WEED CONTROL IN RIPARIAN AREAS

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by

David L. Zamora and Edward S. Davis*

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INTRODUCTION

Riparian areas are susceptible to weed invasions because wildlife, livestock, and humans transport weed seeds and create the disturbances these weed seedlings need for establishment. Weeds in riparian areas can adversely affect livestock production, recreational uses, wildlife, and native plant communities. Weeds should be controlled and beneficial vegetation encouraged in riparian areas to prevent erosion, maintain water quality, and to improve wildlife and fish habitat, livestock forage, and recreational uses. By adhering to sound principles of weed management and integrating appropriate management goals and control techniques, weeds can be controlled safely and effectively in riparian areas.

COMMON WEEDS OF RIPARIAN AREAS

Weeds most commonly associated with riparian areas are species introduced from Eurasia having a perennial or biennial growth habit. Each species has special characteristics enabling it to outcompete and displace desirable vegetation and some have specialized seed dispersal mechanisms especially adapted to riparian areas. These characteristics need to be considered when selecting control methods.

Four perennial weed species particularly troublesome in riparian areas are leafy spurge (*Euphorbia esula* L.), spotted knapweed (*Centaurea maculosa* Lam.), Canada thistle [*Cirsium arvense* (L.)Scop.] and purple lythrum (*Lythrum salicaria* L.). All four are classified as noxious weeds in Montana.

Leafy spurge has an extensive root system containing large reserves of nutrients making it extremely difficult to control. Vegetative buds located on the crown and roots of individual plants enable spurge to reproduce and spread vegetatively. Leafy spurge also reproduces by seed which can be propelled up to 15 feet by exploding seed capsules. The seed floats and is transported by flowing water. Once established, patches of leafy spurge displace other more desirable vegetation.

Spotted knapweed is the most widespread noxious weed in Montana. It thrives on disturbed sites such as dry streambeds created by fluctuating water levels or changes in the course of the waterway. Mature plants have a penetrating tap root adapted to gravelly well drained sites. The seeds readily float in water due to a waxy coating and a small pappus that traps air bubbles. Knapweed is an undesirable forage for livestock and wildlife due to a high fiber content and bitter taste. Once established it is extremely competitive and may even be allelopathic (toxic) to other plant species, resulting in a decrease in vegetative diversity.

Canada thistle is a colony forming perennial that has a deep and extensive horizontal root system, containing extensive nutrient reserves, making control difficult. Canada thistle plants also produce copious amounts of seed that have a large pappus which allows for wind dissemination and water transport.

Purple lythrum (*Lythrum salicaria* L.) is an ornamental species that often escapes to aquatic sites such as streambanks or shore lines of shallow ponds. Also called purple loosestrife, this weedy species is a prolific seed producer and has a persistent rhizomatous root system. Mature plants often grow 6 to 8

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*Extension Weed Specialist and assistant professor, Department of Plant and Soil Science, Central Agr. Research Center, Montana State University.

feet tall, and dense infestations can interfere with water flow in ditches, canals and streams. Purple lythrum is extremely competitive and displaces desirable streambank vegetation needed for waterfowl nesting sites.

Three weed species which have a biennial growth habit and are frequently associated with riparian areas are common burdock (*Arctium minus* (Hill) Bernh.), houndstongue (*Cynoglossum officinale* L.) and poison-hemlock (*Conium maculatum* L.). These plants will bolt, flower and produce seed the second year following germination. These species are not native to North America and are particularly troublesome because of their affect on livestock. Houndstongue and poison-hemlock are toxic and have caused death of livestock, and in some cases humans, when plant materials were consumed. Water hemlock [*Cicuta douglasii* (DC)C&R] is closely related to poison-hemlock, has similar distribution, and also is poisonous. The seed coat of houndstongue and the seed head (burr) of common burdock have velcro-like appendages which become entangled in the coat of wildlife and livestock effectively aiding the spread of these weeds.

INTEGRATED WEED MANAGEMENT

Integrated management of weeds utilizes different goals and controls to provide long-term measures to hinder the establishment and spread of weeds. Weed management in riparian areas must be integrated with weed management in adjacent upland areas because weeds in one area can spread to the other. Since riparian areas often encompass more than one land owner and because weed seeds are so easily transported by moving water, livestock, wildlife, and humans, it also is best to conduct cooperative weed management projects.

