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CHAPTER 5
LAWNS AND TURF:
THE APPLICATION OF INTEGRATED PEST MANAGEMENT

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CHAPTER 5
LAWNS AND TURF: THE APPLICATION OF IPM

INTRODUCTION

Contemporary lawn and turf care programs must be cost effective, provide an attractive grass area, control weed establishment and respond to legitimate concerns about environmental quality and human health. Managers can provide healthy lawn and turf by using cultural practices such as the selection of grass species, the appropriate use of fertilizer and water, and the frequency of mowing operations. For many years, these practices have proved their value in optimizing healthy growth of grasses while minimizing opportunities for pest insects, weeds and diseases.

Today, the landscape industry and public agencies must also respond to the challenge of effective weed suppression in lawns and turfs while using a minimum of toxic materials. This challenge is met by applying principles of Integrated Pest Management (IPM). The IPM approach is based on regular visual inspection of the turf areas to detect developing weed problems. The turf managers decide on acceptable levels of weed growth and adjust the maintenance practices accordingly. Then, when weed populations exceed acceptable levels, the maintenance practices are aimed at reducing the stress factors that favor the growth of weeds. Finally, the process is regularly evaluated to determine the effectiveness of the treatments and to make necessary adjustments.

Educating clients and the public about the benefits of an IPM approach is an important aspect for the success of the program. There must be an underlying recognition that a vigorous stand of grass will out-compete most weed species. In some cases, it is justified to raise the level of tolerance for some weeds. With sound cultural practices and the IPM approach, the result will be a healthy looking lawn or turf, reduced use of toxic chemicals and a happy customer.

Across British Columbia, many playing fields and other turf areas are managed by professionals using the IPM approach. With minimal herbicide use, these managers are able to maintain playing fields and golf courses as attractive as any site under intense herbicide management. In this chapter, their experience will be the starting point to discuss IPM principles for lawn and turf programs.

Box 5-1: Components of a least-toxic lawn care program

1. Establish 'tolerance levels' for weeds and other pests.
2. Develop a monitoring program to detect developing weed problems.
3. Institute a maintenance program designed to produce healthy, dense grass, and to discourage the lawn pest species found in your locality.
4. If pest populations appear likely to exceed tolerance levels, implement cultural and biological controls.
5. If cultural and biological control are not sufficient, use least-toxic pesticides.

Source: Daar, Sheila, "Least-Toxic Pest Management for Lawns", The Bio-Integral Resource Center (Berkeley CA), 1992.

A) GRASS SELECTION

The establishment of turf grass is an important process that relies on 2 building blocks: a healthy soil and the appropriate cultivars. When grass is provided with the right environment, it will produce a healthy lawn that minimizes future problems of weeds and poor drainage.

The most vigorous lawn growth occurs in friable, loamy soils that are teeming with beneficial microorganisms, insects, worms and other invertebrates. These organisms play critical roles in decomposing dead organic matter such as lawn clippings into an end product called humus. Soils rich in humus provide an environment with good nutrients uptake, water holding capacity and resistance to fungal diseases.

Soil tests should be taken 4 to 6 weeks before the establishment of a turf grass to allow sufficient time to adjust fertilization of the site based on the results of the test. A composite sample is a mixture of 10 to 20 samples per sites at 4 inches deep. Remove stones, debris and thatch before submitting to a laboratory.

i) Characteristics of turf grasses

Grass cultivars should be selected for their vigorous growth in the local climate, soil and site. When a grass is ill-suited it does not thrive and may require chemical pesticides as a cure-all solution.

Important characteristics of grasses include:

- growth (low growth is preferred),
- germination (fast germination is preferred for fast establishment),
- cover (dense and weed-resistant cover is preferred),
- water and sunlight needs (drought and shade tolerant cultivars are available),
- resistance (wear resistance is usually preferred).

On many lawn and turf sites, seeding with a mixture of grass species provide a greater tolerance to stress than seeding with a single species. For example, in an area with low rainfall, a mixture can be utilized with one grass species fast establishing and one grass species drought resistant. Such a mixture would help prevent weed growth until the turf grass is established. In another example, the common lawn grass Kentucky bluegrass (*Poa pratensis*) is often replaced by park maintenance personnel with a mixture of perennial rye grass (better for wear resistance) and Kentucky bluegrass (darker green color). This mixture varies for areas of heavy foot traffic or areas in deeper shade.

In chapter 9: "APPENDICES", suitable lawn seed mixtures for coastal and interior regions of British Columbia are presented based on the work of researchers at Agriculture Canada.

Table 5-2: Horticultural characteristics of common cool season lawn grasses

Grass species	Tolerance to: Wear	Drought	Shade	Cold
Perennial Ryegrass	G	E	F	P
Fast establishment, grows in compacted soils.				
Tall Fescue	E	E	F	G
Moderate rate of establishment, tolerates wide range of soil conditions.				
Hard Fescue	E	E	G	G
Slow establishment, competitive under dry conditions and low fertility.				
Creeping Red Fescue	E	E	G	G
Slow to moderate establishment, more shade tolerant than others.				
Chewings Fescue	E	E	G	G
Slow to moderate establishment, competitive under low fertility.				
Bentgrass	G	G	P	F
Moderate establishment, tolerates acid soils, can become very invasive.				
Kentucky Bluegrass	E	F	F	G
Slow to moderate establishment, grows best in near neutral pH soils.				
Annual Bluegrass	F	P	F	-
Fast establishment, persists under wet conditions.				
Orchard Grass	G	E	G	G
Moderate establishment, does not respond well to close clipping.				

E = Excellent G = Good F = Fair P = Poor

Adapted from William, R.D., "Living Mulch Options for Precision Management of Horticultural Crops", Extension Circular 1258, Oregon State University, July 1987.

ii) Insect and disease resistant grasses

Disease resistance is another characteristic of some grass varieties. Many varieties of Kentucky bluegrass, perennial ryegrass and fine fescues were developed in recent years for their resistance to one or more diseases (Schultz, 1989). This capacity to resist infection from disease spores varies from region to region, and the selection of resistant cultivars should be done in consultation with local specialists.

