. List five items that should be contained in a pesticide spill kit.

3. Do licensed pesticide operators in New Brunswick require a contingency plan?

4. Why should your business have a contingency plan?

## Emergency Contacts

### A.GENERAL EMERGENCY SERVICES

| | |
|---|---|
| Provincial or municipal police Department | _____ |
| Ambulance | _____ |
| Hospital | _____ |
| Aviation Services | _____ |
| Client | _____ |
| Landowner | _____ |
| Occupant | _____ |
| Company Emergency Contacts | _____ |
| | _____ |
| | _____ |
| | _____ |

### B. CHEMICAL FIRES, SPILLS AND TRANSPORTATION ACCIDENTS

| | |
|---|---|
| Canadian Transport Emergency Centre (CANUTEC) (for advice and information on hazards, response procedures and cleanup procedures for accidents occurring during transportation of products – if on-site services are needed, CANUTEC will activate TEAP) | 1-613-996-6666 |
| Chemical Manufacturer | _____ |
| Provincial forestry division | _____ |

## C. INJURIES AND FATALITIES

Provincial Poison Control Centre _____

Occupational Health and Safety _____

Worker's Compensation Board _____

## D. FOREST FIRES

Provincial Forest Service _____

## E. ACCIDENTS INVOLVING POWERLINES, COMMUNICATION LINES AND ELECTRICAL EQUIPMENT

Provincial Electrical
Protection Branch _____

# 10 Professionalism

## Introduction

As noted in an earlier chapter, many of the challenges facing forestry and industrial pesticide applicators stem from the per - ception that pesticide application destroys habitat and contami - nates our resources. Responsible foresters and industrial appli - cators need to address public concerns raised over pesticide use. A commitment to sustainable forests and right-of-ways will demonstrate that all methods are given equal consideration and that the environment is a priority.

**Goals for the Chapter**

- Understand why good communications and public relations are essential for a pest management program.
- Know how to effectively provide public information.

**Bystander exposure** is probably the biggest area of concern for the public and the one that receives the majority of negative media attention. Bystander exposure includes people who may come into contact with pesticides without being directly involved with application. This exposure may occur from:

- berry picking in or next to treated areas
- hiking in a treated area
- homeowners living adjacent to treated areas

The main causes of bystander exposure are drift and early re-entry into sprayed areas.

## Notification

Bystander exposure can be minimized with an organized notification program. Notification programs may also reduce or satisfy public concerns over an application program.A notification program should include information on:

- where the work is to be carried out
- the purpose behind the work
- the method chosen and why
- short and long term impact of work
- re-entry period

Notification usually includes newspaper articles and notices, public meetings and door-to-door information sessions. Notification is an area that can make pesticide applicators uncomfortable but experience has shown that a good notification program will alleviate problems and misunderstandings down the road.

**In New Brunswick, public notification is a condition on a Pesticide Use Permit. Notices must be placed in newspapers a minimum of 14 days before program startup and include:**

- location(s) of program
- description of program and reason for program
- info on contractors utilized
- general information on product(s) – environmental, health information
- legislation requirements
- contact name, address, etc.

This notification program is applicable to forestry applications (ground and aerial) as well as certain industrial programs. Contact the New Brunswick Department of the Environment for the most up-to-date requirements.

**Staff training** is crucial in a good notification program. Applicators must be organized and present a good first impression. They must be prepared to answer questions about:

- toxicity level of pesticide products being used
- impact on people and wildlife
- alternative methods considered
- protection of off-target vegetation (drift control, control of fire hazards)

This information must be given in a clear, concise and positive manner. Applicators should have information regarding the program, contact person, return address and telephone numbers that they can make available to the public.

In the province of New Brunswick, signage is required in all treatment areas, with few exceptions. Signs must meet the following criteria:

- rectangular in shape with a minimum size of 14cm x 12cm
- rain resistant with type letters of sufficient size and clarity to be easily read
- contain a symbol of a cautionary raised hand inside the symbol of a stop sign
- contain the following information – "ATTENTION", "Pesticide Application", name of the pesticide and the Pest Control Product Registration Number, date of application, name of the applicator and the operator or logo and phone number
- information must be bilingual

**Criteria for signs and posting of signs are specified on pesticide use permits.**

Contact the New Brunswick Department of the Environment for the most up-to-date requirements.

