PENNSTATE
Vegetation Management
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Integrated Vegetation Management

Integrated vegetation management (IVM) is a structured approach to common sense management of weeds. You can think of it as a strategic planning for managing vegetation. IVM is a vegetation-only subset of integrated pest management, or IPM. IPM gained popularity in the 1960's, when it became apparent that relying solely on the 'new technology' of pesticides to manage pests had serious drawbacks. IPM stressed the need to continue to rely on all effective management techniques, and use them in a coordinated manner.

IVM is a means to achieve a well-planned program, stressing preventive maintenance, rather than engaging in 'fire fighting' and being stuck in a reactive mode.

On Pennsylvania roadsides, the goal of an IVM program is to end up with a mixture of plants (groundcover, or plant communities) that are 'tree-and-weed-resistant', and require little maintenance activity.

Why Manage Roadside Vegetation?

Roadside vegetation has an acute affect on the safety and function of the roadway, and it is a commodity shared by PENNDOT and thousands of neighbors.

Maintain Safety and Function

The primary reason to manage vegetation along roadways is to reduce risk to motorists. Vegetation management is necessary to maintain maximum sight distance, reduce collision targets, and prevent vegetation from degrading the function and integrity of the road surface.

Trees and shrubs are the most problematic roadside vegetation, but certain non-woody (herbaceous) weeds grow large enough or fast enough to pose safety hazards as well.

Be a Good Neighbor

A second reason to manage vegetation is to serve as a good neighbor. PENNDOT maintenance activities border thousands of properties, and have a definite impact on the environmental and economic condition of those properties.

The roadside vegetation management program needs to maintain an aesthetic that is compatible with the neighboring properties and surrounding community. Additionally, it is important that noxious and invasive weeds are not allowed to spread from the roadside onto adjacent properties.

Noxious and invasive weeds are a form of pollution - *biological pollution*. It is just as important to prevent biological pollution as it is to prevent pollution of the water, air, and soil bordering the highways of the Commonwealth.

Components of an IVM Program

An essential ingredient in any program is to clearly define your management objective. Without a vision of what you want to accomplish, it is impossible to develop a program to achieve it. On the roadside, the goal is low-growing vegetation that provides visibility, prevents erosion, and is free of undesirable woody vegetation and weeds.

It is important to understand that the groundcover you desire may take several years to achieve. The plant community changes in response to your management operations, and your goal is a program that causes the groundcover to change towards your goal.

With the goal established, you assemble the program by defining what your target priorities are, determining where the targets are, directing operations to manage the targets while maintaining a desirable groundcover, and determining whether your efforts were successful.

Define the Target

A weed is a 'plant out of place' - what you want to accomplish defines what is a weed. The considerations that determine your control operations are what the target species is, where it is, and how many targets are present.

Desirable vs. Undesirable Vegetation

Any vegetation that is not a problem is providing a benefit by occupying space that a weed could be in. One of the ongoing issues as you develop your program is finding a good balance between preserving desirable vegetation while eliminating undesirable vegetation.

Penn State College of Agricultural Sciences research programs are funded in part by the Commonwealth of Pennsylvania and the U,S. Department of Agriculture.

Some weed species are very problematic, and you may decide that elimination of this species takes a higher priority than preserving the desirable vegetation that is present. Sometimes there is no desirable vegetation present, and the IVM program creates an opportunity for desirable vegetation to become established by eliminating the problem vegetation.

Determine Target Thresholds

In IVM, a *threshold* is the level of weed infestation that justifies a control measure. *Where* a weed is, and *how many* there are or *how big* they are will determine the priority for controlling them. Seedling and sapling trees creeping out from the forest edge are less pressing an issue than a more mature tree of the same species that is close to the roadway.

Use the Zone Concept

One method to help you define threshold levels is to divide the roadside into management zones, based on distance from the roadway. This concept is illustrated in Figure 1.

Non-selective Zone

This zone is the area immediately adjacent to the roadway. This area should be free of vegetation to promote the flow of water off the road surface and towards the ditch. This zone also includes the guiderail. In the non-selective zone, *all* vegetation is a target.

