

Final Report for Contract C-01-44

Evaluation of Herbaceous Perennial Groundcovers and Direct Seeded Species and Mixtures for Use in New York State Roadsides and Under Guiderails

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Executive Summary

This alternative vegetation study is an important component of NYSDOT's efforts to pursue environmentally sensitive, lower maintenance, and cost effective vegetation management techniques that can be integrated into the overall vegetation management program (IVM). NYSDOT's objective was to determine which species, either transplanted or direct seeded, could be successfully established along or underneath guiderails of paved highway routes in diverse climatic zones encountered across New York State. The NYSDOT was interested in determining which mixtures of species could be established cost-effectively, and also contribute to aesthetic appeal along managed highways, but more importantly, intended to determine which species could be managed without excessive herbicide application or mowing in areas located within 20 feet of the roadside and underneath the guiderail along NY State highways.

Our studies have shown that in more traditional landscape settings or low maintenance sites located more than 20 feet from the roadside, certain groundcovers (with groundcovers defined as transplanted perennials or direct seeded mixtures of grasses) can prove successful in establishing over time (within a one year period). Nearly all groundcover species we selected to evaluate can overwinter well in nearly all climatic zones across New York State, provided they are successfully established in the late summer or early fall. A very few groundcovers can successfully continue to compete over time against weeds with no additional weeding if mowed or if trimmed. Competition against weeds is improved if a groundcover can rapidly establish after seeding or planting, and forms a denser canopy to suppress light interception at the soil surface. Nearly all species that are transplanted do require some additional weeding in order to survive and thrive, but there are species such as blue lymegrass, coral bells, sumac (*Rhus*), and catmint that have successfully performed in landscape and roadside settings without any additional weeding, and have continued to thrive over a 2 to 3 year period. However, much past this time frame of 2 years, the beds must be trimmed, plant materials clipped, and replanting of dead materials undertaken to manage these established zones, either in a roadside or median setting. In settings right next to the roadside, weed infestation problems tended to predominate and soil conditions were often less suitable or unsuitable for perennial establishment.

Nearly all of the perennial groundcovers we evaluated are, in fact, highly suitable for establishment in sunny sites in road medians or areas needing aesthetic emphasis along the highway, but not directly along the roadside. Given their relative expense to purchase as sizeable transplants, they are not suitable for general establishment along a highway and would require far too much labor to install and manage in general establishments along the roadside. They all require that soil be adequately tilled and prepared before establishment and this limits their usage around the state of New York, except in particular managed sites. In addition, they do not perform well when exposed to heavy traffic, random mowing, salt run off, debris deposit and other typical situations encountered next to the pavement in roadside areas. In this case, soils next to paved roadsides are too poor to generally support the establishment of these perennial transplanted groundcovers. The handbook completed with this project does, however, suggest where these materials can be best utilized in landscaped areas along the highway, in limited maintenance settings. In addition, we have found there are certain species of groundcovers which do very well in both droughty and high salt conditions that are frequently encountered along roadsides, such as ornamental goldenrod and stonecrop (sedum). In this case, the challenge will be for landscape managers and DOT personnel to find these materials at a garden center for later establishment, or order them from a whole sale producer or nursery. Many of these materials are not so readily

located in every region of the state of New York, and their purchase can be costly.

In addition, we evaluated mixtures and cultivars of direct seeded grass and forb species for their ability to establish in low maintenance settings in landscapes or roadsides across New York State. Again, we have shown that certain cultivars and mixtures have the capacity to establish well and be highly weed suppressive when planted into a well-prepared site, where soil has been tilled and prepared, or weed interference has been limited by previous application of glyphosate. Over time, certain direct seeded grasses require little maintenance, limited mowing and limited fertility and rainfall to thrive. However, these cultivars or mixtures can also be expensive to purchase and difficult to locate in sizeable quantities. Seed producers of native species or turf grass producers have access to these cultivars but they may not be inexpensive. (NYSDOT has, however, also found sources of no-mow grass seed with only minor cost increases). In addition, if grasses are direct seeded into sites that are compacted, have poor drainage or into areas already heavily infested with annual and perennial weeds, our work has shown that they are not likely to establish well initially. Many of the fine fescues which performed well in our experiments and regional roadside demonstrations require additional time to germinate and establish. Once established, cultivars like Oxford, Intrigue and Reliant II and mixtures such as the No Mow mix perform very well, especially if they are mowed after they become well established, to minimize weed competition. Demonstration trials across the state of New York showed that the No Mow Mixture of fine fescues and mixtures containing Intrigue and Oxford fine fescue were highly successful in establishing, preventing establishment of perennial weeds and were aesthetically appealing, if proper care was applied to establish these plantings. In particular, late summer or fall seeding at rates of over 2 lbs/1000 square feet will assist in obtaining a good stand, especially following preliminary application of glyphosate for elimination of problem perennial weeds. However, perennial ryegrasses and tall fescues such as Palmer and Prelude and Rebel and Tarheel turfgrasses also can perform well, and they establish more rapidly. Unfortunately, they also require additional mowing to thrive as they produce more biomass.

If one is considering establishment immediately next to the guiderail or highway, these slower growing, direct seeded, cool season grasses will not always perform well as we have seen in roadside trials, due to poor drainage, poor soil and difficult conditions encountered along most roadsides, as well as runoff encountered at these locations. In addition, it is nearly always a prerequisite that glyphosate be utilized to control existing vegetation before planting. To establish them successfully after removing infestations of weeds into a newly planted or disturbed site, it is almost certain that hydroseeding or careful hand seeding into a well prepared soil seed bed must occur, where weed removal and soil tilth is ensured. For new construction sites, new roadside areas, ditch cleaning, reclamation sites and medians of interest, these direct seeded cultivars and mixtures would be of interest. In areas where turf is already established, overseeding with fine fescues can be utilized in the fall to ensure a more dense, weed suppressive turf and would, if it successfully became dominant, require little, if any, mowing. However, the availability of seed, potential for added expense and specific requirements for establishment of these no mow fescues or selected cultivars, must be considered in determining if these direct seeded native groundcovers or turfgrasses can be readily incorporated into current applications and large scale usage in NYSDOT situations. Sources of seed without excessive cost increase have however been obtainable from local suppliers and on-line sources such as Ernst. Given the discussion of rising budget constraints and limited equipment and labor availability, the use of no-mow groundcovers may indeed have stronger potential interest in short-term.

Task 1: Continue Field Testing and Plan Roadside Evaluations:

Continue Field Testing:

The Consultant shall evaluate 25 additional groundcover species (both native and cultivated ornamentals) for their performance in field testing in 2 climatic zones in NY State (Ithaca and Riverhead NY). The number of species tested will vary depending on plant availability in fall 2004 and spring 2005, so the Consultant may propose to the Project Manager increasing or reducing the number of species to be tested, accordingly.*

- *Location: Riverhead (Long Island Horticultural Research and Extension Center: LIHREC) and Ithaca, if plant materials are available.*
- *The Consultant and the NYSDOT shall develop roadside demonstrations of selected species in selected NYSDOT regions for roadside evaluations. A minimum of 2 road side trials shall be developed from new species or from species previously tested. The Consultant may develop additional roadside trials with the approval of the Project Manager.*

*The Consultant shall collect data from field trials in summer 2005-2006. The Consultant shall analyze data obtained, provide a summary report of species recommended for roadside evaluation and update the groundcover website as information and photos become available, starting in 2005. *Note: These 25 additional groundcovers were species identified at a later date and were not included in the first phase of this project which field tested many groundcovers.*

Methods:

The purpose of this field screening, the third such trial at LIHREC, was to determine the weed suppressive abilities of these selected groundcover species. Species were selected by use of an expansive literature search to find low-growing groundcovers which might prove successful in low-maintenance settings. Emphasis was also placed on selection of native species that might fit this criterion. Both producers as well as garden managers were consulted. Although forbs or broadleaves were primarily selected, woody species and a few grasses were also included. An initial list of 100 possible species was narrowed to 25 based on availability, grower and researcher expertise and expense. Presented below are the results from the final year of the two-year study conducted at Riverhead NY. As discussed above, a greater priority was placed on finding native plants suitable for roadside use. Eleven of the 25 species are northeastern natives or cultivars of a northeast native and fourteen are North American natives.

New groundcover species trials were established only in Riverhead NY (see Table 1 and appendix Table 1A for list of species evaluated). Sufficient planting material was not available for evaluation in Ithaca NY so no experiment was performed at this site. Plants were transplanted into treatment groupings containing 15 plants each per plot at standard spacings of 12 or 15 inches between plants. Twenty five total species were planted during June 2005. Plots were 27" wide X 45". Plots were established in a sunny location at Long Island Horticulture Research and Extension Center on a level, well-drained sandy loam soil. Each plot was planted with 15 plugs. Within each plot, data was later collected from an area designated as the area surrounding the central three plants, 9" X 27" (1.7 SF). Treatments for each species included: (1) weed free-plots which were maintained with frequent hand weeding throughout the season, (2) weed to establish-plots which were weeded early in the first season until the crop became established but

not during this, the second, season, and (3) weedy-plots in which no weeding was performed. Plants were irrigated after establishment and as needed in 2006. Plots were fertilized once at planting with a standard fertilizer application of N, P and K (25 lbs/A). Data was collected from 2005-2006 in Riverhead NY on groundcover survival, height and performance including canopy formation and weed suppression and compiled (see attached file on disk for supporting data from Riverhead). The groundcover website and handbook was updated in 2007 to include all species evaluated and results related to weed suppression. The herbaceous perennial groundcover website can be currently accessed at this address and is also available from a DOT research link prepared by Paul Weston:

(<http://www.entomology.cornell.edu/Extension/Woodys/CUGroundCoverSite/GroundcoverMain.html>).

Species evaluated included monocots or grasses: *Ammophila breviligulata*, *Andropogon gerardii* 'Roundtree', *Buchloe dactyloides* 'Texoka', *Dichanthelium clandestinum* 'Tioga'; Sedges: *Carex flaccosperma*, *Carex glauca*; Herbaceous or broadleaf perennials: *Antennaria dioica* 'Rubra', *Antennaria plantaginifolia*, *Asclepias tuberosa*, *Aster ericoides* 'Snow Flurry', *Ceratostigma plumbaginoides*, *Epimedium x perralchicum* 'Frohnleiten', *Geranium macrorrhizum*, *Laurentia fluvialtilis*, *Lysimachia punctata* 'Alexander', *Rudbeckia fulgida* 'Goldstrum', *Sedum spurium* 'John Creech', *Teucrium canadensis*, *Tiarella cordifolia* 'Running Tapestry', *Veronica peduncularis* 'Waterperry'; and Woody Shrubs: *Deutzia gracilis* 'Nikko', *Microbiota decussata*, *Sarcococca hookeriana* v. *humilis*, *Vaccinium angustifolium*, *Viburnum trilobum* 'Compactum'.

Results:

By the end of the first growing season (3 months after planting), several species were outstanding in their ability to cover the ground in both hand weeded and non-hand weeded treatments, in their reduction of light transmittance, and in their ability to suppress weeds. These species included *Asclepias*, *Aster*, *Ceratostigma*, *Rudbeckia*, *Dichanthelium*, *Laurentia*, and *Teucrium*.

Results from the second season varied somewhat from the first season's results because some species did not continue to compete successfully with weeds over the long term. For certain species like *Asclepias*, which was rather late to emerge, tardy emergence influenced the ability of the groundcover to suppress weeds. For others, like *Laurentia*, an extremely low growth habit allowed taller weed species to invade and overtake the low-growing groundcover. In landscaped areas with more maintenance available, such species would be excellent choices, but for the roadside which is managed with very-low maintenance, other more competitive species are superior choices for establishment.

Species with excellent weed suppression ratings after the second season included *Andropogon gerardii* 'Roundtree', *Dichanthelium clandestinum* 'Tioga', *Ammophila breviligulata*, *Carex glauca*, *Carex flaccosperma*, *Rudbeckia fulgida* 'Goldstrum', *Ceratostigma plumbaginoides*, and *Teucrium canadensis*. These species are recommended for consideration for use in roadside establishment in areas for native species establishment or for use in low maintenance plantings in sunny conditions with well-drained soils.

