



Native Prairie Restoration Study

Final Report 1998-2002

North Dakota Game and Fish Department
and
USDA-NRCS Bismarck Plant Materials Center

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Executive Summary

This report is the final cumulative report (1998-2002) for the cooperative Prairie Restoration Study between the Natural Resources Conservation Service and the North Dakota State Game and Fish Department. The project was a cooperative five-year study to determine establishment and cultural management strategies for promoting diverse prairie plantings. The study site was located in the Coteau region of central North Dakota. Sites of introduced grass stands were renovated to diverse native stands. Seeding methods and dates were evaluated to determine optimum methods of establishment under a no-till system. Seedings of diverse native plantings were made into killed introduced sod. Direct seedings of native shrubs and forbs into chemically killed sod were also accomplished. Evaluations documented stand establishment, species composition, weed competition, and introduced grass competition. Refer to each individual planting site for 2002 and past project activities.

- Site management prior to seeding is extremely critical for success.
- Weed competition in diverse plantings will pose some degree of competition to the native seedlings even when good initial weed control techniques are used prior to seeding. This will challenge the land manager, as herbicides for chemical weed control on these diverse native stands will be limited.
- Diverse native seedings can be successfully established into killed sod of introduced grass fields in one year.
- Chemically killed smooth brome grass provided an excellent seedbed for no-till seeding. Dead sod of Kentucky bluegrass provided a poor no-till seedbed.
- Diverse mixes of native grasses and forbs will be a challenge for long-term management.
- Reestablishment of introduced species into the site will ultimately result if management is not done in a correct and timely manner.
- Different management techniques may be required for longevity of diverse native planting in comparison to introduced cool-season stands.
- Prescribed burns provide an excellent management tool. Grazing and haying although not evaluated in this study also will serve as important management tools for the land manager.
- The cost of establishment and long-term maintenance will ultimately be affected by past site history and by the land manager's vision of what is a successful native prairie.

Russ Stuart Wildlife Management Area (WMA) Farmstead Site

Purpose:

The purpose of this planting was to compare seeding dates for native plantings using no-till seeding methods. A summer seeding and a fall dormant seeding were compared. Introduced grass suppression, primarily smooth brome grass, was measured on the two sites.

Site Description:

This site consisted of 4 acres of Williams loam soils. Legal description is the SW1/4 of 3-144-78 Burleigh County.



Russ Stuart WMA Farmstead site. Comparing a dormant no-till seeding on the left to a summer no-till seeding on the right.

Treatments:

This location was been split into two test sites. The west half was seeded in July 1998 and the east half was dormant seeded in October 1998. The same diverse mixture of native grasses and forbs were planted on both sites. See Table 1 for species used in the mix. Two permanent transects 200 feet long were placed in each treatment. Metal steel posts mark the boundaries of each transect. A steel tape was stretched between the posts as a reference line for plant counts. Figure 1 shows a layout of the transects. Frequency percent of plant species was recorded as a measure of stand establishment. See Attachment 1 for species frequency on the farmstead site. Table 2 compares average frequency of selected species for the two seeding dates. Table 3 shows the site preparation and maintenance activities for both sites.

Figure 1. Transect treatments on Russ Stuart WMA Farmstead Site.
 1998 summer seeded (July) 1998 dormant seeded (October)

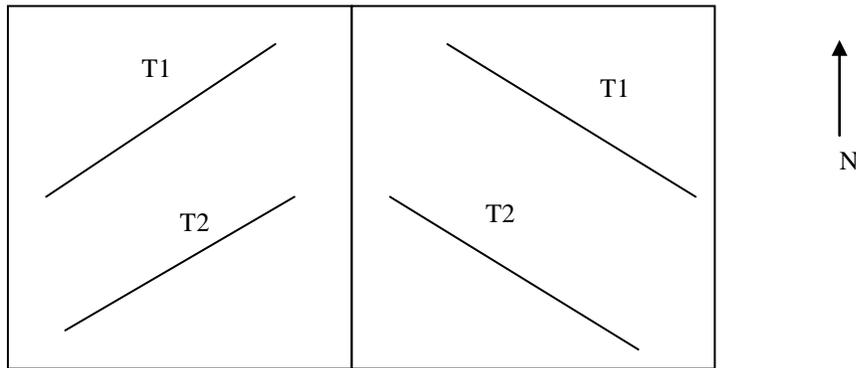


Table 1.
Seed mix used at the Russ Stuart WMA Farmstead Site

Species	Cultivar/Source	Seed Mix
Switchgrass	Forestburg	20%
Big bluestem	Bison	30%
Indiangrass	Tomahawk	20%
Prairie cordgrass	Red River	5%
Green needlegrass	SD-93	20%
Canada wildrye	Mandan	5%
Slender wheatgrass	NA	Trace
Purple prairieclover	PMC	22 PLS gm/ac
Lewis wild flax	Appar	45 PLS gm/ac
Canada milkvetch	PMC	45 PLS gm/ac
Plains coreopsis	Purchased	11 PLS gm/ac
Maximilian sunflower	PMC	11 PLS gm/ac
Two-grooved milkvetch	PMC	22 PLS gm/ac
Leadplant	PMC	15 PLS gm/ac
Narrow-leaved purple coneflower	PMC	9 PLS gm/ac
Silky prairieclover	PMC	8 PLS gm/ac
Stiff sunflower	PMC	22 PLS gm/ac
Yellow coneflower	Purchased	22 PLS gm/ac

Table 2.
Average Frequency Comparisons for Selected Species – 1999¹, Farmstead Site

	July Seeding	October Seeding
Seeded Species		
Big bluestem	60%	35%
Switchgrass	88%	20%
Canada wildrye	10%	33%
Green needlegrass	8%	35%
Invaders		
Bromegrass	15%	3%
Bluegrass	35%	0%
Crested wheatgrass	38%	13%
Sweetclover	>50% ²	95% ³

¹Frequency percent is the number of frames species was present in divided by total frames (120) collected.

²Consisted of plants in their second year of growth

³High percentage of first year growth

Table 3.			
Site Preparation and Maintenance of Summer and Dormant Seeded Plots at the Farmstead Site			
Summer (July 1998) seeding			
	Date	Activity	Remarks
	4/21/98	Controlled burn	Remove surface residue and initiate regrowth of introduced species
	5/24/98	Spray	2 qts/ac glyphosate applied for burndown
	6/25/98	Spray	2 qts/ac of glyphosate applied for burndown of remaining introduced species
	7/8/98	Seeded	Truax no-till drill
	10/1/98	Stand evaluation	Notes collected along the 2 transects
	5/27/99	Spray	2,4-D applied on sweetclover, first 40' on north
	7/21/99	Evaluation	Notes collected along transects
	7/22/99	Spot mowing	Spot mowing of wormwood and Canada thistle
	4/24/00	Controlled burn	Suppress introduced grasses and broadleaf weeds
	6/23/00	Mow	Weed control and enhance native warm-season grasses and forbs
	9/13/00	Evaluation	Notes collected along transects
	4/01	Controlled burn	Suppress introduced grasses and broadleaf weeds
	7/29/01	Mow	Weed control
Dormant (October 1998) seeding			
	4/21/98	Controlled burn	Remove surface residue and initiate regrowth of introduced species
	5/24/98	Spray	2 qts/ac glyphosate applied for burndown
	6/25/98	Spray	2 qts/ac of glyphosate applied for burndown of remaining introduced species
	9/22/98	Spray	2,4-D and glyphosate applied for burndown of remaining introduced species
	10/20/98	Seeded	Truax no-till drill
	5/27/99	Spray	2,4-D applied on sweetclover, and broadleaf weeds
	7/21/99	Evaluation	Notes collected along transects
	7/22/99	Spot mowing	Spot mowing of wormwood and Canada thistle
	4/24/00	Controlled burn	Suppress introduced grasses and broadleaf weeds
	6/23/00	Mow	Weed control and enhance native warm-season grasses and forbs
	9/13/00	Evaluation	Notes collected along transects
	4/01	Controlled burn	Suppress introduced grasses and broadleaf weeds
	7/29/01	Mow	Weed control

SUMMER SEEDING

1999 Observations

- ◆ A very high density of sweetclover was present in the spring of 1999. An application of 2,4-D was completed on a portion of this field (area represented by transect 1) to reduce sweetclover competition.
- ◆ Areas where sweetclover was reduced by spraying had increased numbers of grass seedlings that were more vigorous compared to uncontrolled areas.
- ◆ Native forbs showed some tolerance to 2,4-D. This was especially evident for yellow coneflower and Lewis wild flax.
- ◆ A large seed bank of numerous weedy species, which is typical for an old farmstead, exists at this site.

- ◆ Absinth wormwood and Canada thistle grew in various patches at the site and had to be chemically controlled.
- ◆ Cool-season introduced species had higher average frequencies on the spring seeding in comparison to the dormant seeding.
- ◆ Warm-season grass species were favored by a spring seeding.

2000 Observations

- ◆ A good stand of the seeded native grasses and forbs was present on the site. There continued to be moderate weed pressure within the site that needed additional management to maintain the native planting.
- ◆ Nine native species of grasses and forbs were found within the data frames after seeding. Additional native species were visually present but not found within frames in the transects.
- ◆ Warm-season grasses were the predominant species. Cool-season grasses were found in minimal numbers.
- ◆ Sweetclover appeared to be suppressed in 2000.
- ◆ See Table 4 for percent canopy cover composition for 2000.

Species	Percent of Stand - Summer Seeding		Percent of Stand - Dormant Seeding	
	Transect 1	Transect 2	Transect 1	Transect 2
Switchgrass	32	19	-	Trace
Big bluestem	23	9	-	2
Indiangrass	4	Trace	-	Trace
Canada wildrye	3	2	9	5
Green needlegrass	-	-	2	3
Slender wheatgrass	-	-	Trace	-
Smooth bromegrass	3	12	-	Trace
Crested wheatgrass	9	2	Trace	-
Kentucky bluegrass	-	18	-	8
Purple prairieclover	Trace	Trace	-	-
Lewis wild flax	Trace	-	3	2
Two-grooved milkvetch	Trace	-	-	-
Yellow coneflower	Trace		2	-
Maximilian sunflower	-	-	6	Trace
Canada milkvetch	Trace	-	-	-
Weeds	7	10	38	58

2001 Observations

- ◆ Native stand density continued to increase.
- ◆ Stand had a good diversity of grass and forb components.
- ◆ Big bluestem, sideoats grama, Indiangrass, and switchgrass were the major grass components.
- ◆ Lewis wild flax, Canada milkvetch, purple prairieclover, and Maximilian sunflower were the major forbs observed.

