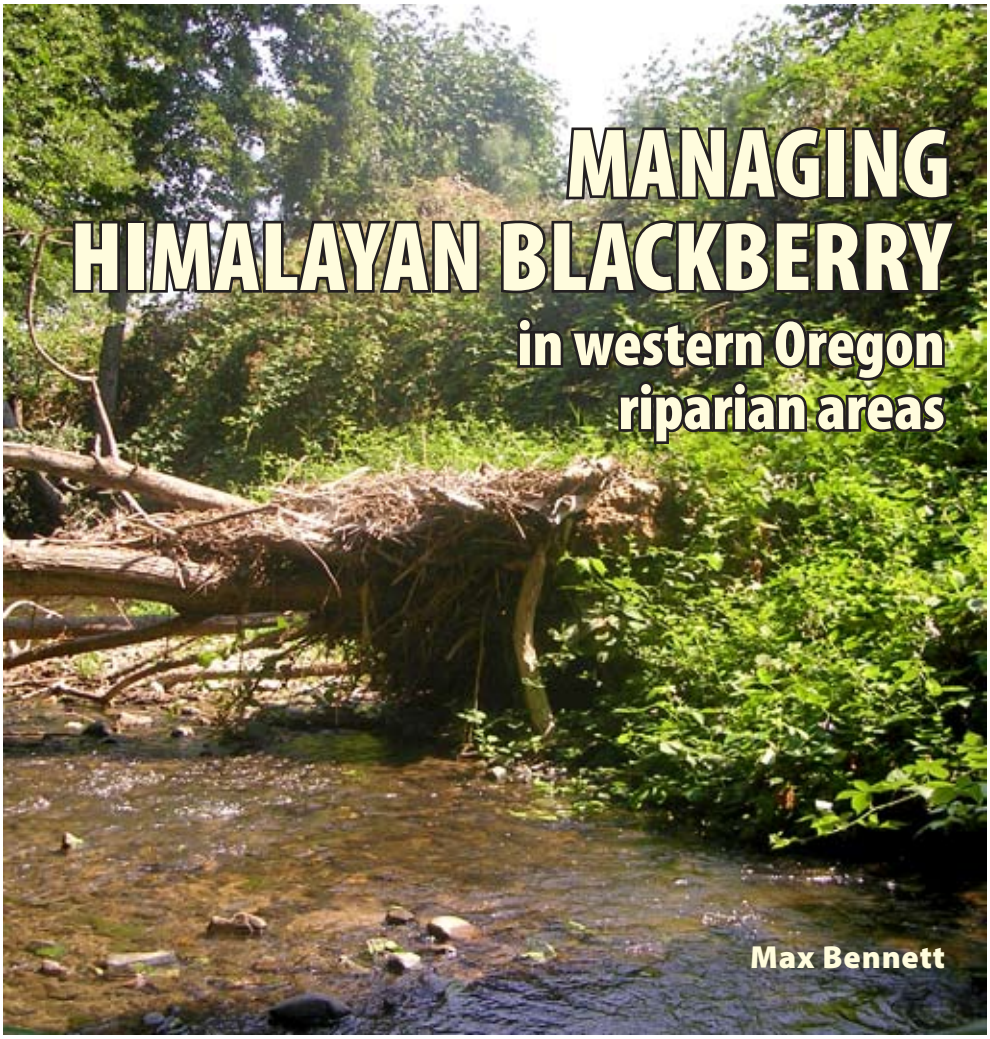
Himalayan blackberry *(Rubus armeniacus,* formerly *Rubus discolor* and *Rubus procerus*) is a European shrub that was introduced in the United States as a crop in the late 19th century. It escaped cultivation and has since invaded a variety of sites, including low-elevation streamside areas throughout the Pacific Northwest. Listed as a noxious weed in Oregon, Himalayan blackberry rapidly occupies disturbed areas, is very difficult to eradicate once established, and tends to out-compete native vegetation. For those trying to restore or enhance native streamside vegetation, Himalayan blackberry control is a major problem.

This publication discusses the biology of Himalayan blackberry, its effects on riparian functions, and strategies for managing Himalayan blackberry specifically in riparian areas.



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Why be concerned?

While many watershed councils, landowners, and others are involved in projects to reduce Himalayan blackberry and reestablish native plant cover, some question the need for Himalayan blackberry control. After all, doesn't Himalayan blackberry provide cover for birds and wildlife, erosion control, streambank stability, and food for wildlife and berry pickers? What's so bad about blackberry?

From the standpoint of riparian function, Himalayan blackberry may indeed have some benefits. As with most vegetative cover along a streamside, and as opposed to bare soil, it helps filter sediments out of overland water flow. Himalayan blackberry provides channel roughness to dissipate the energy of floods, and its roots help hold the streambank together. In recognition of these benefits, Himalayan blackberry has even been planted for erosion control in central Washington. However, for many key riparian functions, native riparian vegetation is superior.

Himalayan blackberry thickets cannot provide significant shade for stream water (except along deeply entrenched streams) and cannot contribute large woody debris to the stream. Himalayan blackberry patches provide some habitat values (food and cover), but overall plant and animal diversity is likely to be higher in areas with more diverse native vegetation. In addition, Himalayan blackberry has a shallow root system compared to native trees such as alder *(Alnus* spp.) and black cottonwood *(Populus trichocarpa)*. On incised stream channels, blackberry plants frequently drape over the bank, but the banks tend to be undercut. Thus, while Himalayan blackberry may provide some benefits and is better than

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no cover at all, it is a poor substitute for a diverse assemblage of native trees, shrubs, and other streamside vegetation.

