DEVELOPMENT OF A NATIVE PLANT PRESCRIPTION FOR URBAN HYDRO RIGHTS OF WAY

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ABSTRACT

Ontario Hydro must save costs on mown urban rights-of-way, and its conservation policy encourages native vegetation. Thus the Corporation commissioned a study to evaluate whether a community of sown native species of prairie affinity can inhibit tall woody species. The research involves 70, 5 x 5 m plots on a gently sloping oldfield site, on Bennington series silt loam, at Kitchener, Ontario. The plots have been surveyed annually since 1996 using 7 random, permanent 1.0 x 0.5 m quadrats per plot. In Fall 1996, seed of 7 locally native species of prairie affinity was collected in the Region of Waterloo. Species were; Canada wild rye [*Elymus canadensis* L.], Indian grass [*Sorghastrum nutans* (L.) Nash], Big bluestem [*Andropogon Gerardi* Vitm.], Little bluestem [*Schizacyrium scoparium* Michx. (Nees)], Tick trefoil [*Desmodium canadense* (L.) DC.], Black-eyed Susan [*Rudbeckia hirta* L.] and Wild bergamot [*Monarda fistulosa* L.]. Sixty four plots were prepared and sown using 4 methods: 1] Fall 1996 glyphosate herbicide [1% in water applied at 380L/ha] and fall sowing, 2] Spring 1997 glyphosate and spring sowing, 3] Fall 1996 and spring 1997 rototilling and spring sowing, and 4] No preparation and fall sowing. Each preparation is managed in 4 ways: 1] Mowing, 2] Burning, 3] Mowing and burning and 4] No management. There are, additionally, 4 true controls neither sown nor managed, and 2 plots planted with plugs. Preliminary establishment results will be discussed in relation to weed competition arising from a soil seed bank that predates the last turning of the soil about 40 years ago.

Introduction

Utility companies like Ontario Hydro need to control tall woody vegetation on rights-of-way because trees cause power leakage, and because trees and tall shrubs make maintenance difficult. Control of woody vegetation is achieved conventionally through herbicides, or by mowing, and in a few instances, by brush cutting. Brush cutting has always been expensive, and mowing is also under cost scrutiny in an era of increasing economic deregulation and competition. Herbicides while effective and cheap, have proven controversial with certain elements of the public, especially in urban areas. In the light of this background, Ontario Hydro and researchers from the University of Waterloo began a study to assess the feasibility of using herbaceous species of prairie affinity on rights-of-way in urban areas. It is hoped that this vegetation offers a low-cost, environmentally benign alternative.

Tallgrass prairie has long been known to inhibit invasion of woody species (e.g. Curtis 1959). In addition, the area of tallgrass prairie has been severely reduced in Ontario (Pratt 1989), so there are conservation benefits to this approach. On the other hand, there are potential problems: Can tallgrass species be established on soils that never supported prairie in historic times? And are tallgrass communities aesthetically acceptable to the majority of the neighbouring public? A further series of questions concerns how best to establish a tallgrass system, and how to maintain it in ways acceptable to both Hydro and the public. For instance, can this vegetation be maintained without burning?

We are tackling these questions in a 3-phase program. The first phase (reported here) involves a randomised plot experiment to test establishment and maintenance techniques. The second phase will use large, semi-operational plots with the focus on costs and public acceptability, and the third phase will be a full-scale operational test. The use of progressively larger plot sizes is predicated not only on the usual process of scaling up experiments, but also on the need to generate a large seed supply without compromising wild supplies or conservation values

Methods

Experimental Site

The experimental site is Ontario Hydro's Detweiler Transformer Station on the western outskirts of Kitchener, Ontario (80°40'W, 42°20'N). The area is underlain by Bennington series silt loam and slopes gently to the East. Air photos show that the area had been under row crops in 1947, was in fallow in 1955 at the time of construction of the Hydro facility, and has subsequently developed into grassland (1967, 1971, 1975, 1980, 1985, 1990, 1995). We are informed by Hydro staff that the area has been rough-mown once or twice a year since at least 1970 and has been otherwise undisturbed. At the beginning of the experiment the vegetation was a relatively species-poor, uniform Poa/Festuca grassland.