The goals of weed management include prevention, eradication, containment, and suppression. Prevention minimizes the number of weeds invading riparian areas and prevents them from becoming established, widespread problems. Weed seeds and vegetative parts should be removed from equipment and vehicles and weed-free seed should be used for revegetation to minimize weed invasions. The establishment and spread of weeds also can be prevented by detecting them early through annual surveys. These surveys are especially effective if conducted in areas frequently used by livestock, wildlife, or humans. Eradication is an appropriate management goal for weeds that are not widespread. Weeds are eradicated by stopping reproduction and spread, and depleting viable seeds in an infested area. Weeds are contained by stopping their spread. Weeds are suppressed by reducing their density enough to allow alternate uses of the land. Surveys to appraise the effectiveness of methods to prevent, eradicate, contain or suppress weed infestations should be part of every weed management plan for riparian areas.

CHEMICAL WEED CONTROL

Herbicides can be used effectively and safely in riparian areas. Herbicides should be applied when weeds are most susceptible to injury (Table 1). Misuse of herbicides in riparian and upland areas can have immediate and far-reaching impacts, so it is very important to protect nontarget vegetation and prevent water contamination.

Nontarget vegetation can be protected by using herbicides to which they are less susceptible, by using the herbicides during the safest season, and by minimizing drift. Many desirable riparian plant species are susceptible to herbicides used to control noxious weeds. Woody plants that shed their leaves in the fall may be less susceptible to 2,4-D or Roundup injury after the leaves have dropped. When using herbicides that can be absorbed by roots, spray at least four feet beyond the drip-line (farthest branches) of desirable trees. Some plants have shallow, spreading roots that may extend further than four feet beyond the drip-line.

Preventing drift will protect nontarget vegetation and prevent water contamination. Drift control agents, coarse sprays and low pressure, spraying when wind direction is away from susceptible vegetation or water, and avoiding spraying during inversions are all methods of minimizing drift. Using a rope wick or roller wick applicator can totally eliminate drift caused by spray droplets. Fall applications can decrease drift because there is less runoff in the fall that can contaminate streams, less chance of streambank erosion, and also fewer leaves, which after being sprayed, can fall or wash into the water.

Herbicides also can enter water through direct application, runoff, and leaching. Only herbicides registered for direct application to water or up to the water's edge should be applied below the high water mark. Contamination of water by runoff can be avoided by following the label (Table 2), using buffer strips, avoiding soil and vegetation that is particularly susceptible to movement, and by using the appropriate herbicide and herbicide formulation to minimize runoff and leaching. Grass strips with few weeds next to riparian areas may hinder loss of soil- or vegetation-bound herbicide residues from reaching water. Research conducted in Montana demonstrated that slopes dominated by bluebunch wheatgrass have less sediment loss than slopes dominated by spotted knapweed. Areas that are particularly susceptible to runoff include ephemeral stream channels, steep slopes, and bare soils. Herbicide residues bound to soil particles can be moved from stream channels that had no water during application but which transport runoff water after heavy rainfall or snow melt. Herbicides applied to steep slopes followed by heavy rainfall are susceptible to overland movement. Movement is especially likely if the herbicides are applied to saturated soils and a heavy rainfall occurs soon after application. Managing grazing or using cultural techniques that leave litter on the ground also can minimize runoff losses.

Some herbicides and herbicide formulations may minimize the risk of contaminating ground or surafce water in riparian areas (Table 3). Ground water can be protected by using herbicides with small leaching potential and shorter persistence that are less likely to leach through the soil profile. Herbicides that adhere strongly to soil particles are not as susceptible to loss due to leaching; however, they are more likely to be lost through surface runoff. Amine formulations of 2,4-D are more likely to move from the site of application through surface runoff and leaching; however, they are less likely to drift away from the site of application. There may be less loss due to surface runoff with Tordon on a steep slope than Krenite; however, Krenite is less likely to be leached to ground water than Tordon. There may be less risk of movement due to surface runoff with Stinger or Curtail than Tordon due to a shorter soil half-life. Other practices that can minimize leaching losses are loading and cleaning spray equipment at sites where there is minimal chance of contaminating ground water, equipping the water supply with an anti-back siphon valve, and avoiding herbicide applications over geological formations that would allow entry of the herbicide into an aquifer.

BIOLOGICAL CONTROL

Biological weed control methods are particularly suited for riparian areas because they are not likely to impact nontarget vegetation and water quality. However, biological control agents will not eradicate or stop the spread of weeds. Biological control agents can be integrated with other control methods. *Urophora affinis* and *U. quadrifasciata* populations are not harmed by limited amounts of 2,4-D or picloram if it is applied to rosette-stage spotted knapweed in the spring.

what are these?

Populations of biological control agents that spend a part of their life

cycle in the soil are susceptible to injury during spring flooding. *Agapeta zoegana*, a root-boring moth of spotted knapweed, *Aphthona* sp., flea beetles of leafy spurge, and *Spurgia esulae*, a gall midge of leafy spurge spend part of their life cycle in the soil. In spite of their susceptibility to injury due to spring flooding, each of these insects can be successfully established in riparian areas.

