



Seven **steps** to **Managing Your Weeds**

**A Manual for
Integrated Weed Management
in British Columbia**



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- *Weed Watch*, a video for weed awareness workshops
- Weed awareness public service announcements on BC television stations
- *WeedsBC*, a website at <http://www.weedsbc.ca>

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Contents

Introduction	1	Step 6: Develop an Integrated Weed Management Plan	30
The Seven Steps.....	1	Principles of Integrated Weed Management	30
A Brief Overview of Weeds.....	2	Key Points for Your Management Plan	32
Step 1: Map the Management Area and Its Resources.....	4	Step 7: Develop a Monitoring Program	33
Selecting Your Mapping Tools.....	4	Qualities of a Monitoring Program	33
Identifying Your Resources	8	Keeping Written Records.....	34
Step 2: Map and Inventory the Area for Weeds	10	Keeping Photographic Records	38
Learning about Weed Species	10	Testing Monitoring Procedures	39
Planning Your Fieldwork	11	Implementing a Monitoring Program	39
Recording with Map and Journal	13	Appendices	40
Step 3: Set Weed Management Goals and Objectives	15	Appendix A: Noxious Weeds in BC (2001)	40
Step 4: Set Priorities for Your Weed Management	17	Appendix B: Seed Production and Dormancy	41
Step 5: Select Your Weed Management Strategies	18	Appendix C: Best Weed Management Practices.....	42
Prevention.....	18	Appendix D: Bioagents Attacking Weeds in BC	43
Physical Strategies	19	Appendix E: Mode of Action of Herbicides Used in BC	46
Cultural Strategies	21	Appendix F: Weed Management Plan	48
Livestock Grazing	22	Related Publications.....	58
Biological Control	23		
Use of Herbicides.....	24		
Strategies in Review	29		

To go to any topic, just click on it.

Introductory Notes

- Your integrated weed management plan will consist of:
 - A base map of your weed management area and its resources, as shown in [Step 1](#)
 - A transparent overlay showing your weeds, as shown in [Step 2](#)
 - A completed set of planning charts related to Steps 3–7, as shown in [Appendix F](#), pages 48–57
- As you work through this manual, it will often be useful to have copies of certain pages available. In particular, you will need copies of Appendix F, Weed Management Plan—at least by the time you begin reading about Step 3. You will then be able to keep those sheets in front of you for easy reference and perhaps for making notes. You are permitted and encouraged to copy pages for that purpose.
- This manual is available online at the WeedsBC Website, <http://www.weedsbc.ca>, in Portable Document Format (PDF); it can be viewed with Acrobat Reader. In the PDF file, the hyperlinks that enable you to navigate the manual quickly and go to external sites are shown in blue.
- You may wish to follow up with some of the books and articles that are mentioned in this manual. The facts of publication are provided in the [“Related Publications”](#) section on page 58.

Viewing and Navigating This Manual On-Line

This manual is designed to be viewed with Acrobat Reader, available as a free download at <http://www.adobe.com/products/acrobat/readstep2.html>. You will typically need to view it at 125%. You are also welcome to print it out for your own use. Alternatively, you can purchase a printed manual, as indicated at the end of the [Acknowledgements](#) page.

If you are connected to the Internet while viewing this manual, blue URLs such as <http://www.weedsbc.ca> will take you to Web pages by means of your selected Web browser. Any other text in blue type, including the Contents items, is a hyperlink to another page. You can jump back by choosing “Go Back” in Acrobat Reader’s “Document” menu—or by using the keyboard shortcut given there. To go to the Contents page from anywhere in the manual, click on the “Seven Steps to Managing Your Weeds” header. Besides the Contents page, the “Search” and “Find” commands (and the “Find” keyboard shortcut) in Acrobat Reader’s “Edit” menu are useful for quickly locating information in the manual.

Introduction

Weeds and the damage they cause have become an important management issue for many landowners and other land managers in British Columbia. It is essential for everyone who manages land to have access to:

- Relevant information on the weeds that impact their resources
- The strategies by which the impact of weeds can be reduced

This manual provides step-by-step guidance through seven steps for creating an integrated weed management plan. It will help you to develop an efficient and cost-effective long-term solution. Use it with other resources on weeds in BC, which should include the *Guide to Weeds in British Columbia*. Preferably also use the *Field Guide to Noxious and Other Selected Weeds of British Columbia*. These resources provide detailed information on weed species in the province.

This manual focuses on managing properties to protect native plant communities from the negative impact of invasive weeds. Most of the weed management advice can be extended to industrial sites, roadsides, and lands used for producing crops.

Note: Since your purpose in using this manual is to manage weeds, this manual will generally refer to you as the *weed manager* and to the land you look after as the *weed management area* or *management area*.

How to Use This Manual

- Read the Introduction.
- Browse through each chapter—each step—to understand the general approach to developing a weed management plan.
- Then go back and draw on the information you need in order to prepare your own plan. The 📖 symbol indicates a specific action that will help you to develop your plan.
- Prepare your weed management plan, using [Appendix F](#).
- Refer back to this manual as you monitor and revise the plan.

The Seven Steps

Step 1: Map the management area and its resources.

Step 2: Map and inventory the management area for weeds.

Step 3: Set weed management goals and objectives.

Step 4: Set priorities for your weed management.

Step 5: Select weed management strategies.

Step 6: Develop an integrated weed management plan.

Step 7: Develop a monitoring program.

Before you proceed with the seven steps, it may be useful to read “[A Brief Overview of Weeds](#),” starting on the next page.



Canada thistle

Note: This manual is current at the time of writing, but new information often becomes available. You can obtain it from your local Ministry of Agriculture, Food and Fisheries office, but the first way to update your knowledge is to visit the WeedsBC site, <http://www.weedsbc.ca>.

A Brief Overview of Weeds

What Is a Weed?

Weeds are defined in many ways. For instance, a weed is a plant growing where it is not wanted or a plant that interferes with your management objectives. All definitions deal with a plant's impact on human activities. Weeds are usually introduced species—rather than members of an area's native plant community. However, some native plants may be regarded as weeds when they negatively affect management objectives.

Noxious weeds in British Columbia are legislated in the Weed Control Act (RSBC 1996). The Act designates alien plant species as noxious when they meet one or more of the following four criteria:

- They aggressively invade natural resources and agricultural crops or are detrimental to them.
- They are poisonous or injurious to livestock.
- They are exceptionally difficult to control by standard methods.
- There is a need to enforce control to prevent expansion of new invaders.

The terms *alien*, *non-native*, and *exotic* are used to describe species that have been introduced into BC.

Why Are Weeds a Problem?

The spread of invasive non-native plants is one of the most serious problems affecting native plant communities in western North America. Introduced alien “weeds” have a devastating impact on BC's plants and animals:

- After habitat destruction, they are the second greatest threat to the diversity of our natural resources.
- They contribute to losses of agricultural productivity.
- They adversely affect ecological processes in some of the province's most valuable and productive wildlife and recreational habitat.



diffuse knapweed

Weed infestations affect many aspects of our lives. Controlling them costs ranchers, farmers, conservation groups, utility companies, governments, and the general public millions of dollars each year. Weeds:

- Kill native grasses and wildflowers, including rare and endangered species.
- Destroy natural habitat for wildlife, birds, and domestic animals.
- Destroy habitat for fish and other aquatic organisms.
- Reduce the yield and quality of agricultural crops.
- Interfere with the regeneration of forests.
- Increase wildfire hazards.
- Increase soil erosion and stream sedimentation.
- Ruin water quality.
- Endanger public health and safety.
- Increase allergies and hay fever.
- Are potentially toxic to humans, pets, livestock, and wildlife.
- Act as carriers of disease and harmful insects to beneficial plants.
- Clog waterways used for swimming and boating.
- Destroy recreational opportunities and the beauty of the landscape.
- Reduce visibility on transportation corridors.
- Increase costs for maintaining resources and public utilities.
- Decrease the value of marketable livestock.
- Decrease land values.

The BC Weed Control Act (RSBC 1996)

In British Columbia, the Weed Control Act is intended to protect natural resources and industry from the negative impact of foreign weeds.

The Act states: “*Every occupier shall control, in accordance with the regulations, noxious weeds growing or located on land and premises, and on any other property located on land and premises, occupied by him.*”

This means that landowners, private companies, utility companies, regional districts and municipalities, and provincial government agencies or anyone else in physical possession of land all have a responsibility to manage weeds in the province. The complete text of the Weed Control Act and Regulations can be accessed on the Internet at:

http://www.qp.gov.bc.ca/statreg/stat/W/96487_01.htm and
http://www.qp.gov.bc.ca/statreg/reg/w66_85.htm.

The Weed Control Act currently designates 48 plant species as noxious weeds. They are named in [Appendix A, Noxious Weeds in BC](#). Currently, 21 weeds are listed as noxious weeds within all regions of the province. A further 27 are classified as noxious within the boundaries of specified regional districts.

All of the designated species are non-native plants that create problems in agriculture and/or natural habitats:

- Spotted knapweed and diffuse knapweed have caused severe damage to natural resources in the Interior of BC for decades.
- Many other species found in BC pose major ecological and economic threats. They include Dalmatian toadflax, rush skeletonweed, hound’s-tongue, leafy spurge, orange hawkweed, yellow hawkweed, oxeye daisy, scentless chamomile, sulphur cinquefoil, and tansy ragwort.
- Common crupina and yellow starthistle are also designated as provincially noxious weeds even though they are not currently found in BC. Their presence in neighbouring Washington and Idaho presents a potential to invade the province.

Integrated Weed Management Strategies

Integrated weed management includes techniques that focus on prevention, rather than eradication. An integrated approach is an essential part of the ongoing maintenance program for any property. This strategy is a balanced approach to resource management. To achieve long-term results, it must include the following processes:

- Managing the resources to *prevent* weeds from invading.
- Identifying invasive weed species and being knowledgeable about them.
- Mapping and inventorying weed populations and recognizing the damage they cause.
- Making control decisions based on knowledge of the potential damage, the cost of the control method, and the environmental impact of the weed and the control option.
- Using a suitable combination of control strategies to reduce the weed population to an acceptable level.
- Monitoring effectiveness and adjusting as need be.



hound's-tongue

Step 1: Map the Management Area and Its Resources

An effective weed management strategy relies on your awareness of the distribution of weeds in the weed management area. When you map and inventory the weeds, you will do it in relation to:

- Geographical references
- Resources requiring protection

Step 1 is therefore to map the management area. You will need to obtain or make a map on which you:

- Mark the boundaries of the area.
- Identify the resources that require protection.

The map scale will typically be between 1:2,000 and 1:50,000. The size of the management area will determine the suitable kind and scale of map.

This map will be a base map. In Step 2, you will add details about the weeds, probably on overlays. The resulting map will assist you to:

- Identify environmentally sensitive locations and other locations that require management.
- Understand the magnitude of the problem.
- Set priorities about which weeds to manage.
- Monitor the rate of weed spread and the effectiveness of control methods as a basis for making adjustments.

The area that you map may go beyond the property that is your direct responsibility. It is quite possible that you will need to collaborate to address a larger area. Why? Since weeds do not know boundaries, it is often necessary to be conscious of surrounding areas. For example, owners of small properties in a rural subdivision may need to work together to develop a weed management plan for the subdivision. Agencies may need to develop comprehensive plans in addition to their agency-specific plans in order to satisfy legal requirements, agency policies, and personal needs. A comprehensive plan—a cooperative and coordinated effort—is often more efficient and effective than an individual plan alone.

Selecting Your Mapping Tools

You will need to select a suitable map (or photo) at a suitable scale for your management area. Later in this step, you will add to this base map the resources to protect. In Step 2, you will show the distribution of weeds.

For a smaller property, you could sketch the property, including landmarks such as roads, water bodies, wells, fencelines, and buildings. This will be a base for mapping weed infestations and isolated patches to be controlled.

A small property is often a single management area (or management unit). However, you may need to subdivide a larger holding into more than one management unit, especially where landscape varies greatly in weed species, weed distribution, topography, soils, elevation, or management objectives. You may therefore need more than one map.

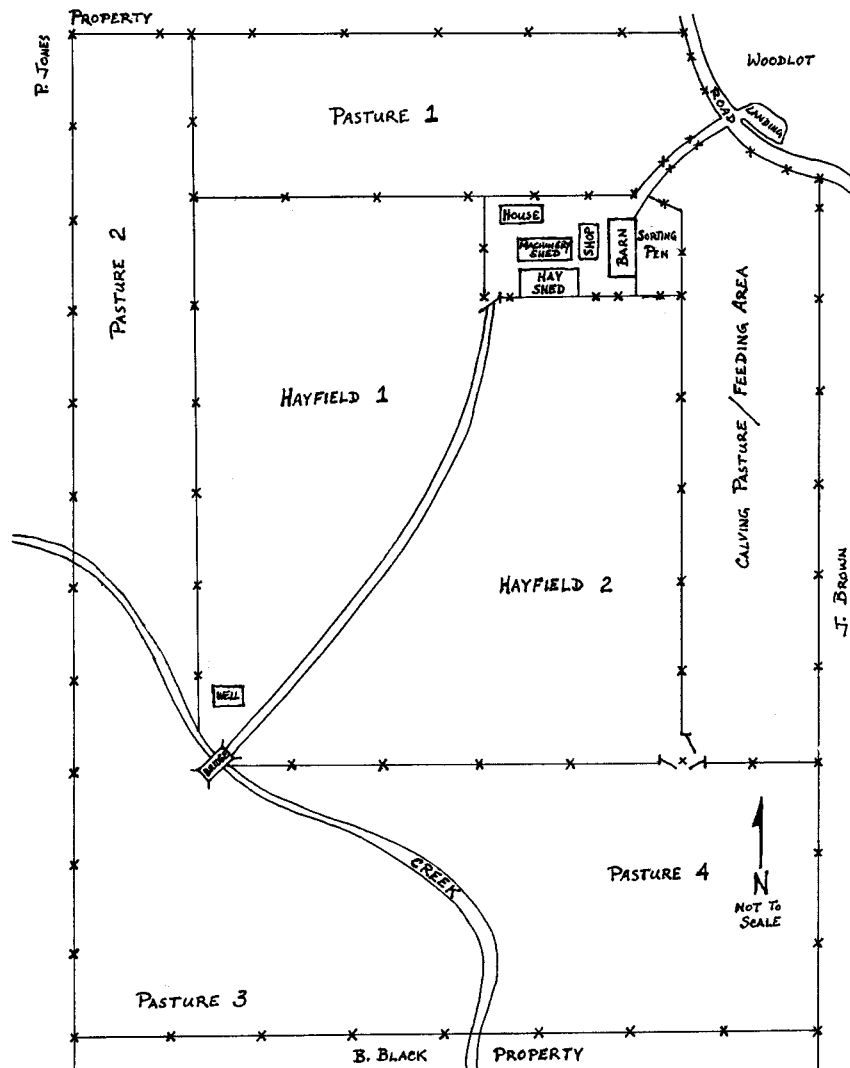
For larger areas, aerial photos can be especially useful as supplements to maps for developing weed management plans. When available, aerial photos are useful for showing topography, forest cover, open areas, watercourses, forest cut blocks, forage seedings, cropped land, fencelines, roads, and buildings. You can obtain high-quality black-and-white aerial photos from several sources, as explained later in this section.