Experimental Design

Four methods of establishment were used: Fall application of glyphosate herbicide, spring glyphosate, Fall and spring Rototilling and No preparation ("Sown Control"). Four methods of maintenance are also used, namely: Mowing, burning, mowing and burning, and no maintenance. These make 16

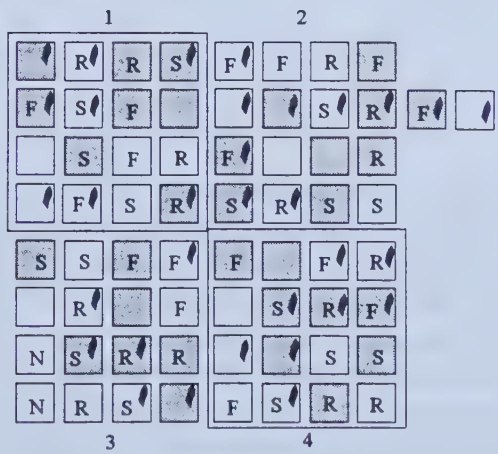

Fig. 1. The plot design. F = fall glyphosate, S = spring glyphosate, R = fall and spring rototill. No letter = sown control, N = plot unusable. Shaded = mowed, = Future burn, Numbers = replicate experiments.

combinations comprising a single experiment of 4 x 4 plots. This experimental design is replicated 4 times, making a total of 64 plots in an 8 x 8 block (Fig. 1). Each plot is 5 x 5 m within which is a 0.5-m wide buffer strip receiving treatment but in which vegetation is not sampled. No burning has been done yet, so half the plots have been mowed and the other half are unmowed. Two plots were unusable because of a soil anomaly, and these were replaced with plots adjacent to the main grid.

Procedure

In 1996 when the plots were set up, a base-line vegetation survey was conducted, seed was gathered, and selected plots were prepared and sown. In Spring 1997, the remaining plots were prepared, and sown. The vegetation survey was repeated in summer 1997 (reported here) and summer 1998. Relevant plots were mowed in the summers of 1997 and 1998, but no burn has been done yet

Plot preparation

Fall glyphosate plots were treated on 3rd October 1996 [1% Monsanto liquid Roundup in water at 380L/ha and 50 psi, using a TKSS-20 truck-mounted sprayer, with hand held hoses and #20 Flowjet Nozzles]. Spring glyphosate plots were treated on 22nd May 1997, using the same rate of herbicide application but from a backpack sprayer. The rototilled plots were mowed to 10cm height (Husqvarna 56DH highwheel rotary mower without mulching attachment), raked, and tilled on Oct 31st – Nov 6th 1996 with a 4WD Kubota tractor equipped with floatation tires, and rear-mounted FL1000 tiller. Tillage was repeated on May 22nd 1997. All remaining plots were mowed in early November 1997 to 10cm height.

Seeding of fall glyphosate and sown controls was completed on Dec 2nd 1996, just at the time of freeze-up. Spring glyphosate and Rototilled plots were sown on June 4th 1997, during a late, cold spring.

Seed Collection, Storage and Sowing

Seed was collected from several sites in North Dumfries township near Kitchener on 5 occasions in October 1996. The species were: Canada wild rye [*Elymus canadensis* L.], Indian grass *[Sorghastrum nutans* (L.) Nash], Big bluestem [*Andropogon Gerardi* Vitm.], Little *bluestem [Schizacyrium scoparium* Michx. (Nees)], Tick trefoil [*Desmodium canadense* (L.) DC.], Black-eyed Susan [*Rudbeckia hirta* L.] and Wild bergamot [*Monarda fistulosa* L.]. The seed for fall glyphosate and untreated plots was air dried, then prepared at the University of Guelph Elora Research Station. Forb seedheads were milled and winnowed, and grass heads were chopped. The grass seed was treated with Vitaflow fungicide. Forb seed was not treated because the small quantities involved would have balled up with the fungicide carrier in the machinery. The seed of each species was divided into 64 exactly equal packets for sowing. Seed for each of the 7 species was mixed immediately prior to sowing to achieve exactly the same seeding weight and species ratio for each plot. The remaining dried seed was stored at –15°C for spring sowing.

Vegetation Survey

All plots were surveyed between June and mid August 1996, 1997 and 1998 using 7 randomly placed permanent quadrats of 0.5 x 1.0m divided into 5 cells of 20 x 50cm. Each cell was rated for each higher plant and bryophyte species using a 7-class standardised dominance/abundance scale.

