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CHAPTER 6
VEGETATION MANAGEMENT FOR SPECIAL SITES:
THE APPLICATION OF INTEGRATED PEST MANAGEMENT

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CHAPTER 6
VEGETATION MANAGEMENT FOR SPECIAL SITES: THE APPLICATION OF IPM

INTRODUCTION

The management of urban landscapes requires the control of unwanted vegetation on various sites.

For shrub and flower beds, weed control techniques are presented in chapter 4: mulches, ground cover plants to out-compete the weeds, manual cultivation, and herbicides under specific circumstances.

For lawns and turf areas, weed control approaches are presented in chapter 5: reducing the turf area with pavement or maturing grasses, monitoring the turf with transects, using weeds as indicator of soil condition, and establishing threshold of acceptable weed presence to determine if control is required.

The control of grasses, weeds or brushes is also required in other urban areas not in turf or ornamental beds. Vegetation control is required in high-traffic areas such as sidewalks, paved paths, around fences and park benches. It is also required in low-traffic areas such as remote sections of parks, drainage ditches and field edges.

An Integrated Pest Management approach to vegetation management includes the following steps:

- monitor the site to identify the plants and assess changes over time,
- establish a threshold by accepting the presence of some vegetation and determining when a control measure is necessary,
- selection of a control measure with least-toxic materials to permanently remove the unwanted species.

A few examples are found in Box 6-1.

Box 6-1: Weed control tactics in IPM

Mechanical and physical controls

Examples: mowing, cultivation, burning, paving

Horticultural controls

Examples: establishment of competitive plants, mulching

Biological controls

Examples: augmentation of predators, parasites, pathogens or other natural controls including grazing animals

Chemical controls

Examples: growth retardants, weed oils, selective and non-selective herbicides.

Source: Daar, Sheila, "Integrated Weed Management for Urban Areas", Bio-Integral Resource Center (Berkeley, CA), 1991.

A) WEED CONTROL AROUND FENCES, BENCHES AND SIDEWALKS

i) Proper design to prevent weed growth

The prevention of weed problems and the reduction of herbicide use start at the design stage. For example, weeds growing along sidewalks pose a maintenance problem in many urban areas, because they tend to grow in the interface between the sidewalk pavement and the street pavement. One solution is to design and build the sidewalk to remove the weed habitat, by adding an apron of concrete from the curb of the sidewalk to extend over the street pavement.

In lawns and turf areas, sections under and around a fence is constantly a problem. Mowing grass is made extremely difficult by fence posts planted in the lawn and the meshing of the fence installed down to the soil surface. Broadleaf weeds thrive along these edges. The same scenario occurs under park benches.

Herbicides or weed-eaters are often used in these areas. Herbicides are only a temporary solution as they leave the soil bare, which favour the weeds to grow back. Weed eaters are more desirable, as they select for low-growing plants and do not create a bare soil.

A more permanent solution is to replace the soil and lawn with brick pavers or a concrete underlying. Pavers installed directly under the fence, extending for 5 to 10 cm on each side of the fence, and placed so the top of the paver is at ground level, will serve as a mow strip. One wheel of the mower riding on the paver allows even cut of all the lawn. For play areas such as tennis courts, the fence posts can be installed inside the asphalt surface and, again, provide a mow strip adjacent to the grass.

To prevent weeds from growing through the brick or concrete pavement, layers of heavy building paper or roofing paper are placed on the soil and under the pavement. Jogger trails in parks or walking paths in a yard can be constructed with weed-proof paper against the soil and a few inches of sand or gravel on top for drainage.

In the City of Coquitlam, the installation of concrete pads impervious to weeds under fence lines costs about $6.50 per linear foot (Nihls, 1993). This installation is phased over many years to cover all areas and respect budget constraints.

Box 6-2: Sidewalk weed control in Coquitlam

The superintendent and field personnel of the Parks Operations, city of Coquitlam, use an IPM decision-making process for weed and vegetation management. A problem requiring constant attention is the control of weeds on and around sidewalks.

The first approach to weed growth in cracks is the regular monitoring of problem sites. A threshold has been established, so when weed growth exceeds 50% of the space, a treatment control is initiated.