Another significant problem with the dominance of Himalayan blackberry is its effect on the development of streamside vegetation over time. Because of the intense competition for light, moisture, and other resources in Himalayan blackberry thickets, few new trees and shrubs can become established. Those that do are mainly root suckers of established plants. As short-lived riparian trees such as alder and black cottonwood die, they will not be replaced with younger trees (Figure 1). Thus many tree-covered riparian zones may be in danger of turning into shrub fields dominated by Himalayan blackberry.

Figure 1.—If the Himalayan blackberry shown here is not checked, it could crowd out the existing trees and prevent new ones from establishing.

Precautions

When replacing Himalayan blackberry with native vegetation is a long-term goal, control efforts should proceed cautiously. Three primary concerns with blackberry removal in riparian areas are: loss of habitat, increased erosion, and loss of streambank stability.

Habitat loss

Blackberry provides hiding cover for a variety of wildlife. Many birds nest in blackberry thickets. The bird breeding season (roughly spring through midsummer, varying by locality) coincides with blackberry's growing season—which is when mowing, cutting, and other treatments often are done. However, unless the area to be treated is a large part of the available habitat, effects on bird populations are likely to be minor. Also, the temporary loss of habitat should be balanced against the long-term benefit to wildlife when more diverse native vegetation is established.

Erosion and bank stability

Any treatments that expose bare soil may result in erosion. This can take the form of erosion of exposed areas associated with overland flow, or erosion associated with flooding, when storm flows wash against unprotected banks. Himalayan blackberry control efforts on steeper streambanks, near the channel, and below the average high-water mark are particularly vulnerable. Simply mowing or slashing Himalayan blackberry thickets to the ground line on streambanks may expose bare soil. Though the roots remain, the loss of channel roughness that the blackberry canes provided might increase stream velocities, resulting in bank sloughing. Grubbing and mechanically removing roots, combined with the loss of channel roughness, can lead to even greater problems with bank erosion. Strategies for minimizing erosion problems following Himalayan blackberry control are discussed below.

Characteristics of Himalayan blackberry

Growth habits

Himalayan blackberry is a robust, semi-evergreen shrub that can grow nearly 10 feet high, with individual canes extending as much as 23 feet in a single season. Canes or stems are biennial. First-year canes develop from buds at or below the ground surface and bear only leaves. Second-year canes arise on the first-year canes where leaves join the stem; second-year canes bear both leaves and flowers. After the second year, the canes die. The dead canes provide a supporting architecture for live canes that sprawl over them, ultimately forming a nearly impenetrable thicket. Stem density has been reported at 525 canes per square meter. In several southwest Oregon field trials, average root-crown density was

about 10.4 per square meter (range was 1.5 to 21.5 per square meter), with multiple canes emerging from each root crown. In a study near Corvallis, OR, root crown density averaged 3.3 per square meter.

Himalayan blackberry cannot tolerate deep shade. It is rarely in dense forest stands except in openings. Vigor and seed production appear to decline as shade increases. However, many lowland riparian areas are not shady enough to significantly suppress Himalayan blackberry. Side light may be available in narrow tree buffers, and direct sunlight may be available early in the growing season before the deciduous trees leaf out.

Range and distribution

Himalayan blackberry grows from northern California to southern British Columbia and eastward to Idaho. It is found along roadsides, fence corridors, abandoned fields, and other disturbed sites as well as in riparian zones. Within riparian zones, Himalayan blackberry sometimes grows as scattered plants or clumps of plants within a matrix of native vegetation. More frequently, small clumps or "islands" of trees grow within larger patches of Himalayan blackberry that form virtual monocultures. Even where riparian tree cover is significant, Himalayan blackberry often dominates the understory. Himalayan blackberry is much more common in "lowland" riparian zones—that is, riparian areas within agricultural, urban, and rural residential settings—than in heavily shaded stream reaches within the forest proper.

Himalayan blackberry grows mainly in areas with annual precipitation of at least 29 inches (Hoshovsky 1989). It also is found on moist sites in more arid areas such as interior southwest Oregon. Growth is most vigorous on deep, moist, well-drained soils, but Himalayan blackberry seems to tolerate a wide variety of soil conditions. It tolerates periodic winter flooding but not saturated or poorly drained soils. Thus, while it often is found near streams, it is not a true riparian species.

Reproduction

Seeds

Himalayan blackberry can produce vast numbers of seeds, up to 13,000 per square meter. The seeds, which are in berries highly palatable to humans and wildlife, are spread by birds and small mammals. Seeds remain viable in the soil for several years, and so new blackberry plants can germinate from the soil seed bank even when existing plants have largely been controlled. However, seedlings grow much more slowly than daughter plants (those resulting from vegetative reproduction).

