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Weed Management on Small Acreage in Montana



ADVISORY COMMITTEE:

This publication was produced by the Montana Noxious Weed Education Campaign with suggestions from:

Dave Brink Mineral County MSU Extension, Superior

Dave Burch Montana Department of Agriculture, Helena

Celestine Duncan Weed Management Services, Helena

Shantell Frame-Martin Montana Noxious Weed Education Campaign, Bozeman

Melissa Maggio-Kassner Montana Biological Control Program, Missoula

Jane Mangold Montana State University, Bozeman

Dave Martin Montana DNRC, Helena

Steffany Rogge-Kindseth Missoula County Weed District, Missoula

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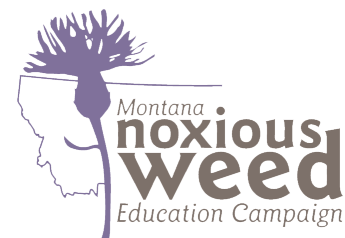
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Proper grazing management and the use of noxious-weed-seed-free forage for supplemental feeding is important for healthy, weed-free pastures.



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Introduction

Managing plant communities on your property can be both challenging and rewarding. This handbook was designed to help landowners manage their land, with a special focus on preventing and controlling invasive weeds. Following the guidelines in this booklet will help you successfully manage plant communities and achieve your land use goals.

This booklet provides the foundation for developing a weed management plan by explaining basic concepts and practices of vegetation management. The resources section located at the back of this publication contains references to many resources, including publications, websites, and contact information for weed management expertise.



Kim Antonick, MT Dept. of Agriculture

What is the difference between a weed and a noxious weed?

A weed can be defined as a plant growing where it isn't wanted, for example a dandelion growing in your lawn. Noxious weeds are non-native plants that cause injury to livestock, agriculture and/or the environment, and were introduced to North America from another region or continent. Most noxious weeds are also invasive, which means they are capable of establishing and spreading to new habitats and may displace desired plants. A plant is declared "noxious" by the Montana Department of Agriculture. The Montana County Noxious Weed Control Act mandates that land owners manage noxious weeds on their property. To find out more about how a plant is declared noxious in Montana and for a list of plants on Montana's Noxious Weed list visit: agr.mt.gov/Weeds.

LEFT: Houndstongue is a Montana state-listed noxious weed that produces bur-like seeds.

BELOW: In addition to state-listed noxious weeds, counties may also have plants that are of concern in their area. Black henbane is listed as a county noxious weed in several counties across Montana.

In addition to state-listed noxious weeds, counties may also list species that are particularly problematic in more localized areas. Contact your local county weed coordinator or Extension agent to check for county-listed species.

Some noxious weeds were brought to North America intentionally for their medicinal and ornamental traits. Others were introduced accidentally as contaminants of crop seed, livestock feed, straw, or packaging materials. Disturbances in plant communities and soil



Shantell Martin, MNWEC



Howard F. Schwartz, CSU Bugwood.org

associated with westward expansion and land use change made landscapes more susceptible to invasion by non-native, invasive plants.

Montana County Noxious Weed Control Act

Montana has a long history of being proactive when it comes to weed management. The first weed law in Montana was enacted in 1895, the weed law that is enforced in counties presently is the "Montana County Noxious Weed Control Act," which was signed by the Montana Legislature in 1948. This law states that, "It is unlawful for any person to permit any noxious weed to propagate or go to seed on the person's land, except that any person who adheres to the noxious weed management program of the person's weed management district or who has entered into and is in compliance with a noxious weed management agreement is considered to be in compliance with this section" (MCA 7-22-2116).

The Montana County Noxious Weed Control Act paved the way for additional legislation that protects the state from invasion of weeds.

Plants such as dandelions are considered a nuisance weed and are not listed on Montana's noxious weed list.



The Montana Noxious Weed Seed Free Forage Act was passed in 1995 because Montana's legislators realized that the natural resources of the state needed to be protected from noxious weeds and their seeds. The Department of Agriculture administers the Noxious Weed Seed Free Forage (NWSFF) program, which required people to use certified noxious weed seed free hay, straw, pellets, and cubes while on public lands to stop the spread of noxious weeds to the backcountry. People are also encouraged to feed their horses, mules, or pack animals certified forage for at least three days before riding on public lands. Small acreage landowners who buy feed for their livestock should feed NWSFF to prevent introduction of new noxious weeds onto their property. In addition, the Montana

Environmental Policy Act, the Montana Agricultural Seed Act and the Commercial Feed Act all mention noxious weeds. Each of these laws

help to prevent or reduce the spread and/or introduction of weeds into Montana.

Certified noxious weed seed free products can be found across Montana and are marked with special blue and orange twine or red tags on baled certified forage, or orange labels on bagged, processed feed. To find the nearest producer of hay, straw, pellets, or cubes, visit: agr.mt.gov/Noxious-Weed-Seed-Free-Forage.

Why Worry About Weeds?

Weeds crowd out more desirable plants in lawns, gardens, croplands, pastures, and natural areas. Infestations can reduce crop yield and available livestock forage, causing economic hardships for farmers and ranchers. Weeds diminish wildlife habitat, decrease property values, and can lead to soil erosion. Some species are poisonous and can sicken or be fatal if ingested by pets, livestock, or people.

Weeds also impact outdoor recreational activities. For example, infestations of spotted knapweed can reduce desirable grasses on elk winter range by up to 90%, affecting hunting opportunities.



Humans are the number one means by which weeds spread! If you hike, bike, hunt, fish, ride a horse, go camping or ride an ATV anywhere, you should arrive at your destination with clean gear. It is important to wash tires, undercarriages, wheel wells and running boards to help reduce the possibility of transporting weed seeds in the mud that collects in these places. If you use horses or other animal companions for recreation, you should remove mud and weed seeds from fur, hair and hooves. The use of certified noxious weed seed free forage (NWSFF) products three days before going on to and during your time on public lands will help reduce the spread of weed seeds through contaminated forage products. If you always PlayCleanGo (PCG®), you'll be doing your part to help stop invasive species in YOUR tracks! To learn more about PCG®, visit: playcleango.org.



Similarly, curlyleaf pondweed and Eurasian watermilfoil impact fisheries and make water recreation (swimming, water skiing, boating) difficult due to extensive mats of floating plant material on the surface of ponds and lakes.

Once established, the costs associated with weed management are a large and long-term investment. For example, the cost of weed management can range from \$10 to \$350 or more per acre, depending on the location of the weed and type of management method used. In many cases, long-term management over many years is needed to effectively contain and control an established infestation.

Weeds are highly competitive and thrive where soils have been disturbed and plants



Improving habitat for wildlife such as birds is a great land use goal. Wild bird species such as the Western Meadowlark depend on healthy, diverse habitats.

Spotted knapweed infestations cause a monoculture, which means that little to nothing else grows there besides spotted knapweed. Infestations like this are an example of a very unhealthy plant community because of the lack of species diversity.



A healthy plant community features many types of plants that together have the capability to ward off infestations of noxious weeds.

Photos by Jane Mangold, MSU

are unhealthy due to recent or reoccurring disturbance. A plant community can be considered “unhealthy” when constant disturbances occur that lead to degradation of the site including erosion, reduced plant growth, reduction in species diversity and changes in soil such as compaction.

Unhealthy plant communities can be caused by overgrazing, logging, new construction (including building of structures, roads, railway, and utility lines), and off-road trail use, as well as natural causes such as fire and flooding. One of the key things to remember about “healthy” versus “unhealthy” plant communities is competition. A healthy plant community is better suited to compete with an impending weed infestation, whereas an unhealthy plant community is not because of the lack of diversity and poor health of the plants located in the community.

A “healthy” plant community is naturally the opposite of what an unhealthy plant community is; there is diversity of species, plants are actively growing, little to no erosion occurs and the soil is providing nutrients and water to benefit the plant community. A healthy plant community wards off weed invasion because it is competitive. To help prevent weeds from invading, nurture and encourage competitive, healthy plant communities.

Small acreage landowners who buy feed for their horses may want to feed NWSFF to prevent the introduction of new weeds onto their property.

BENEFITS OF MAINTAINING A HEALTHY AND COMPETITIVE PLANT COMMUNITY:

- **Enhance property value, improve aesthetics**
- **Save money and time, and reduce long-term maintenance costs**
- **Improve wildlife habitat**
- **Provide forage for horses and other livestock**
- **Protect native plants**
- **Protect water and soil resources**
- **Develop positive neighbor relations**



Skyler Frame

Common land use goals include livestock grazing, raising hay, or improving native plant communities to increase wildlife or pollinator habitat.