Soil seedbank Survey

Cores were taken from the first 25 cm soil layer of each plot (16 from the buffer area of each plot). Cores were frozen for 3 months and, following mixing with sterile soil amendments, and then placed in a growth chamber. Germination was recorded weekly for 3 months, and the seedling species identified. After 3 months the soil was frozen again for 3 months, and then observed, as before for 3 months. This procedure allows one to measure the species present and their relative numbers. The first samples were collected in September 1996, and the experimental run was completed in September 1997. A further series of samples is currently under observation.

Results and Discussion

Establishment of Sown Species

Abundance data for the 7 sown species were collated by treatment. Many cells within quadrats, and many whole quadrats within plots, did not contain germinated seedlings of the sown species in summer 1997 (or perhaps the seedlings were too small to be identified at that time). This made the intended complex analysis of variance (ANOVA) untenable because assumptions of statistical normality inherent in ANOVA would be violated. The data were therefore blocked into 4 replicates x 4 treatments x 28 observations. Complete absence of germination in sown controls and/or spring glyphosate treatments in *Rudbekia, Sorghastrum and Andropogon* compromised the sensitivity of Least Significant Difference (LSD) tests. These species' data were therefore re-analysed without sown controls, and these LSD results are reported in Figure 2.

Laboratory tests showed that germinability of *Schizacyrium scoparium* was very low, and this was reflected in complete absence in the vegetation samples. *Elymus canadensis* was also absent from the samples, though it had germinated at low rates in the laboratory. The remaining five species all germinated in numbers, and only these are discussed hereafter.

All five species had significant differences between treatments (ANOVA F-test, $P<0.05$). The sown controls had negligible numbers of *Andropogon gerardi* and *Rudbekia hirta* (Fig. 2). As expected, establishment of the other three species was also very sparse on control plots. The fall glyphosate treatment was effective in establishing 4 of the 5 species, but *Desmodium canadensis* had all but failed to show at the date of the 1997 survey. Spring glyphosate was most effective in promoting the establishment of *Andropogon gerardi*, and there was a little *Monarda fistulosa* and *Desmodium canadense*. *Sorghastrum nutans* and *Rudbekia* failed under this regime. The rototill treatment was effective for *Desmodium*, slightly effective with *Monarda*, *Andropogon* and *Rudbekia*, and failed with *Sorghastrum*.

Soil seedbank Observations

The main species in the seed bank (Table 1) were *Medicago lupulina* (black medick), *Ambrosia artemiisifolia* (common ragweed), *Sonchus oleraceus*, *Agrostis tenuis* (Rhode island bent/trembling redtop), *Prunella vulgaris* (selfheal), *Amaranthus retroflexus* (redroot pigweed), *Elytria repens* (quackgrass), *and Phleum pratense* (timothy grass). Only one native species *(Panicum capillare* witchgrass/ panic grass) was represented by more than 50 germinating seeds. Two natives in the seed bank, *Conyza canadensis* (horseweed) and *Echinocystis lobata* (wild cucumber), are appropriate to