Vegetative reproduction

The vigorous reproduction of Himalayan blackberry by vegetative means is one of its most notable features. Anyone grubbing blackberry roots will encounter one of the large root crowns or "burls" from which many stout lateral and smaller, fibrous roots emerge (Figure 2). Roots have been found at depths of 35 inches and up to 34 feet in length. Shoots (new canes) emerge from the root crowns and roots (Figure 3) at depths up to 18 inches (Hoshovsky 1989). Himalayan blackberry will propagate from root fragments and stem cuttings, making it a challenge to

Figure 2 (at far left).—A root crown, or "burl," of Himalayan blackberry. Many stout lateral roots and smaller, fibrous roots could have emerged from

Figure 3 (at left).—Shoots can emerge from blackberry roots and root crowns at depths up to 18 inches.

remove all potential rooting material. Canes will root at the tips (Figure 4) and nodes, contributing to plants' rapid spread. According to one study, in less than 2 years a single cane cutting can produce a thicket 16 feet in diameter (Amor 1972). In several southwest Oregon field trials, the average height of canes 1 year after cutting to ground level was 41 inches, with individual canes as tall as 60 inches.

Management strategies

The long-term goal of most Himalayan blackberry management efforts in riparian zones is to successfully restore native trees and other vegetation to promote desired riparian conditions and functions.

One tactic is to establish conifers and other vegetation with dense canopies in wide buffers or in a continuous canopy from the upland forest to the stream's edge. Site preparation and maintenance must be sufficient to establish free-to-grow[1] trees, but complete Himalayan blackberry control is not needed because the dominant canopy will shade it out over time.

Another common tactic is to create a narrow, primarily deciduous canopy that admits enough light to maintain Himalayan blackberry. But, control efforts must be more thorough or must include maintenance over a longer term.

Managing Himalayan-blackberry-dominated riparian zones typically has four major steps.

1. A site preparation treatment that removes most of the aboveground plant parts; for example, by mowing or hand slashing. The purpose is to gain better access to the site and to prepare for Step 2.
2. Removing or killing the root crowns and roots, to prevent regrowth and reinfestation of the site. Steps 1 and 2 can be reversed; i.e., the plants first can be sprayed to kill the roots and root crowns, and then the dead plants can be mowed or burned to prepare the site for planting.
3. Planting or seeding native vegetation to reoccupy the site.

[1] Free-to-grow means the trees are established, are not in danger of being overtopped or otherwise threatened by competing vegetation, and are vigorous enough to grow on their own and eventually to dominate the site.

Figure 4.—A new blackberry cane, called a "daughter" plant, can root where another cane's tip or nodes touch the ground.

4. Maintenance treatments to reduce or eliminate competing vegetation surrounding desirable native vegetation.

The site preparation phase offers the best opportunity for Himalayan blackberry control, since the widest range of tools can be used at this time, and treatments generally can be more intensive.

Site preparation methods

This section discusses site preparation methods for western Oregon riparian zones dominated by Himalayan blackberry. The strategies are divided into three broad categories, based on how effective they are at reducing or eliminating Himalayan blackberry from a site:

- Most effective—the treatment is documented as successful in a broad range of situations
- Somewhat or possibly effective—there is anecdotal evidence of treatment effectiveness, and/or the treatment may be suitable in some circumstances
- Ineffective—available evidence suggests the treatment is unlikely to work

Most effective treatments

Mowing or cutting, plus herbicide treatment(s), are most effective. Options include the following.

Option 1 The area to be treated is mowed or cut in early to mid-growing season. The Himalayan blackberry is allowed to resprout and grow back to about 18 inches tall. Then, herbicides are applied in a broadcast or spot treatment, either using a motorized rig with a spray hose or using a backpack sprayer. Two effective herbicides are triclopyr and glyphosate (see "Using glyphosate and triclopyr for blackberry control in riparian areas," page 7, for more information). Herbicide applications in September through early November are most effective because the plant is sending energy reserves downward at that season, and the herbicide is translocated easily to the roots. Early-season applications, when sapflow is upward, result in poor translocation, and the plant may be only burned or top-killed. Timing is especially critical for glyphosate. Triclopyr is less sensitive to timing, but fall applications still are the most effective. Wait at least 1 week after spraying to mow or cut the canes to ground level.

Option 2 Broadcast the herbicide in late summer or fall before cutting or burning. Experience suggests this results in better translocation of the herbicide to the roots and thus less resprouting than in Option 1. However, translocation will be poor if the plants are under drought stress, as is sometimes the case in late summer. Also, more herbicide may be needed to adequately cover the foliage.

Effectiveness of these treatments is good to excellent (Figures 5, 6, and 7). If applied correctly, Himalayan blackberry cover will be significantly reduced. However, not all plants will be killed; some resprouting is likely. Effectiveness drops significantly when plants are drought stressed before treatment or have not leafed out fully.

Figures 5, 6, and 7.—An example of replacing Himalayan blackberry with native trees. Site preparation included two mowings and an autumn application of glyphosate, made with a backpack sprayer. Postplanting treatments included spring spot-spraying with glyphosate and hand weeding. At top, the initial mowing, in May 2000. The Himalayan blackberry thicket was 4 to 8 feet tall on a terrace above Jackson Creek, adjacent to a farm field. Figure 6, center, is the same site in autumn 2001, after the first growing season. Note white alder and Oregon ash in the background. Species planted included ponderosa pine, bigleaf maple, Oregon ash, and Oregon white oak. Himalayan blackberry cover is minimal; competing vegetation is dominated by thistles and poison hemlock. Figure 7, bottom, is the site in spring 2005 from the same photopoint. Trees are well above competing vegetation and capable of dominating the site. Grasses have invaded the plot from the adjacent field; Himalayan blackberry is scarce within the treated area but is invading from the sides (the "edge effect").