Table 1. Field Screening of Perennial Groundcovers for Weed Suppressiveness (Year 2 results, presented as representative of longer term establishment findings)

Investigators: Senesac, Tsontakis-Bradley, Weston

Location: Long Island Horticultural Research and Extension Center

Ornamental Name	Type	Weed Suppressiveness Rating*	Percent Cover of Crop	Percent Light Reduction under Crop Canopy	Crop Biomass at Season End(g)
<i>Ammophila breviligulata</i>	Grass	Excellent	82	75	484
<i>Andropogon gerardii</i> 'Roundtree'	Grass	Excellent	98	91	1309
<i>Buchloe dactyloides</i> 'Texoka'	Grass	Good	77	87	159
<i>Dichanthelium clandestinum</i> 'Tioga'	Grass	Excellent	99	98	438
<i>Carex flaccosperma</i>	Sedge	Excellent	86	93	228
<i>Carex glauca</i>	Sedge	Excellent	87	94	513
<i>Antennaria dioica</i> 'Rubra'	Herb. Per.	Fair	60	49	261
<i>Antennaria plantaginifolia</i>	Herb. Per.	Fair	62	54	418
<i>Asclepias tuberosa</i>	Herb. Per.	Good	72	80	251
<i>Aster ericoides</i> 'Snow Flurry'	Herb. Per.	Good	76	83	292
<i>Ceratostigma plumbaginoides</i>	Herb. Per.	Excellent	93	86	404
<i>Epimedium</i> x <i>perralchicum</i> 'Frohnleiten'	Herb. Per.	Poor	47	28	46
<i>Geranium macrorrhizum</i>	Herb. Per.	Fair	58	57	102
<i>Laurentia fluviatilis</i>	Herb. Per.	Fair	68	28	82
<i>Lysimachia punctata</i> 'Alexander'	Herb. Per.	Good	84	76	221
<i>Rudbeckia fulgida</i> 'Goldstrum'	Herb. Per.	Excellent	90	87	258
<i>Sedum spurium</i> 'John Creech'	Herb. Per.	Good	91	30	219
<i>Teucrium canadensis</i>	Herb. Per.	Excellent	85	84	223
<i>Tiarella cordifolia</i> 'Running Tapestry'	Herb. Per.	Poor	56	40	19
<i>Veronica peduncularis</i> 'Waterperry'	Herb. Per.	Good	81	78	165
<i>Deutzia gracilis</i> 'Nikko'	Woody	Fair	57	66	70
<i>Microbiota decussata</i>	Woody	Fair	60	68	145
<i>Sarcococca hookeriana</i> v. <i>humilis</i>	Woody	Poor	25	26	21
<i>Vaccinium angustifolium</i>	Woody	Poor	44	34	21
<i>Viburnum trilobum</i> 'Compactum'	Woody	Poor	51	55	50

*Weed Suppressiveness Rating is a compilation of all data collected throughout the season resulting in a rating indicating the plant's ability to compete with weeds.

†Average throughout the season

Task 1 continued – Roadside Trials:

The Consultant (Principle Investigator and graduate student) and NYSDOT staff shall meet in fall 2004 and winter 2005 to identify Regions and Residencies to participate in roadside evaluations. The Consultant and NYSDOT shall confirm staffing and equipment needs for roadside evaluations, including:

- *maintenance and protection of traffic*
- *equipment to undertake plantings and maintenance of plantings*
- *staff to prepare soil for evaluations*
- *staff to plant and maintain groundcover species*

The Consultant and NYSDOT shall establish roadside evaluation plots in late 2005 to 2006. The Consultant shall direct the planting and monitor results. NYSDOT staff shall help with planting. Upstate, the graduate student shall represent the Consultant and coordinate work and data collection. Downstate, LIHREC staff shall coordinate work and data collection. The majority of trials shall be located in upstate NY. The Consultant shall survey NYSDOT personnel regarding success of establishment and performance of best species in roadside evaluation trials.

Methods:

Roadside demonstrations of successful groundcovers were developed in 2005 and 2006 and monitored into 2007, and, in some cases, 2008. Sites established included the following:

1. Riverhead NY – along Yaphank Parkway, planted in planting design as specified in September 2005 with 8 species, planted within 20 feet of roadside.
2. Amherst NY along Rt. 290 interchange, 2 sites established in October 2005 with 8 species as designated in planned layout, planted within 20 to 40 feet of roadside.
3. Rochester NY along Interstate 490 (I490) site established in late October 2005 with 8 species as designated in planned layout, planted within 25 to 40 feet of roadside.
4. Binghamton NY along I81, exit 1 rest area, site established in October 2005 with 8 species as designated in planned layout, planted moderately far from roadside in poorly drained site.
5. Hornell NY along Rt. 36 and between the highway and hospital, planted close to roadside within 15 to 25 feet of roadside.
6. Millbrook NY along Rt. 44 in front of Cornell Cooperative Extension Office of Dutchess County, site established in September 2005 with 8 species as designated in planned layout, planted within 10 feet of the roadside.
7. Groton NY on Lansing Rd. in front of Baker’s Acres, site established in summer 2006 with 8 species in informal planting on mounded site located moderately far from roadside.
8. An additional site was established with 8 transplanted groundcover species in July 2007, with the assistance of Elisabeth Kolb of NYSDOT in Saugerties NY at the I87exit for Saugerties within a triangular traffic median very near roadside.

All sites were transplanted with groundcovers produced in 6 inch pots in Cornell University greenhouses with a well-developed root system. These are small standard sized pots which would be encountered in the retail industry and are commonly available. The planting design is at Figure 1. Eight groundcover species were evaluated and included our best performers to date from 2002-2003 field trials: Walker’s Low catmint, ornamental goldenrod, lady’s mantle, coral bells “Chocolate Veil”, creeping thyme, dianthus, sedum, and creeping phlox “Emerald blue”. Each planting site had soil adequately prepared before planting by tillage. Certain sites including those

in Rochester, Hornell, Yaphank, Millbrook and Saugerties utilized glyphosate for perennial weed and grass control before tillage. In general, a tractor mounted rototiller was used to till a sodded site, and then tillage was repeated until soil tilth was adequate, under dry conditions. In some sites, mulch or compost was incorporated before planting to improve soil tilth. Sites were planted by hand with assistance of DOT and Cornell Cooperative Extension service staff, and after planting the experiments were fertilized with a complete N, P, K fertilizer at a rate of 25 lbs/ acre. Each site was then mulched with a shredded bark mulch obtained locally to a depth of approximately 2 to 3 inches. Sites were not irrigated.

From visual observations performed in spring 2006, all sites planted in fall 2005 overwintered well and were generally well-established due to good weather conditions and mild fall temperatures encountered in 2005. None of the sites were irrigated at planting or later in the experiment. Sites were generally moist at planting and adequate rainfall was generally received in 2006. Sites were fertilized at time of planting using similar rate of fertilizer with the exception of Groton NY which did not require fertilization. Further maintenance, mainly weeding around the perimeters, was performed in Groton, Saugerties, Rochester and Millbrook NY by volunteers; with 1 to 2 hand weedings performed at these sites. Other sites received no weeding but plot perimeters were routinely mowed.

Each site was evaluated by Leslie Weston or Andy Senesac in 2006 after establishment in during the growing season and again in 2007 by these researchers. Sites were also evaluated by area cooperators including DOT and cooperative extension personnel throughout the growing season at various times. Ratings of plant establishment were taken in early and late summer by Weston or Senesac. Photos were generally obtained at each site by DOT personnel. Plantings were evaluated for number of plants of each species surviving in June of 2006 and overall performance which was evaluated in June and again in August 2006. Overall performance was based on the investigators' knowledge of plant performance for each species from past experimentation.

Elisabeth Kolb worked with volunteers to establish the Saugerties planting in July 2007. This site contained particularly poor quality, compacted soil and was low-lying in certain areas. With the assistance of volunteers, a composted organic material was worked into the site, and tillage provided a good planting bed for transplanted groundcovers. Groundcovers were established within the median in clusters of at least 15 plants per species which were replicated throughout the site. Plants were fertilized and mulched following transplanting. Plants were hand watered after establishment as a serious drought was noted at this time in Saugerties. After establishment, plots were hand weeded once to remove seedling annual weeds.

Results:

Nearly all plantings had good to excellent survival of plants when evaluated in June 2006 with the exception of the Binghamton and Amherst sites. These sites had wetter soils which were less well drained, contributing to likely damping off and dieback of groundcovers due to disease pressures, and up to 25% losses in plant materials was noted in most groundcovers evaluated by first rating in 2006. One site in Amherst NY (two were established) experienced more injury and winter kill than the other; this was the site on the south of 290 which received great salt spray and was less well-drained. The Saugerties NY site, when evaluated in fall 2007, had exceptional establishment with over 98% of plants of all species surviving the initial transplantation year.

Weed pressures encountered during summer 2006 were variable depending on the site evaluated.

Weed infestation was highest in Millbrook NY, Amherst NY and Hornell NY plots. Typical weeds encountered in these sites included crabgrass and foxtail, barnyardgrass and yellow nutsedge, white clover, dandelion and other broadleaves including thistles, and in Millbrook NY, black swallow-wort which predominated. Weed pressures were limited in Groton NY, Riverhead NY and Rochester NY, likely due to inherently lower numbers of weed propagules in the established weed seed bank, and better overall performance of groundcovers in these sites, which rendered them more suppressive to existing weeds. In general, groundcovers performed very well in these 3 sites due to excellent soil conditions, including site drainage and fertility and lack of interference by weeds. Groundcovers performed extremely poorly by August 2006 in Binghamton NY due to excessive soil moisture at the planting site and poor soil drainage which was exacerbated by severe spring flooding in this area. Other sites exhibited mixed performance by August 2006 which was dependant upon groundcover species evaluated. The Buffalo and Binghamton sites had heavier clay soils and soil was not as extensively prepared in these sites in comparison to other sites. Winter damage due to increased snowfall and deicing run off was also likely greater in Millbrook and south site established in Amherst due to proximity to roadside, possibly contributing to poorer overall performance at these sites, combined with increased weed pressures encountered at these sites. By August 2006, significant weed pressures existed in Millbrook, Amherst and Hornell sites, and plots were already unsightly and groundcover performance and survival was significantly reduced in comparison to Rochester, Ithaca and Riverhead locations.

Figure 1. Typical diagram of roadside plantings performed in 2005 in various locations around New York State including Groton, Rochester, Amherst, Riverhead, Hornell, Millbrook and Binghamton. Plots measured approximately 12 feet wide by 100 feet long. Planting design was repeated twice in each site, with 25 plants per species planted in each plot. *Please note that in Rochester NY perennial salvia replaced lady's mantle due to lack of availability.*

Nepeta catmint	Solidago goldenrod	Nepeta catmint	Solidago goldenrod	25 plants	25 plants	25 plants	25 plants
Heuchera Coral bells	Alchemilla Lady's mantle	Heuchera Coral bells	Alchemilla Lady's mantle	25 plants	25 plants	25 plants	25 plants
Dianthus Ruby bells	Phlox Emerald bue	Dianthus Ruby bells	Phlox Emerald blue	25 plants	25 plants	25 plants	25 plants
Creeping thyme	Sedum Blue acre	Creeping thyme	Sedum Blue acre	25 plants	25 plants	25 plants	25 plants

In general at all locations, it was observed that taller groundcovers outperformed the low growing groundcovers, likely because they were more competitive with local populations of weeds encountered and were able to eventually suppress weeds more successfully once established. These groundcovers included catmint (*Nepeta* spp.) and coral bells (*Heuchera* spp.) and also ornamental goldenrod, which was slower to fill in, but once established was quite competitive with surrounding weeds. *Alchemilla* and creeping phlox also generally performed well in most settings, but both were eventually overtaken by weed competition by August 2006 in those sites with heavy infestation of weeds such as Amherst, Millbrook and Hornell. Low-growing groundcovers including dianthus and sedum also performed well in well-drained soils and in sites that had limited weed infestation, such as Groton, Rochester and Riverhead. Creeping thyme was generally

less successful in all sites evaluated. Coral bells (*Heuchera* spp.) and catmint (*Nepeta* spp.) were most consistently well established in all settings, followed by ornamental goldenrod. This had been observed in previous landscape and roadside investigations performed by Jennifer Allaire and Magali Sorin across New York State and in Ithaca NY, specifically. None of the groundcover species evaluated at any of the demonstration sites was seriously impacted by insect infestation or by direct grazing by herbivores including deer.

