Introduction to vegetation management

Key Questions:
Introduction to vegetation management

Learning Objectives:

• Understand the positive and negative effects of non-crop vegetation.
• Understand the importance of competition thresholds.
• Know the 3 basic strategies used for vegetation management.
• Know the considerations in choosing among alternative brushing techniques (manual, chemical, sheep).
Succession, Stand Development and Interspecies Competition

• Following disturbance, a series of new plant communities occupies the site.
• Re-occupation of the site by conifers may be slow.
• The objective of timber management is rapid re-occupation of site by crop trees to minimize regeneration delay
• On most sites it is easier to establish crop trees before brush communities dominate site.

What are the sources of re-vegetation on harvested sites?
At the pre-harvest, SP, stage, silviculturists need to predict species and rate of growth of vegetation community after disturbance and anticipate the need for vegetation management:

- What is going to come in, how much, how fast?
- How will it affect the survival and growth of crop trees?

*How can silviculturists answer these questions?*
Non-crop vegetation can have both beneficial and negative effects on crop trees, and on the broader objectives for a site:

*What are some beneficial effects?*

*What are some negative effects?*
As vegetation cover increases, light levels at the ground decrease, and competition for soil moisture and nutrients increases.

![Graph showing the fraction of full sunlight versus the sum of vegetation cover.](image)

**Equation:**
\[ \ln\left(\frac{I_z}{I_0}\right) = -0.0337 \times C_t \]

**Statistical Values:**
- \( R^2 = 0.913 \)
- \( S_{yx} = 0.761 \)
- \( n = 70 \)

![Graph showing soil water potential (MPa) versus months with different vegetation cover levels.](image)

**Figure 19.1:** The fraction of full sunlight which penetrates vegetation canopies decreases as cover increases. Results shown are from mixed-shrub and fireweed communities of southern British Columbia. (from Spittlehouse & Goldstein 1990)

(from Newton and Comeau 1990)
The objective of vegetation management is to achieve desired level of survival and growth of crop trees while maintaining benefits of non-crop vegetation:  
- growth is affected before survival.  
- look for thresholds where growth or survival drops rapidly.
Free growing stand - a stand of healthy trees of desired species whose growth is not impeded by competition from non-crop vegetation; silviculture prescription or guidelines specify species, age, stocking and height over non-crop vegetation.

Is this seedling free growing?
What about these ones?

Figure 3. The dynamics of three classes of competing vegetation. In projecting tree-growing status the growth pattern of the competitors and the tree must be taken into account.
Well-growing stand - a stand of healthy trees of desired species whose growth is impeded by competition from non-crop vegetation within acceptable limits; silviculture prescription or guidelines specify species, age, stocking and height relative to non-crop vegetation and other canopy layers.

Are these spruce well growing?
Silviculturists need to know the autecology of local vegetation complexes.

What attributes of competing species do you need to know?
# A Preliminary Guide to the Response of Major Species of Competing Vegetation to Silvicultural Treatments