The herbicide glyphosate has been the traditional method of control for sidewalks heavily infested. The City worked with a new application system where the herbicide formulation is pre-mixed in a box, loaded in a light backpack and connected to a long shaft lance. At the end of the shaft, a choice of nozzle attachments allow for spray swaths as narrow as 3 cm or as wide as 90 cm.

Advantages are many. The closed-system of mixing and application reduces the chemical exposure for applicators. The application of low volume, large droplets requires wetting the foliage without runoff. Finally, the nozzle attachments allow for accurate spot applications where required.

Other weed control techniques are being experimented. On areas of lower weed pressure, weed flaming with hand held torches was started in 1990. On large sites, tractor-mounted multi-torch units were tried. Weed flaming was compared to manual removal and herbicide for effectiveness and cost.

Long-term weed control is done through proper design of the facilities. For example, a maintenance problem is posed by weeds growing on the curb side, in the interface between the sidewalk and the street pavement. A solution was to pour a curb and gutter with gutter pan extending beyond the curb face a distance of 300 - 400 mm, which removes the weed habitat.

The design detail is specified by the Engineering Department. It also implements a program of flushing with high pressure water to remove dirt, debris and weed seed and provide a clean sidewalk.

Finally, the City passed a Boulevard Maintenance Bylaw in 1991 which requires owners of property adjacent boulevards to maintain sidewalk cracks and curbs free of weeds and debris. This approach enlists community involvement in helping control sidewalk vegetation in a cost effective manner.

Source: Nihls, Michael. Superintendent of Parks Operations (City of Coquitlam, B.C.) Personal Interview. July 13, 1993.

ii) Weed flaming to control weed growth

Weed flaming is being tested in various areas of B.C. for the control of weeds in sidewalks and in parks. The technology has been available for many years and is used on European urban sites to avoid using chemicals (Harris, 1992 and Daar, 1987). It is also used in the United States for agricultural crops such as sorghum, corn, potatoes and others.

Conditions of application

The equipment usually consists of torches held manually or mounted on a tractor. Heat and flame from burning liquid propane-gas are directed towards the weeds. Flamers are set 20 to 30 cm above the ground and moved at a speed of 2 to 4 km/h. Flamers set at a 30^{o} angle reach a larger weed leaf area without reflecting away. Higher pressure and a smooth surface are desired to keep the flames closer to the ground.

Only a light searing is required to kill the weeds. Heat in the range of 1800^{o}C (2000^{o}F) causes the liquid in plant cells to expand, rupturing the cell walls. There is no immediate physical evidence of damage, but within hours the weeds turn color, and within days they die. If the weeds are flamed long enough to blacken them, the opposite effect is obtained as the burning stimulates growth from remaining roots.

Weeds are more susceptible when they are young seedlings, 2.5 to 5 cm tall or in the 3-to-5 leaf stage. Broadleaf weeds such as pigweeds and small thistles are susceptible, but grasses larger than 2 to 3 cm tall will suffer a setback without dying. Weeds larger than 25 cm may cause difficulty to the flaming operation. Flaming does not destroy all weeds. Repeated treatments are required to exhaust root reserves and larger weeds must be cleared manually.

Field trials

A number of experiments conducted in the early 1960s in the United States demonstrated the weed control effect of weed flaming. Various treatments were compared for weed control in corn fields of Indiana in 1964. The best results were obtained from early shovel cultivation or pre-emergence herbicide, followed by two flamings (Liljedahl, 1965).

On ditchbanks of Arizona, the most effective control was obtained by searing, followed by a second burning a few days later. On similar sites in Texas, complete grass control was originally obtained with 12 burnings per year. Later, adequate control was maintained by burning 8 times during the growing season (Lowry, 1965).

Disadvantages

A number of disadvantages prevent the large scale use of weed flamers. A technology combining pressurized liquid propane and flames must be handled with great care to ensure a safe operation. Based on British Columbia experience, there are four problem areas.

1) The equipment must be bought or assembled while respecting technical and safety standards. Safety valves must be installed at various points to quickly shut off the device in case of problems or in windy conditions. The safety of the operator is a critical factor in the design and assembly of the machinery.