When you are choosing a map, it may be necessary to purchase it in more than one map scale in order to see:

- The entire management area in an overview
- Specific weed management areas (units) within the larger area

It may also be useful to choose a map that extends beyond the management area. This will enable you (in Step 2) to map weed infestations adjacent to your property so that you can be aware of:

- Future threats to your land from weeds on neighbouring properties
- The potential impact of your management techniques on neighbouring properties



This aerial photo shows the resources in a larger area in considerable detail. In Step 2, you will see it used as a base for mapping weeds.

This hand-drawn base map shows the boundaries and resources of a property. In the Step 2 part of this manual, you will see it used as a base for mapping weeds.

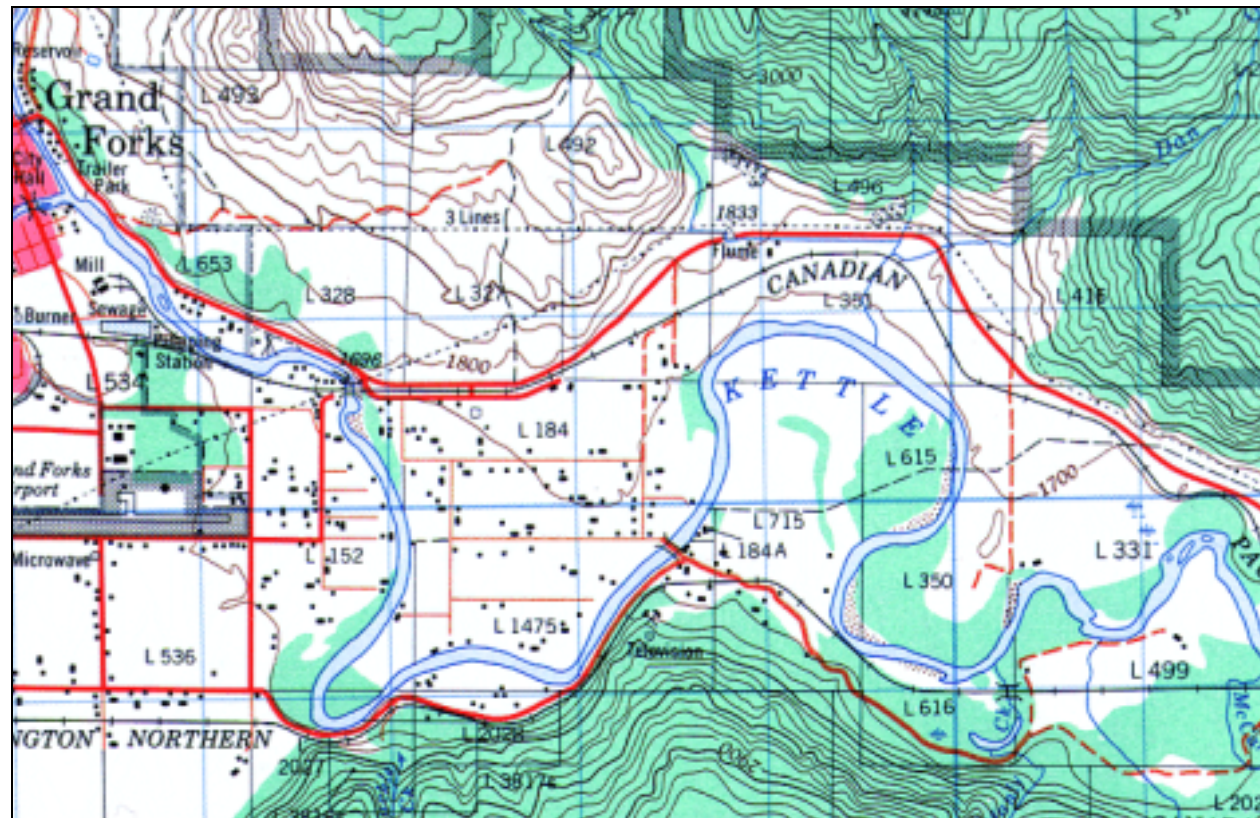
Sources of Aerial Photos and Maps

LandData BC

LandData BC is a joint undertaking of the Ministry of Land, Water and Air Protection, Geographic Data BC, BC OnLine, and MacDonald Dettwiler. It acts as a clearing house for land-related information, and it provides access to a variety of land resource databases within the province. The database can be accessed online at <http://www.landdata.gov.bc.ca>.

National Topographic System

The National Topographic System is an online service of Natural Resources Canada. It provides 1:50,000 and 1:250,000 scale topographic maps showing features such as hills, valleys, contours, lakes, rivers, streams, trails, wooded areas, major and secondary roads, railroads, buildings, power lines, dams, and lot numbers. The service can be accessed at <http://maps.nrcan.gc.ca/topographic.html>.



1:50,000 scale topographic map

Base Mapping and Geomatic Services Branch (BMGS)

BMGS is an online government service from BC's Ministry of Sustainable Resource Management. It is linked to LandData BC. The service provides aerial photos as hard copies and downloadable digital copies. You can access a catalogue of aerial photos at <http://home.gdbc.gov.bc.ca>.

Government Agent Offices

Some government agents have microfiche indices of aerial photos up to 1996. These indicate the specific aerial photo numbers (roll and frame) to order. Digital aerial photo indices, beginning in 1993, can be ordered from LandData BC. Most government agents have samples of Terrain Resource Information Management maps (TRIM maps, described later) to cover local areas, with indices to the surrounding map sheets in a given area. Locations and contacts for government agents can be found at the Government Agents site, <http://www.governmentagents.sb.gov.bc.ca>.

Authorized Air Photo Agents

Authorized air photo agents also provide air photos and maps. BMGS lists authorized agents in the private sector that are located on the Lower Mainland and in Dawson Creek, Fort St. John, Kamloops, Penticton, Prince George, Salmon Arm, Smithers, Terrace, Williams Lake, and Victoria. Full addresses, telephone numbers, and e-mail addresses are available from Geographic Data BC, <http://home.gdbc.gov.bc.ca>.


TRIM Maps

The TRIM program includes over 7,000 digital files. Digital and print maps are available at 1:20,000, 1:10,000 (limited), and 1:5,000 scales. These base maps generally depict natural and man-made physical features, topography, contours, and spot heights. Features such as roads, streams, forest openings, and topography can be overlaid on the TRIM base map.



1: 20,000 TRIM map

BMGS recommends ordering TRIM print maps from a private map agent or a government agent in your area. Contact these agents for availability, prices, and payment method. For the TRIM map sheet numbers, you will find that indices for each 1:250,000 block are available for viewing on the BMGS Website at <http://home.gdbc.gov.bc.ca>.

 Sketch a map of your weed management area, or purchase a suitable map (or aerial photo). Indicate the boundaries of your area.

Identifying Your Resources

In order to develop a successful weed management plan, you will need to do an inventory of the natural and man-made resources in the management area. Knowing the locations is essential to developing the weed management plan and protecting the resources. In alphabetical order, these are some examples of natural and human-made resources to consider:

- Aboriginal values
- Archaeological and heritage sites
- Buildings
- Cropland
- Fencing and corrals
- Grazing tenures
- Important or identified wildlife habitat
- Pastures
- Rare and endangered species habitats
- Recreation areas
- Research areas
- Roads and trails
- Timber areas
- Water developments for livestock
- Wells and water bodies—rivers, streams, ponds, and wetlands
- Wilderness areas, parks, and ecological reserves

Good sources of information about the natural resources may include:


- Federal, provincial, and local resource management personnel
- Local naturalists
- Neighbours
- Local First Nations people
- University or college faculty members


Mapping the Resources

To map the resources in the management area, you can enter information directly onto a base map that you have purchased or sketched. However, it is generally advisable to write or draw on a Mylar or plastic transparency placed over the base map (or photo). By using overlays, you will be able to track your program effectiveness over time. When you map the weeds: each year, you will be able to add an overlay sheet, thereby making it easy to see what changes are occurring. If you are using the overlay method, make reference marks by inscribing a plus sign (+) in each corner of the base map so that you can place each transparent overlay precisely.

Public land managers and utility agencies often incorporate colour computer maps with a geographical information system (GIS) with extensive data on natural resources and weed infestations delineated by global positioning systems (GPS).

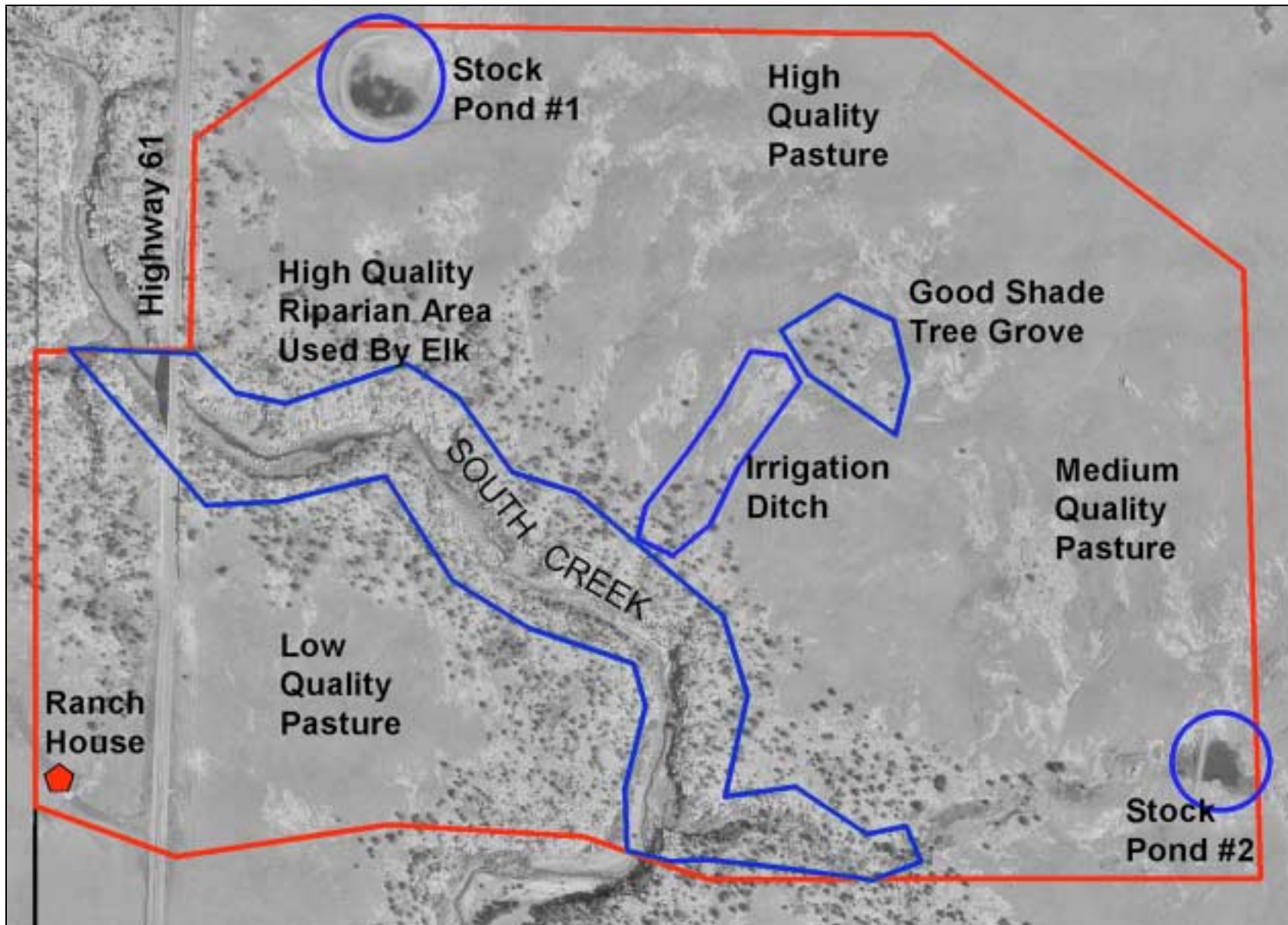
The Websites for LandData BC (<http://www.landdata.gov.bc.ca>) and the Base Mapping and Geomatic Services (<http://home.gdbc.gov.bc.ca>) are good starting points for obtaining map resources and expertise on GIS.

 On your base map, write the names and locations of the important resources in your management area.

 In your field journal, list the main resources in the management area.



leafy spurge



Small ranch with resources indicated

Step 2: Map and Inventory the Area for Weeds

A weed inventory is an inspection of your property for the purpose of identifying what weeds are present. Mapping consists of recording their locations on a map, usually on transparent overlays.

In order to complete this step successfully:

- Learn about the weed species common to your area. Find out which are designated as noxious and which are most aggressive.
- Plan your fieldwork around the periods when weeds may be most recognizable. This is often during the flowering periods of the weeds.
- Be as precise in your mapping as possible.
- Update your inventory periodically.

This section describes the four procedures in detail.

Learning about Weed Species

The following resources will help you to identify the weeds:

- Appendix A, Noxious Weeds in BC, in this manual—or the current list at <http://www.agf.gov.bc.ca/croplive/cropprot/weedman.htm>.
- *Field Guide to Noxious and Other Selected Weeds of British Columbia*—colour photos of life cycle stages and brief essential facts, including habitat and seed production. Also online at <http://www.agf.gov.bc.ca/croplive/cropprot/weedguid/weedguid.htm>.
- *Guide to Weeds in British Columbia*. Detailed species profiles and line drawings—more complete information on many weed species.
- The WeedsBC site, <http://www.weedsbc.ca>—with a searchable database and colour images, intended to promote identification and management of many of the weed species currently found in BC.

If you are unsure about the identity of a weed after consulting these resources, check with local experts and resource agency staff.

Knowledgeable people include:

- Provincial and federal agrologists
- Local naturalists
- Research scientists at Agriculture and Agrifood Canada and at universities and colleges

To preserve unknown weeds for future identification by a weed specialist, collect a plant sample intact with its roots, leaves, stem, and—preferably—flowers. If you are doing the collecting after seed set, ensure that you are using packaging that will avoid seed spread:

- Place the plant between sheets of newsprint or coarse paper.
- Press everything between two equal pieces of board that are at least 16 inches (40 cm) long and 12 inches (30 cm) wide.
- Wrap two pieces of heavy twine (or rope) around the boards, and tie the twine tightly.

If you have collected a number of plant samples, separate them with pieces of cardboard after placing each sample between newsprint sheets but before pressing the samples between boards.

Tag each weed sample with the location and date of collection. For future reference, also record this information in your field journal.

Note: As a weed manager, you will focus on the noxious species found in your region. However, it is best to learn also about species suited to the habitat but not currently present in it.