2002 Observations

- ◆ The spring seeded stand continued to have greater native species diversity than the dormant seeded. Switchgrass, big bluestem, and Indiangrass dominated the site.
- ◆ Good forb densities were present on the site. Canada milkvetch, purple prairieclover, and lewis wild flax composed most of the forb population.
- ◆ The summer seeding was established within three years as compared to the dormant seeding which continued to establish at a slower rate.

DORMANT SEEDING

1999 Observations

- ◆ A dense canopy of numerous weedy species resulted in severe competition.
- ◆ Seedling numbers were low for all planted grasses and forbs.
- ◆ Weed competition was reduced and the canopy opened up after the spray treatment.
- ◆ Native cool-season species were more prevalent than later warm-season species. Cool-season species emerged before most weeds established. Monitoring continued to determine if warm-season species established.
- ◆ Plant vigor and stand were poor during observations in September 1999.
- ◆ Cool-season grasses were favored by dormant seeding.
- ◆ Sweetclover showed a sharp increase in the dormant seeding.

2000 Observations

- ◆ Spring mowing opened up the canopy, but native warm-season grasses did not respond.
- ◆ Low warm-season grass densities were due in part to severe weed competition in 1999.
- ◆ The overall grass/forb stand was poor on the dormant seeding.
- ◆ Canada wildrye, a cool-season perennial, was the dominant species present.
- ◆ See Table 4 for percent composition for 2000.

2001 Observations

- ◆ The dormant seeding lacked vigor due to the initial weed competition during seedling establishment.
- ◆ Canada wildrye and green needlegrass were the primary species observed.
- ◆ Seeded species were present at a low frequency.
- ◆ Fire did not appear to suppress wormwood.
- ◆ The seeded stand remained thin throughout the growing season.

2002 Observations

- ◆ Species composition was lower than on the summer seeding.
- ◆ Higher weed densities were present on the dormant seeding site than on the summer seeding site.
- ◆ Areas known to have high weed populations, such as the farmstead site, require additional weed control prior to making dormant seedings.

- ◆ Cool-season and warm-season native grasses were present but densities were low. With continued management the stand developed into an acceptable native planting.



Stand of Canada wildrye at Russ Stuart WMA Farmstead Site - dormant seeding



Second year of native seeding showing establishment. Note the dead Kentucky bluegrass sod shown at the center of this photo provided a very poor seedbed because of dense root mass.

Russ Stuart Wildlife Management Area (WMA) Plot A

Purpose:

The purpose of this planting was to compare spring and dormant seeding dates for establishing native grasses and forbs using a no-till system. Suppression of introduced species was also compared.



Russ Stuart WMA (Plot A) fourth growing season, showing a well established native stand (seeded July 1998)

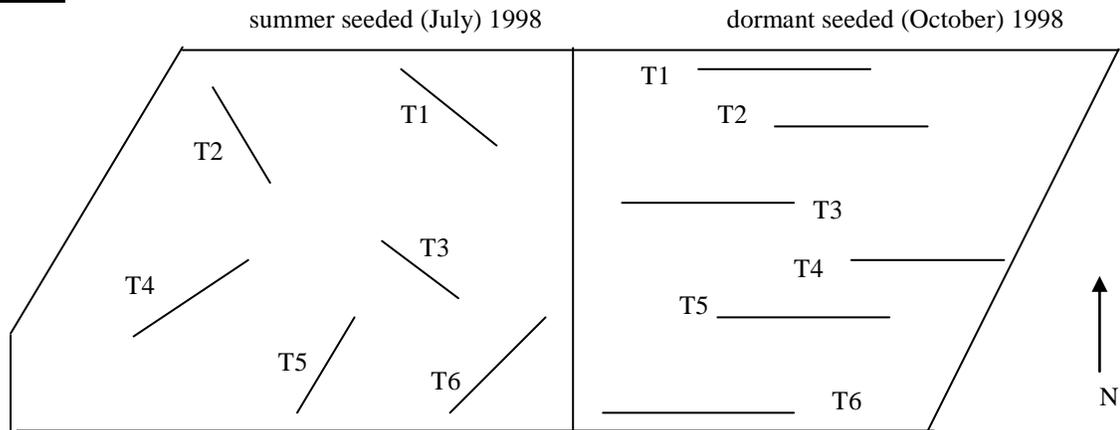
Site Description:

This site consisted of 32 acres Lehr loam soils. Legal description is section 3-144-78 Burleigh County.

Treatments:

This site was split into two parts. Part 1 was the west half (16 acres) which was seeded July 1998 and part 2 was the east half (16 acres) which was dormant seeded October 1998. Six permanent transects 200 feet in length were laid out in each of the two treatments. Metal fence posts mark each transect boundary. A metal tape was stretched between the posts as a reference line for plant counts. Figure 2 shows the layout of transects. See Attachment 2 for species frequency on the Russ Stuart Plot A site. See Table 5 for species seeded in the mixture. Table 6 compares average frequency of selected species for the two seeding dates. Table 7 shows the site preparation and maintenance activities for each of the summer seeded and dormant seeded parts of the site.

Figure 2. Transect Treatments on Russ Stuart WMA Plot A



Species	Cultivar/Source	Seed Mix
Switchgrass	Forestburg	20%
Switchgrass	Dacotah	Trace
Big bluestem	Bison	30%
Blue grama	Bad River	10%
Canada wildrye	Mandan	Trace
Prairie sandreed	ND-95	5%
Prairie sandreed	Goshen	Trace
Sideoats grama	Pierre	Trace
Sideoats grama	Killdeer	15%
Thickspike wheatgrass	Critana	Trace
Slender wheatgrass	Revenue	Trace
Green needlegrass	Lodorm	15%
Green needlegrass	SD-93	Trace
Western wheatgrass	Rosana	Trace
Little bluestem	Camper	Trace
Sand bluestem	Garden	Trace
Indiangrass	Tomahawk	Trace
Purple prairieclover	PMC	22 PLS gm/ac
Lewis wild flax	Appar	45 PLS gm/ac
Canada milkvetch	PMC	45 PLS gm/ac
Plains coreopsis	Purchased	11 PLS gm/ac
Maximilian sunflower	PMC	11 PLS gm/ac
Two-grooved milkvetch	PMC	22 PLS gm/ac
Leadplant	PMC	15 PLS gm/ac
Narrow-leaved purple coneflower	PMC	9 PLS gm/ac
Silky prairieclover	PMC	8 PLS gm/ac
Stiff sunflower	PMC	22 PLS gm/ac
Yellow coneflower	Purchased	22 PLS gm/ac



Russ Stuart WMA Plot A. Seeding comparing two different seeding dates. A summer seeding (7/98) is pictured on the left (2nd growing season). On the right, shows the 1st growing season of a dormant seeding (10/98).

Table 6.		
Average Frequency Comparisons for Selected Species – 1999 Russ Stuart WMA Plot A		
	July Seeding	October Seeding
Seeded Species		
Big bluestem	88%	76%
Switchgrass	43%	89%
Blue grama	21%	10%
Sideoats grama	4%	36%
Canada wildrye	1%	12%
Green needlegrass	1%	11%
Canada milkvetch	2%	5%
Lewis wild flax	1%	22%
Maximilian sunflower	1%	9%
Yellow coneflower	11%	23%
Invaders		
Bromegrass	70%	51%
Bluegrass	13%	10%

Table 7.			
Site Preparation and Maintenance of Summer and Dormant Seeded Plots at Russ Stuart WMA Plot A			
Summer (July 1998) seeding			
	Date	Activity	Remarks
	4/21/98	Controlled burn	Remove surface residue and initiate regrowth of introduced species, conducted by ND Game & Fish Dept.
	5/24/98	Spray	2 qts/ac glyphosate applied for burndown
	6/25/98	Spray	2 qts/ac of glyphosate applied for burndown of remaining introduced species
	7/8/98	Seeded	Truax no-till drill
	10/1/98	Stand evaluation	Notes collected along the 6 transects
	5/8/99	Spray	2 qts/ac glyphosate across north half
	7/20/99	Evaluation	Notes collected on 6 transects
	7/20/99	Mow	Spot mow Canada thistle
	6/27/00	Spray	Spot spray Canada thistle
	9/13/00	Evaluation	Notes collected on 6 transects
	4/01	Burn	Conducted by ND Game & Fish Dept.
	7/01	Evaluation	General observations of stand progress
	10/02	Evaluation	5-year stand composition
Dormant (October 1998) seeding			
	4/21/98	Controlled burn	Remove surface residue and initiate regrowth of introduced species, conducted by ND Game & Fish Dept.
	5/24/98	Spray	2 qts/ac glyphosate applied for burndown
	6/25/98	Spray	2 qts/ac of glyphosate applied for burndown of remaining introduced species
	10/21/98	Seeded	Truax no-till drill
	5/08/99	Spray	2 qts/ac glyphosate across north half
	7/20/99	Evaluation	Notes collected on 6 transects
	7/20/99	Mow	Spot mow Canada thistle
	6/27/00	Spray	Spot spray Canada thistle
	9/13/00	Evaluation	Notes collected on 6 transects
	4/01	Burn	Conducted by ND Game & Fish Dept.
	7/01	Evaluation	General observations of stand progress
	10/02	Evaluation	5-year stand composition

PART 1- WEST HALF - SUMMER (JULY) SEEDING

1999 Observations

- ◆ Bromegrass regrowth was greater than 50 percent by late April 1999.
- ◆ Glyphosate was applied May 1999 to the north half of this field to control bromegrass. This resulted in greater than 75 percent control of smooth bromegrass by the end of June.
- ◆ The unsprayed half of the field (south half) had bromegrass 3-4 ft. tall and covered greater than 75 percent of the field by the end of June.
- ◆ Reducing bromegrass competition in May using glyphosate application appeared to increase warm-season species vigor, but also appeared to reduce the cool-season native component.
- ◆ Lewis wild flax and yellow coneflower appeared to tolerate glyphosate.
- ◆ Big bluestem, switchgrass, and sideoats grama were the predominant species on this site.

2000 Observations

- ◆ The native seeded species became well established by the end of 2000.
- ◆ Increasing competition from natives has suppressed smaller weeds.
- ◆ Taller, earlier weeds such as Canada thistle and perennial sowthistle continued to persist.
- ◆ Bromegrass cover continued to increase on the site that was not sprayed on May 1999 with glyphosate. The area that was sprayed had far less smooth bromegrass present.
- ◆ Canopy cover was measured in 2000 to record species present and to indicate what percent each of the species contributed to the canopy cover of the total stand. See Attachment 3 for percent canopy cover composition for 2000.

