NYSDOT Living Willow Snowfence Training Program 2010

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Background

The Challenge

- Snow and ice removal and control costs over $2 billion annually in the US
- NYSDOT annual S&I costs are $252 million
  - $154 million labor
  - $38 million equipment
  - $60 million materials
- Blowing and drifting snow causes:
  - Reduced visibility
  - Impaired road conditions
  - Reduced road width
  - More frequent road closures
  - Increased number of accidents and injuries
  - Increased need for plowing and deicing materials

The Challenge

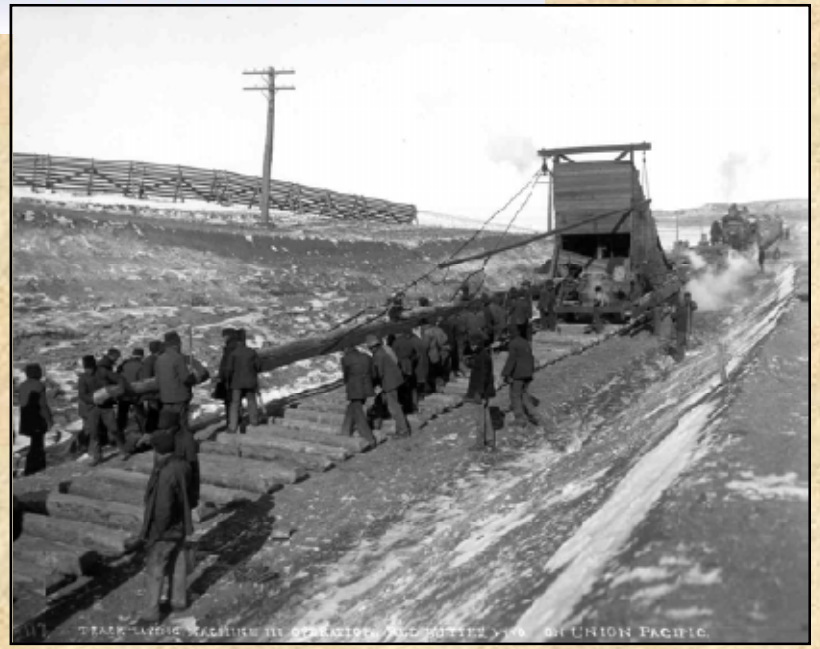
- Mechanical snow removal costs up to 100 times more than trapping snow with snowfences (SHRP 1991)
- Options
  - Wood, plastic or other structural snowfences
  - Living snowfences

Historical Use of Snow Fences

The forest acts powerfully in checking the force of the winds because the elastic swaying of the twigs and branches is a very effective hindrance to the movement of air.

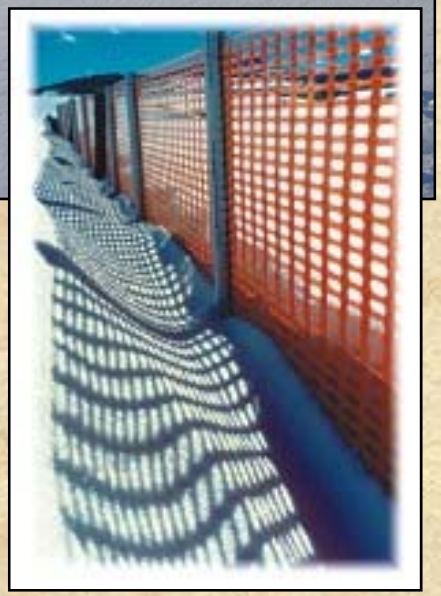
~Gifford Pinchot, 1905

Rock snow fences protecting a railroad cut in SEW Wyoming were probably built in 1868 (Tabler 2003)



Snow fences protecting the Union Pacific Railroad in 1901 (Tabler 2003)

Structural Snowfences



- Less costly than snow removal
  - Snow removal costs about $3/ton (Tabler 2003)
  - A 4 ft high snowfence can trap up to 4.2 tons of snow per linear ft
  - That is >24,000 tons per mile
- Temporary or permanent
  - Wood or plastic composite
  - Cost varies with material and installation location
- Visually unappealing

Temporary Structural Snow Fences

- In areas with large snow transport loads, 4 ft structural snow fences can become buried and ineffective

Temporary Structural Snow Fences

A Solution – Larger Structural Fences

- Permanent structural snow fence being tested in the town of Scott

- Challenging to properly design and locate permanent snow fences with limited rights of way

A Solution – Larger Structural Fences

Structural snow fence
along highway 219

A Solution – Larger Structural Fences

Structural snow fence
along highway 219

Another Solution - Living Snowfences

- Designed plantings of trees, shrubs, and/or native grasses that are strategically established short distances upwind of area of concern used to control drifting snow
- Key characteristics for suitable species
  - High density that extends to the ground
    - » Many deciduous trees do not have this form and are ineffective for snowfences
  - Rapid growth
    - » Several conifers have good crown depth and denswity but are slow to establish
  - Suited to local soil and climate conditions
  - Easy to establish and maintain

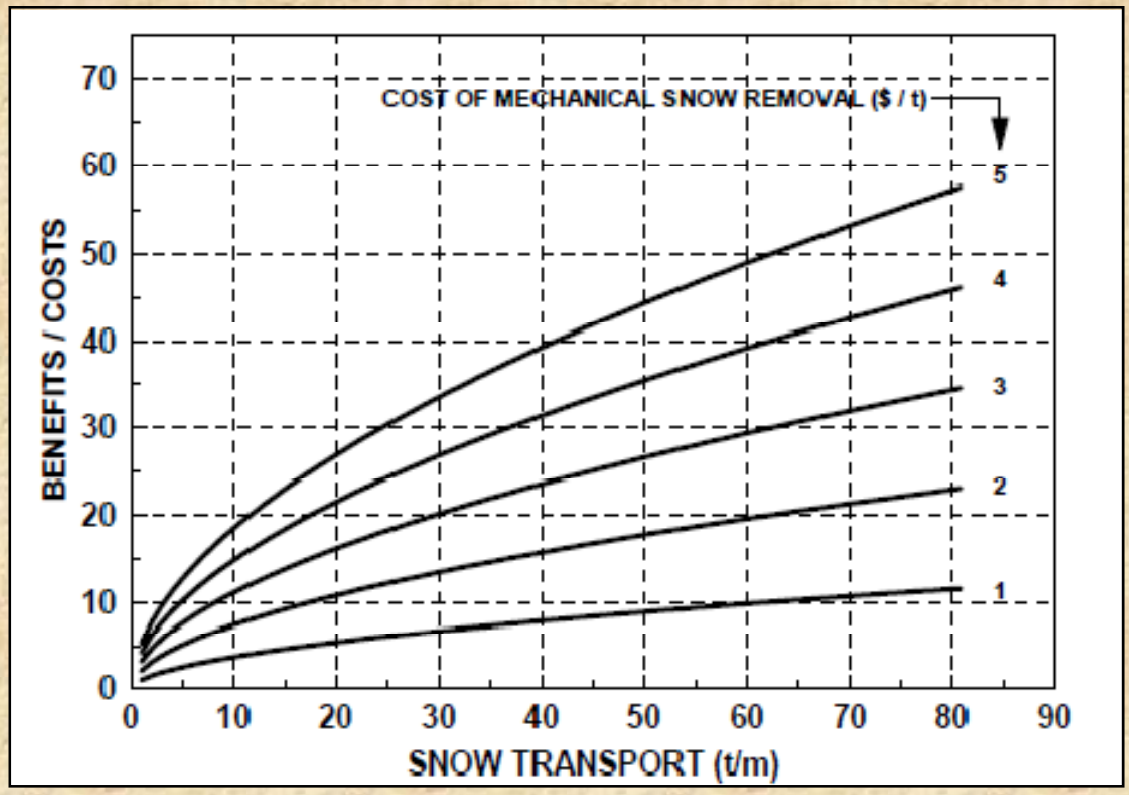
Living Snowfences - Benefits

- Over the long term they can be cheaper than plastic or wood snowfences
- Effective in years with heavy snowfall once established
  - Young living snowfences can be damaged by heavy snow accumulation
- Potential to provide wildlife habitat
  - May be a benefit or limitation
- Potential for income generation for landowner from materials produced from shrubs and trees
- Opportunities for carbon sequestration

Economic Benefit

- Cost benefit ratio of living snow fences in MN ranged from 2:1 to 36:1 (Gullickson et al. 1999)
  - Used average snowfall (32 inches)
  - $1/ton snow removal (it can be $3/ton or greater in severe storms)
  - Only benefits related to snow removal were used as benefits
  - Benefits would be higher if road closure and accident reductions were accounted for
- Developing a cost benefit model for conditions in NY as part of this project

Structural Snow Fences – Cost Benefit



- Benefit cost ratio for snow fences as a function of average annual snow transport and cost of snow removal (Tabler 2003)

- Benefit cost ratio will increase as the amount of snow transported increases and the cost of removal increases

Living Snowfences - Limitations

- Traditional living snowfences require 6 – 20 years to become effective (Tabler 1994)
  - Address with choice of plants and design of system
- Require more space than manufactured snowfences because they often require more than one row of plants
- Biological systems – more care need to establish, potential for damage from pests and diseases
- They are permanent installations so sometimes it is harder to get landowner cooperation

Potential Solution – Willow Snowfences

Mature single row willow snowfence in central NY

- A double row of densely planted shrub willows
  - Easier to establish
  - Rapid growth
  - Dense canopy and lots of stems near the ground
- May not meet aesthetic expectations of landowners and community
  - Mix with other species if desired
- Shrub willow research at SUNY ESF since 1986
  - Excellent knowledge base of willow growth, development and management
- Over 1,200 varieties of shrub willow

Keys for Success

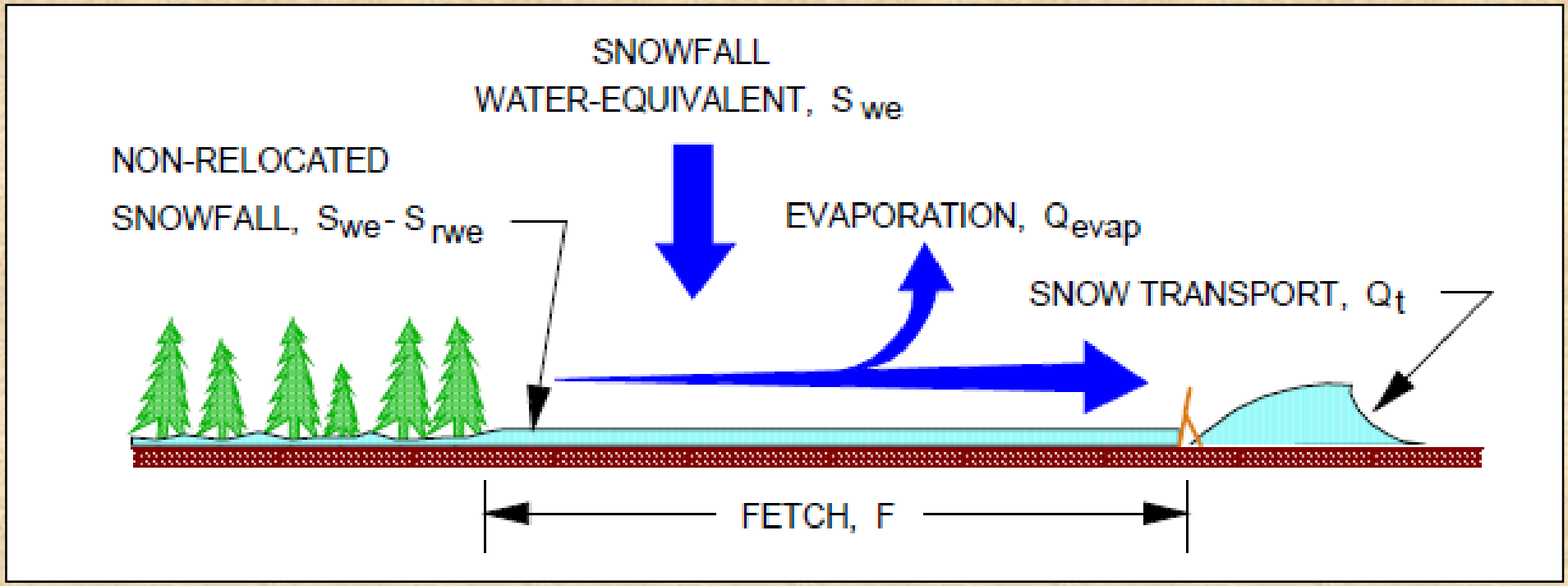
Willow snowfence two years after coppicing

- Collaboration with multiple agencies and landowners
- Planning and design in advance
  - Use of SnowMan software very beneficial
- Proper site preparation
- Careful planting and maintenance

Principles of Blowing and Drifting Snow and Snow Fence Design

Snow Transport

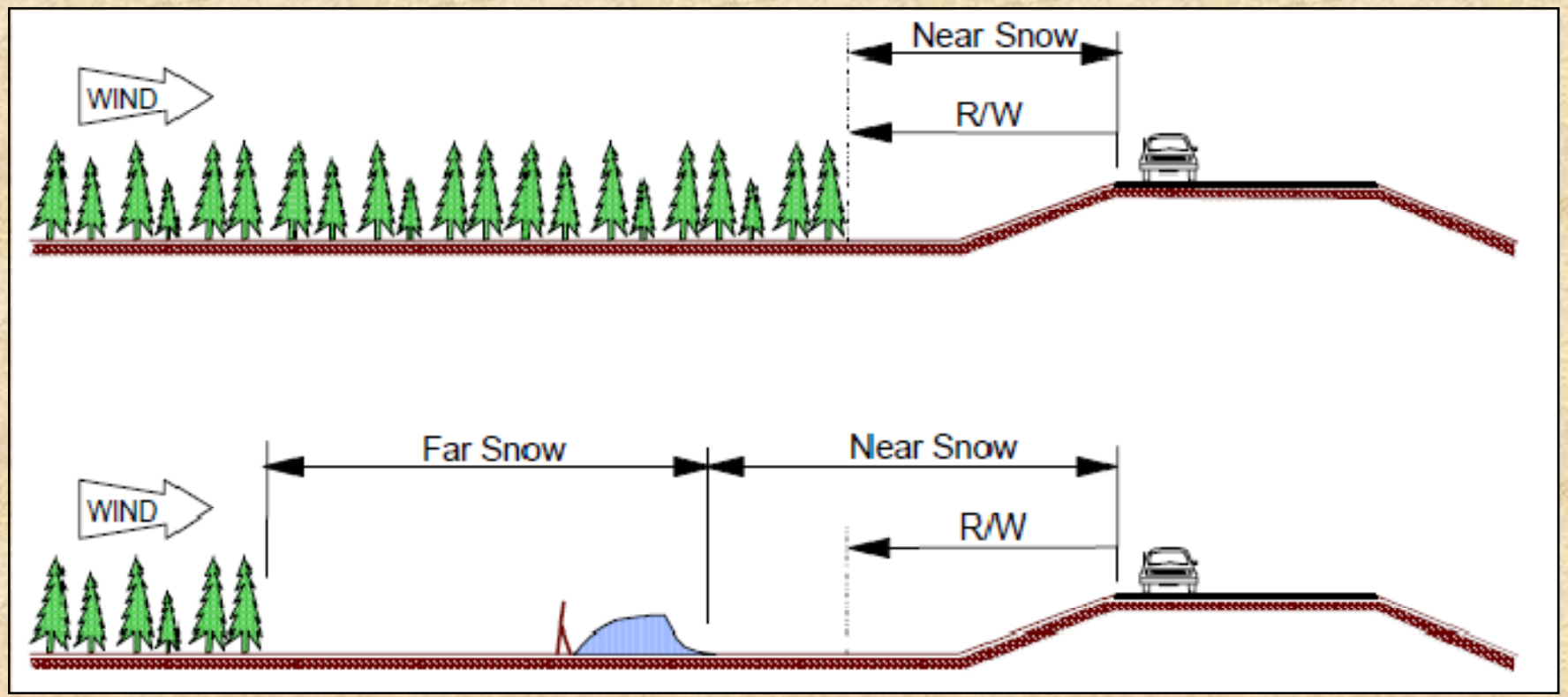
- Factors influencing the amount of snow that could be transported
- Important for determining the storage capacity of a snow fence



(Tabler 2003)

Near Snow and Far Snow

- Different designs and approaches are needed to address near and far snow problems.