by
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March 1986

## Table 3. Reproductive characteristics of selected species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Propagule description</th>
<th>Sexual reproduction</th>
<th>Miscellaneous</th>
<th>Vegetative reproduction</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acer glabrum</em> (Douglas maple)</td>
<td>Winged seeds</td>
<td>Wind</td>
<td></td>
<td>Basal sprouts</td>
<td></td>
</tr>
<tr>
<td><em>Acer macrophyllum</em> (bigleaf maple)</td>
<td>Large winged seeds</td>
<td>Wind (rarely animals)</td>
<td>Seedlings survival depends on adequate moisture</td>
<td>Basal (stump) sprouts</td>
<td>Considered a seeding banker</td>
</tr>
<tr>
<td><em>Alnus incana ssp. tenuifolia</em> (mountain alder)</td>
<td>Small, winged nutlets</td>
<td>Wind, Water</td>
<td>Low seed viability. Mineral soil seedbed preferred</td>
<td>Basal sprouts (Layering)</td>
<td>May be clone-forming</td>
</tr>
<tr>
<td><em>Alnus rubra</em> (red alder)</td>
<td>Small, winged nutlets</td>
<td>Wind</td>
<td>Moist mineral soil seedbed preferred</td>
<td>Basal (stump) sprouts</td>
<td>Aggressively seeds-in to disturbed sites</td>
</tr>
<tr>
<td><em>Alnus viridis</em> (Sitka or green alder)</td>
<td>Small, winged nutlets</td>
<td>Wind, Water</td>
<td>Moist mineral soil seedbed preferred</td>
<td>Basal sprouts</td>
<td>Seeds-in to disturbed sites</td>
</tr>
<tr>
<td><em>Asplenium trichomanes</em> (lady fern)</td>
<td>Spores</td>
<td>Wind, water and animals</td>
<td>Requires free water for sexual reproduction to succeed</td>
<td>Rhizomes</td>
<td>Prolific, widely disseminated spores. Forms small clones</td>
</tr>
<tr>
<td><em>Betula papyrifera</em> (paper birch)</td>
<td>Small, winged nutlets</td>
<td>Wind</td>
<td>Dispersal mostly within 100 m of tree, Mixed mineral/organic seedbed preferred</td>
<td>Basal (stump) sprouts</td>
<td>Seeding-in most important form of regeneration</td>
</tr>
<tr>
<td><em>Calamagrostis canadensis</em> (bluejoint)</td>
<td>Light seeds</td>
<td>Wind</td>
<td>Germinates on disturbed sites</td>
<td>Rhizomes</td>
<td>Invades both rhizomatically and by seed</td>
</tr>
</tbody>
</table>

http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh09.htm
Rubus spectabilis

Overstory Removal
- In areas where salmonberry is present prior to harvesting, it will rapidly expand in frequency and cover following overstory removal.
- Expansion is primarily by means of rhizomatous suckers and germination of buried seed.
- Seedling germination is enhanced by soil disturbance accompanying logging.
- Where salmonberry is not present prior to logging, it can invade areas of disturbed soil with seed carried in by animals or by germination of long-buried seed.
- Salmonberry is an aggressive invader and frequently becomes the dominant species on moist sites that were disturbed during logging operations.
- Salmonberry can increase significantly in the understory following thinning of conifer stands.

Manual Treatments
- Salmonberry rapidly sprouts and suckers following cutting.
- Most stems produce two or three sprouts each. Season of cutting apparently has no effect on the number of sprouts produced.
- In an Oregon study, growth of sprouts was significantly less on stems cut early in the growing season than on those cut when dormant; neither treatment succeeded in reducing competitive stress on conifers.
- Salmonberry stem density and leaf area increases after cutting.
- Multiple cuttings in one growing season do not appear to reduce the vigour of vegetative reproduction the following year.
- Manual treatments are not considered a viable method of reducing salmonberry frequency or cover.

Chemical Treatments
- Salmonberry is resistant to 2,4-D.
- Roundup applied as a foliar spray at 1-3 kg a.i./ha usually gives excellent control of salmonberry. All above-ground parts are killed and little subsequent sprouting or suckering occurs.
- Salmonberry tends to be more sensitive to late foliar sprays than to early foliar sprays.
- An Oregon study found that plants damaged by logging operations were less susceptible to Roundup than undamaged plants.

Mechanical Site Preparation
- Unless it is severe enough to remove surficial soil layers, mechanical site preparation will probably increase the frequency of salmonberry.
- Damaged or flattened stems can sprout, sucker, or layer.
- Stem fragments incorporated into the soil frequently root and produce new colonies.
- Exposure of mineral soil can stimulate germination of buried seed.