2001 Observations

- ◆ The native seeding established well.
- ◆ Weed pressure was less in the spring seeding due to a better established native stand.
- ◆ Smooth bromegrass density was still noticeably less in areas that had the spring application of glyphosate in 1999.
- ◆ There was excellent seed production on the site. Big bluestem, switchgrass, sideoats grama, and Indiangrass made up the majority of seed.

2002 Observations

- ◆ Stand composition five years after seeding was evaluated (see Table 8).
- ◆ Invasion of introduced grasses into the stand was highest in the unsprayed dormant seeding (51 percent) as compared to the sprayed spring seeding (17 percent).
- ◆ Composition of native species was highest on the spring seeding that was sprayed (59 percent) as compared to the dormant unsprayed seeding, which had the lowest native stand composition (27 percent).
- ◆ Stand management after establishment will be needed to maintain native species composition and reduce encroachment of introduced grasses.

	Percent Stand Composition for the Four Treatments			
2002 Established Stand Composition	Dormant seeding (Oct. 1998) sprayed	Dormant seeding (Oct. 1998) unsprayed	Spring seeding (July 1998) sprayed	Spring seeding (July 1998) unsprayed
Smooth bromegrass	27.5	35	10	18
Kentucky bluegrass	3	16	7	10
Warm-season native grasses	54	15	56	54
Cool-season native grasses	0.5	0	0	0
Native forbs	3.5	12	3	4
Bareground	11	22	23	14
Weeds	0.5	trace	2	Trace

All plot treatments were the same except for seeding date and a spring application of 2 quarts of glyphosate applied in May of 1999. Glyphosate was applied to half of the dormant seeding and half of the summer seeding.



Russ Stuart WMA Plot A. Compares a spring glyphosate application in the foreground to no chemical application in the background. Note low presence of smooth brome grass in the native stand compared to no treatment (background) which shows high densities of smooth brome grass. Smooth brome grass is vegetation indicated by the brown color in the background.

PART 2 – EAST HALF - DORMANT (OCTOBER) SEEDING

1999 Observations

- ◆ Bromegrass regrowth was greater than 50 percent by late April 1999.
- ◆ Glyphosate was applied in May 1999 to the north half of the seeding to reduce bromegrass. Bromegrass was reduced to minimal amounts as a result of spraying.
- ◆ Seedlings could be rowed visually by late July 1999.
- ◆ Bromegrass was greater than 75 percent in south half of the dormant seeding that was not sprayed with glyphosate.
- ◆ The additional application of glyphosate early in the year reduced bromegrass competition resulting in a stronger and more vigorous stand. Cool-season components of the original mix were reduced, as were the forbs, but still were observed in the stands.
- ◆ Switchgrass and sideoats grama had substantially higher average frequencies on the dormant seeding.
- ◆ Cool-season seeded species were favored by the dormant seeding.
- ◆ Several of the forb/legume species had substantially higher average frequencies on the dormant seeding.
- ◆ Average frequencies of bromegrass and bluegrass were similar for both planting dates.

2000 Observations

- ◆ As with the spring seeding, the field portion not treated with glyphosate in May 1999 had very high densities of smooth brome grass reestablishing.
- ◆ Percent canopy cover was recorded in 2000 to establish the average canopy cover individual species were comprising. See Attachment 3 for percent canopy cover.

2001 Observations

- ◆ The dormant seeding had less stand density than the summer seeding.
- ◆ Switchgrass appeared to be the most dominant grass species present.
- ◆ More weeds were present on the dormant seeding.
- ◆ The May 1999 application of glyphosate continued to have a positive effect on the stand. Where the herbicide was applied, there were fewer broadleaf weeds and less brome grass competition for the native species.

2002 Observations

- ◆ Stand composition five years after seeding was evaluated (see Table 8).
- ◆ The highest native forb composition was observed on the unsprayed dormant seeding (12 percent).
- ◆ Initial establishment was slower on the dormant seeding than on the summer seeding.
- ◆ Weeds were more evident on the dormant seeding.
- ◆ Switchgrass was the dominant species on the site.

Old Johns Lake Wildlife Management Area (WMA), Site A

Purpose:

This seeding compared seeding methods for establishment of native grasses and forbs. The methods compared were a no-till seeding using a Truax no-till drill and a broadcast seeding using a Vicon spreader. Suppression of introduced species was also compared with the seeding techniques.

Site Description:

This site consisted of approximately 60 acres. The major soil mapping units are Wabek and Arvilla sandy loams. Wabek consists of very shallow soils, and Arvilla consists of shallow to gravel. The location is section 28-145-77 Sheridan County. This site consisted primarily of smooth brome grass sod that was low in plant vigor.

Treatments:

The site was split into two major portions. The north half (30 acres) was prepared for a no-till drilled seeding and the south half (30 acres) was prepared for a no-till broadcast seeding. A Truax no-till drill was used for drilling and a Vicon spreader was used for broadcast seeding. Seedbed preparation consisted of chemical application and a direct seeding into the residue. The drilled seeding was completed on 5/10/01, and the broadcast seeding was done on 4/2/01. The seeding mix was the same for both sites. See Table 9 for a list of species planted. See Table 10 for site preparation and maintenance activities.

Table 9.		
Native grass and forb/legume species no-till and broadcast seeded, Old Johns Lake WMA, Site A		
Common Name	Scientific Name	Seed Mix
Little bluestem	<i>Schizachyrium scoparium</i>	20%
Sideoats grama	<i>Bouteloua curtipendula</i>	15%
Prairie sandreed	<i>Calamovilfa longifolia</i>	10%
Big bluestem	<i>Andropogon gerardii</i>	10%
Switchgrass	<i>Panicum virgatum</i>	10%
Canada wildrye	<i>Elymus canadensis</i>	10%
Western wheatgrass	<i>Pascopyrum smithii</i>	8%
Blue grama	<i>Bouteloua gracilis</i>	5%
Slender wheatgrass	<i>Elymus trachycaulus</i>	3%
Sand bluestem	<i>Andropogon hallii</i>	Trace
Green needlegrass	<i>Nassella viridula</i>	Trace
Needle-and-thread	<i>Stipa comata</i>	Trace
Indiangrass	<i>Sorghastrum nutans</i>	Trace
Prairie cordgrass	<i>Spartina pectinata</i>	Trace
Alkali sacaton	<i>Sporobolus airoides</i>	Trace
Streambank wheatgrass	<i>Elymus lanceolatus</i>	Trace
Native forbs/legumes		9%
Leadplant	<i>Amorpha canescens</i>	
Canada milkvetch	<i>Astragalus canadensis</i>	
Ground plum	<i>Astragalus crassicaarpus</i>	
Downy paintbrush	<i>Castilleja sessiliflora</i>	
Pink flowering beeplant	<i>Cleome serrulata</i>	

Common Name	Scientific Name	Seed Mix
Pale purple coneflower	<i>Echinacea angustifolia</i>	
Western wallflower	<i>Erysimum asperum</i>	
Blanketflower	<i>Gaillardia aristata</i>	
Maximilian sunflower	<i>Helianthus maximiliani</i>	
Stiff sunflower	<i>Helianthus pauciflorus</i>	
Blue flax	<i>Linum lewisii</i>	
Wild bergamot	<i>Monarda fistulosa</i>	
Big flowered penstemon	<i>Penstemon grandiflorus</i>	
White prairieclover	<i>Dalea candida</i>	
Purple prairieclover	<i>Dalea purpurea</i>	
Long-headed coneflower	<i>Ratibida columnifera</i>	
Black-eyed susan	<i>Rudbeckia hirta</i>	
Prairie groundsel	<i>Senecio plattensis</i>	
Stiff goldenrod	<i>Solidago rigida</i>	
Hoary vervain	<i>Verbena stricta</i>	
Fragrant giant hyssop	<i>Agastache foeniculum</i>	
Plains coreopsis	<i>Coreopsis tinctoria</i>	
Camas lily	<i>Zigadenus elegans</i>	
Golden alexander	<i>Zizia aptera</i>	

Site Preparation and Maintenance of No-till and Broadcast Seeded Plots at Old Johns Lake, Site A			
No-till seeding			
	Date	Activity	Remarks
	9/13/99	Mow	To initiate regrowth of bromegrass in preparation of glyphosate application
	9/29/99		Killing frost prevented glyphosate application
	6/03/00	Spray	Glyphosate applied at 1 qt/ac
	6/28/00	Spray	Glyphosate applied at 1 qt/ac
	5/10/01	Seeded	Truax no-till drill
	Summer 2001	Picked rocks	
	5/02/02	Burn	Prescribed fire by ND Game & Fish Dept.
	5/31/02	Spray	Plateau herbicide applied to suppress smooth bromegrass growth
	7/11/02	Data collection	Stand density counts
Broadcast seeding			
	9/13/99	Mowed	To initiate regrowth of bromegrass in preparation of glyphosate application
	9/29/99		Killing frost prevented glyphosate application
	6/03/00	Spray	Glyphosate applied at 1 qt/ac
	4/02/01	Seeded	Vicon broadcast spreader
	4/23/01	Harrowed	To help place seed at soil surface
	Summer 2001	Picked rocks	
	5/02/02	Burn	Prescribed fire by ND Game & Fish Dept.
	5/31/02	Spray	Plateau herbicide applied to suppress smooth bromegrass growth
	7/11/02	Data collection	Stand density counts

1999 Observations

- ◆ Smooth bromegrass was the primary species existing on the site.
- ◆ Smooth bromegrass was controlled prior to seeding. Residue was removed prior to seeding using a controlled burn.
- ◆ Rocks were picked and piled to allow equipment access.
- ◆ Smooth bromegrass had low vigor on most of the site. Average height of smooth bromegrass was observed at less than 18 inches.

2000 Observations

- ◆ Glyphosate was applied at the rate of 2 qts/ac on the south half of the field and 1 qt/ac on the north half of the field on 6/3/00. Smooth bromegrass control resulting from this application was poor.
- ◆ Glyphosate was reapplied on 6/28/00 at the rate of 1 qt/ac on the entire field. A fair kill on the smooth bromegrass was achieved.

2001 Observations

- ◆ Thirty acres on the south half of this site were broadcast seeded on 4/2/01 using a Vicon spreader.
- ◆ 1,500 lbs/acre of old plant residue was recorded on the site 4/19/01.
- ◆ Due to heavy residue the broadcast seeding was harrowed to help seed placement.
- ◆ Both seedings were done into heavy residue (1,500 lbs/ac).
- ◆ Observations on 6/20/01 showed seedlings emerging on the no-till seeded site and no seedling emergence on the broadcast site.
- ◆ A heavy canopy cover of smooth bromegrass developed by mid summer.
- ◆ Seedlings were still evident on the no-tilled site by mid summer.
- ◆ No seedlings were observed in the broadcast site by mid summer.