Some biological control agents seem to be adapted to moist sites. There has been no research to verify a difference in preference for specific moisture regimes in leafy spurge flea beetles; however, observations of field populations suggest that the order of most to least adapted to moist sites for *Aphthona* sp. is *A. czwalinae*, *A. flava*, *A. cyparissiae*, and *A. nigriscutis*. For spotted knapweed biological control, *Agapeta zoegana* seems best adapted to moist sites. Knapweed plants need to be green and growing in August for successful establishment.

PHYSICAL WEED CONTROL

Physical weed control methods include burning, hand-pulling, mowing, and tillage. Physical methods of weed control should be used judiciously in riparian areas because of the risk of erosion. Burning has had limited success for managing noxious weed infestations and is not recommended for riparian areas. Hand-pulling also has had limited success as a weed control method for noxious weeds. Resprouting can occur in both annual and perennial plants. It is most effective and economical for very small infestations. Mowing can reduce seed production of weeds; however, it will have limited use in riparian areas because of numerous natural obstructions.

Tillage by itself is inappropriate for weed control in riparian areas. Tillage alone will control perennial noxious weeds if done with sufficient frequency to prevent the root reserves from being replenished by above-ground growth. Tillage is probably most effective when used to help establish desirable vegetation.

Revegetation

Revegetating riparian areas helps to manage weeds, reduces erosion, and provides shade and forage for livestock and wildlife. Revegetation can help reduce the ability of weeds to become established by increasing species diversity and by increasing utilization of available resources. Revegetation can occur naturally if there are sufficient seeds of desireable species in the soil. For areas that with insufficient seeds, desirable species may have to be seeded.

Revegetation will normally require the suppression of existing vegetation (even of desirable species) and deferment of grazing to allow for natural or artificial establishment of desirable species. Most broadleaf and grass vegetation can be temporarily suppressed with glyphosate (Roundup) or tillage. Periodic treatments with herbicides such as 2,4-D, picloram (Tordon), and dicamba (Banvel) will suppress broadleaf weeds so that desirable grasses will become established. Applications of 2,4-D can be safely made to grasses the year after seeding. Just as with general weed control in riparian areas with herbicides, it is best not to treat large areas if erosion will be a problem. Careful use of livestock may also suppress existing vegetation long enough to revegetate a riparian area.

Grazing

Grazing can be used to manage weeds in riparian areas. Grazing alone can reduce vegetative matter and seed production but will not eradicate weeds or prevent their spread. Some weeds such as Canada thistle actually may increase after livestock are removed. If livestock are used to manage weeds in riparian areas a rotational grazing system should be used and season-long

grazing should be avoided. Livestock grazing when the banks are wet can cause excessive soil disturbance. Overgrazing also is a disturbance that can lead to weed invasions because there is insufficient vegetation to resist the establishment of invading weeds. Leaving sufficient vegetation in the fall also will help prevent erosion the next spring. Sheep used to graze leafy spurge can be especially hard on riparian vegetation if not moved frequently. Livestock are more likely to utilize weeds in late spring or early summer since many weeds become less palatable later in the summer. Livestock can spread weeds if sufficient time (seven to nine days) is not allowed for livestock to pass weed seeds consumed before moving them to uninfested areas. Improved forage on upland sites can reduce utilization and overgrazing by livestock and wildlife in adjacent riparian areas. If salt blocks are used to redistribute livestock, weeds may invade where the salt blocks are placed and subsequently spread to adjacent riparian areas. Like most of the other methods discussed, grazing probably is most effective for controlling weeds when integrated with other management techniques, especially natural or artificial revegetation.

Environmental and human safety can be protected while effectively managing weeds in riparian areas with the proper selection of management goals and control methods. Managing weeds in riparian areas can improve livestock production, recreational uses, wildlife, and native plant communities.

