Long Term Recovery of Native Prairie from Industrial Disturbance

Express Pipeline Revegetation Monitoring Project 2010

September 2011

Prepared For:

Kinder Morgan Canada
TransCanada PipeLines
ConocoPhillips Canada
ASRD Public Lands Division

Do we know if the revegetation strategies used to stabilize the soils post-construction and promote recovery in the early years are successful in the longer term at achieving industry goals to restore native grasslands after disturbance?

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Sponsorship

Acknowledgements

The Express Pipeline Monitoring Project 2010 was a multi-stakeholder effort with many individuals and partnerships involved. The authors wish to express their appreciation for the opportunity to have worked on such a productive collaborative effort.

Sponsorship for the project included Alberta Sustainable Resource Development Public Lands Range Resource Management Branch, Kinder Morgan Canada Ltd., ConocoPhillips Canada Ltd. and TransCanada Pipelines. Special thanks to Barry Adams, ASRD, Mike Droppo, Kinder Morgan, Sandra Marken, ConocoPhillips and Rob MacKinnon, TransCanada. These individuals and the partnership they formed shared a vision of the need to better understand the long term impact of specific construction, reclamation and revegetation strategies on native prairie grassland plant communities.

Thanks to the Kinder Morgan Canada operations staff for providing support for the field crews through their safety and environmental training programs. Thanks to the land department for providing landowner notification. It was obvious the Express operation staff appreciated the need for the project. Thanks especially to Mike Droppo, who took the time to spend two days in the field with us sharing his long term experience in native grassland reclamation and pipeline construction.

The field work was completed by two assessment crews working together in the field as a team. The Kestrel Research field assessment crew was composed of Jane Lancaster, Ken Baker, Varge Craig and Marilyn Neville. The ASRD field crew was captained by Barry Adams, Head of the Range Resource Management Branch, Public Lands Division and included Kevin France, Rangeland Management Specialist for Prairie and Parkland, Public Lands Rangeland Agrologists Jennifer Richman and Tennille Kupsch. Matt Veikle, Lakeland College practicum student and Gerry Ehlert (persuaded out of retirement) rounded out the team. The team found it was a wonderful opportunity for information sharing and learning. Alan Violette, ASRD GIS analyst, provided Grassland Vegetation Inventory mapping for the monitoring sites. Many of the monitoring sites on Express are remote and access is difficult. Due to the wet weather and low fire hazard, ASRD was able to provide a helicopter from the Forest Protection Branch to access the most difficult sites. Thanks to pilot Adam Sloan of Alpine Helicopters Ltd. Great Pilot, great machine, great ride!

Data processing and analysis for the plant community ordination reports were conducted by Laura Hickman. Ross Adams pulled night duty many times assisting Laura by compiling field data into Excel spreadsheets and also did data analysis for species group diversity. Varge Craig and Cheryl Bradley provided thoughtful review comments on the draft report. Review, guidance and quality control was provided by Barry Adams, Kevin France, Jane Lancaster and Marilyn Neville. It really was exciting to see the final results.

Jane Lancaster

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Marilyn Neville

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September 2011

Executive Summary

The purpose of the Express Pipeline Long-term Revegetation Monitoring Project is to provide industry and the Government of Alberta regulatory agencies with a unique opportunity to gather and process much needed data on the long term revegetation success of reclamation techniques used on native prairie.

Express Pipeline Project Setting and Regulatory History

Express Pipeline (Express), owned and operated by Kinder Morgan Canada Inc., is a 24 inch (610 mm) crude oil pipeline that extends from Kinder Morgan's tank farm near Hardisty, Alberta, south 434 kilometres to cross the United States border at Wildhorse, Alberta. The permanent right-of-way (RoW) is 20m wide and an additional 10m of temporary workspace was required for construction. At linear infrastructure crossings, on steep slopes and at water crossings, extra temporary workspace was also required.

Express crosses large contiguous tracks of native prairie along its alignment. Portions of the RoW cross native prairie in the Central Parkland, Northern Fescue, Mixedgrass and Dry Mixedgrass Natural Subregions of Alberta. The long term impact of pipeline construction and reclamation on native prairie ecosystems was an issue identified by stakeholders early in the planning process in 1994. Express Pipeline's regulatory commitment was to reclaim the RoW in native prairie areas with the goal of establishing a positive successional trend towards the native plant community present prior to construction. This was an early opportunity to demonstrate minimum disturbance practices in the Grassland Natural Region. To pursue this goal, native seed mixes were developed, specialized seeding equipment was used, and erosion control procedures were implemented. Revegetation trials such as natural recovery and sod salvage were also implemented to test the response of unconventional revegetation techniques.

A five year post-construction monitoring program was conducted between 1997 and 2001. Monitoring sites included; a diversity of soil types and native rangeland plant communities, construction practices areas where spoil was stored directly on prairie vegetation and areas where construction vehicles were driven on the grass, and areas where disturbed soils were seeded or left to recover naturally. Each monitoring site includes a pair of observations including an undisturbed control and a treatment area on the RoW. Quantitative data on species composition and cover was collected at 63 monitoring sites along the pipeline.

Over the years stakeholders and regulatory agencies recognized that further monitoring of Express could provide a valuable contribution to reclamation science regarding the long term performance of the cultivars and wild harvested seed used in the seed mixes, and the plant community succession of seeded sites, natural recovery trials and the sod salvage sites. Further monitoring could build on the initial five years monitoring results and the two years of data collected at the rough fescue sod salvage trials.

Long Term Monitoring Program Scope

The objectives of the study in 2010 are to assess whether current reclamation methods are achieving the desired long-term goal of restoring native prairie (successes and areas to improve) by providing data on:

- Long term performance of the native cultivars used in the native seed mixes; and
- Recovery and succession of seeded sites, natural recovery trials and the sod salvage trials.

Considerable progress has been made in understanding the processes of grassland ecology and function since the mid 1990's when Express was constructed. ASRD Lands Division, Range Resource Management Branch has developed three tools (GVI mapping, Range Plant Community Guides and Rangeland Health Assessment Protocols) that enable a standardized assessment of the ecological health and function of native grassland plant communities. These tools were applied on the long term monitoring of the Express Pipeline and in the interpretation of the results.

Available resources limited the number of monitoring sites re-assessed in 2010. Priority was given to the natural recovery trial sites and the sites where soils were stripped and seeded. A total of 51 of the original 63 sites were re-evaluated in the 2010 program. Two plains rough fescue sod salvage trials assessed by Wilfred Lane Petherbridge in 1997 and 1998 as part of a Master's thesis were also evaluated in 2010.

TransCanada funded monitoring of sixteen sites north of the Red Deer River. Monitoring of sites south of the Red Deer River was funded by Kinder Morgan Canada and ConocoPhillips Canada. ASRD Lands Division, Range Resource Management Branch also contributed substantially to the completion of this section by providing an additional five rangeland agrologists to the Express monitoring team and a helicopter for two days to access remote sites. This enabled monitoring of 19 of the 30 seeded monitoring sites and 15 of the original 18 natural recovery sites in 2010.

Data Processing and Analysis

Historic Data

Detailed information on construction procedures in relation to minimal width stripping, reclamation procedures including seeding rates, seeding techniques and final surface preparation is presented in the report. Details of the natural recovery reclamation procedures and the sod salvage procedures are also documented.

Data and reporting from all monitoring years have been collected and archived for this project. Plot inventory data has been compiled into a composite dataset for use in the analyses. Data from monitoring sites was grouped for comparison according to several environmental variables including; Natural Subregion, ecological range site, type of disturbance and reclamation treatment.

Seasonal weather plays a significant role in the establishment and recovery of vegetation after disturbance and in the range health of grazed pastures. Of note is the high snowfall year in the winter of 1996 after most of the line was constructed, the dry growing season of 1998 in northern portions of the line and the extreme drought years in 2000 and 2001 in the south.

Cumulative Data Including 2010 Results

The performance of each species in the seed mixes in terms of cover was tracked over time and compared to undisturbed native plant communities on the controls.

To assess whether succession towards pre-disturbance native plant communities is occurring, a time series of observations from each monitoring site, collected one, two, three, five and 14 years post-construction, were analysed. Methods included cluster analysis and non-metric multi-dimensional scaling analysis. The resulting groupings of species (communities) were described using indicator species analysis.

Successional stages (or seral stages) for the reclaiming plant communities are a series of plant community conditions that develop during ecological succession from bare soils (in this case topsoil). Definitions were developed for seral stages of communities recovering from disturbance and applied to each group resulting from the plant community ordination analysis.

Range health of the plant communities developing on the disturbance was also documented and compared to adjacent controls in the same pastures.

Results – Dry Mixedgrass Seed Mixes

Cultivars

- In the Dry Mixedgrass, slender wheatgrass and northern wheatgrass behaved as transition species, establishing in the early years and providing initial cover to stabilize soils, build litter and shelter other seedlings. Both species are diminishing with time to near natural cover levels.
- Western wheatgrass established early but cover has slowly increased over the 14 years. Western wheatgrass persists at greater cover than on the controls.
- Seeded June grass developed a persistent but low cover in the earlier years which has not changed much over time. This species is beneficial for rebuilding diversity and the mid structural layer and is resilient to grazing.
- Green needle grass cover increased steadily over five years in both the Sandy and Solonetzic seed mixes. By year 14, cover levels have declined on Solonetzic sites. However, on Sandy soils, green needle grass cultivars persist at cover levels that are significantly higher than on control sites resulting in higher structure than found on the controls.
- Sand grass (sand reed grass) cultivars developed average cover levels comparable to controls, but their large size creates a persistent increase in structure on the reclaiming RoW relative to the controls.
- Non-native sheep fescue is invasive, increasing in cover slowly but steadily on both healthy and unhealthy rangeland. Sheep fescue may contribute to plant community modification over time.
- After 14 years, persistent cultivars that are still expanding or maintaining relative cover beyond control levels are influencing the trajectory of plant community succession.

Mixedgrass Seed Mixes

Wild Harvested Seed

- Establishment of wild harvested rough fescue from two sources (plains rough fescue *Roes* from the Hand Hills and likely foothills rough fescue *Petherbridge* from the Milk River Ridge) was very slow initially, but the average cover has increased slowly and steadily on ecological range sites with potential to support rough fescue. 14 years after seeding, average cover values of rough fescue on the seeded RoW are more than 50% of the average cover values on the controls.
- Wild harvested June grass performed well, reaching average cover values close to those of the controls by the third year. It performed comparatively better than the June grass cultivar used in the Dry Mixedgrass seed mix.

Cultivars

- Similarly to the Dry Mixedgrass seed mixes, the two slender wheatgrass cultivars, *Revenue* and *Adanac*, provided good pioneer and early seral cover and disappeared from the plant community after 14 years.
- Northern wheatgrass and streambank wheatgrass provided good cover during the first five years and have since declined to comparable average cover values to the controls. The seeded cultivars are more robust and taller than their natural counterparts.
- Western wheatgrass established early but has slowly increased over the 14 years and persists at seven fold higher cover than on the controls.

- Green needle grass is only present at low cover levels on a limited number of the native rangeland controls. The seeded cultivar provided good cover during the first five years, but is persisting well beyond natural cover levels (19 fold more) after 14 years. This grass cultivar is significantly taller and more robust than the surrounding native vegetation, creating persistent taller structure and differences in composition in the successional plant community.
- After 14 years, persistent cultivars which are still expanding or maintaining relative cover beyond levels on the controls are influencing the trajectory of plant community succession.

Results – Natural Recovery

Natural recovery trials were established at four upland locations on the pipeline RoW; two on Solonetzic soils in the Dry Mixedgrass, one on Sandy soils in the Dry Mixedgrass and one on Loamy soils in the Mixedgrass. Sites were selected on relatively level terrain where site stability due to slopes was not an issue and soil exposure to wind erosion was minimized.

Over 14 years, native plant communities re-established on all the natural recovery sites. Cultivars are absent from the reclaiming plant communities, which results in better potential to match off RoW communities in terms of composition and the structural characteristics of local plants. On all Dry Mixedgrass sites there was significant establishment of needle grasses and wheatgrasses that are dominant in the reference plant community state.