2002 Observations

- ◆ To reduce competition to new native seedlings, Plateau herbicide was applied at two rates on 5/31/02 to suppress smooth bromegrass growth. A control strip was left unsprayed.
- ◆ Data was collected to determine percent composition of the no-till seeding. See Table 11 for stand densities.
- ◆ Few native seedlings were observed on the broadcast site, so no stand composition data was collected.
- ◆ Native seedlings were lowest (6 percent) for the control and highest (11.6 percent) for the 8-ounce/acre Plateau herbicide application rate.
- ◆ Introduced grasses made up 61.5 percent on the control strip compared to 39.8 percent on the 8-ounce/acre Plateau application rate.
- ◆ Smooth bromegrass growth measured 2-4 inches in height on both the 4-ounce/acre and 8 ounce/acre sites as compared to 12-18 inches in height where no Plateau application was made.

Percent composition of no-till drilled site after Plateau herbicide application			
Component	Control	4 oz rate	8 oz rate
Native seedlings	6	8.6	11.6
Introduced cool-season grasses and weeds	61.5	56.9	39.8
Litter/ bareground	32.5	34.5	48.6



Old Johns Lake WMA Site A. Native seedlings were observed on the no-till drilled seeding (June 2001). Note the heavy residue seedlings are emerging through.



Old Johns Lake WMA Site A. Broadcast seeding being harrowed due to heavy surface residue (4/23/01).



Old Johns Lake WMA Site A. A diverse mix of native grasses and forbs were broadcast seeded on 30 acres using a Vicon spreader.

Old Johns Lake Wildlife Management Area (WMA), Site B

Purpose:

The purpose of this seeding was to determine the feasibility of interseeding native forbs into existing native stands to increase specie diversity.

Site Description:

This site was approximately 20 acres. Soils are Arvilla sandy loam (shallow to gravel site). It is located in the NE1/4 of Section 21-145-77 Sheridan County. This site was primarily made up of native species with introduced species (smooth brome) found in heavy patches within the site.

Treatments:

Glyphosate at the rate of 2 qts/ac was applied on selected sites (1.8 acres total) in stands of smooth brome grass to kill introduced species. The chemically treated 1.8 acres and an additional 3.2 acres of existing native vegetation (18 feet around the fence line of the entire site) were no-till seeded on 10/26/99. Ten native forb species at the rate of 1 lb/ac of forbs and 4 lbs/ac of native grass mixture were planted. The native forbs were planted through the legume box on a Truax no-till drill and the grasses were planted through the wheatgrass box (back box) on the Truax drill. Tables 12 and 13 list species used and percentages of the mix.

Table 12.		
Forbs No-till Seeded at Old Johns Lake Site B, 10/26/99		
Species	Bulk weight (g)	Seed Mix
Purple prairieclover	539	20%
Lewis wild flax	555	20%
Canada milkvetch	269	10%
Maximilian sunflower	770	10%
Leadplant	320	10%
Narrow-leaved purple coneflower	377	10%
Stiff sunflower	188	5%
Stiff goldenrod	227	5%
Big flowered penstemon	227	5%
Pink flowered beeplant	227	5%

Table 13.		
Native Grass Mix No-till Seeded at Old Johns Lake WMA Site B, 10/26/99		
Species	Cultivar/Source	Seed Mix
Switchgrass	Forestburg	20%
Switchgrass	Dacotah	Trace
Big bluestem	Bison	30%
Blue grama	Bad River	10%
Canada wildrye	Mandan	Trace
Prairie sandreed	ND-95	5%
Prairie sandreed	Goshen	Trace
Sideoats grama	Pierre	Trace
Sideoats grama	Killdeer	15%
Thickspike wheatgrass	Critana	Trace
Slender wheatgrass	Revenue	Trace
Green needlegrass	Lodorm	15%
Green needlegrass	SD-93	Trace
Western wheatgrass	Rosana	Trace
Little bluestem	Camper	Trace
Sand bluestem	Garden	Trace
Indiangrass	Tomahawk	Trace

1999 Observations

- ◆ Chemical burndown was good on the introduced species. Existing sideoats grama was not seriously affected by the glyphosate application and remained in the site.
- ◆ Soils are low in productivity and plant density was low on the selected site.
- ◆ A good seed to soil contact was achieved in the forb seeding with a seed placement at approximately ¼ inch deep.
- ◆ There was a heavy litter cover around the fence line perimeter where 3.2 acres of native forbs were no-till seeded. Soil to seed contact was good and a depth of ¼ to ½ inch was achieved in the interseeding. The forbs were interseeded into cover consisting of sweetclover, sideoats grama, little bluestem, and some introduced grasses.
- ◆ Good moisture was present in the soil profile.

2000 Observations

- ◆ Data collection from seventy 2.4 ft² frames on 9/20/00 showed a diverse mix of planted forbs.
- ◆ Direct seeding into dense existing native vegetation resulted in very few forbs being observed.
- ◆ The site consists of approximately 60 percent warm-season grasses, with sideoats grama being the predominant grass species.
- ◆ Lewis wild flax establishment was favorable when no-till seeded into a chemically prepared seedbed. Frequency of occurrence was 50 percent.
- ◆ See Table 14 for species frequency.

Species	Number of plants	Number of frames plant observed in	*Frequency %
Purple prairieclover	8	7	10
Lewis wild flax	81	35	50
Canada milkvetch	0	0	0
Maximilian sunflower	19	17	24
Leadplant	1	1	1
Narrow-leaved purple coneflower	16	14	20
Stiff sunflower	5	4	6
Stiff goldenrod	4	4	6
Big flowered penstemon	25	17	24
Pink flowered beepant	10	6	9

* frequency percent is figured as the number of frames each species was observed in divided by the total number of frames taken (70).

2001 Observations

- ◆ Data was collected 7/2/01 from one hundred 2.4 ft² frames.
- ◆ Native forb diversity was high on the site.
- ◆ A substantial amount of bare ground existed on the site with the exception of the 3.2-acre perimeter seeding.
- ◆ Soils appeared to be low in organic matter on the seeding site, and total overall production of the site was low.
- ◆ The most abundant native forbs were Lewis blue flax, big flowered penstemon, Maximilian sunflower, and stiff goldenrod.
- ◆ See Table 15 for species frequency.

Species	Number of plants	Number of frames plant observed in	*Frequency %
Purple prairieclover	13	12	12
Lewis wild flax	143	60	60
Canada milkvetch	3	3	3
Maximilian sunflower	23	14	14
Leadplant	3	3	3
Narrow-leaved purple coneflower	14	13	13
Stiff sunflower	15	14	14
Stiff goldenrod	13	9	9
Big flowered penstemon	52	37	37
Pink flowered beepant	0	0	0

*frequency percent is figured as the number of frames each species was observed in divided by the total number of frames taken (100).

2002 Observations

- ◆ Higher populations of forbs were present on the sites with lower grass populations. Where heavy stands of grass developed, forbs were less evident.

- ◆ The perimeter area, which was seeded into heavy residue with no chemical seedbed preparation, had a low forb composition and was not considered successful at this site.
- ◆ Lewis wild flax, big flowered penstemon and Maximilian sunflower comprised the majority of forbs present.
- ◆ Dormant no-till seeding of native forbs was successful.

Old Johns Lake Wildlife Management Area (WMA), Site C

Purpose:

A no-till seeding of five native shrubs using a sculptured design was tested at this site. The sculptured design placed each species on the landscape where each would likely be found naturally. This planting evaluated direct seeding of woody species.

Site Location:

This site was approximately 15 acres. Soils are primarily Williams-Zahl loams. This site is located in SW1/4 of section 22-145-77 Sheridan County. A fall seeding was completed in October 1999 and a spring seeding was completed in May 2000.

Treatments:

Two qts/ac of glyphosate were applied on 5/27/99 for site preparation on 0.28 acres. This 0.28 acres was split among five sites within the 15 acres. Introduced species were primarily crested wheatgrass, Kentucky bluegrass, smooth brome grass with some scattered native species. A good kill on all species was achieved except on Kentucky bluegrass. Sideoats grama was still present and showed some degree of tolerance to the glyphosate application. Surface residue was mowed and removed from sites in July 1999. One-half the area of each of the five sites was no-till seeded on 10/26/99 with one of the five shrub species and 5 lbs/ac of a native grass mix. Seedbed moisture was excellent. The Truax no-till drill did an excellent job of seed placement, proper seeding rate and good soil to seed contact. Table 11 and 12 lists species and seeding rates used.

Figure 3. Old Johns Lake WMA Site C plot layout

Seeding dates: October 26, 1999 (shaded areas)
May 9, 2000 (non-shaded areas)

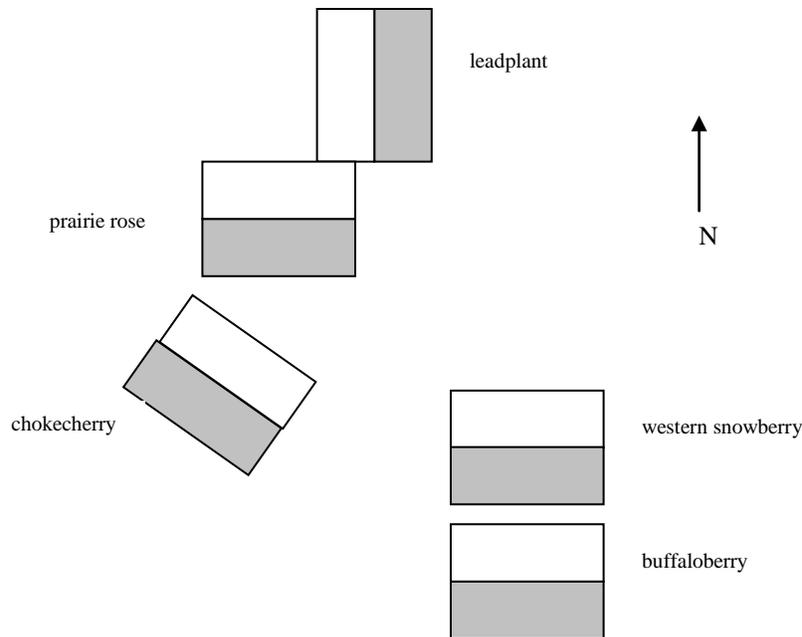


Table 16.	
Shrubs No-till Seeded at Old Johns Lake Site C, 10/26/1999	
Species	Seeding rates lbs/ac
Western Snowberry	4.0
Prairie Rose	4.5
Leadplant	1.3
Buffaloberry	4.2
Chokecherry	26.0

Table 17.		
Native Grass Mix No-till Seeded at Old Johns Lake Site C, 10/26/1999		
Species	Cultivar/Source	Seed Mix
Switchgrass	Forestburg	20%
Switchgrass	Dacotah	Trace
Big bluestem	Bison	30%
Blue grama	Bad River	10%
Canada wildrye	Mandan	Trace
Prairie sandreed	ND-95	5%
Prairie sandreed	Goshen	Trace
Sideoats grama	Pierre	Trace
Sideoats grama	Killdeer	15%
Thickspike wheatgrass	Critana	Trace
Slender wheatgrass	Revenue	Trace
Green needlegrass	Lodorm	15%
Green needlegrass	SD-93	Trace
Western wheatgrass	Rosana	Trace
Little bluestem	Camper	Trace
Sand bluestem	Garden	Trace
Indiangrass	Tomahawk	Trace

2000 Observations

- ◆ A spring seeding was completed within each of the five plots adjacent to the October 1999 dormant seeding.
- ◆ Seeding rates and species seeded on 5/9/00 were the same as in Table 5.
- ◆ Shrubs were planted alone without any native warm season grasses on 5/9/00, because of the high amount of natives encroaching from the surrounding area.
- ◆ Shrub seed was planted into excellent moisture using a no-till drill.
- ◆ Smooth brome grass and Kentucky bluegrass were observed as major components, especially in the leadplant and prairie rose plots.
- ◆ Dormant seeded buffaloberry and western snowberry were the most observed species.
- ◆ Data was collected on 9/14/00. See Table 18 for species counts and frequency.
- ◆ See Figure 3 for plot layout.