Safety Clear Zone

This zone is to be kept clear of woody plants to provide a recovery zone for vehicles that have left the travel lane. On a secondary road with a 33-foot right-of-way (ROW), this zone extends from the outer edge of the non-selective zone to the ROW boundary, and is only a few feet wide. On a larger ROW, the safety clear zone is usually considered to extend to at least 30 feet from the edge of the roadway.

Selective Zone

The selective zone only occurs on wider ROW, and would extend from the outer edge of the safety clear zone to a distance of up to 80 ft from the edge of the roadway, depending on ROW width. In this zone, the target vegetation is tall-growing tree species and noxious and invasive species. If terrain permits, this zone can be maintained by occasional mowing, perhaps once every two to three years. This zone could also be easily maintained by periodic herbicide applications to selectively remove trees and problem weeds.

Natural Zone

This zone would only occur on very wide ROW, and would be an area that would require vegetation management only if noxious or invasive weeds are present.

Scouting

In a high-value agricultural setting, such as an orchard, scouting for damaging insect or disease pests may occur quite often, particularly when environmental conditions are ripe for an outbreak. In a roadside situation, the resources are not available for extensive scouting. Scouting will most likely occur during the weed control operation, and the decision will be made by the applicator to treat or not treat based on the targets present and the objective of the operation.

Control Operations

The business end of the program is the operations used to manage vegetation (see *Vegetation Management Techniques*). The overriding concept of IVM is to rely on as many methods as you can, and to use them in a coordinated manner so that the effects of one operation add to the effects of another.

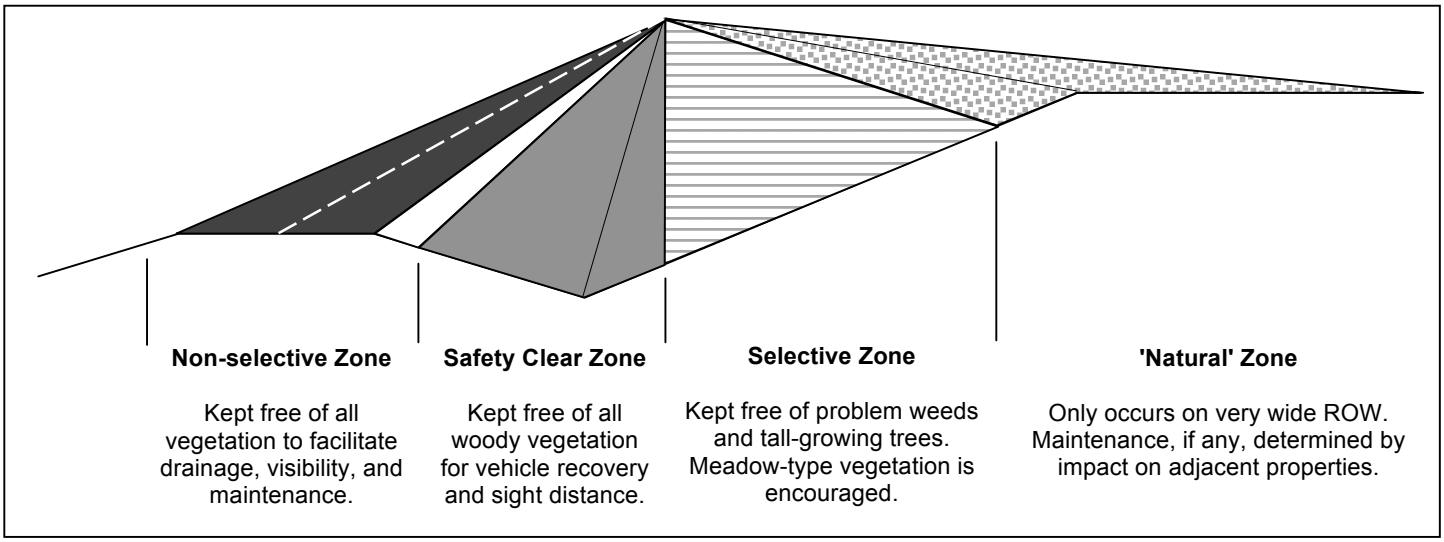

Figure 1: General roadway cross-section showing roadside vegetation management zones on the shoulder of a limited-access highway with a very wide right-of-way (ROW). Many limited-access ROW would not have a Natural Zone, and secondary roads would only have a Non-selective Zone and a portion of the Safety Clear Zone.