Planning Your Fieldwork

Developing a weed inventory will make you familiar with the species and locations of the weeds that you need to manage. You will then be in a position to determine:

- The best methods for control
- Your schedule (timing) of control work

Note: When you get to the related step, you will plan fieldwork to coincide with the flowering periods of weeds, as species identification is usually easiest at those times. However, become familiar with other characteristics in order to allow identification throughout the year.

Gathering Materials for a Weed Inventory

A detailed weed inventory can take time, and preparation can ensure that you spend that time efficiently. You will need materials like these:

- A copy of the base map (and/or aerial photos)
- Transparency overlay material, usually Mylar or plastic
- An aerial photo case or large freezer bags to keep photos and maps dry
- Coloured pencils/pens to colour-code each weed species to be mapped
- A field reference guide such as:
 - *Field Guide to Noxious and Other Selected Weeds of British Columbia*
 - *Plants of Southern Interior British Columbia*
 - *Plants of Northern British Columbia*
 - *Plants of Coastal British Columbia*
 - *Plants of the Rocky Mountains*
- A small field journal for recording observations, ideas for weed management, and any limitations that should be considered
- Optionally, a hand-held GPS (global positioning system) unit to enable you to precisely record the locations of weed sites, identify boundaries, and calculate areas

Planning Your Search for Weeds

When planning your search for weeds, aim to:

- Search your entire management area for weeds.
- Concentrate on the weed species that are the most invasive and that have the greatest potential to spread.
- Attend to less aggressive species not listed as noxious if time permits.
- Focus on locations most likely to be occupied by weeds—road edges, bedding grounds, high-use recreation areas, riparian areas, disturbed sites, log landings, corrals, unused areas, field edges, etc.
- Also focus on highest-value natural resource areas such as grasslands and areas that are currently not infested.

Beginning the Inventory

When you begin developing your inventory of weeds in your management area (after reading the rest of the Step 2 information):

- If the management area is large, divide it into smaller management areas (units).
- Review your base maps to locate priority areas to be checked.
- Check the high priorities on all the units before you move on to the lower priorities on any unit.
- Be as precise as possible in your mapping.
- If you are uncertain of your identification of a weed, note the location of the unidentified weed on the map. Collect a sample for later identification.
- In your field journal, record observations about density, size of patch, soils, and aspect. Also indicate any areas you did not check.

Recording with Map and Journal

As you systematically check your weed management area, record each infestation on your map (or aerial photo), normally on overlays, in order to:

- Get a pictorial overview of the weed species, locations, and quantity.
- Plan where to focus your management efforts.
- Be ready to evaluate the effectiveness of your management actions.

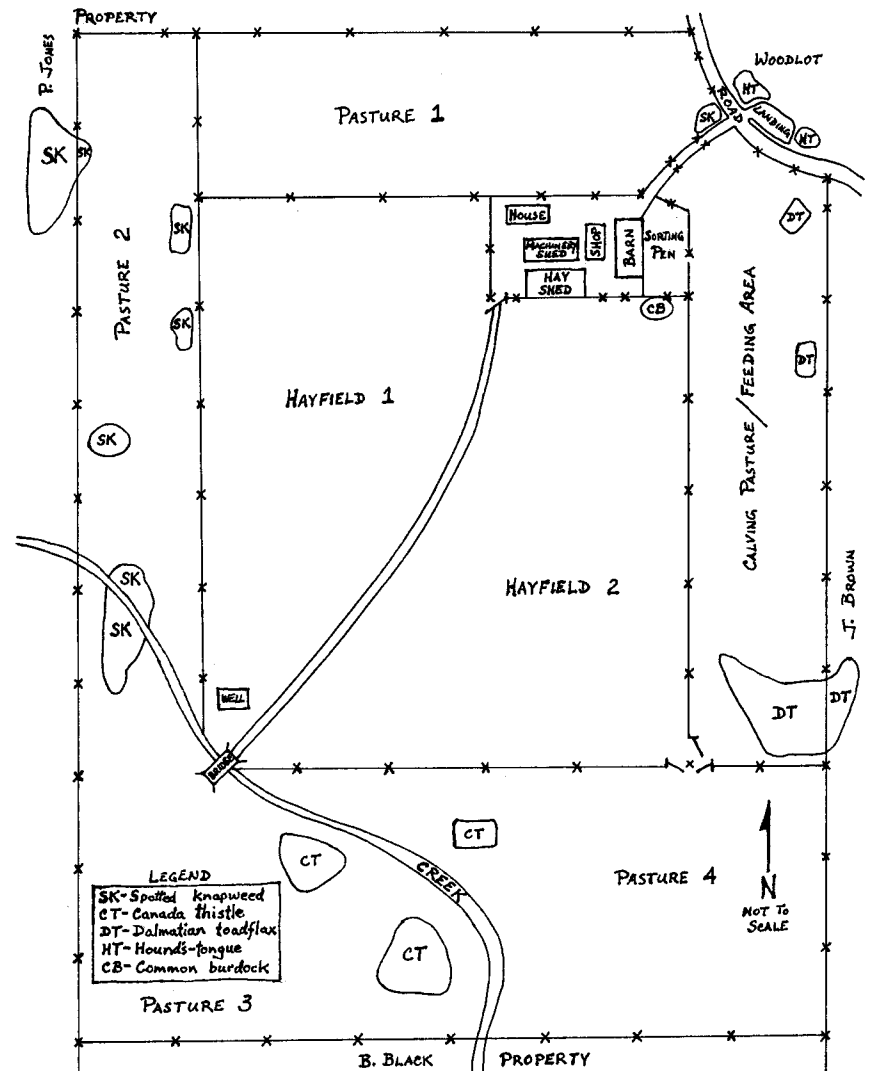
When you detect a weed infestation:

- Follow its perimeter to identify its outer boundaries.
- Look for landmarks on your base map, such as groves of trees, roads, cut blocks, and creeks.
- On the overlay on your base map, draw a line around the perimeter of the weed site, or use an X to mark a small patch.
- Use one colour for each species. Keep a legend of the colour codes in your journal, and be consistent with the legend.
- If there is enough room on the map, include a code name for each species. Keep a legend of your map codes.

A code usually consists of the first letters of the weed's common name. For example, spotted knapweed is often coded as "SK," leafy spurge as "LS." Where there are duplications, such as for Canada thistle and common tansy, adding a third letter allows a unique identification.

Make additional observations about the site in your journal. For example, you could note that:

- The Russian knapweed along Such-and-Such Creek is confined to riparian areas only, that it does not appear to be spreading into upland areas, and that biocontrol agents may be required because the site cannot be manually or chemically treated.
- The Dalmatian toadflax sites in So-and-So pasture are small and comprised of individual plants, and the soils are suitable for spraying.



In the Step 1 part of this manual, a version of this hand-drawn base map was used as an example of a base map showing boundaries and resources. Now, for Step 2, the weed infestations have been added (on a transparent overlay).

Suggested map codes for noxious weeds found in BC

Provincial Noxious Weed	Code	Regional Noxious Weed	Code
annual sow thistle	aST	blueweed	BW
Canada thistle	CT	burdock	Bk
common crupina	CC	cleavers	Cvr
Dalmatian toadflax	DT	common bugloss	CB
diffuse knapweed	DK	common tansy	Tns
dodder	Ddr	field scabious	FS
gorse	Grs	green foxtail	GF
hound's-tongue	HT	hoary alyssum	HA
jointed goatgrass	JG	hoary cress	HC
leafy spurge	LS	kochia	Koc
perennial sow thistle	pST	marsh plume thistle	MPt
purple nutsedge	PN	meadow knapweed	MK
rush skeletonweed	RS	night-flowering catchfly	NfC
scentless chamomile	SCh	orange hawkweed	OH
spotted knapweed	SK	oxeye daisy	OD
tansy ragwort	TR	perennial pepperweed	PP
velvetleaf	VL	plumeless thistle	PT
wild oats	WO	puncturevine	PV
yellow nutsedge	YN	quackgrass	QG
yellow starthistle	YS	Russian knapweed	RK
yellow toadflax	YT	Russian thistle	RT
		Scotch thistle	ST
		sulphur cinquefoil	SC
		tartary buckwheat	TB
		white cockle	WCo
		wild chervil	WCh
		wild mustard	WM

It is also desirable to code the infestation by how dense it is. This will provide a mental picture of the site and assist in the choice of appropriate management techniques. (Step 7 in this manual includes an explanation of how to estimate density and weed cover and how to code them.) For now, here are two examples:

- If you identify a few Dalmatian toadflax plants, you will code the site as DT-L (Dalmatian toadflax—light). Since Dalmatian toadflax is a highly invasive weed, that could be the basis for deciding to take immediate action in order to prevent the weed from spreading.
- If you identify numerous weed sites that are densely infested with spotted knapweed, you will use the code SK-H. On that basis, you may decide that the site is well beyond the scope of chemical control and that biological control or renovation may be required.

In place of letter coding, you can alternatively use a more precise measure of density, using averages of number of weeds per unit of area.

For larger areas, you may wish to use a handheld GPS (global positioning system) unit to record the locations of weed sites. GPS units use signals from satellites in orbit above the earth to determine the precise location of each site. They are very useful for inventory work. If you have a GPS unit:

- Mark each site as a waypoint in the unit's memory, or record the coordinates on your map or in your journal. Assign a code to each site.
- Mark the perimeter of each large weed infestation by collecting position data for various points while walking around the patch.
- Alternatively, obtain a GPS point consistently at a chosen corner of the infestation; for example, it might be the southwest corner. Record this code and the site location on the map (or photo) or in your journal, along with observations about the site itself. You can use the GPS UTM, or latitude/longitude position of each waypoint, to verify the location of your field mapping of the site.



On your map overlay and in your field journal, record each weed infestation in your management area.



In the Step 1 part of this manual, [the photo at left](#) served as an example, showing how much is visible in an aerial photo. For Step 2, the weed infestations have now been added (on a transparent overlay). Notice the codes: SK for spotted knapweed, DT for Dalmatian toadflax, and CT for Canada thistle.



spotted knapweed (SK)



Dalmatian toadflax (DT)



Canada thistle (CT)

Step 3: Set Weed Management Goals and Objectives

It is important to write down a set of overall goals and objectives for the weed management of your area. This will keep you focused on the end result, and it will assist you in monitoring the effectiveness of your plan.

- Your weed management goals are essentially land management goals. They will provide a general sense of direction.
- Your objectives are more-specific aims. They will be measurable.

Weed Management Goals

Your aim is not simply to kill weeds. In trying to create or maintain conditions in your management area, you are aiming to cost-effectively accomplish land management goals. When you set goals, you are aiming for a general result that is observable and achievable, even though you may express it in a way that is not precisely measurable. You already have a rough idea of your goals, but you will find that it is useful to write them down in order to define them, refer to them, and keep them in mind throughout your weed management work.

Here are some examples of realistic—attainable—goals:

- Maintain a viable working ranch so that the children will be able to continue a family tradition.
- Generate enough income from the farm to support the family.
- Protect the local watershed.
- Improve the conditions in the pastures.
- Preserve habitat for native plants and animals.
- Maintain a diverse landscape of plant communities (forest, shrubs, and grasslands).

- Maintain and encourage rare and endangered plants.
- Improve the condition of the riparian areas and wetlands adjacent to water bodies (lake, river, and creek).
- Be a good neighbour to surrounding landowners.
- Provide opportunities for educating the general public about the noxious weed problem.



In your weed management plan, draft your weed management goals.

- Quickly jot down possible goals in the “Possible Weed Management Goals” chart at the beginning of [Appendix F, page 48](#).
- Check each of the draft goals by asking yourself these questions:
 - Is this goal important enough to be a focus of weed management?
 - Can I realistically expect to achieve this goal?
- Revise your goals as you go along.
- As you consider your goals, it will be evident that some of them are more important than others. Put a number next to each possible goal—in the “Priority” column—to indicate your initial sense of its relative importance.

Note: In this context, the only land management goals you are addressing are ones with a weed management aspect, and this manual will usually refer to them accordingly as *weed management goals*.


Weed Management Objectives

Weed management objectives are scheduled with deadlines, specific to locations (with geographic limits), measurable, and achievable. They help you to achieve attainable goals. They lead to action—and guide it.

Your weed management objectives must take into consideration the resources in your management area and the weed species you are dealing with. Here are some good examples:

- Within one year, eliminate noxious weeds from the barn area, stock handling areas, and parking areas.
- Within three years, eliminate noxious weed seed production along the roads and trails in grassland pastures.
- Within five years, reduce the abundance of spotted knapweed on the property by 50%.
- Within one year of their discovery, eradicate any new noxious weed infestations in the weed management area.
- Within three years, eliminate overgrazing of the spring pastures.
- Within two years, protect Jones Creek from the weed-favouring effects of excessive grazing.
- Within three years, reduce livestock concentration on Jones Creek.
- Over the next five years, prevent new infestations of noxious weeds within 100 metres of property lines.
- Over the next ten years, reduce leafy spurge infestation in Griffin Pasture by 80%.
- For the next five years, promote public awareness of weed prevention and weed management.

As far as possible, select your strategies *in a later step* after considering the various strategies that could be suitable. That step is Step 5, Select Your Weed Management Strategies. On [page 18](#), you will see examples of strategies that could suit some of the objectives listed above.

 In your plan (Appendix F), draft your weed management objectives in the “Possible Weed Management Objectives” chart.

- Quickly jot down “Possible Objectives” in the [chart on page 49](#).
- Ensure that the listed objectives will help you to achieve your goals. If need be, add, delete, and adjust the objectives—and goals.
- Check each objective by asking yourself the following questions. Use a ✓ mark and perhaps include a brief note.
 - Does this objective have a deadline?
 - Have I defined the location—geographic limits—of the objective?
 - Will I know whether I have met the objective? (Is it observable and measurable?)
 - Can I realistically expect to be able to meet this objective?
- Number each objective (in the “Priority” column) to indicate your initial sense of its relative importance.
- Keep revising your objectives as you go along.



orange
hawkweed

Step 4: Set Priorities for Your Weed Management

So far you have a rough sense of the priority of your goals and objectives. In this step, Step 4, you will refine those priorities by focusing on two specific aspects of the objectives:

- The general priority of the weed species that are present
- The priority of the weed sites.

Prioritizing will allow you to direct your resources to cost-effective action.

Priority of Weed Species

Look at your weed inventory and determine the most aggressive weeds in your area. When identifying the priority of the weed species, refer to the *Guide to Weeds in BC* and to Appendix A, Noxious Weeds in BC. The listed weeds have had the greatest economic impact on BC and are therefore likely candidates for your Most Unwanted List. If possible, get a local agrologist to assist you in identifying priority weeds.

Priority of Weed Sites


High-priority sites could be one or more of the following:

- *Uninfested areas:* Maintain the health of the plant community to resist weed invasion.
- *Satellite plants:* Eradicate single plants and isolated patches prior to seed production.
- *Seed dispersal sites:* Roadsides, parking lots, trails, ditches, and streams are all examples of places where weeds can become established and be dispersed by human or natural vectors. Vehicles, people, and animals travelling along roads and trails can spread weed seeds to high-value areas. Similarly, wind and flowing water can quickly carry seeds considerable distances along natural corridors.