Near snow and far snow often require different solutions (Tabler 2003)

How Snow Fences Work

- Snow fences redirect and change wind speed
  - Wind speed increases over the top and around the sides of the barrier
  - Wind speed is reduced below the top of the barrier and downwind, from the snow fence

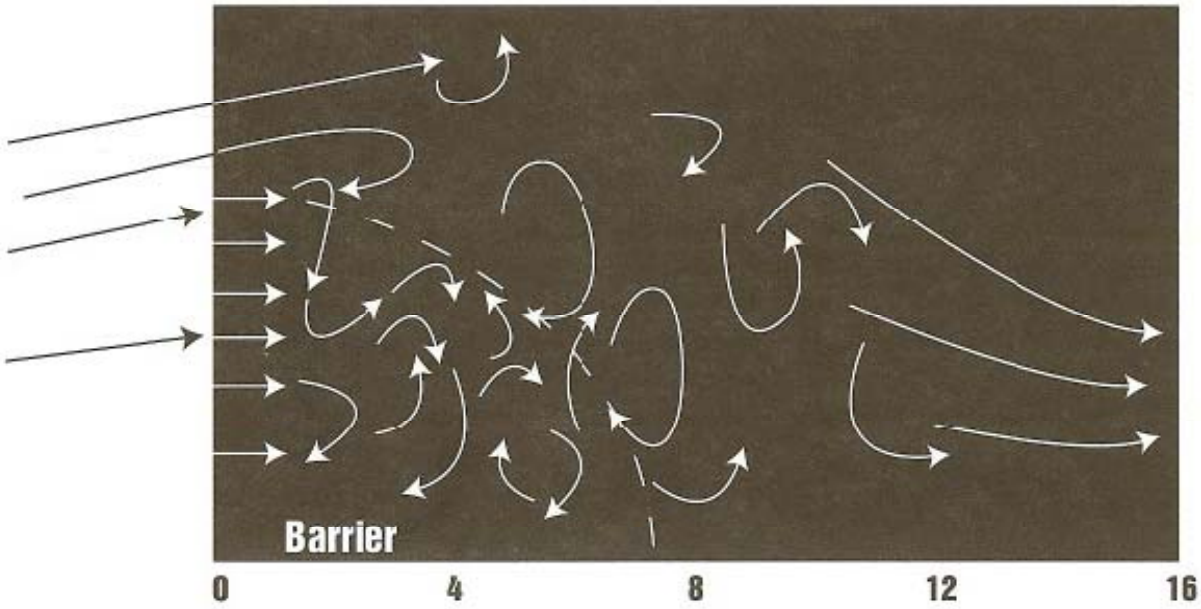


Figure 3.3.
Schematic representation of turbulence in the wake and in the quiet zone behind a model windbreak.

Snow Drift Development

- Snow drifts develop in stages over time
- Main components of snow drifts are snow below

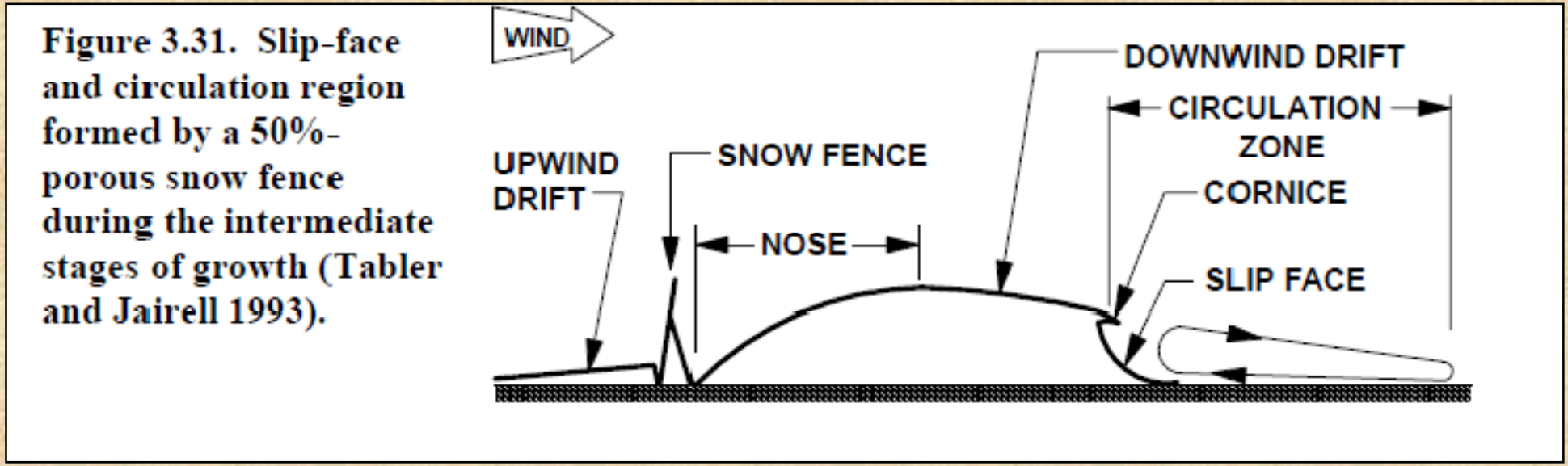


Figure 3.31. Slip-face and circulation region formed by a 50%-porous snow fence during the intermediate stages of growth (Tabler and Jairell 1993).

(Tabler 2003)

Snow Drift Development

- Maximum depth of drift in stage 1 (dates 1 – 3 below) is about 1.0 – 1.2 the height of the snow fence for a 50% porous fence
- Stage 3 (dates 4 – 6 below) occurs as depth of drift approaches its maximum
- Stage 4 (date 7) occurs when drift is smooth with no slip face or circulation zone. At this stage the snow fence is not trapping snow. Good snow fence design will avoid reaching this stage.

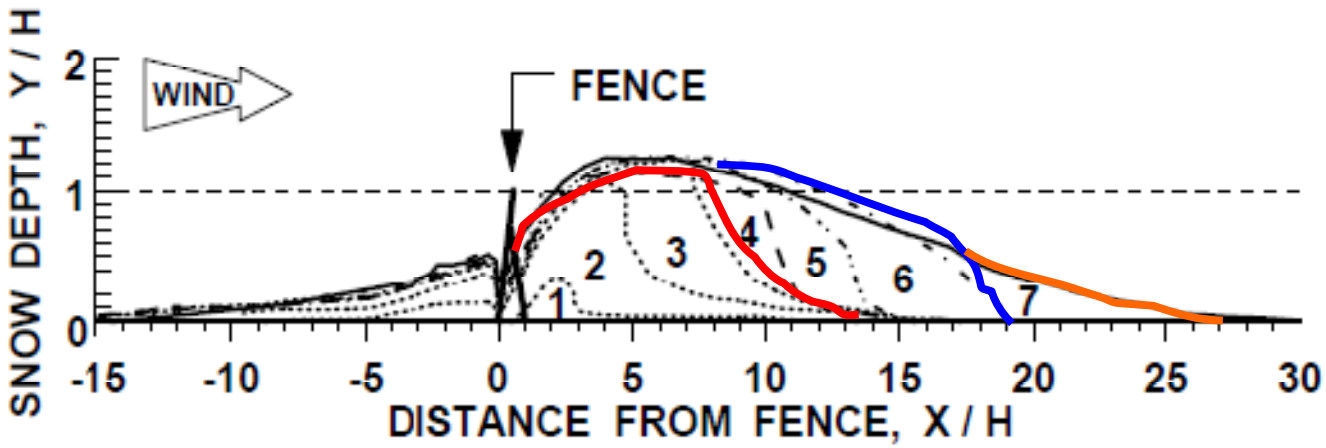


Figure 3.33. Cross-section of snowdrift formed by a 3.8-m (12.4-ft) 50% porous horizontal-board fence on seven dates (Tabler 1986).

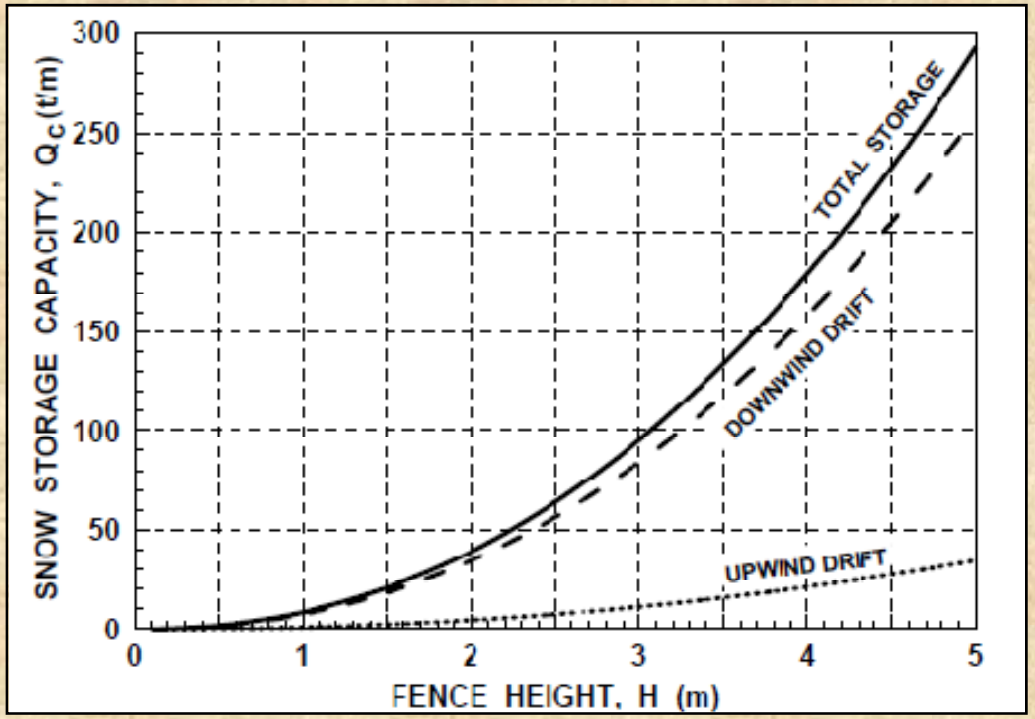
Snow Drift Development

Snow storage capacity of structural snow fences can become filled making them ineffective

- Potential snow storage is related to the height of the snow fence
- Doubling the height of the snow fence increases snow storage potential by 4x assuming all other factors are equal

Snow Storage vs. Height

50% Density Structural Snow Fence



- Snow storage capacity in upwind and downwind drifts formed by a Wyoming snow fence (Tabler 2003)

- Snow can be stored upwind and down wind from snow fences
- For 50% density shown here the amount of snow stored upwind is relatively small
- As density increases the amount of upwind snow stored increases

Snow Storage vs. Height

50% Density Structural Snow Fence

Fence Height (ft)	Tons of snow/linear ft.
4.0	4.4
4.5	5.7
6.75	14.0
8.0	20.3
10.0	33.1
12.0	49.5
15.0	79.0

(Tabler 2004)

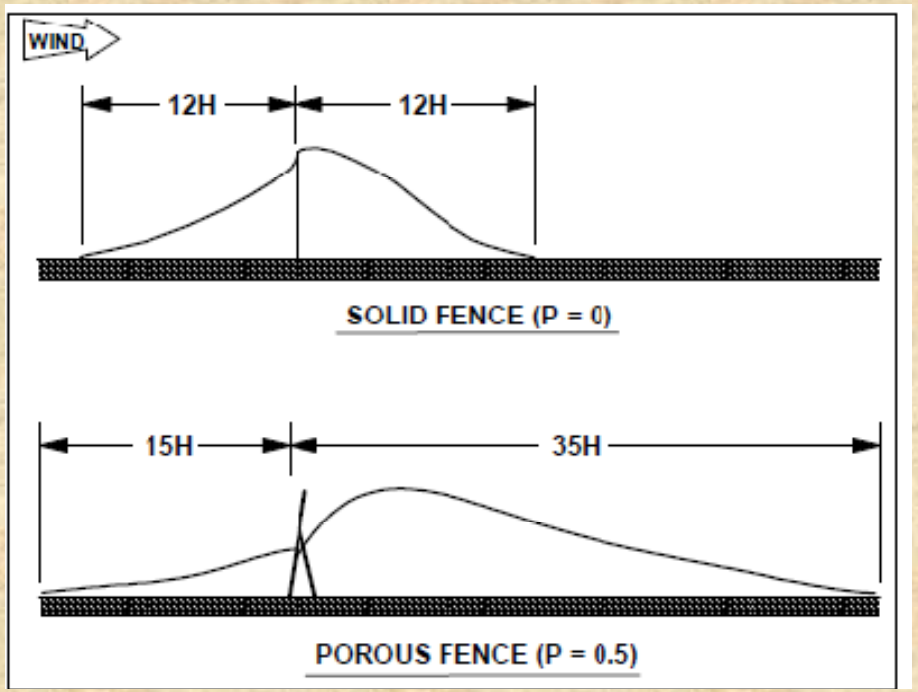
Snow Drift Development

(Double Row of Shrub Willow Two years after Coppicing)

