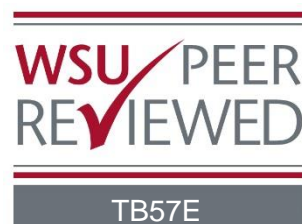




SHRUB WILLOWS: AN IDEAL PLANT CHOICE FOR LIVING SNOW FENCES WITH MULTIPLE BENEFITS

This Environmental Application is a companion to:
[EM115E A Roadmap for Poplar and Willow to Provide
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[TB58E Short-Rotation Coppice Willow in Ireland](#)



SHRUB WILLOWS: AN IDEAL PLANT CHOICE FOR LIVING SNOW FENCES WITH MULTIPLE BENEFITS

By,

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Introduction

Blowing and drifting snow on roadways is a challenge in many cold-weather regions, especially those adjacent to large open fields with little or no vegetation or other obstructions to disrupt wind patterns. These areas are often remote from transportation maintenance facilities, and problems from blowing and drifting snow can persist for days or weeks after a snow event—closing roads and causing traffic delays. Constructed snow fences are often used to help keep snow from blowing onto the roadway. While these constructed fences work well, they serve only one capacity. An alternative is a “living snow fence” (LSF) which is composed of rows of trees or shrubs. The biomass from these plantings has the potential to be used for bioenergy and other purposes. Species such as poplar or willow can be particularly useful as a LSF, planted at low cost, and providing useful biomass. This publication provides details of willow LSFs being implemented in upstate New York and includes recommendations for other locations.

Benefits of Living Snow Fences

Snow and ice on roadways from blowing and drifting snow can lead to dangerous road conditions, reduced visibility (whiteouts), travel delays, automobile accidents, personal injury or death (Gopalakrishna et al. 2017). Snow fences act as a windbreak that traps blowing snow in designated areas around the fence before it reaches the road

(Figure 1), improving road safety. Snow fences can reduce the cost of mechanical and chemical snow control by transportation agencies as it reduces the need for additional plowing, salting, and deicing, which costs billions of dollars each year in the U.S. alone (National Academies of Sciences, Engineering, and Medicine 2005; Gopalakrishna et al. 2017). LSFs can help mitigate these costs and provide additional benefits. Blowing and drifting snow can close roads and removing it requires labor and equipment, such as loaders, graders, snow throwers, and dump trucks. Travel delays and vehicular accidents also have a financial cost associated with them that can be mitigated with snow fences. LSFs created through planting trees and shrubs have been shown to be more cost-effective over their lifecycle than snow fences constructed of wood or plastic (Daigneault and Betters 2000). While many different tree and shrub species, such as dogwoods, honeysuckles, pines, and spruces, have been used, willow LSFs have been shown to be more cost-effective than LSFs created from other species (Heavey and Volk 2014). Economic analyses of willow LSFs in New York State have shown positive economic returns from avoided snow- and ice-control costs alone. Cost savings from accident avoidance and reduced travel time contribute towards the high benefit-cost ratios of using willow LSFs as well as the relatively short period wherein establishment costs are recouped (Heavey and Volk 2014).

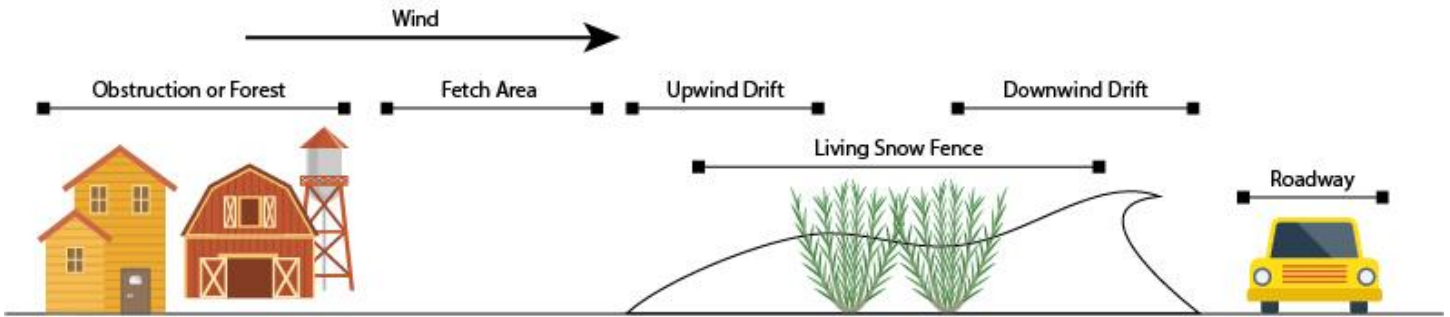


Figure 1. A living fence of shrub willow can be used to protect roadways from deep snow.

