

A guide to forest understory revegetation

To help manage buckthorn and other invasive plants

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Introduction

Revegetation (the re-establishment of plant cover through seeding or planting) is almost always advantageous and often necessary to achieve temperate forest restoration goals following removal of invasive plants, such as buckthorn (*Rhamnus cathartica*). For example, without revegetation, managed areas can quickly return to a buckthorn-dominated state, thus prolonging need for management and increasing associated economic and environmental costs.

This document synthesizes current knowledge on forest understory revegetation and is designed to provide science-driven guidance on strategies that effectively suppress invasive plant re-establishment and promote native biodiversity. Herein we focus on buckthorn in particular, a widespread and resilient invader of forest understories through much of North America.

Initial management considerations

There are many different approaches that can be utilized in initial control efforts of a site already heavily occupied by buckthorn. No one approach is perfect: each has associated strengths and limitations, and a combination of different approaches is often necessary based on varied conditions within each site. Prominent buckthorn removal approaches are summarized by:

- [University of Minnesota Extension](#)
- [Minnesota Department of Natural Resources](#)

Initial management of buckthorn should focus on reducing the total number of living stems within the treatment area. This includes prioritizing fruiting trees (note: trees that are not fruiting at the time of management may become fruiting in subsequent years) and ensuring adequate treatment of targeted stems. Stems that are damaged but not killed will resprout, replacing each damaged stem with many more new shoots.

Other invasive plants

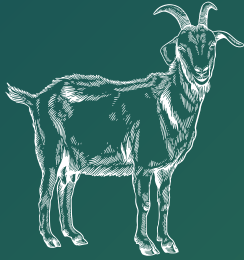
Although this document focuses on buckthorn-invaded understories, many of the strategies outlined here are likely to support restoration efforts in other contexts as well.

The same mechanisms that allow revegetation to effectively suppress buckthorn can be applied to suppress other invasive plant species, including honeysuckles and garlic mustard.



Buckthorn seedlings germinating in the spring following forestry mowing.

What about goats?



Scientific evidence on the efficacy of goats in buckthorn control is scarce and more research is needed to determine when and how goats can be best utilized in buckthorn control. However, available evidence suggests that targeted grazing by goats is not a universally effective approach to controlling buckthorn. Prior to management, most sites contain buckthorn that are either too large to be consumed by goats or are so small that they are easily missed, and stems that are targeted by goats often resprout, leading to thicker buckthorn regrowth. Goats can also damage remaining native plants and can contribute to soil disturbance and erosion. Consequently, grazing alone is not advisable as an approach to initial buckthorn control in wooded areas.

Grazing may be effective when combined with other methods of control in some settings. Areas that contain mostly small buckthorn or those that have undergone mechanical removal and are now heavily dominated by resprouts may benefit from repeated grazing over multiple years. Deploying goats regularly over 3-6 years can reduce the abundance of these smaller stems. Restoring native biodiversity following grazing often requires active revegetation, but non-target impacts of grazing may not be compatible with native plant establishment.

Why revegetate?

Restoration of native plant communities is challenged by all buckthorn that remain following initial management: resprouting stems, stems (typically small) that escape initial management, and new stems establishing from seed. The growth and survival of remaining stems is significantly enhanced following the removal of their larger predecessors. Without other buckthorn to soak up light and other resources, remaining stems grow much larger and faster than they would otherwise, quickly reclaiming dominance of the site. Revegetation replaces the competition exerted by large buckthorn with that of native plants, allowing them to steal key resources back before remaining buckthorn grow too large.



Experimental site in Marine-on-St. Croix, Minnesota comparing buckthorn-invaded areas that have undergone forestry mowing and foliar herbicide with (left) and without (right) seeding grasses and wildflowers. Photo taken July 2018 (16 months after initial management and seeding).