Snow Drift Development

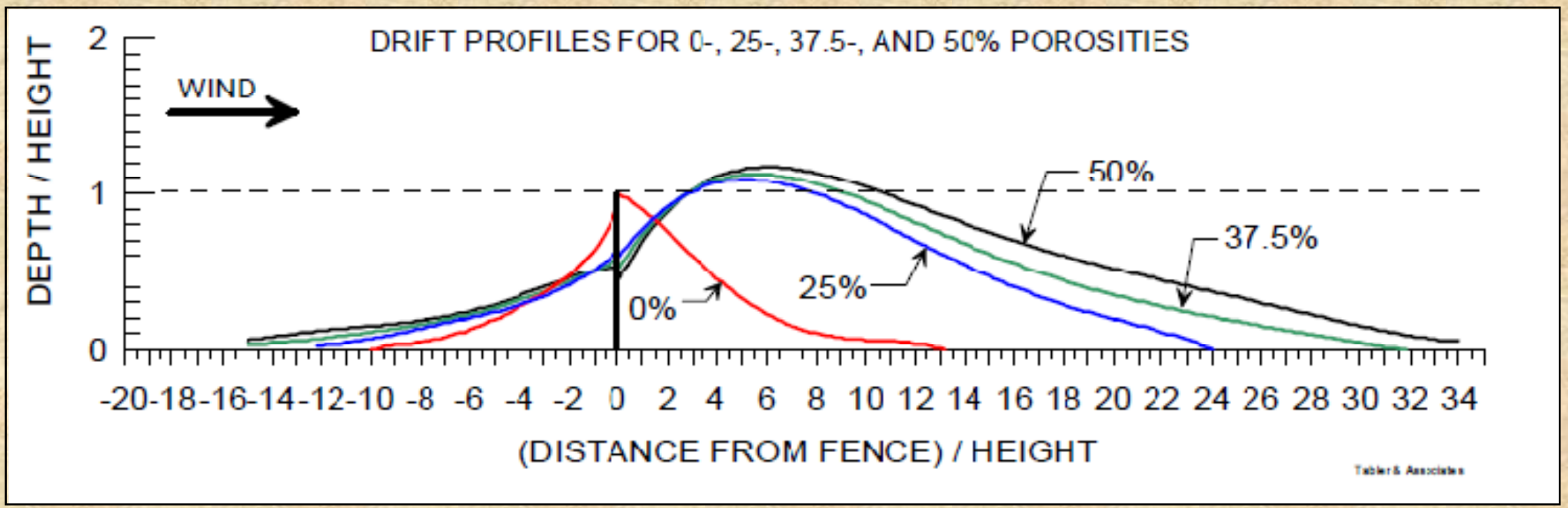
(Double Row of Shrub Willow Two years after Coppicing)

Snow Fence Density / Porosity



- Snow fence density or porosity effect ability to trap snow and the shape and size of an equilibrium snow drift change
  - Solid fence has larger drifts on the upwind side and smaller drift down wind
  - Snow fence density of 50 – 60% (porosity of 50 – 40%) has the greatest storage capacity

Snow Fence Density / Porosity



(Tabler 2003)

Snow Fence Design

- Snow fences- either structural or living – are only some of the options to address blowing and drifting snow
- The situation needs to be addressed properly so that the best solution is implemented
- Other possible solutions may include
  - Modification of cross sections
  - Changes in snow removal practices
  - Modification of safety barriers
  - Management of roadside vegetation or structures including signs

Controlling Far Snow with Snow Fences

- Keys for a successful installation:
  - Adequate storage capacity
    - Factors such as height, porosity and location are important
  - Durable so that it lasts
    - Benefits associated with initial investment increase over time
  - Proper coverage of problem area
    - Long fences without openings and gaps

Snow Fence Design

- Several important factors associated with proper design and placement of snow fences
- Calculating snow transport (i.e. the amount of snow transported by the wind over a given period of time and distance) or capacity needed
  - Identify the snowfall over the snow accumulation season
  - Identify the snowfall water equivalent
  - Identify the relocation coefficient
  - Determine the prevailing direction of greatest snow transport
    - Measure orientation of snow drifts formed by large objects late in the snow season
    - Analyze historical wind records
  - Determine the fetch distance for your location

Snow Fence Design

- Determine required snow fence height
  - Distance from the road
- Determine required set back for snow fence
  - Key factors are
    - » Amount of transported snow
    - » Porosity of snow fence
    - » Height of snow fence
- Length of fence should extend from either side of the problem area that is calculated

Snow Fence Design - Snowman

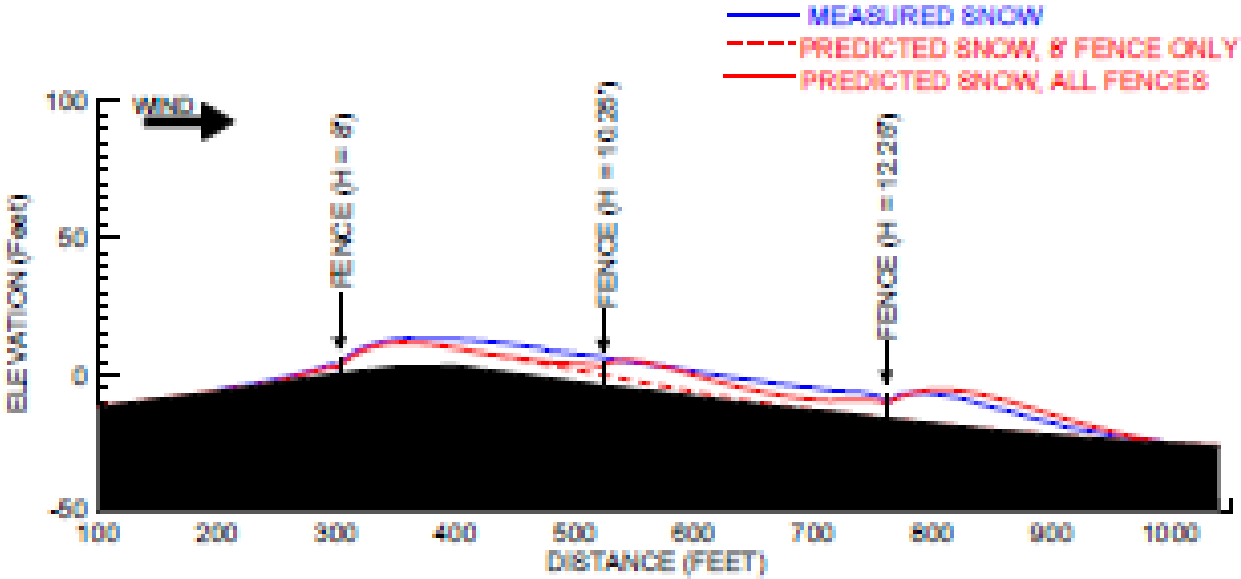


Figure 6.92. Snowdrift profiles predicted with the SNOWMAN drift generation routine, compared with measured drift profile at a site on Wyoming I-80.

Assessing Site Conditions for Plants

Assessing Site Specific Conditions

- More permanent characteristics of living snow fences can be an issue with landowners
- Landowner objectives
  - Clearly identify and discuss the landowner's short and longer term plans and intentions for the area being considered
  - Design will have to fit with the landowner's plans and preferences for the area
    - » Location of living snow fence may not be ideal
    - » Planting design and species selection may have to be adjusted to accommodate landowner
    - » Site preparation and maintenance may have to be modified

Landowner Involvement is Essential

Assessing Site Specific Conditions

- Successful living snow fences start with proper site assessment
- Proper site evaluation will help to avoid many establishment and long term growth and survival problems
  - Site limitations such as wet areas, excessive slopes, stones, fence line removal/trimming
  - Soil conditions
  - Current and previous land use history
  - Existing vegetation
    - Woody plants
    - Herbaceous annual or perennials
    - Agricultural crop

Site Limitations

- Walk the site and determine if there are any barriers to preparing, planting or maintaining the site
- If limitations exist work with the landowner and create a plan to modify them if possible
  - Physically modify the site
  - Adapt equipment to suit the site
  - Change the snow fence design to avoid limitations

Site Assessment – Soil Conditions

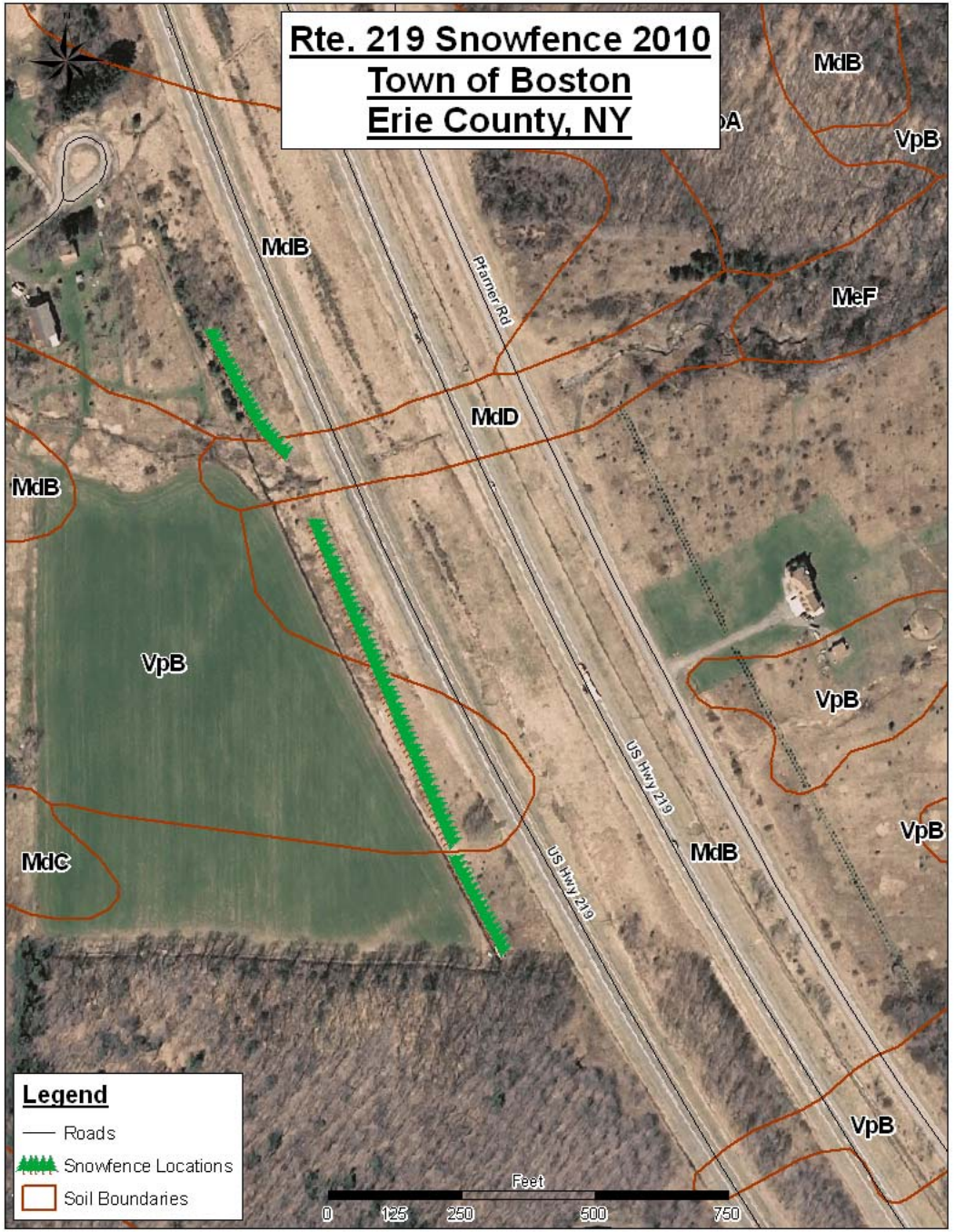
- Soil survey
- Soil samples and testing
- Site specific assessments
  - Drainage problems
  - Bulk density or root growth restrictions from hardpans or fill material

Assessing Site Specific Conditions

- Soil type and conditions
  - USDA soil survey information for fields or areas away from the right of way
  - Specific soil conditions should be assessed, especially on right of ways
    - Soil samples and testing
    - Identify other potential limitations such as wet or seasonally flooded areas, rocks, fence lines, other barriers
  - Collect soil samples, assess rooting depth and potential barriers to successful growth

Soil Survey Information

Highway 219 Town of Boston



Soil Survey Information

Highway 219 Town of Concord

Soil Series Information

- The **Mardin** series consists of very deep, moderately well drained soils formed in loamy till.
  - In glaciated uplands, mostly on broad hilltops, shoulder slopes and back slopes
  - Dense fragipan that starts at a depth of 14 through 26 inches
- The **Volusia** series consists of very deep, somewhat poorly drained soils formed in loamy till.
  - On concave to planer landscape positions in glaciated upland areas.
  - A dense fragipan is at a depth of 10 to 22 inches
  - Saturated hydraulic conductivity in the mineral soil above the fragipan is moderately high or high and in the fragipan and substratum it is low to moderately high.

Soil Sampling

- Make use of standard sampling protocol and testing lab
- For woody plants use recommended sampling depths of 0 – 6 inches and 6 – 20 inches

Soil Test Results

PENNSTATE

(814) 863-0841 Fax (814) 863-4540
Agricultural Analytical Services Laboratory
The Pennsylvania State University
University Park PA 16802
http://www.aasl.psu.edu

SOIL TEST REPORT FOR:	ADDITIONAL COPY TO:
TIMOTHY VOLK SUNY ESF 1 FORESTRY DR SYRACUSE NY 13210	AMOS K QUAYE NY

DATE	LAB #	SERIAL #	COUNTY	ACRES	FIELD ID	SOIL
04/09/2010	S09-31226		OUT OF STATE		1	

South End - 0-6"

SOIL NUTRIENT LEVELS	Below Optimum	Optimum	Above Optimum
Soil pH			
Phosphate (P_2O_5)			
Potash (K_2O)			
Magnesium (MgO)			
Calcium(CaO)			

RECOMMENDATIONS FOR: *Landscape, Maint, pH 7.0*

Limestone, Calcium And Magnesium Recommendations

Apply the following quantities of limestone, epsom salts and/or gypsum to the soil to correct soil pH, calcium and magnesium levels.