Information should also be made available during the implementation of a pesticide program. Applicators should be able to briefly and simply explain to the public:

- the control method being used (including herbicide trade name and the active ingredient)
- safety measures in place including personal safety gear and drift control
- the reason for the pesticide application

- for whom the work is being done
- re-entry period, if applicable
- how to contact their supervisor for more information

**Berry Picking Areas**

## Berry Picking Areas

There are special considerations for industrial applications as berry picking areas are often located along roadsides, transmission corridors, etc. It is important to keep in mind that berries are:

- a source of food for wildlife
- a source of food for people
- a source of income for people

Spraying these areas may contaminate the berries and/or destroy the berry plants. Berry picking areas should be identified in a site management plan and the following precautions should be taken:

- areas should be tagged so applications can be avoided
- implement alternative methods of vegetation control
- if a pesticide application is the only acceptable method of control, ensure that it will occur after the berries have been picked.

If a known berry picking area has been accidentally sprayed, the site must be posted until the berries have fallen off the branches.

Information regarding proposed pesticide applications should tie in with public information guidelines of forestry management in general. It is easier to inform people about a pesticide project if an on-going effort has already been in place to educate the public on forest management and pesticide use.

**Credibility and professionalism are the cornerstones to any good notification program. Information sources must come from trustworthy individuals and be presented in a factual, unbiased manner.**

## “Actions will speak louder than words”

A professional applicator will increase the success of a pesti - cide application program by gaining public confidence by:

- being knowledgeable about the control program
- considering the neighbors needs
- taking the time to listen to the publics concerns

The end message is that pesticides can be applied safely in the environment when proper techniques, equipment and products are used.

## Review Questions –
## Chapter 10 / Professionalism

1. What is bystander exposure?

2. What information should be included in a notification program?

3. What information should the applicator be prepared to discuss with the public?

4. What management program should be followed in a berry-picking area?

# 11 Interpreting a Label

## Introduction

The pesticide label is an essential source of information for the applicator and is a legal document. Applicators must read the label before using the product and abide by the directions.

**Goals of the Chapter**

- Be familiar with label restrictions as they apply to forestry applications.
- Be able to describe forest/woodland use restrictions.

## Label Restrictions

**Label Restrictions**

Applicators need to be aware of and understand restrictions that may occur on certain pesticide labels. These restrictions may include information on:

- tank mixes
- compatibility
- Forest/Woodland Use
- Aerial application

Pesticides used in forestry are divided into the following prod - uct categories and the categories are specified on labels:

## Forest Management – Restricted

**Forest Management – Restricted**

These products can be used for treatment of more than 500 hectares of a wooded area or of a site to be planted to forest and may include aerial application. All products with direction for "forest" or "forest management" uses are classified as Restricted. The labels of these products bear the statement: "This product is to be used only in the manner authorized; consult provincial pesticide regulatory authorities about use permits which may be required". This applies to all crown, leased and private lands.

## Woodlands Management

**Woodlands Management**

These products can be used for the treatment of not more than 500 hectares of a wooded area or of a site to be planted to for - est. A site is defined as a continuous monoculture without a break in cultural practice or management stage. A site of 1,000 ha cannot be divided into blocks of 500 ha to be treated indi - vidually under the Woodlands Management category. Products with directions for Woodlands Management can be applied by air if they have a Restricted classification or have aerial appli - cation as a Restricted Use. The Restriction instructs the user to consult provincial pesticide regulatory authorities about use permits that may be required.

Products for Woodlands Management with commercial classi - fication can be used for treatment of no more than 500 hectares of a wooded area, as follows:

1. Application of pesticides to woodlands only by ground equipment.

2. Application of pesticides in tree nurseries or seed orchards by ground or aerial equipment.

3. Application of pesticides in treed areas such as municipal parks only by ground equipment.

## Ornamentals

Ornamentals

Application of pesticides in treed areas of less than one hectare is designated as ornamental uses and may include single trees. These products are generally classified as Commercial or Domestic pesticides.

## Rights-of-way (Brush Control)

Rights-of-Way (Brush Control)

Products with directions for rights-of-way (ROW) can be used for ROW in forestlands and can be applied by ground or aerial equipment within the Commercial label classification. Aerial application is not permitted in urban areas.

**Note: The application rate for insecticides may vary among the Forest Management, Woodlands Management and Ornamental use categories for the same pest and tree species because the degree of control required may be different.**

## Review Questions –
## Chapter 11 / Interpreting a Label

1. What are the four restrictions that could appear on a pesticide label for forestry applications?

2. Describe one of the four restrictions.

# Answers to Review Questions

**Legislation – Chapter 1**

1. Pesticides Control Act and Regulations.

2. Pesticides Management Unit, New Brunswick Department of Environment.

3. Any company conducting commercial forestry and or industrial pesticide application programs in the Province of New Brunswick must have a Business Operator's License.