2) The personnel involved must become acquainted with the functional characteristics of the machinery. For example, the optimum flame temperature of 1800^{o}C is reached at 30 cm from the ground with a propane tank of 30 lbs. pressure. A propane tank of 25 lbs. pressure has to be set at a different height from the ground for the same effect. Technical information is available from distributors of liquid propane.

3) Timing is critical and repeated applications are necessary to control persistent weeds. This increases the cost of the treatment.

4) Operating the machinery close to landscape beds and wood mulch presents the risk of damaging valuable plants or starting uncontrolled fires. Flaming low branches and low foliage may not kill the landscape plants but it does seriously stunt their growth.

iii) Steam treatment to control weed growth

An approach to weed control currently researched in B.C. is the use of steam on right-of-ways and railway ballast. This technique for weed control is environmentally safe and poses no health hazard. As with flaming, the weed plant is exposed to high temperatures for a short period of time, disrupting the cell functions.

Many weed seedlings are killed with exposures of 1 to 2 seconds to steam heated to 200^{o}C (Upadhyaya, 1991). This exposure was found to kill seedlings of downy brome, curled dock, fireweed, meadow goat's-beard, narrow-leaved plantain, and orange hawkweed. Larger weed plants were killed by a two second exposure to steam. The treatment has to be repeated 3 or more times per year to kill the deep rooted weeds such as dandelion.

Experiments were conducted at the University of British Columbia to determine the effect of steam temperature on germination of weed and crop seeds (Upadhyaya, 1992). Seeds of kochia and diffuse knapweed lost their viability after an exposure of 0.5 second. Air dried seeds of wheat and barley require a two second exposure to steam at 200oC to lose their viability, while canola seeds must be exposed for one second.

As with other weed control treatments, using steam treatment to remove the unwanted vegetation exposes the soil and allows buried seeds to infest the area. When seedlings grow back, a repeated treatment application must be done before the weed sets new seeds. Over time, this will reduce the number of seeds. For perennial weeds growing from roots or rhizomes, repeated treatment applications will deplete the food reserves and reduce the severity of the weed problem.

B) VEGETATION CONTROL FOR PARKS, MEDIAN STRIPS AND ROADSIDES

i) Naturalization of remote park areas

A vegetation control approach is required in urban areas of limited public access. In remote areas of parks or roadsides of rural areas, the objective is to establish a low-maintenance program.

One approach is to naturalize these areas. Letting plants grow as they would in a forest can provide a visually appealing site with low labour requirements. A hedge of native flowers may be trimmed once per summer to help soften the contrast with the maintained turf.

Naturalizing can be enhanced by planting appropriate landscape materials. Evergreen trees and deciduous trees with dense foliage are used in or on the edge of clearings or as boundary subjects. Lighter deciduous trees permit lower layers, consisting of mixed evergreen and deciduous shrubs, shade-tolerant perennials and varieties of bulbs.

Woody ground covers can be arranged in an informal manner to spill out into the adjacent rough lawn. They can also be used on steep banks to reduce mowing needs and prevent soil erosion. Woody ground covers for use in B.C. are listed in Box 6-3.

Naturalizing can also be done with existing vegetation. An inspection will identify the desirable plant species of low-growing shrubs, herbs and grasses. These are encouraged to grow and are left untouched. Undesirable plants such as taller shrubs or invasive trees are targeted for selective removal. The site is monitored on an annual basis to maintain the desired mixture.

Removal is done is a number of ways. Hand cutting with chain or brush saws is possible, but usually results in stronger sucker growth from the roots. Chemical control is achieved by selective application of herbicides, but spray droplets may drift to desirable plants.

Box 6-3: Twelve woody ground covers

Kinnikinnick (*Arctostaphylos uva-ursi*)

An evergreen plant, 10 to 15 cm high, found throughout the province from near mountain tops to the seacoast. It is excellent for sunny banks.

Point reyes ceanothus (*Ceanothus gloriosus*)

Native of the West coast, it appears to be a hardy and useful ground cover. Fifteen to 25 cm tall, the leaves are thick and leathery, the flowers purplish blue. Grown in full sun.