- *Small infestations:* Small infestations can often be managed before they become larger and more costly to control. “Small” typically refers to weed infestations under 0.5 hectares (approximately equal to a circle with an 80 m diameter or a square with 70 m sides).
- *Other high-impact sites:* These might include salting areas for livestock, corrals, campgrounds, visitor centres, developed recreational facilities, and other high-use areas.

People often attack large areas of weeds first while leaving small isolated patches untreated. An effective weed management program typically reverses those priorities.

While large infestations should not normally be high-priority sites for weed management, they are often well suited to biological control and renovation. Management efforts are best directed at containing further spread, reducing density, and decreasing size if possible.

 In Appendix F, on pages 50–51, complete the chart titled “Priority of Weeds and Sites”:

- Referring to your list of objectives, field journal, and map, use the “Weed Species” column to list the species that you are managing.
- Referring to your resource publications and Websites, add notes about each weed species in the column provided.
- In the “High-Priority Species?” column, annotate in your preferred way. At minimum, either put a check mark next to the higher priority species or number the species by priority. You might briefly add reasons for your ratings.
- Similarly, address the weed sites that you are managing by filling in the “Infestation Sites” and “High-Priority Sites?” columns.
- On your base map, highlight the high-priority weed infestations.

Note: While helping you to determine management priorities, this step may also give you reason to modify your goals and especially your objectives. If you are going to modify them, this is a good time to do it.

Step 5: Select Your Weed Management Strategies

In Step 5, you will identify strategies to help you contain and reduce weed problems in your weed management area.

It may be useful to pause and consider the context for this step, which will lead into Step 6, “Develop an Integrated Weed Management Plan.” When you think about it, no doubt you realize that a single weed management strategy is seldom effective by itself. A plan of attack that is based on knowledge of the weeds in the management area and all options will be successful when combined with commitment and persistence. You will then achieve your goals and objectives. In doing so, you will safeguard your threatened resources—crops, livestock, natural areas, landscapes, etc. Remind yourself about what your goals and objectives are and are not.


Examples of strategies that suit particular weed management objectives

Objective	Strategy
Within three years, eliminate overgrazing of the spring pastures.	Increase forage production to make sufficient feed available for late winter and, if necessary, early spring.
Within two years, protect Jones Creek from the weed-favouring effects of excessive grazing.	Cross-fence the spring pasture.
Within three years, reduce livestock concentration on Jones Creek	Install two off-site watering facilities
Over the next five years, prevent new infestations of noxious weeds within 100 metres of property lines.	Work with the neighbouring property owners.
Within ten years, reduce leafy spurge infestation in Griffin Pasture by 80%.	Establish biological control agents.
For the next five years, promote public awareness of weed prevention and weed management.	Invite the local noxious weed coordinator to lead an annual public field trip.

To be successful, an integrated weed management plan must incorporate a number of these kinds of strategies:

- Prevention
- Physical strategies
- Cultural strategies
- Livestock grazing
- Biological control
- Use of herbicides

The effectiveness of each strategy will depend on site conditions, the size of the infestation, and the weed species that are present.

 Look over the “Weed Management Strategies” chart in Appendix F on pages 52–53. You will be filling it in throughout your Step 5 work. For a start, list your objectives in the first column.

Prevention

Prevention is the most important weed management strategy but often the least used one. The critical action is to prevent weeds from spreading and becoming established in new areas. How can you practise prevention?

- **Educate yourself about weeds in your area—and take action now!**
Be knowledgeable about the weeds in the area, and take *immediate* action when you find invading weeds.
- **Sow only Certified seed.**
Don’t seed weeds! While not totally free of weed seed, Certified seed has a lower allowable tolerance for noxious weed seeds than uncertified seed. Paying a little more for quality seed pays dividends by reducing future weed management costs.

➤ **Prevent soil disturbance or destruction of native vegetation.**

Weeds often invade bare soil. For example, weeds can easily invade sites that have been disturbed by ATVs, vehicles, or heavy grazing. A small roadside weed site can easily expand into an adjoining plant community, especially if the existing plants are in a weakened condition. Reseed disturbed soil *immediately*.

Weeds can germinate earlier than other plants and often germinate under poor growing conditions (for example, when the soil is cold or dry). Healthy plant communities resist weed invasion best, although some aggressive weeds—including the knapweeds, leafy spurge, and Dalmatian toadflax—can invade healthy, well-managed lands.

➤ **Keep machinery and vehicles clean.**

Wash equipment before transporting it so as to remove weeds and mud that contain weed seeds. Tarp grain loads to prevent the spread of seeds.

➤ **Clean the feet and hair of animals.**

Weeds are often transported on the coats of livestock and pets. Remove burrs and weeds from livestock before moving them to another site.

➤ **Cut weed-infested crops prior to seed formation.**

Some weed seeds can lie dormant but viable in the soil for fifty years! For more about seed production and dormancy, please see [Appendix B](#).

➤ **Do not move weed-infested soil or gravel.**

When purchasing soil, gravel, manure, or compost, be aware that you may be introducing new weeds to your property.

➤ **Practise total area weed management.**

Remove annual sources of weed seed—nurseries growing along fencelines and beside roadways, irrigation ditches, stockyards, buildings, storage areas, and parking areas.

 Look over [Appendix C, Best Weed Management Practices, page 42](#).

- Put a copy in a prominent place where it will serve as a reminder.
- In your “Weed Management Strategies Chart,” list any preventive measures you plan to take.

Physical Strategies

Physical strategies for managing weeds include:

- Tillage or cultivation
- Hand weeding or pulling
- Mowing or cutting
- Burning

Tillage or Cultivation


Soil is the main environmental factor that is manipulated in crop production. Tillage (cultivation) results in an attack on many weed survival mechanisms:

- For annual weeds, the objective of tillage is to prevent seed production and to deplete current seed reserves in the soil. This is done by encouraging weeds to germinate and then killing them.
- With perennials, tillage destroys underground roots, depletes seed reserves in the soil, and prevents seed production.

When is tillage effective?

- Tillage should be timed to catch the first flush of weeds before sowing a crop.
- Post-seeding tillage, if practical, should be done in dry, warm, sunny conditions so that the weeds cannot transplant themselves.
- Autumn tillage can be effective in killing winter annuals and biennials and suppressing perennials. It can also aid in stimulating the germination of new weeds that will be susceptible to winter frost.

Tillage is best suited to agricultural soils and gardens or large grassland areas requiring rehabilitation.

 Might you use tillage to help meet your weed management objectives? If so, make notes in the “[Weed Management Strategies](#)” chart in [Appendix F, pages 52–53](#).


Hand Weeding or Pulling

Where is hand weeding (pulling) an effective physical strategy?

- It can manage small patches or individual plants of annuals, biennials, and non-creeping perennials.
- Persistent pulling can even manage some creeping perennial weeds such as Dalmatian toadflax.
- Pulling works best in moist soils, particularly if these soils are sandy or gravelly.

When using the hand-weeding strategy, take these precautions:

- Seed disturbed areas immediately. (Act promptly because hand weeding can create a fresh seedbed for weed germination.)
- Always wear gloves and a long-sleeved shirt to avoid allergic reactions.
- If at all possible, pull weeds before they set seed.
- If seeds are present, prevent wind dispersal by bagging and burying the plant material or burning it on site to prevent wind dispersal. Do *not* compost the material.

 Are there infested areas that you can manage by hand weeding? If so, make notes in the “[Weed Management Strategies](#)” chart.


Mowing or Cutting

Mowing (or cutting) is a physical strategy that is useful when:

- The weeds are too numerous to pull by hand.
- Tilling (cultivation) and herbicide spraying are not practical.

Here are a few tips about mowing:

- In order to avoid spreading seeds to weed-free areas, mow weeds before they produce seed—never after they have gone to seed.
- Perennial weeds usually require several cuttings before the energy in the roots is depleted. If only a single cut is feasible, the best time is just before blooming because energy in the roots is at its lowest level and because viable seed can be produced just after flowering in some weeds. Perennial sow thistle, for example, begins producing viable seed only three days after flowering. Nine days after flowering, 73% of its seeds may be viable.
- Cut the weeds as close to the ground as possible. Many weeds will still produce seeds below the cutter blades, but seed production and spread potential are much reduced.

 Are there any infestations in your management area that could be managed by mowing (cutting), perhaps in combination with another method? Make notes in your “[Weed Management Strategies](#)” chart.

Burning

In situations where seed production has already occurred, burning can destroy some seeds. Like other strategies, burning has limitations:

- The effectiveness of burning depends on the duration and intensity of the heat produced, as well as the maturity and location of the seeds. Mature, dry seeds are more heat resistant than green seeds, which have a high moisture content.
- Intense heat will destroy some seeds remaining in the seed head, but only a small number of seeds on or below the soil surface will be killed.
- Burning is not effective in killing underground roots and is therefore of most benefit only for managing annual weeds or reducing the dissemination of weeds that are already in seed.

 Make notes in your “[Weed Management Strategies Chart](#)” if there are any situations in which burning might be a suitable strategy for you.

Cultural Strategies

The cultural strategies for weed management consist of using crop rotation and plant competition to suppress weeds.

Crop Rotation

Certain weeds are associated with specific crops and crop rotations because the weed can compete well with the crop or because it is not destroyed by the herbicides and cultivations normally used for that crop. For example:

- Continuous cropping to small grains results in an increase in annual weeds.
- Perennial forages and permanent pastures favour development of perennial weeds such as quackgrass and Canada thistle.

Repeated planting of the same crop also favours an increase in insects and diseases. This results in a weakened crop that weeds easily invade.

Competition

Competition uses one of nature's oldest laws—survival of the fittest. Maximizing competition will suppress weeds, especially when it is combined with other management strategies. When you are using competition as a weed management tool, it is critical to get early establishment of a vigorous, dense crop. You should consider these important factors that affect germination and emergence:

- The viability of the crop seed
- Soil temperature at planting
- Availability of moisture
- The physical resistance (crusting) of the soil

Besides early establishment, several factors enhance crop competition:

- **Preparing a good seedbed**
A firm, moist, warm seedbed with no clods encourages rapid crop germination.

➤ Seeding rate

Where moisture is available, increasing the crop seeding rate can provide competition with weeds. However, the use of higher-than-recommended seeding rates is dependent on crop type and location.

➤ Seeding date

- Mustards, wild oats, and many other weeds germinate best in cool conditions. Early-sown crops are less able to compete with them. Late seeding also allows for tillage or pre-seeding herbicide control of early weeds.
- Redroot pigweed and green foxtail prefer warm soils and therefore germinate later. Early seeding results in the crop competing better with later-germinating weeds.

➤ Crop variety


Choose a crop variety that is well adapted to your local conditions of soil, climate, and disease resistance.

➤ Fertility

Many weeds use fertilizer at least as well as crop plants. In row crop production, limit the weed growth by targeting the fertilizer to the crop row (banding), rather than also fertilizing between rows.


➤ Soil moisture and pH

- Improve the drainage to reduce weeds such as creeping buttercup and bog rush that prefer moist-to-wet soils.
- Use amendments such as lime or sulphur to adjust the soil pH to the level favoured by your crop, not the weeds. Wild barley and arrowgrass prefer soils that are alkaline—high in salts. Wild oats and curly dock often prefer acid conditions.

 Are there any infestations in your weed management area that could be managed by the cultural strategies of crop rotation and competition? Make notes in your “[Weed Management Strategies](#)” chart.

Livestock Grazing

Like close mowing, the repeated removal of weed topgrowth by grazing animals prevents seed formation, and it also gradually weakens roots. With proper management, however, horses, cattle, sheep, goats, and hogs can destroy many weeds. Sound grazing management can maintain or even increase the vigour of native plants, especially grasses.

- Only permit livestock on spring range when plants have sufficient leaf material and have begun replacing root reserves. If grazing occurs too early in the spring, the grasses do not develop a competitive stand, and weeds therefore tend to take over.
 - Aim to graze a pasture before the weeds there set seed so that the animals do not spread weed seed to other pastures in their hides and manure. Many weed seeds will pass through an animal's digestive tract intact and be viable. If the weeds have set seed, corral the livestock for a few days—before moving the cattle to another pasture—in order to ensure that weed seeds do not spread to the new pasture.
 - Never permit season-long grazing. Instead, take these actions:
 - Ideally, subdivide your pasture to allow a rest-rotation system of grazing lots. This encourages desirable plants to grow into a healthier, more competitive stand during the rest period.
 - Rotate the grazing lots. This also permits herbicide treatments with a greater safety margin.
 - Intensively graze the smaller lots. This also prompts the cattle to eat more weeds. (On a larger pasture, in contrast, the cattle can more easily eat only the more palatable forage, leaving the weeds, which become dominant.) Ensure that the forage on each grazing lot will enable the livestock to meet their nutritional needs.
 - Discourage overuse of favoured parts of the grazing area by:
 - Moving salt licks.
 - Strategically placing water developments and fencing.
 - Be aware that the time of year and stage of plant growth can be important. For example:
 - Livestock eat some weed species, such as knapweed, only in the early spring when the plants are young.
 - Cattle will eat Canada thistle when it is young and immature but will not eat it once it flowers or sets seed.
 - Take into account the weed preferences of different animals:
 - Goats and sheep are more likely than horses or cattle to prefer broadleaved weeds. Leafy spurge is a good example of a weed species that can be managed with grazing by sheep and goats.
 - Young livestock may also have different preferences than mature livestock.
 - Not all weed species are edible to animals. Some species, such as water hemlock, tansy ragwort, and hound's-tongue, are toxic to livestock.
 - Other considerations in using livestock for weed management include the presence of predators and the costs of fencing and herding.
-  Consider relevant questions like these:
- Are any weed species on your site suitable for management by grazing?
 - Are there sufficient quantities of forage to maintain livestock?
 - Do you have livestock of the right type available?

Make notes in the “[Weed Management Strategies](#)” chart about any sites where livestock grazing (or a change in livestock grazing) would be a suitable strategy for managing weeds.

Biological Control

Biological control agents—bioagents—are natural organisms (usually insects, nematodes, fungi, or viruses) that can be used to reduce weed populations. These agents are usually natural enemies of weeds in their native environments of Europe and Asia.

Biological control is best suited to large, dense infestations where other management strategies are neither cost-effective nor environmentally desirable. It is intended to weaken the target weed by decreasing seed production and reducing weed density. It will not eliminate the weed problem.

CABI Bioscience in Switzerland partners with the Province of British Columbia, Agriculture and Agri-Food Canada, and a consortium of other Canadian provinces and US states in undertaking bioagent research. Before introduction of a natural agent to Canada is approved, Canadian and US scientists review exhaustive long-term studies to ensure safety. In order to be released in North America, the agent must damage only the target weed and not transfer to any other plants.