4. The Regulatory Requirements for a pesticide storage are:
   - meet all federal, provincial and municipal legislation.
   - must have a floor impermeable to pesticides stored.
   - restricted access to authorized personnel only.
   - signs posted containing the words "Pesticide Storage; authorized persons only; no smoking" and "Entreposage de pesticides; personnes autorisees seulement; interdiction de fumer".
   - have a contingency plan in place.
   - have been equipped according to the directions of the Director of Pesticides Control.
   - meet any other terms and/or conditions imposed by the Director of Pesticides Control.

5. True, in the Province of New Brunswick a pesticide operator must hold a Certificate of Insurance.

6. A Pesticide Use Permit must include information on the type of application, the product or products to be used, where in the province the application will take place and the purpose of the application.

**Vegetation Management – Chapter 2**

1. The factors that influence herbicide activity are:
   - Shape and surface of leaves
   - Weather conditions

- Plant growth stage
- Soil type
- Soil moisture
- Cultivation
- Resistance

2. A contact herbicide kills only the part of the plant that the herbicide comes into contact. There is relatively little movement of the herbicide within the plant.

3. Four vegetation management techniques are:
   - prevention.
   - cultural control.
   - mechanical control.
   - biological control.
   - chemical control.

4. Integrated vegetation management is utilizing various methods of control combined into a single management program.

5. The environmental considerations when using residual herbicides are:
   - Set up buffer zones.
   - Ensuring the treatment site is not in an area of a high water table.
   - Future use of the site.
   - Persistence of the product
   - Avoid steep slopes
   - Be aware of off-target species that may be adversely impacted by the herbicide

**Insect Management – Chapter 3**

1. The common stages of insect growth are:
   - Egg
   - Larva
   - Nymph
   - Pupa
   - Adult

2. The stages that the insects are most susceptible to control measures is during the early part of development – young nymph or larva stage.

3. True, defoliators do the majority of the damage in the larval stage.

4. Contact pesticides must (a and d), come in contact with the pest to be effective and come in contact with pest or vegetation that the pest comes into contact with.

5. True, growth regulators act like the organisms own hormones.

**Disease Management – Chapter 4**

1. The environmental stresses that may cause disease symptoms in forestry are:
   - Damage from frost, snow or ice
   - Prolonged flooding on the forest floor
   - Drought
   - Nutrient deficiencies or excesses

2. Four pathogens that cause disease in trees are:
   - Fungi
   - Bacteria
   - Viruses
   - Nematodes

3. A protectant fungicide provides a protective film of fungicide on or around the plant to prevent fungal spores from germinating.

4. The factors that influence fungicide efficacy are:
   - Timing of application
   - Fungus lifecycle
   - Weather
   - Resistance

5. Good management practices for disease control are:
   - selecting disease tolerant species
   - site preparation
   - stump and root extraction
   - harvest scheduling
   - pruning and spacing operations

**Vertebrate Management – Chapter 5**

1. Vertebrates do most of their damage during the winter months when food is scarce.

2. When implementing an effective control program, the fol - lowing must be considered:
   - Population density
   - Mobility of the pest
   - Habitat of the pest
   - Availability of food
   - Predators of the pest

3. The federal, provincial and municipal authorities must be contacted before initiating a vertebrate control program.

**Environmental Impact – Chapter 6**

1. Buffer zones are important because they:
   - Catch spray drift or run-off that minimizes aquatic habitats.
   - Prevent damage to stream -side vegetation.

2. Land resources can be protected from pesticide contamina - tion by:
   - Setting aside certain areas of treatment blocks
   - Choosing selective methods of application to protect non-target organisms.
   - Working with wildlife habitat staff to develop a site specific management plan.

3. Aquatic organisms can be harmed through incorrect pesti - cide use by:
   - Contaminating habitat.
   - Reducing food supply through loss of food organisms or stream side vegetation.
   - Loss of vegetation canopy over streams.

**Application Technology– Chapter 7**

1. The types of foliar application are:
   - Bud break spray
   - Early foliar spray
   - Late foliar spray
   - Fall spray

2. A basal bark application is the application of a herbicide solution on the base of stems from a height of approximate - ly 0.5 meters to ground level, on root collars and on exposed roots.

3. False, tree growth retardants are not registered for commer - cial use in Canada.

4. Two types of compressed air sprayers are hand sprayers ad backpack sprayers.

5. Disadvantages of using a shroud for a boomless sprayer are:
   - Operator cannot see the nozzles
   - Difficult to calibrate nozzle tips
   - Difficult to clean under some models
   - Possible buildup and runoff of some herbicides

6. A hypo-hatchet is a hand held unit that is a “hatchet” attached to a hose and a small mixing tank. The herbicide is delivered to the cambium layer after the chisel head has been inserted into the bark. A lever is than activated to dispense the herbi - cide. A measured amount of herbicide is delivered with each hit of the axe to the stem or trunk.