Mowing and cutting produce "slash" consisting of cane fragments. Mowing tends to produce smaller cane fragments than hand cutting. Slash can be left in place or removed and burned or otherwise disposed of. Relatively fine slash from mowing often is best left on site to serve as a mulch, helping to retain soil moisture, suppress weed seed germination, and add organic matter to the soil. The larger fragments from hand cutting usually are less effective as a mulch and make planting and follow-up maintenance more difficult. For large amounts of very coarse Himalayan blackberry slash or debris, removal may be the best option. However, exposing mineral soil will invite weed germination and invasion.

A rough cost range for herbicide application is $50 to $300 per acre, though rates may be much higher on small jobs.

Somewhat effective or possibly effective treatments

Mechanically removing plants, roots, and root crowns A backhoe with an opposable thumb, mechanical claw, or other implement grabs and uproots Himalayan blackberry canes and attached roots and root crowns.

The key to effectiveness of this treatment is not to sever roots or dig more than a few inches into the soil. Mechanical removal is most effective when soils are moist, loose, and free of rocks and other obstructions. With the right equipment and a skilled operator, much of the root and root crown volume can be removed. However, it is difficult to remove it all. Frequently, roots are severed, and the remaining fragments resprout. In dry, rocky, heavy clay, or compacted soils, effectiveness is greatly reduced because fewer roots and root crowns are removed. A thorough job is likely to disturb the soil substantially, with subsequent weed and erosion problems. Less thorough removal means less disturbance but more post-treatment sprouting.

Cost is highly variable depending on the site, equipment, and size of job. Estimated cost range is $250 to $1,000 per acre.

Hand removing plants, roots, and root crowns The root crowns and roots are dug up using a Pulaski, mattock, or similar device. An initial mowing or cutting makes the task much easier.

This treatment can be effective if done thoroughly, but it presents many challenges. Removing root crowns and roots is very strenuous. Roots frequently form a dense network and may be 12 inches or deeper in the soil, so removing them disturbs the soil considerably. This raises the possibility of erosion and sedimentation, especially on slopes or near streams. Soil disturbance also provides ideal conditions for weed invasions. Removal is most feasible on deep loamy or sandy soils but is extremely difficult in rocky soil.

Soll (2004) gave a range of 300 to 1,000 hours per acre depending on conditions and crew capabilities. Livingtson (2004) reported costs of $3,500 per acre for a thorough manual grubbing that appeared to provide good to excellent control of Himalayan blackberry on a site near the Little Applegate River.

Mowing followed by tilling and raking After an initial mowing or cutting, the area is tilled or subsoiled and then raked to remove root fragments. Because of the extensive soil disturbance, the treated area should be reseeded with grasses or other desirable vegetation.

This treatment, if thorough, will eliminate most Himalayan blackberry from a site, but weed seeds already in the soil will germinate; in addition, weed seed blown into the area will germinate. Both native and non-native species are likely to occupy the treated area. The flush of herbaceous weed vegetation will pose a significant competitive threat to planted vegetation. Erosion may be a serious issue, depending on soil and site characteristics. This treatment is suitable for upland areas but has limited applicability in riparian management.

Cost of mowing and tilling is estimated at $250 to $500 per acre. Raking costs are not reported but are likely to be high because raking is labor intensive.

Repeated mowing, cutting, or hand slashing The initial cutting is early in the growing season. Subsequent cuttings are at flowering or when the plant has grown back to around 18 inches high. A brush hog mounted on a tractor is effective for mowing on flats or gentle slopes, such as riparian terraces. For uneven or steep terrain, and when closer to the stream, hand cutting usually is the only option. Tools for hand cutting include brushcutters, chainsaws,

(continued on page 9)

Using glyposate and triclopyr for blackberry control in riparian areas

Several herbicides effectively control Himalayan blackberry including glyphosate, triclopyr, and metsulfuron. Two herbicide treatments that have been used successfully for riparian blackberry control, with minimal risk to fish and aquatic invertebrates, are spot or broadcast foliar applications of Garlon 3A (triclopyr) and Rodeo or Accord (glyphosate). However, other herbicide treatments may achieve equal or better results. Contact a pesticide consultant or Extension agent for specific recommendations. For more information, consult the current-year edition of the *Pacific Northwest Weed Management Handbook* (http://pnwpest.org/pnw/weeds) and the manufacturers' herbicide labels (http://www.cdms.net/manuf/manuf.asp).

Triclopyr controls broadleaf herbs and woody species and does not affect grasses; however, pines are very sensitive to it. Triclopyr formulations include Garlon 3A, Renovate (equivalent to Garlon 3A but with an aquatic label), and Garlon 4. One effective treatment for Himalayan blackberry control in riparian areas is a 2-percent solution of Garlon 3A mixed with a nonionic surfactant, applied midsummer through early November. Garlon 4 also is effective for Himalayan blackberry control but cannot be used along some salmon-bearing streams; also, it has a tendency to vaporize at temperatures above 80°F. While triclopyr is relatively nontoxic to terrestrial vertebrates and invetebrates, the Garlon 4 formulation may be toxic to fish at high concentrations.