In BC, biological control began as early as the 1950s on St. John's-wort, which infested thousands of hectares, especially in the Kootenay region. This plant, as well as nodding thistle, is now regarded as being under control by biological agents.

Agriculture and Agri-Food Canada and the provincial Ministry of Forests are currently the only agencies involved in the rearing of biological control agents in BC. Their primary focus is to distribute bioagents to Crown land weed infestations. The Ministry of Agriculture, Food and Fisheries also assists private landowners, naturalist groups, and others in bioagent distribution.


These weeds are targets for biological control in British Columbia:

- Canada and bull thistle
- Dalmatian and yellow toadflax
- Diffuse and spotted knapweed
- Hound's-tongue
- Leafy spurge
- Nodding and plumeless thistle
- Purple loosestrife

Some biological control agents may already be established on your weed site. Your local agrologist or weed specialist can assist in identifying them. Photos and information on biological control agents and how to collect and release them are available online at:

- <http://res2.agr.ca/lethbridge/weedbio/index.htm>
- <http://www.nysaes.cornell.edu/ent/biocontrol>
- <http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh27.htm>

Also see [Appendix D, “Bioagents Attacking Weeds in BC,”](#) pages 43–45.

 In your “[Weed Management Strategies](#)” chart, make notes if there are any sites where bioagents would be suitable. Include notes about any locations already supporting bioagents.



rush skeletonweed

Use of Herbicides

Herbicides are chemicals designed to kill or injure plants. Like most other weed management methods, herbicides offer short-term solutions, not cures. Herbicide use does not address the reasons for weed problems, and spraying a herbicide may merely treat a symptom.

Your choice of herbicide depends on many factors. They include:

- The target weed species
- The stage of growth
- Crops or other plants on the site
- Soil texture and depth
- Distance from water

Preparing to Take Precautions

Before using herbicides, carefully consider potential environmental impacts and public concerns.

Always read and understand the label before using a herbicide. You must apply the herbicide according to the instructions. The label is the law. For full label information, refer to Health Canada's Pest Management Regulatory Agency site at <http://64.26.129.82/search/queryhit.htm>.

When applying a herbicide:

- First consider the soil conditions and the presence of water.
- Do not increase the concentration beyond the limit set by the manufacturer. More is not better. Higher concentrations can injure animals and damage non-target plants. A chemical's presumed safety is based on the manufacturer's recommended concentrations only.
- Take precautions to ensure that the herbicide does not move beyond the area where it is applied. Without sufficient care, herbicides can affect non-target plants, soils, and animals.

Training in Pesticide Application

It is a good idea for all persons applying any kind of pesticide to take the training—as well as the exam for certification for pesticide application—that is offered by the Pesticide Management Branch, Ministry of Water, Land and Air Protection. The available categories include Agriculture General, Forestry Management, Landscape General, Industrial Vegetation, and Noxious Weed Control.

Choosing a Herbicide

When choosing a herbicide, you will need to consider questions like these:

- Is it registered (legal) for my intended use?
- Are my weeds listed on the label as controlled?
- At what growth stage of the weed and my crop can I apply it?
- How does the herbicide work? Is it effective when applied to the soil, the weed leaves, or both?
- Can I use the herbicide on my soil type? Are my soils permeable or close to a water table? Does soil pH affect the herbicide?
- What are my long-term plans for the site to be treated? This is particularly important if you are considering a residual herbicide.
- How close can I apply the herbicide to a well, water body, or other environmentally sensitive area?
- Do I have appropriate personal protective equipment?

To study herbicides further, you will first need to be aware of how they are classified, which is according to:

- Their selectivity
- The timing of application
- Their mode of action

Selectivity of Herbicides

Herbicides can be non-selective or selective:

- A *non-selective* herbicide kills or damages all plant life in a treated area. An example is glyphosate.
- A *selective* herbicide kills weeds in a germinating or growing crop without harming the crop beyond the point of recovery. For example, 2,4-D is used to manage broadleaved weeds in a grass pasture.

These factors influence the selective action of the herbicide:

- The nature of the weed
- The biochemical makeup of the plant
- The depth of rooting
- The nature of the herbicide

Selectivity—Nature of the Weeds

Perhaps the most important consideration in selectivity is the nature of the weed itself. As an example, look over the table that shows the characteristics associated with 2,4-D susceptibility and resistance, with these points in mind:

- Studies on a large number of plant species have indicated that species having the characteristics listed as “Susceptible” are generally injured more by 2,4-D than those having the characteristics listed as “Tolerant or Resistant.”
- The first five characteristics in the “Weed Susceptibility to 2,4-D” table are associated with the amount of spray that will make initial contact with the plant and the plant’s subsequent ability to retain herbicide materials on leaf and stem surfaces.

Weed susceptibility to 2,4-D

Characteristic	Susceptible to 2,4-D	Tolerant or Resistant to 2,4-D
Plant form	Erect	Spreading, prostrate
Leaf shape	Broad, large	Narrow, short, or linear—grasses, for example
Leaf position	Horizontal	Upright or pendulous
Rosettes	Rosettes formed	Rosettes lacking
Leaf surface	Rough, hairy	Waxy, very hairy
Growing point	Terminal, axillary	Protected (sheath, crown)
Root depth	Shallow	Deep
Condition	Growing actively	Dormant
Age	Young	Mature

Selectivity—Biochemical Makeup

Some plants can tolerate a given amount of herbicide within their tissues, whereas others with a different chemical makeup will succumb. It is thought that the resistant plant is able to break down the herbicide to non-toxic components, whereas the susceptible plant cannot.

An example: Corn, which is resistant to atrazine, contrasts with oats, which are susceptible. The greater accumulations of atrazine in the oat leaves eventually kill the plant—because of three factors:

- Oats absorb more atrazine.
- Oats translocate atrazine more effectively.
- Oats cannot break atrazine down as readily.

Be aware that biochemical selectivity can be lost if you apply herbicide at excessive rates.

Selectivity—Depth of Rooting

Most germinating weeds arise from seeds in the top centimeter of soil (the top one-quarter to one-half inch). A soil-applied herbicide will be taken up by weed roots in this zone, whereas crop seeds planted deeper than this will germinate in a herbicide-free zone.

Influence of Herbicide on Selectivity

The herbicide itself can influence selective action due to:

- The nature of the chemical molecule
- The concentration applied
- The formulation used
- Surface tension and spreading qualities

These are some examples:

- Selective action is observed where MCPB (a 4-carbon chemical) is used for weed management in clover or peas. The weeds are able to change the MCPB to MCPA (a 2-carbon chemical), which is much more toxic than the original herbicide. The crop cannot do this. In essence, the weeds commit suicide.
- Exceeding recommended use rates could kill or injure normally tolerant non-target plants.
- Oil-soluble ester formulations of 2,4-D are more effective on many weeds than water-soluble amine formulations, which can more easily penetrate the waxy coating on plant leaves.

Timing of Herbicide Application

When classified according to timing of application, herbicides include:

➤ Pre-planting soil-incorporated herbicides

These herbicides are applied to the soil before the crop is sown. They are incorporated in the soil to prevent loss due to vapourization and breakdown by sunlight. Examples include trifluralin, ethalfluralin, and EPTC.

➤ Pre-emergence herbicides

These herbicides are applied to the soil prior to seeding or after the crop has been sown but before the crop and weeds emerge. In most cases, the weeds germinate in treated soil while the crop germinates below the herbicide zone. Examples include metolachlor, linuron, and prometryne.

➤ Post-emergence herbicides

These herbicides are sprayed directly on weeds after they are up and growing. Examples include 2,4-D, picloram, and metsulfuron-methyl.



diffuse
knapweed

Mode of Action of Herbicides

Herbicides can be classified according to the way they work to damage weeds, which is called their “mode of action”:

➤ **Contact herbicides**

Contact herbicides kill plant parts covered by the herbicide. They are directly toxic to living cells. There is little or no translocation—movement of the material through the plant. Contact herbicides are effective against annual weeds, but they only “burn off” the tops of perennial weeds, chemically mowing them. Contact herbicides may be selective or non-selective. For example, bromoxynil selectively kills broadleaved weeds in cereals without damaging the crop, while paraquat non-selectively kills any green plant material.

➤ **Systemic herbicides**

Systemic herbicides are absorbed by either the roots or the above-ground parts of plants. They then move (are translocated) in the plant. They exhibit a chronic effect, and the full effects may not show for a week or more after treatment. Systemic herbicides generally interfere with plant processes such as cell division, production of chlorophyll, photosynthesis, respiration, and enzyme activity. An overdose on the leaves may kill the leaf cells more quickly, thus preventing translocation to the site of action. “If a little is good, more will be better” is an axiom that does *not* apply to herbicide use rates.

Systemic herbicides can be selective (2,4-D, MCPA, dicamba, and picloram) or non-selective (glyphosate products).

➤ **Soil sterilants**

When present in the soil, soil sterilants prevent growth of plant life for periods of a few months to a number of years. Examples include diuron and imazapyr.

For details about the mode of action of particular herbicides, please see [Appendix E, Mode of Action of Herbicides Used in BC, pages 46–47](#).

Resistance to Herbicides

Starting in 1946 with the introduction of 2,4-D, agrochemical companies have manufactured and brought to market a wide variety of herbicides. The success of herbicides and other crop-protection chemicals has revolutionized weed management, farm practices, and food production. However, herbicide-resistant weeds are threatening the utility of herbicides.

Weed populations contain a very small number of individuals that are naturally able to withstand a particular herbicide or herbicide group. (This naturally occurring resistance is not due to weather conditions or application techniques but is an inherent characteristic of the resistant plant’s genetic make-up.) Applying the same herbicide or herbicide group year after year allows the naturally resistant plants to set seed and multiply: after the herbicide has killed the plants that are susceptible to it, the resistant strain has greater opportunity to flourish.

There are over 250 herbicide-resistant weed biotypes worldwide, and new cases are developing annually. Twenty-two resistant biotypes are known in Canada. In British Columbia, redroot pigweed, common groundsel, and wild oats have developed resistance to some herbicides.

To manage herbicide resistance:

- Rotate crops. (This usually results in using a diversity of herbicides.)
- Rotate herbicides with different modes of action.
- Use tank mixes that manage the target weeds by different modes of action.
- Use short-term residual herbicides whenever possible. (If you must use a long-term residual herbicide, do not use it continuously on an area.)
- Integrate herbicide use with other weed management strategies.
- Use good sanitation practices to prevent movement of weed seed with soil, machinery, crop residue, and so forth.


Herbicide Information Sources/Resources

- For herbicide information, consult Health Canada’s Pest Management Regulatory Agency site, <http://64.26.129.82/search/queryhit.htm>. The site is a fully searchable database on pesticides.
- Licensed pesticide applicators and pesticide dispensers at agricultural supply stores and nurseries are knowledgeable about herbicides. Your local Ministry of Water, Land and Air Protection office or Ministry of Agriculture, Food and Fisheries office may be able to provide the names of licensed applicators in your area.
- Chemical company salespeople and Websites are sources of information, particularly about the products they sell.
- The BC Ministry of Agriculture, Food and Fisheries can direct you to information about herbicides.

In addition, the following sources were useful reference material for the development of the herbicide information in this manual:

- *How Herbicides Work: Biology to Application*
- *Introduction to Weeds and Herbicide*
- *Herbicide Mode of Action Categories*

Reminder: For facts of publication, please see the “Related Resources” list at the end of the manual, [page 58](#).


 Make notes in your “[Weed Management Strategies](#)” chart on pages 52–53 if there are locations in your weed management area where herbicide action would:

- Be effective.
- Have little impact on other species.
- Not be restricted by soils and water.



sulphur
cinquefoil

Strategies in Review

 Review these tables. On your “Weed Management Strategies” chart (Appendix F, pages 52–53) jot down comments about a combination—a balanced approach—that might be best for your management area.

Comments about weed management strategies

Strategy	Comments
Prevention	Seed soil disturbances. Use Certified seed. Clean machinery, vehicles, and animals. Control sources of weed seed production.
Pulling	Suited to small infestations that can be eradicated or managed with a small amount of labour—riparian areas, single plants, and small patches.
Mowing/cutting	Suited to sites that are small and accessible with equipment and that can be mowed more than once in a growing season. Combine with other methods where possible.
Livestock grazing	Suited to areas where rotational grazing could be put into place and that have a weed that is palatable to livestock. Check that the appropriate type of livestock is also available at the right plant growth stage for the grazing to be effective.
Cultural strategies	Suited to areas that could be farmed or managed to maximize competition from beneficial plants.
Biological control	Suited to extensive areas that do not suit other management methods. Or use biological control agents to supplement other management activities.
Herbicide use	Use the right herbicide on the right location at the right stage of growth. Soils and water are a concern. Check with your local Ministry of Agriculture, Food and Fisheries office for advice on weed management, herbicide use, and environmental protection.

Advantages and disadvantages of weed management strategies

Strategy	Advantages	Limitations
Pulling	No permit. Prevents seed production. Can use near water.	Soil disturbance. Timing. Must generally repeat treatment. Labour-intensive. Costly. Root fragments may remain. Moist or loose soils required for pulling.
Mowing/cutting	No permit. Prevents seed production. Can use near water. No soil disturbance.	Roots remain, and plant may re-sprout or grow back more woody and more aggressive. Timing important. Must generally repeat treatment. Labour-intensive. Costly.
Tillage/seeding	Can use near water. No permit. Establish preferred species.	Repeat treatment usually required. Labour-intensive. Costly. Dry soil conditions required. Best suited to agricultural settings or heavily infested grassland.
Burning	May destroy seeds. Can be selective (propane torch). Mimics natural processes.	Public relations (smoke). Timing limited. Seeds in the soil unaffected. Re-vegetation may be necessary.
Herbicide use	No soil disturbance. Kills roots. If residual, will affect seed bank and emerging plants. Can be selective.	Limitations near water. Public perception. Timing important. Must generally repeat treatment (long-term cost). Permits and regulations.
Biological control	Cost-effective. Self-perpetuating. Self-dispersing. Long-term. Many successful bioagents available.	Takes time to establish. Not effective in all habitats. Does not eradicate weeds. Target weed often replaced by new species.
No action	None.	Infestation will spread (unless at range limit). Long-term costs and environmental degradation.

Step 6: Develop an Integrated Weed Management Plan

Using a single management practice will not result in effective weed management. You will need to choose and implement a number of strategies, using a combination of preventive, biological, chemical, physical, and cultural options that together suit the weed problems you are facing. Traditional weed management over the past fifty years has relied heavily on herbicides to kill weeds. This only treated symptoms and didn't take into consideration why weeds became established, how they spread, or how they could have been prevented. Conversely, integrated weed management (IWM) is a process that looks at the possible causes of weed infestation, identifies a number of solutions to contain them, and selects the optimal combination of solutions.

Note: In your weed management planning work, be aware that multiple weed species that are present together may respond differently to the same combination of strategies.

