Shrub Willow Living Snow Fences

show potential for snow trapping and reduced drift length shortly after planting

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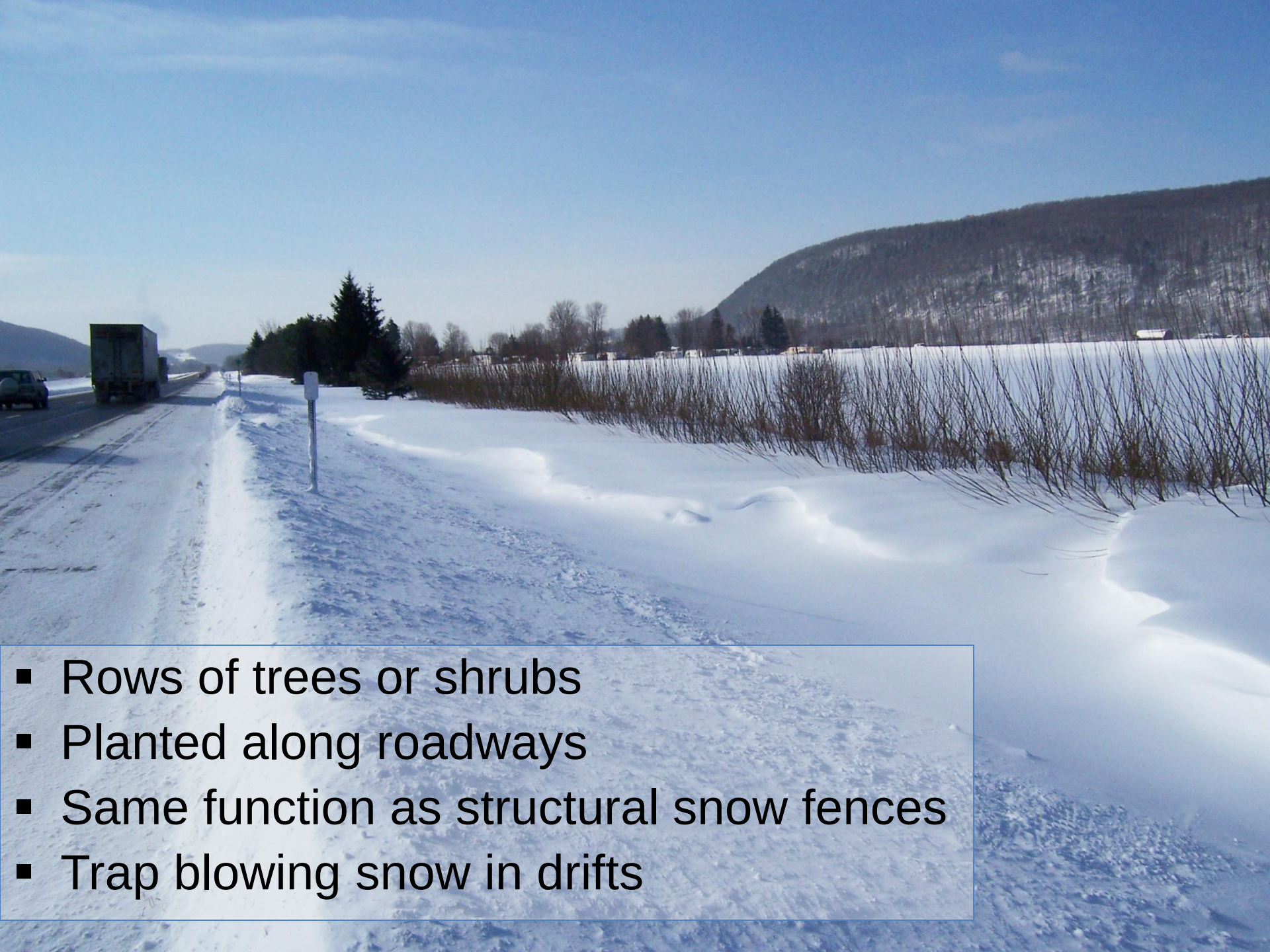


- Rows of trees or shrubs
- Planted along roadways
- Same function as structural snow fences
- Trap blowing snow in drifts

Support

USDOT

NYSDOT

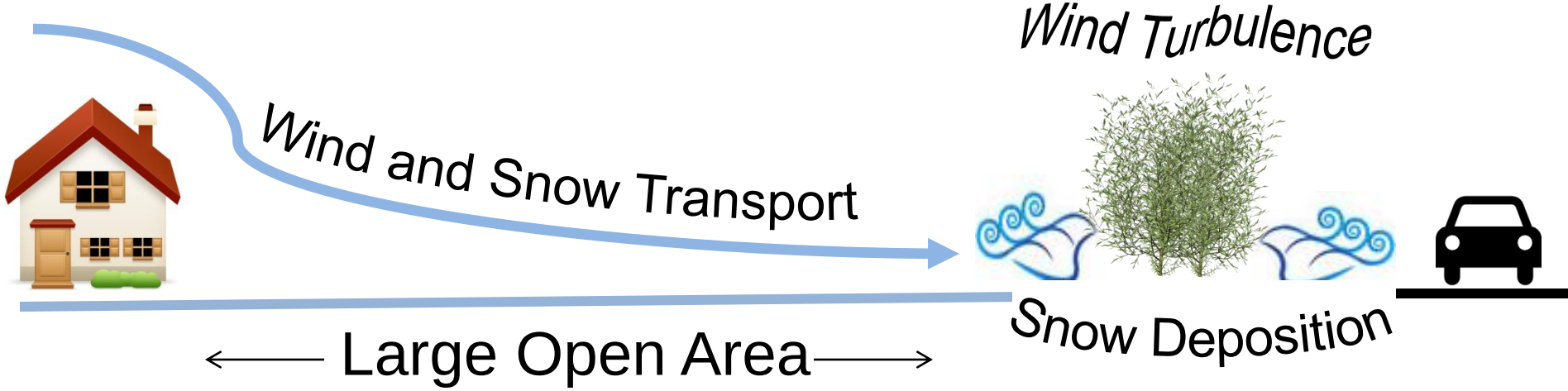
New York State
Department of Transportation