Certain grass varieties resist insect and disease attack through their association with beneficial endophytic fungus. This fungus lives in the tissues of the mature grass plant but causes no harm to the plant. Research at Rutgers University, in New Jersey, has showed that grasses with levels of endophytic fungi are particularly resistant to insects such as sod webworms (*Crambus* spp.), armyworm (*Spodoptera* spp.) and cutworm (many species). Some commercial cultivars of perennial ryegrass show better disease resistance when they contain very high to moderate levels of endophytic fungi, or grow better under stress conditions (Funk, 1989).

Researchers have observed a tremendous variation in the levels of endophyte found within the same species of grass. Thus, one of the most active areas of current research is identification of those varieties that naturally contain high endophyte levels. At present there are endophytic cultivars of perennial ryegrass, tall fescue, hard fescue and chewings fescue. Neither Kentucky bluegrass nor bentgrass cultivars with endophyte association are available.

'Endophytic' grasses are available at seed suppliers in B.C. Make sure the seeds are fresh (check the lot numbers) and are stored correctly. Endophytes can die in improper storage, although the grass seed remains viable.

iii) Reducing turf areas

If weeds are a problem and lawn maintenance a constant chore, the solution may be to remove part or all of the lawn. On some sites, the lawn area is too big for the intended use, the conditions are not favorable to grasses, or the site makes mowing difficult. On such sites, the turf area can be reduced in a number of ways.

Paved areas provide a long-term solution to weed problems in areas too shady for grass, too difficult to mow or subject to intense pedestrian traffic.

Hardy and competitive ground covers are used instead of grasses in areas seldom utilized or receiving little direct sunlight. The ground covers can be selected for their lawn-like look, such as clovers, creeping thyme (*Thymus serpyllum*) and chamomile (*Anthemis nobilis*). Ground covers reduce mowing time and lend form and color to the landscape, but will require weeding, watering and fertilizing until established.

Grasses can be left to mature. For example, creeping red fescue (*Festuca rubra* 'Ruby') grows up to 35 cm long with the blades lying on their sides, creating attractive swirls and ripples when left uncut. Once the fescue is well established, it out-competes weeds and prevents them from germinating. Where needed, paths can be mowed for pedestrian use.

In other areas, the lawn can be allowed to become profusely spotted with wild flowers. This approach is not acceptable on a playing field but provides a nice setting for picnics or sunbathing. The mowing schedule is adapted to the type of flowers. For spring flowers and bulbs, no mowing takes place until all flowers have faded away. For summer flowers, the grass is mowed in the spring but left uncut through the summer months.

Box 5-3: Low maintenance turf with wild flowers

Doctor Tom Cook is an Associate professor at Oregon State University. Since 1986, he has been looking into alternatives to conventional grass lawns. The goal is to combine grasses with selected broadleaf plants in an attempt to produce an ecologically stable mixture of plants with low maintenance requirements.

The resulting ecolawn should require less mowing, irrigation, fertilizer and pesticides than a typical lawn. The ecolawn is not a wild flower meadow, however, and should be compatible with lawn uses such as sitting, strolling, and general play.

The preferred grasses in the mixtures are perennial ryegrass and Kentucky bluegrass, as they are least competitive in low maintenance situations and do not produce a weedy lawn with clumps.

Some flowers tested so far include the following.

Clovers (*Trifolium spp.*)

White and strawberry clovers were used in early trials for their nitrogen-fixing capacity, but tended to be vigorous and attract bees. Bees attracted to the lawn in the summer is a problem for many lawn uses. Future research will attempt to find a good nitrogen fixer that doesn't grow much.

Yarrow (*Achillea millifolium*)

Selected because it is dark green, rhizomatous, moderately wear tolerant and very drought tolerant. On a mowing cycle, it rarely flowers. Current plots with only yarrow and hard fescue are developing nicely. The author is planning to increase the amount of yarrow in future trials.

English Lawn Daisy (*Bellis perennis*)

This plant produces hundreds of beautiful flowers each spring and has a good track record in low fertility sites. They are low growing and contribute relatively little to herbage production. The flowers are the highlight of the mixes each spring.

Baby blue eyes (*Nemophila menjiesii*)

Stunning the first spring after planting for its attractive blue flowers, but a poor performer over time.

Roman chamomile (*Chamaemelum nobile*)

Similar to yarrow but glossy and brighter green. When mowed it smells like pineapple. Disappears over time

Future trials will include lawn violets (*Viola spp.*), Speedwell (*Veronica filiformis*), wild Galium (*Galium verum*), and creeping buttercup (*Raununculus r*.)

Regular maintenance included mowing (once per week to once per 3 weeks), irrigation (once a month during the summer), fertilizer (no fertilizer or one application at the time of planting) and pesticides (not needed, but the mix components are resistant enough to 2.4-D). The trials were done in Corvallis, Oregon and the results may be different in other regions or climate.

Source: Cook, T., "Low Maintenance Turf?", *Turf Line News* (Vancouver, B.C.), 114: 44-47, 1993.

B) MAINTENANCE CARE FOR TURF AND LAWN

Across British Columbia, many park managers deliver a nice-looking lawn with few weeds and with minimal herbicide use. In every case, the success is built on cultural practices that optimize growth of grasses and minimize opportunities for pest insects, weeds or diseases.

The basic rules are:

- mow high, often, and with sharp blades;
- water deeply but not too often;
- fertilize wisely with organic or slow-release fertilizer;
- correct compaction with regular aeration and top dressing.

i) Mowing

Mowing practices may have more impact on weed problems than any other cultural practice. Most lawns are mowed too short, too often. If repeated close mowing occurs in conjunction with one or more additional stresses such as drought or insufficient nutrients, grass plants become smaller and fewer. This creates openings for weed invasion.