By 2007, only three established sites continued to grow with less weed infestation which resulted in good aesthetic appeal when visualized from along a roadside or in a landscaped environment and these included the site in Groton at Baker's Acres. This site was maintained by volunteers in a landscaped site along the roadside with limited hand pulling (less than 2 hand weeding) of weeds by volunteers. This site was not initially heavily weed infested and soil was very well drained and fertile. Rochester NY also was maintained very successfully with limited weeding required, and suppression provided by groundcovers themselves and mulching materials was significant. This site was previously in sod, but was not heavily infested with weed propagules and soil was sandy and well drained. The Riverhead site also continued to perform well and was visually attractive. Several species were judged to be so attractive in this setting that they were lifted from the plots by theft, particularly *Heuchera* and *Alchemilla*. Also see attached notes (Appendix 1) of plots rated visually by L. Weston in summer 2007 for groundcover establishment and weed suppression.

In 2008, Elisabeth Kolb has reported good performance of selected groundcovers from the demonstration site in Saugerties NY. In particular, taller groundcover species were more resistant to infestation from weeds. Preliminary results from this site suggest near 100% survival and all were excellent performers. This success could potentially be due to the high organic content of the soil used as a planting medium. Ornamental goldenrod and catmint showed thorough weed suppression. Creeping thyme and phlox appear less likely to be maintained in weed-free condition over time. Further reporting from this site in 2009 will provide information on a longer term of an establishment in a roadside median experiencing salt and water run-off and possible soil compaction due to snow placement.

Roadside Screening of Ornamental Groundcovers (Year 3)

Investigators: Senesac, Tsontakis-Bradley

Location: Four sites in Suffolk County, NY

Roadside Location	Species	April 2006		June 2006		July 2006	
		% Cover Crop	% Cover Weeds	% Cover Crop	% Cover Weeds	% Cover Crop	% Cover Weeds
Rocky Point	Leymus	90	1	100	3	100	4
Hampton Bays	Thymus	100	23	50	26	74	25
Hampton Bays	Rubus	18	26	19	34	10	64
Hampton Bays	Carex	23	28	40	28	10	88
Hampton Bays	Liriope	95	23	95	5	98	4
Yaphank N	Thymus	10	20	13	65	18	28
Yaphank N	Alchemilla	0	60	0	0	0	95
Yaphank N	Nepeta	73	5	100	0	91	0
Yaphank N	Solidago	10	40	23	60	20	90
Yaphank S	Thymus	48	10	70	28	80	19
Yaphank S	Alchemilla	50	10	89	15	86	10
Yaphank S	Dianthus	60	10	90	14	84	15
Yaphank S	Solidago	63	10	96	5	99	4
Yaphank S	Sedum	68	10	89	11	85	14
Yaphank S	Phlox	73	10	98	6	93	9
Yaphank S	Heuchera	75	10	100	1	98	1
Yaphank S	Nepeta	78	10	100	5	75	1

Rocky Point, Hampton Bays, and Yaphank N planted 2003. Yaphank S planted 2005.

Ratings were made by comparison of ground covers and estimation of total groundcover as 100% and those with no groundcover (greater light penetration at soil surface) as 0%. Percentage weed biomass was estimated by comparison to unplanted controls (100% weed establishment).

Note: Weeds and groundcover were evaluated separately. They often grew and intercepted light at different heights within the plot and in some cases the cumulative percent cover adds to more than 100%.

Table 2. General performance of groundcover species in locations across NY State in 2007, final evaluation by L. Weston in July 2007 after establishment for 18 months.

Species/Location	Rochester	Millbrook	Groton	Amherst	Binghamton	Hornell
Coral bells	Excellent	Good	Excellent	Fair-good	Poor to dead	Fair to good
Nepeta	Excellent	Good	Excellent	Fair-good	Dead	Fair-good
Goldenrod	Excellent	Fair- good	Excellent	Fair -poor	Dead	Fair
Lady's mantle*	Good - excellent	Fair -good	Excellent	Fair -poor	Dead	Fair- good
Dianthus	Good - excellent	Fair - poor	Good	Fair - poor	Dead	Fair - poor
Creeping phlox	Excellent	Fair	Good - excellent	Fair - poor	Dead	Fair
Sedum	Good to excellent	Fair - poor	Good	Fair - poor	Dead	Fair- poor
Creeping thyme	Fair to good	Poor	Fair - good	Poor	Dead	Poor

Excellent=90% + establishment, Good=75%+ establishment, Fair=50%+ establishment, Poor=50% or less establishment, Dead= no establishment. *Note in Rochester site, lady's mantle was replaced with perennial salvia due to lack of availability of lady's mantle. Salvia also performed well in this setting. These ratings were conducted only until summer 2007 by investigators. However, by summer 2008, some sites experienced poorer performance of groundcovers due to more serious weed infestation.

Task 2: Groundcover Evaluations In A Controlled Environment Greenhouse, Performed Before Roadside Evaluations:

The Consultant shall evaluate in simple greenhouse experiments the ability of best groundcover performers to tolerate drought and salt stress. The Consultant shall evaluate newly investigated species not currently screened and develop a ranking of species response.

➤ *Location: Ithaca*

The Consultant shall conduct experiments in 2005 -2006 in Ithaca NY.

The Consultant shall analyze data from greenhouse experiments and add it to the groundcover website by December 2005. The Consultant shall share pertinent information from the experiments with NYSDOT staff participating in roadside evaluations.

Methods:

A total of 6 species was evaluated for salt tolerance in experiments conducted initially in 2005 at Ithaca NY. An additional 8 top performing species were evaluated for their ability to withstand high salt concentrations in greenhouse experiments conducted at Cornell University, in addition to those evaluated in 2005 for groundcover tolerance to NaCl solutions. Species evaluated in 2006 included: *Sedum retroflexum*, *Dianthus myrtinervius*, *Laurentia fluviatilis*, *Mazus reptans*, *Aster ericoides*, *Potentilla pneumanianna*, *Rhus aromatica*, and *Stachys byzantina*. In this series of experiments, selected groundcovers which performed well in field studies and roadside trials and which had a history of being salt tolerant from review of the literature were evaluated for further study in controlled greenhouse experiments. Potted groundcovers were grown in artificial media mix in controlled climate greenhouses with 14 hours of light provided and temperatures ranging from 75 to 80 degrees F during the day and 70 to 75 degrees F at night. In this case, salt solutions in form of NaCl dissolved in tap water were provided to the potted plants on a daily basis in the form of watering from above. Salt concentrations ranged from 0 to 400 mM and were carefully formulated by dilution of preformatted stock solutions of NaCl (400 mM is similar to that of sea water and is highly concentrated). Groundcovers were previously established before treatment in pots and all had a height of approximately 3 to 10 inches, depending on groundcover, at the time of experiment initiation.

All groundcovers were trimmed several weeks before experimental initiation to provide uniform foliar size and shape. Root systems were well developed and generally filled the pot as plants were all at least 12 weeks of age. Plants of each species of similar size and good condition were selected for this trial. We assayed 10 plants per treatment and each treatment was replicated 5 times. After salt application, drainage of solutions was allowed to occur and plants were watered again with clear tap water to allow previously applied salt solutions to leach into the root zone and through the pot. Waterings were performed on a daily basis to simulate salt movement in the rhizosphere after rainfall. The experiment was terminated after 3 to 4 weeks of daily salt applications.

Results:

Salt tolerance was evaluated by plant weight at harvest, plant height, and general appearance of each plant following salt treatment. Ratings were performed twice per week. Salt injury was generally readily apparent and included chlorosis, stunted growth, root death, and eventual wilting and necrosis of tissue, followed by death. Sensitive species showed injury within days of application and were generally dead at higher treatment salt concentrations (200 to 400 mM) within 2 weeks. There were relatively few truly salt tolerant species observed in both experiments. However, ornamental goldenrod was highly tolerant to high salt concentrations, and creeping thyme and creeping phlox were moderately tolerant. In the 2006 experiment, we observed moderate salt tolerance in cinquefoil

and aster, followed by aromatic sumac. Moderate tolerance enabled plants to survive a treatment of 100mM salt without necrosis and death, but significant stunting was often observed. Others species evaluated were not tolerant to even 100mM salt concentrations (see Table 3).

In an additional simple visual demonstration to evaluate the ability of selected groundcovers to tolerate drought, or survive without watering in the greenhouse for 1 to 3 weeks, ornamental goldenrod, *Sedum retroflexum*, *Sedum acre*, creeping thyme, creeping phlox, dianthus, cinquefoil and *Rhus* tolerated droughty conditions readily in comparison to the other species evaluated in all field experiments. These species are well adapted to sunny, dry roadside conditions, and we have seen them perform well in similar field settings. Only *Solidago* or ornamental goldenrod was highly tolerant of both drought and high salt conditions which would be encountered along roadsides receiving snow or rain melt, from salted roadside settings.

It is noted that not all groundcover species were tested for response to salt application. This was due to limitations of time and expense. Only selected groundcovers that were thought to exhibit potential resistance to salt application were evaluated further in greenhouse experiments. In the DOT handbook, we have described findings observed in the literature with respect to tolerance to salt.

Table 3. List of all species evaluated for salt tolerance in greenhouse experiments in Ithaca NY in 2005-2006.

Scientific name	Common name	Salt tolerance	Drought tolerance
<i>Sedum retroflexum</i>	ornamental sedum	moderate	high
<i>Dianthus myrtinervius</i>	dianthus	low	moderate
<i>Laurentia fluviatilis</i>	laurentia	low	low
<i>Mazus reptans</i>	mazus	low	low
<i>Aster ericoides</i>	ornamental aster	moderate	moderate
<i>Potentilla pneumanianna</i>	cinquefoil	moderate	high
<i>Rhus aromatica</i>	aromatic sumac	moderate	high
<i>Stachys byzantina</i>	lambsears	moderate	moderate

*Low refers to plant species that tolerated 100 ppm NaCl or less (became chlorotic, necrotic and died within 21 days of application at 100 ppm NaCl).

*Moderate refers to plant species that tolerated 200 ppm NaCl or less (became chlorotic, necrotic and died within 21 days of application at 200 ppm NaCl).

Species evaluated previously in 2002-2004

<i>Nepeta x faassennii</i>	catmint	low
<i>Solidago sphaceolata</i>	ornamental goldenrod	high
<i>Sedum acre</i>	ornamental sedum	moderate
<i>Phlox subulata</i>	creeping phlox	moderate
<i>Thymus praecox</i>	creeping thyme	moderate
<i>Alchemilla mollis</i>	lady's mantle	low

*Low refers to plant species that tolerated 100 ppm NaCl or less (became chlorotic, necrotic and died within 21 days of application at 100 ppm NaCl).

*Moderate refers to plant species that tolerated 200 ppm NaCl or less (became chlorotic, necrotic and died within 21 days of application at 200 ppm NaCl).

*High refers to plant species that tolerated 400 ppm NaCl or less (became chlorotic, necrotic and died within 21 days of application at 400 ppm NaCl or greater).

Task 3: Turfgrass and Cultivar Field Trials and Roadside Evaluations:

Turfgrass Field Trials:

The Consultant shall evaluate selected weed suppressive turf grass species and cultivars as well as mixtures of these species for their ability to establish by direct seeding along NY roadsides.

Seeding rate, fertility, mowing procedure and need for irrigation shall be factors considered in generation of final recommendations for a stress resistant, weed suppressive, low maintenance grass mixture for establishment under guiderails and in road medians. In addition, the Consultant shall begin to evaluate a selection of mixtures to be maintained without mowing, to create a naturalized, low maintenance stand for NYSDOT consideration for use under guiderails.

- *Location: Ithaca—The Consultant shall evaluate grass mixtures in replicated field trials and then recommend mixtures for roadside evaluations in selected NYSDOT regions.*

The Consultant shall conduct field trials in 2005 and 2006 in Ithaca NY. Based on experiments, the Consultant and NYSDOT shall establish at least one roadside evaluation in late 2005 in a selected NY location(s). Establishment of the evaluation shall include the Consultant's graduate student coordinator and NYSDOT staff in the Main Office and the Regional office.

The Consultant and NYSDOT shall monitor and maintain the roadside evaluations. The Consultant shall analyze data from the weed suppressive turf grass roadside evaluations, survey NYSDOT staff about their experience, provide a summary report and add information to the groundcover website in 2006. Evaluation of success of establishment shall be based on data collection, and survey of NYSDOT personnel.

Methods:

Experimentation with up to 20 turfgrass cultivars as well as conservation and native grass species were conducted in Ithaca and Riverhead NY (see list of species evaluated in Table 4). Species and cultivars selected for study were chosen based on previous literature review and reported performance in low maintenance settings, as well as availability of seed for research purposes. Species selected were chosen for generally their ability to establish in poorer, unfertilized soils, low stature or height, reduced requirements for continual mowing. Some were reported to exhibit tolerance to high salt and high pH soils as well.