Table 18.																		
Shrub Species Count from Dormant and Spring No-till Seeded Plots, 2000 and 2001, Old Johns Lake Site C																		
Species	Dormant Seeding 10/26/99									Spring Seeding 5/09/00								
	Number of Plants			*Number of frames plants observed in			**Frequency Percent			Number of plants			*Number of frames plants observed in			**Frequency Percent		
	00	01	02	00	01	02	00	01	02	00	01	02	00	01	02	00	01	02
Prairie Rose	0	9	3	0	6	2	0	60	20	0	0	0	0	0	0	0	0	0
Leadplant	0	0	2	0	0	2	0	0	20	3	20	17	2	6	8	40	60	80
Chokecherry	0	0	0	0	0	0	0	0	0	0	11	2	0	7	2	0	70	20
Western snowberry	4	6	4	2	3	1	40	30	10	2	17	19	2	5	8	40	50	80
Buffaloberry	5	3	3	3	3	3	60	30	30	0	0	0	0	0	0	0	0	0

*2000 data collected from five 2.4 ft² frames; 2001 and 2002 data collected from ten 2.4 ft² frames.

**Frequency percent is figured as the number of frames each species was observed in divided by the total number of frames taken.

2001 Observations

- ◆ Data was collected on 7/2/01 using 2.4 ft² frames. All five native shrub species were observed June 2001 in either the dormant seeded or the spring seeded plots.
- ◆ Timing of seeding (dormant or spring) had an effect on seedling presence in the plots.
- ◆ All five plots were marked with corner stakes.
- ◆ Grass cover, both native and introduced, became heavy inside the plots.
- ◆ See Table 18 above for specie counts and frequency for 2001.

2002 Observations

- ◆ All seeded species were observed in the plots.
- ◆ Buffaloberry seedlings in the October 1999 dormant seeded plot measured six to fifteen inches in height.
- ◆ Western snowberry and leadplant were observed in both the dormant and spring seeded plots.
- ◆ All five species can be successfully direct seeded.
- ◆ Grass competition needs to be eliminated prior to seeding and controlled during establishment.
- ◆ Adding grass to the initial seeding is not recommended unless erosion problems exist.
- ◆ One additional year of chemical weed control prior to seeding should have been completed to eliminate excessive competition.
- ◆ Long-term establishment for these species will need to be determined.
- ◆ See Table 18 above for species counts and frequency for 2002.



*Old Johns Lake WMA, Site C.
Chokecherry seedlings from a May 2000 seeding.*



*Old Johns Lake WMA, Site C. Prairie rose was
observed in the dormant seeded plots (June 2001).*



*Old Johns Lake WMA, Site C. Buffaloberry seedlings
from the dormant seeding (June 2001).*

PROJECT SUMMARY

- ◆ It appears that initial chemical seedbed preparation with glyphosate relies on many climatic variables. It may require multiple applications over a two-year period to prepare the desired seedbed.
- ◆ Based on visual estimates, crested wheatgrass is the easiest to control followed by smooth brome grass, with Kentucky bluegrass being the most difficult. This may be due to the timing of the chemical application or other factors. These were the three main introduced species encountered.
- ◆ Smooth brome grass presented the most competition during establishment due to its aggressive rhizome system, increased height, and shading effects over Kentucky bluegrass and crested wheatgrass. Smooth brome grass will probably be the most competitive of the three species on the established native stand over the long-term.
- ◆ No-till warm-season grass establishment is possible as a fall dormant seeding, but develops more slowly than a spring seeding (Table 6).
- ◆ No-till seeding methods increased the window of seeding dates. Minimal soil disturbance appears to place seed in a more opportune microenvironment increasing the chances of establishment.
- ◆ Timely herbicide application and/or mowing after seeding can greatly improve stand establishment.
- ◆ Initial results indicate that broadcast methods of native seeding directly into existing brome grass stands were not successful, especially where heavy layers of mulch/litter were left on the soil surface.
- ◆ No-till seeding of native species into heavy residue (1,500 lbs/ac) appeared to provide adequate seed to soil contact for seedling emergence.
- ◆ Management after establishment will be needed to keep introduced species under control. Fire, mowing, chemical alternatives, and grazing could be used alone or in combination to manage established stands to achieve the desired species mix and composition.
- ◆ Management becomes more complex as the diversity of species increases. There may be times when selection of certain types of plants (warm vs. cool, grasses vs. forbs) is acceptable and more economical. Planting a diverse mix of native warm-season grasses gives an excellent option of controlling introduced cool-season grasses with glyphosate but species diversity is sacrificed.
- ◆ Introduced species tend to rapidly reestablish into renovated sites. Management decisions are critical to long-term success of restoration activities.

- ◆ Degree of control of introduced species will ultimately be a management decision. Important considerations include the amount of money the land manager is willing to spend for seedbed preparation and the percentage of introduced species the land manager is willing to accept in the final stand.
- ◆ Once established, native species compete well with weeds.
- ◆ Reducing weed competition on newly planted native seedlings appeared to have a long-term effect to the final stand.
- ◆ Initial results indicate purple prairieclover, Lewis wild flax, Maximilian sunflower, narrow-leaved purple coneflower, big flowered penstemon, and pink flowered beeplant establish quite readily when interseeded into killed brome grass sod (Table 14).
- ◆ Some native forbs establish quite easily when direct seeded into old stands, providing competition is low and old residue is removed.
- ◆ The establishment of small clumps of native shrubs by seed is possible. Long-term results are unknown.
- ◆ All direct seeded native shrubs were observed during 2001 and 2002. Frequency of individual species was dependent on seeding date. Western snowberry, buffaloberry, and leadplant had the highest frequency (Table 18).
- ◆ Grass competition during establishment will need to be suppressed to allow successful establishment of native shrubs.
- ◆ Future monitoring of these sites is needed to gain further insight into prairie restoration techniques.

*western
meadowlark*



Photo by C. Grondahl, NDGFD

Seeding	Collection	Tran-																					TO-	%	
Date	Date	sect	Species	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'	140'	150'	160'	170'	180'	190'	200'	TAL	freq
10/21/98	07/20/99	5	bluegrass-old				1		1		1						2							5	20
10/21/98	07/20/99	6	bluegrass-old				1	2																3	10
07/08/98	07/20/99	1	bromegrass-old	1	1		1	1	1						1	1								7	35
07/08/98	07/20/99	2	bromegrass-old			1			1			1	1	1		1	1	1	1	1	1	1	1	13	65
07/08/98	07/20/99	3	bromegrass-old	1		1		1	1	1		1	1	1	1	1	1		1	1	1	1	1	16	80
07/08/98	07/20/99	4	bromegrass-old	1	1	1	1	1	1		1	1	1	1	1	1	1		1		1		1	16	80
07/08/98	07/20/99	5	bromegrass-old	1		1	1	1	1	1	1		1	1	1	1	1	1			1	1		15	75
07/08/98	07/20/99	6	bromegrass-old			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	17	85
10/21/98	07/20/99	1	bromegrass-old		2	0.1		0.1					0.1	0.1			0.1								30
10/21/98	07/20/99	2	bromegrass-old				0.2	0.4		0.2			0.4	0.2		0.1	0.1			0.1			0		45
10/21/98	07/20/99	3	bromegrass-old						0				0.1		0.2	0.3	0.3	0.3	0.3	0.2	0.5				45
10/21/98	07/20/99	4	bromegrass-old			0.1	0.1		0.1			0.1	1	1	0.1		1		1						45
10/21/98	07/20/99	5	bromegrass-old		6		2	0.1	0.1	0.3				0.1		0.1	0.2	0.2		1	4				55
10/21/98	07/20/99	6	bromegrass-old	0.1	1	0.8		6	5	0.1	0.1	0.5	0.1	0.1	0.6	0.3	0.7	0.2	0.2			0.6	0.8		85
07/08/98	07/20/99	5	Canada wildrye			1																		1	5
10/21/98	07/20/99	1	Canada wildrye	1																				1	5
10/21/98	07/20/99	4	Canada wildrye			1										3		1	1	1				7	25
10/21/98	07/20/99	5	Canada wildrye				2	1		1	5			2										11	25
10/21/98	07/20/99	6	Canada wildrye					1	1				2					2						6	20
07/08/98	07/20/99	5	green needlegrass			1																		1	5
10/21/98	07/20/99	4	green needlegrass				1	1							1	1	3	1		1		1		10	40
10/21/98	07/20/99	5	green needlegrass													2								2	5
10/21/98	07/20/99	6	green needlegrass						1	1										3	1			6	20
07/08/98	07/20/99	4	Indiangrass																		1			1	5
10/21/98	07/20/99	2	Indiangrass								1													1	5
10/21/98	07/20/99	4	Indiangrass				1																	1	5
10/21/98	07/20/99	5	Indiangrass								1						1							2	10
07/08/98	07/20/99	4	little bluestem							1			1											2	10
10/21/98	07/20/99	1	little bluestem									1		1							1			3	15
10/21/98	07/20/99	2	little bluestem	1																				1	5
07/08/98	07/20/99	3	other	1																				1	5
07/08/98	07/20/99	6	other							1														1	5
07/08/98	07/20/99	6	other	1	6																			7	10
10/21/98	07/20/99	2	other	1			2		3	1	1	2					2	1	1	3	1	1		19	60
10/21/98	07/20/99	3	other					3	1		4	3				1	1		1		1			15	40