"Developing and Implementing a Living Snow Fence Program for New York State"

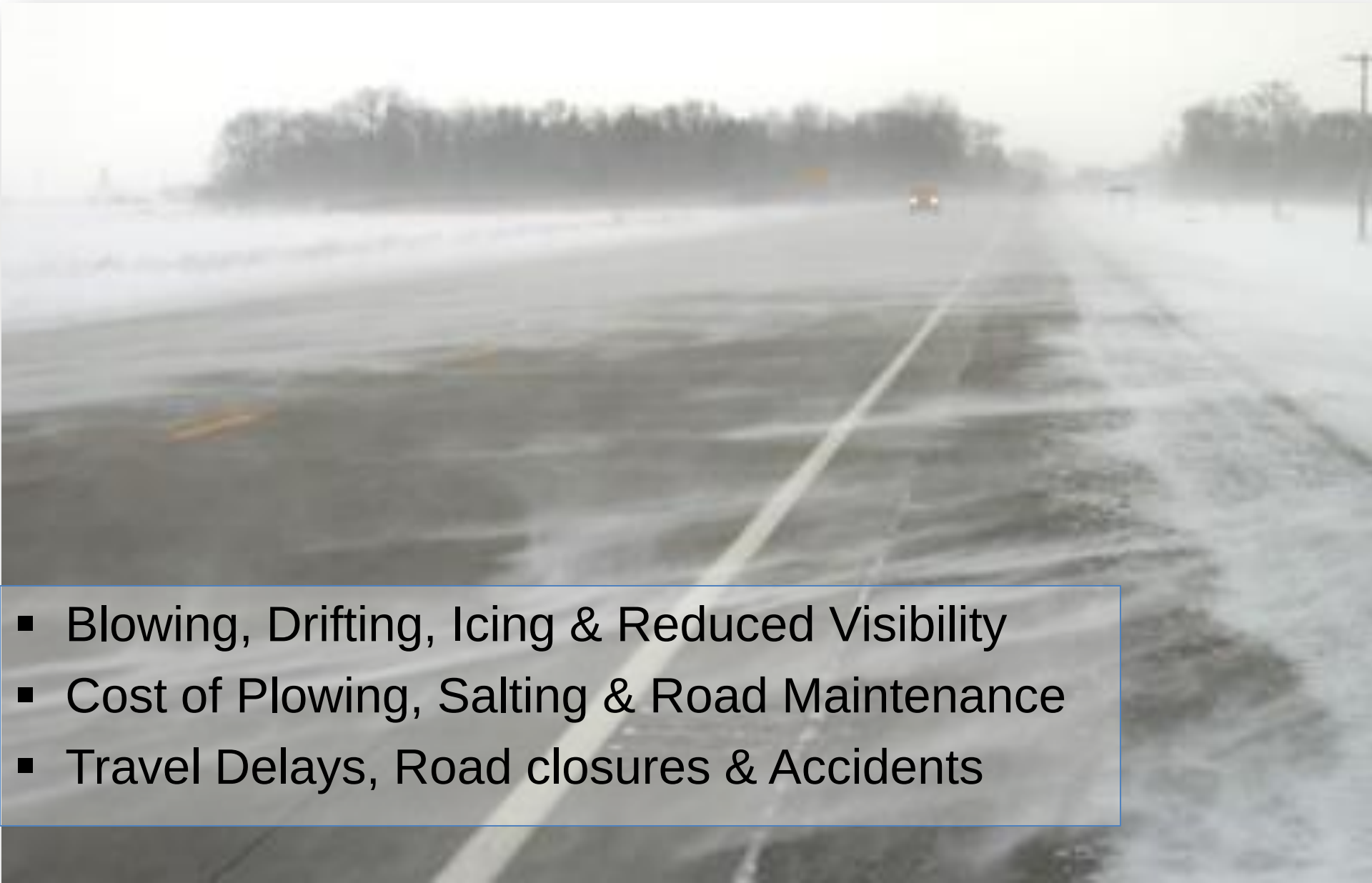
A Living Alternative

Structural **Snow Fences**	**Living** **Snow Fences**
Effective immediately	Some years after planting
Lifecycle 1 - 15 years	20 - 30 years or more
Capacity = Height and Porosity	Capacity = Height and Porosity
Constant over time	Changes as plants grow

How Do Snow Fences Work?



Problem



- Blowing, Drifting, Icing & Reduced Visibility
- Cost of Plowing, Salting & Road Maintenance
- Travel Delays, Road closures & Accidents

Opportunity

Reduce Cost of Snow Control

- $2.3 billion annually in the US
- $300 million annually in New York State

Improve Road Safety

- Driving conditions
- Accidents rates
- Save lives

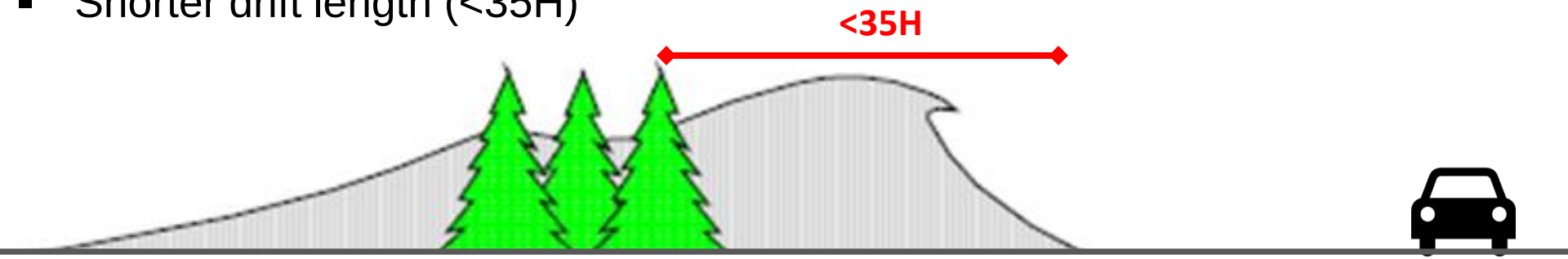
Provide Additional Benefits

- Travel time savings
- Environmental benefits
- Aesthetics
- Value-added products