Soil in Ithaca NY was a well drained silty clay loam. Weed pressures were moderate. Soil in Riverhead NY was a well drained sandy loam, and weed pressures at this site were higher than those in Ithaca NY. Soil was prepared at each site by moderate tillage followed by additional cultivation to ensure a fine seed bed in September 2005. Plots measured 6 feet by 6 feet each in Ithaca NY and were replicated 8 times in each experiment. Plots were hand seeded with a preweighed amount of seed, corresponding to recommended seeding rates for each species, generally about 4 lbs/1000 square feet, depending on seed size and number. Seed numbers were taken into account and corrected for when weighing out seed for each plot, to try to standardize numbers of seed applied /plot. Seeding rate was calculated based on seed density per volume. It as determined that standard seeding rate alone would not be sufficient to calculate density of planting

as some conservation mixtures were typically seeded at very low densities and other cultivars were seeded at higher densities. We attempted thus to compare species at a similar density of plantation which was estimated to be 1440 seeds per square foot, an intermediate seeding rate for conservation and turf cultivars. Plots in Riverhead measured 5 square feet so weights for each location took into account slightly different plot size at each location. One irrigation of one acre inch of water was provided directly after seeding, and additional moisture was received only by direct rainfall in experimental site in Ithaca NY. Plots were irrigated in Riverhead NY on an as needed basis, but since rainfall was adequate, irrigation was not generally performed. Grasses started to establish and germinate within a week after seeding at each site. Within one month after seeding, most plots contained well established seedlings at both sites.

All selections evaluated in this experiment were one cultivar or one species selections, with the exception of the no mow fescue mix. This mixture can be obtained from Prairie Nursery at www.prairienursery.com in the U.S. No mow fescue mix contains a preformulated mixture of six hard, chewings and sheep fescues which are noted for their performance in low-maintenance situations and require limited, if any, mowing over time. They are also reported to be weed suppressive over time. This cool-season grass mix is well adapted for cooler sites in the Northeastern U.S. and seed from Prairie Nursery is available commercially in prices ranging from 3.50 to 6.00 per lb.

Results:

With the exception of a few species, all grasses established well at both sites by late spring 2006. Mowing was performed at least 3 times per season in 2006 at each site, on a monthly basis, and grasses were generally mowed to a height of 3 to 4 inches. Data was collected on establishment, weed infestation and performance in 2006 at both sites, along with photographs. In addition, a website on cool season grasses and fescues was designed and completed with photographs of selected grasses (<http://www.hort.cornell.edu/departments/faculty/weston/fescue/references.html>)

All cool season grasses generally performed well at each site with the exception of the following: weeping alkaligrass, Arizona fescue and zoysiagrass had very poor germination and establishment at both locations. Fine fescues germinated relatively slowly but performed very well by summer 2006. These included Intrigue and Columbra fine fescue, no mow fescue and Reliant II fescue. Palmer and Prelude perennial ryegrass, Russian wild rye, and redtop also performed well in both settings. The others were intermediate in performance.

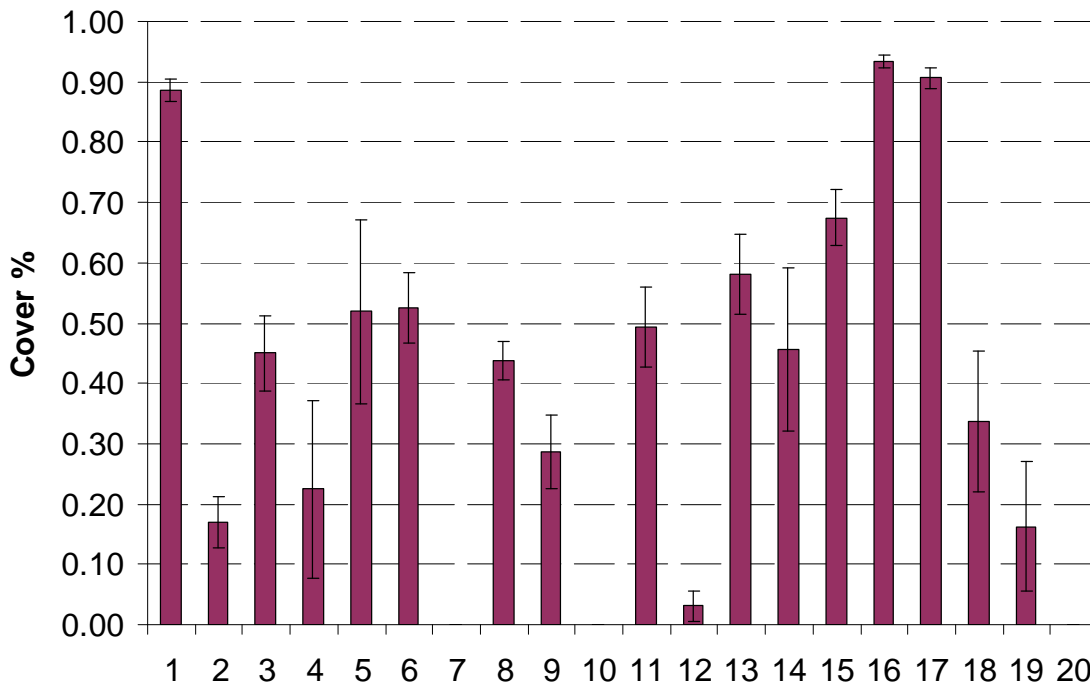
In Ithaca NY, mowing in July generally resulted in elimination of the majority of weed competitors within well established plots. Weeds were mainly small seed broadleaf annuals and annual grasses. Although denser weed infestations were noted in Riverhead NY in comparison to Ithaca NY, the majority of grass species evaluated performed well in both sites. The use of an herbicide to suppress broadleaf weeds in May of 2006 in Ithaca or Riverhead NY generally had no visible impact upon performance of the established grasses. One year later, in Ithaca NY similar performance was noted among established grasses. Several of the fine fescue cultivars were very weed suppressive, followed by Russian wild rye and redtop. Less suppressive were tall fescue cultivars and perennial ryegrass over time, which supported moderate weed populations.

In Riverhead, nine species and one mixture performed exceptionally well after establishment in fall 2005, and evaluation over 2006. Each species/mix was both untreated or treated with an herbicide on 4/11/06 to control broadleaf weeds. Herbicide treatment did not impact performance of established grasses in most cases, as most were very well established at these seeding rates. Data on

percent cover of weeds and turf was collected throughout the 2006 season. Best performing species were: redtop 'VNS', Chewing's fescue 'Intrigue', hard fescue 'Oxford', hard fescue 'Reliant II', tall fescue 'Rebel Exceda', tall fescue 'Tar Heel II', perennial rye 'Palmer', perennial rye 'Prelude', and a "no mow" fescue blend. The excellent early performance of these species in 2006 is in general agreement with performance observed of the same species in Ithaca. These species continued to perform well through 2007.

We would recommend consideration of Russian wild rye, redtop, fine fescues Intrigue, Oxford and Reliant II and perennial ryegrass Palmer and Prelude, along with “no mow” fescue blend for utilization in low maintenance roadside settings or reclamation areas. Perennial ryegrasses Palmer and Prelude will require more frequent mowing than the fine fescues or other preferred grasses. These species and mixtures performed well in the year of establishment, provided they were seeded by late summer or early fall so as to establish well before winter, and continued to suppress weeds and perform well one year after establishment, with limited mowing and no additional maintenance.

Figure 2. Mean percentage of cover for crop and weeds in each grass species evaluated in 2006, months after initial establishment in fall 2005. a. establishment of grasses in the month of May in Ithaca NY. b. Mean percentage of cover for crop and weeds in each grass species evaluated in the month of June in Ithaca NY. c. Mean percentage of cover for crop and weeds in each grass species evaluated in the month of July in Ithaca NY. Means were calculated on the basis of eight replicates per treatment. Along the y axis, treatments 1 through 19 are the specific species or cultivars evaluated and are listed in table 1, in the same order. Treatment 20 is an unseeded control, which became later infested with turf and weedy grasses.



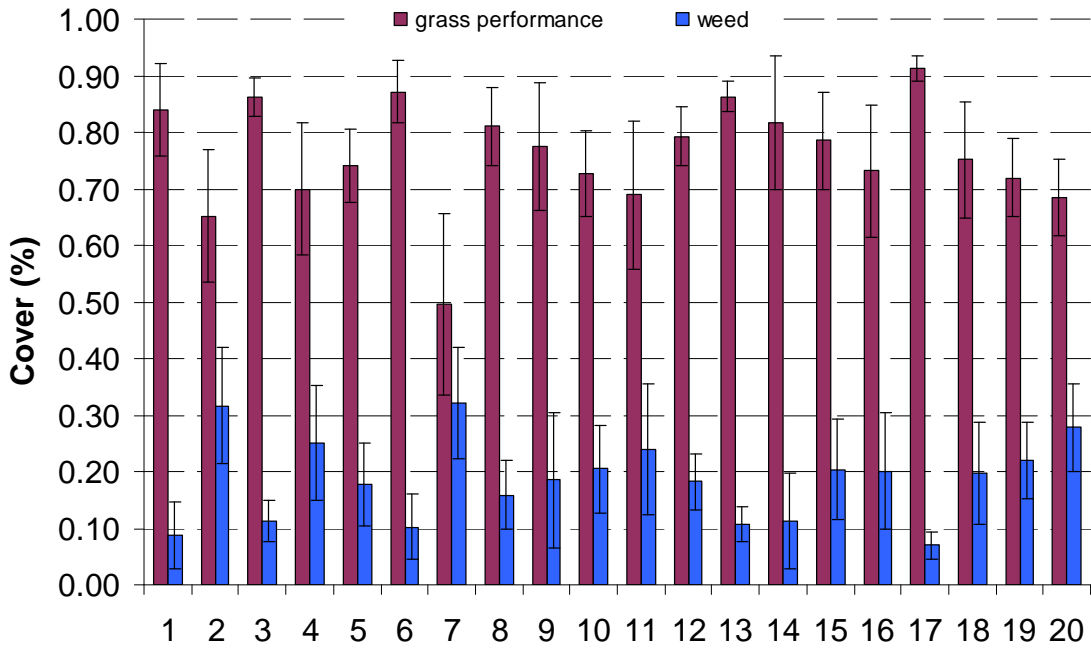
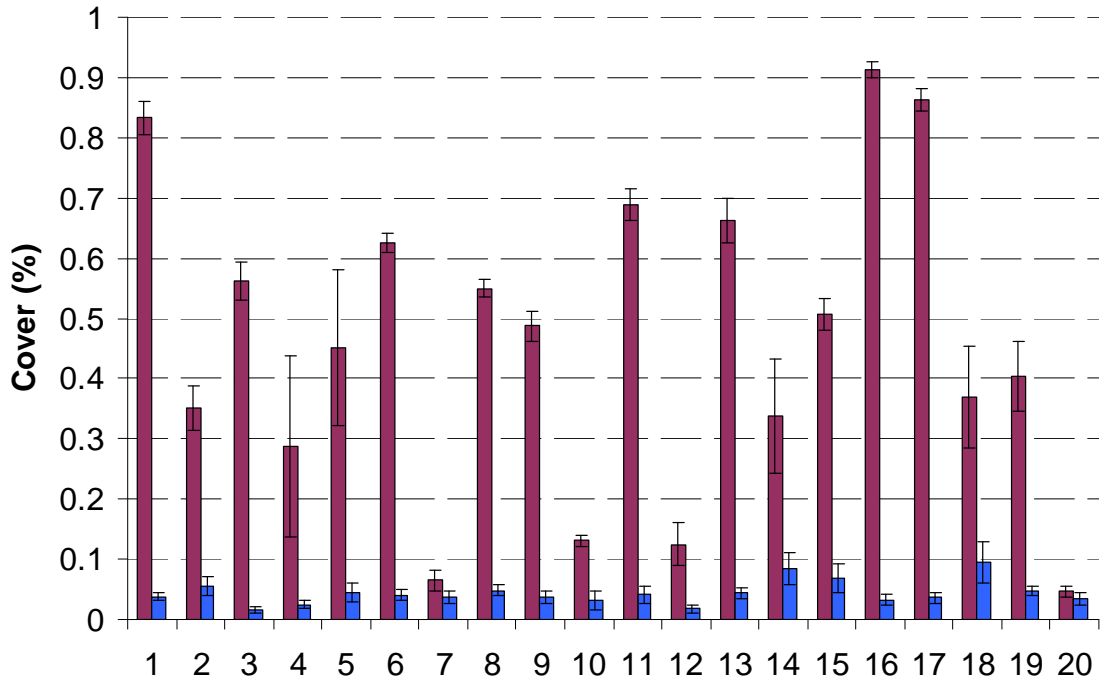


Table 4. Percentage of weed infestation observed in 2007 in cultivated grass species for low maintenance areas established in Ithaca in fall 2005.