Seeding	Collection	Tran-																					TO-	%		
Date	Date	sect	Species	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'	140'	150'	160'	170'	180'	190'	200'	TAL	freq	
10/21/98	07/20/99	5	other					2	8	4	2													16	20	
10/21/98	07/20/99	1	prairie sandreed												1										1	5
10/21/98	07/20/99	5	prairie sandreed																1				1		2	10
10/21/98	07/20/99	6	prairie sandreed	1																					1	5
07/08/98	07/20/99	2	sideoats grama														2								2	5
07/08/98	07/20/99	4	sideoats grama				1																		1	5
07/08/98	07/20/99	5	sideoats grama	1			1																		2	10
07/08/98	07/20/99	6	sideoats grama					1					1												2	10
10/21/98	07/20/99	1	sideoats grama		1	6					1		2	1	2		1	2				1			17	45
10/21/98	07/20/99	2	sideoats grama			5					1	1	2		1	2		1							13	35
10/21/98	07/20/99	3	sideoats grama		2						1			1	1		1	1			1				8	35
10/21/98	07/20/99	4	sideoats grama				1	1					1	1	1	1	1	1				1			9	45
10/21/98	07/20/99	5	sideoats grama		6	1	1				3	2	1			3									17	35
10/21/98	07/20/99	6	sideoats grama		1				1	1			1												4	20
07/08/98	07/20/99	1	switchgrass				3		1	3	2	2			2				1		2	2			18	45
07/08/98	07/20/99	2	switchgrass		2		4		5			1	3		2	1	1		1	1	1				22	55
07/08/98	07/20/99	3	switchgrass	2			2	1	1			1	1	1		1									10	40
07/08/98	07/20/99	4	switchgrass		1			1	2			2	1			1	1						1		10	40
07/08/98	07/20/99	5	switchgrass	1		1				2	1						1				1		3	2	12	40
07/08/98	07/20/99	6	switchgrass	1					1		2		1		1	1	1	1							9	40
10/21/98	07/20/99	1	switchgrass	8	1	2	5	2	4	7	4	11	3	4	6	5	5	5		12	3	2	8		97	95
10/21/98	07/20/99	2	switchgrass	6	5	4	3	1	7	3	4	12	3	3	9	2	1	4	2			2	7		78	90
10/21/98	07/20/99	3	switchgrass	3	5	3	7		6	1	4				7			1	6	4	2	1	2		52	70
10/21/98	07/20/99	4	switchgrass	2	1	3	3	4	3	7	1	7	7	3	1	2	2	4	5	9	6	4	3		77	100
10/21/98	07/20/99	5	switchgrass	12	2	5	4	4	5	6	8	6	3	4	8	7	5	6	1	5	2	5	1		99	100
10/21/98	07/20/99	6	switchgrass	4	5	1	4	5	2	5	3	1	5	1			1	2	1	3		3			46	80
07/08/98	07/20/99	4	unknown				1																		1	5
07/08/98	07/20/99	5	unknown	1																					1	5
10/21/98	07/20/99	1	unknown-new	1								1		1								1			4	20
10/21/98	07/20/99	2	unknown-new				1																		1	5
10/21/98	07/20/99	4	unknown-new	1	1		2	2			2	3	2		1	1	2	2	2	3	1	2			27	75
10/21/98	07/20/99	5	unknown-new										1		1										2	10
10/21/98	07/20/99	6	unknown-new	1																					1	5
07/08/98	07/20/99	3	wheatgrass															1		1	1	1			4	20
07/08/98	07/20/99	4	wheatgrass		1																				1	5

Seeding	Collection	Tran-																					TO-	%	
Date	Date	sect	Species	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'	140'	150'	160'	170'	180'	190'	200'	TAL	freq
10/21/98	07/20/99	1	wheatgrass			2																	2	5	
10/21/98	07/20/99	3	wheatgrass							1					3	1					1			6	20
10/21/98	07/20/99	4	wheatgrass	0.1				0.1		1	0.1												1		25
10/21/98	07/20/99	5	wheatgrass			1					1													2	10
10/21/98	07/20/99	6	wheatgrass			1				1	0.5									1					20
10/21/98	07/20/99	4	black samson																	1				1	5
10/21/98	07/20/99	5	black samson						1															1	5
10/21/98	07/20/99	6	black samson										1											1	5
07/08/98	07/20/99	4	Canada milkvetch														1							1	5
10/21/98	07/20/99	1	Canada milkvetch														1							1	5
10/21/98	07/20/99	5	Canada milkvetch	1																			1	2	10
10/21/98	07/20/99	6	Canada milkvetch				1	1										1						3	15
07/08/98	07/20/99	6	Canada milkvetch										1											1	5
07/08/98	07/20/99	6	Lewis wild flax			1																		1	5
10/21/98	07/20/99	4	Lewis wild flax				1	1				1		2	1	1	2	1		1	1	1		13	55
10/21/98	07/20/99	5	Lewis wild flax		1		2		5	1		1			3	1	2		2					18	45
10/21/98	07/20/99	6	Lewis wild flax	1				2		1		2	1					2						9	30
07/08/98	07/20/99	5	maximilian sunflower		1																			1	5
10/21/98	07/20/99	2	maximilian sunflower																				1	1	5
10/21/98	07/20/99	3	maximilian sunflower		1																			1	5
10/21/98	07/20/99	4	maximilian sunflower	1			2						1								2			6	20
10/21/98	07/20/99	5	maximilian sunflower			1				1								1						3	15
10/21/98	07/20/99	6	maximilian sunflower					1															1	2	10
10/21/98	07/20/99	1	other-clover				0.2																		5
10/21/98	07/20/99	5	other-sweetclover										0.8	0.2	0.1				0.1	0.3			0.3		30
10/21/98	07/20/99	1	plains coreopsis												1		2							3	10
10/21/98	07/20/99	3	plains coreopsis													1								1	5
10/21/98	07/20/99	4	plains coreopsis					1	3	1	1													6	20
10/21/98	07/20/99	5	plains coreopsis			1									1							1		3	15
10/21/98	07/20/99	6	plains coreopsis																		1			1	5
07/08/98	07/20/99	1	purple prairieclover							1														1	5
07/08/98	07/20/99	2	purple prairieclover															1						1	5
07/08/98	07/20/99	3	purple prairieclover						1															1	5
07/08/98	07/20/99	4	purple prairieclover													1								1	5
07/08/98	07/20/99	5	purple prairieclover										1											1	5

Seeding	Collection	Tran-																					TO-	%	
Date	Date	sect	Species	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'	140'	150'	160'	170'	180'	190'	200'	TAL	freq
10/21/98	07/20/99	5	stiff sunflower					1																1	5
10/21/98	07/20/99	6	stiff sunflower					1															1	2	10
10/21/98	07/20/99	5	two-grooved milkvetch										1											1	5
07/08/98	07/20/99	2	yellow coneflower											2										2	5
07/08/98	07/20/99	3	yellow coneflower		1		1	1					1											4	20
07/08/98	07/20/99	4	yellow coneflower							1	1													2	10
07/08/98	07/20/99	5	yellow coneflower	1							1						1							3	15
07/08/98	07/20/99	6	yellow coneflower							1				1		1								3	15
10/21/98	07/20/99	1	yellow coneflower		1		1	1																3	15
10/21/98	07/20/99	2	yellow coneflower	1																				1	5
10/21/98	07/20/99	3	yellow coneflower						1									1						2	10
10/21/98	07/20/99	4	yellow coneflower		2		2			3	1	1			1		1				1			12	40
10/21/98	07/20/99	5	yellow coneflower	1					1	1	1			1			1	1				1		8	40
10/21/98	07/20/99	6	yellow coneflower	1				2					1					2				1		7	25

Seeding	Collection	Tran-																						TO-	%
Date	Date	sect	Species	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'	140'	150'	160'	170'	180'	190'	200'	TAL	freq
10/21/98	07/19/99	2	other-crested				1								1	3		1		1				7	25
07/08/98	07/22/99	2	other-quack			2	3																	5	10
10/21/98	07/19/99	2	other-quack																					0	0
07/08/98	07/22/99	2	other-wheatgrass												25	10	15	3		6				59	25
10/21/98	07/19/99	2	other-wheatgrass																					0	0
07/08/98	07/22/99	1	prairie cordgrass																					0	0
07/08/98	07/22/99	2	prairie cordgrass																					0	0
10/21/98	07/19/99	1	prairie cordgrass																					0	0
10/21/98	07/19/99	2	prairie cordgrass																					0	0
07/08/98	07/22/99	1	slender wheatgrass																					0	0
07/08/98	07/22/99	2	slender wheatgrass																					0	0
10/21/98	07/19/99	1	slender wheatgrass							2		1		1		1								5	20
10/21/98	07/19/99	2	slender wheatgrass																					0	0
07/08/98	07/22/99	1	switchgrass	1	3	3	10	2	6	3	1	1	3	2	3	4		3	1	1	2		2	51	90
07/08/98	07/22/99	2	switchgrass	1	9	12	1	10	6	3	3	2	5		3	3	2	1	4		1		4	70	85
10/21/98	07/19/99	1	switchgrass					1							2				2		2			7	20
10/21/98	07/19/99	2	switchgrass			2										1					3	2		8	20
07/08/98	07/22/99	1	Unknown new grass																					0	0
07/08/98	07/22/99	1	Unknown new grass																					0	0
07/08/98	07/22/99	1	Unknown new grass																					0	0
07/08/98	07/22/99	2	Unknown new grass							3														3	5
07/08/98	07/22/99	2	Unknown new grass																			1		1	5
10/21/98	07/19/99	1	Unknown new grass													2								2	5
10/21/98	07/19/99	1	Unknown new grass																					0	0
10/21/98	07/19/99	1	Unknown new grass																					0	0
10/21/98	07/19/99	2	Unknown new grass		1																			1	5
10/21/98	07/19/99	2	Unknown new grass					1							2									3	10
10/21/98	07/19/99	2	Unknown new grass										1			1	1		1	1	1	1	1	8	40
07/08/98	07/22/99	2	unknown-sideoats?					2																2	5
10/21/98	07/19/99	2	unknown-sideoats?																					0	0
07/08/98	07/22/99	1	other																					0	0
07/08/98	07/22/99	2	other																					0	0
10/21/98	07/19/99	1	other																					0	0
10/21/98	07/19/99	2	other																					0	0
07/08/98	07/22/99	1	sweetclover																					0	0