Plant Growth & Drift Length

- Small plants
- Small snow storage capacity
- Fences fill to capacity
- Long drift length (35H)

- Same quantity of blowing snow…
- Larger plants
- More snow storage capacity
- Fences *do not* fill to capacity
- Shorter drift length (<35H)



Objectives

1. **Measure…**
   - Fence Height
   - Porosity
   - Site and climate variables

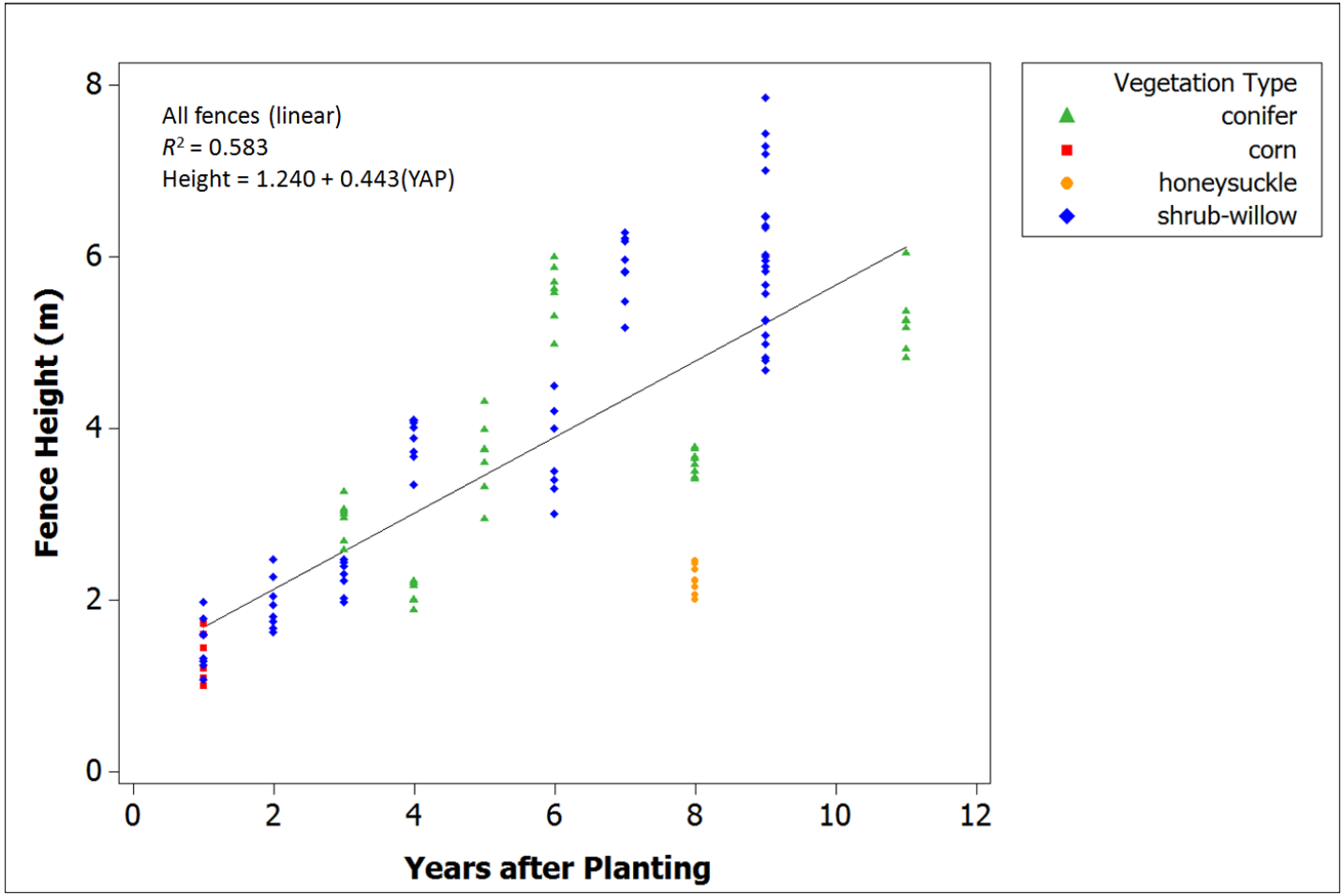
2. **Model…**
   - Snow storage capacity of fences
   - Snow transport (blowing snow at each site)
   - Downwind drift length

18 Living Snow Fences

- 10 shrub willow
- 6 conifer
- 1 corn and honeysuckle
- 1 - 11 years after planting