Cotoneaster dammeri

Native of China, it quickly forms a mat of trailing shoots covered with ovate shining leaves. The bright red fruits remain long into the winter or early spring. The branches root as they elongate.

Winter Heath (*Erica herbacea*)

Native of Europe, this hardy *Erica* tolerates a calcareous soil. The plant forms cushions or mats of flowers from November to April. It needs a fairly sunny site to flower well and stay compact.

Wintergreen (*Gaultheria procumbens*)

Native to eastern U.S.A. and Canada. This stoloniferous plant, no more than 15 cm high, enjoys woodland conditions and an acid soil. Bright red fruits appear in the fall.

Genista pilosa

European plant, useful for sunny banks on well-drained sites. It forms a mat of interlacing branches, which in May are covered with the numerous golden flowers. An excellent small shrub for the rock garden.

Ivy (*Hedera helix* 'Green Feather')

This cultivar does not grow too fast or cover the ground too densely, so it can be safely introduced. It forms a dense mass of interweaving shoots.

Candytuft (*Iberis sempervirens*)

Valuable and frequently used as a ground cover in drier places, including beneath trees. A native of Europe and Asia, the plant reaches a height of 30 cm but spreads to 1 meter in a few years.

Japanese spurge (*Pachysandra terminalis*)

One of the most useful, subshrub evergreen ground covers, especially for planting in the shade. The plant spreads rapidly by underground runners, to form a carpet of rosettes.

Rubus calycinoides

Native to the mountains of Taiwan, it creeps over the ground or over rocks in a manner similar to the smaller kinds of wild strawberries. A valuable ground cover in partly shaded sites.

Cowberry (*Vaccinium vitis-idaea*)

Native to the mountains of Europe and Asia, it is a neat, low-growing subshrub spreading by underground runners. It thrives in a soil with plenty of humus such as peat or compost.

Lesser periwinkle (*Vinca minor*)

Native to Europe and Asia. A useful ground cover, particularly beneath trees, where it is a good alternative to ivy. Ornamental because of its flowers, in blue, white and purple variants.

Source: Mulligan, B.C., "Groundcovers and Small Shrubs", in: "Trees and Shrubs for Coastal British Columbia Gardens", Whitecap Books (Vancouver, B.C.), Second Edition, 1990.

Different methods can be integrated together to reduce the amount of herbicide needed and prevent drift problems. With shrubby wild berries, a brush saw or weed-eater is used to cut the brush as low to the ground as possible in late spring. New sucker growth coming from all canes later in the summer is treated with a systemic herbicide. This product is applied to foliage or smaller branches and translocates throughout the plant to kill the roots. The new top growth will actively translocate the herbicide with nutrients to the roots in the fall. This approach provides the maximum effect from a minimum of herbicide.

ii) Native grasses and shrubs for roadsides and median strips

In many situations, urban roadsides and median strips are growing naturally in a fashion not requiring outside intervention. In other situations, the natural growth is undesirable, because it is a safety hazard, it unnecessarily prevents maintenance activities or the weeds may spread and injure adjacent areas.

A vegetation management program will attempt to naturalize the area, encourage the regeneration of acceptable vegetation and reduce maintenance costs. Allowed vegetation should be grasses, legumes, wildflowers or shrubs. Various techniques are used to stimulate the competition between desirable, less desirable and undesirable vegetation. For example, mowing operations are planned to prevent seed formation and weaken weeds intolerant of mowing.

On roadsides and median strips, ecological principles may be more important than horticultural practices. For example, many weeds grow in open, disturbed soil sites. One approach to weed control is to plant desired landscape species on those open sites before the weeds grow, in effect taking weeds out of the vegetation system. Another approach is to install an entire plant succession at once. Nature usually colonizes a freshly cultivated planting bed with weeds, but the plant succession outwits nature by including in the design wildflowers or grasses to colonize the typical weed habitat.

Box 6-4: Weed control procedures for median strips and road sides

Experiments were set-up in 1992 in California to study the use of native forbs and grasses along roadsides. Native forbs and grasses are seeded on the site to suppress introduced weeds, reduce the need for herbicides, provide erosion control and enhance the beneficial insects.