Calcitic Limestone: (0-3 % Mg) 16 lb/100 square feet

Magnesium: NONE

Gypsum ($CaSO_4$): NONE

Nitrogen, Phosphate And Potash Recommendations

Apply 3.5 lbs per 100 square feet of 5-10-10 and 0.75 lbs per 100 square feet of 0-46-0.

MESSAGES

The above lime and fertilizer recommendations are for this soil sample and this season only. Nitrogen, phosphate and potash recommendations are for fertilizers containing specific ratios of nitrogen (N), phophate (P_2O_5) and potash (K_2O). As an example 5-10-10 contains 5 % N, 10 % P_2O_5, and 10 % K_2O. If fertilizers with the ratio(s) shown are not available, contact your local garden center or fertilizer supplier for the appropriate substitution.

LABORATORY RESULTS:										Optional Tests:		
[1]pH	[2]P lb/A	Exchangeable Cations (meq/100g)					% Saturation of the CEC			Organic Matter %	Nitrate-N ppm	Soluble salts mmhos/cm
		[3]Acidity	[2]K	[2]Mg	[2]Ca	[4]CEC	K	Mg	Ca			
5.7	24	6.9	0.3	1.4	5.3	13.8	1.9	10.0	38.1			

Test Methods: [1]1:1 soil:water pH, [2]Mehlich 3 (ICP), [3]Mehlich Buffer pH, [4]Summation of Cations

3120

Home Garden-1

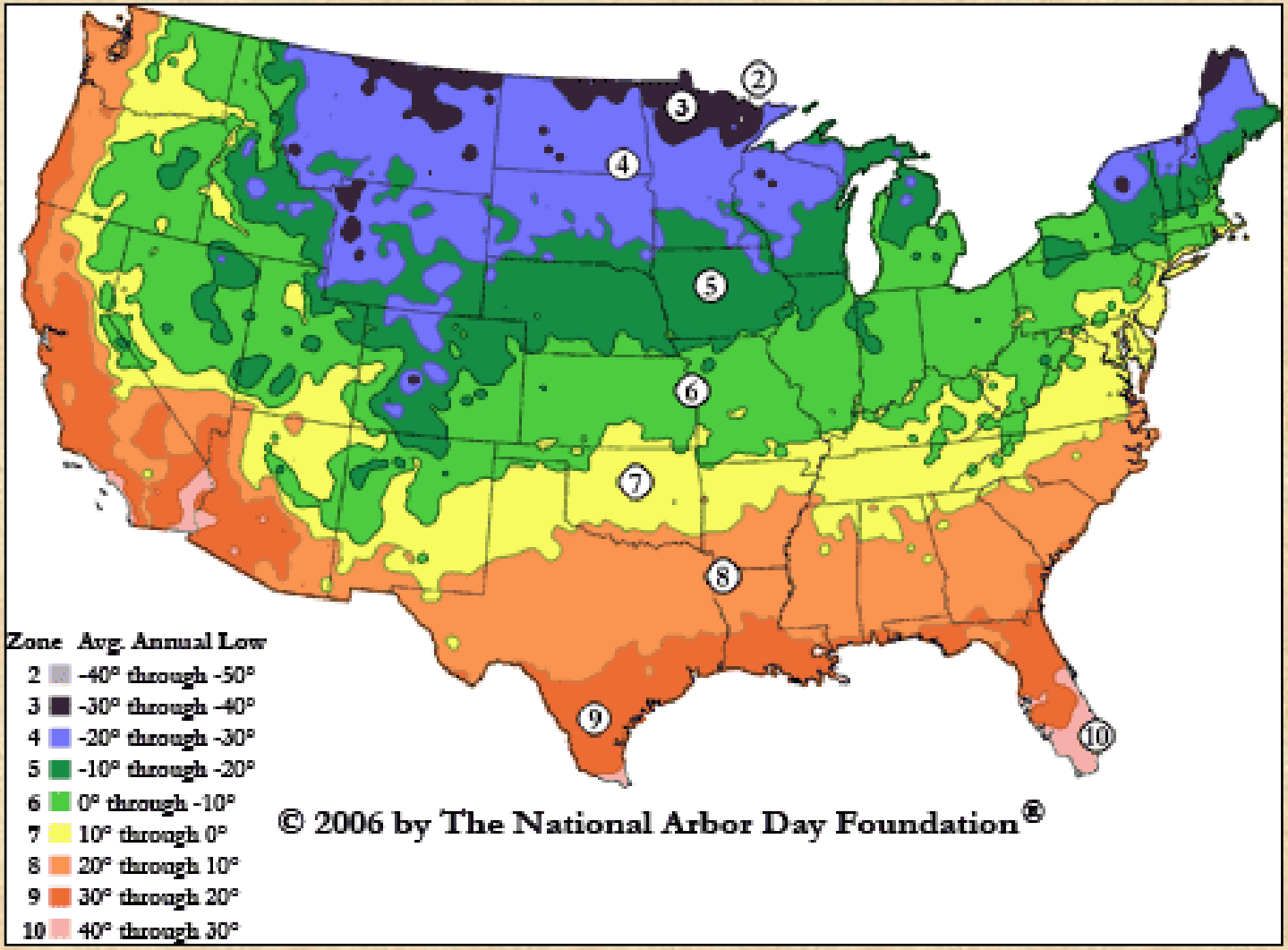
Comments

Soil Testing Results

- If organic matter is less than 1.5% consider incorporating an organic amendment like composted yard waste, manure, or other locally available sources
- Remember that organic amendments will also address some nutrient limitations if they are present
- Pay attention to other characteristics like pH and nutrient level
- Do not add nitrogen (N) fertilizer in the first year, but use results as a guide for second year
  - If mulch is used as part of post planting weed control strategy then N rates should be increased

Selecting Plants for Living Snow Fences

Plant Hardiness Zones



Selecting Plants – Growth Characteristics

- A limitation of living snow fences is the time required for them to become effective
  - Can take up to 20 years
  - But can be as short as 2 – 3 years
- Time for living snow fences to become effective depends on:
  - Site preparation prior to planting
  - Growth rate of plants
  - Growth form and habit of plant
  - Spacing of plants
  - Management of site (weeds and nutrients) after watering
  - Quantity of snow transport

Selecting Plants – Growth Characteristics

- Growth rate
  - Slower growing plants will take longer to form an effective living snow fence
    - In some cases this can be 15 – 20 years
    - Greater potential for damage during this time resulting in gaps
  - Effect of living snow fence will vary as the plants develop, so different growth stages should be considered in the design
  - Interim measures, such as structural snow fences may be required
  - Care in placement is necessary so developing plants do not become buried and damaged by snow drifts
  - Using a mixture of plants with slower and faster growth rates can be effective

First Year Growth of Shrub Willow Double Row Living Snow Fence

Willow Living Snow Fence

One Year Regrowth on Two Year Old Roots

Willow Living Snow Fence

One Year Regrowth on Three Year Old Roots

Selecting Plants – Growth Characteristics

This variety of willow (*S. purpurea*) had prostrate growth when planted in a single row living snow fence

- Height of the plant where the density is great enough to influence wind speed
  - Effective height of the plant will influence the amount of snow that can be stored
  - Effective height does not necessarily correspond to the general height of the plant

Selecting Plants – Growth Characteristics

- Plants need to have dense foliage or branching pattern that extends to close to ground level
  - Self pruning species should be avoided
  - Large gaps (> 10 – 15% of snow fence height) at the bottom of the plant can create wind tunnels and exacerbate blowing snow problems

Selecting Plants – Growth Characteristics

- A space between the ground and the bottom of the snow fence minimizes snow deposition close to the snow fence
- With strong winds and a solid structural (Wyoming) snow fence, larger gaps creates a longer distribution pattern and less snow accumulation on the windward side
- Fences that become buried are less efficient at trapping snow

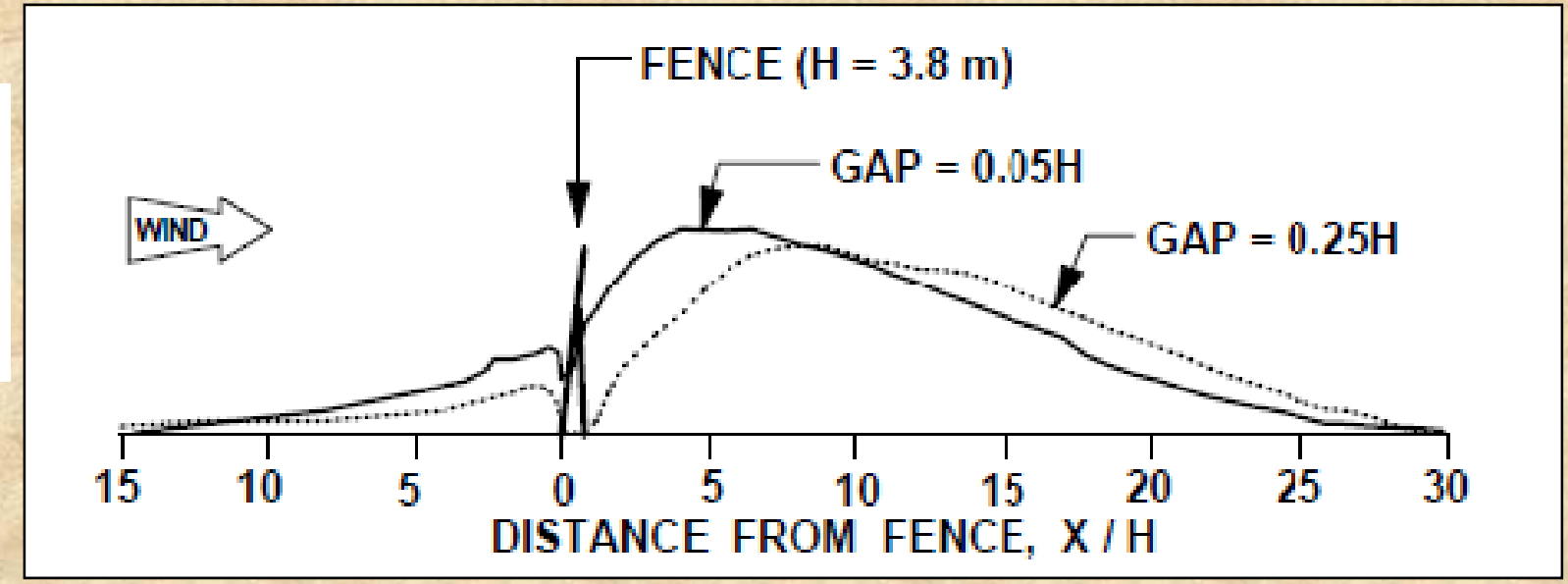


Figure 3.47. Comparison of drifts formed by two 3.8-m (12.4-ft) Wyoming fences that have 30- and 90-cm (12- and 36-in.) bottom gaps, respectively (Tabler 1986).

Selecting Plants – Growth Characteristics

- Gaps or openings in living snow fences caused by mortality can result in large drifts downwind
  - Avoid creation of gaps by planting multiple rows and staggering plantings
  - Select plants that are suited to the conditions of the site
  - Gaps that do result should be filled with structural snow fence until replacement vegetation can be established

Continuous Living Snow Fences

- Snow fences should be continuous without openings
- Access fields and rights-of-way around ends of snow fences
- If access lanes are required, place them at an angle to the prevailing wind

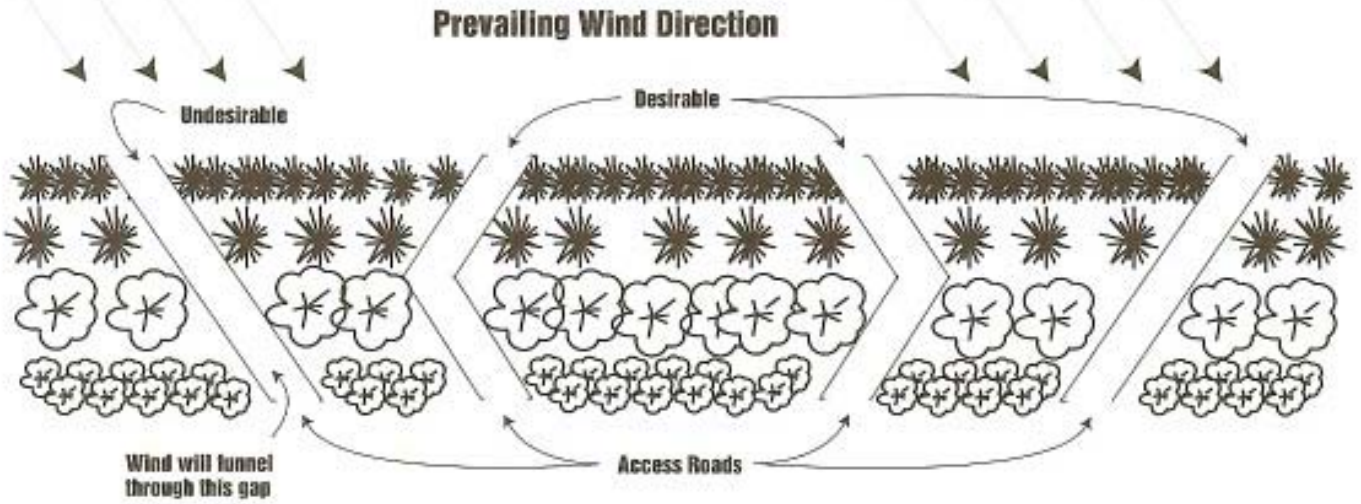
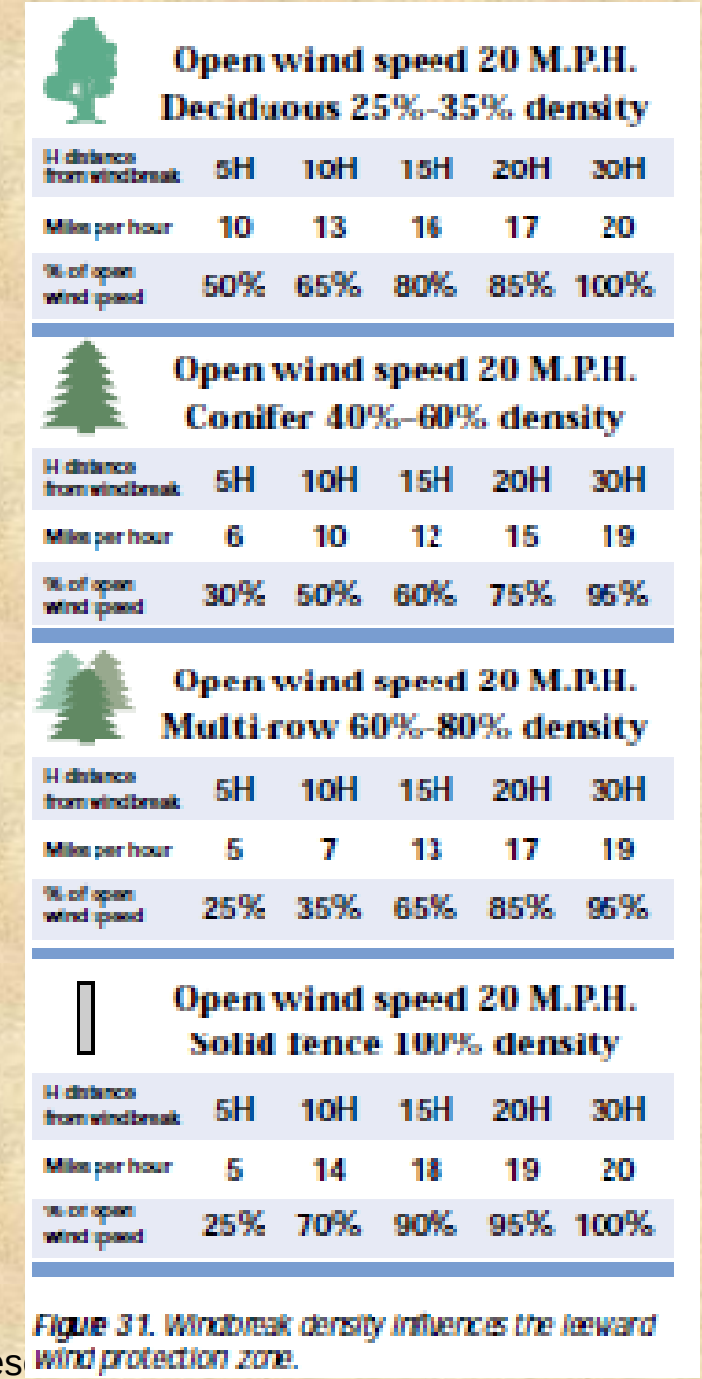


Figure 3.5.
Access lanes and roads should be at an angle to prevailing or troublesome winds.