7. Advantages of high pressure boom sprayers are:
   - Provide good penetration and coverage
   - Well built and long lasting

**Safety – Chapter 8**

1. Hazards that may be present at the application site are: terrain, weather, man-made, traffic or strenuous physical hazards

2. The pre application functions are:
   - Pre application meeting that will discuss application details, legal requirements, hazards, sensitive areas and emergency response plants.
   - Work site survey and maps to plan sensitive areas and mark hazards.
   - Develop a management plan that includes application decisions, crew supervision guidelines (chain of command, spot checks to ensure safe working conditions), job scheduling,

3. Applicators can protect themselves and others from equip - ment hazards by:
   - Being fully trained and certified in the use of the equipment.
   - Follow manufacturers guidelines
   - Properly maintain equipment
   - Wear appropriate personal protective equipment
   - Pay attention
   - Keep unauthorized people away from job site

4. False, Temporary pesticide storage **does** need to meet provincial regulations.

**Contingency Planning - Chapter 9**

1. The five features that an emergency response program should have are:
   - Facility emergency plans
   - Field emergency plans
   - Emergency services, supplies and equipment
   - Training
   - Emergency notification

2. False, Vomiting should only be induced when recommended by the provincial poison control center.

3. Items that should be contained in a pesticide spill kit are:
   - personal protective equipment (gloves, boots, waterproof apron, coveralls, eye protection and respiratory protective equipment)
   - absorbent material such as sand, activated charcoal, vermiculite, dry coarse clay, kitty litter or commercial absorbent
   - neutralizing material such as hydrated lime or activated charcoal
   - long-handled brooms
   - shovels
   - waste container with lid
   - blank labels to identify contents of waste containers

4. Yes, licensed pesticide operators in New Brunswick require a contingency plan.

5. Your business should have a contingency plan to:
   - Protect your employees
   - Prevent an emergency from becoming a major disaster
   - Protect the community
   - Protect your business
   - Keep environmental damage to a minimum
   - Build confidence with your neighbours

**Professionalism -Chapter 10**

1. Bystander exposure includes people who may come into contact with pesticides without being directly involved.

2. Information that should be included in a notification program is:
   - Where the work is to be carried out
   - The purpose of the work
   - The method chosen and why
   - Short and long term impact of work
   - Re-entry period

3. Information that the applicator should be prepared to discuss with public:
   - The control method being used
   - Safety Measures
   - The reason for the pesticide application
   - For whom the work is being done
   - Re-Entry period
   - Contact names and numbers

4. The management program that should be followed in a berry-picking area includes:
   - Areas should be tagged so applications should be avoided
   - Implement alternative methods of vegetation control
   - If pesticide application is unavoidable, ensure that the work will occur after the berries have been picked

**Interpreting a Label -Chapter 11**

1. Forest Management – Restricted; Woodlands Management; Ornamentals; Right-of-Way (Brush Control).

2. See chapter 11 for descriptions.

# Glossary

ABSORPTION: The movement of a chemical into plants, animals (including humans), microorganisms, or soil.

ACARICIDE: A pesticide used to control mites and ticks. A miticide is a type of acaricide.

ACTIVATED CHARCOAL: Charcoal which when finely ground adsorbs liquids and gases.

ACTIVE INGREDIENT: The chemical or chemicals in a product responsible for pesticidal activity.

ADHERENCE: The property of a substance to stick to a given surface.

ADJUVANT: A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION: The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high organic soils tend to adsorb pesticides.

AEROSOL: A material stored in a container under pressure. An extremely fine mist is produced when the material, dissolved in a liquid, is released into the air from the pressurized container.

AGITATION: Process of stirring or mixing in a sprayer.

ANNUAL: A plant that completes its life cycle in one year.

ANTIDOTE: A practical treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ANTI-SIPHONING: A hose attachment designed to prevent backflow into a water source. Used to prevent flow of pesticide mix from spray tank.

ARACHNID: A wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks, and mites are arachnids.

ARTHROPOD: An invertebrate animal characterized by a jointed body and usually a hard body covering that is molted at intervals. Mites are arthropods.

ATROPINS (ATROPINE SULFATE): An antidote used to treat organophosphate and carbamate poisoning.

ATTRACTANT: A substance or device to lure insects or other pests to a trap or poison bait.

AVICIDE: A chemical used to kill or repel birds.

BACTERIA: Microscopic organisms, some of which are capable of producing diseases in plants and animals.

BACTERICIDE: Chemical used to control bacteria.

BAIT: A food or other substance used to attract a pest to a pesticide or a trap where it will be destroyed.

BAND APPLICATION: Application of a pesticide or other material in or beside a crop row rather than over the entire field area (See Broadcast Application).

BENEFICIAL INSECT: Inset that is useful or helpful to humans. Examples are pollinators and parasites and predators of pests.