Use pesticides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label—even if you've used the pesticide before. Follow label instructions precisely (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.
- Avoiding injurious spray drift is always important and all the more critical in riparian areas and other sensitive sites. Closely follow label requirements for spray-drift management.

Glyphosate is a broad-spectrum foliar herbicide that will kill or damage most vegetation it contacts. It is deactivated quickly when it comes into contact with soil and is not very mobile. Glyphosate comes in several formulations and has a variety of trade names. The chemical itself is relatively nontoxic to terrestrial vertebrates, invertebrates, fish, and other aquatic organisms. However, the surfactant in some formulations, such as Roundup, can be toxic to fish at high concentrations. Some formulations without the surfactant are labeled for aquatic use (e.g., Rodeo, Aquamaster). Accord Concentrate is a glyphosate formulation without a surfactant that is labeled for forestry uses.

Himalayan blackberry in riparian areas can be controlled by using a solution of up to 7.5 percent Rodeo with 0.5 percent nonionic surfactant from September through early November. Aim to thoroughly cover the foliage but not to the point of runoff.

Herbicide use in riparian areas

- Avoiding injurious spray drift is always important and all the more critical in riparian areas and other sensitive sites. Closely follow label requirements for spray-drift management.
- Some products are labeled specifically for aquatic use and pose very low risk for fish and other aquatic organisms. You may wish to use these products to provide an extra margin of safety when working near water.
- Some surfactants and other adjuvants (e.g., dyes and thickeners) may be hazardous to aquatic organisms. Read labels and seek expert advice on choice of adjuvants for herbicide applications near streams.

Herbicide guidelines in this report are not meant to substitute for the label. Read and follow label instructions and talk with pesticide consultants, local Extension professionals, and other natural-resource advisers familiar with pesticide use.

Table 1. Summary of Himalayan blackberry control methods.

Treatment	Treatment summary	Effectiveness	Cost	Considerations
Most effective				
Cutting + herbicide combinations	1. Area dominated by H. blackberry is mowed or cut midsummer, allowed to grow back to 18 inches, then sprayed in fall with glyphosate or triclopyr. 2. Or, the area first is sprayed in fall and is mowed, cut, or burned in late fall or the following season.	Effective if herbicide coverage is good and the plants are vigorous and not moisture stressed.	$50–$300/acre contract cost for herbicide application. Also must factor in initial mechanical treatment (cutting or mowing).	Most cost effective. Requires expertise in selecting and using herbicides. Some control of resprouts will be needed.
Somewhat or possibly effective				
Mechanically removing rootstock	Canes, roots, and root crowns are uprooted by a mechanical implement.	Can be effective if done thoroughly. But, roots often are severed and left in the ground. Difficult on rocky, compacted, or heavy clay soils.	Highly variable depending on the site, equipment, and size of job. Estimated cost range $500–$1,000/acre.	Results in significant soil disturbance.
Removing rootstock by hand	Root crowns and roots are dug up using a Pulaski, mattock, or similar device.	Can be effective if done thoroughly. But, roots often are severed and left in the ground. Difficult on rocky, compacted, or heavy clay soils.	300–1,000 hours/acre depending on conditions and crew capabilities. Reported contract cost $3,500/acre.	Results in significant soil disturbance. Extremely labor intensive. Best suited for small projects or when abundant volunteer or low-cost labor available.
Repeatedly tilling and removing canes	Area is tilled and canes are raked and moved off site.	Effective, but degree of soil disturbance makes unsuitable for most riparian projects.	$250–$500/acre, plus raking cost.	Significantly disturbs soil.
Multiple cuttings each year, continued over multiple years	Site preparation: Area is mowed or cut multiple times each year for several years. Release: H. blackberry resprouts are cut back around planted trees or natural regeneration two or more times per year.	Possibly effective when intensity (times per season) and duration (number of years) are sufficient.	165–400 hours/acre for initial hand clearing; 40–100 hours/acre for release. Contract cost $1,000/acre. Tractor mowing estimated cost $100–$150/acre.	Mowings are much more cost-effective than cutting by hand but require relatively flat ground and good access.
Not effective				
Goats	Goats are pastured in area to be treated.	Not effective. Goats will eat succulent new growth but not older canes. H. blackberry will regrow rapidly once goats leave the site. Goats are non-selective browsers and will damage desirable riparian vegetation.	Variable.	
Fire	Live or dead blackberry thickets are burned.	Not effective as a site preparation method. Efficient way to clear dead canes after spraying.	No costs available for riparian projects.	
Mowing, cutting, slashing	Mowing or cutting blackberry to ground level once or twice prior to planting desirable vegetation.	Not effective.	165–400 hours/acre for initial hand clearing. Contract cost $1,000/acre. Tractor mowing estimated cost $100–$150/acre.	

hedge trimmers, loppers, and string trimmers. The latter two are much less efficient.

Removing only the aboveground portion of the Himalayan blackberry plant through mowing or cutting temporarily reduces cover, but the plant typically grows back rapidly. In fact, there is some evidence that repeated mowing or cutting increases the formation of suckers from lateral roots and induces branching. On the other hand, mowing or cutting, if frequent enough, will theoretically reduce or exhaust the plant's energy reserves.