Program Evaluation

Putting together a great plan on paper is of little value if you do not know if it works. You need to keep track of the details of the operations, evaluate the results, and make changes if the results do not meet your expectations.

Recordkeeping

The value of detailed recordkeeping can only truly be appreciated when you go back later to check on some detail of your vegetation management operations. Keeping detailed records of what you did, how much you got done, how much material you used, how long it took, and who were the operators makes it much easier to evaluate the results you observe, and to plan your program in the following years. Proper use of the PENNDOT M609 Form will accomplish most of your recordkeeping functions.

Monitoring Control Success

If you don't take the time to carefully review whether your program works, you have largely wasted the time you invested in getting your program on the ground. You cannot be sure it's working, and you certainly cannot improve the program if you do not know how effective it was.

Fine Tuning the Program

A goal of any viable program is improvement. Good recordkeeping and evaluation give you the information you need to get better results, or to get equal results with less effort or expense.

Vegetation Management Techniques

There is a wide array of maintenance practices that can be used to manage vegetation. The most common way to describe these practices is to put them into four different control-method categories: cultural, mechanical, biological, and chemical.

Not all operations fall neatly into one of the categories, and many practices are a combination of control techniques.

Cultural Control

Operations that are not directed specifically against a pest, but still provide a weed management benefit fall into the category of cultural control. Another way to think of cultural control practices is to regard them as 'indirect weed management'. Two common categories of cultural control include enhancing desirable vegetation, and practices to prevent the spread of weeds

Enhancing Desirable Vegetation

For our discussion, desirable vegetation is simply any vegetation that is not problem vegetation. Intact, desirable vegetation is the best and 'easiest' way to manage undesirable vegetation. In simple terms, two plants cannot occupy the same space. The more space you fill with desirable plants, the less space that is available for weeds. Another way to look at it is to remember that 'it's a jungle out there'. Plants compete for sunlight, space, and water and nutrients in the soil. A desirable groundcover makes it much harder for weeds to establish and thrive. What follows are some examples of methods to enhance the quality of a desirable groundcover.

Figure 2: Hydraulic seeding of a mixture of grasses to a roadside area where brush has been cleared. Establishing a competitive groundcover by selecting a well-adapted plant material and using proper establishment procedures helps reduce the opportunity for weeds to infest the roadside.

Plant Material Selection

Roadside sites are usually highly disturbed, and feature poor, infertile soils. Choosing the best plant material for the conditions is the first step in establishing a desirable groundcover. However, plant material selection usually occurs during the design phase, before any earth is even moved. In the maintenance setting, revitalization is a prime opportunity to start over with the best plant material possible. Choosing the right plant material at the beginning will save long-term maintenance effort by reducing erosion and weed infestations.

Planting and Site Preparation

When revitalization opportunities occur, take advantage of the opportunity to properly prepare the site for planting. Going to the effort to insure there is some semblance of topsoil present, preventing soil compaction by 'recreational grading' (unnecessary smoothing by heavy equipment), seeding at the correct rate and timing, and using the proper rates of approved mulch and supplements will improve plant establishment (Figure 2).

Fertilization

Application of fertilizer is usually limited to establishment during the construction phase or revitalization. However, taking the opportunity to fertilize grass seedings in the first season after planting will provide quicker growth and 'filling in', and reduce future weed pressure. Fertilizer can be applied to turf during broadcast weed control applications by incorporating a soluble fertilizer into the spray treatment.

Mowing

Mowing is usually regarded as an example of mechanical control, but *how* you mow grass and other plants such as crownvetch definitely impacts how it grows. Mowing is stressful to all plants. Reduce stress by mowing as high as possible and as few times as possible. More foliage remains on the plant, and allows for more vigorous growth.