(Gullickson 1999)

Selecting Plants – Growth Characteristics

Selecting Plants – Growth Characteristics



Open wind speed 20 M.P.H.
Deciduous 25%-35% density

H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	10	13	16	17	20
% of open wind speed	50%	65%	80%	85%	100%

Open wind speed 20 M.P.H.
Conifer 40%-60% density

H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	6	10	12	15	19
% of open wind speed	30%	50%	60%	75%	95%

Open wind speed 20 M.P.H.
Multi-row 60%-80% density

H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	5	7	13	17	19
% of open wind speed	25%	35%	65%	85%	95%

Open wind speed 20 M.P.H.
Solid fence 100% density

H distance from windbreak	5H	10H	15H	20H	30H
Miles per hour	5	14	18	19	20
% of open wind speed	25%	70%	90%	95%	100%

Figure 31. Windbreak density influences the leeward wind protection zone.

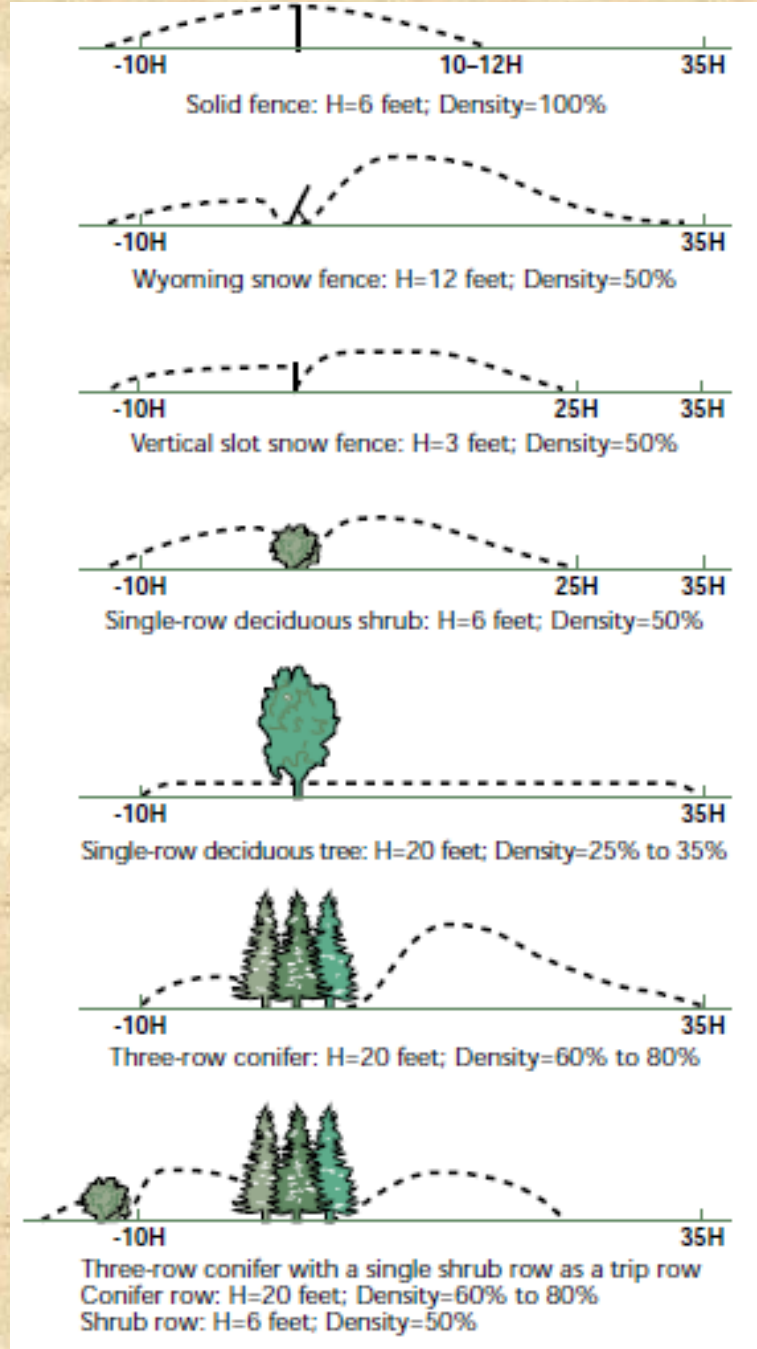
(PNW 2003)

Optical Density

- Optical Density
  - The amount of area composed of solid material (porosity is the amount of area not covered in solid material)
  - For deciduous woody plants this is all stem and branch material
  - For conifers this includes foliage
  - Solid barrier is 100% density (0% porosity)
- Vary density by species selection, spacing, management, number of rows
- Living snow fences with high density >65% will generally have narrower drift patterns

Effect of Density and Height

- Density and height of snow fences influence the storage capacity and drift size and shape
- Can vary this feature with species selection, number of rows, spacing and other management decisions



Selecting Plants – Plant Characteristics Change Over Time

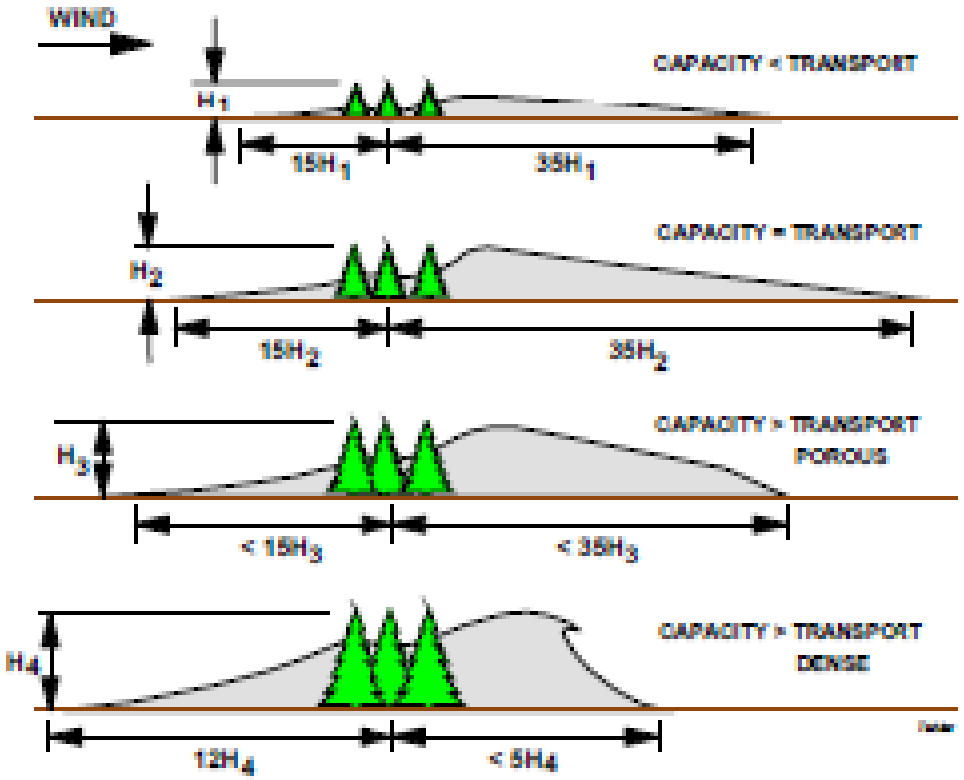


Figure 7.1. Changes in snowdrift shape and snow storage as a living fence grows.

(Tabler 2003)

One Year Old Coppice Growth on a Two Year Old Root System – Single Row

Fish Creek - Density - 47.5%

SV1 - Density – 23.7%

Two Year Old Coppice Growth on a Three Year Old Root System – Single Row

Fish Creek - Density – 50%

SV1 - Density – 53%

Snow Break Forests

- Dense plantings that act as a solid barrier can be planted closer to the road
- Shade from plants may effect road conditions
- Drifts may occur as plants are developing

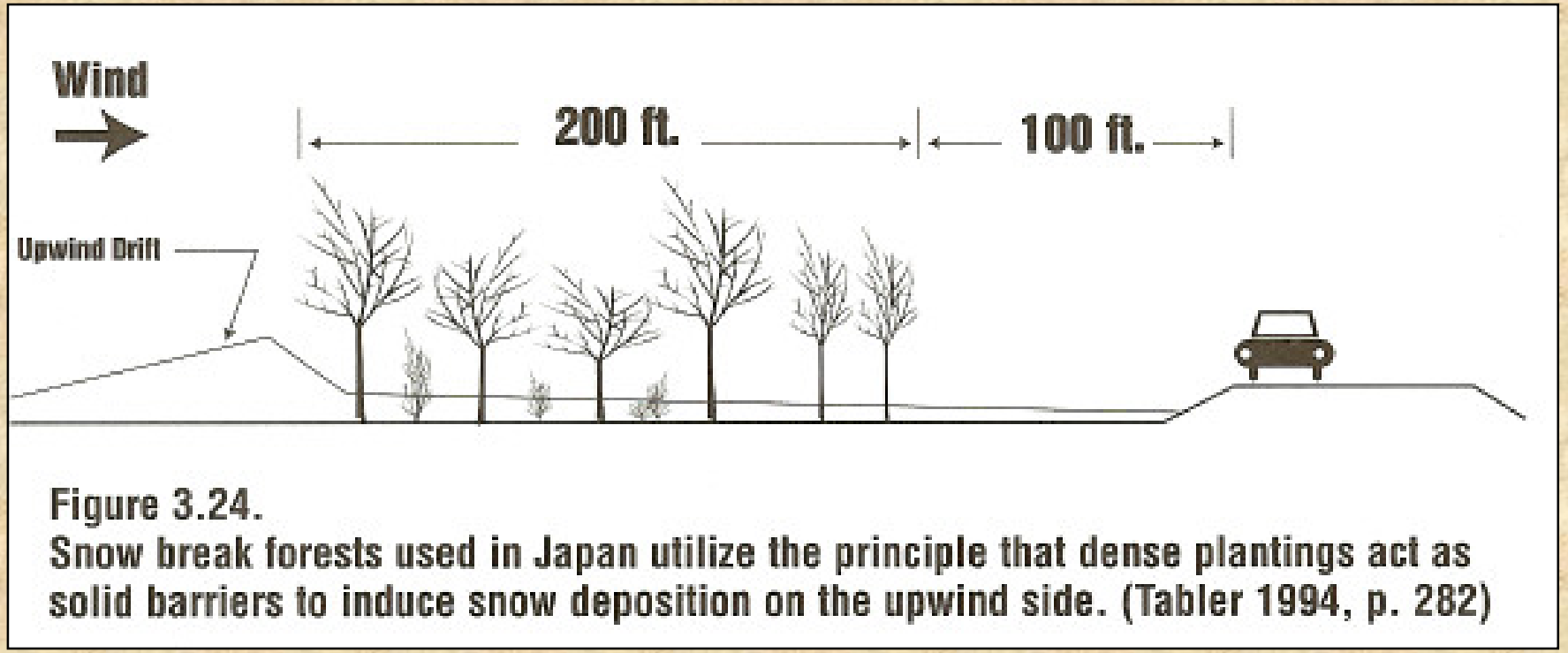


Figure 3.24.
Snow break forests used in Japan utilize the principle that dense plantings act as solid barriers to induce snow deposition on the upwind side. (Tabler 1994, p. 282)

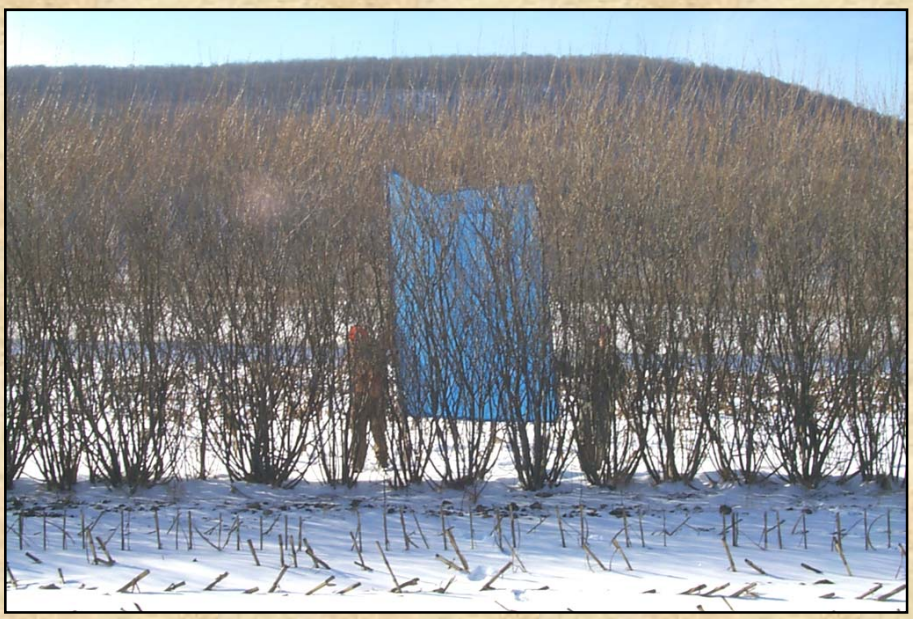
Selecting Plants – Growth Characteristics