In a southwest Oregon field trial, cuttings in 2 successive years produced no significant reduction in cover 1 year after treatment. In another trial, nine cuttings in a single season resulted in a substantial reduction in cover measured 1 year after treatment. On still another western Oregon site (Mount Pisgah), five mowings per year, repeated for several years, substantially reduced Himalayan blackberry on a site it had dominated. This site was converted over time to one with a variety of herbaceous vegetation and a few Himalayan blackberry resprouts. These results suggest that multiple cuttings repeated over multiple years *may* significantly reduce cover. The threshold (i.e., the number of cuttings needed annually and number of years repeated) is unknown and is likely to vary by site.

Contract costs are difficult to estimate due to the variability in number and type of treatments. The initial treatment will be the most expensive. In a southwest Oregon field trial, initial clearings (site preparations) took from 165 to 400 hours per acre, depending on conditions and crew capabilities. Release work (cutting the regrowth) took 40 to 100 hours per acre. Tractor mowing, if feasible, is much cheaper ($100 to $150 per acre).

Ineffective treatments

Prescribed fire Burn either untreated thickets or mowed or cut areas that have regrown. During spring and summer, blackberry plant moisture content is high. It is lower in late fall and winter and may be easier to burn then. Note that burning permits are required in most localities, and other rules might apply; contact your municipal or county government for information.

Figure 8.—Goats will eat succulent green leaves and canes of Himalayan blackberry but not dead, woody canes. Blackberry regrows rapidly after the goats leave the site.

By itself, burning is not effective for long-term control. It might help remove aboveground parts of the plant, either to prepare for subsequent treatments or after a broadcast herbicide treatment has killed the plants. However, untreated Himalayan blackberry will resprout rapidly from root crowns after a fire.

No information is available about the cost of burning blackberry.

Browsing by goats Goats are used for Himalayan blackberry control in Australia and New Zealand and have been tried in a few cases in the Pacific Northwest. Goats may be pastured in areas with untreated Himalayan blackberry thickets or areas that have regrown after cutting, mowing, or fire. Browsing may be intensive and short term, with a large number of animals that are moved on and off the site within a few days or weeks, or may be all season long with a smaller number of animals.

Browsing is largely ineffective for managing Himalayan blackberry in riparian zones. Goats will eat the succulent leaves and canes (new growth) of Himalayan blackberry but not the older growth (Figure 8). Also, plants regrow rapidly once the goats are removed from the site unless the duration and intensity of browsing is enough to deplete the plant's energy reserves—which is impractical in most riparian management situations. Goats are nonselective browsers, so they will eat virtually any woody vegetation available. Overall,

Figure 9.—A dense growth of thistles has invaded this site, initially a 6-foot-tall Himalayan blackberry thicket that was hand slashed and then grubbed to remove root crowns and roots and branching. Cost for this treatment is the same as noted above for the repeated mowing, cutting, or slashing treatment.

goats probably are best suited for Himalayan blackberry control in upland areas when:

- There is an initial mechanical treatment so the goats can browse the resprouting canes and leaves
- The goats are allowed to browse over the entire growing season
- This process is continued for two or more growing seasons
- Browsing of desirable woody vegetation in the area can be controlled adequately or is not an issue
- Fencing, access to water, predation, and other management issues can be addressed

The cost of browsing is highly variable and depends on needs for fencing and the cost to buy and care for goats.

Mowing, cutting, or slashing The area to be planted is cut back once or twice before planting. This is not effective. The Himalayan blackberry plants grow back rapidly, and the treatment may increase suckering from lateral

Considerations in site preparation

Reducing invasion by other weeds

As noted previously, Himalayan blackberry control methods that disturb the soil may set the stage for invasion by other noxious weeds (Figure 9). Steps to minimize this possibility include:

- After the initial mowing or cutting, leave the cane "mulch" on site to cover the bare mineral soil
- Plant trees, shrubs, and other desirable vegetation immediately after treatment
- Seed grasses and other herbaceous vegetation to quickly occupy the site

If used, grasses should be *one* component of a diverse assemblage of native vegetation. Replacing a Himalayan blackberry thicket with a "lawn" down to water's edge merely replaces one problem with another. Grasses probably are best suited for terrace locations. For steeper slopes, use erosion-control fabric such as jute matting. Native grasses are desirable but may take longer to establish. Contact your local Soil and Water Conservation District or Natural Resources Conservation Service office for information about grass seeding. Note that grasses may be significant competitors with planted trees and shrubs, especially for moisture.

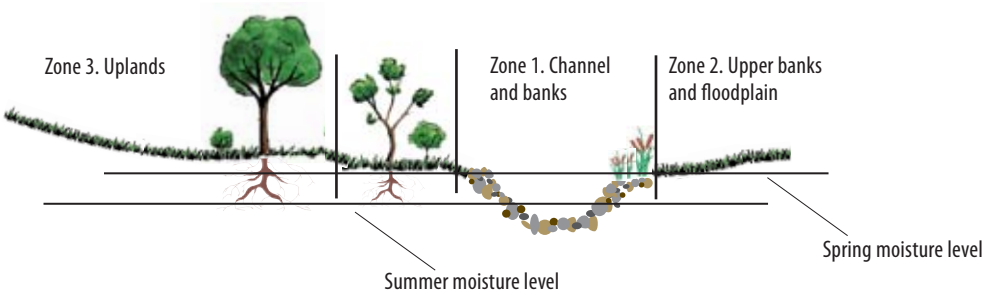

Figure 10.—Riparian planting zones (from Crowder and Edelen 1996).