Natural recovery was problematic on the Mixedgrass plains rough fescue site. Exposed topsoil remained relatively bare for the first three years, lacking the flush of colonizing annuals typical of Dry Mixedgrass sites. After 14 years, plains rough fescue is notably absent from the plant community. Although diverse, the plant community does not reflect the proportional cover of species in the reference plant community or the controls. This result highlights the additional challenge of re-establishing rough fescue on disturbed topsoils.

Timing of topsoil replacement is an important factor in the outcome of the natural recovery trials. The best results in terms of reflecting the composition and cover levels of the surrounding undisturbed prairie were on Dry Mixedgrass sites where soils were replaced before the following growing season. The cover of key species for the Dry Mixedgrass, blue grama and needle-and-thread, were greatly reduced on the Rainy Hills sites where topsoils were stored through the winter and re-handled once conditions were dry enough in late spring.

There was an increase of undesirable non-native Kentucky bluegrass at the two sites where it was present on the controls. This species is able to capitalize on disturbances and moisture to expand cover when it is present in adjacent undisturbed grasslands.

The timing and duration of livestock grazing can also affect the success of natural recovery, particularly in plains rough fescue plant communities.

Results – Plant Community Succession

The plant community ordination analysis indicates that positive successional change is occurring on most seeded and unseeded disturbed soils in the long term. Forty percent of all sites where soils were disturbed developed into a late seral plant community after 14 years. Definitions of seral stages are presented in the report.

Seeded Soils

- Unfortunately the use of sheep fescue in the Dry Mixedgrass seed mixes has resulted in 50% of these sites trending to modified plant communities over 14 years. The communities are still primarily native plant communities but non-native sheep fescue cover is increasing over time and occupying > 5% of the total live cover.
- On Loamy Mixedgrass soils in the Cypress Hills, where no non-native species were present in the seed mixes, four of the six seeded sites developed into a late seral plant community dominated by plains rough fescue and trending towards the MGA1 reference community for these sites. None of the seeded species are present beyond natural levels. Part of the reason for the success of these sites is likely their location in very large pastures with little presence of invasive species, little fragmentation and few routine sources for introducing invasive species. Two sites remain as mid-seral communities in 2010, with seeded northern and western wheatgrass dominant, and characteristic off RoW species such as the needle grasses and plains rough fescue still at very low cover.
- For seeded sites that remain as early or mid-seral plant communities after 14 years (both in the Mixedgrass and the Dry Mixedgrass), pasture sagewort (a persistent native disturbance forb) or seeded cultivars (including green needle grass, northern wheatgrass or western wheatgrass) are still dominant, often beyond natural levels.

Unseeded Soils

On Dry Mixedgrass soils, 78% of the natural recovery sites support late mid-seral to late seral communities after 14 years.

- Dry Mixedgrass Solonetzic Soils: Three of five natural recovery sites support a late seral plant community dominated by western wheatgrass and pasture sagewort. Two remain as early seral communities with pasture sagewort still dominant.
- Dry Mixedgrass Loamy Soils: Of the two sites, one is a late mid-seral Needle-and-Thread – Pasture Sagewort community and the other is a late seral Needle-and-thread – Northern Wheatgrass community.
- Dry Mixedgrass Sandy Soils: The six sites all re-established to a late seral Western Porcupine Grass – Pasture Sagewort community by the fifth year. By year 14, five of the sites shifted to two different late seral needle-and-thread communities. One site shifted to a mid-seral stage buckbrush / sun-loving sedge community.

Mixedgrass Loamy Soils: There was only one unseeded trial site in the Mixedgrass due to concerns about the ability of these sites to revegetate to desirable species and the vulnerability of sites in the Cypress Hills to erosion. This site had very little cover for the first three years and was subject to summer grazing. The bare RoW attracted cattle. Although in the analysis the developing plant community clustered with a late seral community in years two and three, it has shifted into a community dominated by Kentucky bluegrass (an invasive exotic species) in years five and 14.

Unstripped Spoil Storage Areas and Travel Lanes

Native vegetation at monitoring sites where spoil was stored directly on the grass or where vehicles drove directly on the grass did not revert to a pioneer stage. Native vegetation re-established quickly from underground propagules to provide partial cover and early to mid-seral plant communities. However, many of these sites do not appear to have progressed towards more mature seral stages. Most maintained the same plant community cover over five years. Some sites have maintained the same plant community over the 14 year recovery period.

Results – Range Health

Range health was measured both on the disturbance and the associated controls in 2010. Health assessments included measures of ecological status (as indicated by the community of plants present on the site), plant community structure, litter, site stability, soil exposure and the presence of noxious weeds (Adams et al. 2009). The health of the range before disturbance affects the ability of a disturbed area to respond and can affect the outcome of restoration. Ultimately, impacts to plant community integrity will impact the provision of ecological services.

Ecological Status

After 14 years, 45% of the sites on disturbed soils have developed into late seral plant communities of varying ecological status. Some 43% of the 42 measured sites have the same ecological status as the adjacent undisturbed pasture. Another 43% of the sites have reduced ecological status compared to the adjacent rangeland. Ecological status scores dropped by two health classes for 11% of the sites and increased by one health class at one site. There were no discernible differences in range health status between seeded and unseeded sites after 14 years.

Plant Community Structure

Healthy native rangeland communities include tall, mid, low and ground cover structural layers. Diversity in the canopy structure provides resilience to fluctuations in grazing pressure and climate events, promotes energy flow and nutrient cycling, and protects the ground surface from erosion (Adams et al. 2009). A consistent observation from all the reclaiming sites on disturbed soils is the continuing lack of a groundcover layer after 14 years. Bare soils were still more prevalent on the recovering RoW than on native rangeland, which contributed to reduced health scores. Typically prairie selaginella (*Selaginella densa*), and to a lesser extent mosses and lichen are the major components of this layer. Litter values were also diminished with increased grazing pressure and lower range health scores.

Invasive Species

Establishment of invasive species from the seedbank or through infill has only been an issue at a few monitoring sites. Kentucky bluegrass is the dominant cover at two natural recovery sites in the Mixedgrass that are used as summer pasture. Crested wheatgrass is also establishing on two southern sites in the Dry Mixedgrass where it is present off RoW. The large pastures in the expansive areas of native prairie in the southern portion of the Express Pipeline route are relatively free of introduced species. Further north, where there is increased landscape fragmentation and cultivation, introduced species are more common.

Interacting Variables

Range health was generally better in larger pastures and on Public Land. Smaller pastures and private land, particularly on more northern portions of the RoW, tended to have reduced range health scores. In smaller pastures the disturbed RoW takes up proportionally more of the available land which can put further pressure on both the undisturbed and disturbed portions of the area. The droughts experienced during recovery can also exacerbate grazing impacts on the recovering RoW, particularly in smaller pastures.

Results – Diversity after Disturbance

An assessment was made of the proportion over time of three growth forms of interest (annual forbs, perennial forbs, and graminoids) on reclaiming soils in the Dry Mixedgrass. The assessment compares the relationship between the diversity of species on a site (represented by Shannon's Diversity Index) and the proportion of a site occupied by each growth form. The biggest changes in proportion are the flush of annual forbs immediately after disturbance, their gradual decline over time and the slow steady increase in the diversity of graminoids (grasses and sedges) on natural recovery sites as opposed to the high cover, low diversity seed mix graminoid cover in early years.

Over time the diversity of graminoids and the proportion of the naturally reclaiming sites occupied by graminoids increases and are comparable to values on seeded areas and undisturbed controls by 2010.

Results – Plains Rough Fescue Sod Salvage Trials

Plains rough fescue plants can survive a transplant procedure in the long term where sod of sufficient depth and quality is used. Range health plays an important role in transplant success over the long term. Shallow-rooted, rhizomatous, non-native grasses such as Kentucky bluegrass or smooth brome can colonize the sod transplant areas from outside sources, competing with the recovering plains rough fescue and associated native bunch grasses. The presence of invasive non-native grasses in the stand prior to disturbance severely limits the success of the sod salvage procedure. Loamy range sites appear to be more susceptible to Kentucky bluegrass and smooth brome invasion than drier, less fertile range sites. Restoring surface contours is challenging and changes to drainage can also result in changes in the plant associations on the sod blocks over time. This technique is also very labour intensive.

Management Recommendations

A number of recommendations based on key learnings from Express are presented in Section 11. A few are highlighted here.

Restoration Planning

- Sites where long-lived seeded species matched those present naturally on the surrounding rangeland had the best chance of establishing and persisting over time.
- New tools for planning restoration of native prairie after disturbance will identify ecological site characteristics and target plant communities for restoration planning.
- There may be more options for restoration in healthy rangeland. Diminished range health or high grazing intensity can hinder recovery.

Seed Mixes

- Avoid seeding persistent species that are not present naturally on the same ecological range site (ERS).
- Non-native sheep fescue is invasive and should not be used for restoration. Sheep fescue may contribute to plant community modification over time.
- It is important to plan for different structural layers when designing a seed mix and include a variety of species with tall, mid and low structural characteristics. Diverse structure improves range health and builds ecological resilience.
- Persistent cultivars that developed taller structure on the RoW are green needle grass, sand grass (sand reed grass), northern wheatgrass and western wheatgrass.

- It is very important to use seed with genetic origin that is compatible with the area of the project. Some cultivars are much taller and more robust than local plants, creating persistent increases in plant community structure on the revegetating disturbance. The common aggressive cultivars on Express were green needle grass, western wheatgrass and northern wheatgrass.
- Slender wheatgrass in a useful short term cover crop, providing erosion control and shade for slower growing species and disappearing for the most part by year five, leaving space for infill by other species.
- Do not use non-native species for native prairie restoration unless they are annual cover crops that are guaranteed not to persist more than one year or reseed.

Natural Recovery

- Natural recovery techniques were successful in establishing native plant communities in the Dry Mixedgrass Natural Subregion. Cultivars are absent from the reclaiming plant communities, which results in better potential to match off RoW communities in terms of composition and the structural characteristics of local plants. The result is a native plant community rather than a community of native cultivars.
- The timing of topsoil replacement is an important factor in the outcome of natural recovery as a revegetation strategy. Topsoil replacement in the fall or during dormant conditions before the first post-construction growing season is recommended.
- The presence of undesirable non-native species such as Kentucky bluegrass prior to disturbance can negatively affect the outcome of natural recovery as a revegetation strategy. Seeding may be a better option on invaded sites.
- The timing and duration of livestock grazing can also affect the success of natural recovery, particularly in plains rough fescue plant communities. Protecting sites from grazing during spring and summer in the first few years can be beneficial.
- Natural recovery is more risky on moist, Loamy sites in the Mixedgrass Natural Subregion and on sites where invasive species are present in the pre-disturbance plant community.

Sod Salvage

- Although plains rough fescue plants can survive a transplant procedure and persist if range health is good, sods are vulnerable to invasion by undesirable rhizomatous species. Sod salvage is very labour intensive and not recommended for mitigating industrial scale disturbance.

Communication of Restoration Commitments and Strategies from Construction to Operations

- Remedial repairs and seeding may be required on projects up to 10 years after construction. It is important to communicate restoration goals, commitments and strategies agreed to for construction to the operations team. A failure to communicate reclamation commitments made at the restoration design phase is a problem experienced on Express.

Assessing Restoration Progress

- Patience is required to restore native grassland communities. The 14 year post-construction monitoring on Express indicates that succession is still on-going and range health on the disturbances is improving, but is lower than the surrounding rangeland.

The Importance of Long-term Follow-up Monitoring

If we are to conserve what remains of our native prairie for future generations then we must continue to improve our reclamation and revegetation practices in native prairie landscapes. Our focus must shift from reclamation to restoration.

Time is an important factor in the process of recovery from industrial disturbance in native grasslands. Extended timeframe monitoring until restoration goals are achieved using standardized methods of evaluation provides the opportunity to reflect on construction and reclamation procedures used in the past and make informed choices that will improve future restoration potential.

The results of the Express monitoring 14 years after construction indicate that significant changes may occur after the first five years of reclamation both in positive and negative directions. There is very little information available on the long term efficacy of various native grassland reclamation techniques in the Natural Subregions of Alberta and on native plant community successional pathways following industrial disturbance in the long term. Long term monitoring is needed to contribute to our understanding of whether restoration of native vegetation communities is possible, and if so, in what situations and over what timeframe. It is necessary to continue to develop best management practices and appropriate revegetation strategies for industrial disturbances in native prairie to promote industry stewardship on increasingly pressured prairie landscapes.