Treatment	May 2007(% cover/% weed)	July 2007(% cover/% weed)
1. Redtop	75/25	88/12
2. Creeping meadowgrass	50/50	50/50
3. Smooth brome grass	40/60	50/50
4. Streambank wheatgrass	65/35	70/30
5. No mow fescue blend	90/10	92/8
6. Arizona fescue	0/100	0/100
7. Columbra fine fescue	85/100	90/10
8. Intrigue fine fescue	95/100	95/100
9. Sandpiper fine fescue	90/100	95/100
10. Oxford fine fescue	85/100	92/100
11. Reliant II fine fescue	70/30	70/30
12. Rebel Exceeda tall fescue	60/40	75/25
13. Tar Hill tall fescue	75/25	80/20
14. Palmer perennial rye	80/20	82/18
15. Prelude perennial rye	75/25	74/26
16. Russian wild rye	85/15	88/12
17. Weeping alkaligrass	0/100	0/100
18. Zenith Zoysiagrass	0/100	0/100
19. Fine fescue Aurora Gold	0/100	0/100

Cool Season Grasses for Weed Suppression Field Screening (Yr 2)

Investigators: Senesac, Tsontakis-Bradley

Location: Long Island Horticultural Research and Extension Center

Grass	Herbicide	reseed	Percent Cover									
			Overall		5/22/2006		6/19/2006		7/17/2006		8/14/2006	
			crop	weed	crop	weed	crop	weed	crop	weed	crop	weed
Untreated	none		0	87	0	80	0	90	0	88	0	91
Untreated			0	70	0	45	0	60	0	90	0	84
Crested wheatgrass	none		38	47	35	40	35	50	30	58	50	41
Crested wheatgrass			43	37	40	18	63	28	35	53	35	50
Elbee Northern Wheatgrass	none		48	38	38	38	68	23	48	43	38	48
Elbee Northern Wheatgrass			49	32	35	30	68	15	58	30	38	51
Redtop 'VNS'	none		70	17	53	25	78	15	70	16	80	13
Redtop 'VNS'			67	13	48	20	73	13	73	10	76	9
Creeping meadow foxtail	none		55	31	53	26	65	18	54	35	48	45
Creeping meadow foxtail			55	21	43	18	70	10	63	18	45	40
Smooth brome	none		66	23	63	20	75	18	63	29	65	28
Smooth brome			66	16	60	10	73	9	78	15	53	30
Arizona fescue 'Redondo'	none	√	19	48	10	18	23	38	18	70	26	66
Arizona fescue 'Redondo'		√	15	56	13	18	18	48	13	85	16	74
Chewing's fescue 'Columbra'	none		69	24	53	43	58	28	83	13	85	13
Chewing's fescue 'Columbra'			64	14	53	18	55	18	76	11	73	11
Chewing's fescue 'Intrigue'	none		77	18	60	33	83	13	85	13	81	15
Chewing's fescue 'Intrigue'			81	10	70	20	75	10	90	5	90	4
Chewing's fescue 'Sandpiper'	none	√	18	51	8	28	25	40	16	73	25	63
Chewing's fescue 'Sandpiper'		√	18	38	5	23	20	30	19	50	28	48
Hard fescue 'Oxford'	none		66	20	43	33	63	23	78	18	81	9
Hard fescue 'Oxford'			68	14	43	28	70	15	79	9	81	5
Hard fescue 'Reliant II'	none		72	16	48	28	75	18	84	10	81	9
Hard fescue 'Reliant II'			73	12	50	23	78	10	83	11	84	6

Hard fescue 'Aurora Gold'	none	√	12	54	8	20	15	43	8	83	18	71
Hard fescue 'Aurora Gold'		√	12	53	8	18	13	48	10	84	18	65
Hard fescue 'Pure Gold'	none	√	14	57	10	25	20	40	10	88	16	74
Hard fescue 'Pure Gold'		√	18	49	10	25	18	38	23	68	21	66
Tall fescue 'Tomahawk'	none		62	25	48	30	55	40	68	15	76	15
Tall fescue 'Tomahawk'			65	13	45	10	63	20	75	11	76	13
Tall fescue 'Rebel Exeda'	none		76	17	63	18	80	18	78	18	83	14
Tall fescue 'Rebel Exeda'			79	8	68	10	78	8	83	10	88	6
Tall fescue 'Tar Heel II'	none		69	25	60	30	78	18	69	26	71	26
Tall fescue 'Tar Heel II'			74	10	60	15	74	10	81	8	81	6
Perennial ryegrass 'Palmer'	none		74	20	78	13	75	20	70	28	74	20
Perennial ryegrass 'Palmer'			82	4	70	3	83	3	90	4	85	6
Perennial ryegrass 'Prelude'	none		79	17	83	10	85	15	71	25	76	19
Perennial ryegrass 'Prelude'			86	3	80	3	86	0	90	5	88	5
Russian wildrye 'Bozsiski'	none	√	19	58	28	33	20	50	10	83	20	69
Russian wildrye 'Bozsiski'		√	23	48	28	25	38	33	10	80	15	55
Weeping alkaligrass 'Fulfs'	none	√	23	36	25	18	25	28	28	43	15	58
Weeping alkaligrass 'Fulfs'		√	21	46	23	19	30	38	18	63	15	64
Zoysiagrass 'Zenith'	none	√	9	48	8	20	10	38	5	78	13	58
Zoysiagrass 'Zenith'		√	9	49	5	20	10	43	10	65	13	69
"No Mow" Fescue Blend	none		72	19	55	28	73	18	78	19	83	13
"No Mow" Fescue Blend			77	8	60	15	74	9	88	5	86	4
Mixture 1	none		67	22	53	23	73	23	70	20	73	21
Mixture 1			64	13	53	10	63	13	70	15	70	13
Mixture 2	none		63	14	45	13	70	15	66	14	70	15
Mixture 2			68	9	50	10	68	10	78	9	78	6

Herbicide treatment = Speedzone to control broadleaf weeds applied on 4/11/06.

Mixture 1 = (25% each by count) wheatgrass/hard fescue/bromegrass/alkaligrass

Mixture 2 = (25% each by count) redtop/wildrye/alkaligrass/hard fescue

Seeds sown Fall 2005.

Reseeded-These species did not survive over the winter and were reseeded Spring 2006.

Task 3 continued – Roadside Trials:

Roadside trials with best cultivated grass performers as determined previously were organized and initiated in 2006. Sites included the following:

1. One replicated site in NYSDOT Region 6 was planted at the I86 Almond Dam overlook with 8 turf species and cultivars and was replicated twice within intermediate distance of the highway. Tillage was performed by large rototiller to prepare soil adequately and cultivation also occurred before planting. Seeding occurred at a rate of 4 lbs/1000 square feet. No fertilizer was applied.
2. Another site in Riverhead was established with the same 8 cultivars at the Yaphank highway site close to the roadside. Tillage was performed by a rototiller and soil tilth was excellent. Same seeding rate was utilized. No fertilizer was applied.
3. A site near Rochester under a bridge overpass was established in Chili near the intersection of Rts. 252 and 383. This site was professionally graded and topsoil was brought in to complete construction, and had good tilth and fertility. At this site, 2 seed treatments were planted, cultivar Intrigue fine fescue and a no mow mixture. Sites planted included several 1000 square feet, approximately 5000 in total with a seeding rate of 3-4 lbs/1000 square feet. This site was seeded by hand.
4. A site in southeastern NY was established with several fine fescue cultivars for evaluation by James Buck in Hancock, on Sands Creek Road, behind the Bridge Crew facility, in Delaware County. In this case, a roadside was prepared and seeded by hand with several fine fescue cultivars including Intrigue, Columbra and Oxford and a larger area planted to no-mow fescue which was seeded using hydroseeding by a commercial applicator.
5. Several locations in Ulster County were established under the lead of Tom Story of Residency 8-7. A commercially available no-mow fine fescue mix was used which included hard, chewings, and blue fescues which are able to slowly establish and require little mowing. Roadside medians and other sites requiring reseeding were either treated with glyphosate or not and overseeded or direct seeded, with or without mulching to evaluate success of establishment. Sites evaluated included Highland Yard (near the intersection of Route 9W and Route 299), Kingston Roundabout Point and various locations along I-587 in Ulster County. Seeding occurred in 2006 and 2007.

Methods:

Various sites described above utilized different mixtures of fine fescue seed as supplied by L. Weston or ordered commercially. Seeding generally occurred after killing vegetation with glyphosate and was performed at 4 to 5 lbs/1000 square feet. None of the above sites were watered, and ample rainfall was generally received in these locations in fall 2006.

Results:

Although we have no actual data which we collected from these sites, we have communicated with our DOT collaborators who have reported that the site at the Almond Dam overlook was not particularly well established and some of the treatments were relatively weedy initially, especially before mowing in 2007. We have generally found that for fine fescues, seeding must occur in late August or early September for sufficient establishment due to slow germination of fine fescues, before winter conditions set in. If not yet established by winter, then late spring establishment often occurs and more weed pressures are in force at this time of year. At the overlook, later establishment by seeding in the fall was attempted due to poor weather conditions for soil preparation. In this case, early mowing to remove competitive annual weeds is required to assist in spring establishment. Generally by the following July after fall establishment, the fescues are quite competitive, but one to two mowings will be useful to

reduce heavy weed infestations. The site in Chili was successfully established by 2006 and presented a mix of fine fescue, and annual ryegrass, which was seeded initially by the roadside maintenance crew. Over time, we expected the fine fescue would dominate as the annual ryegrass would eventually die out. The site in Delaware County was very successful in seeding between a road and stream where mowing was unlikely to occur. The fescue established thickly and weed suppression appeared to be very successful. Cultivar performance in Riverhead was acceptable for all cultivars evaluated. Results in Ulster County with fine fescue seeding trials along roadsides was generally excellent. Best establishment occurred with fall seeding following glyphosate treatment to eliminate perennial weeds. Following successful establishment which required several months, one mowing was generally performed to eliminate annual and perennial weed pressures. Little if any mowing would be required in road medians where mowing is difficult to perform. These results indicate a very promising future for no-mow mixtures in settings requiring low height or limited maintenance for groundcovers.

LIHREC Roadside Planting 2006 Cool Season Grasses Yaphank

Scientific Name	Common Name	Cultivar or Trade Name
Festuca rubra L. ssp. commutata	Chewing's fescue	Columbra
Festuca rubra L. ssp. commutata	Chewing's fescue	Intrigue
Festuca trachyphylla	hard fescue perennial	Reliant II
Lolium perenne	ryegrass perennial	Palmer
Lolium perenne	ryegrass	Prelude
Agrostis gigantea	redtop	VNS
Bromus inermis	smooth brome	
Lolium arundinaceum	tall fescue	Tomahawk
Lolium arundinaceum	tall fescue	Rebel Exeda
Commercial "No Mow" Fescue Blend		Chewing's SR100/ Azay sheep/ SR3100 hard/ Scaldis hard/ creeping red/Dawson red
Mixture 2 (25% each by count)	redtop/wildrye/alkaligrass/hard fescue	

No Mow fescue blend from Prairie Nursery in Westfield WI contains the following: SR5100 chewings fescue (24.5%), Azay sheep fescue (24.5%), SR3100 hard fescue (12.25%), Scaldis hard fescue (12.25%), creeping red fescue (12.25%) and Dawson red fescue (12.25%).

Task 4: Native Grasses and Forbs Field Trials and Roadside Evaluations:

The Consultant shall evaluate by field trials a mixture of native grasses and forbs in the field. Based on these evaluations, the Consultant and NYSDOT shall undertake roadside evaluations for comparison to suppressive fescues as stress tolerant, non-weedy groundcovers.