Erosion control

Erosion control considerations vary by riparian planting zone (Figure 10). In Zone 3, all treatment strategies usually are acceptable from an erosion-control standpoint. In Zone 2, much greater caution is needed. Treatments should be limited to stable, low-gradient banks (2:1 slopes or less), the size of treatment areas should be minimized, and treated areas should be separated by untreated buffers. If treatment exposes bare soil, cover it with mulch, erosion-control fabric, or other material. Establishing willow posts (cuttings) at the stream's edge before treating Himalayan blackberry that grows upslope can help minimize future bank sloughing problems. In Zone 1, avoid removing Himalayan blackberry and other vegetation, or remove it only in conjunction with soil bioengineering techniques (see Bentrup, G. and C. Hoag, "For more information," page 15).

Blackberry rust: A new biological control agent

The blackberry leaf rust fungus *(Phragmidium violaceum)* is a biological control agent of potentially great significance in efforts to manage Himalayan blackberry. This fungus, a native of Europe, the Middle East, and Africa, has been used for years to control native blackberry plants in Australia and New Zealand but had not been reported from North America until spring 2005, when it was discovered on Himalayan blackberry plants in Coos and Curry counties. Since then, the rust has spread rapidly through western Oregon and currently is found in every county west of the Cascades except Jackson and Josephine. The introduction appears to be accidental.

The rust infects Himalayan blackberry as well as evergreen blackberry *(Rubus lacinatus),* including both the native and cultivated varieties of the latter species. No other native or horticultural *Rubus* species growing in Oregon appear to be susceptible. The rust affects primarily the leaves, and it causes infected plants to partially or completely defoliate. Tip rooting also is reduced. The vigor of affected plants can be reduced significantly, but plants are not killed outright, at least initially. Also, some populations or individual plants within populations appear to be resistant. Infection levels and susceptibility to the fungus are highest in high-precipitation zones such as coastal areas.

The presence of the rust presents a window of opportunity for efforts to restore desirable native vegetation. Control should be focused on the most rust-resistant plants so they don't spread at the expense of more susceptible varieties. Since new information about the rust is emerging rapidly, riparian practitioners should consult with the Oregon Department of Agriculture or local experts before beginning blackberry control projects in areas where the rust is present.

At top left, spores of the blackberry leaf fungus and (top right) the leaf spots that signal infection. Above, blackberry defoliated by the fungus. *Photos courtesy of Oregon Department of Agriculture.*

Maintenance and release

Regardless of the treatment used, maintenance is essential to successful Himalayan blackberry control and restoration of desired vegetation. Initial treatments, even if intensive, seldom are successful in killing all roots and root crowns or removing them from the site. Some resprouting probably will occur. Also, new Himalayan blackberry plants may germinate from seed. Though these seedlings are less vigorous initially than Himalayan blackberry plants with established root systems, seedlings may be extremely numerous.

Even when Himalayan blackberry has been controlled effectively, the site often will be invaded from surrounding Himalayan blackberry patches. In addition, when Himalayan blackberry control is successful, other weeds may come to dominate the site. All weeds compete with planted vegetation for limited supplies of soil moisture, sunlight, and nutrients.

Maintenance techniques

Spot spraying

In all cases, take extreme care not to damage desirable plants. When using directed sprays, protect trees with stovepipes or plastic shields. Periodically wiping the protector helps minimize the potential for spray drip to contact desirable vegetation. Trees' susceptibility to herbicides varies by the chemical used and the tree species. To control Himalayan blackberry resprouts, triclopyr (midsummer through fall) and glyphosate (fall) are effective.

Hoeing and grubbing new resprouts

Young seedlings can be hoed easily when their roots systems are not well established.

Figure 11.— Two seasons after cutting back Himalayan blackberry (at right), sandbar willow *(Salix exigua,* below) is making a good recovery on the site.

Mulch mats

Mulch mats can reduce herbaceous weed competition. They temporarily will inhibit—but will not prevent—Himalayan blackberry resprouting. In a southwest Oregon field trial, Himalayan blackberry was cut to the ground, trees were planted, and mats 36 inches square were installed. During the growing season, sprouting canes pressed the mats' undersides, and a few canes emerged and grew up from the side. After 1 year, the mats began to deteriorate, and some sprouts grew through holes in the matting.

Release cuttings

Cut all Himalayan blackberry sprouts within a 6-foot radius around each planted tree. In addition, cut canes projecting aboveground into the circle. Adjacent untreated Himalayan blackberry thickets also may need to be cut back.

Shade

Shading out Himalayan blackberry plants is a long-term maintenance strategy. Himalayan blackberry is considered shade intolerant. In an experiment near Corvallis, artificial shade (shade cloth) appeared to reduce Himalayan blackberry biomass accumulation and stem diameter after an initial mowing, but there was wide variation among the plots, and the results were not statistically significant. Artificial shade appeared to interact with other treatments (mowing plus tilling, mowing plus herbicides) to increase the level of Himalayan blackberry control.