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Abbreviations

ACIMS.....Alberta Conservation Information Management System
AI .....Alberta Innovates
ARC .....Alberta Research Council
ASRD.....Alberta Sustainable Resource Development
AWA.....Alberta Wilderness Association
AVG ..... average
DMG .....Dry Mixedgrass
ERS ..... ecological range site
Est% ..... estimated percent
Express..... Express Pipeline
FAN..... Federation of Alberta Naturalists
g.....gram
GPS ..... global positioning system
GVI..... Grassland Vegetation Inventory
ha..... hectare
kg.....kilogram
km.....kilometre
m..... metre
MGA.....mixedgrass association
MG..... Mixedgrass
mm..... millimetre
NEB .....National Energy Board
NSR .....Natural Subregion
BlO.....Blowouts/Solonetzic
CS.....Choppy Sandhills
Li.....Limy
Lo.....Loamy
Ov ..... Overflow
PLS..... pure live seed
plt..... plants per metre squared
PPRP ..... permanent photographic reference point
RoW.....right-of-way
Sa .....Sands
Sy .....Sandy
TB .....Thin Breaks
TCPL.....TransCanada Pipeline
wt .....weight

1 INTRODUCTION

The purpose of the Express Pipeline Long-term Revegetation Monitoring Project is to provide industry and the Government of Alberta regulatory agencies with a unique opportunity to gather and process much needed data on the long term revegetation success of reclamation techniques used on native prairie. The first few years of recovery after industrial disturbance and reclamation are well documented, but there is little to no data on native plant community successional pathways following industrial disturbance in the long term. Do we know if the revegetation strategies used to stabilize the soils post-construction and promote recovery in the early years are successful in the longer term at achieving industry goals to restore native grasslands after disturbance?

1.1 Express Pipeline Project Setting and Regulatory History

Express Pipeline (Express), owned and operated by Kinder Morgan Canada Inc., is a 24 inch (610 mm) diameter crude oil pipeline. The permanent right-of-way (RoW) is 20m wide and an additional 10m of temporary workspace was required for construction. The pipeline RoW extends from Kinder Morgan's tank farm near Hardisty, Alberta, south 434 kilometres to cross the United States border at Wildhorse, Alberta, (see Figure 1-1). The southern delivery terminal is located near Casper, Wyoming. Because Express crosses an international boundary the project is regulated by the National Energy Board (NEB).

1.1.1 Regulatory Process and Approval Conditions

Express crosses large contiguous tracks of native prairie along its alignment. Portions of the right-of-way (RoW) cross native prairie in the Central Parkland, Northern Fescue, Mixedgrass and Dry Mixedgrass Natural Subregions of Alberta. The long term impact of pipeline construction and reclamation on native prairie ecosystems was an issue identified by stakeholders early in the planning process in 1994.

Native prairie issues continued to be a focal point of negotiations with the Alberta Wilderness Association (AWA), the Federation of Alberta Naturalists (FAN) and provincial government agencies (ASRD - Lands Division, Fish and Wildlife, Special Areas Board) throughout the NEB application process, public hearing and subsequent approval process. To resolve identified issues, an Environmental Advisory Committee was formed with representatives of Express, its environmental and construction consultants, provincial agencies, FAN and the AWA. The Committee met on a regular basis and reached consensus on improved pipeline construction, reclamation and revegetation practices designed to reduce the impact in native prairie.

Natural recovery was an emerging industrial revegetation strategy in the mid-1990s. Also, research initiatives were being completed on the use of various types of native seed mixes in reclamation. As a result, numerous trial sites were established on Express, including: natural recovery trial sites, no-strip trial sites, sod salvage trial sites and native cultivar seed trial sites.

A five year post-construction monitoring program was established with rigorous vegetation assessment methodology. The post-construction monitoring program was conducted between 1997 and 2001. Monitoring sites selected included a diversity of soil types and native rangeland plant communities. Monitoring sites evaluated minimal disturbance construction practices such as reduced soil stripping and handling, and revegetation strategies where disturbed soils were either seeded or left to recover naturally. The resulting monitoring reports filed with the NEB are available to the public at the NEB office in Calgary.

1.1.2 Sustained Interest in Long Term Monitoring

There has been continued stakeholder interest in the long term recovery of native prairie on Express pipeline. Research conducted at the Alberta Research Council (Woosaree, J. 2007) indicates that a timeframe longer than 5 years is needed to evaluate performance trends of seeded native plant cultivars. Over the years stakeholders and regulatory agencies have recognized that further monitoring of Express could provide a valuable contribution to reclamation science regarding the long term performance of the native plant cultivars used in the native seed mixes and the progression of plant community succession on the seeded sites, the natural recovery trial sites and the sod salvage trial sites. Further monitoring could build on the monitoring data collected for five years following construction, including the two years of data collected at the rough fescue sod salvage trial sites.

The idea for the Express Pipeline Tour 2008 originated when members of the Express monitoring team came together at the Foothills Restoration Forum held at Maycroft in November of 2007. It was agreed that important information sharing would occur if the original stakeholders in the Environmental Advisory Committee were invited to participate. The idea was explored, developed and agreed to with the assistance of Mike Droppo, Kinder Morgan Canada, TransCanada Pipelines, and the Canadian Energy Pipeline Association. A three day field tour to visit representative sites was organized based on requests from representatives of the original stakeholders of the Express Environmental Advisory Committee. The August 2008 tour provided the opportunity for field based observation and information sharing among the participants. A report was produced following the tour that compiled key observations and research questions. A strong central message from the participants is expressed in the following excerpt from the field tour report:

"Express Pipeline offers rich opportunities for better understanding the long term efficacy of various native prairie reclamation techniques in the Dry Mixedgrass, Mixedgrass, Northern Fescue and Central Parkland Natural Subregions of Alberta. Additional monitoring is merited; given that there was monitoring data collected using a well-defined methodology over the first five years post-construction. The results would inform future decisions about routing of large diameter pipelines in similar environments and appropriate reclamation/ restoration requirements. Additional monitoring data from the Express Pipeline could contribute to our understanding about whether restoration of native vegetation communities is possible, and if so, in what situations and over what time frame."

Funds were then solicited to conduct the monitoring from petroleum industry companies operating on native prairie. Kinder Morgan Canada, TransCanada Pipelines and Conoco Phillips Canada made generous contributions as did ASRD Lands Division, Range Resource Management Branch. This monitoring project was conducted in 2010, 14 years after construction.

1.2 2010 Long-term Monitoring Program Objectives

The objectives of this study are to assess whether current reclamation methods are achieving the desired long-term goal of restoring native prairie (successes and areas to improve) by providing data on:

- Long term performance of the native plant cultivars and wild harvested native seed used in the seed mixes; and
- Recovery and secondary succession of seeded sites, natural recovery trial sites and the sod salvage trial sites.

Monitoring program results will provide information to:

- Develop best management practices and appropriate revegetation strategies for industrial disturbances in native prairie;
- Provide a framework for future monitoring programs for industrial disturbances in native prairie;
- Develop state and transition models for bare ground disturbances; and
- Promote industry stewardship on increasingly pressured prairie landscapes.

Figure 1-1 Context Map

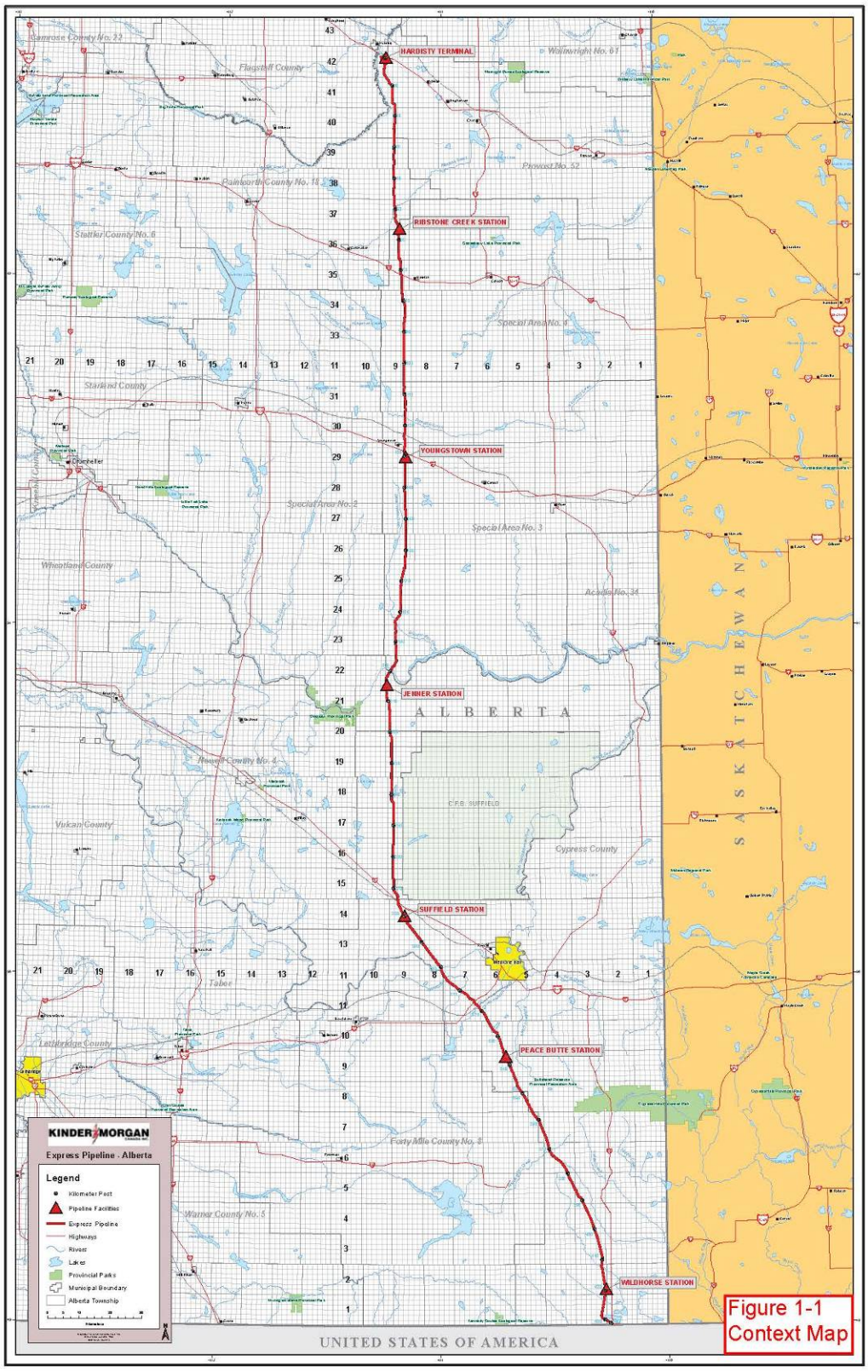
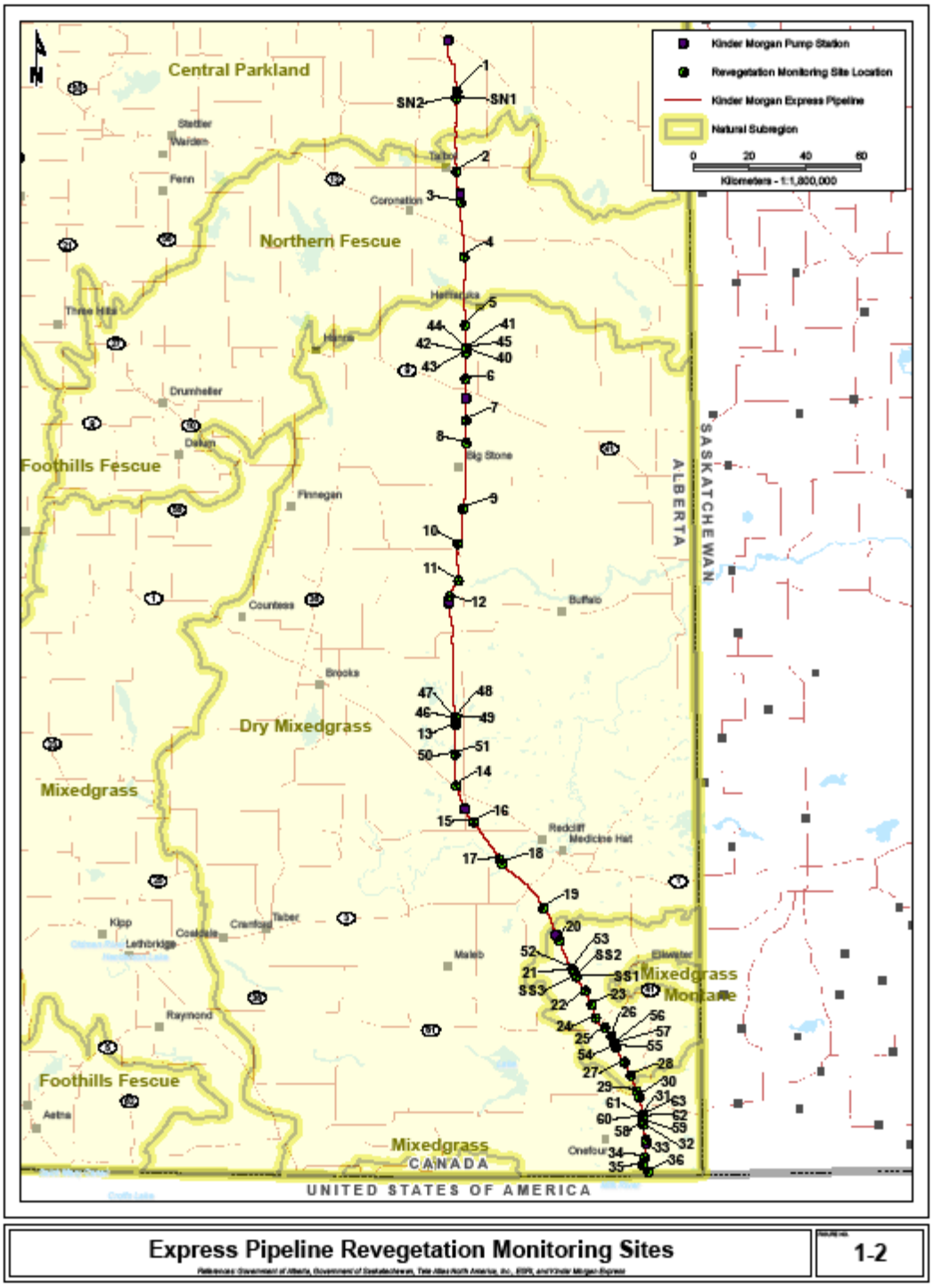