Prescribed burning
- Germination is similar on burned and unburned sites, but severe fires can reduce the frequency of surviving seedlings.
- Salmonberry seems to be more sensitive to fire than thimbleberry.
There are 3 basic strategies for vegetation management:

- **Prevention** - create conditions which do not favour establishment and growth of competitors.

- **Outcompetition** - increase rate of establishment and growth of crop trees.

- **Suppression** - reduce non-crop vegetation cover below threshold level after your crop is established.
The Protection Triangle; Integrated Pest Management

Pathogen/Non-Crop Vegetation

Susceptible Host

Suitable Environment or Contributing Factors
Strategies and silviculture phases
1. ‘Prevention’ occurs at the harvesting and site preparation phases.

Treatments include retention of overstory shade, reduction of mineral soil exposure, killing or removing parent plants (seeders); or minimizing disturbance of parents (suckers and sprouters).
2. ‘Outcompete’ at the site preparation and planting phases.

Create and/or use optimal microsites, large vigorous planting stock of species/provenances well adapted to site, spot fertilize or use brush mats to enable crop trees to ‘outcompete’ competitors.
3. ‘Suppression’ occurs during the post-regeneration brushing phase. Treatments such as herbicide application, manual cutting, and grazing ‘remove’ or more commonly reduce competition.
Perennial herbs, trees and shrubs resprout after cutting.

Figure 1. Effect of season of cutting on the relative number, total height, average height, and crown width of dogwood sprouts observed 3 years after
Consider the efficiency, ergonomics and safety of manual techniques:

Brush saw, Clearing Saw
Silvana selective cutting head on a Ford Versatile tractor
Girdling (cutting through bark, phloem and cambium) suppresses resprouting.

L’il Beaver Power Girdler
Pruning Hook
Sandvik, brush axe
Brush Hook
Vredenburg Girdler
Chain Girdlers

http://www.for.gov.bc.ca/hfd/pubs/Docs/Frh/Frh005.htm
Worker safety

Manual and motor manual treatments have high accident rates relative to other silvicultural treatments.

What can you do during design and implementation phases to reduce the potential for accidents?
Grazing – sheep

Advantages
• multiple use of forest resources
• popular with public, avoids concerns about herbicides
• can control herbs and deciduous shrubs less than 120cm tall

Disadvantages
• may conflict with wildlife - cross infection domestic to wild sheep, predation by bears/wolves, loss of critical wildlife browse
• damage to riparian areas through trampling of banks, water quality concern
• trampling, browsing of crop trees, and compaction of high use areas
• need corrals and drinking water
• generally need to subsidize stock owner
Operational Considerations
• sheep herding used in high elevation clearcuts with mainly herbaceous brush and minimal slash (e.g. broadcast burned)
• browse needs to be palatable and have sufficient nutritive value
• avoid browsing too early or crop trees will be browsed - early to mid-summer is best
• control livestock movement to achieve moderately heavy, well distributed grazing
• need careful flock management to avoid conflicts with wildlife and water quality.
Brush mats - mechanical barrier
• Reduce grass and herb competition on young seedlings
• Increase soil temperature
• Trap soil moisture
• Apply at time of planting
• Slash and brush are major problem in installing
• Wind and livestock can damage or displace mats
Compared to manual and grazing methods for vegetation management, public acceptance of herbicides is low, especially for broadcast treatments:

- Controlling weeds to protect trees
  - Manual cutting
  - Sheep grazing
  - Cover crops
  - Natural plant toxins
  - Mechanical site-prep.
  - Mulches
  - Prescribed fire
  - Herbicide-individual plant
  - Herbicide-backpack
  - Microorganisms
  - Genetically engineered organisms
  - Herbicide-tractors
  - Viruses
  - Herbicide-aerial

% Public Acceptance in Ontario
Forest herbicides

Learning Objectives:
• Know the purpose of herbicides, and the biological, operational and social considerations in using them.
• Understand the public health and environmental concerns which underlie regulation of herbicide use.
• Know key principles of herbicide treatment design and implementation.
Acute toxicity is the capacity of a substance to cause ill-effects within a few hours or days after a single dose or exposure. • The amount of pesticide given in one dose required to kill 50% of a test population is called the lethal dose to 50% (LD50) or lethal concentration to 50% (LC50 is the ratio of pesticide to water/air in parts per million).