Getting Started



The first step to successfully managing weeds on your property is to define what you wish to do with your land. In other words, develop realistic land use goals that align with your property's potential. If you graze too many animals on too few acres or repeatedly disturb plants and soils through other means, you will likely have weeds. Some common land use goals include livestock grazing, raising hay, or improving native plant communities to increase wildlife or pollinator habitat.

The second step is to identify any weeds that are growing on the property and interfering with land use goals. Familiarizing yourself with plants growing on your land will enable you to develop an inventory of desired and undesired plants, assess plant types and determine control methods for those you do not want, e.g. weeds. A detailed inventory will help you achieve land use goals by serving as a reference point in monitoring management progress. Once you know what is growing on your land, you can begin to promote healthy plant communities, which is a major component to effective weed management and a benchmark of good land stewardship.

The third step is to implement good land use practices. Good land use practices include seeding or revegetating any disturbed areas associated with new construction, road ditches, water lines, etc.; using Certified Noxious Weed Seed Free Forage (NWSFF) to feed livestock; grazing an appropriate number of livestock; and managing weed infestations while they are small. Another component of good land use is to choose the right weed control method or combination of methods that will maximize your efforts. Combining multiple weed control methods is called "Integrated Weed Management" or IWM. There are numerous factors to consider when determining what types of control methods will

be effective for use in your situation. Chemical, mechanical, biological and grazing are all very effective management methods; when used in conjunction with one another, these tools can be even more successful.

The fourth step is to monitor your progress and adjust management methods over time as necessary. It is important to remember that no weed control method works alone; IWM will help to achieve your land use goals so that you may fully enjoy your property now and in the future.



Kim Antonick, MT Dept. of Agriculture



Meadow fritillary (*Boloria bellona*)



Missoula County Weed District



Missoula County Weed District

Integrated Weed Management or IWM is combining multiple methods of weed control to maximize efforts.



Jane Mangold, MSU



Jane Mangold, MSU

Plant/Weed Identification

The lifecycle of a plant is how a plant moves from being a seed to an adult plant capable of reproducing. Lifecycles can affect overall plant productivity as well as how the weed can be best controlled.

NOTE DISTINGUISHING CHARACTERISTICS OF A PLANT

- **Leaves:** location on stem, shape, texture and size.
- **Stem:** shape, thorns, fuzzy or smooth, single stem or vine.
- **Height:** size and overall shape of the plant.
- **Flower:** color, petal shape, and whether there are multiple blossoms or just one.
- **Seeds:** shape, size, color, barbed, hooked, spines.
- **Roots:** Roots are generally divided into two types, taproots and rhizomatous. Taproots have

a strongly developed main root that extends vertically into the ground, like a carrot, with smaller lateral roots growing from the main root. Rhizomatous roots spread vertically and horizontally, exhibiting a creeping appearance.

Need Help Identifying a Plant?

If you cannot identify a plant and you fear it may be a weed, dig up three or four samples of the plant, bag them in a sealed plastic bag and take them to your local Extension office or county weed coordinator within 24 hours of collecting. If your local experts cannot identify the plant, they will send the specimen to the Schutter Diagnostic Lab at Montana State University for identification. Sometimes the unknown plant can be identified through photos. If you are unsure about digging up a plant, take photos first and share with local experts.

Take an inventory of weeds growing on your land by drawing a map of your property and noting areas where weed infestations are located. To begin, make note of areas where weeds are growing, areas of bare or disturbed soil, and areas where desirable plants, such as grasses and shrubs are thriving. This map may seem basic, but it is an essential first step to help you better understand where weed infestations occur and to determine the size of infestation(s). This map will serve as a reference point that you can use year after year to help determine if management

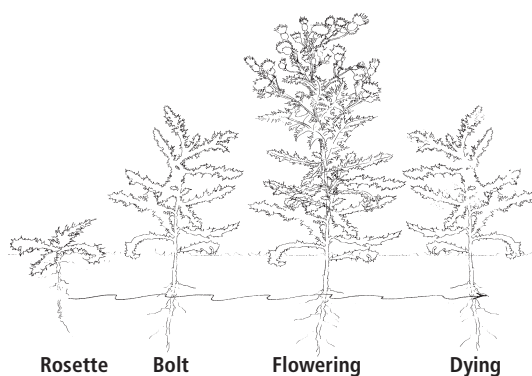
4 Principles of Weed Management:

- *Know what you want to do with your land (define land use goals).*
- *Identify weeds growing on your land.*
- *Choose the right method(s)/tool(s) to reduce weeds and implement good land use practices.*
- *Monitor your progress and adjust your methods over time.*

methods are working. If you would like a more technical way to track and report the species that occur on your property you may use an app called EDDMapS. For more information about EDDMapS, visit: <https://www.eddmaps.org/>.

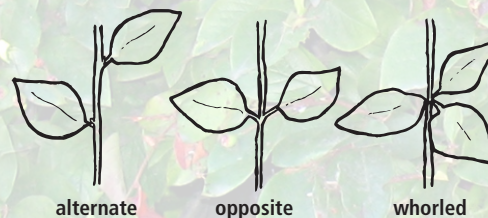
What a Weed Inventory Tells You

Once your inventory map is complete, you may see that different areas of your property have plant communities that are in various states of health. Use this information to determine how to treat the weeds in each area. Areas with disturbed ground from construction activities or along roads are one of the first areas weeds will invade. These areas usually need immediate and constant attention.



Recognizing the growth stage of plants and their lifecycle is essential to successful weed management.

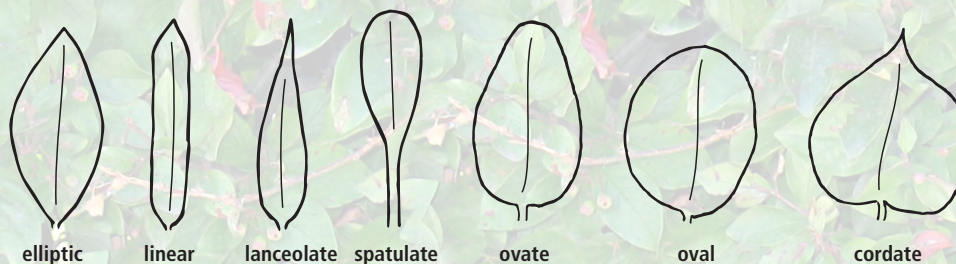
ARRANGEMENTS



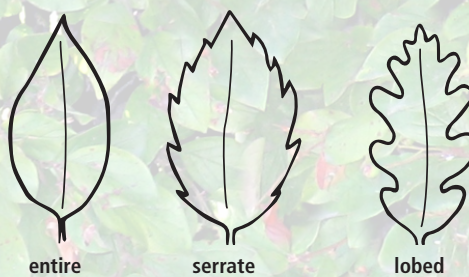
TYPES



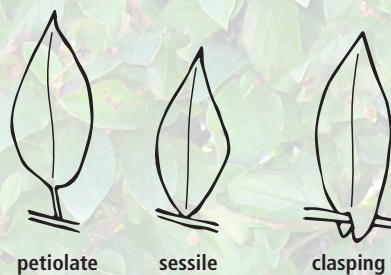
SHAPES



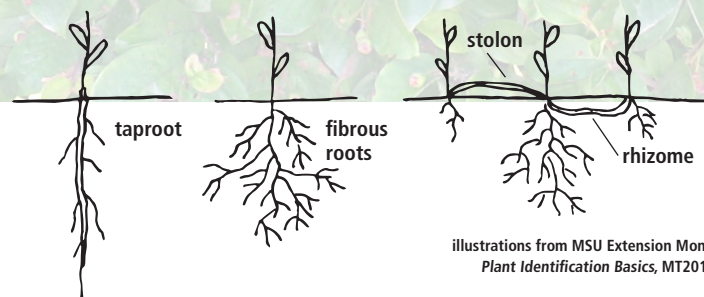
MARGINS



ATTACHMENTS



ROOTS

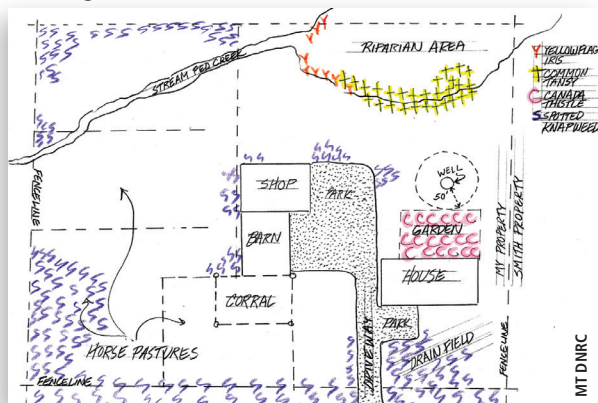


illustrations from MSU Extension Montguide, Plant Identification Basics, MT201304AG

Bare ground may or may not indicate a problem; much of Montana is an arid or semi-arid environment where bare ground can occur naturally. If the bare ground is due to natural causes, it may not be prone to weeds. However, bare ground caused from human actions, such as overgrazing, construction, logging or fire (human- or natural-caused), can lead to soil erosion or weed invasion if left unaddressed.