Sanitation & Prevention

Another example of cultural control is to employ practices that prevent the unintentional spread of weeds. In the roadside setting, a common way that weeds are spread is on equipment and in soil. Cleaning equipment between sites will reduce movement of plant parts and seeds.

Where soil disturbance and movement is planned, such as shoulder grading, treat the vegetation with herbicides prior to the operation so that the soil will contain fewer viable plant parts when it's loaded and stockpiled. Treat stockpiled soil with non-residual herbicides to prevent weeds from becoming established and spread when the soil is placed.

When soil needs to be taken from borrow areas, choose sites that do not contain perennial weeds. If there are sites designated as borrow areas, include these areas in routine weed management programs to prevent weeds from getting established and spreading to other sites.

Figure 3: Clearing small-diameter brush with a mower that treats the brush stubble with herbicide as it cuts. This provides increased recovery area and sight distance, and prevents brush re-establishment.

Mechanical Control

Mechanical control practices physically injure or remove target vegetation. Common examples of mechanical operations include brushing, mowing, and grading. Mechanical operations usually remove plant top growth. Many plants will simply regrow after removal of their tops, so combining mechanical operations with herbicide applications is often an effective approach to restore clearance and prevent re-encroachment.

Brushing

Tree and shrub growth needs to be physically removed when it encroaches into clear zones or lines of sight. Unlike herbaceous growth, which dies back each year, woody stems continue to extend into areas that need to remain clear. Most trees and shrubs will regrow vigorously after being cut. If you do not take steps to prevent regrowth, the time and effort spent cutting will produce only a short-term result. To make brushing truly effective, the stumps should be treated with an herbicide during the cutting operation, and an herbicide application should be programmed during the next growing season to eliminate the sprouts that do form.

Mowing

Mowing eliminates the top growth of vegetation. The effects on most perennial weeds and woody vegetation will be temporary. When mowing is done to minimize the injury to desirable vegetation (*see Cultural Control*) such as turf or crownvetch, weeds will be suppressed. Infrequent mowing (perhaps every two years) in ROW areas outside the established mow line will prevent woody plant establishment. Where woody vegetation has become established, specialized mowers can be used to clear the woody vegetation. Recently, several brush mowers have become available that mow and treat the remaining stumps and stubble with an herbicide in a single pass (Figure 3).

Pulling and Grubbing

Pulling and grubbing remove the plant root system from the soil, and will effectively kill many plants. Pulling is only practical for very small areas such as flower beds. Grubbing is often done to remove the root systems of trees and shrubs prior to excavation. Where the tree root system is not interfering with the maintenance of the site, grubbing is unnecessary and costly. Simply cutting woody vegetation and treating the stumps or early regrowth will provide effective control and prevent soil disturbance.

Biological Control

Biological Control describes using an organism or multiple organisms to control a pest species.

'Classical' Biological Control

In vegetation management, classical biological control describes using an insect or disease from the

Figure 4: The loosestrife leaf beetle (Galerucella calmariensis) has been released in Pennsylvania and throughout the U.S. to provide biological control of purple loosestrife.

native range of the pest plant to attack it. Releasing biological control agents is a highly regulated process, and requires that extensive testing be done to ensure that the biological control agent is not only effective, but will limit its effects to the target species.

A current example of biological control in Pennsylvania is the release of *Galerucella* beetles to feed on the Noxious Weed purple loosestrife (Figure 4).

Ecological Control - Competitive Groundcovers

A variation on the theme of biological control is 'ecological control', which describes the effect of desirable groundcovers competing with undesirable species. This effect was also described above as a form of cultural control. In ecological control, a complex of desirable species can be competing with many undesirable species, while classical biological control targets one-to-several organisms against a single weed species.

Chemical Control - Herbicides

There are many ways to use herbicides to control weeds, and many ways to try to divide these many applications into categories. These applications will be described in detail in other modules in this series.

We will discuss applications in terms of being selective or non-selective, and applied to the plant or to the soil.

A selective treatment affects weeds, but not the desirable plants around the weeds. The desirable plants are not injured because they are not affected by the herbicide, or because the susceptible part of the plant does not come into contact with the herbicide. A non-selective treatment affects all treated plants.