The objectives and techniques are applicable to hedgerows, parks and median strips. The alternative weed control procedures necessary in this project form the basis of a solid IPM weed control program.

1) Reduce weed densities prior to seedbed preparation.

Non-chemical procedure: establish a summer fallow by disking the weeds before they set mature seeds. Disking perpetuates the disturbed conditions under which weeds prosper, thus reducing the weed seed bank. The practice can be used for one or more years prior to seeding a site with native perennial grasses.

2) Reduce weed population after seedbed preparation.

Non-chemical procedure: prior to seeding the native perennial grasses, flame-kill the emerged weed seedlings. Flaming can also be used after the seeding, but timing is critical as any emerged native grasses will be killed along with the weeds.

3) Reduce weed competition and seed production during first season of native grass growth.

Non-chemical procedure: high mowing (6" minimum) can be used to remove seed heads of winter-annual grasses and reduce seed bank of these weeds in subsequent years. Most native grasses produce seeds later and can recover from high mowing at this time. Repeated mowing will control tough perennial weeds such as Canadian thistle.

When the stands of natives are vigorous and producing seeds later in the season, mowing should be avoided to allow seed maturation. Weedy plants that are dominant and setting seed can be controlled with mowing, hoeing or digging.

4) Control remaining weed infestations after the establishment of the native grasses.

Non-chemical procedure: mowing as mentioned for the first year of establishment. Patches of annual and perennial weeds can be controlled with spot use of hoe or weed whip. This practice can be repeated every year upon need to maintain the mature stand of native grasses.

Adapted from Bugg, R.L., C. Brown, J.H. Anderson, "California Native Forbs and Grasses for Weed Suppression in Rights-Of-Way", University of California (Davis, CA), 1992.

iii) Drainage ditches and swales

The collection and transportation of excess water from landscape areas is often done with drainage ditches or swales. Weeds growing in these structures reduce the carrying capacity of the swale. Another common feature in urban areas is the presence of water canals and reservoirs, where vegetation control is necessary for weed growth at the bottom of the canal. Also, the exposed slopes (riparian area) of water canals may require vegetation management to control weedy plants, restore native plant communities, stabilize the streambanks and shorelines, or restore fish and wildlife habitat.

For drainage ditches and swales, one form of vegetation control was described by Sheila Daar in 1993. Drain rock and sand installed at the bottom of the swales and intercepting intake pipes at regular intervals absorb the excessive water runoff and recharge the groundwater. The sides of the swales are graded to facilitate the planting and mowing of grass to outcompete the weeds. Native trees are planted in groves along the artificial creek to provide the effect of a natural setting.

For water canals and reservoirs, the use of aquatic plants is being tested in California since 1966. Various spike-rushes plants from large mats of lawn-like sod under water. They can displace submersed aquatic weeds and prevent new ones from establishing. The spike-rushes have the adaptability to change habitats, thriving both underwater or with only their roots immersed (Daar, 1984).

For riparian areas, researchers in Oregon and Washington are currently testing native deciduous shrubs to enhance vegetative restoration efforts. The shrubs are used on streambanks to prevent the growth of weedy grass species. Four shrub species, native to British Columbia, show promise for this use (Flessner et al, 1993).

The Sitka alder (*Alnus sinuata*) forms dense thickets in moist areas, particularly along streams and lakes. It has rapid initial growth rate at a wide range of elevations on infertile soils. Its nitrogen-fixing capability makes it desirable in rotations and mixtures with other plants.

A second plant is the pacific serviceberry (*Amelanchier alnifolia*). It is found in open woods, along canyons or on hillsides. It is an excellent candidate for streambank restoration, as it tolerates many soil types and suckers profusely. Several cultivars are available for ornamental plantings in naturalized plantings and as hedges or screens in urban areas.

A third shrub for riparian areas is ocean spray (*Holodiscus discolor*). It is abundant along the coastline, on the banks of creeks and in the understory of moist woods. This species is tolerant of wide moisture regimes, sun or shade, and many soil types, making it useful for riparian plantings. It is a deciduous shrub that also has ornamental potential with unique flowering and branching.