Once you have your inventory complete and have questions on how to determine a treatment plan for the property, contact your local Extension or county weed district office for assistance. Your local weed experts can help identify any unknown plants you may have encountered with inventorying, formulate an integrated weed management (IWM) plan, and make treatment recommendations for specific weeds based on your land use goals.

Draw a simple map of your property, indicating where weeds and other vegetation occurs.



Bare ground may occur on healthy land, however bare ground caused by disturbance opens the land up for invasion of weeds.

Basic plant life cycles:

- **Annual:** completes lifecycle in 1 year (grows from seed, flowers, produces seed, and dies).
- **Biennial:** completes lifecycle in 2 years (grows from seed and remains vegetative the first year, produces seed the second year, and dies).
- **Perennial:** lives for more than 2 years, usually flowers and produces seeds every year

RIGHTS-OF-WAY and ROADSIDE INFORMATION

In Montana, weed control along public roads and rights-of-way is the responsibility of the agency tasked with maintaining those roads. Private landowners may enter into an agreement with those agencies that allows them to manage weeds along rights-of-way that border or bisect their property, which may be of interest to you if you do not want herbicides sprayed adjacent to your fields, flowers, or gardens. Such an agreement must be approved by the local county weed board and the Montana Department of Transportation if the right-of-way is maintained by the state. Failure to adequately control weeds through such an agreement will result in notice by the weed board, reversion of weed control responsibility to the agency in charge, and possibly further misdemeanor charges.



Integrated Weed Management (IWM)

Controlling weeds can seem like an impossible chore, but with the right mindset and tools you can attain land use goals by implementing integrated weed management (IWM).

Prevention

The old phrase, “An ounce of prevention is worth a pound of cure” is especially true when dealing with weeds. If you prevent new weeds from being introduced to your property, you are saving yourself both time and money in the long run. It is a good idea to survey and inventory what is growing on your property to find weeds early, as it is easier to control small infestations rather than larger, more established populations. Weeds spread to new areas in a variety of ways; some have specialized barbs, hooks or appendages on their seeds which make them attach easily to animals, people and vehicles. Always remember to wash vehicles and equipment after driving or working in weed-infested areas. Reduce human-caused opportunities for weeds to spread by being educated about exotic plants that have invasive characteristics such as the ability to sprout from cuttings, roots and “dormant” seeds, and the adaptation to emerge rapidly after fire

or soil disturbance. These characteristics give weeds a competitive advantage over native plants when people disturb the land and native plant communities. Some of Montana’s weeds got their start as ornamental plants so it is important to choose native species for landscaping (or at least avoid species that show invasive characteristics), don’t overgraze or disturb plant communities, use weed-seed-free products (forage, straw, seed, gravel and other fill materials), and always be aware of what is growing on your property. If you know what you have and what you do not want, then you can work toward your land use goals.

Mechanical (Mowing and Hand-Pulling)

Mowing and hand-pulling are two techniques that stress weeds and give healthy communities a chance to out-compete weeds for essential resources such as water and nutrients. These methods also reduce weeds by eliminating, or at least reducing, seed production.

Mowing removes plant parts that occur above ground, which is where plants produce food (i.e. sugars) that are stored in the roots. Hand-pulling removes plant parts above ground and if done correctly, also belowground parts of the plant (i.e. roots). Removing leaves and/or roots interrupts food production and weakens the weed.

Oxeye daisy (top), often mistaken for a wildflower, is actually a state listed noxious weed in Montana. St. Johnswort, (below), was intentionally introduced into North America for its use in medicinal folk remedies.

Photos by Shantell Martin, MNWEC



Mowing can be an effective control method if used consistently with other tools. Dispose of seeds found in a trash receptacle. Always make sure to bag any weeds pulled to eliminate further seed spread. To avoid bringing new noxious weeds home, always clean your gear to remove weed seeds after recreating.



Most deep-rooted perennial weeds cannot be controlled by mowing or hand-pulling. Therefore, it is important to know how your target weed will respond to these techniques. Weeds are highly competitive, and one treatment will not usually kill them. Although, when combined with other weed management tools and promoting healthy plant communities through good land use practices, desirable plants can replace weeds over time.

MOWING

Depending on the target weed, mowing can be effective if used consistently and with other tools. Mowing frequency is determined by the general climate and growing seasons in your area and can take place in spring, summer and fall. You may have to adjust for annual changes such as an early spring, a wet summer, or drought; each year will be different.

The best time to mow weeds that reproduce by seed only is just before the weeds start to flower. Each weed flowers at a different time, usually in late spring or early summer depending on your local growing season. Mowing before weeds flower reduces seed production. If you mow too early and repeatedly, though, some like spotted knapweed grow low to the ground but still flower and produce seeds. For weeds that reproduce both by seed and vegetatively through rhizomatous roots like Canada thistle, mowing should be done frequently to stress the roots throughout the growing season. Consult your county Extension agent or weed coordinator if you are not sure of the best time to mow.

After revegetation, mowing in the first year removes fast-growing annual weeds before they flower and produce seed. Set mowing height above height of seeded species, if possible.

Before spraying herbicides in the fall, mowing removes dead stems and leaves to allow for better herbicide contact with the remaining weeds. To be most effective, there needs to be some fall regrowth or green material left on the plant.

If you are not grazing animals, mow grass stands approximately every three years,

Mowing and hand-pulling:

- should be strategically timed to stop seed production and remove seed sources,
- must be combined with good land use practices,
- may be used in conjunction with other weed control methods, and
- are excellent alternatives for sensitive areas, such as near water (wellheads or streams) or sensitive plants where herbicide application is not advised.



wherever possible, to stimulate healthy plant growth. Excessive mowing can weaken native bunchgrasses, so do not mow too often.

HAND-PULLING

Ideally, hand-pulling removes both aboveground and belowground portions of the plant and the roots. Hand-pulling works well for weeds with taproots, such as knapweed and houndstongue. Other weeds, such as leafy spurge and Canada thistle, have spreading underground roots (rhizomes). These can re-sprout and quickly recover from hand-pulling. In such cases, hand-pulling should be combined with other control methods. However, there are exceptions to this and it's best to check with your local Extension agent or county weed coordinator to make sure that hand-pulling will be an effective method of control for the weeds on your property.



WHERE TO PULL

Pulling is most effective for small patches of weeds (less than 1 acre), to prevent new infestations, and as a follow-up to other treatments.

Pulling is effective on land not suited to herbicide applications such as around wellheads, streams, and sensitive plants.

TIMING

The best time to pull is when the ground is moist in the spring or after rain or irrigation.

Pulling should be repeated a minimum of every 10 to 20 days throughout the growing season (usually May through October).

HOW TO PULL

Grasp the plant firmly near the base. Pull the weed from the ground, trying to disturb as little soil as possible. You may need to use a shovel or other tool to pry out tap-rooted weeds.

Weeds that are flowering should be pulled and placed in a plastic bag to reduce the spread of seeds. Dispose of them in a trash container or incinerate.



Chemical (Herbicides)

Herbicides are an effective management tool for weeds when used properly. An effective long-term strategy incorporates other IWM tools in addition to herbicides, e.g. hand-pulling small patches in addition to spraying larger patches. Once you have identified herbicides as a component of your overall weed management program, you need to consider the following:

- herbicide selection,
- where and when to apply,
- sprayer calibration,
- mixing and handling,
- clean-up, disposal, and storage of herbicides.

Herbicides are designed to be toxic to plants. When handled correctly, there is little toxicity risk to humans and animals. The label provides information about how to use the herbicide effectively and safely. The label is a legal document. It is YOUR responsibility to use an herbicide correctly, so you must always **READ THE LABEL!**

The presence of grazing animals will influence the type of herbicide you select. **READ THE LABEL!**

Herbicide labels can be difficult to read. If you have trouble understanding a label or selecting the correct herbicide, contact your local Extension office, county weed coordinator, Montana Department of Agriculture, or the product manufacturer.

HERBICIDE SELECTION

Choosing the correct herbicide to control weeds on your property while protecting desirable plants and the environment is very important. Remember, most herbicides control only specific weeds, so you must first know what is growing on your property.