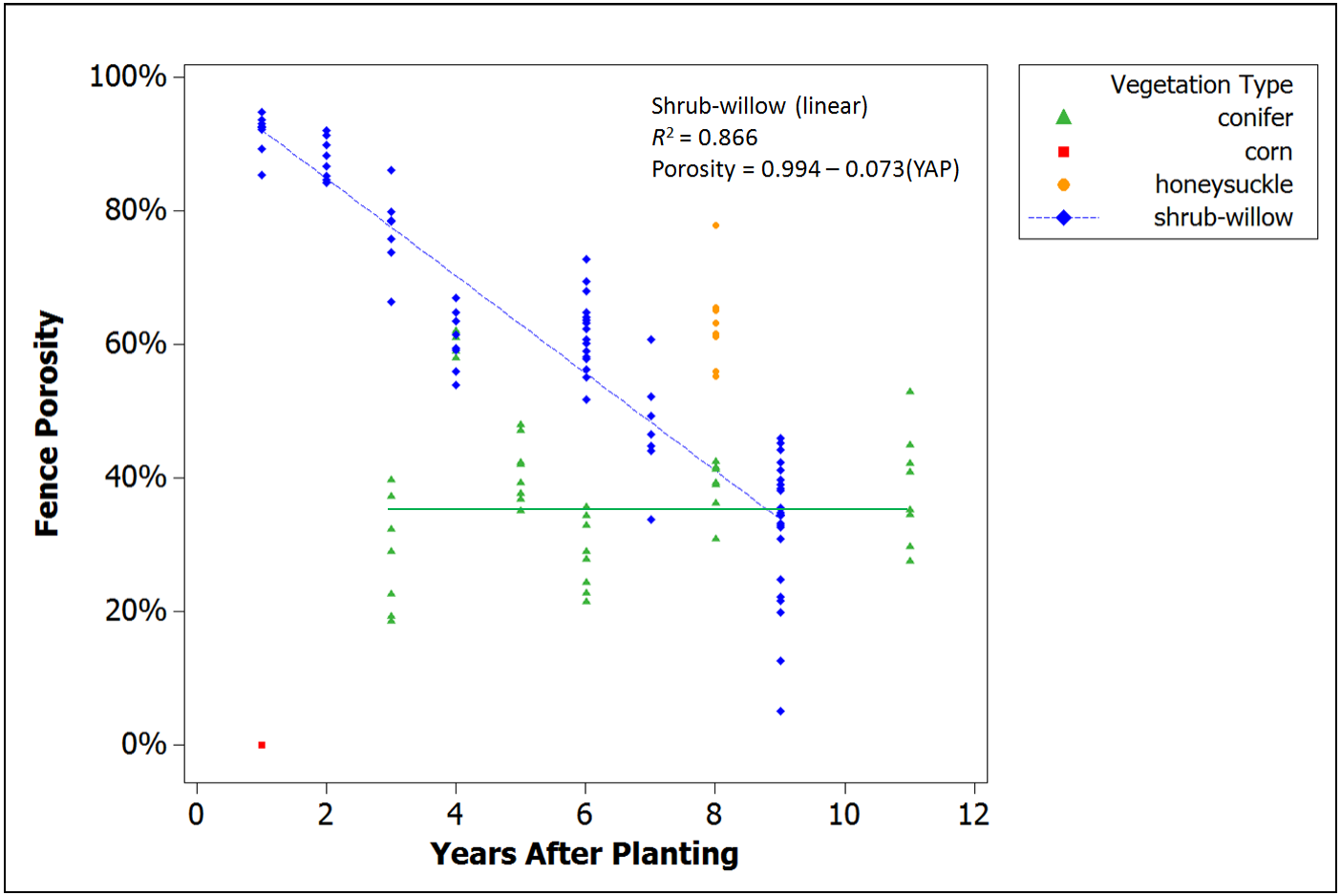
Height Over Time

- 1 m - 8 m increased linearly over time ($P < 0.001$)
- Height of conifer fences was similar to willow at various YAP



Porosity Over Time

- 40% - 60% ideal - anything <80% sufficient
- Willow ranged from 90% to 10% - effective 3 YAP
- Conifer did not change - generally lower than willow



Capacity versus Transport

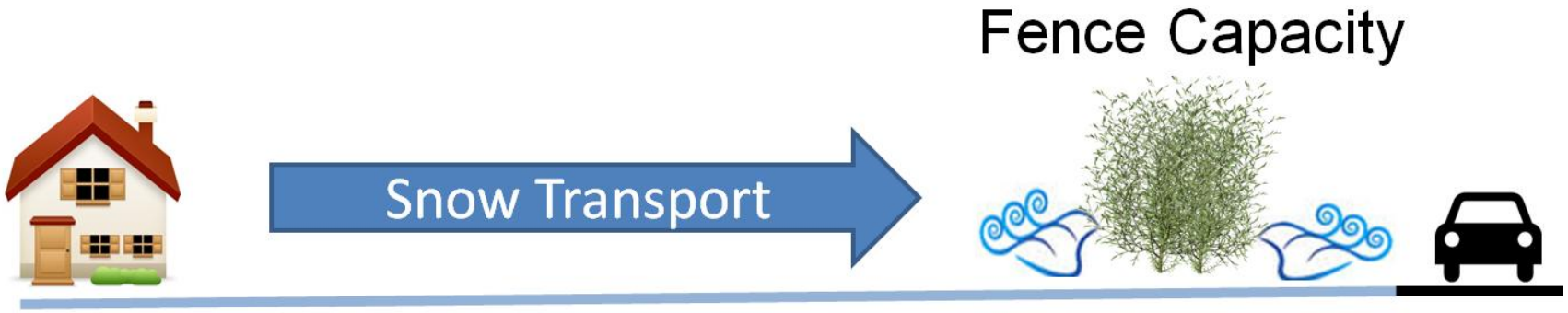
Fence Capacity (Snow Storage Available)

- Height and Porosity

Snow Transport (Blowing Snow in Avg. Year)