Chronic toxicity - the capacity of a substance to cause ill-effects which develop slowly and last a long time, e.g. months or years.

Health Risk=Toxicity * Exposure. Be aware of product toxicity and manage exposure.
Precautionary symbols indicate hazards posed by products.

Table 2. Precautionary shape and symbol combinations used on pesticide labels.

<table>
<thead>
<tr>
<th></th>
<th>Danger</th>
<th>Warning</th>
<th>Caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poison</td>
<td>![Poison]</td>
<td>![Warning]</td>
<td>![Caution]</td>
</tr>
<tr>
<td>Flammable</td>
<td>![Flammable]</td>
<td>![Warning]</td>
<td>![Caution]</td>
</tr>
<tr>
<td>Explosive</td>
<td>![Explosive]</td>
<td>![Warning]</td>
<td>![Caution]</td>
</tr>
<tr>
<td>Corrosive</td>
<td>![Corrosive]</td>
<td>![Warning]</td>
<td>![Caution]</td>
</tr>
</tbody>
</table>

Table 6. Interpretation of precautionary poison symbol and shapes used on pesticide labels. The shape indicates a pesticide has one (or more) of the characteristics indicated below.

<table>
<thead>
<tr>
<th>POISON HAZARD SYMBOL — the shape indicates one (or more) characteristics below</th>
<th>DANGER POISON</th>
<th>WARNING POISON</th>
<th>CAUTION POISON</th>
</tr>
</thead>
<tbody>
<tr>
<td>acute oral LD₉₀</td>
<td>less than 500 mg/kg</td>
<td>500—1,000 mg/kg</td>
<td>1,000—2,500 mg/kg</td>
</tr>
<tr>
<td>acute dermal LD₉₀</td>
<td>less than 1,000 mg/kg</td>
<td>1,000—2,000 mg/kg</td>
<td>2,000—5,000 mg/kg</td>
</tr>
<tr>
<td>respirator</td>
<td>required</td>
<td>advisable in confined spaces</td>
<td>advisable in confined spaces</td>
</tr>
<tr>
<td>eye effects</td>
<td>corrosive/irreversible</td>
<td>severe/reversible</td>
<td>irritant</td>
</tr>
<tr>
<td>chronic effects</td>
<td>fatal/irreversible</td>
<td>non-fatal/irreversible</td>
<td>non-fatal/reversible</td>
</tr>
<tr>
<td>petroleum distillates</td>
<td>10% or more (Domestic products)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active ingredient</td>
<td>Found in</td>
<td>Oral LD50 (mg/kg)</td>
<td>To kill 50% of a group of 100kg adults (kg or l)</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------</td>
<td>-------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>sodium chloride</td>
<td>table salt</td>
<td>3320</td>
<td>0.3 kg (1/3 of a box; 150 packages of ramen noodles)</td>
</tr>
<tr>
<td>hydrogen cyanide</td>
<td>fumigants</td>
<td>4</td>
<td>0.0004 kg (a few drops!)</td>
</tr>
<tr>
<td>1080</td>
<td>wolf/wallaby bait</td>
<td>0.22</td>
<td>0.000002 kg (less than one drop!!)</td>
</tr>
<tr>
<td>oil of citronella</td>
<td>bug repellent</td>
<td>7200</td>
<td>720 (0.7 litres)</td>
</tr>
<tr>
<td>deet</td>
<td>bug repellent</td>
<td>1950</td>
<td>195 (0.2 litres of bug repellent)</td>
</tr>
<tr>
<td>2,4 -D</td>
<td>herbicide</td>
<td>300</td>
<td>30 (3.9 kg of Weed &amp; Feed)</td>
</tr>
<tr>
<td>hexazinone</td>
<td>Velpar herbicide</td>
<td>1700</td>
<td>170 (0.7 litres of Velpar-L)</td>
</tr>
<tr>
<td>glyphosate</td>
<td>Vision herbicide</td>
<td>4300</td>
<td>430 (1.2 litres of Vision)</td>
</tr>
<tr>
<td>ethanol</td>
<td>Jägermeister</td>
<td>5500</td>
<td>550 (1.5 litres of Jägr)</td>
</tr>
</tbody>
</table>
Pesticide Labels are Standardized:

1. Trade Name
2. Guarantee
3. Formulation
4. Pest
5. Marketing Code
6. Warnings
7. Directions for Use
8. First Aid
9. Company Name and Address
10.

**Du Pont “Velbar” L Weed Killer** is a water dispersible solution to be used in water and applied as a spray for selective control of certain weeds in Christmas tree plantations, and for weed control in reforestation areas in excess of 200 ha (Woodland management). It may also be applied undiluted as a basal soil (spot) treatment for brush control in Woodland management. It is non-corrosive to equipment.

“Velbar” L is an effective general herbicide providing both contact and residual control. It is absorbed through the roots and foliage. For brush control, soil application is most effective.

Moisture is required to activate “Velbar” L in the soil. Best results are obtained when the weeds are less than 5 cm in height or diameter, soil is moist at time of application, and larger than 0.5 — 1.2 cm of rainfall occurs within two weeks after application. Foliar application to weeds is most effective under conditions of high temperature (above 27°C), high humidity and good soil moisture. Foliar application when vegetation is dormant or semi-dormant may not be effective.

In herbaceous plants, symptoms usually appear within two weeks after application under warm humid conditions, while 6 - 8 weeks may be required when weather is cool. If rainfall after application is inadequate to activate “Velbar” L in the soil, plants may recover from contact effects and continue to grow.

In woody plants, symptoms usually appear within three weeks after sufficient rainfall has carried the herbicide into the root zone, during periods of active growth. Defoliation and subsequent refoliation may occur, but susceptible plants are killed. The degree of control and duration of effect will vary with the amount of chemical applied, rainfall, temperature, and brush species, soil and other conditions.

**Directions for Use**

For broadcast treatments, apply “Velbar” L as a spray just before or soon after weed emergence. Do not apply to frozen or snow-covered soil. Before spraying, calibrate equipment to determine the quantity of water necessary to uniformly and thoroughly cover the vegetation and soil in a measured area to be treated. Use at least 5 L of water for each litre of “Velbar” L.

Add the proper amount of “Velbar” L to a spray tank filled with the amount of water to be used and mix thoroughly.

Christmas Trees and Areas of Woodland Management (plantations of less than 500 ha)

**Broadcast Application**

Use a sprayer properly calibrated to a constant speed and rate of delivery. Avoid overlapping or shutting off spray booms while starting, turning, slowing, or stopping in order to avoid injury to desirable trees. Spray by ground equipment only. Do not apply by air.

**Site Preparation**

Apply 9.0 to 19.0 litres of “Velbar” L per hectare in the spring after the ground has thawed. The higher rate will provide longer residual control. Black spruce, Manufactured by E. I. du Pont de Nemours & Company (Inc.)

**Wilmington, Delaware USA**

**UNPUBLISHED SPOT TREATMENT**

For control of deciduous brush and thorny plants (balsam fir, black spruce, white spruce or red pine) apply “Velbar” L undiluted to thawed soil in the spring or early summer. Use an exact or delivery hand-gun applicator (spot gun). Apply 0.75 to 1.50 L of “Velbar” L for 1 cm of stem diameter (breast height) of plants to be controlled. Direct the treatment as close as possible (within 0.5 m) to the root collar of plants to be controlled. When more than one delivery of “Velbar” L is applied in a stem, make applications around the circumference of the plant. Direct the applicator gun so that “Velbar” L is applied at least 1.0 m from desirable conifers.