Once you know what is growing on your property, you can select the appropriate herbicide for treatment.

There are two general categories of herbicides; non-selective and selective. Non-selective herbicides are toxic to ALL plants that come in contact with the herbicide. A commonly used non-selective herbicide is glyphosate (Roundup®).

Selective herbicides are those that kill either grasses or broad-leaved plants. Most of the weeds on the Montana noxious weed list are broad-leaved plants. Selective herbicides will control certain broad-leaved plants and typically not harm desirable grasses when applied at recommended rates. Remember, though, that even herbicides specific for broad-leaved plants can cause injury to desirable grasses if not applied according to label directions. And, broad-leaved herbicides can injure desired broad-leaved plants in addition to weeds.

The herbicide label contains important information such as active ingredients, where herbicide can be applied, and weeds that the herbicide will control. The label is a legal document that you are required to follow. For advice on herbicide selection, please contact your local county Extension agent or weed district coordinator for assistance. To find contact information for your county Extension agent or weed coordinator, visit: www.mtweed.org.



For more information about selecting herbicides, visit:

Weed Control in Natural Areas in the Western United States. <http://techlinenews.com/articles/ucdaviscontrolhandbook>

WHERE AND WHEN TO APPLY HERBICIDES

It is important to protect yourself and the environment when applying herbicides. The environmental conditions and location where weeds are growing on your property will influence the type of herbicide you use and will help to determine if herbicides are an appropriate tool. Some herbicides cannot be applied next to streams or rivers where the groundwater is near the soil surface, or on certain sites such as cropland, lawns (turf), or rangeland.

READ AND FOLLOW THE LABEL to be sure to apply the herbicide only in approved areas.



NEVER mix or spray herbicides near water bodies, wellheads, food, animal feed or high traffic areas.



NEVER place the end of your garden hose into the spray solution while filling the sprayer.



NEVER clean nozzles with a metal object. Instead, use a soft-bristled brush.

Photos provided by MT DNRC.

The presence of grazing animals will also influence which herbicide you select. The label will tell you if grazing is restricted during or following herbicide application. Remember that some herbicides can pass through an animal after it eats treated forage. These herbicide residues may be present in the manure of the animal, and if the manure is used to fertilize plants in gardens or flower beds, damage may occur. Herbicide residues may also be present on desirable plants (such as grass) that has been sprayed. Do not add clippings from sprayed plants to compost. Injury to desirable plants can also occur if herbicide spray or vapor drifts during the application. Apply herbicides when winds are less than six miles per hour (e.g. when a light flag is weakly extended).

Temperature, moisture, and humidity influence herbicide effectiveness. In general, the best temperatures to apply herbicides are between 65° and 85°F. Hot, dry conditions can increase the thickness of the plant leaf surface and slow plant metabolism, making plants less susceptible to herbicides. High temperatures can also cause herbicides to volatilize, thus reducing effectiveness and increasing the risk of drift to non-target areas. Rain following application of herbicides can affect how well the herbicide will control the weed. If rain is in the short-term

forecast, check the herbicide label for the “rain fast” period, which is the required length of time between application and rainfall.

For the best control, apply herbicides when the weed is at the proper growth stage. Most weeds in Montana can be controlled in mid- to late-spring or early summer before the weeds flower and again in the fall. Plants are most sensitive to herbicide applications when they are actively growing.

MIXING AND HANDLING HERBICIDES

Be sure weather and plant growing conditions are suitable for spraying before mixing so spray solution can be used immediately.

- Mix away from water bodies, wellheads, food, animal feed, and high traffic areas; preferably on an impervious surface (place sprayer in large tub or bin to contain spills). Follow all label directions for mixing and applying herbicides.
- Do not place the end of the garden hose into the spray solution while filling your sprayer. Hold the hose clear of the tank to prevent herbicide from siphoning back into the hose.
- Mix only the amount of herbicide you need. It is better to mix one gallon of spray solution, apply that amount, and mix more if necessary.



- Do not mix an herbicide with another herbicide or chemical unless the combination is listed on the label.
- For most liquid herbicides, fill sprayer with half the water you need, add the proper amount of herbicide and other additives (surfactants or dye), then add the remaining water.
- For most dry herbicides, mix dry material in a smaller container with water and vigorously shake the container until the herbicide is dissolved, then pour this solution into your spray tank as described above for liquid herbicides.
- Rinse your measuring container (spoon or cup) in clean water and add this solution to the tank mixture.

If a spill occurs, follow label directions for containment and cleaning.

For more information about how to calculate dry herbicide formulations, visit:

- techlinenews.com/articles/2013/1/25/herbicide-sprayer-calibration-guidelines

For more information about calibration visit:

- *Weed Calibration: Importance of Calibration*
www.youtube.com/watch?v=9PtFu7vN1eg

Amount of herbicide to add to sprayer, based on recommended herbicide rate (from label) and volume of water dispensed by sprayer (from calibration steps, page 15)

Volume Sprayed GPA	Recommended Herbicide Rate/Acre				
	5 fl oz/acre	7 fl oz/acre	1 pint/acre	1 quart/acre	2 quarts/acre
20	7.5 cc/gal	10.5 cc/gal	5 tsp/gal	10 tsp/gal	3¼ fl oz/gal
30	5 cc/gal	7.0 cc/gal	3 tsp/gal	6 tsp/gal	2 fl oz/gal
40	3.8 cc/gal	5.3 cc/gal	2½ tsp/gal	4¾ tsp/gal	1⅔ fl oz/gal
50	3.0 cc/gal	4.2 cc/gal	2 tsp/gal	3¾ tsp/gal	1¼ fl oz/gal
60	2.5 cc/gal	3.5 cc/gal	1⅔ tsp/gal	3¼ tsp/gal	6⅓ tsp/gal
70	2.1 cc/gal	3.0 cc/gal	1⅓ tsp/gal	2¾ tsp/gal	5½ tsp/gal
80	1.9 cc/gal	2.6 cc/gal	1¼ tsp/gal	2⅓ tsp/gal	4¾ tsp/gal
90	1.7 cc/gal	2.3 cc/gal	1 tsp/gal	2 tsp/gal	4¼ tsp/gal
100	1.5 cc/gal	2.1 cc/gal	1 tsp/gal	2 tsp/gal	3¾ tsp/gal

LIQUID CONVERSIONS: tsp = teaspoons; TBS = tablespoons; fl oz = fluid ounces;
 1 cc = 1 ml; 3 teaspoons = 1 tablespoon; 8 fluid ounces = 1 cup; 2 tablespoon = 1 fluid ounce; 1 cup = 16 tablespoons

- *Equipment and Pre-Calibration:*
www.youtube.com/watch?v=LJw_LtJJ6CA
- *Understanding Calibration*
www.youtube.com/watch?v=DsOH1BihwWM
- *Calibrating a Backpack Sprayer & Hand Line*
www.youtube.com/watch?v=ya89f627R14
- *Using the Strip Method*
www.youtube.com/watch?v=BRsvbBwa_M
- *ATV boom sprayer calibration*
www.youtube.com/watch?v=fW6g0uq8byo



Personal Protective Equipment (PPE) consists of rubber gloves, long-sleeve shirt, long pants, boots, and eye protection.

SPRAYER CALIBRATION

Calibrating your sprayer before you mix and apply herbicides is very important. A properly calibrated sprayer will ensure the herbicide is being applied at the correct rate, thereby saving you money, protecting the environment, and resulting in the most effective weed control. This section explains how to calibrate a backpack sprayer. If you want to calibrate other types of spray equipment such as broadcast, ATV-mounted, or boom-type sprayers, contact your local Extension agent or county weed coordinator.

The following method of calibrating a backpack sprayer involves very little math or formulas. It is based on the principle that 1 gallon equals 128 ounces and the area you will spray for calibration is $\frac{1}{128}$ of an acre. Thus, ounces collected equals gallons per acre. Calibrate your sprayer using clean water only. (DO NOT add herbicide.)

Step 1: Examine your sprayer carefully, checking for and repairing any leaks or cracks; clean or replace nozzles, as necessary. Clean nozzles with a soft-bristled brush such as a toothbrush, never with a metal object.

Step 2: Measure an area 18.5 by 18.5 foot ($\frac{1}{128}$ acre). This should be done on terrain similar to where you will be spraying.