In practice, most narrow riparian buffers with deciduous trees have adequate sunlight, from above and from the side, to sustain vigorous Himalayan blackberry growth. Establishing wider buffers with a heavy conifer component may provide enough shading to achieve long-term control. For example, one or two rows of conifers planted on the outside edge of the buffer could, over time, provide substantial shading, to the benefit of stream temperatures as well as blackberry control. While of little immediate benefit, such measures may ultimately prove to be the most important steps that can be taken to reduce Himalayan blackberry dominance along lowland riparian areas in western Oregon.

Releasing existing native vegetation

Natural regeneration often can be released or promoted with persistent mechanical Himalayan blackberry control. This works better in areas with patchy tree or shrub cover than in extensive Himalayan blackberry monocultures. Three steps are key.

Step 1. Release existing plants from competition. Often, riparian shrubs and seedling or sapling trees are encroached upon or overtopped by Himalayan blackberry and other competing vegetation. Cutting back the Himalayan blackberry provides the desirable plants with more growing space. If root systems of desirable shrubs and trees are well developed, response can be rapid. Often, more desirable woody plants are in riparian zones than first meet the eye. These plants may need to be flagged before release treatments so they are not cut.

Step 2. Stimulate root suckering, layering, and sprouting of desirable species by cutting back Himalayan blackberry two or more times per year. Black cottonwood and sandbar willow *(Salix exigua)* both sprout vigorously from underground shoot buds on lateral roots. A temporary reprieve from competition can result in rapid expansion of these species into previously unoccupied areas (Figure 11).

Step 3. Minimize cover of competing vegetation, primarily blackberry, to stimulate germination and rapid early growth of seedlings of desirable species from seed. Seed often falls into riparian zones, but new plants can regenerate only under favorable conditions. Note that it isn't important to eliminate Himalayan blackberry entirely; just reduce its cover to low levels while desirable species germinate and grow.

Legal guidelines for using herbicides near streams

Follow the directions on the herbicide label. It is a violation of federal law to use an herbicide in a manner inconsistent with its label.

Except where permitted by the herbicide label (e.g., for certain aquatic-use herbicides), allowing pesticides to enter the waters of the state is prohibited. Many herbicides can be used near streams as long as you keep them out of the water.

However, as of this writing, use of certain herbicides is restricted along salmon-bearing streams. A federal order released January 22, 2004 requires buffer widths for ground and aerial pesticide applications of 20 yards and 100 yards, respectively, from the "ordinary high water mark" of salmon-bearing streams for certain chemicals. For a list of the chemicals restricted, see the Oregon Department of Agriculture website at http://egov.oregon.gov/ODA/PEST/buffers.shtml

For county maps showing the affected streams and stream segments, go to http://egov.oregon.gov/ODA/PEST/buffermaps.shtml

Glyphosate (e.g., Rodeo, Accord, Roundup) is not on the list of restricted chemicals. Triclopyr BEE (the ester formulation of Garlon, such as Garlon 4) is on the restricted list, while triclopyr TEA (the amine formulation of Garlon, such as Garlon 3A) is not. Restrictions are specific to salmon species and stream segments. Consult the website for detailed information.

If EPA-listed fish species or federal land or money are involved (as with a federal grant), a consultation with the National Oceanic and Atmospheric Administration (NOAA) Fisheries or the U.S. Fish and Wildlife Service will be required.

Herbicide use on forest lands is subject to the Oregon Forest Practices Act. For most stream types, the law requires a 10-foot stream buffer for herbicides applied with a backpack sprayer and a 60-foot buffer for herbicides applied by air. Also, all understory vegetation within 10 feet of the stream must be retained, regardless of stream classification. A "notification of operations" must be filed with the Oregon Department of Forestry at least 2 weeks before the treatment. A written plan may be required. This is a brief summary; other rules apply. Contact the Oregon Department of Forestry (ODF) for more information.

Oregon Forest Practices Rules do not apply when "…[T]he establishment or management of trees is intended to mitigate the effects of agricultural practices on the environment or fish and wildlife resources, such as trees that are established or managed for windbreaks, riparian filters or shade strips immediately adjacent to actively farmed lands" (OAR 629-600-0100 Section 47).

In a nutshell, operations to establish and/or maintain a forested riparian buffer strip next to agricultural lands are not considered a forest practice and do not fall under ODF's rules.

Summary

Himalayan blackberry management is a key part of efforts to restore or establish native streamside vegetation to promote desired riparian functions. Efforts to remove Himalayan blackberry and establish native plant cover should proceed cautiously. Wholesale, rapid eradication of Himalayan blackberry may lead to serious streambank erosion problems.

The most effective site preparation method for Himalayan-blackberry-dominated areas is an herbicide application before or after a mowing or cutting.

Removing roots and root crowns mechanically or by hand also can be effective but is more costly and labor intensive and results in greater problems with erosion control and other weeds. These approaches probably are best suited to smaller areas, or when large volunteer groups are available, or when high per-acre cost is not a decisive factor.

There is anecdotal evidence that repeated mowing or cutting, if done intensely and long enough, can significantly reduce Himalayan blackberry cover. However, this is difficult to achieve in most cases. Less intensive treatments (e.g., one or two mowings or cuttings per year) are likely to fail.

Take steps to reduce weed invasion and erosion after site preparation. Regardless of the treatment used, a strong commitment to maintenance is critical. Maintenance must focus not only on regrowth of Himalayan blackberry in the treated area but also invasion from surrounding untreated sites. Over the long term, managing for higher levels of understory shade in riparian zones will help keep Himalayan blackberry in check.

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