**Weeds Controlled by Spot Applications**

Aspen-Poplar

Maple

Cherry

Birch

**Storage:** Store product in original container only, away from fertilizers, food, or feed.

Decontamination and Disposal: Clean equipment and empty containers by thoroughly rinsing with water dispose of the rinse water by draining in a non-graze area away from water supplies. Do not re-use empty container. Crush, break or puncture empty containers and bury them with the rinsings or deliver to sanitary landfill in accordance with municipal requirements. For additional information on disposal of containers and rinsings and for information about the applicable means of disposal, contact the regional office of the Environmental Protection Service, Environment Canada.

**NOTICE TO USER:** This product is to be used only according to the directions on this label. It is an active ingredient under the PEST CONTROL PRODUCTS ACT to control weeds under unsafe conditions on farms, market gardens, nurseries, or as specified by the administrator.

**NOTICE TO BUYER:** Location of the label and product description is accurate as of the date of this label. If you receive this product and there is a difference in the label and product description, contact the distributor at the address on the label.

Purchased from this material does not confer any rights under any paper containers outside Canada.

**Distributed in Canada by:**

**PONT CANADA INC**

General Products Division
Box 2300, Streetsville
Mississauga, Ontario
L5M 2J4
Glyphosate (a.i.)
• non-selective, foliar active, systemic herbicide.
• translocated in phloem to root and shoot meristems where it blocks synthesis of amino acids essential for protein synthesis, (via shikimic acid pathway which animals do not have).
• first registered in Canada for agricultural, industrial and domestic use in 1976.
• available for forestry use as: Vision (liquid formulation), Gel-Cap and Ez-Ject capsules (in domestic and agricultural use, the product is Round-up)
• accounts for 96% of total herbicide use in BC forests.

Advantages
• very low toxicity to mammals
• classified as non-carcinogenic by US EPA
• does not bioaccumulate
• tightly bound by soil particles therefore not transported
• readily metabolized by soil microbes into non-harmful breakdown products
• doesn't usually penetrate waxy cuticles or bark if surface applied
• liquid formulation mixed with water, applied using a variety of methods

Disadvantages
• non-selective, so timing and dosage are critical to avoid damage to crop
• rain within 6 hours of application reduces effectiveness
Growth in adoption of genetically engineered crops continues in the U.S.

Percent of planted acres

HT soybeans

HT cotton

Bt cotton

Bt corn

HT corn

Data for each crop category include varieties with both HT and Bt (stacked) traits.

http://www.ers.usda.gov/data/biotechcrops/
http://www.friendlysofcottagelake.org/waterlilies.htm

http://www.invasive.org/gist/handbook.html
Hexazinone (a.i)
• broad spectrum, residual, soil active systemic herbicide.
• absorbed by roots from soil, translocated to leaves through xylem
• interferes with photosynthetic activity
• first registered in Canada for industrial weed control in 1975.
• available for forestry as Velpar L (liquid), Pronone (pellets)
• 3% of total herbicide use in BC forests.

Advantages
• low toxicity to mammals
• does not bioaccumulate
• fast application of Velpar L in grid pattern using spot guns
• apply in spring and early summer, any weather as long as soil is not frozen
• residual activity in soil for 2-3 growing seasons
• degrades readily by photodegradation