BIENNIAL: A plant that completes its life cycle in two years.

BIOLOGICAL CONTROL: Control of pests using predators, parasites, and disease-causing organisms. May be naturally occurring or introduced.

BRAND NAME: The name, number, or designation of a specific product or device made by a manufacturer or formulator.

BROADCAST APPLICATION: The uniform application of a pesticide or other material over an entire field or area.

BROADLEAF PLANTS: Plants with broad, rounded, or flattened leaves with netted veins (Examples: dandelion and rose). Different from the narrow blade-like leaves with parallel veins of grasses, sedges, rushes and onions.

BROAD-SPECTRUM PESTICIDE: A pesticide that is effective against a wide range of pests. Usually refers to insecticides and fungicides.

BUFFERS: Adjuvants used to retard chemical degradation of some pesticides by lowering the pH of alkaline water.

CALIBRATE-CALIBRATION: To properly adjust equipment, to determine the amount of material applied to the target area.

CANUTEC: Canadian Transport Emergency Center established to provide information on chemicals. Operated by Transport Canada.

CARBAMATES: A group of pesticides containing nitrogen, formulated as insecticides, fungicides and herbicides.

CARCINOGENIC: The ability of a substance or agent to induce malignant tumors (Cancer).

CARRIER: An inert liquid, solid, or gas added to an active ingredient to make a pesticide formulation. A carrier is also the material, usually water or oil, used to dilute the formulated product for application.

CHEMICAL NAME: The scientific name of the active ingredient(s) found in the formulated product. This complex name is derived from the chemical structure of the active ingredient.

CHLORINATED HYDROCARBON: A pesticide containing chlorine, carbon and hydrogen. Many are persistent in the environment.

CHLOROSIS: The yellowing of a plant's normally green tissue.

CHOLINESTERASE: A chemical catalyst (enzyme) found in animals that reduce the activity of nerve impulses.

CHRONIC TOXICITY: The ability of a material to cause injury from repeated, prolonged exposure to small amounts (See Acute Toxicity).

COMMERCIAL USE PESTICIDE: A pesticide which is intended for use by commercial users. Categories include agriculture, pest control operators and forestry. Pesticides are highly concentrated, available in larger quantities and can be relatively toxic. Training for handling and using is advisable and is actually required in some provinces.

COMMON NAME: A name given to a pesticide active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are know by a number of trade or brand names but the active ingredient(s) has only one recognized common name. Example: The common name for Sevin insecticide is carbaryl.

COMPATIBLE: Chemicals are compatible if they can be mixed without reducing the effectiveness of any individual product.

CONCENTRATION: Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTACT HERBICIDE: A chemical that kills primarily by contact with plant tissue, with little or no translocation.

CONTAMINATION: The presence of an unwanted substance in or on a plant, animal, soil, water, air or structure (See Residue).

CORROSIVE POISON: A poison containig a strong acid or base which will severely burn the skin, mouth, stomach, etc.

DAYS TO HARVEST: The minimum number of days permitted by law between the last pesticide application and the harvest date (Same as Preharvest Interval).

DECONTAMINATE: To remove or break down a pesticide chemical from a surface or substance.

DEFOLIANT: A chemical which initiates the premature drop of leaves.

DEGRADATION: The process by which a chemical compound is broken down to a simpler compound by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT: The amount of pesticide on the treated surface after application.

DERMAL TOXICITY: The ability of a pesticide to cause injury to a human or animal when absorbed through the skin.

DESICCANT: A chemical that promotes drying or loss of moisture from a leaf or plant part.

DIAGNOSIS: The positive identification of a problem and its cause.

DILUENT: Any liquid or solid material used to dilute or carry an active ingredient.

DISINFECTANT: A chemical or other agent that sills or inactivates disease-producing microorganisms in animals, seeds, or other plant parts. Also, commonly refers to chemicals used to surface-sterialize inanimate objects.

DISPERSING AGENT: An adjuvant that facilitates mixing and suspension of a pesticide formulation in water.

DOMESTIC USE PESTICIDE: A pesticide which is intended for use around homes and in gardens. Pesticide is dilute, available only in small quantities and no special training is required for its use.

DOSE, DOSAGE: Quantity of pesticide applied to a given area or target.

DRIFT: The airborne movement of a pesticide to a given area or target.

DUST: A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

EMULSIFIABLE CONCENTRATE: A pesticide formulation produced by dissolving the active ingredient and an emulsifying agent in a suitable solvent. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER): A chemical which aids in the suspension of one liquid in another which normally would not mix together.

EMULSION: A mixture of two liquids which are not soluble in one another. One is suspended as very small droplets in the other with the aid of an emulsifying agent. Example: Oil in water.