Timely mowing at a recommended height is important to discourage weed flowering and spread. Regular mowing eliminates weeds that do not tolerate mowing and prevents seed production in mowing-tolerant weeds. Mowing also stimulates the growth of the lower buds on grass blades, which increases turf density and prevent weed invasion.

The optimum grass height for mowing is based on the grass species and the intended use (Fushtey et al, 1982). Best results are obtained when mowing removes about 1/3 of the plant height. Do not remove more than 1/2 of the total plant height. The height of cut is raised during hot, dry periods, in the early spring whenroot systems are actively growing, and, in the interior of the province, in the fall.

Do not remove the clippings. They decompose rapidly to provide a valuable source of nutrients and reduce fertilizer needs. The exception is when interval between mowing is too long. FInally, keep the mower blades sharp to prevent uncessary injury to the grass blade.

Table 5-4: Recommended mowing height for turfgrass in Southern British Columbia

Grass species	Optimum Mowing Height
Creeping Bentgrass	0.5 to 1.0 cm.
Colonial Bentgrass	1.0 to 2.5 cm.
Kentucky Bluegrass	2.5 to 5.0 cm.
Red Fescue	2.5 to 5.0 cm.
Perennial Ryegrass	2.5 to 5.0 cm.
Tall Fescue	4.0 to 7.0 cm.
Created Wheatgrass	4.0 to 7.0 cm.
Canada Bluegrass	6.0 to 10.0 cm.

Source: Fushtey, S.G., L.G. Denby and A. McLean, "Lawns for Southern British Columbia", Agriculture Canada (Agassiz, B.C.), 1982.

In public agencies, the preferred practice of frequent, high mowing is perceived as too expensive for the available budgets. More commonly, grasses are allowed to grow fairly long and then mowed fairly short, thus reducing the maintenance labour cost. This approach removes too much grass blade at one time and does not stimulate deep rooting.

In Eugene, Oregon the Parks Department was able to adjust mowing heights without increases in funding, personnel or equipment devoted to turf maintenance. In some parks the lawn was allowed to developed into a natural area spotted with English daisy and other wildflowers. Areas used primarily for picnics and leisure activities were identified for less intensive maintenance. Higher mowing height yielded an attractive turf with increased vigor and greater resistance to drought stress and weed invasion. Where the higher mowing height was not appropriate because of use patters, mowers were set as high as possible without sacrificing the necessary result (Rhay, 1981).

ii) Irrigation

Many variables influence the amount of water used by turf grasses, including the amount of solar radiation, the temperature, and the rate of grass growth. Light, frequent irrigation produces shallow root systems that make grass more dependent on frequent watering, with the result that missed irrigations can cause extensive damage to the lawn.

Watering deeply but not too often will train the grass roots down. Appropriately irrigated lawn grasses normally root in the top 15 to 30 cm. of soil, whereas lawns irrigated on a daily basis often root only in the top 2.5 cm. The best technique to determine when to water is to observe both soil and plant conditions. Irrigate when the grass begins to wilt from dryness and footprints stay compressed for more than a few seconds.

A general guideline is 2.5 cm. of irrigation water, soaking 15 to 20 cm. of soil. On sandy soils (low-water-holding ability), reduce the quantity of water applied and water more often. On clayish soil (high water-holding ability), use short watering cycles or water slowly so the water can soak into the soil before runoff occurs.

In large public areas, the irrigation systems should be checked for even distribution and an efficient use of water. Leaks should be repaired as they waste water. Low spots should be leveled or drained to avoid waterlogged soils, which favor weeds.

Table 5-5: When *NOT* to water turf

Do Not Water			Do Not Water	
[.....]			**[.....]**	
		[.....Dew.....]		
X	X	X	X	X
4 p.m.	8 p.m.	midnight	10 am	noon

Source: Bhowmik, P.C. et al, "Professional Turfgrass Management Guide", M.C. Owen editor, University of Massachusetts Cooperative Extension System (Amherst, MA), 1992.

NOTE: Irrigation should not extend the time blades are wet from dew. Night irrigation helps conserve water, but is not recommended on hot, humid nights when dew appears because it increases the incidence of some diseases.

iii) Fertilization

Good soil is the foundation of a healthy lawn. To grow well, the lawn needs soil with good texture, nutrients, and the right pH. Most lawns need to be fertilized every year, because they need more nutrients than soils usually contain. Fertilizer needs vary according to the cultivars grown, the soil physical conditions and many other factors. The components of a fertility program should be adapted to a particular situation and based on laboratory soil tests.

As a general rule, most lawn grass species require nitrogen at about 2 kg per 100 m^2 per year for reasonably healthy growth (Fushtey, 1982). For a high-maintenance turf growing on sandy soil, clayish soil or in high rainfall areas. apply smaller amounts of nitrogen fertilizer more frequently, or use a slow-release form of nitrogen fertilizer. Grass clippings left on the lawn to decompose return about 1 kg of nitrogen per 100 m^2 per year. This practice helps for low-maintenance fertilizer programs and for general lawn care.

It is important not to exceed the required levels: quickly soluble nitrogen will cause grass to grow more quickly, requiring frequent mowing, and may encourage insect pests attracted by succulent growth. Chemical slow-release fertilizers and good organic fertilizers are preferred. They provide a constant supply of nutrients to the grass and are less likely to leach into ground water. Finally. do not fertilize wet grass, because burning will occur.