Disadvantages
• kills conifer crop trees if grid spot is near roots
• requires adequate rainfall and takes 60-90 days for adequate root uptake
• extremely mobile in soil water, watch out for mobility on compacted soils
Triclopyr (a.i.)
• selective, foliar active (bark/cut stump), systemic growth regulator.
• available for forestry use as Release (formerly Garlon), registered in Canada in 1991.
• apply ester formulation in oil during dormant season to foliage, stem or cut surface or deciduous trees and shrubs.
• effective against salal
• may leach from sandy soils
• low acute toxicity to mammals
• ester formulation has high acute toxicity to fish, but breaks down rapidly in water.
• minor but increasing use in BC forests.
For each herbicide need to know the dose-response curve for the target species:
Objectives of herbicide treatments
• maximize delivery to and uptake by target plants.
• get enough active ingredient at site of action to disrupt metabolism of target plants.
• minimize delivery to and uptake by crop plants.
• contain herbicides within treatment area - minimize drift and avoid surface and subsurface water transport.
• minimize risk of weather disrupting treatment.
• minimize risks to worker safety and maximize efficiency of operation.

http://www.for.gov.bc.ca/hfd/pubs/docs/Frh/Frh006.htm
Considerations in developing a herbicide prescription:
1. herbicide
2. application pattern:
   - broadcast - treat whole site
   - band - treat strips along rows of crop trees
   - grid - apply herbicide to ground in grid pattern (Velpar L)
   - spot - treat circle around crop tree.
   - individual plant - foliar, ground spot or stem injection
3. prime mover and tool
4. rate - kg of active ingredient per hectare
5. carrier and concentration of herbicide in mix
6. timing – phenology of target and crop species
7. acceptable weather conditions before, during and after application
8. layout of treatment unit
<table>
<thead>
<tr>
<th>Prime mover</th>
<th>Application Tool</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>helicopter or fixed wing airplane</td>
<td>conventional boom/nozzle broadcast</td>
<td>broadcast</td>
</tr>
<tr>
<td></td>
<td>microfoil boom broadcast</td>
<td>broadcast</td>
</tr>
<tr>
<td></td>
<td>thru-valve boom broadcast/strip</td>
<td>broadcast/strip</td>
</tr>
<tr>
<td>off-road vehicle</td>
<td>conventional boom/nozzle broadcast/strip</td>
<td>broadcast/strip</td>
</tr>
<tr>
<td></td>
<td>thru-valve boom broadcast/strip</td>
<td>broadcast/strip</td>
</tr>
<tr>
<td>on-road tanker</td>
<td>hose and nozzle broadcast/strip</td>
<td>broadcast/strip</td>
</tr>
<tr>
<td>human</td>
<td>backpack and wand broadcast/strip</td>
<td>broadcast/strip/spot/individual</td>
</tr>
<tr>
<td></td>
<td>backpack and spot gun broadcast/strip</td>
<td>grid/spot/individual</td>
</tr>
<tr>
<td></td>
<td>backpack and mist blower broadcast</td>
<td>broadcast</td>
</tr>
<tr>
<td>human</td>
<td>hack and squirt broadcast/strip</td>
<td>individual weed stem</td>
</tr>
<tr>
<td></td>
<td>Gel-cap with drill broadcast/strip</td>
<td>individual weed stem</td>
</tr>
<tr>
<td></td>
<td>Ez-Ject cartridges with lance broadcast/strip</td>
<td>individual weed stem</td>
</tr>
<tr>
<td>human</td>
<td>cut &amp; spray stump broadcast/strip</td>
<td>individual weed stem</td>
</tr>
</tbody>
</table>
Herbicide treatments may kill perennial plants. Annuals and perennials re-establish quickly, with herbaceous plants dominating.
In summary:
• Non-crop vegetation is an important ecosystem component.
• Vegetation management begins at the pre-harvest stage.
• Prevent or outcompete severe vegetation competition by:
  - planting in first suitable window after harvesting
  - creating/using good microsites
  - using large vigorous stock of adapted species/provenance
• Suppress vegetation only when growth or survival of crop is threatened
• Manual techniques are more acceptable to public, but often more expensive and less effective than herbicides.
• Herbicides are highly regulated, special certification and permits are required to use them on forest land.
• Use spot herbicide treatments where possible and contain herbicide on site.