Figure 1-2 Express Pipeline Route and Revegetation Monitoring Sites



Express Pipeline Revegetation Monitoring Sites 1-2

2 EXPRESS PIPELINE CONSTRUCTION AND RECLAMATION STRATEGIES ON NATIVE PRAIRIE – 1996-97

2.1 Minimal Disturbance Construction Techniques

The early to mid-1990s was a period of dramatically increased petroleum development activity in native prairie landscapes. Stakeholders expressed concerns regarding the ability of the native prairie ecosystem to recover from the cumulative effects of development activities. The upstream petroleum and pipeline industries and the regulatory authorities responded to the concerns by developing procedures to reduce the footprint and impact of development in native prairie. Procedures used on Express included reducing the area where topsoil was stripped, adjusting the timeframe of construction to minimize the impact to the native plant communities and implementing a traffic control plan during construction and reclamation.

2.1.1 Blade Width Stripping

Blade width stripping was used extensively on this project. Topsoil was stripped eight metres wide centred over the trench where the pipeline was installed. Topsoil was stored in a windrow adjacent to the trench on unstripped native prairie. Spoil from the excavated trench was also stored on unstripped native prairie on the opposite side of the trench. This procedure was implemented in all areas of native prairie where the topography was sufficiently level to allow the safe passage of vehicles, construction equipment and materials over the native grassland. The implementation of reduced stripping widths resulted in a 40% savings in reseeding costs compared to full width stripping. Figure 2-1 illustrates this procedure.

Figure 2-1 Blade Width Stripping

2.1.2 Double Blade Width Stripping

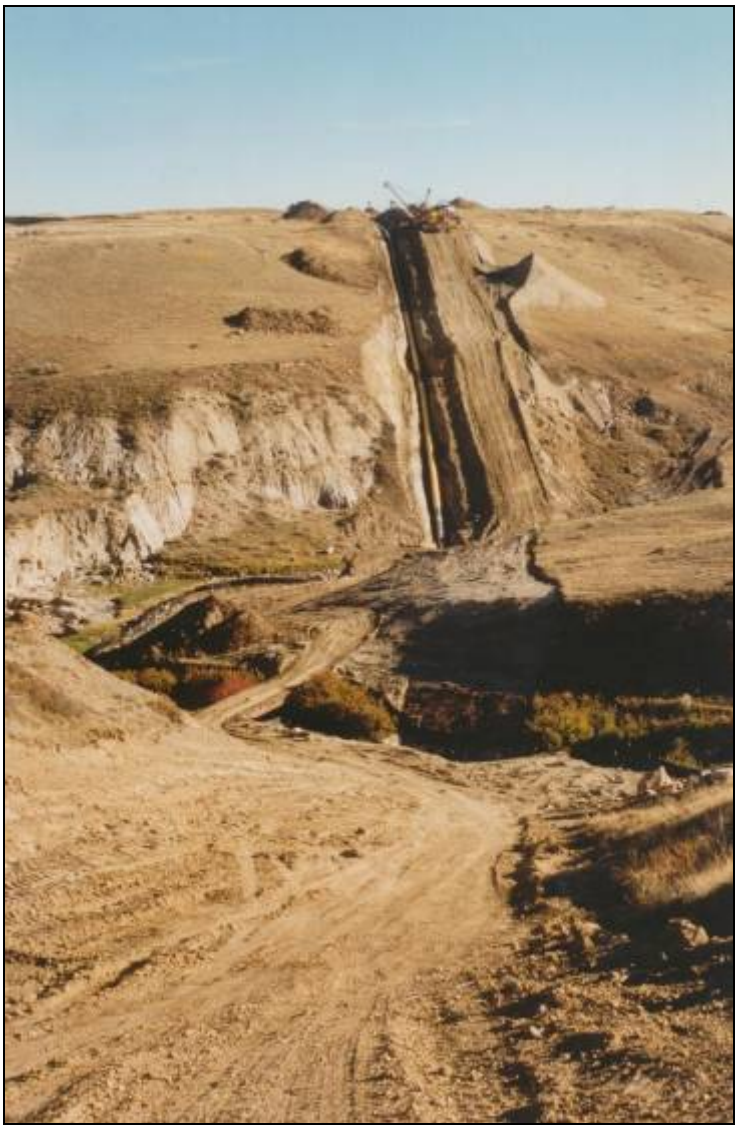
Double blade wide stripping was used where the native prairie micro-topography posed a safety hazard for some construction procedures such as the transport, unloading and stringing of the pipe. Topsoil was stripped eight metres wide centred over the trench and stored adjacent to the trench. An eight metre wide travel lane was also stripped with the topsoil stored adjacent to the trench topsoil pile on the unstripped native prairie. The rest of the RoW remained unstripped with the spoil from the trench stored on the opposite side of the trench from the topsoil, on unstripped native prairie, (Figure 2-2).

Figure 2-2 Double Blade Width Stripping

2.1.3 Full Width Stripping

Full width stripping was implemented in steep topography where grading of the RoW was required for safe installation of the pipeline. For example, the procedure was used on the approach slopes to watercourse crossings. The area of disturbance included the full RoW (30m wide) and the extra workspace required for the storage of topsoil and grade materials (Figure 2-3).

Figure 2-3 Full Width Stripping and Grading



2.1.4 Timing of Construction

The timing of construction was an important factor to the success of the minimal disturbance soil handling procedures. Construction activities were initiated under dry soil conditions in early August when most of the native prairie plants were dormant and suspended in mid-November before the soils were frozen. This timeframe reduced the impact to both the native prairie soils and vegetation.

2.1.5 Traffic Control

Construction related traffic along the RoW was strictly controlled to reduce the impact to the unstripped travel lane. A detailed traffic control plan was developed with input from the contractors and monitored by the environmental inspectors.

2.1.6 Soil Replacement Procedures

The time frame between stripping and replacement of the topsoil resources was reduced significantly on Express to minimize the impact to the native seed bank and plant propagules contained in the stripped topsoil. In most of the native prairie areas the topsoil was replaced prior to the onset of winter. Two pipeline contractors working simultaneously on separate sections of the alignment decreased the time required to complete the construction of the pipeline and replacement of the soils.

Potential for scalping the sod, where the spoil and topsoil were stored on top of native prairie vegetation, was reduced by mounting specially designed Prairie Protector Blades (Figure 2-4) on the equipment used to replace the topsoil.

Figure 2-4 Prairie Protector Blade

2.2 Reclamation and Revegetation Strategies

Express Pipeline's regulatory commitment was to reclaim the RoW in native prairie areas with the goal of establishing a positive successional trend towards the native plant community present prior to construction. To pursue this goal, native seed mixes were developed, specialized seeding equipment was used, and erosion control procedures were implemented. The Kinsella Accuroller was used to seed the native seed mixes. The Accuroller is composed of two large drum rollers with cleats welded to the rollers. Seed is distributed between the rollers from the seed box through dribble tubes. The action of the rollers incorporates the seed into the soil, packs the seedbed and imprints the soil surface to minimize erosion. Revegetation trials such as natural recovery and sod salvage were also implemented to test the response of unconventional revegetation techniques.

2.2.1 Native Seed Mixes

A detailed vegetation inventory was conducted by qualified botanists in all areas of native prairie during the application process and prior to the construction of the pipeline. Dominant species of the native plant communities encountered along the pipeline alignment were described and this information used to formulate five native seed mixes. These seed mixes were developed with and approved by the Environmental Advisory Committee. Wild harvested seed was used when key native plant cultivars could not be procured from conventional, approved sources. The details of each seed mix are included in Tables 6-1, 6-2, 6-3, 6-4 and 6-5.

Plains rough fescue is a component of healthy native grasslands in the Central Parkland and Northern Fescue Natural Subregions. It is also a dominant to co-dominant species in the grasslands of the Mixedgrass Natural Subregion in the transition zone of the Cypress Upland eco-district. Plains rough fescue is a long lived climax species that is very sensitive to man-made disturbance. Previous attempts to restore plains rough fescue communities had been unsuccessful and whether these communities could be restored following industrial disturbance was a key issue debated during the NEB hearing process. The Environmental Advisory Committee conducted a review of available literature to determine what factors limited the re-establishment of plains rough fescue. Seedling mortality during germination and emergence was identified as a major factor. Seedling survival appeared to be restricted by competition with invasive non-native agronomic grass species such as smooth brome and Kentucky bluegrass. The seed mix design, seeding methods and application rates with respect to rough fescue reflect the consensus reached by the Environmental Advisory Committee.

2.2.1.1 Seed Mix 1 - Aspen Parkland

The Aspen Parkland native seed mix was designed to be compatible with native grassland, shrub and aspen forest plant communities of the Central Parkland Natural Subregion. Plains rough fescue is a component of healthy native grassland plant communities in this Natural Subregion. Factors such as sudden heavy rainfall events, erosion prone soils and landscape features influenced the final seed mix design. The wheatgrass component of the seed mix was composed of native wheatgrasses and the drought resistant hybrid cultivar streambank wheatgrass. Other seed in the mix included a June grass cultivar, green needle grass cultivars and sheep fescue, a non-native cultivar. Wild harvested plains rough fescue was seeded separately from the wheatgrass component at a seeding ratio of 1:1 in grassland areas where the vegetation inventory indicated plains rough fescue prior to construction. Special seeding methods were developed to increase the rough fescue seedling survival. The wheatgrass component was drill seeded at 6 kilograms per hectare (kg/ha) by blocking off alternate dribble tubes to reduce the seeding rate and increase the row spacing. The plains rough fescue was then broadcast seeded with the Kinsella Accuroller. The combined seeding rate was 12 kg/ha.