- *Location: Ithaca–The Consultant shall evaluate mixtures in replicated field trials from 2004-2006 for establishment and weed suppression in Ithaca NY. Based on these trials, the Consultant and NYSDOT shall undertake selected roadside evaluations over a one year period in upstate NYSDOT regions.*

Location: Riverhead – The Consultant shall evaluate mixtures in replicated field trials from 2005-2006 for establishment and weed suppression at LIHREC and in selected roadside trials downstate to be conducted over a one year period. Based on these trials, the Consultant and NYSDOT shall undertake roadside evaluations of selected native grass/forb mixtures for weed suppressiveness based on species mix and cultural practices. The Consultant shall conduct identical field trials in 2005 and 2006 in Riverhead and Ithaca NY to evaluate species mixtures for establishment and cover. Experiments with weed suppressive fescues are already underway in Ithaca NY, established in 2004. The Consultant and NYSDOT shall establish roadside evaluations in 2006-2007. The Consultant shall analyze data from the weed suppressive native grass and forbs roadside evaluations, survey NYSDOT staff about their experience, provide a summary report, and add information to the groundcover website in 2007. Evaluation of success of establishment shall be based on data collection, and a survey of NYSDOT personnel.

Methods:

Mixtures of native broadleaf and grass species for direct seeding in low maintenance settings were considered for field evaluation, and investigation, we purchased several mixtures likely to perform well in upstate NY in late 2005. A list of species evaluated in mixtures can be found below in Table 5 or the website for broadleaf forbs and native grass mixtures (<http://www.hort.cornell.edu/departments/faculty/weston/mixes/index.html>).

Field plots were prepared in Ithaca and Riverhead NY in spring 2006. Plots were tilled thoroughly and cultivated to prepare a fine seed bed. In Ithaca NY fumigation was performed before establishment to minimize weed competition so we could evaluate the actual performance of the seed mixtures in the absence of large established weed populations. Many of these mixtures are expensive and also difficult to germinate so we wanted to give them every opportunity to establish to evaluate their ability to overwinter and perform in 2007. In Riverhead NY the same procedure was utilized, without soil fumigation. All plots were 6 feet by 12 feet and were established by direct hand seeding. Irrigation was applied only once, directly after seeding of all treatments at a rate of 1lb/1000 square feet, the suggested seeding rate provided for native seed mixtures. Combinations of seed utilized were determined based on various settings that might be likely encountered along roadsides by NYSDOT personnel. One mixture contained only taller grasses that tolerate dry conditions and is generally not expensive to purchase. The forb mixtures utilized were often more expensive to purchase and included such mixtures as a showy and colorful wildflower mixture and a less colorful but suppressive broadleaf forb mixture.

Once established, plots were mowed in August 2006 to encourage forb and grass development and suppress weed establishment. Data was collected from the Ithaca location in fall 2006 after plots were well established, and again in May and July 2007.

Results:

Weed infestation was severe in Riverhead NY, likely due to lack of soil fumigation before planting, and due to the complete lack of treatment establishment, data collection was rendered impossible. Mixtures of native direct seeded species can be very difficult to establish due to low germination rates of some of these species and slow establishment over time. However, the Ernst conservation seed mixture performed exceptionally well in this experiment in Ithaca NY, and was very weed suppressive and of moderate height, estimated at 10 to 12 inches. Grass and forb mixtures 6 and 7 were also reasonable performers as estimated by percentage cover and resultant weed suppression. Height ranged from 10 to 14 inches in these mixtures. Mixtures were managed successfully in this case by spring establishment, as many species are warm season. In addition, one timely irrigation after seeding was performed to encourage establishment. After this, only routine mowing was performed periodically to encourage successful establishment of the groundcover mixtures. With more careful management than that generally required by turfgrasses established and evaluated in the previous experiment, these native grass and forb mixtures could be expensive to establish but were somewhat successful, depending upon the location of establishment and the mixture used. In soils with heavy weed infestation, these mixtures were much less competitive and did not establish successfully.

Table 5. Broadleaf and native grass mixtures established in Ithaca NY in spring 2006.

Treatment	May 2007 (%cover/%weed)	July 2007 (%cover/%weed)
1. Grass mixture	70/30	75/25
2. Grass mixture	65/35	70/30
3. Forb mixture	40/60	50/50
4. Forb mixture	20/80	20/80
5. Grass and Forb	60/40	70/30
6. Grass and Forb	70/30	75/25
7. Grass and Forb	82/18	85/15
8. Showy NYS native	65/35	65/35
9. NY State native	50/50	55/45
10. Ernst Conserv. Mix	87/13	90/10
11. Weedy control	0/100	0/100

Task 5: Continue Groundcover Roadside Evaluation Trials:

The Consultant shall continue roadside evaluation trials which were established in 2003.

- *Location: Ithaca: The Consultant shall evaluate and maintain (hand weeded, fertilized, re-mulched as needed) the two roadside sites during the growing season. Replicated data on weed suppression of the groundcovers shall be collected.*
- *Location: Riverhead: The Consultant shall evaluate and maintain (hand weeded, fertilized, re-mulched and irrigated as needed) the three roadside sites during the growing season. Replicated data on weed suppression of the groundcovers shall be collected.*

The Consultant shall evaluate existing roadside demonstrations and collect data throughout the 2004 growing season. Data shall be analyzed and added to the groundcover website by summer 2005.

Methods:

Two established sites for groundcovers continued to be evaluated for performance in 2003-2005. One site was discontinued at the entrance to Cornell campus off Rt 366 as Cornell grounds crew needed the space in 2005, after 2 years of experimentation. This site was described in detail in a separate report by Magali Sorin and in our final report presented to the DOT in 2003-2004. The other site along Rt 13 and adjacent to Stewart Park has been repeatedly mowed to discourage weed growth after 2006. The site in Riverhead LI along the Yaphank highway was maintained until 2006 and further performance data was collected. Additional information regarding performance was added to the groundcover website in 2006. In this case, as described in our previous project with NYSDOT, up to 12 groundcover species were evaluated at each site. The groundcover treatments were generally replicated at least 2 or 3 times at each site. Groundcover performance was dependant upon species and location.

Results:

In Riverhead, nearly all groundcovers performed well due to reduced weed pressures. Blue lymegrass, established in a sandy median surrounded by concrete barriers, performed exceptionally well once established and was highly weed suppressive. In 2007 and 2008, blue lymegrass began to dieback in center of established median. It continues to thrive, with perimeter plants continuing to grow and spread, despite this significant dieback. In Ithaca, along Rt 366, the groundcovers that performed well included catmint, dianthus, lambsears, creeping thyme, ornamental goldenrod, lady's mantle and coral bells. In Ithaca along Rt 13, catmint, coral bells, and lady's mantle were best performers. Weed pressure was greater along Rt 13 and indiscriminate mowing by ground crews eliminated some of the groundcovers over time. Deer selectively preferred to graze upon Missouri primrose in the Ithaca location and these plants did not survive past 2003 after deer browsing. In addition, dianthus and other low growing ornamentals did not perform well in wet soils, or when weed pressures became excessive over time, as they were low growing and easily dominated by taller weeds. Best overall long term performers in both Ithaca and Riverhead included catmint, lady's mantle, ornamental goldenrod and coral bells.

Task 6: Handbook (Working Guidelines) and Website

The Consultant shall develop recommendations for plantings of ornamental and groundcover mixtures in a written handbook for NYSDOT personnel. The handbook shall be reviewed by people who participated in the roadside evaluations and a representative sample of NYSDOT staff. The Consultant shall update design and contents of the current groundcover website publication.

- *Location: Based on research and field trial performance, NYSDOT personnel shall work with Ithaca personnel to develop a handbook through a committee for handbook development and design. The committee shall include NYSDOT Landscape Architecture and Maintenance personnel as well as the Consultant researchers including Leslie and Paul Weston.*
- *The Consultant shall undertake website update in Ithaca NY. Riverhead personnel shall provide input and review final handbook for content and design before NYSDOT release.*

The Consultant shall update the groundcover website semiannually throughout 2004 to 2007. The Consultant and NYSDOT shall discuss the handbook format in spring, 2005. The consultant anticipates completion and publication of the handbook in early 2007, for release in 2007. The consultant will prepare the handbook with NYSDOT input.

Results:

We have collected photographs, set up the handbook and website and written species descriptions for all species evaluated in this series of experiments. We have also included a summary of our research findings as they relate to each species performance in the handbook. A comprehensive website on alternative and conventional weed management for landscape and roadside settings, including common and invasive weed identification sections has also been prepared and completed to supplement information in the handbook. We sought additional input from DOT cooperators on the hardcopy manual design and content, and we have now modified the handbook several times, based on suggestions of collaborators. The handbook and accompanying websites are now updated and present information to roadside managers in an organized and easily accessible fashion.

The completed handbook can now be found on NYSDOT web sites and is also located at: <http://www.entomology.cornell.edu/Extension/Woodys/CUGroundCoverSite/DOTgroundcovers/RoadsideVegetationManual.pdf>

Statement On Implementation:

Conclusions from these studies and demonstration sites evaluated across New York State DOT Regions show that certain locations had better establishment of perennial groundcovers and direct seeded grasses than other sites. This was mainly a function of successful site preparation, not regional location, which ensured adequate establishment of seedlings and transplants. In addition, natural infestations of local weeds were hugely problematic in limiting the success of groundcovers and grasses in demonstration plots. Limited weed establishment in planting sites selected could be potentially obtained by composting with weed free compost, as well as reducing established weeds with herbicide application and adequate mulching at the site. Hand weeding utilized in a timely fashion can also assist in successful long-term establishment of groundcovers. Choice of a planting site with some distance from the roadside also proved important in allowing groundcovers to successfully establish. Our tests show that establishment in zone 1, directly beneath the guiderails was problematic not only for establishment of groundcovers but of direct seeded mixtures. In this case, problems with soil quality, texture, salt and run-off and snow packing could reduce establishment. Groundcovers and mixtures of grasses and forbs tended to perform much better in zones 2 and 3, in roadside medians and rest areas. In these areas establishment tended to be more successful due to improved soil quality and tilth, assistance which could be provided at these sites with hand-weeding, mowing and maintenance and absence of roadside runoff from rain or snow fall events. Direct seeded mixtures of no mow fescues or fescue grasses and forbs do seem to have strong potential to perform well along roadsides, particularly if weed eradication is followed ahead of time, and time of seeding occurs in early fall and late summer. One timely mowing after establishment will also assist in reducing weed infestation over time. However, in all cases, use of selected transplanted groundcovers or selected mixtures of direct seeded species can be costly. Difficulty can be encountered in finding plants or seeds for commercial establishment in a large scale. Therefore, these obstacles must be overcome if we are to further utilize the findings associated with successful establishment and weed suppression by selected groundcovers. Although we can establish these plantings in a timely and professional manner, limited maintenance is available following establishment under current NYSDOT budgets. Increased budgetary expenses allocated to establishment and seed purchase may be critical to incorporate this technology into existing NYSDOT recommendations.

Notes From Visits to Individual Roadside Sites for Groundcover Demonstrations

Visit Notes: By Principal Investigator L. Weston in Summer 2007:

All plots were established between October 1 2006 and November 5 2006 by planting as described in the summary report. All plots were established by tillage of site, addition of compost or organic matter, fertilization at 25 lbs N/A, and after transplanting groundcovers by hand, experiment was mulched. Plots were not hand watered. Weeding occurred only in the Dutchess County site as plot was rapidly overtaken by black swallow-wort and other perennial weeds. The Binghamton site on I-81 died in the spring following transplanting due to flooded soils and excessive rainfall. This site was poorly drained and wet to begin with, unfortunately. All other sites continued to be rated in the spring of 2007 for plant counts and establishment, summer 2007, and these notes were taken upon viewing each of the plots in June 2007 after a site visit. I did not travel to Long Island as data was collected there by Andy Senesac and his crew.

Buffalo/ Amherst (2) – Monday 6/18/2007

Site 1 – Northern location on I290 -Infested mainly with grass weeds, small broadleaves including p. ryegrass, quackgrass, fescue, dandelions, Canada thistle. Soil was relatively moist, somewhat compacted clay with decent fertility. Proximity to roadside increased the opportunity for salinity issues from winter salt spray, and trash accumulation. Protection due to slight bank of soil ensured less snow and roadside run-off contacted the plot. Mixed success as far as plant establishment in this setting. Best performance from *Solidago*, *Heuchera*, *Nepeta*. Reduced success for *Alchemilla*, *Dianthus*, *Phlox*, thyme. *Sedum* survived but was overtaken by weeds as were most except *Heuchera* and *Nepeta*.

Site 2 – Southern location on I290 - across the road in Amherst NY. Similar weed infestation but soil tended to be more heavy clay at site 2. Distance from roadside was similar but site was more low lying and subject to greater water accumulation and perhaps salinity accumulation as well. Rainfall, moisture accumulation in plot in less well drained areas, possibly contributed to plant demise in several species and perhaps root disease issues. Poor color in *Solidago*, *Nepeta* in areas. Best performers were *Heuchera*, *Nepeta*, *Solidago*. Major losses in other species. Heavy infestation of weeds in both plots.