Table 5-6: Guide for fertilizer applications in Southern British Columbia

Number of	When to apply fertilizer	
applications	In the coastal region	In the interior region
1	Early May to early September	Early May
2	Early May and early September	May and late October
3	Late May, early September, November	May, August, late October
4	Mid-May, mid-June, early September and November	May, June, August, and late October

Source: Fushtey, S.G., L.G. Denby and A. McLean, "Lawns for Southern British Columbia", Agriculture Canada (Agassiz, B.C.), 1982.

iv) Aeration

Soil compaction is caused by continued foot and equipment traffic, which presses the soil particles closer together. This destroys the soil structure and adversely affects the relationship of air and water to the turf grass roots. Grass grown in compacted soils soon become susceptible to drought, disease, and insect damage. Weed invasion occurs because the turf is weakened.

The remedy for compacted soil under turf grass is to remove 6 to 13 mm-diameter soil cores that are approximately 7.5 to 10 cm. deep. This practice is called aerating or coring the lawn. Aerification relieves soil compaction because the holes usually extend through the compacted surface layers. It allows air to pass more freely through the soil, thereby stimulating root growth. It permits more water and nutrients to enter the soil, making irrigation and fertilization more effective. It reduces the thatch layer and its undesirable effects.

Most lawns only need aeration once every other year. Turf sustaining moderate use are aerated twice every year, while heavily used turf are aerated once every four to eight weeks during peak use periods. Tools that are pressed into the soil by foot pressure and remove a core of soil are available from nurseries and hardware stores. Mechanized equipment is also available. Spiking the soil with solid tines worsens the situation by further compacting the soil.

v) Thatch Management

All grass forms a layer of dead plant material, known as thatch, between the grass blades and the soil. When thatch gets too thick, it prevents water and nutrients from penetrating to the soil and grass roots. Some grasses tend to form a thick layer of thatch. Overuse of fertilizer can also create a heavy layer of thatch.

Top dressing is an excellent cultural practice to prevent thatch build-up. The addition of soil increases the microbial activity that decomposes the thatch. Thatch over 1 cm thick can be reduced by manually raking the lawn or using a machine that slices through the thatch layer to break it up.

There are drawbacks to dethatching. It causes short-term stress to turf and creates openings for weed seed germination. Also, the machinery can be expensive for public agencies on tight budgetary constraints.

Earthworms and soil microbes are known to help with thatch degradation. The earthworms fragment and condition plant debris in their guts. They enrich the soil with their excreta and improve the air and water infiltration with their burrowing action. Killing earthworms to remove the problem of castings is detrimental to the health of the turf. It is better to use a turf groomer, to rake or to hand-pick the castings.

Experiments at the University of Kentucky seem to verify the contribution of earthworms to thatch degradation in turf. Several hundred pre-weighed pieces of intact Kentucky bluegrass thatch were sewn into nylon mesh bags and buried just under the surface of a turf. The bags had different sized openings intended to selectively exclude the earthworms or other components of the soil fauna. After 3 months, dramatic differences were apparent: without earthworms, the structure and composition of the thatch remained nearly unchanged, but with earthworms the pieces were broken apart and dispersed (Potter, 1989).

Pesticides applied to turf also contribute to thatch development. In another experiment at the University of Kentucky, turf grass pesticides were evaluated for toxicity to earthworms. A single application of some products severily reduced the earthworm population. For example, benomyl and diazinon reduced the earthworm population by 51 to 75%. Carbaryl resulted in a 76 to 99% reduction (Potter, 1993). The excessive use of these pesticides can aggravate thatch by interfering with the activities of the earthworms in the soil.

Table 5-7: Earthworm castings on golf greens

One solution: kill the earthworms.
Then, thatch builds up and turf roots are stressed.
Then, water does not penetrate, the grass becomes prone to fungal disease, fungicides are applied and microorganisms are killed.
Then, mechanical thatch removal and aeration is required.
Another solution: do not kill the earthworms.
Rake, roll or remove the castings.
Then, soil fertility is improved.

Source: Gilkeson, L., "Notes on IPM in Turf", Ministry of Environment (Victoria, B.C.), 1993.

v) Over seeding and top dressing

Grass seeds can be sown over an existing lawn or turf. This over seeding makes the existing lawn denser and fills the areas lacking in grass growth. It can also be used to alter the grass cultivars mixture. The seeds can be mixed into the top dressing or fertilizers applied to thinned lawns. Grass seedlings will out-compete weeds that attempt to occupy the openings.

On heavy use playing fields, over seeding can be done up to 4 times per year. The practice may prevent down time and the expense of re-sodding. In low-maintenance areas or on lawns, over seeding is done in the fall, approximately six weeks before the first fall frost.

Top dressing involves spreading a fine layer of soil mix over the grass of an existing lawn. It helps when a turf lacks density or more topsoil is needed beneath the turf. Top dressing often follows aeration, filling the newly opened holes with more desirable components and smothering weed seeds.

Usually, a mixture similar to the soil composition and including sand, organic matter or screened compost is applied twice a year in a fine layer over the soil. Top dressing with composted sewage sludge was shown to enhance the establishment and vigor of turf grass.

Box 5-8: Suppression of red thread with amended top-dressing

Field plots established in 1989 on perennial ryegrass

at the Cornell University Turf grass Field Research Laboratory, Ithaca, NY.

Treatment	Disease rating
Commercial poultry litter compost	1.0
Commercial "Compost Plus"	2.0
Baltimore sludge compost	2.3
Brewery waste compost	3.0
Sphagnum peat	3.7
Commercial sludge compost	4.0
Commercial "Greens Restore"	4.3
Commercial cow manure compost	4.3
Commercial leaf compost	5.3
Commercial horse manure compost	5.3
Spent mushroom compost	5.3
Commercial sludge compost	5.7
Untreated	4.7

Source: Nelson, E.B. and C.M. Craft, "Turf grass", in: "Biological and Cultural Tests", Cornell University (Ithaca, NY), 1991.

Note: Top dressings formulations consisted of 70% fine sand and 30% organic component, applied on May 25. The plots were evaluated for red thread severity 27 days later, on August 1, 1989. The scale is 0 (none of the plot area is diseased) to 10 (100% of the plot area is symptomatic).