When to revegetate

Any revegetation done with the goal of suppressing buckthorn should be conducted as soon as possible following initial management (removal of large stems). Often this means seeding in winter or planting in early spring. Mature buckthorn trees are prolific seed-producers that can leave behind a legacy of thousands of seeds that are “banked” in the soil. These seeds will germinate within two years and exert significant invasion pressure in the years following initial management. Buckthorn seedlings are most vulnerable to competition in their first year of life and become progressively more resistant as they age. By their third year, the probability of any one buckthorn stem dying drops significantly. Establishing dense vegetation to compete against seedlings when they are small and vulnerable will provide the best chance at suppression.

Benefits of revegetation

Primary benefits:

- Soak up resources liberated by management
- Reduce subsequent invasion of buckthorn and other exotic species
- Reduce need for additional management, including herbicides
- Improve efficacy of additional management

Secondary benefits:

- Increase biodiversity
- Improve habitat for wildlife/pollinators
- Increase value of natural areas to humans
- Reduce erosion, improve water quality

Revegetating with grasses and wildflowers

Grasses and wildflowers are suitable for sites with more than 10% canopy openness (i.e. more than 10% of the sky is visible through the tree canopy above). Darker sites will not provide enough light to support the rigorous growth (particularly of grasses) needed for buckthorn suppression and alternative revegetation strategies (see below) are required. Similarly, areas with more than a few inches of ground covering debris (e.g. mulch from a forestry mower) can reduce the efficacy of seeding. When conditions are right, grasses and wildflowers can establish quickly from seed, allowing large areas to be densely revegetated at relatively low cost.

Seed mixtures designed to suppress buckthorn should focus primarily—if not exclusively—on cool-season (C3) grass species. Grasses generally establish quicker than wildflowers and leave a layer of thatch that reduces light to underlying buckthorn later into the autumn than is possible for most wildflowers. This layer of thatch can also enhance the efficacy of other management, especially the use of prescribed fire which is typically limited by low fuel levels.

Understory grasses are also fairly inexpensive and can tolerate several types of common herbicides (e.g. Triclopyr) better than wildflowers. These attributes make grasses the primary competitors against buckthorn invasion during the critical first few years after management when buckthorn are most vulnerable. Seeding grasses at rates of at least 60 seeds per square foot (about 8 lbs per acre) is recommended. Although there are many cool-season grass species that are readily available from seed suppliers, wildrye grasses (*Elymus genus*) warrant special consideration. Wildryes establish quickly after seeding, can establish densely in open woodlands, and are tall enough and have large enough leaves to shade underlying buckthorn. In particular, Canada, Virginia, and Silky wildrye have been used effectively to reduce buckthorn invasion across a wide range of buckthorn-invaded understories.

Wildflowers can take several years to establish, but are more shade-tolerant than grasses and can self-perpetuate for many years. Wildflowers also improve habitat for wildlife and provide floral resources for pollinators. So, although wildflowers don't grow fast enough to suppress the initial wave of buckthorn, dense and diverse patches of wildflowers may be helpful in securing longer-term resistance to invasion and improving overall forest health. Because they are not contributing significantly to buckthorn suppression in the short-term, if included, wildflowers can be seeded at lower rates and can be more tailored to other management goals. Warm-season grasses establish more slowly than cool-season grasses, but are persistent if there is sufficient light and can play a role in maintaining long-term vegetation cover and diversity as well.



Recommended species

Grasses	Wildflowers
<ul style="list-style-type: none">• Canada Wildrye• Virginia Wildrye• Silky Wildrye	<ul style="list-style-type: none">• White Snakeroot• Beebalm• Red Columbine• Tall Meadow Rue• Virginia Waterleaf• Brown-Eyed Susan• Figwort

For sourcing, consult the [list of suppliers maintained by the MN DNR.](#)

A black and white line drawing of a wildflower, likely a Brown-Eyed Susan, showing a single flower head with many petals and a central disk, on a long stem with a single leaf.