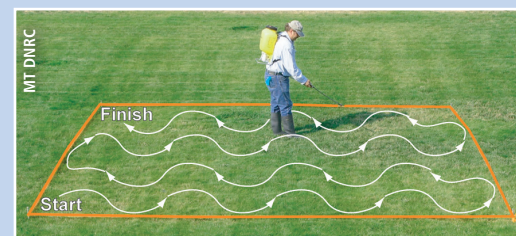
Step 3: Time and record how long it takes you to spray the measured area uniformly with water using a gentle side-to-side sweeping motion with the spray wand. Maintain a constant sprayer pressure during application. REPEAT THIS STEP AT LEAST TWO TIMES AND CALCULATE THE AVERAGE TIME.

Step 4: Spray water into a container for the same amount of time it took you to spray the measured area in Step 3. Again, maintain constant sprayer pressure while you spray into the container.

Step 5: Measure the number of ounces of water in the container. The number of ounces collected in the container equals the number of gallons of water/acre the sprayer is delivering.

Step 6: Use the table on page 14 to determine how much liquid herbicide to add to EACH gallon of water. Find your spray volume in gallons per acre (GPA – calculated in Step 5) and read across the chart to determine the amount of herbicide to add to each gallon of water based on the recommended herbicide application rate.

EXAMPLE: You calibrate your sprayer and the output is 30 GPA (see Step 5). The herbicide label recommends an application rate of 1 pint/acre for the target weed. Go to the table on page 14 and read across from 30 GPA – the amount of herbicide to add to each gallon of water is 3 teaspoons. If your backpack sprayer holds 3 gallons, you would add 9 teaspoons of herbicide. Proper calibration is vital to the success of your management goals and you need to make sure that you are not applying too much or too little herbicide. If you are unsure about how to calibrate your sprayer, seek help from the local Extension agent or county weed coordinator. To find contact information for your local Extension agent or weed coordinator visit: www.mtweed.org



TOP RIGHT: You can add agricultural dyes to your spray solution. The dye will color the spray so you can see treated areas.

BOTTOM RIGHT: Some herbicides act very quickly on a plant, while others take more time; in some cases, it may take two to four weeks before you see any changes in plant vigor.

Once you have calibrated your sprayer, you are ready to mix your herbicide solution. Always **READ AND FOLLOW THE LABEL** to determine what personal protective equipment (PPE) should be worn, how much herbicide to prepare, and the mixing procedure. Remember that when you are preparing an herbicide solution, you are working with the herbicide in its most concentrated form. Some herbicides require the addition of a surfactant for the herbicide to control the target weed. A surfactant allows the herbicide solution to more easily penetrate the leaf surface of plants. If a surfactant is recommended, add one tablespoon of surfactant to each gallon of spray solution. Surfactants can be purchased at the same location as herbicides.



The following basic precautions should be followed when mixing an herbicide:

DOs

- Wear label-recommended personal protective equipment (PPE), e.g. rubber gloves, long pants and long-sleeved shirt
- Wear eye protection
- Wash hands before touching food, drink, or skin
- Wash your clothing and yourself thoroughly within two minutes if a spill or splash occurs

DON'Ts

- Wear shorts, tank tops, open-toed shoes
- Pour herbicides at eye level
- Smoke, drink, eat, or go to the bathroom without washing hands first

For more information about mixing visit:

- Adding Pesticide to Your Tank
www.youtube.com/watch?v=e13L9Y4BNi8

APPLYING THE HERBICIDE

Before applying herbicides be sure to calibrate your sprayer so that you add the correct amount of herbicide to your spray tank. Once your spray is mixed and ready to apply, follow these basic guidelines for best results:



- Carefully examine the area you are spraying so that you do not inadvertently spray desirable plants or contaminate water.
- Mix away from water bodies, wellheads, food, animal feed, and high traffic areas.
- Do not apply herbicides near water, such as streams or shallow groundwater areas, unless approved on the label.
- Do not apply under sensitive shrub or tree species or allow herbicide to drift onto desirable plants (some herbicides can be safely applied under trees and shrubs; **READ THE LABEL**).

If you chose not to apply herbicides yourself, professional commercial applicators are available. Contact your local Extension agent or county weed coordinator for a list of applicators in your area.



- Apply during appropriate environmental conditions (calm winds, no rain, mild temperatures, moderate humidity).

If you choose not to apply herbicides yourself, professional commercial applicators are available. Contact your local Extension agent or county weed coordinator for a list of herbicide applicators. When hiring a commercial applicator, ask for and review his/her current insurance, license, and references. If the applicator is not licensed and insured, do not hire him/her.

EXPECTED OUTCOMES AFTER APPLICATION

Mid-summer herbicide applications may not affect the stature or appearance of the weed because the plant is under summer dormancy and not actively growing. If you spray during mid-summer, you can still control some weeds, but control may be reduced depending on the weed and herbicide used. Herbicides are usually effective when applied to weeds in the fall if you have adequate moisture and some green growth near the base of

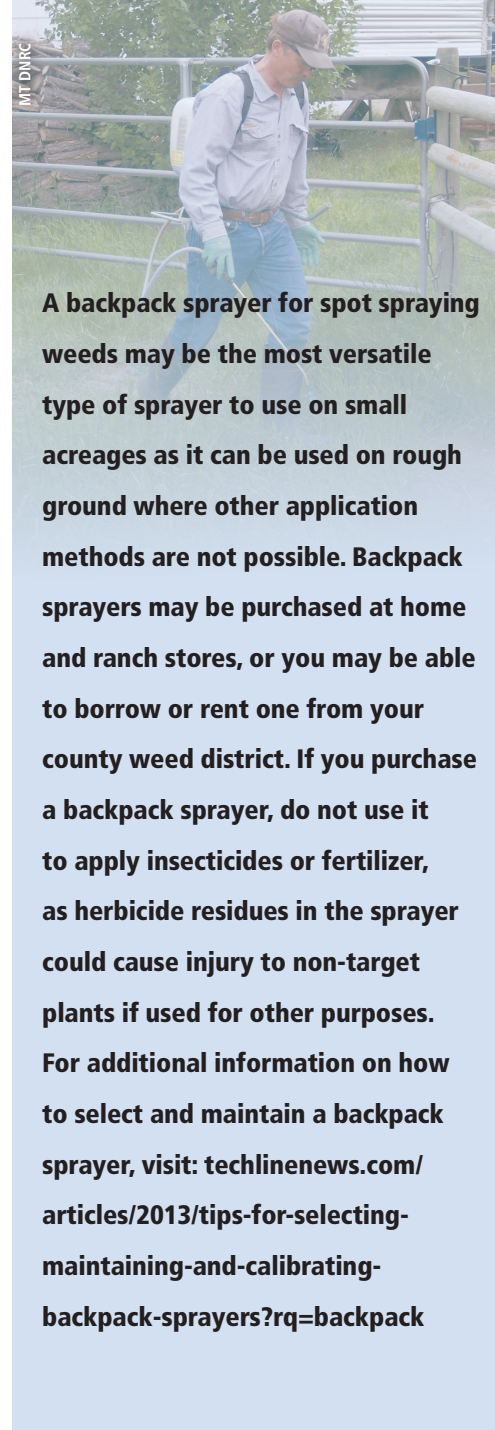
the plant. Some herbicides act very quickly on the plant, while others take more time; in some cases, it may take two to four weeks before you see any change in plant vigor. Usually weeds will curl and twist, and start to turn reddish-brown and/or become yellow at the growing points.

CLEAN-UP AND DISPOSAL

After spraying, clean equipment and clothing to remove herbicide residues.

- Add clean rinse water to your sprayer and spray it on your application site.
- Triple-rinse empty herbicide containers at the mixing site and puncture the container before disposal.
- Do not rinse equipment or empty herbicide containers near a wellhead or other sensitive areas.
- Wash clothing you wore while spraying separately from other clothing with heavy-duty liquid detergent and hot water. Do not use bleach. Line dry clothing where it will be exposed to sunlight, if possible. Shower using soap and warm water and wash your hair.

Herbicide choice, calibration and application can be quite daunting. For assistance contact your local Extension agent or county weed coordinator. To find contact information, visit: www.mtweed.org.



A backpack sprayer for spot spraying weeds may be the most versatile type of sprayer to use on small acreages as it can be used on rough ground where other application methods are not possible. Backpack sprayers may be purchased at home and ranch stores, or you may be able to borrow or rent one from your county weed district. If you purchase a backpack sprayer, do not use it to apply insecticides or fertilizer, as herbicide residues in the sprayer could cause injury to non-target plants if used for other purposes. For additional information on how to select and maintain a backpack sprayer, visit: techlinenews.com/articles/2013/tips-for-selecting-maintaining-and-calibrating-backpack-sprayers?rq=backpack



Always store herbicides in their original containers. Place original containers inside a larger impervious container that will contain spills or leaks that may accidentally occur.