The application categories below are not exclusive - a treatment can contain a mixture of herbicides that are targeting the soil and the plant foliage, and some herbicides are effective whether applied to the soil or the plant.

Non-selective Soil Applications

Treatments to provide bare ground under guiderails and around signposts are an example of a non-selective soil application. For this treatment, a mixture of herbicides is applied early in the season to eliminate any vegetation that is present, and leave an active residue in the soil that prevents the germination of weeds.

Based on the herbicides used and their dosage, you can adjust the period of residual control. For roadside and industrial settings, full season control is typically the objective. In a row crop situation, residual soil activity may only be needed for a few weeks - just enough time to allow the crop to get established and produce a canopy that will limit further weed growth.

Selective Soil Applications

This treatment is common to ornamental and crop settings. The herbicide treatment is applied to the soil, but it does not injure the desirable plants or crops. The desired plants are not injured because they are not affected by the herbicide, or because they are protected from the herbicides effect.

An example of a selective soil application would be controlling crabgrass in a home lawn. The herbicide, often combined with a fertilizer as a 'weed-and-feed' product, is applied in the spring before crabgrass germinates. This herbicide is only effective on germinating seedlings because it prevents roots from growing, and because it is immobile in the soil and stays at the soil surface - where the crabgrass seed is. The roots of the lawn grass are already present, and they are growing beneath the herbicide, so the turf is not affected. This is also why some herbicides can be applied in a flower bed right after you plant the flowers - the flowers already have a developed root system and the root system is below the herbicide.


Figure 5: Poison hemlock, injured by an application of a selective herbicide that injures broadleaved weeds but not grasses.

Non-selective Plant (Foliage) Application

This type of treatment is used when you wish to eliminate all the existing vegetation from a site. The treatment is made non-selective by the herbicides used and the dosage they are applied.

Based on the herbicides you use, this treatment can have soil residual activity, or be non-residual. If you are treating a guiderail, you want this treatment to also be active in the soil to prevent new weed growth. If you are going to reseed the area soon after treatment, you do not want any soil activity from the herbicides.

Selective Plant Application

This treatment is used when you want eliminate some plants and leave other plants intact. The selectivity of the treatment can be due to how the herbicide affects the different plants, how you apply the treatment, or both.

The common example of selectivity due to how the herbicide affects different plant species is controlling broadleaf weeds in turf. Herbicides such as triclopyr or dicamba do not injure grasses at the doses they are applied, but they do injure broadleaved plants (Figure 5).

Using a 'spot treatment' is the most common example of being selective by how you apply the herbicide. In this situation, you only treat the weed targets, and you skip over areas where you have desirable vegetation (Figure 6).

Integrating the Program

IVM is more than simply being able to say that you have a whole 'laundry-list' of programs for managing vegetation. Coordinating, or integrating these elements together to get you closer to your desired groundcover is the 'glue' that holds the program together.

Many vegetation management operations require multiple steps. When you program the first step, make sure to program the next step as well. For example, don't invest in a brushing operation but leave the follow-up treatment in the 'I'll-get-to-it-later' pile. They are not separate operations - they are two steps of the same operation.

Schedule operations so that they complement each other, rather than confounding each other. The timing of mowing and spraying operations provides an example. If you're treating weeds in turf areas that are mowed, make sure the treatment is applied about a week before mowing, or is delayed until the weeds have regrown enough to be treated after mowing. Mowing too soon after an herbicide application prevents the herbicide from getting into the root system. Spraying an herbicide too soon after mowing is ineffective because there is very little foliage to intercept the spray.

Summary

To effectively implement an IVM program, you need the following:

- a goal, or 'mission statement' that can be written in operational terms and that has a time frame - for example, a five-year plan;
- an inventory of your vegetation management resources;
- a description of the program written in terms of prioritized-tasks; and
- flexibility - there will always be some 'fires' that pop up, diverting you away from your preventive-maintenance program.

Figure 6: A selective application of an herbicide mix to roadside brush. The backpack sprayer with a nozzle that delivers a small volume of spray solution is well suited to selectively treating target weeds and leaving the desirable groundcover uninjured.