2.2.1.2 Seed Mix 2 - Mixedgrass Transition

The Mixedgrass Transition seed mix was designed to be compatible with the Mixedgrass Natural Subregion plant communities located at the lower slopes of the Cypress Hills where plains rough fescue is a co-dominant to dominant species. It was also used on sites located in the Northern Fescue Natural Subregion. Terrain and erosion prone soils also influenced seed mix design. The wheatgrass component of the seed mix was composed of native wheatgrasses and the drought resistant hybrid cultivar streambank wheatgrass. Other seed mix components included wild harvested June grass, a green needle grass cultivar and an Indian rice grass cultivar. It is important to note that sheep fescue was not a component of this mix. Again special seeding methods were developed to increase the wild harvested rough fescue seedling survival. The other species were drill seeded at 6 kg/ha by blocking off alternate dribble tubes to reduce the seeding rate and increase the row spacing. The rough fescue was then broadcast seeded with the Kinsella Accuroller. The combined seeding rate was 12 kg/ha.

2.2.1.3 Seed Mix 3 - Dry Mixedgrass - Sandy Soils

The Dry Mixedgrass Sandy Soils seed mix was designed to be compatible with the native plant communities of the Dry Mixedgrass Natural Subregion where sandy loam and loamy sand soils were encountered. Erosion control and drought tolerance were also factors important in this seed mix design. The mix included native wheatgrasses and the drought resistant hybrid cultivar streambank wheatgrass, June grass, prairie sand reed grass, Indian rice grass and green needle grass native grass cultivars. Sheep fescue and Canada bluegrass, both non-native cultivars, were added for erosion control and to provide a mid-structural layer. Seed was broadcast with the Kinsella Accuroller at 12 kg/ha.

2.2.1.4 Seed Mix 4 - Dry Mixedgrass - Solonetzic Soils

The Dry Mixedgrass Solonetzic Soils seed mix was designed to be compatible with the native plant communities where Loamy to Solonetzic soils were encountered along the Express alignment. This seed mix was seeded on by far the largest proportion of the native grasslands disturbed by Express. The seed mix included native wheatgrasses and the drought resistant hybrid cultivar streambank wheatgrass, green needle grass and June grass native grass cultivars. Alkali bluegrass, a native grass cultivar, was added for its salt tolerance performance. Sheep fescue, a non-native cultivar added for erosion control, was also present in this mix. Seed was broadcast with the Kinsella Accuroller at 12 kg/ha.

2.2.1.5 Seed Mix 5 - Prairie Wetlands

A specific native seed mix was designed for prairie wetlands that could not be avoided during construction. The native plant cultivars used were chosen for their resistance to periodic flooding and seasonal drought. Species included tufted hair grass, slender wheatgrass, western wheatgrass and alkali bluegrass. Seed was broadcast and harrowed at 24 kg /ha.

2.2.2 Native Prairie Revegetation Trial Sites

Express agreed to conduct reclamation trials to evaluate the success of revegetation techniques such as natural recovery and sod salvage as part of the approval process. A map illustrating the location of each trial site is provided as Figure 1-2.

2.2.2.1 Natural Recovery Trials

The primary focus of the natural recovery trials was to evaluate the ability of the RoW to naturally revegetate without active reseeding under specific construction and reclamation procedures. Soil handling procedures used in the natural recovery trial sites included blade width, double blade width and full width stripping. The natural recovery strategy relies on the native seed and propagule bank contained in the topsoil and seed rain from the adjacent undisturbed grassland to revegetate the site.

The four natural recovery trial sites represent four regions which differ in climate, soils, vegetation and exposure to erosion. Reclamation procedures for the trials varied with the soil and erosion characteristics of each area. Natural recovery trials were established in the Dry Mixedgrass on Sandy and Solonetzic soils. Climate, soils and terrain pose additional erosion risk in the Mixedgrass region of the Cypress Upland, so only one unseeded natural recovery site was established. Instead, seed trial sites located in the Cypress Upland offered opportunities to explore additional strategies for revegetating rough fescue grasslands. A summary of the natural recovery and seed trials follows in Table 2-1.

Table 2-1 Summary of Natural Recovery and Seed Trials

Sites	Location	Natural Subregion	Reclamation Procedure
40-45	Hemaruka Dunes	Dry Mixedgrass-sandy soils	No seed, straw crimped
46-49	Rainy Hills	Dry Mixedgrass-solonetzic soils	No seed, knolls straw crimped
52	Cypress Upland	Mixedgrass	No seed, straw crimped
53	Cypress Upland	Mixedgrass	Seeded to wild harvested rough fescue at 12 kgs per ha and straw crimped
54-55	Cypress Upland	Mixedgrass	Seeded 6 kg per ha wild harvested needle-and-thread plus 6 kg wild harvested rough fescue seeded with Accuroller, 6 kg of seed mix 2 drill seeded; straw crimped
56-57	Cypress Upland	Mixedgrass	Seeded to wild harvested rough fescue at 12 kg per ha and straw crimped
58-63	Sage Creek	Dry Mixedgrass- solonetzic soils	No seed, imprinted with the Accuroller only

2.2.2.2 Sod Salvage Trial Sites

Two locations were selected to conduct sod salvage and replacement trials within the pipeline alignment in plains rough fescue grasslands. One site is located in the Central Parkland Natural Subregion south of Hardisty. The second site is in the Mixedgrass Natural Subregion, located south of Medicine Hat in the Cypress Upland.

At both sites the removal of the sod took place in late August and early September when the rough fescue plants were dormant and the soils were dry. The removal of the sod was scheduled in advance of the main topsoil stripping operation. Rough fescue is a deep rooted bunch grass with fibrous roots that extend well beyond the depth of topsoil. Specialized equipment was adapted to ensure the sod was salvaged with as much of the root mass intact as was possible. The sod was first pre-cut into 1 metre sections with an asphalt cutter mounted on the bucket of a track hoe. The sod was then lifted with a modified cleanup bucket on the hoe. The sod fractured easily from the subsoil generally at the depth of the topsoil, averaging 20 cm in depth. Labourers guided the sod from the track hoe onto wooden pallets. A pre-cut sheet of filter fabric cut slightly larger than the sod was placed between each layer of sod. Due to the thickness of the sod, the sod was piled an average of four to five layers high. The pallets of sod were transported to the storage area adjacent to the RoW and placed as close together as possible with the front end loader of a farm tractor. The stockpiled sod was then shrouded with white filter fabric to keep it cool and reduce wind erosion and desiccation. Most of the sod was stripped with reasonable efficiency. Where hidden stoniness was encountered removal was not practical. At both locations the sod was stored for approximately two and a half months while the pipeline was constructed. (Figures 2-5 and 2-6.)

Replacement of the sod followed subsoil replacement and contouring. The shrouds were removed and the pallets of sod placed on the prepared subsoil with the farm tractor. The individual sods were slid off the pallets and placed into position by labourers. Stockpiled topsoil was placed in the voids between the sods to prevent dieback.

Figure 2-5 Sod Salvage

Figure 2-6 Sod Salvage

3 EXPRESS MONITORING PROGRAM COMPONENTS 1997 – 2001

The Express Monitoring Program was developed by the Environmental Advisory Committee and approved by the NEB. The monitoring program included a general right-of-way condition evaluation, a number of specific monitoring programs and research studies designed to evaluate the construction and reclamation procedures implemented to address stakeholder concerns. Monitoring was conducted over a five year period in 1997, 1998, 1999 and 2001.

3.1 Qualitative Monitoring for General Right-of-Way Condition

This phase of the monitoring program focused on identifying areas of the RoW that required remedial work due to changing environmental conditions. The entire length of the RoW was reviewed, erosion control measures were assessed and the required remedial work completed and documented.

3.1.1 Permanent Photo Reference Points

In addition to the general RoW monitoring and evaluation, 41 permanent photographic reference points (PPRP) were installed and revisited each year of the five year monitoring program. Sites selected included water course crossings and areas identified during construction that warranted photographic documentation of the process of recovery. A copy of the archived PPRPs and the photos taken in 2010 are included on the DVD which accompanies this document.

3.2 Quantitative Revegetation Monitoring in Native Prairie

Express agreed to the specific methods of data collection designed by the Environmental Advisory Committee to document and evaluate the progress of revegetation in native prairie. This program was conducted in years one, two, three and five post-construction.

3.2.1 Site Selection

The northern portion of the pipeline alignment crosses the Central Parkland, Northern Fescue and Dry Mixedgrass Natural Subregions. The native prairie north of Rush Lake (at the northern edge of the Cypress Hills) is interspersed with transportation corridors, industrial development and agricultural activity. Some of this area was once ploughed but subsequently abandoned as unsuitable for cultivation. Native prairie species have re-established in many of these areas. In this area revegetation monitoring sites were established approximately every 10 km along the pipeline RoW.

The native prairie crossed by the southern portion of the alignment, Rush Lake to Wildhorse, is one of the largest remaining native prairie areas in Canada. Here the alignment crosses both the Dry Mixedgrass and the Mixedgrass Natural Subregions. The Environmental Advisory Committee identified a need for more frequent monitoring of sites in this area; thus sites for monitoring revegetation were established approximately every five kilometres along the RoW.

Figure 1-2 illustrates the location of the revegetation monitoring sites along the entire pipeline alignment.

3.2.2 Monitoring methods

Approximate locations of the 36 monitoring sites were selected randomly before the first field visit and stratified to ensure representation of the natural regions, soil groups, landforms and stripping procedures used during construction. Minor adjustments to site locations were made in the field to ensure representation of the three topsoil stripping procedures in the sampling design.

A helicopter was used to access the sites quickly and efficiently. Sample sites were permanently marked on both boundaries of the 30 metre RoW with orange-coloured metal range pins pounded flush with the ground. The sample site number was permanently marked on the pin on the western boundary. Thirty metre line transects were established at right angles across the RoW from west to east. GPS coordinates were recorded at each location to facilitate relocation of transects.

One metre by one metre plots were used for photographic records of RoW condition. At each site a photograph of the RoW was taken looking north, then four labelled plot photographs were taken. Point zero metres on the transect is the western edge of the RoW (and the location of the range pin). The first photograph was taken with the SE corner of the frame at point zero on the transect in undisturbed vegetation. The second plot photograph was taken with the SW corner of the plot at four metres from the western edge in the spoil storage area. A third plot photograph was taken with the SW corner of the plot at eight metres from the western edge on the pipeline ditch. A fourth photograph was taken with the SW corner of the plot at 20 metres from the western boundary in the travel lane. Each plot photograph was labelled with the year, the site number, the kilometre posting, GPS coordinates, the soil stripping width and the zone of impact chosen for vegetation micro-plot sampling. Duplicate photographs were made with two cameras to ensure a complete record of RoW condition. An example of the photographic record series for one site is illustrated in Figures 3-1, 3-2, 3-4, 3-5 and 3-6.

Plant species composition and percentage cover were used as the key indicators of reclamation progress. Microplot sampling for composition and cover was done using randomly tossed 1/10 metre Daubenmire frames. Seven to ten frames were inventoried north of the line transect in the selected zone of impact, which were; disturbed soils, an unstripped spoil storage area, or an unstripped travel lane. The procedure was also duplicated west of point zero in undisturbed vegetation as a control.

Percentage cover estimates of all vascular vegetation including selaginella, moss and lichen combined, litter (including straw mulch) and bare ground were recorded. The inventory forms were similar to the MF5 Range Inventory forms developed and used by ASRD Lands Division Range Resource Management Program.

3.2.3 Monitoring Natural Recovery Trial Sites

The methods used to monitor the progress of revegetation in the natural recovery areas were generally consistent with the methods described above. Six sample sites were located in each of the four natural recovery trials (or seed trials in the Mixedgrass). Two replicate sample sites of blade width, double blade width and full width soil stripping areas were established and evaluated. One difference in the sampling method was that the micro-plot sampling was not restricted to one zone of impact. Rather, the micro-plot frames were tossed across the breadth of the RoW, including the zone of impact present on the site. This procedure was changed in 1999 when the micro-plot sampling was confined to the zone of disturbance. Micro-plot data prior to 1999 has been discarded from the analysis.