STORING HERBICIDES

Herbicides must be stored in their original containers (NO FOOD OR BEVERAGE CONTAINERS). Place herbicide containers inside a slightly larger impervious container that will contain any spills or leaks that may accidentally occur. Store herbicides where they will not freeze in winter, away from other activities, food, seed, and out of the reach of children. If possible, a locked storage area is ideal.

For questions on how to safely and properly store herbicides, please contact your local Extension agent or weed coordinator. To find contact information, visit: www.mtweed.org.

Important telephone numbers for questions or problems:

EMERGENCY

For aid in human poisoning cases:

- Rocky Mountain Poison and Drug Center (800) 525-5042 (Montana only)

For help involving spills, leaks, and fires:

- Pesticide Accident Hotline (chemtrec) (800) 424-9300

NON-EMERGENCY

For medical and consumer information:

- Montana Department of Agriculture (406) 444-5400
- National Pesticide Telecommunications Network (800) 858-7378

Biological Control (Classical & Grazing)

Biological weed control (biocontrol) involves the use of a living organism to reduce a weed infestation and attempts to recreate a balance between plant species and their natural enemies. Noxious weeds in Montana are not native to North America and were typically introduced without their natural enemies. This is one reason weeds can gain a competitive advantage in their new environment. When talking about biological control, there are essentially two forms of biocontrol; "classical" biocontrol uses plant-feeding insects such as beetles, flies, and moths, but mites and pathogens are also utilized; the other form is targeted grazing by livestock such as cattle, sheep and goats. Classical biocontrol and targeted grazing can be used together and may yield very successful responses in plant communities where weed infestations occur.

CLASSICAL

Classical biocontrol agents can attack a weed's flowers, seeds, roots, foliage, and/or stems. Effective biological control agents rarely kill weeds outright. Regardless of the plant part attacked, the goal is to reduce infestation size and health of the target weed.

TOP RIGHT: "Classical" biological control uses plant-feeding insects such as beetles, flies, and moths to reduce a weed infestation. Pictured are *Cyphocleonus achates* that feed on the roots of spotted knapweed.

MIDDLE: Biological control agents can attack a weed's flowers, seeds, roots, foliage, and/or stems. Pictured are leafy spurge flea beetles that have weakened a leafy spurge plant.

BOTTOM: Goats, sheep and cattle can be used to effectively graze populations of noxious weeds. You must know what types of plants you have growing so that you can graze the right animal as some plants are toxic to livestock.

Biocontrol can be an effective and important weed management tool, but it does not work in all cases and should not be expected to eradicate the target weed when used alone. Biocontrol is best suited for large, well-established and/or difficult to reach weed infestations. It is not an appropriate tool for small infestations or newly invading species that can be quickly eradicated through other techniques such as herbicide application and/or hand-pulling. Even in the most successful cases, biocontrol often requires multiple years before impacts become noticeable. It may not be appropriate for all landowners or every type of land, but when utilized in conjunction with other management tools, biocontrol can decrease the abundance of invasive plants over time.

OBTAINING BIOCONTROL AGENTS

Availability of biocontrol agents varies from species to species in Montana. To obtain insects, start by contacting the local Extension agent,

county weed coordinator, or state biocontrol coordinator. There are school groups and commercial distributors that distribute insects for a fee, as well as occasional collection days that you can attend where you can obtain insects free of charge. For a list of biocontrol vendors in Montana visit mtbiocontrol.org/resources/. Regardless of how you obtain insects, you will want to receive them soon after they emerge as adults and before the females lay their eggs for the season.

RELEASING BIOCONTROL AGENTS

Biocontrol agents should be released on sites where the weed infestation is large enough (around five to ten acres) to sustain a population of the insect. Beyond this guideline, each species has specific releasing recommendations. Details can be found at mtbiocontrol.org. In general, you should release the insects soon after receiving them and follow the specific instructions you were given for that species.

Before they are approved for release in the United States, biocontrol agents must be host-specific and demonstrate effectiveness in impacting the target weed during testing and development. Biocontrol agents undergo five or more years of testing to ensure they are host specific, feed and develop on the target weed, never feed on crop or protected plant species, rarely attack ornamental plants, and have a reasonable level of impact on the weed.



Sheep and goats can be an effective tool in targeted grazing. Sheep and goats are not susceptible to many of the toxins contained in noxious weeds and are very good at reducing large populations.



How biological control agents are collected depends upon the type of biological control agent. For Dalmatian toadflax, top right, tubs are used to gently tap the insects into so they can be counted and put in containers for shipment.

Leafy spurge flea beetles jump very quickly, so sweeping with a net is used to collect them, top left.

Biological control agents need to be released as soon as possible after receiving them, bottom right. Be sure to follow the specific instructions you were given for that species.

All photos by Missoula County Weed District.

BIOCONTROL AS PART OF AN INTEGRATED WEED MANAGEMENT STRATEGY

Biological weed control is best suited for long-term weed management and is an important component of an IWM strategy. How you integrate different weed management tools will vary from species to species. It is almost always a good idea to use an herbicide on the perimeter of the infestation to reduce spread while using biocontrol agents within the center of the infestation. Good results have also been observed when using grazing livestock in combination with biocontrol for some species such as leafy spurge.

TARGETED GRAZING

Targeted grazing is the practice of using livestock to graze (eat) during a certain season for a set length of time and intensity to achieve goals for improving plant communities and the landscape. When utilizing grazing as a weed management option, targeted grazing should be applied with a set goal of reducing weeds as opposed to simply using good grazing management as part of proper land use practices. The difference between the two is that targeted grazing shifts the focus of livestock production to using livestock to enhance plant communities, which in turn may reduce weed infestations and benefit the landscape.



Determining the type of livestock to use depends upon the type of plant you are trying to control. Cattle can be effective at managing invasive weeds such as Canada thistle and cheatgrass, whereas sheep and goats are the better option to graze more broad-leaved weeds like leafy spurge and spotted knapweed. Sheep and goats are more likely than cattle to eat broad-leaved plants and are not as affected by toxins found in some noxious weeds (e.g. leafy spurge, St. Johnswort). Targeted grazing by sheep and goats has proven quite successful and works best when used in concert with other management options including burning, mechanical, hand-pulling, herbicide application and/or re-vegetation. An effective strategy has been to provide heavy grazing early to weaken the roots

of the target plant, allow regrowth and then use herbicide after regrowth has occurred. The use of targeted grazing is also recommended to increase the efficiency of classical biological control agents (insects) when timed correctly. For targeted grazing to be successful, weeds must be grazed when the plants are most susceptible to damage and taste the best. Typically, timing grazing to coincide with when a plant is “bolting” or producing flowering stalks is best. The number of days and years needed to administer a targeted grazing program depends largely on what weed is being managed and how many grazing animals are being utilized. Targeted grazing is not a one-time treatment. It requires many years of follow-up treatments adjusting timing, intensity and duration to fit the response of the surrounding plant community while continuing to target any undesirable plants. In general, a minimum of three years is required to notice a difference in the plant community. For more information about how to

establish a targeted grazing program, contact your local Extension office. To find contact information for a local Extension agent or county weed coordinator or visit: www.mtweed.org.

Cultural

Cultural control focuses on shifting the balance between weeds and other more desirable plants. The primary goal of cultural control is to maintain competitive plant communities so that weeds do not have an opportunity to successfully invade. Cultural controls can be very effective when used as a component of an IWM plan. Examples of cultural controls include: proper livestock grazing, revegetation, fertilization, irrigation and prescribed fire.

GRAZING

If you are not interested in establishing a targeted grazing program for your property, good grazing practices can be used to reduce current infestations of invasive weeds as well

Targeted grazing should:

1. Cause significant damage to the target plant.
2. Limit damage to the surrounding vegetation.
3. Be integrated with other control methods as part of an overall landscape management strategy.



Targeted grazing on leafy spurge. The right side of the fenceline was not grazed, whereas the left side was grazed by sheep.

as preventing any new ones from taking up residence. Montana’s native range plants and non-native plants seeded for forage have evolved with use from wildlife and domestic livestock. These plants are generally healthier when properly grazed. However, “overgrazing” or letting your animals eat every single plant in the pasture down to the ground weakens the plant community and reduces its ability to ward off new invaders. When plant communities are overgrazed, they often have patches of bare ground that are susceptible for establishment of new invasive plants.

To avoid overgrazing there are several things you can do. Divide your property into smaller sub-pastures, so that resting pastures have time to recover. Sub-pastures enable you to control how long and where animals are grazing.

TOP: Overgrazing weakens the plant community and leaves the ground susceptible to invasion by new weeds.