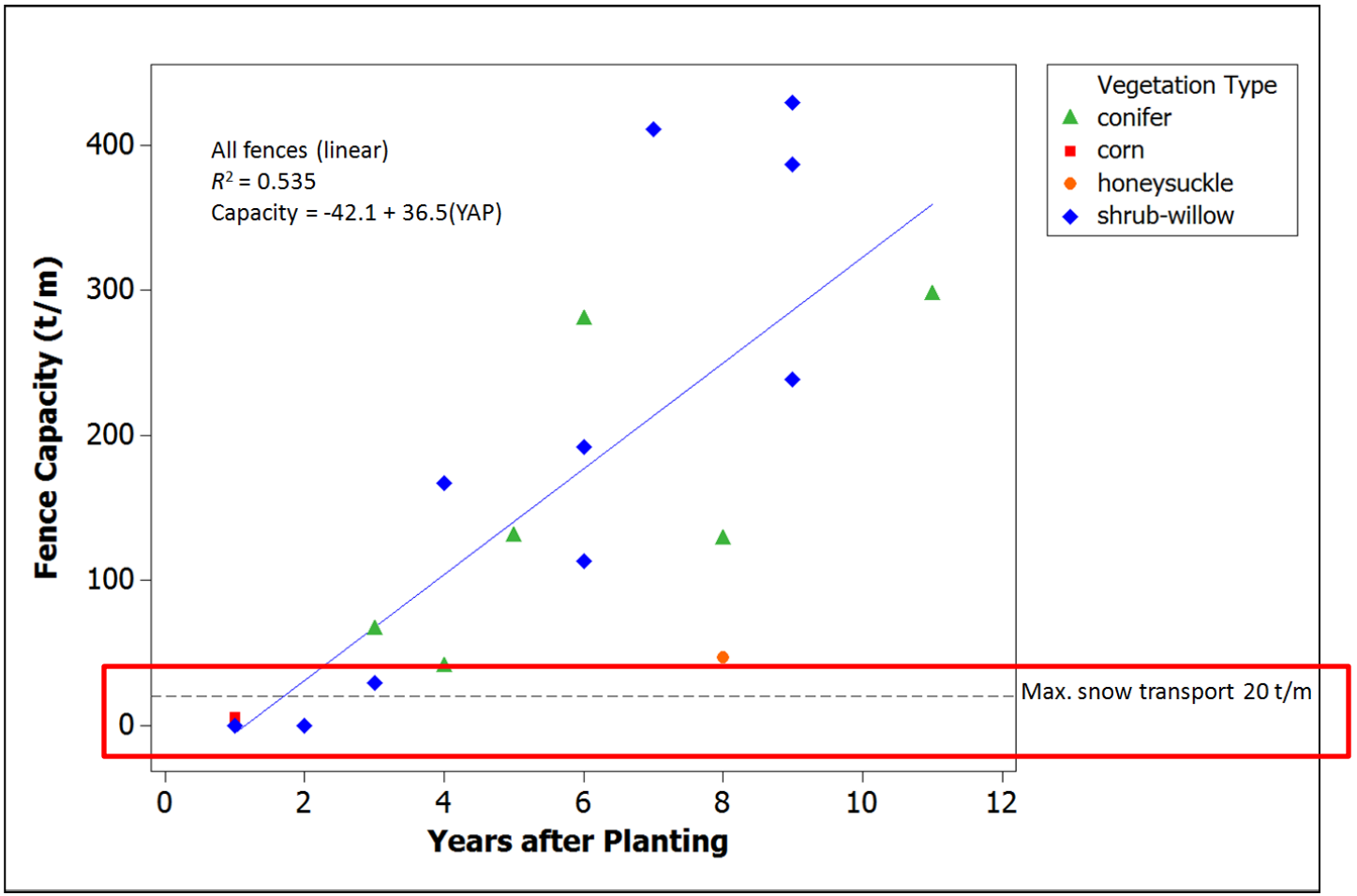
- Fallen snow and % relocated by wind

Units of t/m (tons of snow per linear meter of fence)



Capacity Over Time

- Increased linearly with fence height 1 - 400 t/m
- Max. Snow Transport = 20 t/m
- 3 -11 YAP…Capacity = 2x to 100x transport



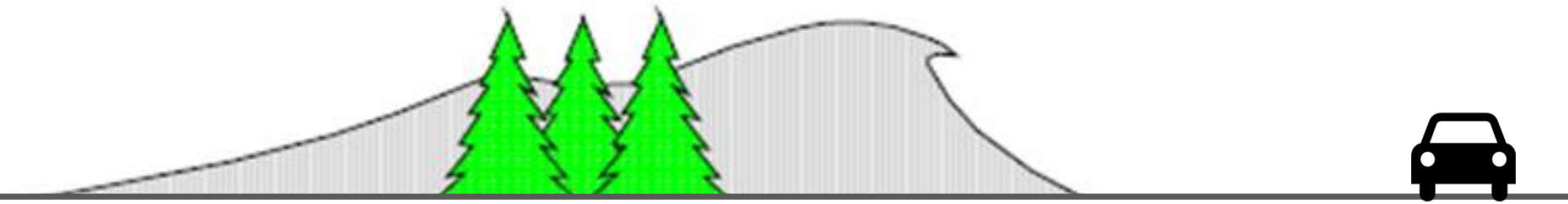
Drift Length and C/T Ratio

Drift length is a function of…

Snow storage capacity relative to annual snow transport

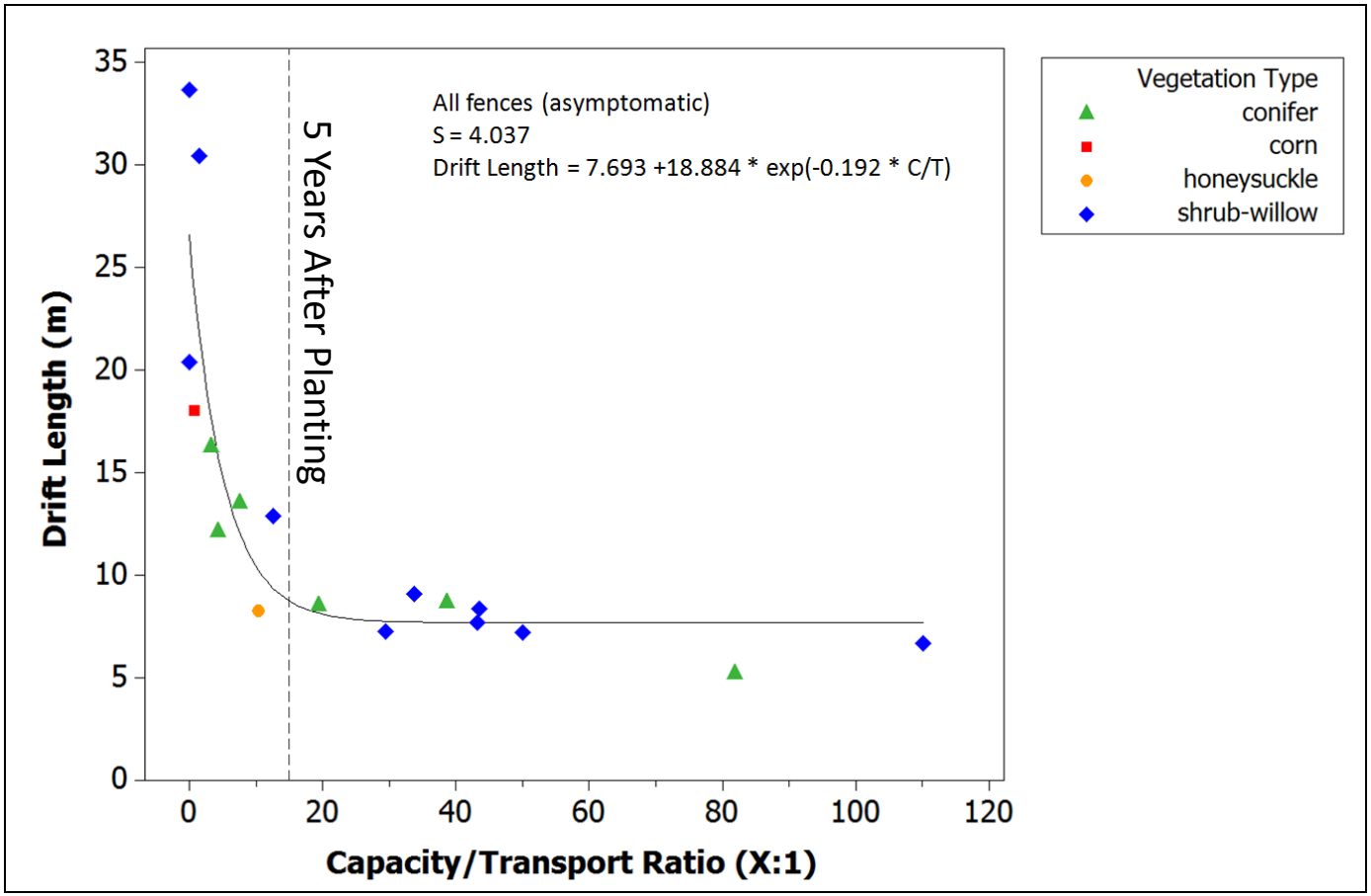
"Capacity/Transport Ratio" (X:1)