ENCAPSULATED PESTICIDE: A pesticide formulation with the active ingredient enclosed in capsules of polyvinyl or other synthetic materials; principally used for slow release.

ENDANGERED SPECIES: Individual plants or animals with a population that has been reduced to the extent that it is near extinction.

ENVIRONMENT: All the features that surround and affect an organism or group of organisms.

FETOTOXIC: The ability of a substance to cause harm to a developing fetus but not necessarily cause deformities. (See Teratogenic)

FLOWABLE: A pesticide formulation in which a very finely ground solid particle is suspended (not dissolved) in a liquid carrier.

FUMIGANT: A pesticide that forms gases that are toxic to plants and animals when absorbed or inhaled.

FUNGI (SINGULAR FUNGUS): Nonchlorophyll-bearing plants, living as saprophytes or parasites. Some infect and cause diseases in plants, animals and humans or destroy wood and fiber products. Others are beneficial e.g. decomposers and human food source (Examples: rusts, mildews, molds, smuts).

FUNGICIDE: A chemical used to control fungi.

GERMINATION: Refers to the sprouting of a seed or the production of a germ tube (mycelium) from a fungus spore.

GPA - Gallons per acre

GPM - Gallons per minute.

GRANULE: A dry pesticide formulation. The active ingredient is either mixed with or coated onto an inert carrier to form a small, ready to use, low-concentrate particle which does not normally present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size and shape.

GROUNDWATER: Water sources located beneath the soil surface from which well water is obtained or surface springs are formed.

GROWTH REGULATOR: A chemical which alters the growth processes of a plant or animal.

GUARANTEE: The amount of active ingredient in a product as stated on the label. Usually expressed as a percentage by weight or as weight per unit volume.

HERBACEOUS PLANTS: Plants that do not develop woody tissues.

HERBICIDE: A pesticide used to kill or inhibit plant growth.

HOST: A plant or animal on or in which a pest lives.

HYDROLYSIS: Breakdown of a chemical in the presence of water.

INCOMPATIBLE: Two or more materials which cannot be mixed or used together.

INERT INGREDIENT: An active material in a pesticide formulation which does not have pesticidal activity.

INHALATION: Taking in through the lungs; breathing in.

INHALATION TOXICITY: The property of a pesticide to be poisonous to humans or animals when breathed in through the lungs.

INOCULUM: That portion of the pathogen that can cause disease in a host.

INSECTS: Arthropods characterized by a body composed of three segments and three pairs of legs.

INSECTICIDE: A pesticide used to control or prevent damage caused by insects.

INTEGRATED PEST MANAGEMENT: The use of all suitable pest control methods to keep pest populations below the economic injury level. Methods include cultural practices, use of biological, physical and genetic control agents, and the selective use of pesticides.

LABEL: All printed material attached to or part of a pesticide container.

LARVAE (SINGULAR LARVA): The immature form of an insect or other animal that hatches from the egg.

LC50: The concentration of a pesticide, usually in air or water, which can kill 50 percent of the test population or animals. LC50 is usually expressed in parts per million (ppm). The lower the LC50 value, the more acutely toxic the chemical.

LD50: The dose amount of pesticide which can kill 50 percent of the test animals when eaten or absorbed through the skin. LD50 is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD50, the more acutely toxic the chemical.

LEACHING: The movement of a substance through soil with water.

METABOLITE: In the case of pesticides, a compound derived from changes in the active ingredient through chemical, biological, or physical reactions. The metabolite may be simpler or more complex and may or may not be more poisonous than the original chemical.

METAMORPHOSIS: A change in the shape, size, and/or form of an animal.

MICROBIAL DEGRADATION: Breakdown of a chemical by microorganisms.

MICROORGANISM: An organism that is so small it cannot be seen without the aid of a microscope.

MITE: A small arthropod similar to an insect but with eight legs. Its body is divided into two parts and has no antennae.

MITICIDE: A pesticide used to control mites; synonymous with acarcide.

MODE OF ACTION: The way in which a pesticide exerts a toxic effect on the target plant or animal.

MUTAGENIC: The ability of a substance or agent to cause genetic changes in living cells.

MYCELIUM: The mass of filaments that forms the body of a fungus.

NEMATICIDE: A pesticide used to control nematodes.

NEMATODES: Microscopic, colourless, worm-like animals that live as saprophytes or parasites. Many cause diseases of plants or animals.

NEUROTOXIC: The ability of a substance or agent to cause disorders of the nervous system.

NIOSH: The U.S. National Institute for Occupational Safety and Health. NIOSH operates a testing and certification program for respirators.

NONPERSISTENT PESTICIDE: A pesticide that does not remain active in the environment more than one growing season.