Rochester site – Monday pm 6/18/2007

Very low weed infestation in this plot. Plot was higher and well drained and soil type was very fertile, well drained loam, perfect for groundcovers. Mainly a few dandelions, grass weeds, ryegrass, crabgrass, clover. Trefoil nearby. Well drained plots, fertile soil, plant materials look excellent. Good performance from all species with relatively little if any loss. Many look very attractive and are starting to bloom or have bloomed including *Dianthus*, *Phlox*, *Heuchera*, *Alchemilla*, *Nepeta*. *Dianthus* had some Ky bluegrass infestation which were in plant materials to begin with from shipper. Others including *Solidago* look excellent. Less canopy with *Solidago* and *Sedum*. No real weed pressure that is heavy at all at this point.

Binghamton Site – Tuesday 6/19/2007

Site was overly wet and poorly drained when planted. Compacted soil, poor drainage. Even though the plot was raised, the soil at planting looked suspect, as a natural spring nearby and runoff from hill looked to be causing drainage issues. Despite this we planted as site was prepared and selected by DOT personnel. Would have been better to place plants high at the drive in rest areas up the hill. Plants initially established well and were ok, 1 month after planting. However, excessive spring and early summer rainfalls occurred in Southern Tier. This caused wet soils and very poor drainage at this site. Plants all look to be dead or headed for serious injury. Can see chlorosis, death and necrosis among all species. Site looks to be a total loss or will be shortly. Weed pressure already coming into plots and includes grasses, perennial rye, crab, fescue and nutsedge. Areas with slightly better drainage seem to have somewhat better plant survival. After viewing plots in August 2007, site was a total loss.

Groton site near Ithaca, Baker's Acres. 6/19/2007. This site was established in a local garden center retail area as a landscape demo. In this case the site was established by myself and Betsy Lamb using 6 species of groundcovers randomly dispersed in groups of 5 to 7 plants per clump on a mounded well drained garden center site. After one month, the plants including *Solidago*, *Heuchera*, *Alchemilla*, *Phlox*, *Nepeta*, thyme, and

sedum performed exceptionally well. The site was fertile and well drained and free of weeds to begin with. Garden center personnel routinely weed the site to provide a weed free garden area. By summer's end the plants had filled in and all had survived due to good rainfall and weed removal. A dense establishment was noted and *Heuchera* and *Nepeta* were particularly weed suppressive and dense. At least 2 weedings were performed on site by fall.

Region 6 site off I-86 at Almond Dam overlook Grasses- 6/21/2007

I looked at fescue establishment as well as groundcover sites here. Fescue and grass plots appeared less successful for establishment at this time as weeds were noted to be coming into plots and fescue groundcovers were slow to germinate. It is difficult to say if grass planting site was adequately prepared for seeding and if seeding was dense enough or if seeding was performed too late in season to gain good growth before winter set in. Plots may still continue to establish as many grasses were emerging but mowing to remove weed pressures needs to take place once plots were established. Best performers were initially perennial rye and Russian wild rye. Fine fescues were slow to establish. May need to reseed and recheck in late August and September.

Hornell site off Rt 36 Groundcovers – by hospital

Planting was performed in soil with good soil tilth. Good fertility and adequate drainage appear to be present at this site. Site is located right next to roadside and under or around several crabapple trees on this side of the road. Some areas get partial shade from trees nearby and fence row grasses and vegetation. Plenty of weed pressure present from weed seed bank and from weeds located along fence behind plot. Proximity to highway is within 20 feet and some trash and debris can accumulate. Mowing is performed around groundcover areas. Site also slopes slightly down from roadside and water runoff, snow melt and salinity may drain towards plot. In this case, establishment was good immediately after planting. Some considerable weed pressure exists here at this site, and is moderate to high, depending on plot location. Weeds include quackgrass, perennial rye, dandelions, clover, other grasses including foxtails, crabgrass. Some perennials coming in including bindweed. Plant establishment appears to be generally over 85% for most species, but weed infestation is serious for low growing groundcovers. Best competitors are *Heuchera* and *Nepeta*, and *Solidago* with *Alchemilla* doing well in most areas. Others are dominated by weed infestation. Taller groundcovers needed at this site.

Dutchess County site – July 2007

Dropped off plants to Elisabeth and returned to view established plots. Plot is directly next to roadside in front of Cornell CCE center. This site needed several attempts at cultivation to till the heavy sod soil before planting. We added organic matter (compost) and then tilled again, planted and fertilized. Plot was mulched heavily. Plants appeared to initially establish very well with few losses. Plot later became droughty due to lack of rain. Now the site is heavily infested with perennial weeds including black swallow-wort and bindweed, clover, dandelions, some thistle. Hand weeding was performed in fall and again in spring to reduce weed pressure, but perennial weed pressure is high. Best performers include *Nepeta*, *Solidago* and *Heuchera*. Lady's mantle is ok. Sedum has established well but low growing groundcovers easily overtaken by weeds and many of larger groundcovers have infestations as well. Plot would perform better if established weeds were hit with glyphosate several times by spot application by master gardeners. Would not fare well if left unweeded. Plot will be maintained by master gardeners if available.

Field Notes by Elisabeth Kolb, Maintenance Environmental Specialist NYSDOT Region 8
Rte 212/32 in Saugerties, Ulster County NY, Near Thruway Exit 20

Groundcover Study Site:

Site is a triangular traffic island area, which is challenging to mow and could provide an aesthetic enhancement to the village entrance if treated with ornamental groundcovers or plantings.

Site was prepared with 2 applications of glyphosate herbicide, a few months apart. The soil is of poor roadside type quality with a heavy infestation of weeds and little organic soil content.

A 4-6" layer of animal manure based compost was brought in to prepare a bed for the ornamental plantings. Planting was accomplished on July 21, 2007. The ensuing weather conditions were hot and dry. Plantings were watered very little after the planting event. Approximately 2 weeks later the village watered about twice a week for about a month during the dry weather period.

The remaining area in the traffic triangle not planted with the ornamentals was seeded with Cornell supplied No-Mow, Intrigue and Russian Wild Rye grasses.



Planting with Volunteers on July 21, 2007. "Blue Kats" willing to assist in the planting under an Adopt-A-Highway agreement. The group volunteered to maintain the site in the near future.

Field Observations: June 27, 2008

Ornamentals:

Plant survival: Near 100 % after almost one year after establishment.

Losses: 1 Coral Bell (plus one distressed) and 1 Ladies Mantle out of 40 each.

Weed Suppression: <1% Weed Cover

Weeds observed included clover. Weeds were pulled in under 5 minutes time.

Grasses:

Low maintenance grasses starting to come up, interspersed among the many types of weeds. Suggest a broadleaf herbicide application and additional seeding.

Field Observations: October 1, 2008

Ornamentals:

Plant survival: Near 100 %.



Photo Date: October 2008

Observation by Species:

Coral Bells:

Losses: 1 Coral Bell; Weed Suppression: 10% Weeds, mostly clover. Along the edges, Coral Bells are overgrown by Catmint and Goldenrod.

Lady's Mantle:

Losses: 2 Lady's Mantles; Weed suppression: 10% weeds. Weeds (mostly clover) are growing in spots left bare by dead plants.

Catmint:

100% Survival. Weed suppression: <1% Weeds. Thick healthy stand of catmint. Some purple blooms throughout season.

Goldenrod:

100% Survival. Weed suppression: <1% Weeds. Bright yellow blooms in fall.

Pinks (Dianthus):

100% Survival. Weed Suppression: 15% Weed cover, mostly clover. Unsightly brown stalks after great blooms for 2 weeks in Spring. Some pinks along the edge overgrown by goldenrods and catmint may not survive much longer.

Phlox:

100% Survival, Weed Suppression: <1% weeds.

Creeping Thyme:

Weed Suppression: From Birds Eye View: 50% Weeds (clover, grasses, dandelion). Expect that if unattended, weeds will outcompete the thyme over the next year unless taller weeds are pulled or cut back. Survival: 100%. Some Thyme is in bloom again.

No-Mow Grasses:

No mow grass seedlings found to cover 5% of site or less. Site is overgrown with clover, plantain and dandelions.

Site has been mowed at least once/month over the spring and summer by an AAH high school volunteer doing community service, which served to keep the weed seed production under control and enhance aesthetics.

Additional Grass Area Treatments Planned:

Seeded the site with the Cornell low maintenance grass seed mix on October 1, 2008. The site will be mowed again in one week to be followed up with additional grass seeding with the mix from the Residency (Signature Heather Links Mix). Next year we will consider applying a broadleaf herbicide to control the weeds and adding a wildflower seed mix to the no-mow grass seeded area.

Field Notes by Peter Pasnik, Landscape Architect and Dan Gentry, Highway Maintenance Supervisor II, NYSDOT Region 5, September 2006 (after one season)

I-290 Amherst, Erie County NY, Near 990 Exit Ramp, East and Westbound- Groundcovers



September 2006
Eastbound 290 Site
(after 1 season)

NY 290 Eastbound @ Weather Station - Notes on individual plants (Row 1 nearest 290):

1 Solidago - Minimal loss of plants (2); No apparent problems with location or condition; Thrived and grew to size; Appeared to choke out weeds/grasses.

3 Heuchera - Minimal loss of plants (1); No apparent problems with location or condition; Thrived and grew to size; Appeared to choke out weeds/grasses.

5 Dianthus - Partial loss of plants (5); No apparent problems with location or condition; Did not thrive and grow to size; Did not choke out grasses, but worked on weeds.

7 Thyme - Partial loss of plants (5); No apparent problems with location or condition; Did not thrive and grow to size; Did not choke out weeds/grasses.

NY 290 Eastbound @ Weather Station - Notes on individual plants (Row 2 farthest from 290):

2 Nepeta - Minimal loss of plants (3); No apparent problems with location or condition; Thrived and grew to size; Appeared to choke out weeds/grasses.

4 Alchemilla - Near total loss of plants (19); No apparent problems with location or condition; Did not thrive and grow to size; Did not choke out weeds/grasses; Only 6 left.

6 Phlox - Near total loss of plants; No apparent problems with location or condition; Did not thrive and grow to size; Did not choke out weeds/grasses.

8 Sedum - Total loss of plants; No apparent problems with location or condition; Did not thrive and grow; Did not choke out any weeds/grasses.

NY 290 Westbound @ 990 Exit Ramp – Notes on individual plants (Row 1 nearest 290):

1 Solidago - Minimal loss of plants (5); No apparent problems with location or condition; Thrived and grew to size; Appeared to choke out weeds/grasses.

3 Heuchera - Minimal loss of plants (2); No apparent problems with location or condition; Thrived and grew to size; Appeared to choke out weeds/grasses..

5 Dianthus - 2/3rds of plants lost; No apparent problems with location or condition; Did not grow to size; Did not choke out weeds/grasses; Remaining plants now growing.

7 Thyme - 1 loss of plants; No apparent problems with location or condition; Did not grow to size; Did not choke out weeds/grasses.

NY 290 Westbound @ 990 Exit Ramp – Notes on individual plants (Row 2 farthest from 290):

2 Nepeta - Minimal loss of plants; Some recovery evident; No apparent problems with location or condition; Thrived and grew to size; Appeared to choke out weeds/grasses.

4 Alchemilla - Lost half of the plants; No apparent problems with location or condition; Did not thrive and grow to size; Did not choke out weeds/grasses.

6 Phlox - No loss of plants; No apparent problems with location or condition; Grew but not to size; Did not choke out weeds/grasses.

8 Sedum - Near total loss of plants; No apparent problems with location or condition; Did not thrive and grow; Did not choke out any weeds/grasses; Browsing and cold be the problem.

Acknowledgments

Laura Greninger and John Rowen, the primary NYSDOT contacts, arranged for assistance with roadside trials and helped shape the final documents. Along with Ms. Greninger, Deniz Sandhu, Charles Nagel and Mike Clarke - - also of NYSDOT - - worked with the researchers in developing the research design, scope of services and discussing the preliminary test results.