- As C/T increases, drift length decreases
- Drifts build up to height of fence before out towards road



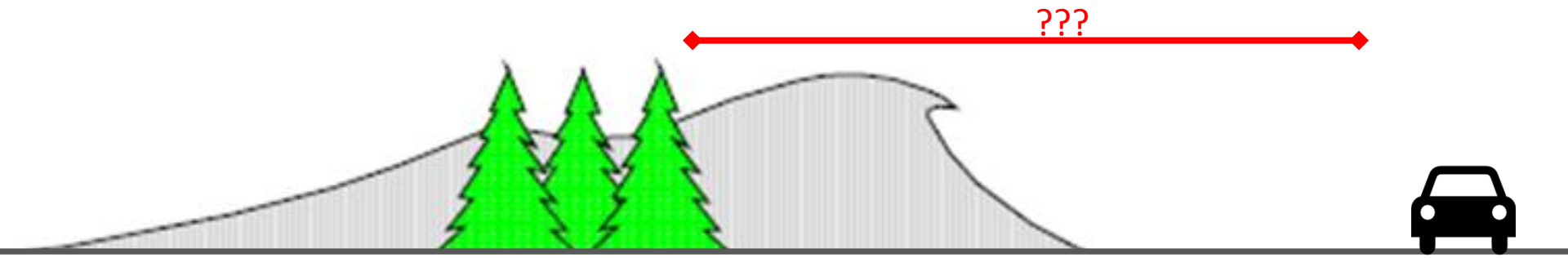
Drift Length and C/T Ratio (Time)

- C/T ratio increases over time as fences grow
- 0 - 4 YAP: C/T 1:1 - 10:1 Drift length decreases rapidly
- 5 -11 YAP: C/T 10:1 -100:1 Drift length <10 m



Required Setback Distance

- Distance between fence and road
- Chosen based on estimated drift length



- **Estimated Drift Length:** <10 m
- **Observed Setback Distances:** 10 - 100 m
- **Published Recommendations:** 30 - 180 m

Implications

- Dynamics of LSF over time have not been well researched or publicized
- **Large C/T ratio = shorter drift lengths**
- More potential sites where planting space is limited (common in northeast)
- Need for improved design standards

- Effective willow snow fence
- 3 years after planting
- Limited ROW space
- 10 m setback
- Drift length safely contained

Shrub Willow Fences

Ideal plant characteristics

- Numerous stems per plant (porosity)
- Rapid growth rate (capacity)
- Coppice ability, tolerance of high planting density

Relatively low costs...

- Other shrub species
- Large conifer trees
- Structural fences

Numerous Applications

- Windbreaks
- Noise & visual screens
- Buffers

Best practices well developed

- SUNY ESF 2007 - 2013

Conclusion

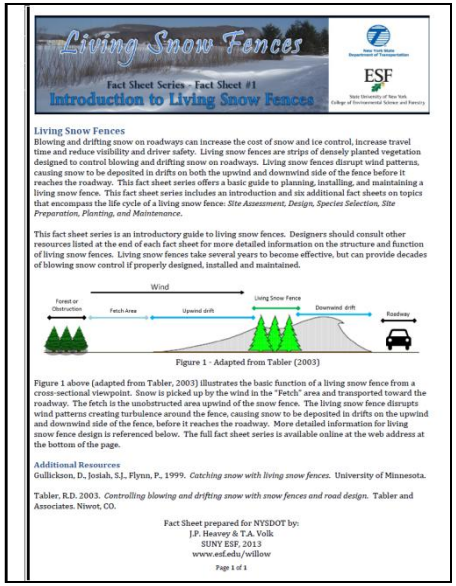
Shrub willows make highly effective LSF..

- Snow trapping just 3 years after planting
- Large storage capacity thereafter

Large capacity = shorter drift lengths…

- Reduced setback requirements
- More potential sites

This is leading to best practices and improved design standards that account for plant growth and snow trapping over time



Living Snow Fences

Fact Sheet Series - Fact Sheet #1

Introduction to Living Snow Fences

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Living Snow Fences

Blowing and drifting snow on roadways can increase the cost of snow and ice control, increase travel time and reduce visibility and driver safety. Living snow fences are strips of densely planted vegetation designed to control blowing and drifting snow on roadways. Living snow fences disrupt wind patterns, causing snow to be deposited in drifts on both the upwind and downwind side of the fence before it reaches the roadway. This fact sheet series offers a basic guide to planning, installing, and maintaining a living snow fence. This fact sheet series includes an introduction and six additional fact sheets on topics that encompass the life cycle of a living snow fence: *Site Assessment, Design, Species Selection, Site Preparation, Planting, and Maintenance.*

This fact sheet series is an introductory guide to living snow fences. Designers should consult other resources listed at the end of each fact sheet for more detailed information on the structure and function of living snow fences. Living snow fences take several years to become effective, but can provide decades of blowing snow control if properly designed, installed and maintained.