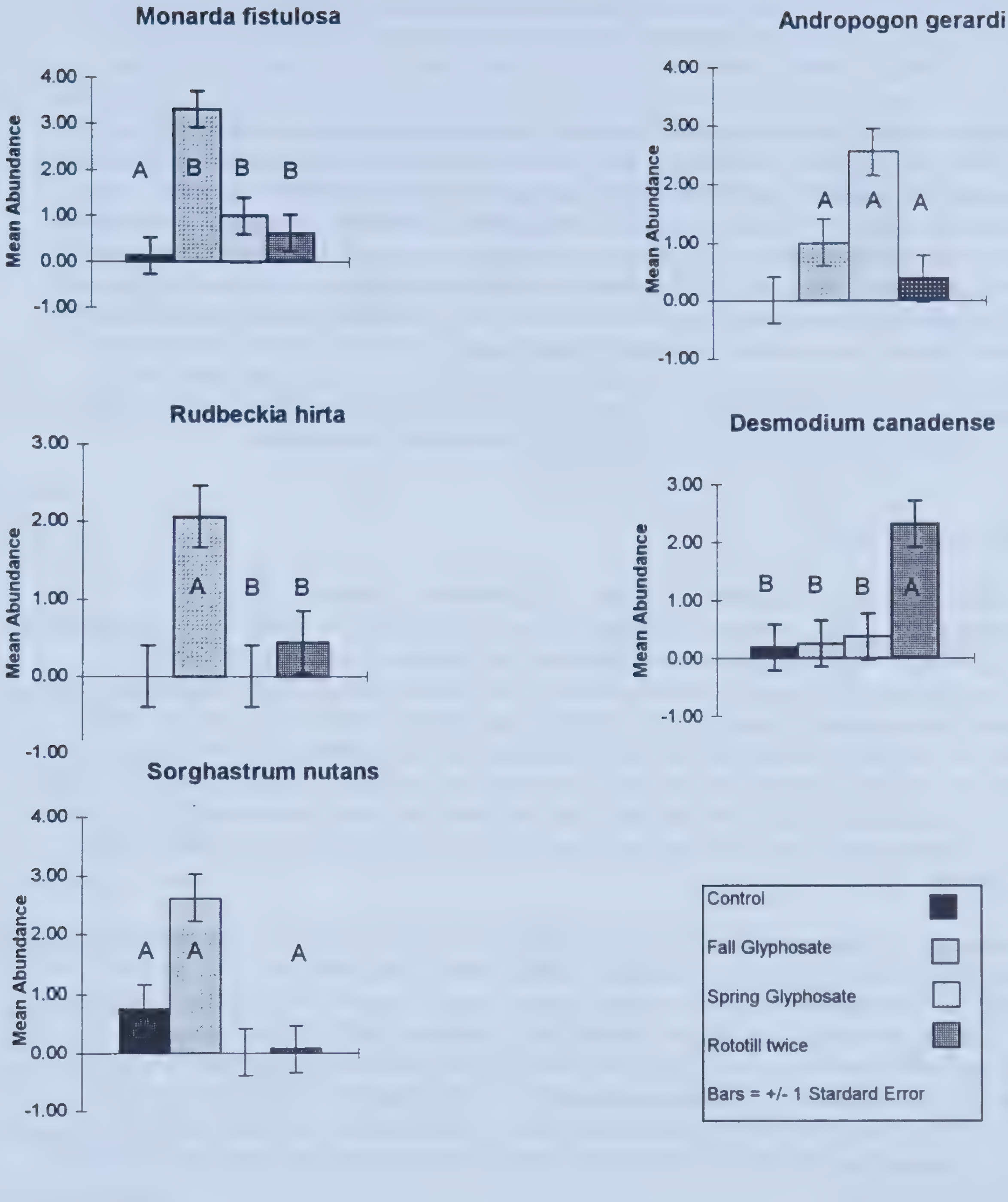

Fig. 2. Seedlings observed during the first growing season. Scores are on a 7-point cover-abundance scale. Bars are +/- 1 Standard error. Letters indicate classes not differing significantly ($p<0.05$) in LSD tests.

tallgrass prairie but are potentially invasive in areas bordering rights-of-way, and this may prove a problem. The early dominance of *Medicago lupulina* on rototilled plots in 1997, while not reported in the present data, was especially striking.

Forty-six species, mainly weeds that germinated from the seed bank had not been observed in the ambient plant survey in 1996. Thus they probably did not invade as seeds from surrounding habitat but have the potential to reinvade from the long-lived seed bank. Of particular interest are *Alliaria petiolata* (garlic mustard), *Cerastium vulgatum* (mouse-eared chickweed), *Medicago lupulina* (black medick), *Setaria pumila* (yellow foxtail), *Setaria viridis* (green foxtail), *Sonchus arvensis* (perennial sow thistle) and *Sonchus oleraceus* (annual sow thistle) which are highly invasive. *Setaria pumila* was not observed in either the ambient or the systematic surveys, but it is likely that this species had been grouped with *Setaria viridis* as they are difficult to distinguish. Two other species, *Elytria repens* (quackgrass) and *Taraxacum officinale* (common dandelion) did not germinate from seeds, but rhizomes and roots re-sprouted. All of these weeds need to be controlled by whatever rehabilitation technique is used, or they are likely to overrun the site, once released from dormancy.