Seeding	Collection	Tran-																						TO-	%
Date	Date	sect	Species	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'	140'	150'	160'	170'	180'	190'	200'	TAL	freq
07/08/98	07/22/99	2	sweetclover																					0	0
10/21/98	07/19/99	1	sweetclover %	10	25	90	95	10	40	80	50	40	60	70	80	20	55	50	50	30	75	50	5		100
10/21/98	07/19/99	2	sweetclover %	20	70	50	60	50	5	0	0	0	5	3	0	0	0	0	10	0	10				90
07/08/98	07/22/99	1	2-grooved milkvetch																					0	0
07/08/98	07/22/99	2	2-grooved milkvetch																					0	0
10/21/98	07/19/99	1	2-grooved milkvetch																					0	0
10/21/98	07/19/99	2	2-grooved milkvetch																					0	0
07/08/98	07/22/99	1	black samson																					0	0
07/08/98	07/22/99	2	black samson																					0	0
10/21/98	07/19/99	1	black samson						1															1	5
10/21/98	07/19/99	2	black samson																1					1	5
07/08/98	07/22/99	1	Canada milkvetch				1																	1	5
07/08/98	07/22/99	2	Canada milkvetch																					0	0
10/21/98	07/19/99	1	Canada milkvetch																					0	0
10/21/98	07/19/99	2	Canada milkvetch																					0	0
07/08/98	07/22/99	1	leadplant																					0	0
07/08/98	07/22/99	2	leadplant																					0	0
10/21/98	07/19/99	1	leadplant																					0	0
10/21/98	07/19/99	2	leadplant																					0	0
07/08/98	07/22/99	1	Lewis wild flax		1		2											1	1				1	6	25
07/08/98	07/22/99	2	Lewis wild flax																					0	0
10/21/98	07/19/99	1	Lewis wild flax	2				2		2												1		7	20
10/21/98	07/19/99	2	Lewis wild flax							1													1	2	10
07/08/98	07/22/99	1	maximilian sunflower																					0	0
07/08/98	07/22/99	2	maximilian sunflower																					0	0
10/21/98	07/19/99	1	maximilian sunflower													1								1	5
10/21/98	07/19/99	2	maximilian sunflower															1		1				2	10
07/08/98	07/22/99	1	other																					0	0
10/21/98	07/19/99	1	other																					0	0
07/08/98	07/22/99	1	other-blue grama								1							1						2	10
07/08/98	07/22/99	2	other-sage	1										1										2	10
07/08/98	07/22/99	1	plains coreopsis																					0	0
07/08/98	07/22/99	2	plains coreopsis		1																			1	5
10/21/98	07/19/99	1	plains coreopsis					1																1	5
10/21/98	07/19/99	2	plains coreopsis																				1	1	5

Seeding	Collection	Tran-																						TO-	%
Date	Date	sect	Species	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'	140'	150'	160'	170'	180'	190'	200'	TAL	freq
07/08/98	07/22/99	1	purple prairieclover								1					1								2	10
07/08/98	07/22/99	2	purple prairieclover																					0	0
10/21/98	07/19/99	1	purple prairieclover																					0	0
10/21/98	07/19/99	2	purple prairieclover																					0	0
07/08/98	07/22/99	1	silky prairieclover																					0	0
07/08/98	07/22/99	2	silky prairieclover																					0	0
10/21/98	07/19/99	1	silky prairieclover																					0	0
10/21/98	07/19/99	2	silky prairieclover																					0	0
07/08/98	07/22/99	1	stiff sunflower																					0	0
07/08/98	07/22/99	2	stiff sunflower																					0	0
10/21/98	07/19/99	1	stiff sunflower																					0	0
10/21/98	07/19/99	2	stiff sunflower																					0	0
07/08/98	07/22/99	1	yellow coneflower									1										1		2	10
07/08/98	07/22/99	2	yellow coneflower					1	1		1													3	15
10/21/98	07/19/99	1	yellow coneflower																					0	0
10/21/98	07/19/99	2	yellow coneflower						1															1	5

Attachment 3.														
Russ Stuart WMA (Plot A)														
32 acres Lehr Loam														
2.4 ft ² quadrats														
Seeding	Collection	Tran-												Average %
Date	Date	sect	Species	10'	30'	50'	70'	90'	110'	130'	150'	170'	190'	canopy cover
07/08/98	09/14/00	1	big bluestem	10	15	25	25	50	45	55	40	40	15	32
07/08/98	09/14/00	2	big bluestem	60	65	10	60	85	40	30	30	20	5	40.5
07/08/98	09/14/00	3	big bluestem	40	40	10	60	15	25	30	5	0	15	24
07/08/98	09/14/00	4	big bluestem	65	65	60	80	20	30	85	15	35	80	53.5
07/08/98	09/14/00	5	big bluestem	0	10	0	10	5	10	35	25	50	60	20.5
07/08/98	09/14/00	6	big bluestem	0	0	10	15	15	30	10	25	0	5	11
10/21/98	09/14/00	1	big bluestem	10	5	10	5	5	5	5	10	2	5	6.2
10/21/98	09/14/00	2	big bluestem	10	20	25	2	10	0	10	15	20	5	11.7
10/21/98	09/14/00	3	big bluestem	15	10	10	30	10	10	5	10	10	15	12.5
10/21/98	09/14/00	4	big bluestem	15	2	0	2	10	2	0	2	0	0	3.3
10/21/98	09/14/00	5	big bluestem	2	0	2	0	0	10	2	0	0	0	1.6
10/21/98	09/14/00	6	big bluestem	5	0	0	0	0	0	0	0	0	0	0.5
07/08/98	09/14/00	2	blue grama	0	0	0	0	0	0	0	0	0	0	0
07/08/98	09/14/00	3	blue grama	0	0	0	2	0	0	0	5	5	2	1.4
07/08/98	09/14/00	4	blue grama	0	0	2	5	2	0	0	0	0	2	1.1
07/08/98	09/14/00	5	blue grama	0	0	5	0	0	0	5	5	0	0	1.5
07/08/98	09/14/00	6	blue grama	0	0	2	0	0	0	0	0	0	0	0.2
10/21/98	09/14/00	1	blue grama	0	0	0	0	0	0	0	0	0	0	0
10/21/98	09/14/00	2	blue grama	0	0	0	0	0	0	0	0	0	0	0
10/21/98	09/14/00	3	blue grama	0	0	0	0	0	0	0	0	0	0	0
10/21/98	09/14/00	4	blue grama	2	0	0	0	0	2	0	2	2	10	1.8
10/21/98	09/14/00	5	blue grama	0	5	5	0	0	0	0	0	0	0	1
10/21/98	09/14/00	6	blue grama	0	0	0	2	0	0	0	0	0	0	0.2
10/21/98	09/14/00	1	bluegrass-old	0	0	0	0	2	0	0	0	0	0	0.2
07/08/98	09/14/00	2	bluegrass-old	0	2	0	0	0	0	0	0	0	0	0.2
07/08/98	09/14/00	3	bluegrass-old	10	2	0		2	15	0	0	0	0	2.9
07/08/98	09/14/00	4	bluegrass-old	0	0	2	5	2	5	0	0	0	0	1.4
07/08/98	09/14/00	5	bluegrass-old	5	0	5	0	60	0	0	0	0	0	7
07/08/98	09/14/00	6	bluegrass-old	0	30	5	5	0	0	0	0	0	0	4
10/21/98	09/14/00	1	bluegrass-old	0	0	0	0	2	0	0	0	0	0	0.2
10/21/98	09/14/00	4	bluegrass-old	0	0	0	0	0	0	15	0	0	0	1.5
10/21/98	09/14/00	5	bluegrass-old	5	0	0	0	0	0	0	2	0	10	1.7
10/21/98	09/14/00	6	bluegrass-old	5	0	5	0	0	10	10	5	0	0	3.5
07/08/98	09/14/00	1	bromegrass-old	0	0	10	20	0	0	2	5	0	5	4.2
07/08/98	09/14/00	2	bromegrass-old	0	2	25	0	2	10	35	0	60	70	20.4
07/08/98	09/14/00	3	bromegrass-old	40	20	80	0	20	30	30	75	80	70	44.5
07/08/98	09/14/00	4	bromegrass-old	20	10	5	5	60	20	5	25	60	0	21
07/08/98	09/14/00	5	bromegrass-old	10	5	30	25	15	50	5	10	0	0	15
07/08/98	09/14/00	6	bromegrass-old	60	25	25	5	2	10	25	10	60	50	27.2
10/21/98	09/14/00	1	bromegrass-old	0	0	0	15	40	40	5	0	40	0	14
10/21/98	09/14/00	2	bromegrass-old	0	15	5	5	2	0	10	25	0	5	6.7
10/21/98	09/14/00	3	bromegrass-old	0	0	0	0	0	15	25	10	5	10	6.5
10/21/98	09/14/00	4	bromegrass-old	40	50	60	80	80	80	15	40	80	45	57
10/21/98	09/14/00	5	bromegrass-old	0	2	10	5	5	2	20	30	10	25	10.9