In recent years, research at Cornell University, New York, has centered on the suppression of various turf grass diseases by top-dressings amended with composts or organic fertilizers (see Box 5-8). The materials re-inoculate the soil in beneficial microorganisms and, in some cases, clearly reduce the damaging effects of various diseases.

For example, dollar spot damage was reduced in 1990 when top dressings were amended with composts or organic fertilizers, providing levels of control equivalent to that of fungicides. In 1989, brown patch on creeping bentgrass and annual bluegrass putting greens was suppressed with top-dressing amended with "Ringer Compost Plus", "Ringer Greens Restore" or with "Sustane" (all registered trade mark of commercial products). Control with the materials was as good as a high rate of Banner, a commercial fungicide (Nelson, 1991).

This promising technique is currently being tested at the University of British Columbia.

vi) Play management

In coastal areas of British Columbia, the opening of play fields is regulated during the winter months to provide a balance between year-round use and management without herbicides.

In these coastal areas, abundant winter rain coincide with the football / soccer season. These conditions create severe surface compacting and lead to reduced plant vigor if not corrected. Invading broadleaf weeds such as plantain will present a slippery surface under the rain and create a hazard to sport players. In areas of concentrated play, such as in front of the goal posts and in the center field areas, the turf may become seriously damaged.

Throughout the soccer season, all fields are inspected on a weekly basis. The assessment includes the physical surface conditions, the long range weather forecast and the number of games scheduled until the next inspection. A prompt repair of worn out areas and depressions is accomplished with commercially grown sod or sand and seeds. When fields are in an unsafe condition, they are closed and posted with signs. This procedure is generally accepted by organized sports groups, but tends to be ignored by non-authorized users.

C) WEEDS, INSECTS AND DISEASES OF TURFS AND LAWNS

As with other IPM programs, pest management in turfs and lawns should be built around a good monitoring system. Monitoring provides advance warnings about pest build-ups. Monitoring is the first step away from routine calendar pesticide treatments and toward a functioning IPM program. It is also built on knowledge about tolerance levels, information about natural enemy populations, and ways to select and evaluate any treatments.

i) Weeds in lawns

Monitoring

Turf areas should be visually inspected at regular enough intervals to detect developing weed problems. Species are identified and information obtained on their life cycles and requirements for growth.

Using a sampling transect is a good way to estimate the percentage of lawn that is occupied by weeds. A transect is simply a line drawn through one or more representative areas of a lawn. The transect is established so it pass through both heavily and lightly used turf. The line can be real (a rope or hose is laid across the lawn) or can be imaginary (walking from point A to point B). The distance between each sample is determined ahead of time: for example, one sample every 3 steps. At each stop (sample site), a small surface of the lawn is examined, for example a 10 cm. by 10 cm. surface at the tip of the toes. A written record is made of the presence of weeds, if possible the identification of the weeds, or the presence of bare soil where weeds will likely grow.

An important aspect of this process is the identification of the weeds. Many books and field guides are available to help identify the seedling (young plant coming out of the ground), the mature and the flowering stages of each weed. Some titles useful in British Columbia are recommended in Chapter 9 "Appendices". The presence of weeds is often correlated to a stressed lawn, and the presence of some weeds can be used to identify the problem and correct the maintenance practice. Some weed indicators are listed in Table 5-10.

Box 5-9: Sample turf transect / Weed monitoring form

Date: August 18, 1993 **Data collection:** Mario

Site: Skaha Lake Beach City Park, Penticton

Data collected by: Number and length of transects:

2 parallel transects going East to West for the length of the park

Length between samples: 1 sample every 5 foot steps

Size of sample: Square 10 cm by 10 cm

	Transect A		Transect B
1	G	**1**	G
2	G	**2**	G
3	G	**3**	W (crab grass)
4	G	**4**	B
5	W (dandelion and plantain)	**5**	B
6	B	**6**	G
7	G	**7**	G
8	G	**8**	G
9	G	**9**	W (very small)
10	G	**10**	G
11	W (unknown)	**11**	G
12	G	**12**	G
13	G	**13**	G
14	G	**14**	W (dandelion)
15	G	**15**	G

CODE:

G if Grass only

W if Weed present, alone or mixed with grass.

B if the soil is bare (weed will likely grow).

Total sites monitored:	30		
Total sites with weeds:	5	**Average %:**	16%
Total sites that are bare:	3	**Average %:**	10%

Comments: Site with bare soil was in the middle of a pathway for persons going to the tennis court .

Adapted from: Daar, S. and W. Olkowski, "Monitoring Weeds in Turf", in: "Least-Toxic Pest Management for Lawns", Sheila Daar editor, The Bio-Integral Resource Center (Berkeley CA), 1992.

Table 5-10: Weed indicators of stress conditions in lawns

Grass Species	Stress Condition Indicated
Barnyard grass (*Echinochloa crus-galli*)	Thinned, wet grass.
Buttercup (*Ranunculus* spp.)	Excessive moisture.
Chickweed (*Stellaria media*)	Thin grass, excessive moisture.
Clover (*Trifolium repens*)	Low nitrogen, drought, compaction.
Crabgrass (*Digitaria* spp.)	Compaction, low fertility, thin grass.
Dandelion (*Taraxacum officinale*)	Thin grass, low moving, low fertility.
Dock (*Rumex* spp.)	Excessive moisture.
Lambsquarters (*Chenopodium album*)	Disturbed soil, insufficient lawn seed
Mallow (*Malva* spp.)	Disturbed soil, thin grass.
Morningglory (*Convolvulus arvense*)	Disturbed, droughty soil, low fertility.
Moss (various genera)	Low fertility, low pH, heavy shade.
Pigweed (*Amaranthus* spp.)	Bare, droughty soil, low mowing.
Plantain (*Plantago* spp.)	Low fertility, low mowing.
Protrate knotweed (*Polygonum aviculare*)	Compaction, drought, thin grass.
Thistles (*Cirsium* spp.)	Low fertility, drought, heavy clay.
Yarrow (*Achillea millefolium*)	Low fertility.