Figure 1 - Adapted from Tabler (2003)

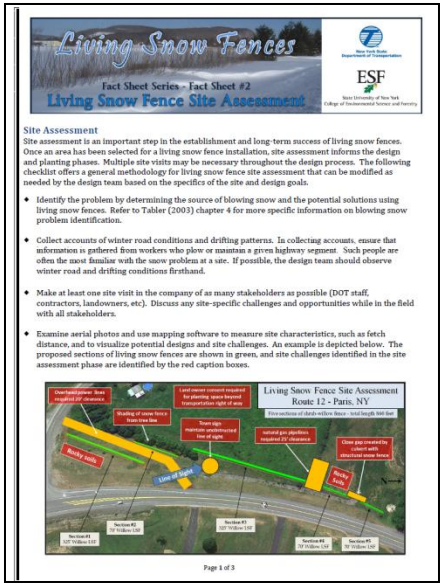
Figure 1 above (adapted from Tabler, 2003) illustrates the basic function of a living snow fence from a cross-sectional viewpoint. Snow is picked up by the wind in the "Fetch" area and transported toward the roadway. The fetch is the unobstructed area upwind of the snow fence. The living snow fence disrupts wind patterns creating turbulence around the fence, causing snow to be deposited in drifts on the upwind and downwind side of the fence, before it reaches the roadway. More detailed information for living snow fence design is referenced below. The full fact sheet series is available online at the web address at the bottom of the page.

Additional Resources

Gullickson, D., Josiah, S.J., Flynn, P., 1999. *Catching snow with living snow fences.* University of Minnesota.

Tabler, R.D. 2003. *Controlling blowing and drifting snow with snow fences and road design.* Tabler and Associates. Niwot, CO.

Fact Sheet prepared for NYSDOT by:
J.P. Heavey & T.A. Volk
SUNY ESF, 2013
www.esf.edu/willow



Living Snow Fences

Fact Sheet Series - Fact Sheet #2

Living Snow Fence Site Assessment

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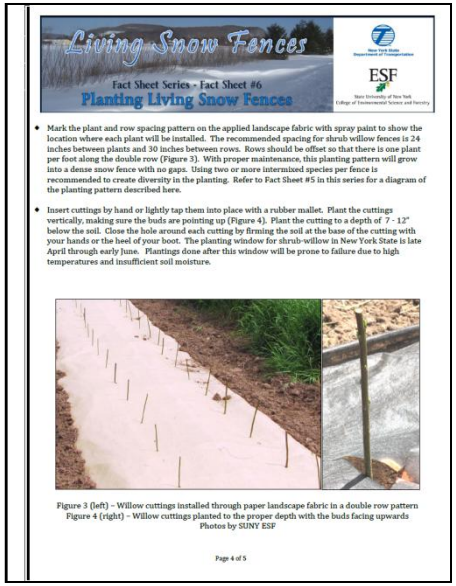
Site Assessment

Site assessment is an important step in the establishment and long-term success of living snow fences. Once an area has been selected for a living snow fence installation, site assessment informs the design and planting phases. Multiple site visits may be necessary throughout the design process. The following checklist offers a general methodology for living snow fence site assessment that can be modified as needed by the design team based on the specifics of the site and design goals.

- Identify the problem by determining the source of blowing snow and the potential solutions using living snow fences. Refer to Tabler (2003) chapter 4 for more specific information on blowing snow problem identification.
- Collect accounts of winter road conditions and drifting patterns. In collecting accounts, ensure that information is gathered from workers who plow or maintain a given highway segment. Such people are often the most familiar with the snow problem at a site. If possible, the design team should observe winter road and drifting conditions firsthand.
- Make at least one site visit in the company of as many stakeholders as possible (DOT staff, contractors, landowners, etc). Discuss any site-specific challenges and opportunities while in the field with all stakeholders.
- Examine aerial photos and use mapping software to measure site characteristics, such as fetch distance, and to visualize potential designs and site challenges. An example is depicted below. The proposed sections of living snow fences are shown in green, and site challenges identified in the site assessment phase are identified by the red caption boxes.



Living Snow Fences

Fact Sheet Series - Fact Sheet #6

Planting Living Snow Fences

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- Mark the plant and row spacing pattern on the applied landscape fabric with spray paint to show the location where each plant will be installed. The recommended spacing for shrub willow fences is 24 inches between plants and 30 inches between rows. Rows should be offset so that there is one plant per foot along the double row (Figure 3). With proper maintenance, this planting pattern will grow into a dense snow fence with no gaps. Using two or more intermixed species per fence is recommended to create diversity in the planting. Refer to Fact Sheet #5 in this series for a diagram of the planting pattern described here.
- Insert cuttings by hand or lightly tap them into place with a rubber mallet. Plant the cuttings vertically, making sure the buds are pointing up (Figure 4). Plant the cutting to a depth of 7 - 12" below the soil. Close the hole around each cutting by firming the soil at the base of the cutting with your hands or the heel of your boot. The planting window for shrub-willow in New York State is late April through early June. Plantings done after this window will be prone to failure due to high temperatures and insufficient soil moisture.