Discussion and Conclusions

As evidenced by low germination rates on controls, site preparation is necessary for effective establishment of these prairie species. The aggregate best "take" of seed for all species can be achieved with Fall glyphosate application, but double rototilling is effective as an alternative to promote *Desmodium*. One should be aware, however, that this result only applies to initial establishment: Some of the species have appeared in quantity in 1998 where they initially failed in 1997, but these results are not collated at the time of writing (July 1998). In particular, we note numbers *of Elymus canadensis* establishing on the glyphosate plots during 1998. It is possible that the very similar seedlings of *Elytria* and *Elymus* were confused in the 1997 survey. Also, the results only apply to the weather in the year of the test - It is quite possible that other patterns of temperature and precipitation would have yielded different results.

On the basis of the above, an effective strategy to establish the widest variety of species would be to apply glyphosate in Fall, sowing a mix of species (minus *Desmodium*) soon after. Then patches of the area should be rototilled in spring and sown to a mix containing *Desmodium* and lacking *Sorghastrum*. If it is important to establish *Andropogon* (and this might be true for both ecological and aesthetic reasons), then further patches can be glyphosate treated in spring and sown to *Andropogon* and *Monarda*. The first approach will be most cost effective, with the second and third adding further species to the community, but with greater cost and effort. The second and third approaches could therefore be concentrated on prominent areas, such as near highways or the entrances to recreational trails along a right of way.

The short and long-term effectiveness of any ecological rehabilitation strategy can be measured in changes in the population of viable seeds in the soil. There should be a decline in the numbers of seeds of nuisance species (e.g. *Cirsium, Medicago*), and a corresponding diminution in numbers of mature plants. Seeds of some weed species can be long lived as evidenced by large numbers of viable *Medicago lupulina* and other seeds. *Medicago*, in fact, appeared in large numbers on the rototilled plots in both 1997 and 1998. Thus the preparation for seeding, though necessary, should not include a general cultivation, regardless of how long the site has remained uncultivated. Glyphosate has an

Table 1. Seed germination from September 1996 (pre-management) soil samples at Detweiler.

The second column indicates how many samples (out of a total of 1056) had germinating seeds of a given species. The third column indicates how many plots (out of a total of 66) had germinating seeds from a given species. For the last two columns, 0 and 1 indicate absence and presence respectively of a species. Nomenclature follows Morton and Venn (1992). Taxonomic synonyms include: *Alliaria petiolata* (= *A. officinalis*), *Agrostis capillaris* (= *A. tenuis*), *Aster lateriflorus* (= *A. vimineus*), *Cerastium fontanum* (= *C. vulgatum*), *Conyza canadensis* (= *Erigeron canadensis*), *Elytrigia repens* (= *Agropyron repens* = *Elymus repens*), *Epilobium ciliatum* (= *E. glandulosum*), *Euthamia graminifolia* (= *Solidago graminifolia*), *Festuca arundinacea* and *Festuca pratensis* (both = *F. elatior*), *Setaria pumila* (= *S. glauca*), *Oxalis stricta* (= *O. europea*). * = native to Canada.

Species	# seeds germinated	# samples from which seeds germinated	# plots from which seeds germinated	Ambient survey	System surve
Achillea millefolium	5	3	2	1	1
Agrostis capillare	87	71	64	1	1
Agrostis stolonifera	3	1	1	0	0
Alliaria petiolata	11	4	2	0	0
Alopecurus pratensis	2	1	1	1	0
Amaranthus powellii	13	7	4	1	0
Amaranthus retroflexus	79	68	61	1	0
Ambrosia artemisiifolia	116	81	62	1	0
Arctium minus	1	1	1	1	0
Asclepias syriaca*	14	8	8	1	1
Aster lateriflorus*	0	0	0	1	0
Aster novae-angliae*	9	7	4	1	1
Bromus inermis	27	18	15	1	1
Cerastium fontanum	61	42	26	1	1
Cirsium arvense	10	7	4	1	1