Source: Olkowski, W., S. Daar, H. Olkowski, "Common-Sense Pest Control", The Taunton Press (Newtown, CT), 1991.

Threshold

The goal of a 'weed-free' lawn is neither feasible nor desirable, particularly when there are large areas of turf to be managed. Even under optimum turf growing conditions, other plants may eventually become established. Turf managers need to determine what weed levels are tolerable in a lawn and establish practices that keep weed growth below these levels.

Most people do tolerate 5 to 10% weed growth in their lawns without knowing it. Weeds are hard to detect at those level. For municipal turf, 20% weed content is a common treatment threshold. In low-maintenance areas, the tolerance is increased to 50% of weed growth.

Establishing an action threshold for weeds can be done by comparing areas of turf that "look fine" with areas that look "marginal" and areas that look "poor". When the percentage of cover for each type of area is averaged, the turf manager should be able to arrive at a reasonably useful guideline for treatment.

Control strategy

When the sampling program shows the number of weeds to be too high, a weed control strategy must be selected. Long-term weed control can be achieved with healthy, vigorous grass using maintenance practices described earlier. Weed control can also be achieved with design changes aimed at removing the weed habitat.

Short-term weed control can be achieved with herbicides. Turf managers may use herbicides to renovate deteriorated fields and to maintain very high aesthetic standards on golf greens. In an IPM program, herbicides are integrated with other strategies. Spot treatment, applying herbicides only where weeds are present, reduces the amount of product used.

The use of herbicides is not the favored option for weed control, because of the potential toxicity to humans and the environment, and because it provides only short-term relief of the weed problem. Using herbicides forces further herbicide use because it doesn't address the reason weeds are a problem. Using herbicides for weed control on school grounds is raising concerns throughout British Columbia that children health may be adversely affected.

Box 5-11: Turf maintenance in Langley

The Township of Langley is located in a rural area of the Lower Mainland. Baseball teams use 30 fields during the summer, while organized soccer is played on 23 fields through the winter. The year-round use creates problems on old sports fields that lack proper water drainage and irrigation facilities.

During a dry summer season, the grass goes dormant, some parts die back, and weeds grow in the open spaces. The weeds have a shallower root system than turf grass and disappear during the winter season. For example, 2 games of soccer are sufficient to rip the clover plants out of the ground. Thus, the weeded section becomes a bare soil section. The exposed soil is damaged and does not offer a good grip for the players who risk ankle injuries.

Maintaining the sports fields in good condition is the responsibility of the Parks and Recreation Services. Monitoring is conducted in the spring by visual inspection. On each field, a number of representative spots are selected and, for each spot, an area 15cm X 15cm is examined to estimate the weed coverage.

The threshold has been established at 15%. If more than 15% of the lawn is covered in weeds, a herbicide treatment is recommended. Notices are posted prior to the treatment to advise the public of the potential health hazard.

Good cultural practices are also used on all fields to ensure a healthy turf grass. Older, non-irrigated fields cause most of the weed problems and budget allocations are made every year to renovate one or two fields.

In summary, the Langley Parks and Recreation Services use an IPM approach that combines monitoring, action threshold, cultural practices and herbicide spraying to keep the weed population at a low and safe level.

Source: Lindahl, Bill. Parks Manager (Corporation of the Township of Langley, B.C.) Personal Interview. September 3, 1993 and Upadhyaya, M.K., "Weed Control in Sportsfield Turf grass in the Township of Langley", mimeographed copy, Langley B.C., December 1990.

ii) Lawn diseases

Monitoring and Identification

The proper identification of turf diseases is important to manage the problem effectively. Identification can be done visually by experienced field personnel, by using photographic field guides, or verified with a laboratory examination. For the latter, the sod sample must be 10 cm. by 10 cm., 5 cm. deep, and should be cut from the edge of the diseased area so that both diseased and healthy grass are represented. Send specimens to the Plant Pathology Laboratory (Ministry of Agriculture) in Surrey or at the Research Station (Agriculture Canada) in Agassiz.

Most turf grass diseases are caused by pathogenic fungi that invade leaves, stems and roots of plants. As a result of the injurious effects of a disease, the plant will exhibit various symptoms such as leaf spots, root rots or death of leaves, tillers or the entire plant. Sometimes these fungi produce visible signs such as mushrooms, white powdery mildew, pink gelatinous mycelial growth, red or black pustules on leaves. It is through the use of these symptoms and signs that disease problems are diagnosed.

Control

On lawns and other less intensely maintained turf grass areas, good cultural practices will help reduce the diseases and nearly eliminate the need for fungicide applications. Treatment recommendations include the modification of cultural practices favoring the disease, and the fall overseeding with resistant cultivars.

Regular tissue testing helps to identify nutrient deficiencies that make plants more susceptible to diseases. For example, the severity of take-all patch is reduced in soils deficient in phosphorus, zinc or copper when the deficient element is applied. Other diseases, such as anthracnose, red thread and brown patch, are promoted by wet foliage or anaerobic conditions. These can be reduced by strategically removing trees to improve air circulation and drainage (MacDonald, 1993).

Table 5-12: Cultural control for common lawn diseases in British Columbia

COMMON NAME (*Latin name*)

D = Distribution S = Symptoms CC = Cultural Control

Damping-off (*Pythium* spp.*, Fusarium, Rhizoctonia*)

D: Very common.

S: Patches of seedlings fail to emerge or turn yellow and collapse.

CC: Avoid seeding too early in spring or too late in fall. Where soil is heavy and drainage is poor, seed in late spring.

Leaf spot and Melting-Out (*Drechslera* spp.)