The following DOT employees assisted with setting up and evaluating roadside trials, and several provided comments on the final report and this handbook:

NYSDOT Region 4

- MaryEllen Papin, Maintenance Environmental Coordinator
- Kevin Miller - Senior Landscape Architect
- Jeff Dunlap, Retired Resident Engineer, Monroe West Residency and Residency staff

NYSDOT Region 5

- Peter Pasnik, Landscape Architect
- Dan Gentry, Highway Maintenance Supervisor II, and staff of the Knoche Road Sub-residency, Erie North Residency

NYSDOT Region 6

- Sandra Rapp, Maintenance Environmental Coordinator
- Joseph Miletti, Resident Engineer, Residency 6-4
- John Cardamone and the staff from Residency 6-4, including Mark Willsey, Brian Clendenin, James Clancy, Nick Alexin, Bob Ranger, Linda Clancy, Karen Winant, Dave Winant and Walt Pakkala

NYSDOT Region 8

- Elisabeth Kolb, Maintenance Environmental Coordinator
- Keith Savoury, Resident Engineer, Tom Story, Assistant Resident Engineer, and the staff of the Ulster Residency
- Mike Temple, Resident Engineer, and the staff of the Northern Dutchess Residency

NYSDOT Region 9

- Mary O'Reilly, Maintenance Environmental Coordinator
- Janet Koch and the staff of Broome Residency
- James Buck, Environmental Specialist 1, Ward Stevens, Assistant Resident Engineer, David Marin, Sam Rowe and the staff of Delaware South Residency

NYSDOT Region 10

- Gary Gentile, Retired Senior Landscape Architect
- Robb Smith, Rich Gass, and Ken DeKenipp, Maintenance Environmental Coordinators
- Darrel Kost, Resident Engineer, Kevin Matthaei, Assistant Resident Engineer, and the staff of Suffolk East Residency

Appendix.

Table 1A. Additional 25 herbaceous perennial transplanted groundcover species evaluated in Riverhead NY in 2005-2006.

Crop and/or Cultivars:	
<i>Ammophila breviligulata</i>	American Beachgrass
<i>Andropogon gerardii</i> 'Roundtree'	Big Bluestem
<i>Buchloe dactyloides</i> 'Texoka'	Buffalograss
<i>Dichanthelium clandestinum</i> (<i>Panicum c.</i>) 'Tioga'	Deertongue
<i>Carex flaccosperma</i>	Blue Wood Sedge
<i>Carex glauca</i> (syn. <i>flacca</i>)	Blue Sedge
<i>Antennaria dioica</i> 'Rubra'	Stoloniferous Pussytoes
<i>Antennaria plantaginifolia</i>	Pussytoes (Woman's tobacco)
<i>Asclepias tuberosa</i>	Butterfly Milkweed
<i>Aster ericoides</i> 'Snow Flurry' (syn. <i>Symphotrichum ericoides</i>)	White Heath Aster
<i>Ceratostigma plumbaginoides</i>	Blue Leadwood (Plumbago)
<i>Epimedium x perralchicum</i> 'Frohnleiten' (<i>E. perraderianum</i> x <i>E. pinnatum</i>)	Bishop's Hat (Barrenwort)
<i>Geranium macrorrhizum</i>	Geranium
<i>Laurentia fluviatilis</i> (syn. <i>Pratia pedunculata</i>)	Laurentia
<i>Lysimachia punctata</i> 'Alexander'	Large Yellow Loosestrife
<i>Rudbeckia fulgida</i> 'Goldstrum'	Orange Coneflower (Black-eyed Susan)
<i>Sedum spurium</i> 'John Creech'	Tworow Stonecrop
<i>Teucrium canadensis</i> (syn. <i>prostrata</i>)	Germander
<i>Tiarella cordifolia</i> 'Running Tapestry'	Foamflower
<i>Veronica peduncularis</i> 'Waterperry'	Speedwell
<i>Deutzia gracilis</i> 'Nikko'	Nikko Deutzia
<i>Microbiota decussate</i>	Microbiota
<i>Sarcococca hookeriana</i> v. <i>humilis</i>	Sweetbox
<i>Vaccinium angustifolium</i>	Lowbush Blueberry
<i>Viburnum trilobum</i> 'Compactum'	Cranberry Viburnum (Am. Cranberrybush)

Table 2A. List of cool season grasses evaluated in 2005-2007 in Ithaca and Riverhead NY. Plots were established in fall 2005.

1	Crested wheatgrass	<i>Agropyron cristatum (L.) Gaertn.</i>
2	Redtop	<i>Agrostis stolonifera L</i>
3	Creeping meadowgrass	<i>Poa pratensis L</i>
4	Smooth brome grass	<i>Bromus inermis Lesser</i>
5	Streambank Wheatgrass	<i>Elymus lanceolatus (Scribn. & J.G. Sm.) Gould</i>
6	"No Mow" Fescue	<i>Festuca rubra L.</i>
7	Arizona Fescue	<i>Festuca arizonica Vasey</i>
8	Columbra chewings fescue	<i>Festuca rubra subsp. commutata L</i>
9	Intrigue chewings fescue	<i>Festuca rubra subsp. commutata L.</i>
10	Sandpiper chewings fescue	<i>Festuca rubra subsp. commutata L</i>
11	Oxford hard fescue	<i>Festuca trachyphylla Hack Krajina</i>
12	Reliant II hard fescue	<i>Festuca trachyphylla Hack Krajina</i>
13	Rebel Exeda tall fescue	<i>Lolium arundinaceum (Schreb.) S.J. Darbyshire</i>
14	Tar Hill 2 tall fescue	<i>Lolium arundinaceum (Schreb.) S.J. Darbyshire</i>
15	Palmer perennial ryegrass	<i>Lolium perenne L.</i>
16	Prelude perennial ryegrass	<i>Lolium perenne L.</i>
17	Russian wild rye	<i>Psathyrostachys juncea Nevski</i>
18	Weeping alkaligrass	<i>Puccinellia distans Jacq Parl</i>
19	Zenith zoysiagrass	<i>Zoysia japonica L</i>
Roadside Demons. plantings included:	Intrigue fine fescue, Columbra fine fescue, Palmer and Prelude perennial ryegrasses, redtop, Russian wild rye, No-mow fescue, Rebel tall fescue	



Table 3A. A list of the native grass and forb mixtures evaluated in Ithaca and Riverhead NY in 2006-2007. Plots were established in June 2006. Ithaca plots continued to be evaluated through 2006 and 2007, while Riverhead plots did not adequately establish and were not evaluated.

Performance

Seeding mixtures were established at an approximate rate of 3lb/1000 square feet in a well drained silty clay loam soil in Ithaca, NY in June 2006. Prior to establishment, the site was tilled, cultivated and fumigated to allow for reasonable first year establishment. Certain grass, forb and grass plus forb mixtures outperformed others in this replicated trial. Late season mowing provided additional weed management and encouraged optimal performance of groundcover mixtures in 2006. Rainfall amounts were adequate throughout the season and irrigation was only performed initially after seeding. The Ernst seed mixture was very effective in forming a densely established cover and it contained numerous flowering forbs. It was evidently our best overall performer in 2006, several months after establishment. It was also highly weed suppressive.

Seed Mixture	% Ground Cover	% Weed Cover	Notes
1. Grass Mixture	61.25	38.75	medium height
2. Grass Mixture	68.75	30	lower height
3. Forb Mixture	40	60	lower height / weedy
4. Forb Mixture	26.25	73.75	lower height / weedy
5. Grass & Forb	62.5	37.5	less grass
6. Grass & Forb	60	45	more grass
7. Grass & Forb	77.5	17.5	mainly grass
8. Showy NYS Native	58.75	41.25	grass and forbs, good mixture of diverse plants
9. NY State Native	53.75	48.75	grass and forbs, decent mixture but some grass weed infestation
10. Ernst Mixture	83.75	15	grass and forbs, colorful and attractive, very few weeds
11. Weedy Control	0	100	weeds consist of large crabgrass, pigweed spp., yellow nutsedge, curly dock, cinquefoil, and many other broadleaves.

No.	Seed Mixture	Common Name	Scientific Name	No.	Seed Mixture	Common Name	Scientific Name						
1	Grass only, med ht, dry	Buffalograss	<i>Buchloe dactyloides</i>	9	NYS Native Community: Bluestem Prairie	Big Bluestem	<i>Andropogon gerardii</i>						
		Switchgrass	<i>Panicum virgatum</i>			Little Bluestem	<i>Schizachyrium scoparium</i>						
		Prairie Junegrass	<i>Koeleria macrantha (cristata)</i>			Switchgrass	<i>Panicum virgatum</i>						
2	Grass only, med ht, moist	Deertongue	<i>Dichanthelium clandestinum</i>			10	Ernst Mix 153-1, Showy NE Native WF Mix	Northern Prairie Dropseed	<i>Sporobolus heterolepsis</i>				
		Little Bluestem	<i>Schizachyrium scoparium</i>					Prairie Junegrass	<i>Koeleria macrantha (cristata)</i>				
		Canada Wild Rye	<i>Elymus canadensis</i>					Smooth blue aster	<i>Aster laevis</i>				
3	Forbs only, med ht, dry	Butterfly Milkweed	<i>Asclepias tuberosa</i>					10	Ernst Mix 153-1, Showy NE Native WF Mix	Antennaria rubra	<i>Antennaria rubra</i>		
		Blue Wild Indigo	<i>Baptisia australis</i>							Stiff goldenrod	<i>Solidago rigida</i>		
		Virginia mountainmint	<i>Pycnanthemum virginianum</i>							Rough blazingstar	<i>Liatris aspera</i>		
		Gray goldenrod	<i>Solidago nemoralis</i>							Narrow leaf sunflower	<i>Helianthus angustifolius</i>		
4	Forbs only, med ht, moist	White Heath Aster	<i>Aster ericoides</i>							10	Ernst Mix 153-1, Showy NE Native WF Mix	Partridge pea	<i>Chamaecrista fasciculata</i>
		Perennial Lupine	<i>Lupinus perenne</i>									Oxeye sunflower	<i>Helipopsis helianthoides</i>
		Obedient Plant	<i>Physostegia virginiana</i>	Wild blue lupine	<i>Lupinus perennis</i>								
		Orange Coneflower	<i>Rudbeckia fulgida</i>	Black eyed Susan	<i>Rudbeckia hirta</i>								
5	Grass & forb low combination	Buffalograss	<i>Buchloe dactyloides</i>	10	Ernst Mix 153-1, Showy NE Native WF Mix							Common milkweed	<i>Asclepias syriaca</i>
		Prairie Junegrass	<i>Koeleria macrantha (cristata)</i>			Brown eyed Susan	<i>Rudbeckia triloba</i>						
		White Heath Aster	<i>Aster ericoides</i>			Smooth blue aster	<i>Aster laevis</i>						
6	Grass & forb med ht, summer flowering	Little Bluestem	<i>Schizachyrium scoparium</i>			10	Ernst Mix 153-1, Showy NE Native WF Mix					Spiked blazingstar	<i>Liatris spicata</i>
		Deertongue	<i>Dichanthelium clandestinum</i>					Wild senna	<i>Senna hebecarpa</i>				
		Northern Prairie Dropseed	<i>Sporobolus heterolepsis</i>					Tall coreopsis	<i>Coreopsis tripteris</i>				
		Butterfly Milkweed	<i>Asclepias tuberosa</i>					Wild bergamot	<i>Monarda fistulosa</i>				
		Virginia mountainmint	<i>Pycnanthemum virginianum</i>					Tall white beardtongue	<i>Penstemon laevigatus</i>				
		Obedient Plant	<i>Physostegia virginiana</i>					Appalachian beardtongue	<i>Baptisia australis</i>				
7	Grass & forb med-low ht, spring flowering	Red fescue	<i>Festuca rubra</i>					10	Ernst Mix 153-1, Showy NE Native WF Mix	Blue false indigo	<i>Asclepias tuberosa</i>		
		White Heath Aster	<i>Aster ericoides</i>							Butterfly Milkweed	<i>Lespedeza capitata</i>		
		Antennaria rubra	<i>Antennaria rubra</i>							Early goldenrod	<i>Solidago juncea</i>		
8	Showy NY native wildflower & grass mix	Little Bluestem	<i>Schizachyrium scoparium</i>	10	Ernst Mix 153-1, Showy NE Native WF Mix					Gray goldenrod	<i>Solidago nemoralis</i>		
		Northern Prairie Dropseed	<i>Sporobolus heterolepsis</i>										
		Canada Wild Rye	<i>Elymus canadensis</i>										
		Butterfly Milkweed	<i>Asclepias tuberosa</i>										
		White Heath Aster	<i>Aster ericoides</i>										
		Orange Coneflower	<i>Rudbeckia fulgida</i>										
		Gray goldenrod	<i>Solidago nemoralis</i>										
		Blue Wild Indigo	<i>Baptisia australis</i>										
		Perennial Lupine	<i>Lupinus perenne</i>										
Tall white beardtongue	<i>Penstemon digitalis</i>												