Principles of Integrated Weed Management

In your weed management work, follow these principles:

- Learn to identify weed species. For descriptions and information about habitat, refer to the colour pictures and species profiles in the *Field Guide to Noxious and Other Selected Weeds of British Columbia* and the *Guide to Weeds in British Columbia*. Also refer to the Ministry of Agriculture, Food and Fisheries site at <http://www.agf.gov.bc.ca/croplive/cropprot/weeds.htm>.
- Understand the biology and ecology of the weed species and its habitat needs. Determine why the weeds are growing where they are. Talk to other weed managers about their experiences with this weed or contact your local Ministry of Agriculture, Food and Fisheries office or Forest Service office.
- Choose management techniques for each weed species that will not only be practical and effective but will also have the least impact on the environment or on non-target plants. Direct your efforts at maintaining a strong, competitive, beneficial plant population.
- Monitor the weed management results, and adjust your control strategies on that basis.

In your integrated weed management planning, it is particularly important to follow the “Think prevention!” approach and to choose the optimal management action.

Think Prevention!

Establish and/or maintain healthy native and domestic plant communities:

- Manage livestock grazing on native grasslands and seeded pastures to maintain a healthy plant community.
- Avoid management practices, farming activities, recreational use, or other activities that damage native plant communities, making them vulnerable to weed invasion.
- Avoid activities that disturb the soil or promote dispersal of weeds. Disturbed areas often become new weed seedbeds.
- Reseed disturbed soils with native or domestic species that are adapted to the climate and soil conditions in your area.
- Plant native trees, shrubs, and herbaceous species to rehabilitate an area, such as along a heavily grazed stream bank.
- Practise good land stewardship to maintain and improve the health of native plants.

Choose the Optimal Management Action

For your integrated weed management, choose a combination of strategies with these qualities:

➤ Sufficiently beneficial to merit the costs

Evaluate the costs and benefits of possible management actions:

- Will a herbicide's potential damage to desirable plants be acceptable?
- Is it acceptable to create a new seedbed by digging out plants?
- Will the continued presence of the weed site be acceptable if biological control agents are released?
- Does the return in production (such as increased forage) justify the cost of applying a herbicide?

➤ Applied at the most effective time

Most management actions are effective only during certain periods of a weed's life cycle. Treat the weeds when they are most vulnerable and when actions are expected to have the least impact on the ecosystem.

➤ Least damaging to non-target plants and animals

Non-target organisms include native plants, wildlife, insect pollinators, and insects that feed on target weed species.

➤ Least hazardous to human health

Herbicides can harm human health when handled or applied incorrectly. Choose effective herbicides with the lowest toxicity.

➤ Least damaging to the environment

Use herbicides according to directions on the label. Prior to application, carefully read the product label, checking for any precautions and restrictions on use. Obtain more information if you need it. Consider employing a licensed pesticide applicator—certified to apply pesticides.

➤ Effective in the long term

One-shot weed control does not work! Develop a follow-up monitoring plan and schedule maintenance treatments as part of your normal land management operations.

Keep in mind that a *combination* of management actions that together *address the underlying cause* of the weed infestation and spread will be effective for managing weeds in the long term.



tansy
ragwort

Key Points for Your Management Plan

In Steps 1 to 5 you gathered the information and tools necessary for completing your weed management plan. By now, you have:

- Obtained or made an appropriate map of your management area.
- Identified natural and man-made resources in the area that require protection from weeds—and marked those resources on your map.
- Identified your problem weeds and learned something about their biology and ecology, especially in relation to your area.
- Performed a weed inventory in which you marked the locations and types of weeds on your map.
- Developed goals and objectives for your weed management plan.
- Set priorities about which weeds and sites you will address.
- Selected appropriate management strategies and timing for each weed, considering such factors as local environmental conditions, cost, practicality, and potential damage to non-target organisms and the environment.

As you worked through the first five steps, you did preliminary work on your weed management plan. Now it is time to prepare the plan. As you do so, remember these six key points:

1. Ask for help.

There are many resources available to you. Some are listed in this manual. The resources include:

- Weed specialists in the Ministry of Agriculture, Food and Fisheries, the Ministry of Forests, and regional districts.
- Knowledgeable people within Agriculture and Agri-Food Canada and the universities and colleges in the province.

They can help with their knowledge and experience.

2. Try new things.

If your weed management program does not work, try a different combination of management techniques. Monitoring will show you when it is necessary to try different ways of managing weeds on your property.

3. Work with your neighbours.

Weeds do not respect land ownership or political boundaries. Weed management is best accomplished when government jurisdictions and individuals cooperate to manage weeds at a community or landscape level.

4. Don't allow short-term success to lull you into complacency.

Managing weeds is an ongoing management responsibility that will not disappear even if you have initial successes. The goal is to learn from your success and become more effective and efficient in the future.

5. Remember that persistence is critical.

Monitor your property regularly to ensure that new species are not encroaching and that your management objectives for other weeds are being met. In most cases, it will take several years of multiple treatments to bring weeds under control and to reduce the bank of weed seeds in the soil.

6. Be aware that patience is necessary for success.

Don't become discouraged if your weed management strategy appears unsuccessful in the short term. Keeping weeds under control requires a long-term commitment to land management.



It is now time to fill out the Appendix F chart on [page 54](#), “[Integrated Weed Management Strategies—Rough Draft](#).” In doing so:

- Pay particular attention to planning the “Stage/Time for Action.”
- You could leave the “Action Dates” until you do the final version after working through Step 7 in this manual.

Step 7: Develop a Monitoring Program

Monitoring is the collection, analysis, and interpretation of information to evaluate progress. It is essential for overall success that you assess the effectiveness of your management strategies. Good monitoring will help you decide if your weed strategy is succeeding and/or needs to be modified.

Qualities of a Monitoring Program

A good monitoring program should be:

- Kept simple.
- Maintained as an ongoing process.
- Focused on causes and effects.

Keeping the Program Simple

Keep your monitoring program as simple as possible. Monitoring can occur at many levels of complexity. This manual addresses simpler levels of monitoring.

Decisions involving legal issues or public health can require detailed monitoring techniques that will stand up to scientific and legal scrutiny. These situations can occur on both private and Crown land. When they do, see the booklet titled *Procedures for Environmental Monitoring in Range and Wildlife Habitat Management* for methods that are appropriate to your needs. It is available in print and online at <http://www.for.gov.bc.ca/ric/Pubs/teEcolo/habitat/>

Making the Program Ongoing

Monitoring needs to be an ongoing process. One reason is that evaluations are most useful with comparative information. In particular, you need records that answer two basic questions:

- What did the weed infestation look like before the management strategy was implemented?
- What does it look like afterward?

For example, if you are going to spray herbicide on a patch of spotted knapweed, you will need to assess the site prior to application and document the size and distribution. If you do the spraying in the spring, reassess the site in late summer or fall; for later applications, reassess the site the following spring. If you find that the spotted knapweed died or declined in density and cover, you can see that your treatment has worked, at least in the short term. However, the process should not stop there. You will need to reassess the site annually. The next year, you may discover that the site is still free of spotted knapweed—or that new spotted knapweed plants have appeared and require follow-up work.

Determining Cause-and-Effect Relationships

Although monitoring can give valuable information about changes in the weed population over time, it cannot tell you that your weed management program is definitely the reason for the changes. Other factors such as annual weather patterns may also have influenced the changes. For example, populations of some weeds can fluctuate widely from year to year on the basis of rainfall patterns. After you have applied a herbicide one year, a significant decline in weed population the following year could be the result of changes in annual moisture conditions and not your management action alone. Follow up for a number of years in order to ensure that your program is actually causing the intended effects.

Examples of Monitoring

The main purpose of monitoring is to get an accurate evaluation of the success of your weed management actions. Here are some examples of specific weed management objectives, monitoring actions, and follow-up management actions that could be initiated if the monitoring shows that the weed management objective is not being met.

Example 1

Weed management objective: Reduce the diffuse knapweed infestation in the horse pasture to less than fifteen patches within five years.

Monitoring action: Survey the pasture when the diffuse knapweed begins flowering, and count the number of patches. Record the patches on the map (on an overlay) and a Weed Density and Cover Monitoring Data Sheet.

Management action: Schedule follow-up treatments as required, preferably before the knapweed goes to seed.

Example 2

Weed management objective: Reduce the density of Dalmatian toadflax on the property to less than 10% within five years.

Monitoring action: Survey the property annually when toadflax plants begin flowering. Record weed density on the map and data sheet.

Management action: Pull or spray any viable plants. Place pulled plants in plastic bags at the site, and incinerate or bury them in a designated area. Schedule follow-up treatments for the next year.

Example 3

Weed management objective: Eliminate the patch of leafy spurge by the front gate within five years.

Monitoring action: Check the infestation in May–June and September.

Management action: Plan for an immediate follow-up treatment to eliminate annual seed production and to kill adult plants.

Example 4

Weed management objective: Eliminate hound’s-tongue infestation along Sand Creek in Mule Deer Pasture within five years.

Monitoring action: Survey both shores of Sand Creek in Mule Deer Pasture every July for hound’s-tongue plants.

Management action: Hand-pull plants. Place any plants with seeds in bags at the site, and burn or bury them in a designated area.

Keeping Written Records

The most basic form of monitoring is simply writing down reference notes about what you see in the field. This will allow you to compare your observations over a period of time. Use your field journal to document your weed management surveys, observations, and management activities.

Record your observations about:

- Weed species and locations in specific areas
- Size and abundance of weed infestations
- Site disturbances that may be encouraging weed spread or promoting weed establishment
- Currently uninfested areas that are prime sites for establishment

Add field notes about your high-priority weeds, management actions taken, and any other information that might be useful to you in the future.

If your monitoring will require *detailed* written records, consult the rest of this “Keeping Written Records” section. You will need to use the “Weed Density and Cover Monitoring Data Sheet” that is provided next. Feel free to make copies for this purpose.

Weed Density and Cover Monitoring Data Sheet

Weed species:	Date of monitoring:	Observers:
Type of plant unit being counted or estimated: <input type="checkbox"/> Number of rooted plants <input type="checkbox"/> Number of flowering stems <input type="checkbox"/> Number of rosettes		
Do the counts or estimates include seedlings? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Kind of data: <input type="checkbox"/> Counts <input type="checkbox"/> Estimates	Size of plot: ____ m × ____ m	
Name of management area (or property):	Name or site number of weed infestation:	
	Size of weed infestation:	

Actual Weed Count Method	
Plot #	Density Number of Units in Plot
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Average density:	

Visual Estimation Method		
Plot #	Density Symbol for Number of Units per Plot	Cover Symbol for % Cover per Plot
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Summary of Data				
Presence of Weeds	Density: Estimated Units per 1 m ² Plot	Total Plots with This Density*	Cover: Estimated % per Plot	Total Plots with This Cover
Absent A	0		0%	
Light L	1		1–25%	
Moderate M	2–5		25–50%	
Heavy H	6–9		50–75%	
Extreme E	≥10		75–100%	
* <i>Note:</i> For “Density,” record only the “Average Density” (in the “Actual Weed Count Method” table) if you are using an actual count.				

Note: You are permitted and encouraged to make copies of this data sheet for the purposes of learning Step 7 and managing your weeds.

Measuring Weed Density

It is valuable to measure or estimate weed abundance in order to evaluate your weed management objective. Plant density and cover are two measures of abundance. Both involve counting or estimating the coverage of plants within a small plot.

Density is the number of plants per unit of ground surface area. It usually refers to the number of plants, stems, or rosettes in a plot. For example, the density of diffuse knapweed can be expressed as the number of single knapweed plants per square metre, or m². (Specify on the “Weed Density and Cover Monitoring Data Sheet” what plant unit—rooted plants, flowering stems, or rosettes—you are recording.)

Density measurements can be taken for rhizomatous plants (plants that spread from creeping underground roots), but these measurements may not reflect the number of individual plants because multiple flowering stems may represent a single plant. Reductions in stem density can, however, be a valuable indicator that your management action is working.

Density can be determined in a series of plots along a transect line by:

- Visually estimating
- Counting the weed plants

For purposes of determining weed management program success, a visual estimate of weed density is generally sufficient.

The Visual Estimation Method

1. Referring to your weed management plan, decide which weed species you want to monitor. Also select a typical stand of weeds in an area you have treated or will treat.
2. Install a transect line that will fit within the weed patch you want to monitor. Decide on the length of the transect on the basis of the size of the patch; in larger weed infestations, a 28 m transect is adequate. Use wooden stakes or steel rebar to mark each end of the transect.

3. Locate your ten plots at regular intervals. For a 28 m transect, locate ten 1 m² plots at three-metre intervals along the transect line for a total of ten plots. (You can use more than ten plots if you choose, or you may wish to install more than one transect in treated weed patches that are very large.)
4. Locate your 1 m² plots, using a plot frame (see below for plot frame construction), starting at the zero interval on the transect. Locate your first plot from zero to one metre along the transect line, the second from three to four metres, and so on. Position the frame on one side of the line. (Later, ensure that follow-up measurements are taken from the same side.)
5. Estimate the number of weed plants in each plot, using the following density categories and symbols:

Density	Number of Target Weed Plants in Each 1 m ² Plot	Symbol
Absent	0	A
Scattered	1	S
Light	2–5	L
Moderate	6–9	M
Heavy	≥10	H

6. On the data sheet, under “Visual Estimation Method,” enter the appropriate “density symbol” for each of the plots.
7. Count the number of plots that fall in each “Density” category. Record this data on your data sheet in the “Summary of Data” table.

The Actual Weed Count Method

- 1–4. The first four steps are the same as for visual estimation.
5. Count the number of weed plants rooted within the plot frame. Do not count seedlings, but make a note of their presence (on your data sheet).
6. On your data sheet, under “Actual Weed Count Method,” enter the numbers. Repeat this process on all the plots.
7. Calculate the average density in the area by totaling the number of plants from each plot and dividing by the number of plots.

Note: Visually estimating weed density is normally done within a 1 m² plot size because this plot size allows for greater accuracy over a large area. However, actual plant counting is normally done within a plot size less than 1 m² (for example, 0.25 m² or 0.10 m²). This reduced plot size makes it quicker and more practical to gather information.

Constructing a Plot Frame

You can make an inexpensive square or rectangular 1 m² plot frame as it suits you. Rectangular plots are generally more efficient than other shapes.

For a square frame you will need four metres of 2.5 cm diameter PVC pipe and four 90° elbow joints. Cut the pipe into four 1 m pieces each. Paint each piece red and white—red on one half of the length and white on the other half. Connect the pieces with the elbows red-to-red and white-to-white. This will divide the 1 m² frame into quarters.

For a rectangular 1 m² plot frame, you will need a 4.5 m length of 2.5 cm diameter PVC pipe and four 90° elbow joints. Cut two lengths to 150 cm and two to 67 cm. Divide the longer pieces into quarters by painting the segments red and white alternately. The shorter pieces can be painted either red or white. These segments will allow you to divide the square metre into smaller portions for determining plant density by counting.