Revegetating with woody species

Trees and shrubs have a wide range of growing requirements and can be selected to fit almost any site that has been invaded by buckthorn, including those too dark to support grasses. Trees and shrubs compete with buckthorn more strongly than either grasses or wildflowers due to similarities in growth requirements and physiology, but are more challenging to restore at high densities. Species that hold their leaves late into autumn are particularly effective competitors since buckthorn relies on autumn light for continued growth and survival: plants that reduce buckthorn light capture in this critical time have been shown to be highly effective at preventing buckthorn invasion. For this reason, species that hold their leaves late into autumn (red elderberry), evergreen species (balsam fir), and shade-adapted species (sugar maple) can be effective choices in understory revegetation.



Woody revegetation plot in Lake Elmo, Minnesota comprised of caged planted stems amongst black cherry volunteers. Photo taken June 2023.

Revegetation with woody species typically requires planting bare-root stems, plugs, or containerized plants. Due to the cost and logistical challenges associated with planting rather than seeding, woody revegetation yields fewer plants and much more localized impacts than revegetation with grasses and wildflowers. To suppress buckthorn, revegetated woody species should be planted at sufficient densities to produce continuous cover within two years after initial management (often only possible at small scales). Otherwise, managers should seek to establish the largest density of woody stems possible.



*Surveying a revegetation plot.
Photo taken July 2023.*

Native woody volunteers that recruit naturally (e.g. black cherry commonly co-occurs with buckthorn) can augment planting to increase total woody density. Lower densities will have proportionally lower impact and only affect buckthorn immediately surrounding planted stems. Inter-seeding with grasses can therefore enhance management outcomes by filling gaps between woody stems.



Seeds of some woody species are available commercially and a wider range of species can be collected by hand (albeit with considerable time and effort). Seeding woody species may offer an alternative to planting, but the scarcity of seeds, as well as differences in plant size, structure, and growth requirements mean that there are currently no guidelines available for effective woody plant revegetation by seed. Establishing buckthorn-suppressing woody cover via seeding is the subject of ongoing research.

Aside from logistical challenges to establishing dense woody cover, revegetation of trees and shrubs requires a dedicated strategy to mitigate impacts of deer and other herbivores. In the absence of fencing or caging, planted native woody stems are highly vulnerable to deer browsing and are preferentially browsed over buckthorn. Woody revegetation in areas with frequent deer activity therefore can only be effective if paired with fencing or caging.

Follow up and monitoring

Revegetation can effectively suppress small buckthorn plants, and those newly germinating from seed. However, natural variation in revegetated plant cover will allow some buckthorn to persist and birds (e.g. American robin) often disperse viable seed from adjacent areas.



Follow-up foliar herbicide application conducted using high-volume pistol grip sprayers in experimental plots (Hastings, Minnesota). Photo taken August 2017 (6 months after initial management and revegetation seeding).

More critically, revegetation alone is insufficient to fully control resprouting buckthorn stems since these stems draw on energy stored in their roots to quickly grow taller than revegetated plants. Therefore, managers must follow-up on revegetated sites and perform supplemental management (see initial management) to prevent re-sprouts and other escaped buckthorn from re-establishing dominance.

Techniques used for follow-up management will often depend on site conditions, the type of revegetation used, and the abundance of resprouting buckthorn.

- Mechanical removal is highly adaptable, particularly when conducted by hand since practitioners can be selective in which plants to remove and can be performed as needed based on buckthorn growth.
- Herbicides offer a more comprehensive approach, particularly in areas without revegetated forbs or woody species. Use of Triclopyr foliar spray can effectively treat large areas of remnant buckthorn stems and sprouts without affecting revegetated grasses. Foliar spray should occur at the end of the first growing season (after native plant dormancy but prior to first frost; September-October) following initial management and revegetation and can be repeated as needed over time.
- Spring prescribed burns can also be effective at removing small stems (not sprouts) in areas where grasses have built fine fuel loads. Because burns rely on dense grass cover, they should be conducted when grasses are most abundant (in the second or third year following initial management and revegetation).

Example timeline and seed mixes

For more information on management timelines and seed mixes used in our research, visit www.coveritup.umn.edu.



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Photo credits

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