Seeding	Collection	Tran-													Average %
Date	Date	sect	Species	10'	30'	50'	70'	90'	110'	130'	150'	170'	190'	canopy cover	
10/21/98	09/14/00	6	bromegrass-old	15	15	20	45	10	10	45	25	40	10	23.5	
07/08/98	09/14/00	3	Canada wildrye	0	0	0	0	0	0	0	0	5	0	0.5	
07/08/98	09/14/00	4	Canada wildrye	0	0	0	0	2	5	0	0	2	0	0.9	
07/08/98	09/14/00	5	Canada wildrye	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	1	Canada wildrye	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	2	Canada wildrye	5	0	0	0	2	0	2	0	0	0	0.9	
10/21/98	09/14/00	4	Canada wildrye	5	0	2	0	0	0	0	2	2	0	1.1	
10/21/98	09/14/00	5	Canada wildrye	0	0	2	2	0	0	0	0	0	0	0.4	
10/21/98	09/14/00	6	Canada wildrye	20	5	10	5	2	10	0	2	10	2	6.6	
07/08/98	09/14/00	3	green needlegrass	0	0	0	0	0	0	0	0	2	0	0.2	
07/08/98	09/14/00	5	green needlegrass	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	4	green needlegrass	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	5	green needlegrass	0	0	0	5	0	0	0	0	0	0	0.5	
10/21/98	09/14/00	6	green needlegrass	0	10	0	0	0	2	5	0	0	10	2.7	
07/08/98	09/14/00	5	Indiangrass	2	0	0	0	2	5	0	0	0	0	0.9	
07/08/98	09/14/00	6	Indiangrass	0	0	2	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	1	Indiangrass	0	0	0	0	0	0	2	0	0	0	0.2	
10/21/98	09/14/00	2	Indiangrass	5	0	5	0	0	0	0	2	0	0	1.2	
10/21/98	09/14/00	3	Indiangrass	0	5	0	0	0	0	0	0	0	0	0.5	
10/21/98	09/14/00	5	Indiangrass	0	0	0	0	0	0	2	0	0	0	0.2	
10/21/98	09/14/00	6	Indiangrass	2	5	2	0	0	15	0	0	0	0	2.4	
07/08/98	09/14/00	6	little bluestem	0	0	0	0	0	0	0	0	0	5	0.5	
10/21/98	09/14/00	4	little bluestem	0	2	0	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	6	little bluestem	0	2	0	0	0	0	0	0	0	0	0.2	
07/08/98	09/14/00	3	other grasses	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	6	other grasses	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	6	other grasses	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	2	other grasses	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	3	other grasses	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	5	other grasses	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	1	prairie sandreed	0	0	0	0	0	0	0	0	5	0	0.5	
10/21/98	09/14/00	2	prairie sandreed	2	0	0	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	4	prairie sandreed	0	0	0	0	0	0	2	0	0	0	0.2	
10/21/98	09/14/00	6	prairie sandreed	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	1	sideoats grama	0	0	0	0	0	0	0	5	2	0	0.7	
07/08/98	09/14/00	2	sideoats grama	0	0	0	0	0	0	0	10	0	0	1	
07/08/98	09/14/00	4	sideoats grama	0	5	0	0	0	0	0	0	0	0	0.5	
07/08/98	09/14/00	5	sideoats grama	0	2	0	5	0	0	0	0	0	0	0.7	
07/08/98	09/14/00	6	sideoats grama	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	1	sideoats grama	0	0	0	0	2	0	0	0	0	0	0.2	
10/21/98	09/14/00	2	sideoats grama	0	2	0	0	2	0	0	0	0	2	0.6	
10/21/98	09/14/00	3	sideoats grama	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	4	sideoats grama	0	0	2	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	5	sideoats grama	0	0	0	0	0	0	2	0	0	0	0.2	
10/21/98	09/14/00	6	sideoats grama	0	0	0	0	0	5	0	0	0	0	0.5	
07/08/98	09/14/00	1	switchgrass	5	10	5	0	0	0	0	0	0	0	2	
07/08/98	09/14/00	2	switchgrass	15	0	15	0	5	25	15	30	0	15	12	
07/08/98	09/14/00	3	switchgrass	5	20	0	20	10	0	25	5	0	5	9	
07/08/98	09/14/00	4	switchgrass	10	0	15	0	0	30	5	35	0	0	9.5	

Seeding	Collection	Tran-													Average %
Date	Date	sect	Species	10'	30'	50'	70'	90'	110'	130'	150'	170'	190'	canopy cover	
07/08/98	09/14/00	5	switchgrass	0	5	0	5	15	5	0	10	0	0	4	
07/08/98	09/14/00	6	switchgrass	0	0	0	15	40	15	5	0	0	0	7.5	
10/21/98	09/14/00	1	switchgrass	15	5	0	5	0	2	0	5	5	15	5.2	
10/21/98	09/14/00	2	switchgrass	0	5	5	0	10	20	2	5	0	2	4.9	
10/21/98	09/14/00	3	switchgrass	15	10	5	0	5	15	5	5	10	5	7.5	
10/21/98	09/14/00	4	switchgrass	5	2	0	0	0	5	0	0	0	0	1.2	
10/21/98	09/14/00	5	switchgrass	5	2	0	0	2	5	2	0	0	0	1.6	
10/21/98	09/14/00	6	switchgrass	2	0	0	0	0	0	0	5	0	10	1.7	
07/08/98	09/14/00	4	unknown	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	5	unknown	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	1	unknown-new	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	2	unknown-new	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	4	unknown-new	0	0	0	0	0	0	0	0	0	2	0.2	
10/21/98	09/14/00	5	unknown-new	0	0	0	0	5	0	0	0	0	0	0.5	
10/21/98	09/14/00	6	unknown-new	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	3	wheatgrass	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	4	wheatgrass	0	0	0	0	0	0	0	0	0	2	0.2	
07/08/98	09/14/00	5	wheatgrass	25	0	0	0	0	0	0	0	0	0	2.5	
10/21/98	09/14/00	2	wheatgrass	0	2	0	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	3	wheatgrass	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	4	wheatgrass	5	0	0	0	0	0	5	0	0	0	1	
10/21/98	09/14/00	5	wheatgrass	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	6	wheatgrass	0	0	0	0	0	0	0	0	2	0	0.2	
10/21/98	09/14/00	4	black samson	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	5	black samson	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	6	black samson	0	0	0	0	0	0	0	0	0	0	0	
10/21/98	09/14/00	3	Canada milkvetch	0	0	0	2	0	5	2	0	0	0	0.9	
07/08/98	09/14/00	4	Canada milkvetch	0	0	0	0	0	0	0	0	0	2	0.2	
07/08/98	09/14/00	6	Canada milkvetch	0	0	0	0	0	0	10	0	0	0	1	
10/21/98	09/14/00	1	Canada milkvetch	0	0	0	0	0	0	2	0	0	0	0.2	
10/21/98	09/14/00	2	Canada milkvetch	0	0	0	0	2	0	0	5	2	2	1.1	
10/21/98	09/14/00	4	Canada milkvetch	0	15	0	0	2	0	2	2	0	0	2.1	
10/21/98	09/14/00	5	Canada milkvetch	0	0	0	5	0	0	0	5	0	0	1	
10/21/98	09/14/00	6	Canada milkvetch	0	0	0	0	0	0	2	2	0	0	0.4	
07/08/98	09/14/00	6	Lewis wild flax	2	0	0	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	4	Lewis wild flax	0	2	2	2	0	0	0	2	5	5	1.8	
10/21/98	09/14/00	5	Lewis wild flax	0	0	5	5	5	5	0	5	2	10	3.7	
10/21/98	09/14/00	6	Lewis wild flax	0	20	2	0	0	0	0	2	0	0	2.4	
07/08/98	09/14/00	3	maximilian sunflower	0	0	0	0	0	2	0	0	0	2	0.4	
07/08/98	09/14/00	4	maximilian sunflower	0	0	0	0	0	0	0	2	0	0	0.2	
07/08/98	09/14/00	5	maximilian sunflower	0	0	0	0	0	0	0	5	0	0	0.5	
10/21/98	09/14/00	1	maximilian sunflower	0	0	0	0	2	2	0	0	0	0	0.4	
10/21/98	09/14/00	3	maximilian sunflower	0	0	2	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	4	maximilian sunflower	0	5	0	0	0	0	20	2	2	0	2.9	
10/21/98	09/14/00	5	maximilian sunflower	5	0	5	15	5	0	0	0	0	0	3	
10/21/98	09/14/00	6	maximilian sunflower	0	0	2	0	10	0	15	30	0	0	5.7	
07/08/98	09/14/00	5	leadplant	0	0	0	0	0	0	0	0	0	2	0.2	
10/21/98	09/14/00	3	leadplant	5	10	0	0	0	0	0	2	0	0	1.7	
07/08/98	09/14/00	1	purple prairieclover	0	0	0	0	0	0	0	0	0	0	0	

Seeding	Collection	Tran-													Average %
Date	Date	sect	Species	10'	30'	50'	70'	90'	110'	130'	150'	170'	190'	canopy cover	
07/08/98	09/14/00	2	purple prairieclover	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	3	purple prairieclover	0	0	0	0	0	0	0	0	0	0	0	
07/08/98	09/14/00	4	purple prairieclover	0	0	0	0	0	0	0	0	0	2	0.2	
07/08/98	09/14/00	5	purple prairieclover	0	0	0	0	0	0	0	5	0	0	0.5	
07/08/98	09/14/00	6	purple prairieclover	0	0	2	0	0	0	0	0	0	0	0.2	
10/21/98	09/14/00	1	purple prairieclover	0	0	0	0	2	0	0	0	0	0	0.2	
10/21/98	09/14/00	4	purple prairieclover	0	4	2	0	0	0	2	0	0	0	0.8	
10/21/98	09/14/00	4	stiff sunflower	0	0	0	0	0	0	0	0	2	0	0.2	
10/21/98	09/14/00	6	stiff sunflower	0	2	0	0	0	0	2	0	2	2	0.8	
07/08/98	09/14/00	1	yellow coneflower	0	0	2	2	0	0	0	0	2	0	0.6	
07/08/98	09/14/00	2	yellow coneflower	0	0	0	0	0	5	0	0	0	2	0.7	
07/08/98	09/14/00	3	yellow coneflower	0	0	0	2	0	0	0	0	0	0	0.2	
07/08/98	09/14/00	4	yellow coneflower	0	0	0	0	2	2	0	2	0	0	0.6	
07/08/98	09/14/00	6	yellow coneflower	0	0	0	0	2	5	0	0	0	0	0.7	
10/21/98	09/14/00	1	yellow coneflower	0	5	0	2	10	5	0	5	0	0	2.7	
10/21/98	09/14/00	2	yellow coneflower	0	0	0	0	5	0	0	0	5	2	1.2	
10/21/98	09/14/00	3	yellow coneflower	0	0	5	0	0	0	0	0	0	0	0.5	
10/21/98	09/14/00	4	yellow coneflower	2	0	0	0	0	0	2	2	0	0	0.6	
10/21/98	09/14/00	5	yellow coneflower	5	5	0	0	0	0	0	0	2	0	1.2	
10/21/98	09/14/00	6	yellow coneflower	2	0	0	0	0	0	2	2	2	0	0.8	
07/08/98	09/14/00	1	weeds	5	5	2	5	10	10	5	5	5	10	6.2	
07/08/98	09/14/00	2	weeds	5	0	40	20	0	0	5	10	15	0	9.5	
07/08/98	09/14/00	3	weeds	0	2	0	0	15	20	5	2	0	0	4.4	
07/08/98	09/14/00	4	weeds	0	0	10	0	0	0		2	0	0	1.2	
07/08/98	09/14/00	5	weeds	5	25	2	0	0	0	0	2	0	0	3.4	
07/08/98	09/14/00	6	weeds	10	2	5	2	2	0	0	2	2	2	2.7	
10/21/98	09/14/00	1	weeds	30	25	10	10	0	5	20	40	10	10	16	
10/21/98	09/14/00	2	weeds	25	5	10	50	2	30	20	0	20	10	17.2	
10/21/98	09/14/00	3	weeds	10	15	30	10	10	15	20	10	5	15	14	
10/21/98	09/14/00	4	weeds	5	0	5	10	5	2	10	10	0	40	8.7	
10/21/98	09/14/00	5	weeds	0	25	2	5	20	10	20	2	40	10	13.4	
10/21/98	09/14/00	6	weeds	20	10	55	40	15	20	5	5	30	20	22	