Estimating Weed Cover

Plant cover (or coverage) refers to the proportion of ground surface hidden by the target species when the sample plot is viewed from directly above it.

- 1–4. For laying out transects, locating plots, and constructing a plot frame, the procedures are as explained for measuring density.
5. Standing at the middle of the plot, look straight down toward the ground and estimate the cover of the target weed species. Estimate weed cover according to the following categories:

Cover	Estimated Cover of the Target Weed in Each Plot	Symbol
Absent	0%	A
Light	1%–25%	L
Moderate	25%–50%	M
Heavy	50%–75%	H
Extreme	75%–100%	E

6. On your “Weed Density and Cover Monitoring Data Sheet,” record the estimated cover for each species in each plot.
7. Count the number of plots that fall in each “Cover” category. Record this data on your data sheet in the “Summary of Data” table.

Keeping Photographic Records

Photo monitoring can be an excellent way to document changes in weeds over time:

- Photo monitoring works best for weed species that can be easily distinguished from other plants during flowering.
- This technique may not be as effective for weed species that are small in stature or without showy flowers.

If you are using photo monitoring, arrange to take the photos from permanent locations—photo points. Set up photo points in selected weed infestations where you have established specific management objectives. Select the location of photo points so that most or all of the area you have treated can be seen from them. Record the locations of the photo points on your weed map with an arrow showing the direction of the photo, and assign a unique number to each point in order to be able to locate the spot again for future monitoring. If you are using a GPS unit, record the geographic coordinates of your photo points. You can mark photo points in the field by using wooden stakes in areas where livestock or wildlife populations do not congregate. Metal stakes—60 cm lengths of 10 mm rebar—are more suitable for long-term projects. Bend the top 15 cm of the rebar into a hook and drive the stake nearly to ground level to prevent injury to people and livestock. Paint your stakes in a bright colour to help you locate your photo point when you revisit the site.

Take photos when the target weed is most visible, which is typically during the peak flowering period. Take pictures at a fixed focal length (usually 50 mm) and close to the same date or plant stage from one year to the next. Take several photos from each photo point location, and include obvious background features such as fences, trees, cliffs, and distant mountains to help you position the photo with the same scene each year. One or two close-up photos will also be useful. Label the prints, and place them in plastic sleeves. These will help you to frame the scenes in future years and will provide a visual comparison of the weed population.

In your field notebook, keep a log of the pictures taken, matching the number of the exposure with the number of the photo point and the scene.



 It is now time to fill out the Appendix F chart on [page 55](#), “[Integrated Weed Management Monitoring—Rough Draft](#).” In doing so:

- Pay particular attention to planning the “Stage/Time for Action.”
- You could leave the “Action Dates” until you do the final version at the end of your current step, Step 7.

Testing Monitoring Procedures

Test your monitoring plans to see if they work under field conditions. If you have chosen to sample plots for density and cover, consider the following questions during the pilot phase of your monitoring program:

- **Will the data collection methods really work in the field?**
 - You may find that it is not practical to count certain species to estimate density.
 - Dense vegetation may prevent you from laying out sampling plots uniformly.
 - You may have trouble locating your permanently marked transects when you return.

Identify and correct these problems before you commit large amounts of time and resources to a monitoring program.

- **Is the cost and time of monitoring acceptable?**

You may find that it takes too long to collect the data you planned to gather in your original monitoring design—or that the monitoring is too expensive. If your monitoring program is too complex or not affordable, consider a simpler process. It is better to do some data collection than to do none at all.

- **Will the information you collect allow you to detect changes?**

Given the constraints of field methods, time, and money, the bottom line is whether or not monitoring is enabling you to evaluate the effectiveness of your weed management plan.

Monitoring is only useful if you keep re-evaluating your treatment areas over time. Taking a systematic approach, with photographic and/or written records, will help you to document whether changes are occurring as a result of your weed management actions.


Implementing a Monitoring Program

The following sequence of events is essential for making your monitoring program work:

1. Collect field data consistently and according to your plan.
2. Write down what you see, using data sheets, a field book, or both.
3. Evaluate your monitoring results immediately after you collect data.
4. Determine whether your management actions need to be revised on the basis of the information you have gathered.
5. Revise your weed management plan as necessary.
6. Begin this cycle again.

Be cautious in interpreting the results:

- You will need more than one year's data to determine whether a treatment has succeeded or failed.
- Remember that many weed populations respond dramatically to annual weather conditions and to other natural or man-made factors. Talk to neighbouring landowners or government weed specialists in order to learn how populations of your target weeds have done under untreated conditions in your area.

 Create the final version of your “Integrated Weed Management Strategies” and “Integrated Weed Management Monitoring” charts in [Appendix F, pages 56–57](#). Together with your map, they are the main parts of your integrated weed management plan.

- Take the time to review and edit the rough versions in detail.
- Neatly fill out the final versions of the charts.
- Include “Action Dates” in the “Planned” column.

Congratulations! You have completed the Seven Steps!

Appendices

Appendix A: Noxious Weeds in BC (2001)

Provincial Weeds: These weeds are classed as noxious within all regions of British Columbia.

annual sow thistle (*Sonchus oleraceus*)
 Canada thistle (*Cirsium arvense*)
 common crupina (*Crupina vulgaris*)
 common toadflax (*Linaria vulgaris*)
 Dalmatian toadflax (*Linaria dalmatica*)
 diffuse knapweed (*Centaurea diffusa*)
 dodder (*Cuscuta* spp.)
 gorse (*Ulex europaeus*)
 hound's-tongue (*Cynoglossum officinale*)
 jointed goatgrass (*Aegilops cylindrica*)
 leafy spurge (*Euphorbia esula*)
 perennial sow thistle (*Sonchus arvensis*)
 purple nutsedge (*Cyperus rotundus*)
 rush skeletonweed (*Chondrilla juncea*)
 scentless chamomile (*Matricaria maritima*)
 spotted knapweed (*Centaurea maculosa*)
 tansy ragwort (*Senecio jacobaea*)
 velvetleaf (*Abutilon theophrasti*)
 wild oats (*Avena fatua*)
 yellow nutsedge (*Cyperus esculentus*)
 yellow starthistle (*Centaurea solstitialis*)

Note: Maps of BC showing the regional districts are available online via <http://www.bcstats.gov.bc.ca>.

Regional Weeds: These weeds are designated as noxious within the boundaries of specified regional districts.

Designated Weed	Regional Districts*
blueweed (<i>Echium vulgare</i>)	Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, Okanagan-Similkameen, Thompson-Nicola
burdock (<i>Arctium</i> spp.)	Bulkley-Nechako, Cariboo, Columbia-Shuswap, Fraser-Fort George, Kitimat-Stikine, North Okanagan, Okanagan-Similkameen, Peace River, Thompson-Nicola
cleavers (<i>Galium aparine</i>)	Peace River
common bugloss (<i>Anchusa officinalis</i>)	Kootenay-Boundary
common tansy (<i>Tanacetum vulgare</i>)	Bulkley-Nechako, Central Kootenay, Columbia-Shuswap, East Kootenay, North Okanagan
field scabious (<i>Knautia arvensis</i>)	Bulkley-Nechako, Kootenay-Boundary, Thompson-Nicola
green foxtail (<i>Setaria viridis</i>)	Peace River
hoary alyssum (<i>Berteroa incana</i>)	Kootenay-Boundary
hoary cress (<i>Cardaria</i> spp.)	Columbia-Shuswap, North Okanagan, Thompson-Nicola
kochia (<i>Kochia scoparia</i>)	Peace River
marsh plume thistle (<i>Cirsium palustre</i>)	Bulkley-Nechako, Fraser-Fort George
meadow knapweed (<i>Centaurea pratensis</i>)	Columbia-Shuswap
night-flowering catchfly (<i>Silene noctiflora</i>)	Peace River
orange hawkweed (<i>Hieracium aurantiacum</i>)	Bulkley-Nechako, Cariboo, Central Kootenay, Columbia-Shuswap, East Kootenay, Thompson-Nicola
oxeye daisy (<i>Chrysanthemum leucanthemum</i>)	Cariboo, North Okanagan, Peace River, Thompson-Nicola
perennial pepperweed (<i>Lepidium latifolium</i>)	East Kootenay, Thompson-Nicola
plumeless thistle (<i>Carduus acanthoides</i>)	Central Kootenay
puncturevine (<i>Tribulus terrestris</i>)	Okanagan-Similkameen
quackgrass (<i>Agropyron repens</i>)	Peace River
Russian knapweed (<i>Acroptilon repens</i>)	North Okanagan
Russian thistle (<i>Salsola kali</i>)	Peace River
Scotch thistle (<i>Onopordum acanthium</i>)	North Okanagan
sulphur cinquefoil (<i>Potentilla recta</i>)	Columbia-Shuswap, North Okanagan, Okanagan-Similkameen, Thompson-Nicola
tartary buckwheat (<i>Fagopyrum tataricum</i>)	Peace River
white cockle (<i>Lychnis alba</i>)	Peace River
wild chervil (<i>Anthriscus sylvestris</i>)	Fraser Valley
wild mustard (<i>Sinapsis arvensis</i>)	Peace River

Appendix B: Seed Production and Dormancy

Average seed production per plant

Plant	Seeds/Plant	Plant	Seeds/Plant
barley, wild	2,420	lettuce, prickly	27,900
beggar ticks	7,000	mallow	47,500
buckwheat, wild	11,900	marsh elder	82,150
buffalo bur	8,460	mullein	223,200
burdock	31,600	mustard, ball	490
catchfly	1,800	mustard, common	2,700
cinquefoil	42,600	mustard, dog	8,482
cockle, pink	4,300	mustard, hare's-ear	3,800
coneflower, long-headed	7,000	mustard, tumbling	80,409
dandelion	15,000	peppergrass	6,009
dock, curled	29,500	pigweed, creeping	14,609
dodder, field	16,000	pigweed, rough	117,400
dodder, hazel	7,000	pigweed, tumbling	129,000
dragonhead	49,600	plantain, common	36,159
evening primrose	118,500	purslane	52,309
false flax (large seeded)	1,970	ragweed	3,330
flixweed	75,650	shepherd's-purse	33,509
frenchweed	7,040	smartweed	19,309
goldenrod, stiff	3,290	spurge, leafy (1 stem)	142

Average seed production per plant (continued)

Plant	Seeds/Plant	Plant	Seeds/Plant
grass, barnyard	7,160	spurge, rhyme-leaved	2,670
grass, green foxtail	34,000	stickseed	2,129
grass, yellow foxtail	6,420	sunflower, common	7,200
grass, stink	82,100	sunflower, narrow-leaved	2,609
grass, witch	11,400	thistle, Canada (1 stem)	630
gumweed	29,700	thistle, Russian	24,700
hemlock, water	5,500	thistle, perennial sow (1 stem)	9,750
kinghead	1,650	vetch, narrow-leaved	150
knotweed	6,380	wild oats	250/head
lamb's-quarters	72,450	wormwood	1,075,000

Weed seed dormancy—number of years that some seeds remain viable (alive) in the soil

Weed	Years
chickweed	10
hedge mustard	10
Canada thistle	11–20
oxeye daisy	11–20
lamb's-quarters	21–40
purslane	21–40
redroot pigweed	21–40
shepherd's-purse	35
dodder	70
curled dock	>80

Appendix C: Best Weed Management Practices

Be Informed

- Become aware of the problem.
- Spread the word that noxious weeds are everyone's concern.
- Learn how to identify weed species in the field so that you can spot them while performing other land management activities.
- Report infestations of weeds not previously known in the area to the local office of the Ministry of Agriculture, Food and Fisheries or the Forest Service.

Detect Weeds Early

- Periodically inspect roads and livestock trails to detect new weed establishment, particularly in disturbed areas.
- Periodically inspect ditch and stream banks for noxious weeds, since seeds can be spread by running water.
- Periodically inspect high-traffic areas for weed infestations. For example, inspect developed trails, parking areas, campgrounds, fairgrounds, and livestock yards.
- Pay particular attention to recreation areas and areas heavily used by wildlife and livestock, such as riparian sites, salt licks, and bedding grounds.
- Know where gravel or fill material is brought in from. Weed seeds in this material can start new infestations, and bare soil provides an ideal environment for weed establishment.
- Don't purchase weedy hay. Question the seller about weed content, and inspect bales prior to unloading.

Limit Dispersal

- Do not pick and transport any roadside plants.
- Do not transport weed seeds that are stuck on clothing, gear, pets, or livestock. Check before leaving the site. Even check your bootlaces, which often harbour lots of seed. Place the seeds in a container such as a plastic bag for safe disposal.
- Avoid driving or biking in areas infested with noxious weeds. Inspect vehicles and bicycles for weed seeds or plant parts. Check the mud in tire treads, on bicycles, and on/underneath vehicles. Check and remove weeds *before* leaving infested areas, not in weed-free areas.
- Before heavy/maintenance equipment enters your weed management area, inspect it and require that it be steam-cleaned to remove weed seeds prior to entry. Clean all equipment (especially mowers) that has been used in weed-infested areas before moving it to another area. Clean all farm equipment before taking it to a new field.
- Always use weed-free hay, straw, and mulch. Use only well-rotted manure at least six months old.
- Confine livestock for a day or two in a small pasture or corral before moving it to a weed-free pasture. Clean the livestock's hair and feet if necessary. Control weeds in bedding and feed grounds to prevent seeds from being dispersed through animal manure.
- Make sure that pack animals used in backcountry areas are fed weed-free hay or an alternative such as alfalfa cubes. Remove weed seeds from pack animals before leaving an area by brushing them thoroughly and cleaning their hooves. Post signs to this effect to encourage other riders.
- If you find a small number of isolated noxious weeds with no flowers or seeds, pull the weeds and leave them where you found them to dry out. If flowers or seeds are present, place the weeds in a container such as a plastic bag for safe disposal.

Minimize Disturbances

- Whenever possible, restrict travel to established roads and trails.
- Do not drive or bike through sensitive areas.
- Limit recreational trails and campsites.
- Avoid leaving piles of exposed soil in construction areas or work yards. Cover such areas with plastic, and re-vegetate with native species as soon as possible. If possible, spread material excavated during trail construction back onto the trail instead of piling it on the side.
- Avoid overgrazing, especially in sensitive areas or areas that are in poor condition and lacking vigour.
- Move salt licks frequently, and keep salt in a shallow container to minimize soil disturbance.

Establish and Maintain Native Plant Communities

- Reseed disturbed areas immediately after the disturbance ends. Reseed before a crust forms on the soil, which can deter germination. Perennial native grasses and legumes are especially valuable for reseeding.
- Avoid livestock grazing on reseeded areas for at least one growing season in order to allow desirable plants to become established.
- Limit fertilizer use when reseeding, as the fertilizer may favour weeds over the native perennial species.

Appendix D: Bioagents Attacking Weeds in BC

Note: Not all agents are established throughout the range of the target weed in British Columbia.