3.2.4 Monitoring Sod Salvage Trial Sites

An evaluation of the sod salvage sites was undertaken by Wilfred Lane Petherbridge as partial fulfilment of a Master of Science degree in Land Reclamation and Remediation, Department of Renewable Resources, University of Alberta. His thesis entitled *"Sod Salvage and Minimal Disturbance Pipeline Reclamation Techniques: Implications for Native Prairie Restoration" (Petherbridge 2000)* can be obtained from the author or through the University of Alberta Library.

Figure 3-1 Site # 46 Photographic Record Example

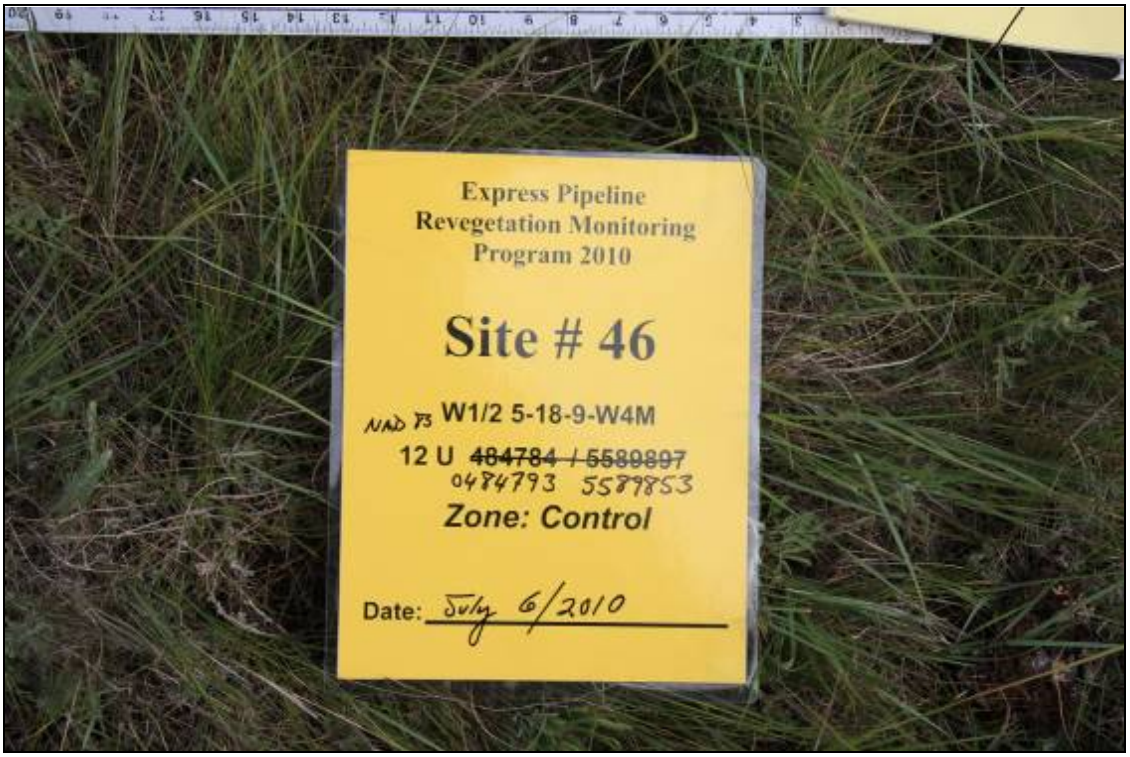


Figure 3-2 North From RoW

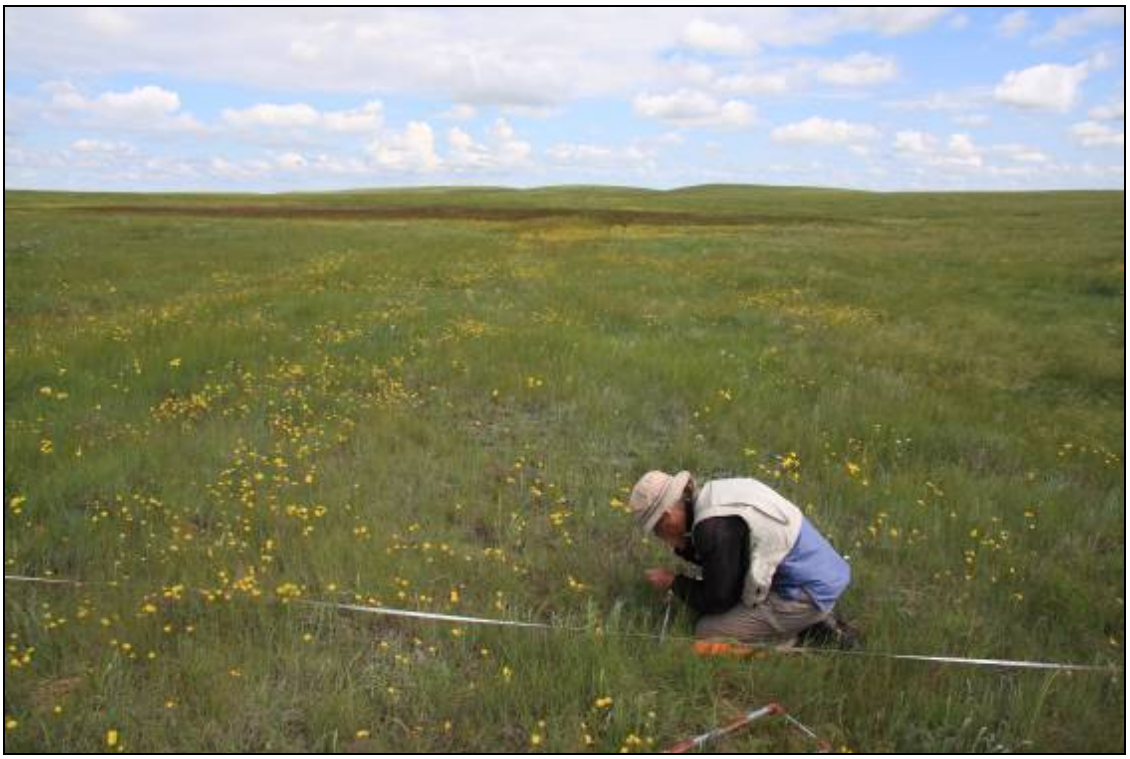


Figure 3-3 SE Corner of Frame Point Zero Transect in Undisturbed Vegetation

Figure 3-4 SW Corner of Plot 4m From Western Edge in Spoil Storage Area

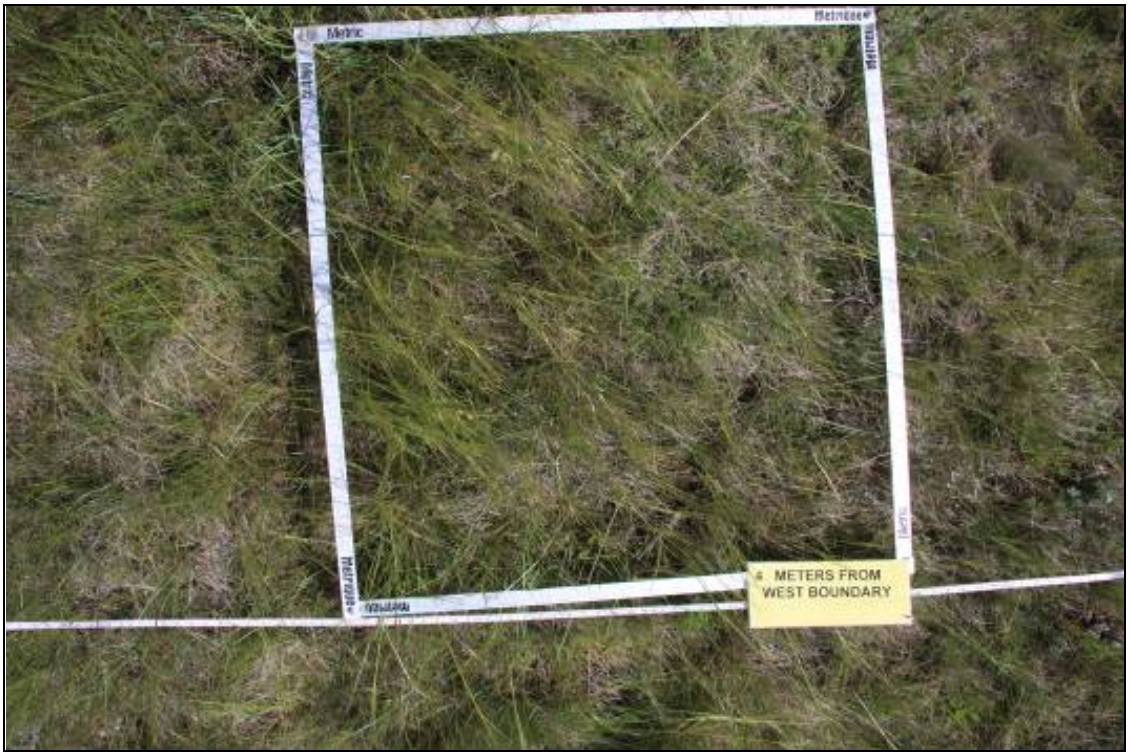


Figure 3-5 SW Corner of Plot 8m From Western Edge on Pipeline Ditch

Figure 3-6 SW Corner of Plot 20m From Western Boundary in Travel Lane

4 LONG TERM REVEGETATION MONITORING – 2010

4.1 New Tools for Grassland Assessment

Considerable progress has been made in understanding the processes of grassland ecology and function since the mid 1990's when Express was constructed. ASRD Lands Division Range Resource Management Program has developed three tools that enable a standardized assessment of the ecological health and function of native grassland plant communities: the Grassland Vegetation Inventory, Rangeland Health Assessment and the Range Health Community Guides. There have also been updates to the Natural Region classification for Alberta (Achuff 1994) with new boundaries defined for some grassland and parkland subregions (Natural Regions Committee 2006). These new tools were applied on the 2010 long term monitoring of Express and in the interpretation of the results.

4.1.1 Grassland Vegetation Inventory

The Grassland Vegetation Inventory (GVI) represents the Government of Alberta's first comprehensive biophysical landform, coarse scale vegetation and anthropogenic inventory of the province's White Area at a landscape scale (ASRD and LandWise Inc. 2010). It addresses requirements defined by the province's rangeland management, fish and wildlife, wetland management, and land use operations sectors. The Grassland Vegetation Inventory is comprised of ecological range sites based on soils and landform information for areas of native vegetation, and defines general land use for non-native areas (agricultural, industrial, and populated areas). It also includes a base hydrological layer or feature. GVI is available through the Alberta Prairie Conservation Forum website and through direct contact with ASRD.

4.1.2 Range Health Assessment

The Range Health Assessment protocol developed by the ASRD Lands Division Range Resource Management Program has been used to assess, monitor and manage Alberta's rangeland since 2003. The assessment approach builds on the traditional range condition concept that considers plant community type in relation to site potential but adds new and important indicators of natural processes and functions. The methodology provides a visual system that allows users to readily see changes in range health and to provide early warning when management changes are needed.

Range health is defined as the ability of rangeland to perform certain key functions. The functions of healthy range include: net primary production, maintenance of soil/site stability, capture and beneficial release of water, nutrient and energy cycling and functional diversity of plant species (Adams et al. 2009). Range health questions are indirect measures of the following indicators:

- Integrity and Ecological Status
- Community Structure
- Hydrologic Function and Nutrient Cycling
- Site Stability
- Noxious Weeds

An evaluation allows the assessor to see whether important ecological functions are being performed.

Range health assessment is an important tool for monitoring the management of multiple use activities taking place on grasslands. It is an important component of the 2010 Reclamation Criteria for Wellsites and Associated Facilities for Native Grasslands (Alberta Environment 2011). The use of a common assessment method for all man-made impacts on grasslands can facilitate more accurate cumulative effects assessment and lead to improved land management. See Appendix H for an example of a range health assessment form.

4.1.3 Range Plant Community Guides

The Range Plant Community Guides are an essential reference for understanding potential grassland communities and conducting range health assessments in the Grassland Natural Region and Subregions of Alberta. The guides provide plant community descriptions (Adams et al. 2004, 2005) which can be linked to the ecological range site types mapped in GVI (ASRD and LandWise Inc. 2010). The plant community that is an expression of site potential is referred to as the reference plant community and acts as a standard for comparison in range health assessment and restoration. The guides are available on the ASRD website and are updated on a regular basis as new data is gathered.