- Ability to withstand wind
- Ability to withstand snow loads
- Native or non native
- Invasive
- Species longevity
- Salt tolerance
- Avoid plants for which a major pest or disease problem is known
  - Elms or hybrid poplar in our region

Beneficial Willow Characteristics

- Easy to establish with unrooted cuttings
  - Easier to handle
  - More tolerant of delays in the field
  - Cheaper than rooted stock
- Tolerates planting at high density (1.5 – 2 ft spacing)

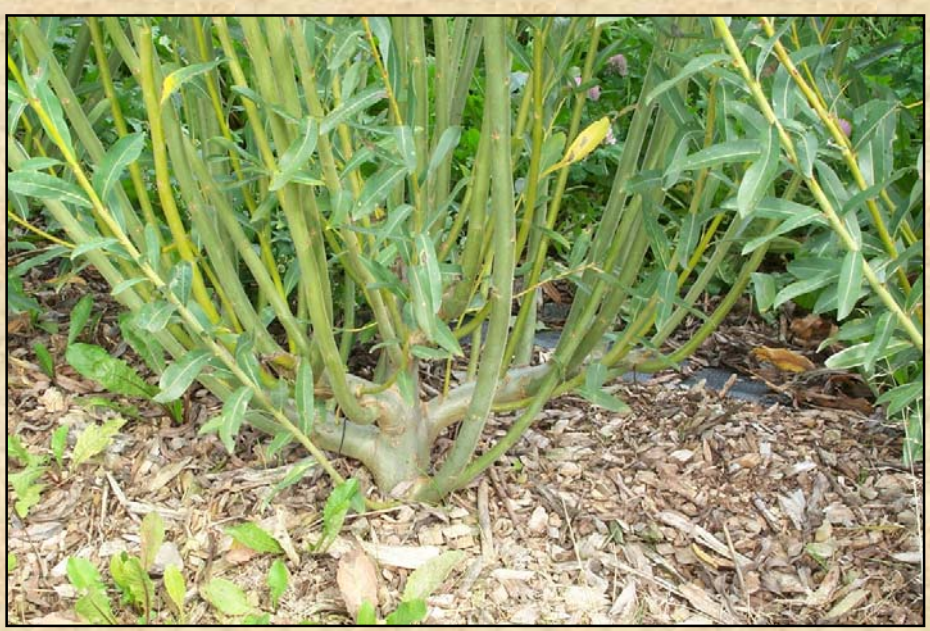
Beneficial Willow Characteristics



Measuring optical density on a living willow snowfence in Cortland County, NY

- Rapid height growth
  - Can reach >20 ft in 3-years
  - Can reach 50% density in 3 years
- Larger planting stock can be used to accelerate establishment
- Effective in as little as two to three years

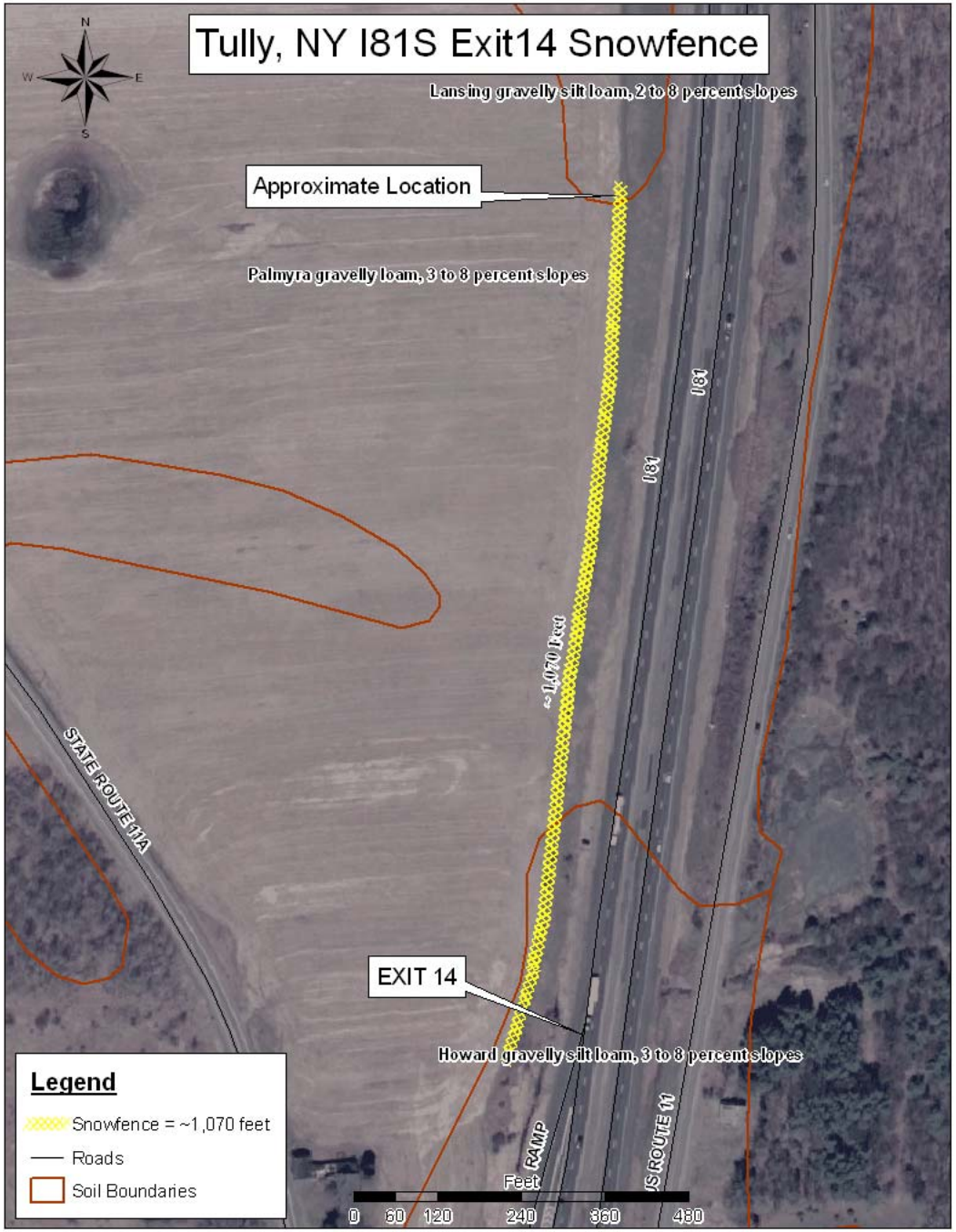
Beneficial Willow Characteristics



Willow (*S. purpurea*) living snowfence five months after coppicing

- Coppicing ability creates good density from the ground to top of the crown
  - Mature willow snowfence has a measured density of 60-70%
- Once established, maintenance is minimal
- Height and density can be modified by selecting willow varieties and changing spacing and/or management

Site Characteristics Influence Plant Selection



Route 81S
Near Tully, NY

- Planted May 2009
- Excellent initial survival
- Late July 2009

Route 81S Near Tully, NY

- Planted two varieties with different growth characteristics
- August 2009

Route 81S Near Tully, NY

August 2009

Route 81S Near Tully, NY

March 2010

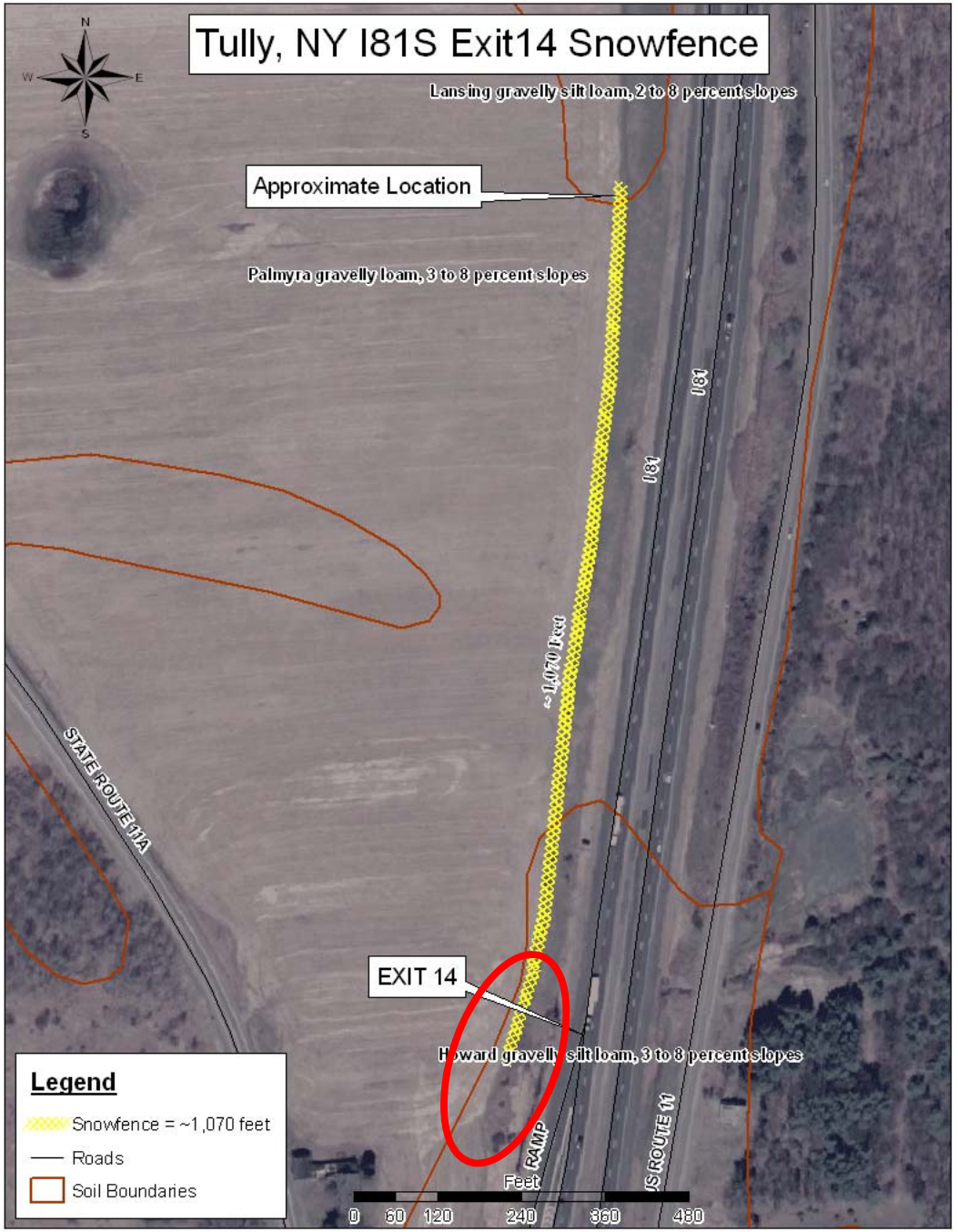
Route 81S Near Tully, NY

March 2010

Selecting Plants

March 2010

Site Characteristics Influence Plant Selection



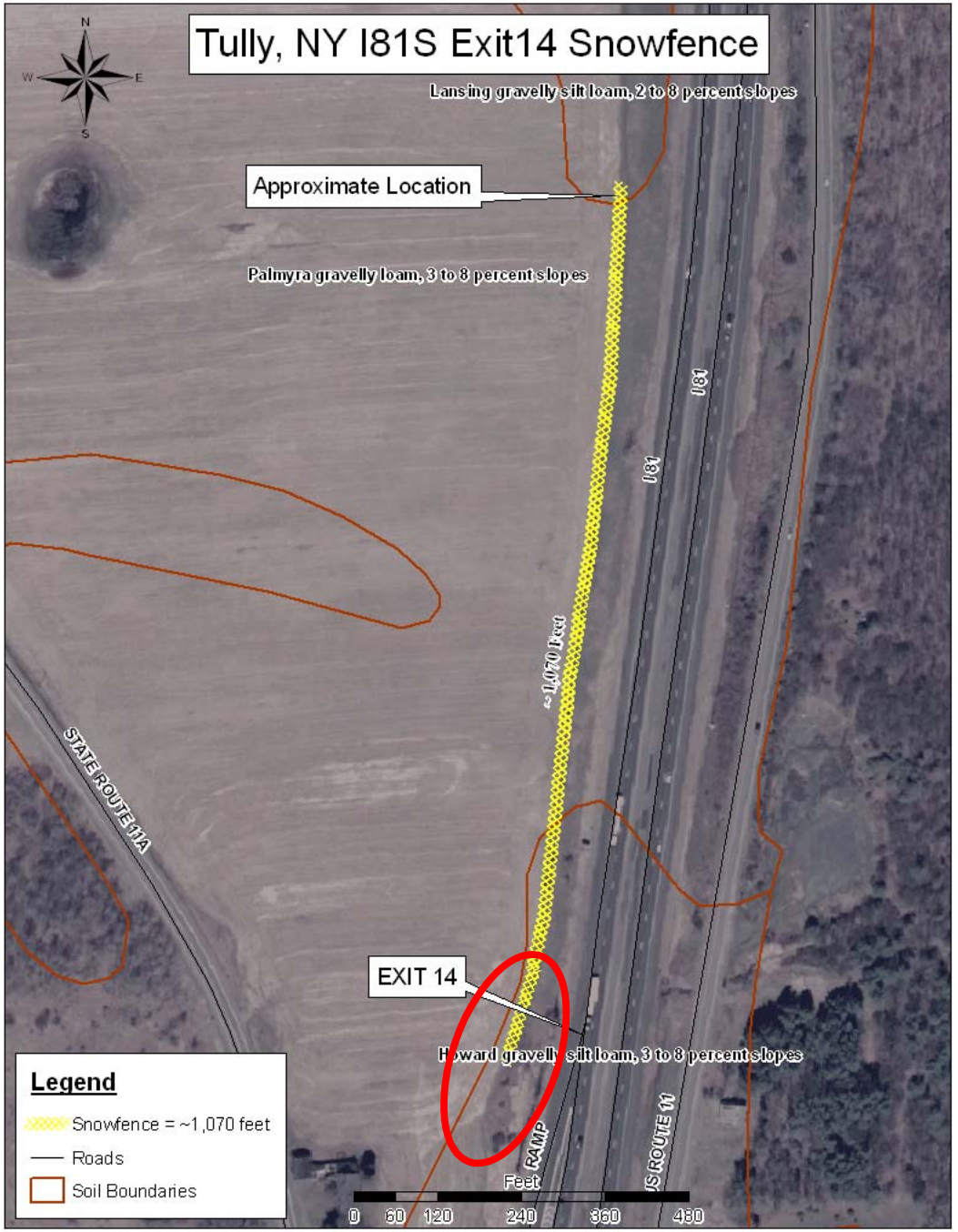
Selecting Plants

First year willow clone breaking under snow load at 81S site near Tully

Route 81S Near Tully, NY

- Concern about snow drift forming around the end of the living snow fence

Site Characteristics Influence Plant Selection



Installation and Maintenance of Living Snow Fences

Successful Living Snow Fence Installation

- Keys for successful installation of living snow fences
  - Proper site preparation base on good site assessment
  - Careful installation of plants
  - Control of grass and broadleaf weeds for 2-3 years after planting

Site Preparation

- Site preparation is a one time investment that influences the effectiveness of the living snow fence for years or decades
  - Take the time, make the effort, do it correctly!
- An important rule for successful living snow fence establishment is to address weed problems and soil limitations during site preparation BEFORE the living snow fence is planted
- Controlling weeds or modifying site conditions after planting is more costly and time consuming!