D: Common throughout southern B.C., especially on Kentucky bluegrass

S: Purplish-red spots appear on leaf blades and sheaths in spring and fall. If severe, the whole grass plant is affected by a reddish-brown decay.

CC: Avoid close mowing. As this disease resembles drought, frequent and heavy watering is often used, worsening the problem.

Snow mold

D: Very common across Canada and prevalent in the B.C. Interior.

S: Damage is visible in the spring in the form of roughly circular, brownish patches often matted with a fluffy, grayish white growth of mold.

CC: Avoid applying nitrogen within 6 weeks of dormancy to allow proper hardening off. Disperse heavy snow accumulations as spring approaches.

Take-all patch (*Gaeumannomyces graminis*)

D: Very damaging on newly established bentgrass lawns at the Coast.

S: Slowly enlarging, depressed circular patches of bronzed grass.

CC: Maintain soil pH below 6.0. Salvage lawn with seeding or sod.

Red thread (*Corticium* or *Laetisaria fuciformis*)

D: Very common, especially in fescues and ryegrasses in Coastal areas.

S: Irregular patches of discolored leaves. Red "threads" of fungus protrude from leaf tips. Causes little damage.

CC: Maintain adequate level of nitrogen fertility. Moderate resistance in most Kentucky bluegrasses and some fescues cultivars.

Adapted from: Ormrod, D.J. and S.G. Fushtey, "Diseases of Lawns", Ministry of Agriculture and Food (Victoria, B.C.), 1985.

Most disease fungi thrive under warm and wet conditions. Spores germinate and infect grass blades when the water or high relative humidity is available over a long period, usually 18 hours or more. Irrigation applied in the evening or at night remains on the grass for a long time and favors the development of diseases. If the irrigation schedule is changed to a morning application, the water will dry rapidly and will not favor the establishment of disease pathogens.

Fungicide use must be carefully considered for disease control. Preventative applications of fungicides on turf grass may reduce the population of beneficial microorganisms in the soil, leading to excessive thatch build-up (Potter, 1989). Fungicides may also disturb a delicate balance among microorganisms that compete with and antagonize disease-causing fungi. Finally, fungicides may control one disease but encourage another (MacDonald, 1993).

iii) Lawn insect pests

Leatherjackets

Leatherjackets, the larvae of the marsh crane fly (*Tipula paludosa*), are considered a pest of lawns, golf courses, pastures and hayfields. This insect has a very limited distribution in North America and is of considerable importance only in southern British Columbia and western Washington State. A survey of 22 golf course superintendents on Vancouver Island, in 1992, found leatherjackets to be the primary turf damaging insect (Davis, 1992).

The adult crane fly resembles a giant mosquito with a body length of about 2.5 cm. It is brown, has two transparent wings and six long, spindly legs. The emerge from mid-July to the end of September and live for about one week. The eggs hatch in the fall and the 3-mm long larvae is called a "leatherjacket" because of its tough leatherlike skin. Most damage occurs from March to June as a result of constant, heavy feeding by the rapidly growing larvae.

Various methods can determine the number of grubs in the lawn. A small area of grass can be removed to count the number of larvae beneath. A well-fertilized lawn can support a large number of leatherjackets without showing damage, thus a routine fall pesticide application for leatherjacket control is not recommended in B.C.

Sod webworm

Sod webworm are grass-infesting moths and larvae of various species. The adult moths are small whitish or dingy-brown, have a habit of folding their wings closely about their bodies when at rest, earning the group the name "close-winged moths". The caterpillar is 1.9 cm to 2.5 cm long and, depending on the species, grayish-brown to greenish to dirty white with four parallel rows of dark brown spots on the abdomen.

They are a problem in commercial turf grass seed production and, to a lesser extent, on home lawns. The worms tend to thin the turf in a circular area the size of a quarter or half dollar. From above, these feeding areas appear as pock marks in the lawn and can be readily recognized. Webworms live in the thatch layer of the lawn rather than in the soil. Signs of their presence include missing grass blades, green fecal pellets or larvae found in the thatch.

A healthy lawn can support the presence of two or three larvae per 0.1 m^2. In stressed turf, or where serious damage is apparent, treatment options are numerous. Some grass cultivars of Kentucky bluegrass, such as 'Windsor' and 'Park' show tolerance for webworms. Endophytic cultivars of perennial ryegrass and tall fescue will kill the webworms or stunt their development. Reducing the thatch layer removes the favored habitat of the larva.

D) IPM FOR SPECIFIC TURF SITES

An IPM program for a turf area varies according to the intended use of the site and the required aesthetic standards. The intensity of turf management can be low (picnic area, home lawns), medium (sports fields) or high (golf courses, bowling high).

i) Public parks and low management areas

Remote park areas, light traffic areas or home lawns require less rigorous management than highly-used sites. Management practices include an increase of the mowing height, a higher tolerance of weeds, a shift to low growing grasses or ground covers, the mulching of path areas for joggers or light foot traffic, and the use of herbicides only for spot treatment.

Slocan Park, located in the East End of Vancouver, is a good example of the various levels of turf management. The field is under the responsibility of the Board of Parks and Recreation, which operates with an IPM policy that includes a ban on pesticide use in public places unless there is unacceptable damage.

The south field of Slocan Park is used for general recreation purposes and is under a low maintenance program. The soil is native (clay), with no irrigation or drainage system. The turf includes some plantain weeds alongside healthy grasses. Public users from the neighborhood have a good tolerance for the weeds as long as the area is in fair condition.

This field often has moderate to severe weed problems affecting sports play. Acceptable conditions are maintained with topdressing and aerification. In some cases, weeds are spot treated with herbicides. This reduces the amount of herbicide used.

By contrast, the north field is under a more intense maintenance program and is used through the winter months by soccer and football teams. Weeds tend to be removed during the play, leaving an area of bare soil that will become muddy under the frequent winter rainy days.