MIDDLE: Avoid overgrazing by dividing your pasture into smaller sub-pastures, so that resting pastures have time to recover.

BOTTOM: Prevent the introduction of any new invasive weeds onto your property by purchasing and feeding Noxious Weed Seed Free Forage products.



Sub-pastures also allow you to control where animals are watering as water troughs are often bare, trodden ground that is open for invading weeds. It is important to note that your property can only sustain a certain number of animals.

Managing your land within its correct stocking rate (number of animals your property can reasonably support) will help to keep your plant communities healthy and reduce weeds. The number of animals that your property can support will be determined by several factors including if it is irrigated, how much precipitation you receive and your growing season. For example, it is unrealistic to expect 10 acres of dry land in eastern Montana to sustain 10 head of horses all year round without supplemental feed. More often than not, supplemental hay is necessary for feeding animals on small acreages. To prevent the introduction of any new invasive weeds, select and feed only certified noxious weed seed free forage. Any forage product that is labeled "certified" has been inspected in the field before its harvest to ensure that there were not any noxious weeds present and/or producing seed. For more information on locations to purchase weed-free forage, contact your local Extension agent, county weed coordinator, or the Montana Department of Agriculture at (406) 444-7819, or go to: www.agr.mt.gov/Noxious-Weed-Seed-Free-Forage.

REVEGETATION

Once weeds are controlled by various means including herbicides, grazing, mowing, biocontrol or other IWM methods, open spaces are created within that plant community. Without competition from weeds, desirable plants often grow back. However, in areas that have been dominated by weeds for some time, desirable plants may be rare or even completely absent from the existing plant community and seed bank. If weeds are controlled but desirable grasses and wildflowers are not present to occupy open spaces, weeds are likely to re-establish, hence the need to revegetate. Revegetation is the process of re-establishing desirable vegetation and is the intentional seeding of plants after disturbance. Your land use goals will determine what plants you consider "desirable." One option is to plant or seed native grasses and wildflowers.



Any type of ground disturbance, including new construction, should be revegetated as soon as possible.



Selecting a seed mix can be difficult. Be sure to contact your local NRCS or Extension office for assistance in selecting plants that will thrive in your area.

Any type of ground disturbance, including new construction, water/sewer/power installation, road construction, logging or new housing construction should be revegetated as soon as possible. Bare soil creates an opening in which weeds may become established unless seeds of desired species are planted. It may also be beneficial to revegetate if you have tried controlling weeds on your property for one or two growing seasons and desirable plants have not rebounded.

Revegetation can be costly and takes a lot of patience. Success depends on many environmental factors. If revegetation is necessary, follow these six steps:

1. Evaluate the site: consider current land use practices, soil type, and precipitation; determine what plants will grow best given environmental conditions and land use goals.

TOP RIGHT: Slender wheatgrass (*Elymus trachycaulus*) is a native grass that would work well for revegetation.

BOTTOM RIGHT: Green needlegrass (*Nassella viridula*) is often suggested for revegetation seed mixes.

2. Eliminate weeds: Address weed infestations prior to seeding; as you remove weeds, desirable plants may recover on their own because more sunlight, water, and nutrients are available. If not, eliminating weeds prior to seeding will reduce competition between your seeded species and weeds attempting to re-invade. To reduce weed seeds in the seedbank and thus competition with seeded species, consider controlling weeds for several years prior to revegetation. Some herbicides have a waiting period between application and seeding desirable plants. Read the label to identify possible plant-back restrictions.

3. Choose plants/seeds: Choose plants and seed mixes that will meet your land use objectives and are well suited to the conditions of your site. Consider average annual precipitation, growing season, sun exposure, and soil types. No matter what species you choose to plant, be sure to select viable seed that is weed free. One of the best ways to determine this is to look at the seed label. Federal and state laws mandate that seed must have a complete analysis label or tag. Key information to look for on the seed label include: Origin, lot number, certification number, germination (high percentage), dormant/hard seed, total viability, test date, weed seed, and restricted weed seed (i.e. weed



seed). Understand that no seed can be totally pure, but it should be certified weed seed free.

4. Prepare the site: Prepare the ground so that seeds will be planted in the best possible conditions. Roughen the soil surface so that seeds will be in good contact with the soil.

5. Apply the seed: Seed can be broadcast by hand or with a broadcast seeder, or seed can be drilled with a seed drill. The basic rule of thumb for seeding grasses is to seed at 12.5 pounds per acre. However, if you are broadcast seeding or seeding where weeds are



1. Prairie clover (*Dalea purpurea*), 2. Rocky Mountain Bee Plant (*Cleome serrulata*), and 3. Maximilian sunflower (*Helianthus maximiliana*) (photos by Matt Lavin, FLICKR) are native wildflowers that would be beneficial for pollinators if added to revegetation seed mixes, below.



plentiful, seed at 20 pounds per acre. Broad-leaved plants and shrubs will be seeded at a lower rate because they typically have much smaller seeds. The best time to seed is fall (e.g. October) or spring (April). Do not seed later than early May unless irrigation is available.

6. Manage and monitor: Treat your plants as an investment. Irrigate lightly for the first 7 to 14 days after seeding, if possible; place weed free mulch over seedings where possible; implement good land use practices; continue to control weeds; don't graze for at least one year after revegetating to allow seeded species to establish.

7. Be patient: Seeded species may take several years to establish.

FERTILIZATION

Fertilization is not recommended as a stand-alone technique to control weeds, because weeds generally take advantage of extra nutrients (e.g. nitrogen, phosphorous, potassium) more quickly than other vegetation. However, fertilization can help keep desired vegetation healthy and competitive, particularly pasture vegetation that is grazed or mowed for hay. In some cases, fertilization may increase production of desired vegetation after weeds are controlled with another technique, e.g. herbicides or mowing.

IRRIGATION

Many noxious weeds in Montana are the most competitive under dry conditions. If irrigation is available, it can be used to shift the competitive balance toward desired vegetation, especially grasses in pasture settings. Therefore, irrigation is most effective when combined with other control techniques to keep desired vegetation healthy and competitive.

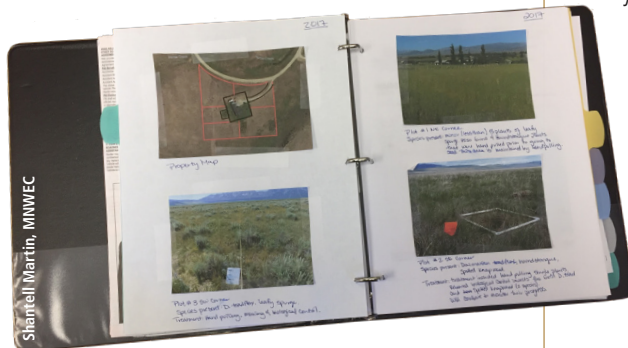
PRESCRIBED FIRE

Similar to fertilization, prescribed fire is typically not recommended as a stand-alone control technique for noxious weeds. In fact, if weeds are present, the nutrients that are released following fire can even benefit weed growth and reproduction. Prescribed fire is most effective when integrated with other techniques. In particular, fire may be used to remove dead stems and leaves to improve herbicide contact with weeds or to increase accessibility to weeds for livestock that are grazing weeds. Carefully timed prescribed fire may be used during or shortly after weeds are flowering to kill developing seeds. Unfortunately, such timing usually corresponds with periods of high fire danger and is therefore not usually recommended.

MONITORING

Monitoring and record keeping is vital to the success of an integrated weed management plan. To determine if your management techniques are successful, you need to keep track of what weed control methods you used, when you used them, and how and where they were applied. For example, you can track:

- what management technique you used,
- what species you planted and where, and
- how much money you spent to control weeds.



Record keeping is vital to the success of an integrated weed management plan.

It is also important to document when something doesn't work so you can adjust your plan accordingly. When you seek help from professionals, having detailed records will make their job easier and more effective. Record keeping may be as simple as writing on a calendar on the shop wall or in a notebook. Maps such as the one you developed during your inventory or photos from established photo points are also very helpful in determining management effectiveness.

Long-term Management

When it comes to weed management, there is no silver bullet and the "one and done" philosophy does not apply. To ensure that your efforts are effectively reducing populations of weeds and that desirable plants are rebounding, you will need to monitor and possibly modify your management plans for long-term success.

Monitoring is an essential component of any successful weed management program. A simple and consistent collection of data can be used to document changes in plant communities that occur over time, allowing you to make knowledgeable decisions on whether to continue or adjust your management.



There are several ways to monitor success of weed management. Two of the easiest are photo points and biological control monitoring protocols, which can be adapted even if biocontrol is not being used. Both are effective and will track changes in plant community trends over time.