Weed	Bioagent	Type	Released	Attack Site
<i>Acroptilon repens</i> (Russian knapweed)	<i>Puccinia acroptili</i>	rust fungus	naturalized	leaf
	<i>Subanquina picridis</i>	nematode	1985	stem, leaf
<i>Carduus acanthoides</i> (plumeless thistle)	<i>Rhinocyllus conicus</i>	weevil	1979	seedhead
	<i>Trichosirocalus horridus</i>	weevil	1986	shoot
	<i>Urophora solstitialis</i>	fly	1991	seedhead
<i>Carduus nutans</i> (nodding thistle)	<i>Rhinocyllus conicus</i>	weevil	1979	seedhead
	<i>Trichosirocalus horridus</i>	weevil	1979	shoot
	<i>Urophora solstitialis</i>	fly	1991	seedhead
<i>Centaurea debauxii</i> (meadow knapweed)	<i>Urophora jaceana</i>	fly	1986	seedhead
	<i>Puccinia centaurea</i>	rust fungus	naturalized	leaf

Weed	Bioagent	Type	Released	Attack Site
<i>Centaurea diffusa</i> (diffuse knapweed)	<i>Agapeta zoegana</i>	moth	1982	root
	<i>Pelochrista medullana</i>	moth	1982	root
	<i>Pterolonche inspersa</i>	moth	1986	root
	<i>Sphenoptera jugoslavica</i>	beetle	1976	root
	<i>Subanquina picridis</i>	nematode	1985	stem, leaf
	<i>Urophora affinis</i>	fly	1971	seedhead
	<i>Urophora quadrifasciata</i>	fly	1971	seedhead
	<i>Cyphocleonus achates</i>	weevil	1989	root
	<i>Chaetorellia acrolophi</i>	fly	1991	seedhead
	<i>Larinus minutus</i>	weevil	1991	seedhead
	<i>Larinus obtusus</i>	weevil	1993	seedhead
	<i>Puccinia jaceae</i>	rust fungus	naturalized	leaves

(Appendix D is continued on the next two pages.)

Appendix D: Bioagents Attacking Weeds in BC (continued)

Weed	Bioagent	Type	Released	Attack Site
<i>Centaurea biebersteinii</i> (spotted knapweed)	<i>Agapeta zoegana</i>	moth	1982	root
	<i>Cyphocleonus achates</i>	weevil	1987	root
	<i>Metzneria paucipunctella</i>	moth	1973	seedhead
	<i>Pterolonche dispersa</i>	moth	1987	root
	<i>Sphenoptera jugoslavica</i>	beetle	1981	root
	<i>Urophora affinis</i>	fly	1970	seedhead
	<i>Urophora quadrifasciata</i>	fly	1970	seedhead
	<i>Pelochrista medullana</i>	moth	1988	root
	<i>Terellia virens</i>	fly	1991	seedhead
	<i>Chaetorellia acrolophi</i>	fly	1991	seedhead
	<i>Larinus minutus</i>	weevil	1991	seedhead
<i>Larinus obtusus</i>	weevil	1993	seedhead	
<i>Chondrilla juncea</i> (rush skeleton-weed)	<i>Aceria chondrillae</i>	mite	Pre-93	flower buds
	<i>Puccinia chondrillina</i>	rust fungus	Pre-93	leaf
<i>Cirsium arvense</i> (Canada thistle)	<i>Altica carduorum</i>	beetle	1964	leaf
	<i>Ceutorynchus litura</i>	weevil	1975	shoots, crown
	<i>Urophora carduii</i>	fly	1974	stem
	<i>Larinus planus</i>	weevil	?	seedhead

Appendix D: Bioagents Attacking Weeds in BC (continued)

Weed	Bioagent	Type	Released	Attack Site
<i>Cirsium vulgare</i> (bull thistle)	<i>Rhinocyllus conicus</i>	weevil	1985	seedhead
	<i>Urophora stylata</i>	fly	1973	seedhead
	<i>Trichosirocalus horridus</i>	weevil	1991	shoot
<i>Convolvulus arvensis</i> (field bindweed)	<i>Chirida guttata</i>	beetle	1969	
	<i>Metriona bicolor</i>	beetle	1969	leaf
	<i>Aceria convolvulii</i>	mite	1991	stem, leaf
<i>Cynoglossum officinale</i> (hound's-tongue)	<i>Mogulones cruciger</i>	weevil	1997	root
	<i>Longitarsus quadriguttatus</i>	beetle	1998	root
	<i>Aphthona nigriscuti</i>	beetle	1987	root
	<i>Aphthona cyparissiae</i>	beetle	1986	root
<i>Euphorbia esula</i> (leafy spurge)	<i>Aphthona flava</i>	beetle	1991	root
	<i>Hyles euphorbia</i>	moth	1966	leaf
	<i>Lobesia euphorbiana</i>	moth	1987	leaf
	<i>Spurgia esula</i>	fly	1990	shoot tip
<i>Hypericum perforatum</i> (St. John's-wort)	<i>Agrilis hyperici</i>	beetle	1955	roots
	<i>Aplocera plagiata</i>	moth	1967	leaf
	<i>Aphis chloris</i>	aphid	1979	stem, root
	<i>Chrysolina hyperici</i>	beetle	1951	leaf
	<i>Chrysolina quadrigemina</i>	beetle	1951	leaf
	<i>Chrysolina varians</i>	beetle	1957	leaf
	<i>Zeuxidiplosis giardi</i>	fly	1955	leaf

Appendix D: Bioagents Attacking Weeds in BC (continued)

Weed	Bioagent	Type	Released	Attack Site
<i>Linaria genistifolia</i> (Dalmatian toadflax)	<i>Calophasia lunula</i>	moth	1965	leaf
	<i>Brachypterolus pulicarius</i>	beetle	naturalized	seed
	<i>Mecinus janthinus</i>	weevil	1992	stem
	<i>Eteobalea intermediella</i>	moth	1992	root
	<i>Gymnaetron antirrhini</i>	weevil	1995?	seed, stem
<i>Linaria vulgaris</i> (yellow toadflax)	<i>Calophasia lunula</i>	moth	1963	leaf
	<i>Brachypterolus pulicarius</i>	beetle	naturalized	seed
	<i>Mecinus janthinus</i>	weevil	1992	stem
	<i>Eteobalea seratella</i>	moth	1992	root
	<i>Gymnetron linariae</i>	weevil	1995?	seed, stem
<i>Lythrum salicaria</i> (purple loosestrife)	<i>Hylobius transversovittatus</i>	beetle	1994	root
	<i>Galerucella californiensis</i>	beetle	1993	leaf
	<i>Galerucella pusilla</i>	beetle	1994	leaf
<i>Matricaria maritima</i> (scentless chamomile)	<i>Onthalapion hookeri</i>	beetle	1992	seedhead
	<i>Microplontus edentulus</i>	beetle	1997	stem

Appendix D: Bioagents Attacking Weeds in BC (continued)

Weed	Bioagent	Type	Released	Attack Site
<i>Senecio jacobaea</i> (tansy ragwort)	<i>Hylemya seneciella</i>	fly	1970	seedhead
	<i>Longitarsus jacobaeae</i>	beetle	1971	root
	<i>Longitarsus flavicornis</i>	beetle	1971	root
	<i>Tyria jacobaeae</i>	moth	1962	leaf, stem
	<i>Cochylis atricapitana</i>	moth	1991	root
	<i>Sonchus arvensis</i> (perennial sow thistle)	<i>Cystiphora sonchi</i>	fly	1992
<i>Tribulus terrestris</i> (puncturevine)		weevil	1986	seed, leaf, stem

Appendix E: Mode of Action of Herbicides Used in BC

*Herbicides marked with an asterisk are a mixture of the listed active ingredient plus one or more other active ingredients.

Herbicides that regulate growth:

- 2,4-D—various trade names, Attain*, Champion Plus*, Grazon*, Estaprop*, Dichlorprop-D*, Turboprop*, Express*, Thumper*
- 2,4-DB—various trade names, Embutox, Caliber, Cobutox
- clopyralid—Curtail M, Lontrel, Transline, Poast Flaxmax*, Prestige*, Prevail*
- dicamba—Banvel II, Dyvel*, Dyvel DS*, Target*, Flaxmax*, Rustler*
- fluroxypyr—Attain*, Prestige*
- MCPA—various trade names, Achieve Extra Gold*, Buctril M*, Champion Plus*, Curtail M*, Dyvel*, Poast Flaxmax*, Prestige*, Prevail*, Target*, Triumph Plus*, Tropotox Plus*
- MCPB—Tropotox Plus*
- mecoprop—Mecoprop, Compitox
- picloram—Tordon, Grazon*
- quinclorac—Accord
- triclopyr—Garlon, Remedy

Herbicides that inhibit amino acid and protein synthesis:

- chlorsulfuron—Telar
- ethametsulfuron-methyl—Muster
- glufosinate—Liberty, Ignite, Harvest
- glyphosate—Roundup, Touchdown, Rustler*
- imazamethabenz—Assert
- imazamox—Odyssey*
- imazapyr—Arsenal
- imazethapyr—Pursuit, Odyssey*
- metsulfuron-methyl—Ally, Escort
- nicosulfuron—Accent
- rimsulfuron—Prism
- tribenuron-methyl—Champion Extra*, Crossfire*, Express*, Harmony Total*, Refine Extra*
- thifensulfuron—Champion Plus*, Triumph Plus*
- thifensulfuron methyl—Champion Extra*, Harmony Total*, Refine Extra*

Herbicides that inhibit fatty acid (lipid biosynthesis):

- clethodim—Select
- clodinafop-propargyl—Harmony Total*, Horizon*
- diclofop-methyl—Hoegrass 284, Hoegrass II*
- fenoxaprop-ethyl—Acclaim
- fenoxaprop-p-ethyl—Champion Plus*, Puma Super, Fusion*, Triumph Plus*
- fluazifop-p-butyl—Venture, Fusion*
- quizalofop-p-ethyl—Assure II, Muster Gold II*
- sethoxydim—Poast Ultra, Flaxmax*

Herbicides that inhibit photosynthesis:

- amitrole—Amitrol
- atrazine—various trade names, Laddok*, Primextra Light*
- bentazon—Basagran, Laddok*
- bromoxynil—Pardner, Achieve Extra Gold*, Buctril M*, Hoegrass II*, Thumper*
- diuron—Karmex
- hexazinone—Velpar
- linuron—Afolan, Linuron, Lorox
- metribuzin—Lexone, Sencor, Crossfire*
- phenmedipham—Spin-Aid
- prometryn—Gesagard
- propanil—Stampede
- pyridate—Lentagran
- simazine—Simazine, Simadex, Princep
- tebuthiuron—Spike
- terbacil—Sinbar

Herbicides that inhibit seedling growth:

- cycloate—Ro-Neet
- DCPA—Dacthal
- bensulide—Betazan
- desmedipham—Betanex
- dichlobenil—Casoron
- ethalfuralin—Edge
- EPTC—Eptam, Eradicane*
- metolachlor—Dual Magnum, Dual II Magnum, Primextra Light*
- napropamide—Devrinol
- naptalam—Alanap
- pebulate—Tillam
- pendimethalin—Prowl
- phenmedipham—Spin-Aid
- propyzamide—Kerb
- triallate—Avadex, Fortress*
- trifluralin—Treflan, Rival, Bonanza, Fortress*

Herbicides that destroy cell membranes by contact:

- bentazon—Basagran, Laddok*
- bromoxynil—Pardner, Achieve Extra Gold*, Buctril M*, Hoegrass II*, Thumper*
- difenzoquat—Avenge
- diquat—Reglone, Gramoxone PDQ*
- endothal—Endothal
- linuron—Afolan, Linuron, Lorox
- oxadiazon—Ronstar
- oxyfluorfen—Goal
- paraquat—Gramoxone, Gramoxone PDQ*
- pyridate—Lentagran
- stoddard solvent—Agricultural Weed Killer #1

Herbicides can further be grouped by the target site impacted within the weed. To manage weed resistance, be sure to rotate herbicides between products that have a different mode of action or that target different sites within the weed. A herbicide dealer or the Ministry of Agriculture, Food and Fisheries can provide more information on herbicide target sites.

Appendix F: Weed Management Plan

This Weed Management Plan appendix is an outline to prompt you in useful ways as you work through the Seven Steps to Managing Your Weeds for the first time. Use it in combination with the rest of the manual and your field journal and map, reference publications and Websites, and sources of advice. As mentioned in the [Introductory Notes](#), you are encouraged to have a copy of these Appendix F charts available as you work through the steps.

Date: _____ Weed manager: _____ Management area: _____

Possible Weed Management Goals

This chart is related to Step 3, especially [page 15](#).

Priority	Possible Goal	Is this goal important enough to be a focus of weed management?	Can I realistically expect to achieve this goal?

Possible Weed Management Objectives

Appendix F continued. This chart is related to Step 3, especially [page 16](#).

Revised List of Goals (with Priority Numbers	Pri- ority	Possible Objective	Scheduled?	Geographic Limits?	Measurable?	Achievable?

Priority of Weeds and Sites

Appendix F continued. This chart is related to Step 4, [page 17](#).

Weed Species	Notes about the Species	High-Priority Species?	Infestation Sites	High-Priority Site?

Priority of Weeds and Sites (Continued)

Appendix F continued. This chart is related to Step 4, [page 17](#).

Weed Species	Notes about the Species	High-Priority Species?	Infestation Sites	High-Priority Site?

Weed Management Strategies

Appendix F continued. This chart is related to Step 5, [pages 18–29](#).

Weed Management Objective	Weed Species	Possible Weed Management Strategies and Related Notes	High-Priority Strategy?

Integrated Weed Management Strategies—Rough Draft

Appendix F continued. This chart is related to Step 6, [pages 30–32](#).

Priority	Weed Management Objectives	Weed Species	Planned Weed Management Strategies	Stage/Time for Action	Action Dates	
					Planned	Actual

Integrated Weed Management Monitoring—Rough Draft

Appendix F continued. This chart is related to Step 7, [pages 33–39](#).

Priority	Weed Management Objectives	Weed Species	Planned Weed Management Monitoring Methods	Stage/Time for Action	Action Dates	
					Planned	Actual

Integrated Weed Management Strategies—Final Plan

Appendix F continued. This chart is related especially to Step 6, [pages 30–32](#).

Pri- ority	Weed Management Objectives	Weed Species	Planned Weed Management Strategies	Stage/Time for Action	Action Dates	
					Planned	Actual

Integrated Weed Management Monitoring—Final Plan

Appendix F continued. This chart is related especially to Step 7, [pages 33–39](#).

Priority	Weed Management Objectives	Weed Species	Planned Weed Management Monitoring Methods	Stage/Time for Action	Action Dates	
					Planned	Actual

Related Publications

- British Columbia Ministry of Water, Land and Air Protection and Ministry of Forests. *Procedures for Environmental Monitoring in Range and Wildlife Habitat Management*. Victoria: Province of British Columbia, 1996. Also available at <http://www.for.gov.bc.ca/ric/Pubs/teEcolo/habitat/>.
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