Cirsium vulgare	18	16	12	1
Chenopodium album	46	37	31	1
Chenopodium botrys	0	0	0	1
Conyza canadensis*	5	3	2	1
Cornus stolonifera*	0	0	0	1
Cyperus esculentus*	0	0	0	1
Dactylis glomerata	19	14	12	1
Daucus carota	3	1	1	1
Dipsacus fullonum	0	0	0	1
Echinochloa crus-galli	0	0	0	1
Echinocystis lobata*	0	0	0	1
Echium vulgare	3	1	1	0
Elytrigia repens	79	56	47	1
Epilobium ciliatum*	0	0	0	1
Epilobium parviflorum	2	1	1	0
Equisetum arvense*	0	0	0	1
Eragrostis pilosa*	7	3	2	0
Erigeron annuus*	4	2	2	1
Erigeron philadelphicus*	1	1	1	1
Erysimum cheiranthoides	6	3	3	1
Euphorbia cyparissias	1	1	1	0
Euthamia graminifolia*	0	0	0	1
Festuca arundinacea	22	17	15	1
Festuca pratensis	29	24	21	1

Fragaria virginiana*	18	11	10	1	1
Galium mollugo	6	4	2	0	0
Hieracium aurantiacum	7	2	2	0	0
Hieracium caespitosum	27	23	22	0	0
Hieracium floribundum	2	2	2	0	0
Hordeum jubatum	1	1	1	1	0
Hypericum perforatum	9	6	5	1	1
Lactuca serriola	2	2	2	0	0
Leersia oryzoides*	0	0	0	2	0
Leonurus cardiaca	0	0	0	0	0
Linaria vulgaris	0	0	0	1	0
Malva neglecta	0	0	0	1	0
Matricaria matricarioides	0	0	0	1	0
Medicago lupulina	188	143	54	1	1
Melilotus alba	0	0	0	1	0
Melilotus officinalis	0	0	0	1	0
Oenothera biennis*	0	0	0	1	0
Oxalis stricta*	47	31	30	1	0
Panicum capillare*	52	44	41	1	0
Panicum flexile*	13	11	7	1	0
Parthenocissus quinqufolia*	4	4	4	0	0
Phleum pratense	73	52	40	1	1
Plantago major	0	0	0	1	0
Poa compressa*	32	15	9	1	1

Poa nemoralis	11	6	5	0
Poa pratensis*	65	48	42	1
Poa trivialis	7	4	1	0
Polygonum aviculare	4	3	3	1
Polygonum convolvulus	16	13	12	0
Prunella vulgaris	84	61	25	1
Prunus sp. (possibly *)	0	0	0	0
Rhamnus cathartica	5	4	4	1
Rhus typhina*	2	1	1	0
Rubus idaeus (possibly *)	0	0	0	1
Rumex crispus*	0	0	0	1
Scirpus atrovirens*	0	0	0	1
Solanum dulcamara	0	0	0	1
Setaria pumila	42	29	22	0
Setaria viridis	57	38	31	0
Silene noctiflora	5	3	2	0
Solidago altissima*	1	1	1	0
Solidago canadensis*	6	4	4	1
Solidago rugosa*	0	0	0	1
Sonchus arvensis	77	68	50	0
Sonchus oleraceus	92	84	79	0
Sorghastrum nutans*	3	1	1	0
Sporobolus vaginiflorus*	14	9	4	1
Stachys palustris	1	1	1	0
Stellaria media	18	12	8	0

Tanacetum vulgare	0	0	0	1	0
Taraxacum officinale	55	40	32	1	1
Thlaspi arvense	34	32	27	0	0
Tragopogon pratensis	6	5	5	0	0
Trifolium hybridum	19	8	7	1	1
Trifolium pratense	24	16	11	1	1
Trifolium repens	14	10	10	1	0
Tussilago farfara	0	0	0	1	0
Typha latifolia*	0	0	0	1	0
Verbascum thapsus	23	17	14	1	0
Veronica arvensis	5	3	1	0	0
Veronica officinalis	11	8	6	0	0
Veronica serpyllifolia*	4	2	1	1	1
Viola kitaibeliana	31	18	13	0	0
TOTAL	1897				

obvious advantage over rototilling in that it does not expose buried seeds of nuisance species. On the other hand, limited soil disturbance is necessary to encourage *Desmodium* and similar species. Cultivation of specific areas to establish species needing mechanical disturbance can be regarded as a trade off between incurring weed problems and maximising biodiversity.

The baseline seedbank observations proved useful in showing the huge numbers of viable weed seeds that remain after 40 years without soil disturbance. In the next few years we shall be tracking the relative numbers of viable weed and native species to see if the relative success of various management regimes is predicated on soil seedbank populations.

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TABLE OF CONTENTS