Photo Points and Biological Control Monitoring Protocols

Photo point monitoring is an easy and inexpensive way of monitoring changes in the landscape that uses materials you probably already have on hand; your camera and a post or other marker that you can pound into the ground. Photo point monitoring consists of repeat photography of an area of interest over a period of time. Photos are taken from the same location yearly to determine changes over time. To establish a photo point monitoring

Monitoring is an essential component of a successful vegetation management program. Using forms such as the % Cover Vegetation Monitoring Form will allow you to document the vegetation cover of your site annually. This form is available at <http://www.missoulaeduplace.org/images/weeds/mapping/Cover%20Vegetation%20Monitoring%20Form.pdf>.

% Cover Vegetation Monitoring Form

Monitoring is an essential component of a successful vegetation management program. Monitoring data can be used to accurately document the impact of your weed management tools. The monitoring information from this form can be used to document vegetation cover of your site and when conducted annually, the monitoring data will document changes in the cover over time. This allows you to adjust your management to ensure that you are using your time and resources in the best way possible.

General Information:

Name of observer: John Doe Date: 5-14-2017

Site Name: Transect #1 Target Weeds: *Spiraea prunifolia
*Geranium macranthum
*Ranunculus acris

Picture Taken? ☒ Yes ☐ No Permanent Site? ☒ Yes ☐ No

Vegetation Cover (all in %, rows add up to 100%)

Frame	Target Weeds %	Other Weeds %	Forb/ Shrub %	Perennial Grass %	Bare ground %	Litter %	Moss %	Total %
1	50	10	5	10	5	15	5	100
2	60	5	5	10	5	10	5	100
3	70	15	0	10	20	10	0	100
4	10	20	10	10	5	10	0	100
5	40	5	20	20	5	10	0	100
6	50	5	30	5	5	10	100	
7	45	5	20	5	0	15	100	
8	10	25	25	10	0	0	100	
9	20	5	35	20	20	0	100	
10	15	10	20	10	5	0	100	
11	25	30	0	20	10	5	100	
12	20	15	15	15	15	15	100	

A step-by-step guide for completing the SNAP biological control monitoring form:

General Information:

Observer(s) - Who are you?
Date - Today's date.
Site name - Which site are you monitoring? This could have a specific name if it is a permanent site.
Target Weeds - Which target weeds are you are managing for?
Picture Taken? - Did you take a photo point of this site?
Permanent? - Is this a permanent monitoring site?

site, place a piece of rebar, metal fence post, or other marker at the site and/or mark coordinates with a GPS to allow you to return to the site in the future. Document any pertinent information about the monitoring site on the inventory map you drew, including latitude and longitude, directions to the site, and any physical landmarks visible in the background of the photo.

Things you should record when taking photos at selected photo points include:

- Day, year and time of day photos were taken
- If photo points are taken after management has taken place (e.g. herbicide application, mowing, etc.), be sure to note that as well including details on the type of management method and date applied.

- If grazing was used as a management method, make note of the type of animals (horse, cow, goat, sheep) as well as the number of animals and how many days they grazed.

Establishing a monitoring schedule is essential as well. You need to determine when photos will be taken, and this schedule should be followed for consistency and alignment with your land use goals. At a minimum, photos should be taken annually and within a day or two of the same date each year.

Biological control monitoring can be conducted on sites where releases have occurred to determine insect establishment and density.

Sweep nets can be used to collect and count insects and are a useful way to monitor whether insects are surviving on your property. This information will give you a good idea if biocontrol is working for you.

More information on monitoring biocontrol agents, including record-keeping forms, can be accessed at mtbiocontrol.org/resources/.



Create a Photo Point ID Card that contains the following information: Site, Date, Plot, Line# and Direction.



Monitoring is essential to determine if weed control efforts have proven effective.

Photos by Jane Mangold, MSU



Monitoring also helps to determine if changes in management need to be made.



Biological control monitoring can be conducted on sites where releases have occurred to determine insect establishment and density.

Photos provided by the Montana Biological Control Project

CONCLUSION

Patience and persistence will help you achieve your weed management goals. The weed problem on your property did not happen overnight nor will it be solved overnight. At first it may seem a bit overwhelming and frustrating, but by setting long-term goals and establishing an integrated management plan, you will be able to successfully manage weeds.

Success in weed management can be measured by:

- fewer weeds established on your property
- less time and money spent on weed control
- plant communities that are meeting your land use goals

If you have questions, concerns or need assistance at any time during your management process, do not hesitate to reach out to the local Extension agent or county weed coordinator for assistance. To find contact information for your local Extension agent or county weed coordinator, visit: www.mtweed.org.



Lindsey Clark, Stillwater Valley Watershed Council

RESOURCES

MSU EXTENSION AGENT

Montana State University Extension
www.msuextension.org/

COUNTY WEED COORDINATOR

Montana Weed Control Association
www.mtweed.org

WEED IDENTIFICATION

Montana State University, Schutter Diagnostic Lab
diagnostics.montana.edu/

Montana State University Extension
www.msuextension.org/

Montana Weed Control Association
www.mtweed.org

WEED EDUCATION

Montana Noxious Weed Education Campaign
www.weedawareness.org

MSU Extension Invasive Plants
www.msuinvasiveplants.org

MAPPING/INVENTORY

EDDMapS West
www.eddmaps.org/west

Montana Weed Control Association
www.mtweed.org

REVEGETATION

Landowner Vegetation Management Plan
www.missoulaeduplace.org/images/weeds/management/revegetation/Landowner%20Vegetation%20Management%20Form%20-%20example.pdf

A Source Guide to Revegetation and Weed Control Options in Missoula County
www.missoulaeduplace.org/images/weeds/management/revegetation/Source%20Guide%20to%20Reveg%20and%20Weed%20Control%20Options.pdf

Revegetation Guidelines for Western Montana
msuextension.org/publications/AgandNaturalResources/EB0170.pdf

Dryland Pastures in Montana and Wyoming
www.msuextension.org/publications/AgandNaturalResources/EB0019.pdf

Bridger Plant Materials Center (MTPMC)
www.nrcs.usda.gov/wps/portal/nrcs/main/plantmaterials/pmc/west/mtpmc/NRCS

Montana Native Plant Society
www.mtnativeplants.org

INTEGRATED WEED MANAGEMENT (MOWING, HAND-PULLING, CULTURAL)

Montana State University Extension
www.msuextension.org/

Montana Weed Control Association
www.mtweed.org

HERBICIDE (SELECTION, APPLICATION, CALIBRATION, STORAGE, SAFETY)

Montana Department of Agriculture
www.mt.agr.gov

MSU Extension Pesticide Education
<http://www.pesticides.montana.edu>

Montana Weed Control Association
www.mtweed.org

National Pesticide Information Center
<http://npic.orst.edu/pest/weeds.html>

Techline News
techlinenews.com/herbicides?category=Education+Series

techlinenews.com/articles/2013/1/25/herbicide-sprayer-calibration-guidelines

Weed Control in Natural Areas in the Western U.S. <http://techlinenews.com/articles/ucdaviscontrolhandbook>

Ravalli County 4-H members doing a service learning project at St. Mary's Mission. The Ravalli County Weed District partnered with 4-H to do a weed pull. The service project started out with learning the noxious weeds and then removing those weeds from the property.

MONITORING

Montana State University Extension
www.msuextension.org

Montana Biological Control Project
mtbiocontrol.org

GRAZING

USDA, Natural Resources Conservation Service
(Range & Pasture Resources)
<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/rangepasture/>

Launchbaugh, Karen and John Walker.
"Chapter 1: Targeted Grazing-A New Paradigm for Livestock Management." *Targeted Grazing: A Natural Approach to Vegetation Management and Landscape Enhancement*, 2006, (pp. 2-8),
www.webpages.uidaho.edu/rx-grazing/Handbook.htm. 9/21/2017.

Olson, Bret and Karen Launchbaugh. "Chapter 7: Managing Herbaceous Broadleaf Weeds with Targeted Grazing." *Targeted Grazing: A Natural Approach to Vegetation Management and Landscape Enhancement*, 2006, (pp. 57-66),
www.webpages.uidaho.edu/rx-grazing/Handbook.htm. 9/21/2017.



Katelyn Andersen, MSU

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

DRAW YOUR OWN MAP

Use this area to draw your property map of weeds. Reference page 6 for tips in creating this valuable map.



Montana Department of Natural Resources and Conservation

Montana Noxious Weed Education Campaign

U.S. Department of Interior - Bureau of Land Management

U.S. Forest Service

Montana Weed Control Association

Montana Department of Transportation

Montana Department of Agriculture

Montana State University Extension