A thick mat of grasses is preferred to support the wear and damage from the players. This field is build on a good layer of sand with proper drainage and irrigation systems. Good fertilization and top dressing occurs, and the field is closed in inclement weather to prevent turf damage. This field does not present weed problems and require no herbicides.

ii) Playing fields and medium management areas in Coquitlam

In 1992, the council of the City of Coquitlam approved an "Integrated Vegetation Management Plan" that established IPM as the "decision-making process to determine if, where, when and how control practices will be implemented". The responsibility for day-to-day implementation lies with supervisors and the field staff of the Parks Operations Division.

Sports fields are built on 45 cm of sand to ensure good drainage. The turf is seeded with perennial rye grass for wear tolerance and Kentucky blue grass for a dark, green color. Water is applied by automatic irrigation 25 minutes every 2-3 nights during hot summer days.

Tissue analysis is performed twice a year and the results determine the type of fertilizer required. In general, about 2.5 kg of slow-release nitrogen is applied per year in 5 or 6 applications. Coquitlam is part of the "Gateway Purchase Plan". In the fall of every year, about 11 municipalities of the lower mainland pool their requirements for fertilizer and grass seeds. The large order is tendered to suppliers and results in lower prices on premium quality products. The supplier must provide seed trial data for each grass cultivar to ensure optimum performance in the region. All seeds are certified Canada #1 to ensure good germination.

On sports fields, the overall objective is to maintain a safe, playable surface. The heaviest use by sport groups is in the winter, when the numerous rainy days make broadleaf weeds such as plantain slippery. The fields are inspected on a weekly basis and closed when in an unsafe condition.

Root zone management is seen as a critical area of turf grass management. Regular aeration with both slit tines and hollow-core tines is conducted a minimum of 5 to 6 times per year, or more frequently if field conditions dictate. Mowing operations are stopped from late-October until early-March. Other maintenance practices include dethatching and inter-seeding.

Highly trained and keenly motivated staff are a critical component in the context of shrinking budgets. Support is offered through in-house training, seminars or continuing education courses. The field personnel is encouraged to report hazards or problems to their supervisors and are involved in the development of annual maintenance plans.

Since 1983, the Integrated Vegetation Program has resulted in a reduced use of pesticides. For example, pesticide applications have been limited to a herbicide application for clover control on a seating area prior to the 1991 Summer Games. Clovers tend to attract bees and wasps and it was feared they would sting spectators during this event. The playing fields of Coquitlam, with healthy turf grass requiring minimum pesticide use, are a testimony to the high standards of Parks Operations personnel and the validity of the IPM approach.

iii) Golf courses and high maintenance areas

Golf courses and bowling greens require intense management to maintain high aesthetic and playing surface standards. However, there should be little need for herbicides to control weeds. Proper turf establishment and cultural maintenance lead to herbicide use as a spot treatment rather than a blanket treatment over the entire area.

Putting greens usually constitute a small portion of the golf course but receive the highest level of maintenance. The required smooth firm surface is achieved by daily mowing, seasonal coring, light frequent top dressing, regular fertilization and consistent frequent irrigation (Cook, 1991). The preferred grass variety is creeping bentgrass (*Agrostis palustris*). The most common weed problem is annual bluegrass (*Poa annua*), but it grows well most of the year and produces an excellent putting surface.

Putting greens are usually close-mowed, stressing the turf which becomes susceptible to diseases. Proper maintenance will keep the turf healthy during most of the growing season, except for fusarium patch and snow mold. Fungicides must be used in the fall to control these winter diseases if greens are to survive the winter in playable condition (Fushtey, 1991).

Fairways are maintained to produce tight, dense growing turf to support golf balls. The principal cultural practices include frequent mowing, periodic fertilization and regular irrigation during dry periods. The choice of grass ranges from creeping bentgrass (low mowing height) to a mixture of perennial ryegrass, Kentucky bluegrass and fescues (high mowing height). The choice of bentgrass in fairways must be discouraged, as it requires more fertilizer and is more prone to thatching and disease.

Fairways require little or no pesticide use with proper cultural maintenance. Localized infestations of weeds or insects are controlled by spot spraying. Diseases may be a problem on old fairways, or near greens where traffic is intense and creates soil compaction.

Rough areas are usually maintained at a low level of management. Mowing is done weekly and fertilization is minimal. Tolerance for weeds is high and public golf courses are not likely to treat roughs for cosmetic reasons.

Box 5-13: Recommended IPM program for B.C. golf courses

During the summer of 1992, the Vancouver Island Golf Course Superintendents Association worked with the Ministry of Environment in a review of their turf and pest management practices. The goal was to assist in the implementation of an Integrated Pest Management program.

The author made recommendations following a visit to 22 golf courses.

The golf course is modified to remove conditions favoring pest problems.

For example, to reduce the incidence of fungal diseases, trees causing excess shade are removed and resistant varieties of grass are selected. Another example, bird houses are installed around the golf course to encourage nesting by insect-eating birds.

Information is provided to the public and the course personnel.

The information explains the objectives and procedures of the IPM program. Golf courses should experiment on selected fairways and greens.

Fungal diseases are controlled by correcting the favorable conditions.

Fungicides are used with caution as they disrupt soil microorganisms and lead to thatch buildup and other diseases.

Weed control is accomplished with a higher tolerance in rough areas.

Soil problems leading to weed growth are corrected. Pesticide use, when required, is done by certified pesticide applicators.

Fairways are planted with grasses other than bentgrass.

Also, non-sand based greens should encourage earthworm populations to assist in thatch decomposition. Finally, wetting agents are recommended to decrease the amount of irrigation water required.

Source: Davis, C., "A Survey of Golf Course Maintenance Practices and Recommendations for Improvement or Implementation of IPM Programs", Publication 92-3, Ministry of Environment (Nanaimo, B.C.), August 18, 1992.

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