Table 1. General guidelines for using selected herbicides to control weeds commonly found in riparian areas (always read label for complete instructions)

Weed	Herbicide	Remarks
Leafy spurge	Tordon 2,4-D	Herbicides do not translocate well in the root system and therefore control is short term and repeated applications are necessary. Leafy spurge is most susceptible to chemical treatment during the true flower and fall regrowth stages. Biological control agents are available for release in leafy spurge. The use of sheep to control leafy spurge is becoming common practice in Montana.
Spotted knapweed & Russian knapweed	Stinger Curtail Banvel 2,4-D Tordon	Spotted knapweed is easily killed with herbicides but periodic reapplication or other follow up control measures are necessary to eliminate new plants originating from the soil seedbank. Biological control agents are available for spotted knapweed. Russian knapweed requires higher rates of these herbicides for control because of its rhizomes.
Canada thistle	Stinger Curtail Banvel Roundup MCPA Tordon 2,4-D	Many herbicides translocate readily in the Canada thistle root system and provide effective control. However, retreatment is usually necessary on established infestations due to subsequent regrowth from this extensive vegetative root system. Herbicides are most effective on Canada thistle when applied to actively growing plants during the fall of the year when plant nutrients are being translocated down to the roots. Several biological control agents are available for release on Canada thistle.
Hounds-tongue	2,4-D Tordon Banvel Ally	Herbicides are most effective applied to the rosette growth stage.
Common burdock	2,4-D	Herbicides are most effective applied to the rosette growth stage.
Hemlock	2,4-D	Herbicides are most effective applied to the rosette growth stage.
Purple lythrum	Roundup Rodeo	Prolific seed production and rhizomatous roots mean that repeat treatments will be necessary for eradication. Applications should be made to seedlings or to actively growing plants at full to late flowering stage of growth.
Common tansy	Banvel Roundup Tordon 2,4-D Ally	This plant can reproduce from rootstalks so repeat treatments will be necessary. Apply 2,4-D at the rosette stage; Apply Roundup or Banvel + Tordon (more effective than either product alone) from early flower bud developement to bloom stage; apply Banvel or Tordon alone before the bud stage; apply Ally to actively growing vegetation in the spring.

Table 2. Guidelines included on the labels for using selected herbicides in or adjacent to riparian areas.

Herbicide	Guidelines
2,4-D	Do not apply directly to water except as directed in labeling (refers to products registered for weeds on irrigation canal ditchbanks and special local need labeling for control of certain noxious weeds). Do not apply when weather conditions favor drift away from target area. Do not contaminate domestic or irrigation waters. Drift or runoff may adversely affect aquatic invertebrates and nontarget plants. Care should be taken not to make applications where runoff could carry the chemical to non-target areas. Apply while traveling upstream to avoid accidental concentration of chemical into water.
Ally	No aerial application on range/pasture. Do not apply to any body of water, including streams. Do not apply during periods of intense rainfall or to water-saturated soils or to frozen ground as off-target movement may occur. Do not apply to dry, powdery soil or light sandy soils when there is little likelihood of rainfall soon after treatment as wind may cause off-target movement.
Banvel	Keep out of lakes, streams or ponds. Do not contaminate water by cleaning of equipment or disposal of wastes. Do not apply when temperature on the day of application is expected to exceed 85 F as drift is more likely. Do not treat subirrigated cropland or areas where the soil remains saturated with water throughout the year.
Krenite	Some recommended uses are noncropland adjacent to and surrounding domestic water supply reservoirs, supply streams, lakes, and ponds, as well as for reforestation areas prior to planting.
Rodeo	May be applied to and along ditches and canals containing water. May also be used to control emersed and floating weeds in all bodies of fresh and brackish water which may be flowing, nonflowing, or transient. This includes lakes, rivers, streams, ponds, estuaries, seeps, irrigation and drainage ditches, canals, reservoirs, and similar sites. Do not apply this product within 1/2 mile upstream of a po water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of a po water intake in a standing body of water such as a lake, pond, or reservoir. Do not overlap more than 1 ft into open water for bankside applications; do not spray across open moving bodies of water, or where weeds do not exist; do not exceed maximum rate of 7.5 pts/A in a single application.
Roundup	Do not apply directly to water or wetland (swamps, bogs, marshes, or potholes). Can be applied to the inside of ditches and canals only if they do not contain water.
Stinger or Curtail	Avoid water contamination. Do not apply into water. Avoid application on coarse soil (loamy sand to sand) with rapid or very rapid permeability and where the aquifer is shallow. Avoid application where soils contain sinkholes over limestone bedrock, severely fractured surfaces, and substrates which would allow direct introduction into an aquifer. It is permissible to treat heavier or slowly permeable soils with a shallow water .
Tordon	Same as for Stinger and Curtail.

Table 3. Runoff and leaching potential and persistence of selected herbicides.

Herbicide	Surface loss potential	Leaching potential	Half-life in soil (days)
2,4-D	Small (acid) Medium (ester & amine)	Small (acid) Medium (acid & amine)	10
Ally	Medium	Large	120
Banvel	Small	Large	14
Krenite	Medium	None	7
Rodeo	Large	Small	30
Roundup	Large	Small	30
Stinger/ Curtail	Small	Large	20
Tordon	Small	Large	90