4.2 2010 Revegetation Monitoring Program

The 2010 field program was conducted between June 20th and August 11th, 2010 and used the same basic methods as the five year post-construction monitoring program for data collection and photo documentation. GVI mapping, provided through ASRD, facilitated coarse interpretation of the ecological range site at each monitoring site. This allowed for the correlation of micro-plot data collected both on and off RoW to successional plant communities that have evolved over time for a given set of environmental factors. Range health assessments were conducted at the off RoW control and at the measured zone of disturbance at every site. This assessment provided insight into the influence of climate and livestock grazing over time within a given management unit.

4.2.1 Site Selection

Available resources limited the number of monitoring sites re-assessed in 2010. Priority was given to the natural recovery trial sites and the monitoring sites where the zone of impact assessed had been stripped and seeded. A total of 51 of the original 63 sites were re-evaluated in the 2010 program. The two sod salvage sites were also evaluated. Information on site locations, construction and revegetation procedures and soils are presented in Appendix I.

4.2.1.1 North of Red Deer River

All of the sites north of the Red Deer River, funded by TransCanada, were assessed in 2010 with the exception of Site #1. Monitoring sites included a variety of construction and reclamation procedures including stripped and seeded soils, unstripped travel lanes, unstripped spoil storage areas and natural recovery trials. In 2001 at Site #1 a new pipeline was installed through the control and adjacent to the Express pipeline on the west side. The disturbance was seeded to agronomic species that included smooth brome and alfalfa. A total of 16 sites north of the Red Deer River were assessed in 2010.

4.2.1.2 South of Red Deer River

The frequency of monitoring sites and the difficulty of access to sites increases south of the Red Deer River. This section of the monitoring program was funded by Kinder Morgan Canada and ConocoPhillips Canada. ASRD Lands Division Range Resource Management Program also contributed substantially to the completion of this section by providing an additional five rangeland agrologists to the Express monitoring team and a helicopter for two days to access remote sites. This enabled 19 of the 30 seeded monitoring sites to be reassessed in 2010. Upland sites where the zone of disturbance had been stripped and seeded were given priority. 15 of the original 18 natural recovery sites were also reassessed in 2010. Natural recovery sites #50 and #51 were not assessed as they are located in semi-permanent lentic wetlands, and upland site #63 was not relocated.

4.2.2 Sampling Methods

The methods used throughout the 1997-2001 monitoring program were used in 2010 with the following additions:

- Foliar cover estimates of plant species cover (Adams et al. 2009) were made instead of the canopy cover measurements measured between 1997 and 2001. Cover measurements were not interpreted as Daubenmire cover classes but left as observed percentage cover.
- 10 micro-plots were inventoried both at the control and at the assessed zone of impact on RoW at every site.
- A range health assessment was conducted according to the protocol outlined in Rangeland Health Assessment for Grassland, Forest and Tame Pasture, Field Workbook (Adams et al 2009) at the control and at the assessed zone of impact on RoW at every site.
- On RoW micro-plot sampling at the natural recovery sites was consistently within the stripped zone of impact (as it was in 1999 – 2001).
- Start and end points for the micro-plot transect were recorded using a handheld GPS.
- Control locations were selected to be most representative of the soil, landform, slope, aspect and moisture conditions on the RoW.
- Photographs of the control area were added.

4.2.3 Monitoring Sod Salvage Trial Sites

The two sod salvage trial sites were extensively assessed by Wilfred Lane Petherbridge in 1997 and 1998. Methods and results are included in the thesis entitled *Sod Salvage and Minimal Disturbance Pipeline Reclamation Techniques: Implications for Native Prairie Restoration* (Petherbridge 2000).

Monitoring methods used in 2010 to assess and provide comments on the status of the sod salvage trials were consistent with those implemented for the seeded and natural recovery sites. Two trial sites were assessed at the northern site south of Hardisty in the Central Parkland Natural Subregion. Three sites were assessed at the southern site in the Cypress Upland of the Mixedgrass Natural Subregion. Transects were installed across the RoW and micro-plot sampling occurred within the sod salvage and replacement area. Off RoW controls were sampled at comparable ecological range sites as close as possible to the RoW. GPS coordinates were recorded at the perimeter of each sod salvage area. Photo documentation was consistent with the seeded and natural recovery sites. Additional photos were taken to record observations of interest. See Figure 4-1 and Figure 4-2.

Figure 4-1 Parkland-Hardisty Sod Salvage Site – View South

Figure 4-2 Mixedgrass-Manyberries Sod Salvage Site – View South

5 DATA ANALYSIS

5.1 Data Processing and Quality Assurance

Data from previous monitoring years has been collected and archived for this project. Plot inventory data has been compiled into a composite dataset for use in the analyses. Historic hard copy photographs of the RoW monitoring sites have been scanned and archived. Past reporting to the NEB has also been archived.

All 2010 MF5 and range health data sheets were scanned to digital files and the data entered into excel spread sheets. Digital photographs have also been compiled. The details of site treatments and environmental variables for each site have been collected and all species data has been reviewed for accuracy in translating field observations to the excel files.

5.2 Environmental Variables

Data from monitoring sites was grouped for comparison according to several environmental variables, including:

- Natural Subregion;
- Ecological range site;
- Type of disturbance; and
- Reclamation treatment.

5.2.1 Weather Records

Weather records for Coronation, near the north end of the pipeline, and for Medicine Hat, near the southern portion of the pipeline, are presented in Tables 5-1 and 5-2. Seasonal weather plays a significant role in the establishment and recovery of vegetation after disturbance and in the range health of grazed pastures. Of note is the high snowfall year in the winter of 1996 after most of the line was constructed (Table 5-2), the dry growing season of 1998 in northern portions of the line (Table 5-1) and the extreme drought years in 2000 and 2001 in the south.

Table 5-1 Coronation - Annual Weather Records during Construction and Monitoring Years

Year	Average Temperature			Precipitation			Snow Depth
	Minimum	Mean	Maximum	Rain (mm)	Snow (cm)	Total (mm)	Last Month (cm)
1996	-6.2	-0.9	4.7	n/a	n/a	205.6	n/a
1997	-4.0	2.4	8.8	204.4	19.0	206.3	n/a
1998	-4.0	2.6	9.1	170.2	14.6	171.7	n/a
1999	-3.7	2.3	8.3	309.3	45.4	313.8	n/a
2001	-4.9	1.9	8.7	164.9	62.0	171.1	Feb 2.0 cm
2010	-4.2	1.7	7.6	n/a	68.0	414.4	May 1.0 cm
AVG 1971 - 2000	-4.0	2.3	8.5	294.6	138.9	401.0	6 cm

Table 5-2 Medicine Hat - Annual Weather Records during Construction and Monitoring Years

Year	Average Temperature			Precipitation			Snow Depth
	Minimum	Mean	Maximum	Rain (mm)	Snow (cm)	Total (mm)	Last Month (cm)
1996	-2.9	3.5	9.8	237.0	137.5	250.7	Feb (4 cm)
1997	-0.5	6.2	12.8	155.9	47.3	160.6	Feb (1 cm)
1998	0.5	7.1	13.7	346.2	92.0	355.4	no accumulation
1999	0.5	7.2	13.8	248.7	62.2	254.9	Jan (9 cm)
2001	0.2	7.2	14.2	93.2	66.5	99.8	Feb (10 cm)
2010	-1.1	5.2	11.5	n/a	n/a	413.7	Mar (1 cm)
AVG 1971 - 2000	-1.0	5.7	12.3	249.6	95.2	333.8	2 cm

5.3 Plant Community Ordination

The objective of the Express Pipeline reclamation plan on native prairie was to establish a positive successional trend towards the plant communities present before construction. To assess whether this trend is occurring, a time series of observations collected one, two, three, five and 14 years post-construction from each monitoring site were analysed. Methods included cluster analysis and non-metric multi-dimensional scaling analysis. The resulting groupings of species (communities) were described using indicator species analysis. Analysis methods and the resulting species groups are presented in Appendix C.

Successional stages (or seral stages) for the reclaiming plant communities are a series of plant community conditions that develop during ecological succession from bare topsoil exposed during pipeline construction. They are described using the definitions in Table 5-3 and were applied to each group resulting from the plant community ordination analysis (See Appendices B and C for details).

The descriptions in the table refer to the range management terms, increaser and decreaser species. Decreasers are desirable forage species that decline in cover as grazing pressure increases (e.g. rough fescue, wheatgrasses, needle grasses). Conversely, increasers are grazing resistant species that increase in cover on a site as grazing pressure increases (e.g. June grass, blue grama, low sedge).

Table 5-3 Definitions for Plant Community Seral Stages on Disturbed Topsoils

Seral Stage	Description
Bare ground	< 5% cover of live vegetation.
Pioneer	Site dominated by annual weeds, a cover crop or first year seeded colonizing grasses such as slender wheatgrass.
Early seral	Site dominated by disturbance forbs such as pasture sagewort and other species such as low sedge. Seeded species and colonizing grasses such as spear grasses also establishing.
Mid-seral	Cover of grasses greater than that of disturbance forbs such as the sageworts; decreaser grasses present as a small component of the cover.
Late mid-seral	Cover of grasses greater than that of disturbance forbs such as the sageworts; decreaser grasses occupy about 50% of the cover; infill species present.
Late Seral - native	Cover of long-lived grass species expanding; native species cover from the seed bank established; slower establishing infill species present; decreaser grasses dominant; no more than one structural layer missing.
Late Seral - cultivars	Cover of long-lived grass species expanding; seeded cultivars clearly still dominant; slower establishing species such as fescues present; decreaser grasses dominant; no more than one structural layer missing.
Reference	Community closely resembles the ecological site potential natural community under light disturbance described in the Range Plant Community Guides.
Trending to Modified *	A primarily native plant community where non-native species are increasing over time and occupying > 5% of the total live cover; the succession time scale is as little as 5 and as many as 20 years or more.
Modified	> 70% cover of non-native species.

* Invasive non-native species that are known to replace native species and establish permanent dominance in Mixedgrass and Dry Mixedgrass communities include crested wheatgrass, smooth brome and sheep fescue. There has been a debate about whether Kentucky bluegrass should be included in the “trending to modified” category. Our feeling is that Kentucky bluegrass is a somewhat naturalized species that is relatively stable. Cover values are high in wet years but are reduced in dry years and in pastures with improved range health. It does not illustrate the same “fire front” effect on the landscape as the previously listed invasive species.

6 EXPRESSION OF SEEDED RECLAMATION SPECIES

Emerging reclamation techniques in the mid-1990s included the use of a variety of native seed mixes. Seed mixes for the Express Pipeline were tailored for native rangeland communities on Sandy, Loamy and Solonetzic soil types in each of the Parkland, Mixedgrass and Dry Mixedgrass Natural Subregions. Most species in the mixes were native. Two exceptions, sheep fescue (*Festuca ovina*) and Canada bluegrass (*Poa compressa*), were selected from seed available at the time to restore the mid structural layer to reclaiming grassland. A third non-native wheatgrass hybrid, streambank wheatgrass (*Agropyron riparium*) was also used. Many of the cultivars available in 1996 originated from plant material in the northern United States or further east in Saskatchewan and Manitoba. Their morphology and ability to establish and persist can be different than local native genotypes. Where cultivars or sources are not identified in the seed mix tables, the seed is assumed to be "common seed".

Composition of seed mixes and the rate of application (12 kg/ha) were designed to allow natural succession to occur. The seeding rate was determined in consultation with the Express Pipeline Environmental Advisory Committee. Further details on site preparation and seeding methods are presented in Section 2.

The expression of species in the seed mixes over time is assessed by averaging the cover on all sites seeded to a particular mix and comparing it to species cover on the adjacent controls. The data is not subdivided by ecological range site. The composition of the seed mixes including percentage by weight and pure live seed per square metre are provided in accompanying tables for reference. Streambank wheatgrass could not be reliably distinguished from northern wheatgrass (*Agropyron dasystachyum* (syn: *Elymus elymoides*)) during the monitoring so is not discussed separately.