Site Preparation

- Benefits of proper site preparation
  - Control of existing weed pressure
  - Initial control of future weed pressure to minimize future maintenance costs and damage to plants in the living snow fence
  - Improve soil structure in rooting zone
  - Expand soil volume for rooting
- Results
  - More effective establishment
  - Reduced maintenance efforts and costs
  - Shorter time for living snow fence to be effective

Weed Control

- Weeds compete for moisture, nutrients and light
- Maintain a weed free area 2-3 ft away from where plants are placed
- Control weeds for 2-3 year establishment period

Site Preparation Flow Chart

Site Preparation - Mechanical

- Cultivation to reduce competition of existing grasses and prepare the soil for planting
  - Disking, subsoiling, rototiller
  - Will not provide long term control of perennial vegetation
- Disturbs the soil
  - Increase soil permeability and aeration
  - Reduce or remove barriers limiting plant growth

Mechanical Site Preparation

Site Preparation - Mechanical

Site Preparation - Chemical

- Herbicides to control competing vegetation before planting
  - If possible this is best done in the late summer or early fall prior to planting
  - Chemical control of existing perennial vegetation is not as effective in the spring
  - Limitations and restrictions on herbicide use
  - Follow label guidelines

Site Preparation - Chemical

One-year old willow snow fence with weed & deer browse problems in western NY

Establishing a living snow fence in Cortland County in the spring of 2001.

- Good weed control for the first two years
  - Herbicides for Site Prep fall before planting
    - glyphosate (Round Up - Touchdown)
      - 2 lbs. a.i./Acre
  - Depending on weeds present may also add following in a herbicide mixture:
    - 2,4-D @ .5 – 1 lb a.i./Acre
    - dicambia (Banvel) @ .5 – 1 lb a.i./Acre
    - Mixture of 2,4-D and triclopyr (Crossbow) (.5 – 1 lb a.i./A and ¼ - ½ lb a.i./A)
  - Herbicides for Site Prep in spring of planting
    - glyphosate (Round Up - Touchdown)
      - 2 lbs. a.i./Acre

Existing Vegetation – Woody Plants

- Bush hog then apply appropriate herbicide
- Stumps less than 3” can usually be removed during tillage operations
- Stumps >3”
  - Remove if only a few
  - Incorporate plants into the living snow fence

Existing Vegetation – Herbaceous

- Bush hog if greater than 10-12 inches tall because effectiveness of herbicide will be limited
- Determine type of vegetation
  - Perennial – herbicide and mechanical cultivation
    - » Check efficacy of post emergent herbicides after use by inspecting above and below ground plant parts
    - » Retreat sections that were missed or where herbicide was not effective
  - Annual – mechanical cultivation alone may be effective

Existing Vegetation – Agricultural Crop

- If actively used for cropping then ask for list and rates of recent herbicides used
- Some herbicides have a carry over effect and can influence establishment of new plants
- Annual crop – mechanical tillage
- Perennial crop – chemical and mechanical control

Post Planting Weed Control

- No method provides 100% guarantee
- Periodic monitoring of site is necessary
- Be prepared to respond quickly to weed pressure before it becomes a serious issue
  - i.e. smaller weeds are easier to control and will have less effect on the plants you are trying to establish

Post Planting Weed Control – Mechanical

- Mechanical cultivation
  - Various types of equipment are available
    - Disks
    - Spring tooth harrows
    - Cultivators
    - Specialized cultivators
  - Work best on young weed seedlings that are not well established
  - Less aggressive cultivation will not be effective on perennial weeds

Post Planting Weed Control – Mechanical

- Mowing of adjacent weeds
  - Important for areas beyond immediate 2-3 foot zone around living snow fence plants
  - Will not effectively reduce weed competition for water and nutrients in the immediate zone around establishing plants

Post Planting Weed Control- Mechanical

- Mechanical cultivation alone not recommended
  - Timing is essential and hard to ensure
  - Up to 4 – 5 cultivations per year required for effective control
  - With each cultivation there is potential for damage to living snow fence plants
  - Difficult to mechanically control weeds near and in between plants
    - » Often requires manual weed control to be effective

Post Planting Weed Control - Chemical

- Can be effective in combination with proper site preparation
- Requires proper selection and use of herbicide
- Monitoring still required to ensure that weed control goals are being met

Post Planting Weed Control - Premergence

0ne-year old willow snowfence with weed & deer browse problems in NY

Establishing a living snowfence in Cortland County in the spring of 2001.

- Proper follow up weed control after planting is essential for success
  - Pre-emergence herbicides:
    - oxyfluorfen (Goal)
      - 1 – 2 lbs a.i./Acre
    - simizine (not in sandy soils)
      - 2 – 4 lbs a.i./Acre
    - pendimethalin (Prowl – Pendulum)
      - 2 lbs a.i./Acre
  - Other pre-emergence herbicides that look ok
    - norflurazon (Solicam) (.8lb a.i./A)
    - flumioxazin (Sureguard) (.25lb a.i./A)
    - imazaquin (Scepter) (.125lb a.i./A)

Post Planting Weed Control – Post Emergence

0ne-year old willow snowfence with weed & deer browse problems in NY

Establishing a living snowfence in Cortland County in the spring of 2001.

- Proper follow up weed control after planting is essential for success
  - Post-emergence herbicides:
    - glyphosate (Round Up - Touchdown)
      - 1- 2 lbs. a.i./Acre shielded/directed spray
    - paraquat (Gramoxone) (burn down only)
      - .5 - 1 lbs. a.i./Acre shielded/directed spray
    - clopyralid (Stinger) (not in Nassau & Suffolk Counties – max of .25 lb a.i./A/year in NY)
      - .125 - .25 lb a.i./Acre
    - Any grass only herbicide
      - Fusilade or Poast, etc.

Post Planting Weed Control – Organic Mulches

- Can help with weed control but will need to be maintained over time if it is the primary weed control method
  - Annual addition of mulch as material degrades and weeds become established on the surface
- Additional benefits include
  - Moisture retention
  - Moderated soil temperatures which can potentially extend root growth into the fall but slows soil warming in the spring

Post Planting Weed Control – Organic Mulches

- Wood chips are the preferred mulch
  - 3 – 4 inch layer of chips
  - If possible the lower layer should be composted
- Limitations
  - Potential for introduction of addition weed seeds
  - May enhance rodent damage in the winter
  - Labor cost associated with spreading mulch

Post Planting Weed Control – Landscape Fabric

Establishing a willow living snow fence in Lewis Co., NY in the spring of 1999.

- Can be effective for 1 – 6 years or more depending on type of fabric and use
- Mats or rolls available
- Select material that has a projected lifespan of 3 – 5 years
  - Breakdown will be slower if not exposed to sunlight
- Recommended width is 6 ft, but comes in 3 – 6+ ft widths

Fabric Barrier

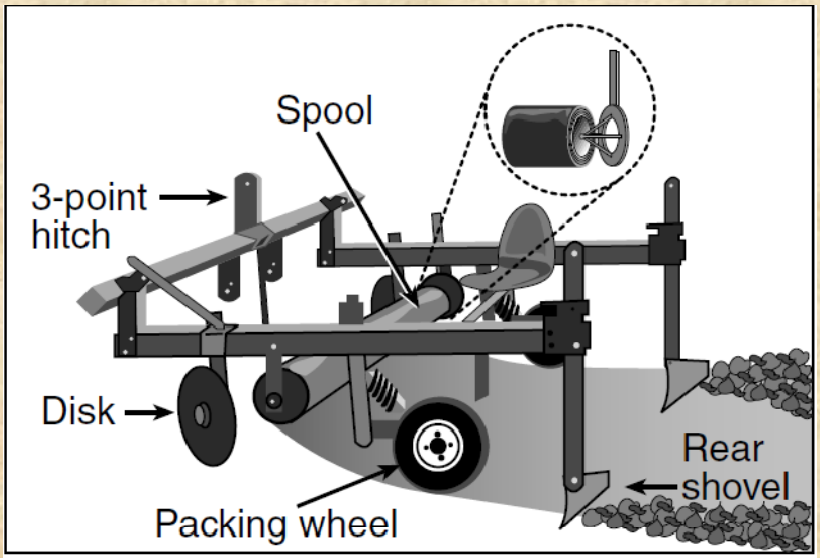


Figure 1. Fabric mulch dispensing machine.

(KSU 2004)

Fabric Advantages

- Applied only once
- Improved tree and shrub establishment and survival
- Increases growth rates immediately following planting
- Easier and more timely weed control
- Long lasting weed control
- Comparable cost to other weed control methods averaged over several years

Fabric Barrier

(PNW 2003)

- **Fabric Disadvantages**
  - Initially expensive
  - Requires specialized machinery to install or done by hand
  - Proper installation is critical to prevent pulling loose in winds
  - Does not break down, especially within the shade of plants or under mulch
  - Stems may be girdled by fabric as trees and shrubs grow
  - Dense sod can become established on top of fabric, negating benefits and complicating future maintenance
  - Ideal habitat for ground hogs, voles and mice

Post Planting Weed Control – Landscape Fabric

- Should remove or till in weeds before use
- Fabric needs to be secured at time of installation to avoid abrasion of planted material
  - Plastic pegs, cover edges with soil (but will promote weed growth), cover with mulch
- Create openings in fabric using X-shaped cuts to avoid girdling as plants grow

Post Planting Weed Control – Landscape Fabric

- Improper installation can result in significant damage to plants
  - Broken stems and braches
  - Girdling from abrasion
  - Plants covered and smothered
  - Excessive temperatures under the fabric

Post Planting Weed Control – Landscape Fabric

- Can be very effective and beneficial
- BUT
  - When installed improperly it can cause extensive damage


03/23/2005


03/23/2005

Fabric Barrier Recommendations

Proper mulching of landscape fabric is important for success.

Fabric Management

- Inspect as part of monitoring in first 1 – 2 years
- Ensure edges are firmly anchored
- Ensure openings are large enough to avoid stem damage
- Control aggressive weeds that may establish in fabric openings
- Enlarge openings as needed to prevent stem girdling
- Cover with mulch but leave area immediately around plants uncovered

Planting Rooted Stock

- Different types available
  - Bare root or plug
- Small sized material is lower cost and easier to handle and plant
- Available from commercial nurseries or from DEC or Soil and Water Conservation Districts

Planting Rooted Stock

Planting Rooted Stock

- Proper care of rooted stock is essential
  - Keep plants moist and in a cool location
  - Roots must never dry out!
- Make the hole deep enough for all roots.
- Cut long roots back to 10 or 12 inches.
- Remove one tree at a time from bucket only after hole is ready for the tree.
- Keep foreign matter (leaves, sticks, rocks, and dry soil) out of hole.
- Place all tree roots in a downward position.
- Place tree in center of hole.
- Hold treetop upright while working soil around roots.

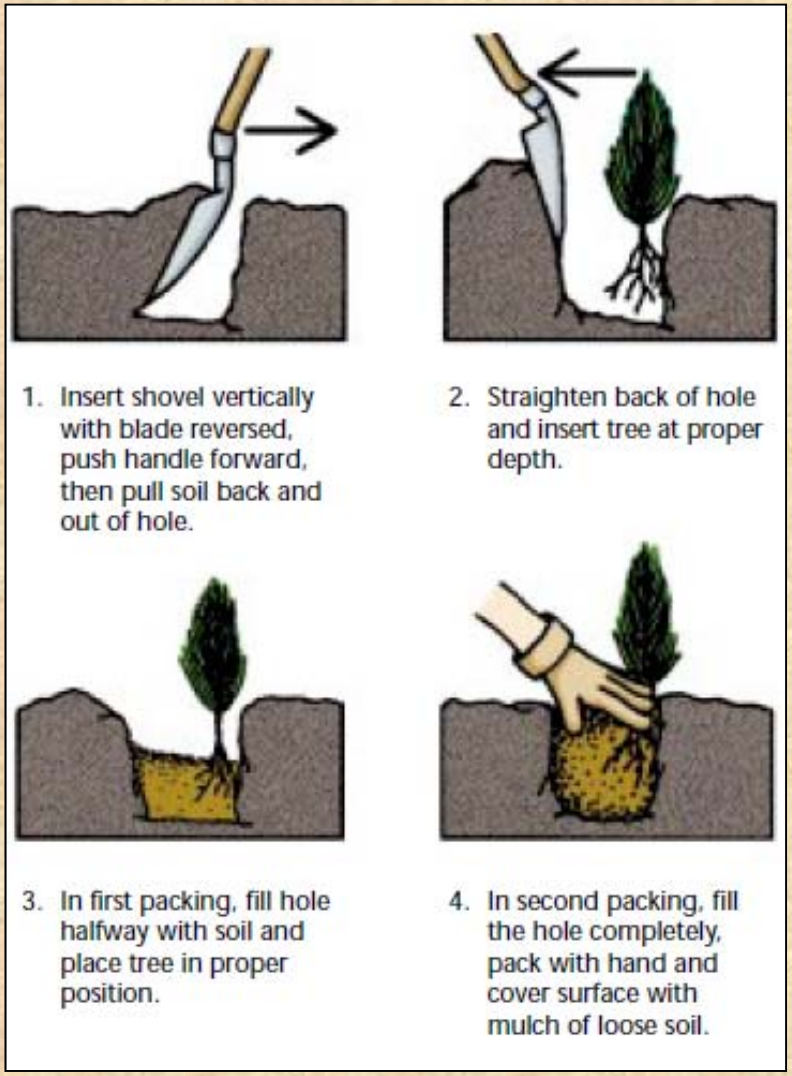
(adapted from PNW 2003)

Planting Rooted Stock

- Firm soil around roots by hand while filling hole, leaving no air spaces. Make sure to use moist soil.
- Bring soil level to root collar (look for color change on stem) above the first roots. Too deep is better than too shallow.
- Firm soil all around tree by hand to give good compaction.