Figure 3 (left) – Willow cuttings installed through paper landscape fabric in a double row pattern
Figure 4 (right) – Willow cuttings planted to the proper depth with the buds facing upwards
Photos by SUNY ESF

Living Snow Fences

Fact Sheet Series - Fact Sheet #7

Living Snow Fence Maintenance

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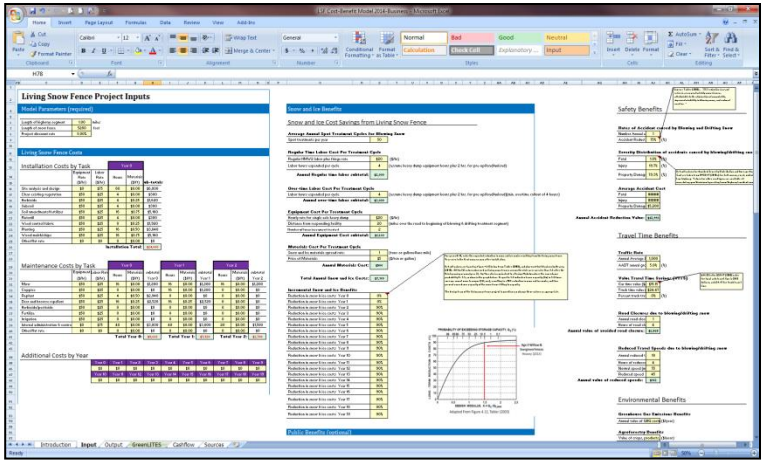
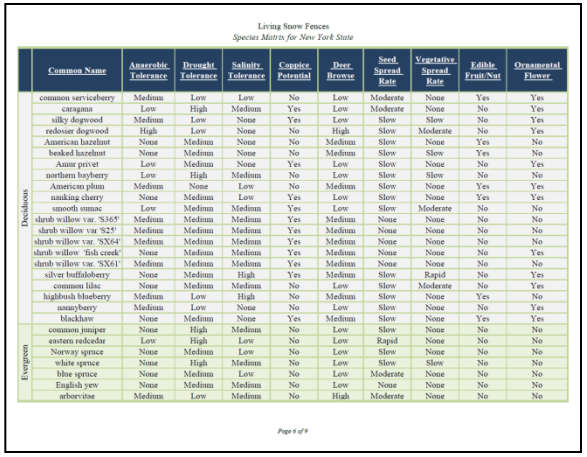
Fence Species Matrix at www.esf.edu/willow/). Long strips of palatable browse in the form of a living snow fence can provide an optimal food source, especially if browsers are not discouraged in any way. Maintaining mowed strips 8 feet or wider can reduce the amount of cover and habitat for browsers and discourage their presence. Shrubs and evergreen trees can be sprayed with natural deer repellent (Figure 1) which works well in preventing browse. Temporary fences can be established around young plants in cases of extreme browse. These measures can temporarily deter browsing long enough for fences to reach heights at which they will be less susceptible to browse.

Figure 1- Maintaining 8+ feet wide mowed strips on either side of the fence, and regularly applying deer repellent to the fence were effective weed and browse controls on this 1 year old shrub-willow snow fence on Route 10 in Beerston, NY. Photo by SUNY ESF

Weather Damage

As in nature, occasional disturbances to trees and plants from weather events are inevitable. Wind, hail, drought, flooding, ice storms, thunderstorms, snow deposition, freeze/thaw cycles, and other adverse weather conditions can damage or kill living snow fences, especially when they are young. Monitor new installations for weather damage, especially after severe weather events. Weather is uncontrollable and often unpredictable, but plants can sometimes be protected before severe weather and rehabilitated or quickly replanted after a severe weather event.





Living Snow Fences
Species Matrix for New York State

	Common Name	Anaerobic Tolerance	Drought Tolerance	Salinity Tolerance	Coppice Potential	Deer Browse	Seed Spread Rate	Vegetative Spread Rate	Edible Fruit/Nut	Ornamental Flower
Deciduous	common serviceberry	Medium	Low	Low	No	Low	Moderate	None	Yes	Yes
	caragana	Low	High	Medium	Yes	Low	Moderate	None	No	Yes
	silky dogwood	Medium	Low	None	Yes	Low	Slow	Slow	No	Yes
	redosier dogwood	High	Low	None	No	High	Slow	Moderate	No	Yes
	American hazelnut	None	Medium	None	No	Medium	Slow	None	Yes	No
	beaked hazelnut	None	Medium	None	No	Medium	Slow	Slow	Yes	No
	Amur privet	Low	Medium	None	Yes	Low	Slow	None	No	Yes
	northern bayberry	Low	High	Medium	No	Low	Slow	Slow	No	No
	American plum	Medium	None	Low	No	Medium	Slow	None	Yes	Yes
	nanking cherry	None	Medium	Low	Yes	Low	Slow	None	Yes	Yes
	smooth sumac	Low	Medium	Medium	Yes	Low	Slow	Moderate	No	No
	shrub willow var. 'S365'	Medium	Medium	Medium	Yes	Medium	None	None	No	No
	shrub willow var 'S25'	Medium	Medium	Medium	Yes	Medium	None	None	No	No
	shrub willow var. 'SX64'	Medium	Medium	Medium	Yes	Medium	None	None	No	No
	shrub willow 'fish creek'	None	Medium	Medium	Yes	Medium	None	None	No	No
	shrub willow var. 'SX61'	Medium	Medium	Medium	Yes	Medium	None	None	No	No
	silver buffaloberry	None	Medium	High	Yes	Medium	Slow	Rapid	No	Yes
	common lilac	None	Medium	Medium	No	Low	Slow	Moderate	No	Yes
	highbush blueberry	Medium	Low	High	No	Medium	Slow	None	Yes	No
	nannyberry	Medium	Low	None	No	Low	Slow	None	No	Yes
	blackhaw	None	Medium	None	Yes	Medium	Slow	None	Yes	Yes
Evergreen	common juniper	None	High	Medium	No	Low	Slow	None	No	No
	eastern redcedar	Low	High	Low	No	Low	Rapid	None	No	No
	Norway spruce	None	Medium	Low	No	Low	Slow	None	No	No
	white spruce	None	High	Medium	No	Low	Slow	Slow	No	No
	blue spruce	None	Medium	Low	No	Low	Moderate	None	No	No
	English yew	None	Medium	Medium	No	Low	None	None	No	No
	arborvitae	Medium	Low	Medium	No	High	Moderate	None	No	No

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