NONSELECTIVE PESTICIDE: A pesticide that is toxic to a wide range of plants or animals without regard to species. For example, a nonselective herbicide can kill or damage all plants it contacts.

NONTARGET ORGANISM: Any plant or animal other than the intended target(s) of a pesticide application.

NOXIOUS WEED: A plant defined by law as being particularly troublesome, undesirable, and difficult to control.

ONCOGENIC: The property to produce tumors (not necessarily cancerous) in living tissues. (See Carcinogenic).

ORAL TOXICITY: Ability of a pesticide to cause injury when taken by mouth.

ORGANOPHOSPHATES: A large group of pesticides which contain the element phosphorus. Most are nonpersistent insecticides/miticides. Many are highly toxic.

PATHOGEN: A disease causing organism.

PENETRANT: An adjuvant added to a spray mixture to enhance the absorption of a pesticide.

PERENNIAL: A plant that lives more than two years.

PERSISTENT HERBICIDE: A herbicide that when applied at the label rate will remain in the soil, often for years. Potentially harmful to rotational crops.

PERSISTENT PESTICIDE: A pesticide chemical (or its metabolites) that remains active in the environment more than one growing season. These compounds sometimes accumulate in animal and plant tissues.

PEST: An undesirable organism (insect, fungus, nematode, weed, virus, rodent) which is injurious to humans, desirable plants and animals, manufactured products, or natural products.

PEST CONTROL PRODUCTS ACT: The Act administered by Agriculture Canada requires a pesticide to be adequately tested before registration and sale. Once registered, the pesticide must bear a registration number.

PESTICIDE: A chemical or other agent used to kill or otherwise control pests, or to protect from a pest.

PH: A measure of the acidity/alkalinity of a liquid; acide below pH7, basic or alkaline above pH7.

PHEROMONE: A substance emitted by an animal to influence the behaviour of other animals of the same species. Some are synthetically produced for use in insect traps.

PHOTODEGRADATION: Breakdown of chemicals by the action of sunlight.

PHYTOTOXICITY: Injury to plants.

PISICICIDE: A chemical used to control pest fish.

POINT OF RUNOFF: When a spray starts to run or drip from the leaves and stems of plants or the hair or feathers of animals.

POISON CONTROL CENTER: An agency, generally a hospital, which has current information as to the proper first aid techniques and antidotes for poisoning emergencies. Listed in telephone directories.

POSTEMERGENCE: After the weed or crop plants have appeared through the soil. Usually used to specify the timing of herbicide applications.

PPM: Part per million. A means to express amounts of chemicals in or on food, plants, animals, water, soil or air. One part per million equals 1 pound in 500 tons. PPB is parts per billion.

PERCIPITATE: A solid substance that forms in a liquid and settles to the bottom of a container . A material that no longer remains in suspension.

PREDATOR: An animal that attacks, feeds on, and kills other animals. Examples of predaceous animals are hawks, owls, snakes, fish and many insects.

PRE-EMERGENCE: Before the weed or crop plants have appeared through the soil. Usually used to specify the timing of herbicide applications.

PREHARVEST INTERVALS: Same as days to harvest.

PROTECTANT: A pesticide applied to a plant or animal prior to infection or attack by the pest in order to prevent infection or injury by the pest.

PROTECTIVE EQUIPMENT: Equipment intended to protect a person from exposure during the handling and application of pesticides. Includes long-sleeved shirts and long trousers, coveralls, suitable hats, gloves, shoes, respirators and other safety items as needed.

PUPA: The intermediate developmental stage of some insects between larva and adult.

RATE OF APPLICATION: The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured as per ha or per 1,000 square meter.

REENETRY INTERVAL: The length of time following an application of a pesticide when a person is required to wear protective clothing and equipment in a treated field.

REGISTRATION NUMBER: A number assigned to a pesticide product by Agriculture Canada when the product is registered by the manufacturer or the designed agent. The number must appear on all labels for a particular product.

REGISTERED PESTICIDES: Pesticide products which have been registered by Agriculture Canada for the uses listed on the label.

REPELLENT: A compound that keeps insects, rodents, birds or other pests away from plants, domestic animals, buildings or other treated areas.

RESIDUAL PESTICIDE: A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE: The pesticide active ingredient or its breakdown product(s) which remain in or on the target after treatment.

RESISTANT: A population of organisms that are uninjured or unaffected by a certain dosage of pesticide chemical used to control other populations of the same organism successfully . Also, plants and animals that are unaffected by a pest species. (See Tolerant)

RESTRICTED USE PESTICIDE: A pesticide which has one or more restrictions placed on its handling, use or storage. For example, all aquatic and forestry use pesticides are restricted. Other restrictions include storage conditions and toxicity.
RODENTICIDE: A pesticide used to control rodents.