(adapted from PNW 2003)

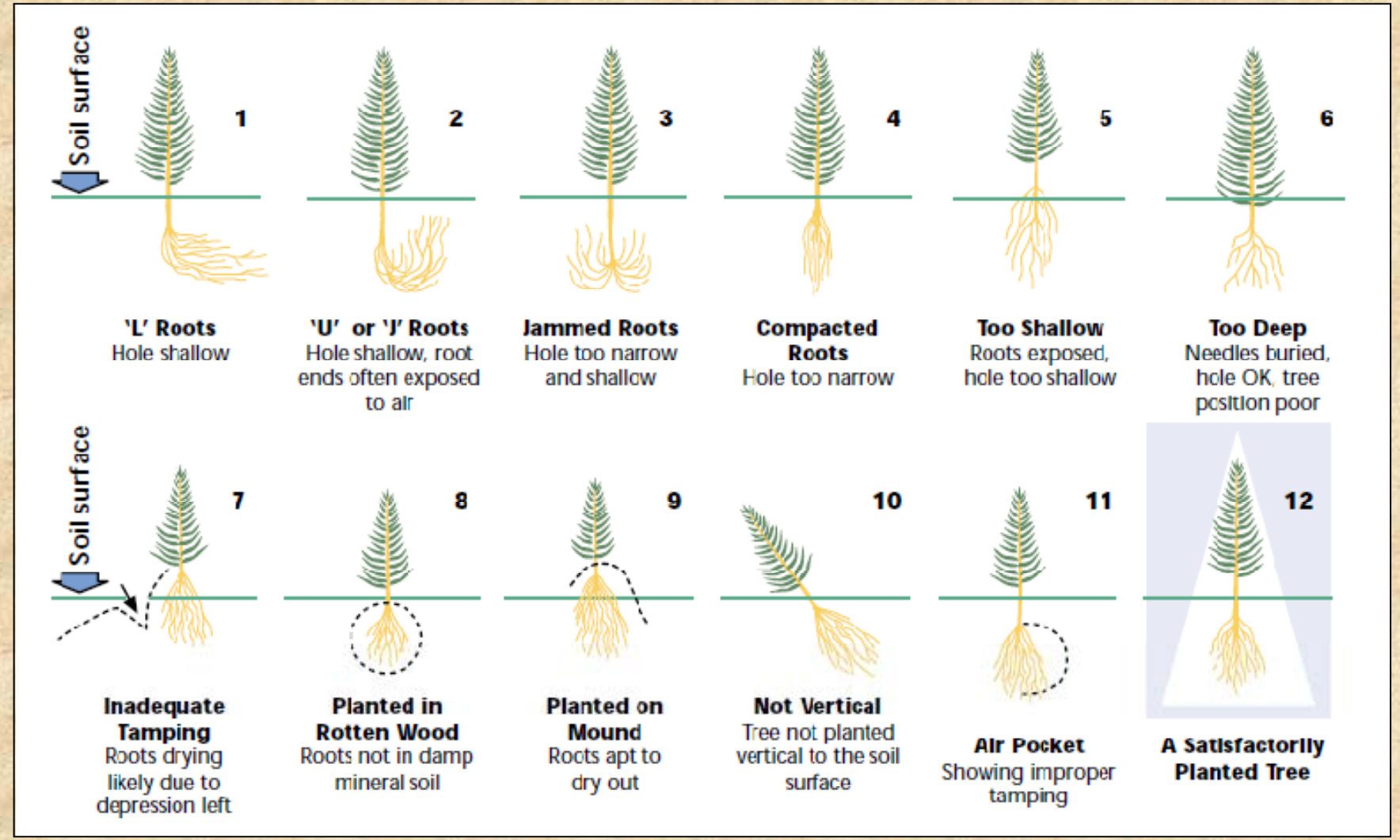
Planting Rooted Stock



- Trees and shrubs planted improperly have little chance to survive. Take an extra moment with each plant and make sure they are planted properly

(adapted from PNW 2003)

Proper Planting is Essential



(PNW 2003)

Planting – Unrooted Cuttings

- Used for establishing willow and hybrid poplar
- Lower cost and easier to handle
- Quality of material is important
- Recommend 10 – 20” cuttings
- Keep frozen until just before planting
- Store in cool location and do not allow them to dry out after being delivered
- Plant with buds pointing up with at least one bud above ground

Planting – Unrooted Cuttings

Planting of unrooted hardwood cuttings is easy and relatively quick

- Plant 10 to 20 in. long cuttings between late April and early June
- Use high quality planting stock that has been properly stored and cared for

Post Planting Care

Weed control is probably the single largest factor for the failure of living snow fences

- Regular monitoring is needed to quickly identify problems before they become serious issues
  - Weed pressure
  - Browsing damage
  - Pest and disease problems
  - Herbicide damage from improper use or drift
  - Other factors that may be limiting growth

Post Planting Care

- Weed control will be necessary for 2-3 seasons at least
  - Longer for sites where growth of shrubs or trees is slow
- Replanting
  - Even under the best conditions some plants will not survive
  - Gaps will create additional problems in the future
- Coppicing
  - For willows coppicing after the first year of growth is recommended to promote the development of multiple stems
- Fertilizer may be applied after the plants are established
  - Fertilizer on young or poorly established plants will just feed the weeds
  - Spring application of fertilizer based on soil analysis or plant tissue analysis

Successful Installations

Willow snowfence three months after planting.

First year of growth after coppicing

Successful Installations

Willow snow fence two months after planting

Successful Installations

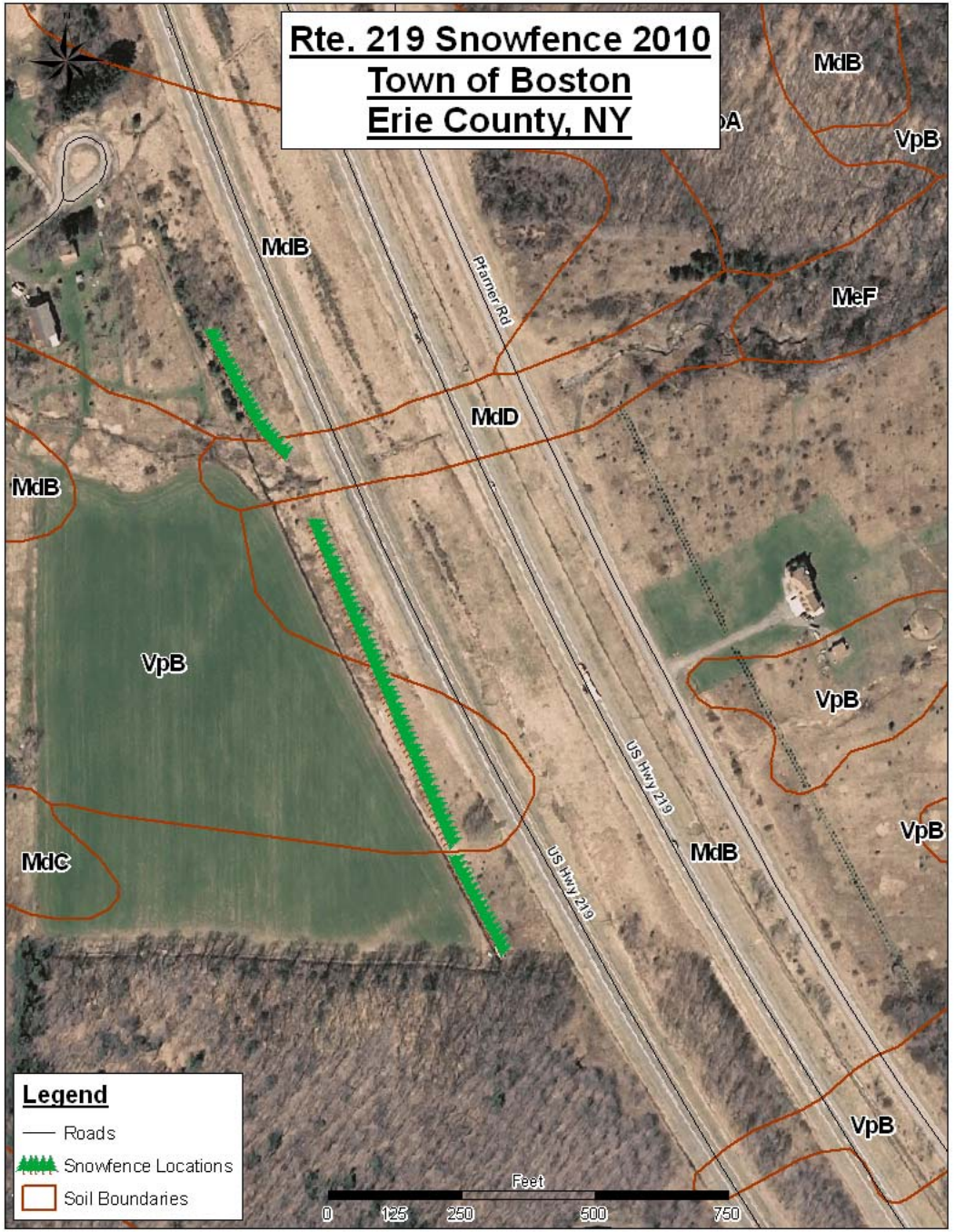
Successful Installations

Lessons Learned/Shared Experiences

Field Installation Activities

Soil Survey Information

Highway 219 Town of Boston



Planning and Site Preparation

- Existing structural snow fences
- Snowman was run for the site to identify location for living snow fence
- Site inspection and soil samples collected
- Revisited site and assessed conditions and decisions this spring

Site Preparation

- Sprayed site to kill existing vegetation
- Subsoiled site due to concerns about fragipan
- Added lime and fertilizer
  - Main nutrient concern was P
- Rototilled site and laid landscape fabric

Site Preparation

- Mark landscape fabric with one double row
  - 2.5 ft between double rows
  - 2 ft along the rows in a staggered design
  - Result is a plant about every foot
  - Slit fabric with X style cut

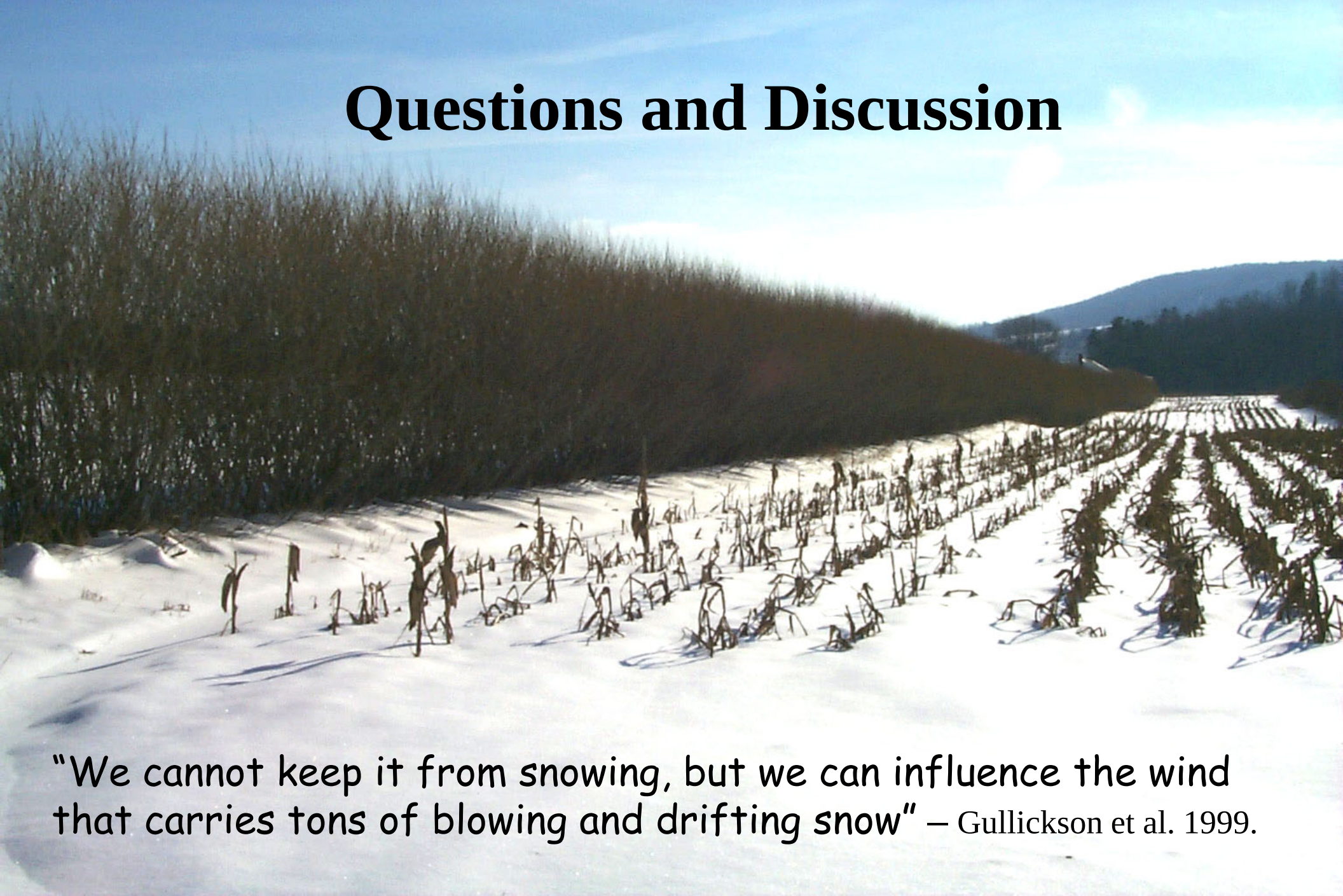
Planting

- Plant 20 inch long cuttings for most of the site
- Trying longer 3 ft long cuttings in wet area
- Add mulch and spread to a depth of 2-3 inches
  - Be sure to cover the fabric so it does not get picked up by the wind

Soil Survey Information

Highway 219 Town of Concord

Questions and Discussion



"We cannot keep it from snowing, but we can influence the wind that carries tons of blowing and drifting snow" – Gullickson et al. 1999.