Use of Shrub Willow as a Living Snow Fence

Hybrid shrub willow cultivars (*Salix* spp.), developed by State University of New York, College of Environmental Science and Forestry (SUNY ESF), are an ideal plant choice for LSFs for several reasons. The key characteristics of these shrub willow cultivars that make them ideal for this application is their multi-stem form, rapid growth, height, and tolerance of high planting density. Willow’s ease of establishment from dormant, unrooted stem cuttings allows large sections of LSFs to be established with relative ease, and at low costs, compared to planting larger, rooted shrubs or trees. Shrub willow’s rapid growth rates allow willow LSFs to be fully effective in trapping blowing snow in as little as three years after planting (Heavey and Volk 2014), compared with other species which can take five to ten years or longer. The snow trapping capacity of a LSF is a factor of the fence height and optical porosity (open space when viewed from the roadside at a perpendicular angle). Shrub willow planted in a single or offset double row, with a spacing of one plant per linear foot (the same spacing used in bioenergy plantings), creates an optical porosity around 40–60% in as little as three years (Heavey and Volk 2014), the optimal range for maximum snow holding capacity (Tabler 2003). Figure 1 shows the general way in which blowing snow is transported by the wind across an open area and trapped in drifts by a LSF before it reaches the road. Cultivated varieties of shrub willow grow to heights of 20–30 feet, providing a large snow holding capacity, or the ability to trap all the blowing

snow on a site over the course of a snow season, even in years with above-average snow fall.

When the snow holding capacity of the fence exceeds the seasonal quantity of blowing snow at a site, the length of the downwind snow drift formed between the fence and road is decreased (Figure 1 and Figure 2). Studies in New York State and Minnesota have shown that willow LSFs can grow to heights that create excess storage capacity in as little as three years after planting (Heavey and Volk 2014;



Figure 2. A snow drift formed around a shrub willow living snow fence along an interstate highway in New York State. The willow stems act as a windbreak causing blowing snow from the open field upwind of the fence to be safely deposited in drifts around the fence before it reaches the road.

Zamora et al. 2015), and can likely achieve similar results in similar climates. This excess capacity shortens the downwind drift length and allows willow LSFs to be safely planted in closer proximity to roadways compared to other species (Figure 3). This expands the number of sites on which LSFs are possible and avoids land rental payments when the land available for planting is limited to the transportation agency right of way.



Figure 3. Perpendicular view of a shrub willow LSF in New York State. The amount of open space in the fence achieved by planting one willow shrub per linear foot of fence. This creates a fence that has the maximum snow holding potential relative to the height of the willows.

Willow LSFs can also provide a range of environmental benefits not achieved by constructed snow fences, such as erosion control, stormwater filtration, carbon sequestration, wildlife habitat, a food source for pollinators, and aesthetics. The biomass can also be harvested in sustainable quantities without negatively impacting snow trapping functions for value-added products, such as wood for basket weaving or furniture. Shrub willow's ability to be coppiced (cut just above the ground with rapid regrowth the following spring) also presents opportunities to regenerate LSFs indefinitely and utilize harvested biomass for bioenergy or other applications. Rather than harvesting the willow stems all at once on a typical bioenergy harvest cycle of three to four years, planting multiple rows and alternating their harvesting years can maximize snow trapping functions. Planting two or more rows of willow can

adequately meet the dual objectives of an intentional multifunctional system.

Using Shrub Willow and Poplar as a Living Snow Fence

Shrub willow and poplar have many characteristics that contribute to their effectiveness as LSFs that can be applied to locations across the northern U.S. Both can be planted as cuttings, tolerate a range of soil conditions, have rapid juvenile growth rates, and can develop a shrubby growth form to trap snow. Poplar and willow should be cut after the first growing season for multi-stem coppice regrowth. LSFs using other species can be developed using the same principals using plants that are suited to the region and have similar attributes to shrub willow (rapid growth, density of 50% or more, tolerant of roadside growing conditions). When selecting poplar, willow, or another species for a LSF please check with your county Extension office or local conservation district for the best species for your region.

Challenges

While willows have significant potential for use as a cost-effective LSF, there are some challenges to establishing the fences. Roadside soils can be a harsh environment that requires thorough site preparation for plants to thrive. Young willow plants are most vulnerable to weed competition, drought, and other stressors in the first few growing seasons. Willow LSFs are living organisms in the environment, so pests, diseases, and other natural and human disturbances are possible, but planting cultivars developed by breeding programs and following best practice guidelines can mitigate these risks, increase the chances of survival, and maximize the life cycle of the planting. Best practice guidelines for willow LSFs have been developed over a number of years and are available at <https://www.esf.edu/willow/lsf/>. The range where these shrubs will grow successfully is limited by the amount of precipitation in much of the western U.S. and by too much heat in the south (Volk et al. 2018). In particularly dry areas, irrigation may be required to successfully establish plants for LSFs, which will lower the benefit-cost ratio.

Conclusion

Dozens of willow LSFs have been successfully deployed in New York State, and some in Minnesota and other states. University researchers and Extension professionals have worked with state transportation agencies to test and better understand the function of these systems. Best practices have been developed and are being disseminated to expand the use of willow LSFs as a cost-effective solution to mitigate blowing and drifting snow problems. When these criteria are met, willow LSFs can have a useful lifecycle of 15 years or more with favorable economics and numerous benefits to transportation agencies, the public, and the environment.

For More Information

[Poplar and Willow Forum 2016](#)

[Shrub Willow Biomass Producer's Handbook](#)

[Willow Living Snow Fences](#)

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