RUNOFF: The movement of water and associated materials on the soil surface.

SAFENER: An adjuvant used to reduce the phyto - toxic effects of a pesticide.

SELECTIVE PESTICIDE: A pesticide that is toxic to some pests, but has little or no effect on other similar species. Example: Some fungicides are so selective that they control only powdery mildews and other fungi.

SIGNALWORDS: Required word(s) which appear on every pesticide label to denote the relative toxi - city of the product.

SOIL INCORPORATION: The mechanical mixing of a pesticide product with soil.

SOIL INJECTION: The placement of a pesticide below the surface of the soil. Common application method for fumigants.

SOIL STERILANT: A chemical or agent that prevents the growth of all organisms present in the soil; a nonselective pesticide. Soil sterilization may be temporary or permanent depending on the chemical.

SOLUBLE POWDER: A finely ground dry pesti - cide formulation which will dissolve in water or some other liquid carrier.

SOLUTION: Mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are completely dissolved. Example: Sugar in water.

SOLVENT: A liquid such as water, oil, or alcohol which will dissolve another substance (solid, liquid, or gas) to form a solution.

SPORE: The reproductive unit of a fungus. A spore is analagous to a plant seed.

SPOT TREATMENT: Application to small areas.

SPRAY DEPOSIT: The amount of pesticide chem - ical that remains on a sprayed surface after the droplets have dried.

SPREADER: An adjuvant used to enhance the spread of a pesticide over a treated surface, thus increasing the area that a given volume of liquid will cover.

STICKER: An adjuvant used to improve pesticide spray droplet adherence to a plant, animal, or other treated surface.

STOMACH POISON: A pesticide that must be eaten by an animal in order to be effective; it will not kill on contact.

SUMMER ANNUAL: Plants that germinate in the spring or summer and complete their life cycle within one year.

SURFACTANT: A component of many adjuvants which improves the spreading, dispersing, and/or wetting properties of a pesticide mixture.

SUSCEPTIBLE: A plant, animal, or site that is affected by a pest. Also refers to pest populations that can be controlled by pesticides.

SUSPENSION: A pesticide mixture consisting of fine particles dispersed or floating in a liquid, usu - ally water or oil. Example: Wettable powders in water.

SWATH: The width of the area covered by one sweep of an airplane, ground sprayer, spreader or duster.

SYSTEMIC: A chemical that is absorbed and translocated within a plant or animal.

TANK MIX: The mixture of pesticides in a spray tank.

TARGET: The plants, animals, structures, areas or pests at which the pesticide or other control method is directed.

TECHNICAL MATERIAL: The pesticide active ingredient in pure form, as it is manufactured by a

chemical company. It is combined with inert ingredients or additives in formulations such as wettable powders, dusts, emulsifiable concentrates, or granules.

TERATOGENIC: The property of a substance or agent able to produce abnormalities or defects in living human or animal embryos and fetuses. These defects are not usually inheritable.

THICKENER: A drift control adjuvant such as cellulose or gel used to promote the formation of a greater proportion of large droplets in a spray mixture.

TOLERANCE: A regulation that establishes the maximum amount of pesticide residue (active ingredient or certain metabolites) that may legally remain in or on a raw agricultural commodity (food or feed product) at harvest or slaughter.

TOLERANT: The property of organisms, including pests, to withstand a certain degree of stress, such as pest attack, poor weather, or pesticides.
TOXIC: Poisonous to living organisms.

TOXICITY: The degree or extent that a chemical or substance is poisonous.

TRANSLOCATION: The movement of materials within a plant or animal from the site of entry . A systemic pesticide is translocated.

TRANSPORTATION OF DANGEROUS GOODS ACT: A federal act, administered by Transport Canada, promoting public safety in the transportation of dangerous goods. A number of pesticides are classified under this Act as dangerous goods.

ULTRA LOW VOLUME (ULV): Sprays that are applied at 4 Lor less per ha or sprays applied as the undiluted formulation.

VAPOR PRESSURE: The property which causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical or the easier it will evaporate.

VIRUS: Ultramicroscopic parasites composed of proteins. Viruses can only multiply in living tissues and cause many animal and plant diseases.

VOLATILITY: The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER DISPERSIBLE GRANULE: A dry, granular pesticide formulation that forms a suspension in water.

WATER TABLE: The upper level of the water saturated zone in the ground.

WEED: An unwanted plant.

WETTABLE POWDER: A dry pesticide formulation in powder form which forms a suspension when added to water.

WETTING AGENT: An adjuvant used to reduce the surface tension between a liquid and contact surface for more thorough coverage.

WINTER ANNUAL: Plants that germinate in the fall and complete their life cycle within one year.

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