Finally, the vine maple (*Acer circinatum*) naturally occurs along streambanks, in the understory of forests and on moist slopes. This natural adaptation, plus a vigorous, fibrous root system, makes it an excellent candidate for riparian restoration. It also has ornamental value with bright fall foliage and contorted growth form.

C) REFERENCES

- Bugg, R.L., C. Brown, J.H. Anderson, "California Native Forbs and Grasses for Weed Suppression in Rights-Of-Way", University of California (Davis, CA), 1992.
- Carlson, Jack R., "Selection, Production, and Use of Riparian Plant Materials for the Western United States", in: "Proceedings, Intermountain Forest Nursery Association", U.S. Department of Agriculture (Fort Collins, CO), 1992.
- Cramer, Craig, "Turbocharge Your Cultivator: Flame Weeding is Cheap, Effective - And Safe", *The New Farm* (Emmaus, PA), 12(3):27-35, 1990.
- Daar, Sheila, "Designing Weeds Out of Urban Landscapes", *The IPM Practitioner*, 15(8): 1-6, 1993.
- Daar, Sheila, "Vegetation Management on Rights-of-Way: An Ecological Approach", *The IPM Practitioner*, 13(2): 1-7, 1991.
- Daar, Sheila, "Update: Flame Weeding On European Farms", *The IPM Practitioner*, 9(3): 1-4, 1987.
- Daar, S., "Integrated Weed Management for Urban Areas", The Bio-Integral Resource Center (Berkeley CA), 1984.
- Flessner, T.R., D.C. Darris, S.M. Lambert, "Seed Source Evaluation of Four Native Riparian Shrubs for Streambank Rehabilitation in the Pacific Northwest", in: "Proceedings, Symposium on ecology and management of riparian shrub communities", U.S. Department of Agriculture (Ogden, UT), 1991.
- Hansen, C.M. and W. Gleason, "Flame Weeding of Grapes, Blueberries, and Strawberries - A Progress Report", in: "Proceedings of Second Annual Symposium on the Use of Flame in Agriculture", Natural Gas Processors Association, National LP Gas Association, 1965.
- Harris, R.W., "Arboriculture: Integrated Management of Landscape, Trees, Shrubs, and Vines", Prentice Hall Inc. (Englewood Cliffs, NJ), 2nd Edition, 1992.
- Lacey, S. editor, "Lawns & Ground Cover", Pavilion Books Limited (London, England), 1991.
- Liljedahl, J.B. et al, "Flame Cultivation of Corn in Indiana", in: "Proceedings of Second Annual Symposium on the Use of Flame in Agriculture", Natural Gas Processors Association, National LP Gas Association, 1965.
- Lowry, O.J., "Weed and Woody Plant Control on Irrigation and Drainage Ditches", in: "Proceedings of Second Annual Symposium on the Use of Flame in Agriculture", Natural Gas Processors Association, National LP Gas Association, 1965.
- Nihls, Michael. Superintendent of Parks Operations (City of Coquitlam, B.C.) Personal Interview. July 13, 1993.
- Mulligan, B.C., "Groundcovers and Small Shrubs", in: "Trees and Shrubs for Coastal British Columbia Gardens", Whitecap Books (Vancouver, B.C.), Second Edition, 1990.
- Olkowski, W., S. Daar, H. Olkowski, "Common-Sense Pest Control", The Taunton Press (Newtown, CT), 1991.
- Stephen, Bill. IPM Coordinator (City of Vancouver, B.C.) Personal Interview. July 15, 1993.
- Swan, D.G. et al, "Weed Control on Rights-of-Way", Extension Bulletin 0669, Washington State University, 1988.
- Tawczynski, Dan, "Fire Your Pests!", *The New Farm* (Emmaus, PA), 12(2): 10-13, 1990.
- Upadhyaya, Dr. M.K., "Effects of Steam Treatment on Seed Germination, Seedling Growth, and Leaf Surface Characteristics", University of British Columbia (Vancouver, B.C.), January 1992.
- Upadyaya, M.K., D.F. Polster, M.J. Klassen, "Use of Steam for Vegetation Control on Railroad Right-Of-Ways", University of British Columbia (Vancouver, B.C.), 1991.