6.1 Dry Mixedgrass Solonetzic Soil Seed Mix

Figure 6-1 illustrates the expression and percent cover of seeded species over time on ten sites seeded to Solonetzic Soil Mix 4. The monitoring sites are primarily on Solonetzic soils, but also include a few Loamy and Overflow ecological range sites. The naturally occurring cover of these species on control sites in 2010 is also shown. Components of the seed mix are presented in Table 6-1.

Two cultivars of slender wheatgrass (*Agropyron trachycaulum (syn: Elymus trachycaulus*)), *Revenue* and *Adanac*, both originating from Saskatchewan, formed 5.4% and 7.1% by weight of the seed mix. This species is designed to provide initial cover to stabilize soils and reduce wind erosion potential. These cultivars performed as expected, providing between 4% and 6% cover in the first three years. Slender wheatgrass cover is declining after five years and is gone from the stand by year 14 post-construction. It is present naturally on only 8% of the control sites, providing 0.2% cover.

The cover of northern wheatgrass (including streambank wheatgrass) increases steadily one through five years after seeding, reaching over 10% cover at year five. By 2010, 14 years after seeding, it has an average of 7.3% cover on seeded sites compared to 5.3% cover naturally on the controls.

Western wheatgrass (*Agropyron smithii* (syn: *Pascopyrum smithii*)), which formed 7.8% by weight of the seed mix, has increased steadily in cover from 1.5% cover after one year to 4.6% cover after 14 years, compared to 2.2% average cover on the control sites.

June grass (*Koeleria macrantha*) comprised 6.5% by weight of the seed mix but only developed between 0.3 and 1.5% cover on the reclaiming RoW, compared to an average cover of 5.9% on control sites in 2010. The highest cover values were in the first year after seeding, at an average of 1.5% cover. The cultivar used, *Prairie Seeds*, originated from southern Alberta foothills plants.

Green needle grass (*Stipa viridula* (syn: *Nassella viridula*)) sourced from Manitoba and Alberta formed 9.9% and 10.7% of the seed mix by weight. The cover of green needle grass increases steadily over five years after seeding to 4.3%, dropping at year 14 post-seeding to 1.8% cover. It was present at 1.0% average cover on the controls. The height of seeded green needle grass is higher than all of the native species in the project area and continues to change the structure of the seeded stand.

Alkali bluegrass (*Poa juncifolia*) is unique to the Dry Mixedgrass Solonetzic Seed mix. It comprised less than 1% of the cover between one and five years post-construction and dropped to close to natural cover levels in the controls in 2010, 0.1% average cover on seeded sites versus 0.3% natural cover.

Sheep fescue (*Festuca ovina*) is an introduced grass seeded at 13.1% by weight in the seed mix. Cover of sheep fescue has increased slowly but steadily over time on seeded sites to 12.4% average cover 14 years post-seeding. It is present on 90% of the seeded sites (9 sites) and forms more than 5% cover on 60% of the sites. It is expanding on the RoW on both healthy and unhealthy rangeland. It was also present on one control site in 2010, where it has spread from the seeded RoW.

6.2 Dry Mixedgrass Sandy Soil Seed Mix

Figure 6-2 illustrates the expression and percent cover of seeded species over time on five sites seeded to Sandy Soil Mix 3. The naturally occurring cover of these species on control sites is also shown. Components of the seed mix are presented in Table 6-2.

Indian rice grass (*Oryzopsis hymenoides*) is a native colonizing species adapted to bare sand and active sand. It formed 30.1% by weight of the seed mix. It provided about 2% cover for the first five years after seeding. After 14 years it dropped to 0.3% cover. It was only present on one of the five control sites in trace quantities.

Two cultivars of slender wheatgrass, *Revenue* and *Adanac*, formed 3.7% and 5.3% by weight of the seed mix. They provided substantial initial cover in the first two years after seeding, at 11.5% and 13.1% average cover respectively. Cover then declined over time and in 2010 slender wheatgrass provides 0.5% cover, which is comparable to 0.3% natural cover on the controls.

Northern wheatgrass (including streambank wheatgrass), seeded at 5.1% and 5.4% by weight respectively, provided a fairly consistent cover of between 2.8% and 5.5% between years two and 14 after seeding. Natural average cover levels are 3.5%.

Western wheatgrass has also established a persistent stable cover of about 4% between three and 14 years after seeding. Natural average cover levels on the adjacent rangeland are 2.4%.

Two cultivars of sand grass (*Calamovilfa longifolia*), also known as sand reed grass, were used in the seed mix. Cultivar *ND95,* seeded at 7.6% by weight, and Cultivar *Goshen*, seeded at 4.6% by weight, originate from North Dakota and Wyoming respectively. This species provided most cover at year three (1.2% cover) and declined by year 14 to 0.8% cover. Naturally occurring cover averaged 0.7%. Although seeded cover is comparable to natural cover of sand grass on the monitoring sites, the cultivars are one and a half to two times taller than the local native sand grass, creating a persistent change in structure on the reclaiming RoW.

The seeded June grass cultivar *Prairie Seeds* established a relatively consistent long term cover of about 2% compared to natural cover levels of about 4%.

Green needle grass cover increased slowly over the first five years to 4.9% cover in 2001. Seeded cover levels were 3.8% in 2010, much higher than the natural average cover of 0.4%. The green needle grass cultivar from Blight in Manitoba (*Lodorm* cultivar originating from North Dakota) is also taller and more robust than the local native species, creating persistent differences in the structure as well as the composition of the plant community on the RoW relative to the undisturbed surrounding rangeland.

Non-native sheep fescue established slowly over the first three years, providing two or less percent cover on the RoW. By year five cover values increased to an average of 5.5% cover and by year 14 post-seeding it has proliferated to 7.1% average cover. Sheep fescue is present on four of the five monitoring sites.

Another non-native species, Canada bluegrass (*Poa compressa*) was seeded at 7.5% by weight to provide diversity and build up the low to mid-height structural layer in dry, Sandy soils. Initial cover one year after planting was 1.9%. Average cover levels have fluctuated a little since then, with average cover 13 years later at 1.4% on the RoW. It is not present naturally in adjacent rangeland.

6.3 Mixedgrass Seed Mix

Figure 6-3 illustrates the expression and percent cover of seeded species over time on sites seeded to the Mixedgrass seed mix. The cover values are averages of multiple observations from five sites during 1997 to 2001 and seven sites in 2010. The naturally occurring cover of these species on control sites is also shown. Components of the seed mix are presented in Table 6-3.

The major component of the Mixedgrass seed mix is wild harvested rough fescue from two sources. The *Roes* seed was plains rough fescue (*Festuca hallii*), harvested in the Hand Hills in south-central Alberta. The *Petherbridge* seed was harvested on the Milk River Ridge in southwestern Alberta. This seed is more likely to be foothills rough fescue (*Festuca campestris*) although plains rough fescue is known to grow along the eastern edge of the Milk River Ridge. *Roes* plains rough fescue was included in the mix at 7.3% by weight and the *Petherbridge* seed formed 24.6% of the mix by weight. Establishment of rough fescue on the disturbed soils of the RoW was slow initially, with average cover in the first year of 0.8%. Since then, average cover of rough fescue has increased slowly and steadily to 7.2% cover 14 years later, compared to 11.5% average cover on the controls.

Two cultivars of slender wheatgrass, *Revenue* and *Adanac*, formed 5.9% and 7.9% by weight of the seed mix. They provided substantial initial cover in the first three years after seeding, at 6.0%, 9.3% and 8.9% average cover respectively. Cover then declined over time and in 2010 slender wheatgrass was absent on the monitoring sites, compared to 0.1% natural cover on the controls.

The cover of northern wheatgrass and streambank wheatgrass, seeded at 6.5% and 16.3% by weight respectively, builds steadily over the first five years to an average cover of 11.7% in 2001. After 14 years, average cover values are the same as the controls, at 5.1%.

Western wheatgrass, seeded at 9.3% by weight, established slowly at first, then provided about 3% cover in years three and five. By year 14 however, it provides significantly more cover than the controls. Average cover on the control sites is 1.3% versus 9.4% on the RoW. The wheatgrasses on the RoW were taller than naturally occurring plants in the pastures in 2010.

Wild harvested June grass *Gillespie,* harvested in Special Areas, formed 2.2% of the seed mix by weight. This seed performed well, reaching average cover values of about 3.5% by the third year. The average natural cover of June grass on the controls is 4.2%.

Green needle grass is only present at low cover levels on the native rangeland controls (average 0.5% cover) and was only observed on 17% of the sample sites. Seeded green needle grass from Blight in Manitoba (*Lodorm* cultivar originating from North Dakota) increased in cover on disturbed soils to a high value of 8.2% average cover in 2001. Cover values decreased to 5.7% cover in 2010 but are still significantly higher than naturally occurring levels. This grass cultivar is taller than the surrounding vegetation, creating persistent differences in the structure as well as the composition of the plant community on the RoW relative to the undisturbed surrounding rangeland.

Indian rice grass was included in this mix at 9.7% by weight, presumably to provide initial cover since it is not found naturally in Loamy and Limy Mixedgrass rangeland. It did not do well, providing an average cover of 1.2% in year one and never reaching more than 1.9% cover. It was not observed in 2010.

6.4 Mixedgrass Seed Mix 2 : Rough Fescue : Needle-&-Thread 5:6:6

The results of these trials are not clear. Sampling indicates the presence of sheep fescue and alkali bluegrass on the RoW although none was present in Seed Mix 2. There is some question as to whether Seed Mix 4 was blended with the rough fescue: needle-and-thread mix. There is no rough fescue either on or off RoW (Figure 6-4, Table 6-3). Needle-and-thread is present on the recovering RoW (average cover 2.2%) and on control sites (average cover 3.4%) although ecological range site conditions favour western porcupine grass, which is prominent naturally on control sites at an average of 19.7% cover. Western porcupine grass established naturally on disturbed soils.

6.5 Mixedgrass Seed Trial 100% Rough Fescue

Three trial sites in the Cypress Hills were seeded to 100% wild harvested rough fescue; a combination of the *Roes* seed and the *Petherbridge* seed. Figure 6-5 illustrates the establishment of rough fescue on the disturbed soils of the RoW. The contributions of seven other species providing the most cover on the control sites are also illustrated. Two of the trial sites (sites 53 and 57) are situated in a reference rangeland community, Plains Rough Fescue – Western Porcupine Grass (MGA1). One site (site 56) is situated in an early to mid-seral Needle-and-thread – June grass community (MGA3) influenced by grazing. This plant community is successional to the MGA1 community and so has the potential to support plains rough fescue naturally.

Rough fescue was not observed on the disturbed soils in the first growing season. It was observed at 1.0% average cover in the second and third year and 2.0% average cover the fifth year. By the 14th year, cover of rough fescue expanded significantly to 12.5% average cover (varying between 8.0% and 19.5% cover on individual sites). Cover on the controls averaged 22.9%.

6.6 Parkland Seed Mix

Figure 6-6 illustrates the expression and percent cover of seeded species over time on two sites seeded to the parkland seed mix (Seed Mix 1). Components of the seed mix are presented in Table 6-4. Both these sites are influenced by heavy grazing and historic drought.

Roes plains rough fescue seed, wild harvested in the Hand Hills in south-central Alberta, was included in the seed mix at 32.8% by weight. It was observed on the revegetating RoW in trace quantities in the first five years after seeding, but was not observed in 2010. It is present on the controls at an average cover of 9.5%.

Two cultivars of slender wheatgrass, *Revenue* and *Adanac*, formed 4.4% and 6.0% by weight of the seed mix. They provided substantial cover between years two and five after seeding, at 19.1% in year two, 22.2% in year three and 18.3% average cover in year five. Cover then declined over time and in 2010 slender wheatgrass provides 0.5% cover, which is comparable to 0.3% natural cover on the controls.

Northern wheatgrass (including streambank wheatgrass), seeded at 5.1% and 5.8% by weight respectively, provided little cover in 1997 after one year, but climbed to 9.7% cover after five years. By year 14 average cover declined to 3.8% cover, compared to 8.1% cover on controls.

Growth of seeded western wheatgrass on the RoW shows a similar trend to northern and streambank wheatgrass, with average cover increasing over five years to 7.0% in year five. By year 14, average cover levels declined to 4.0%. It was not observed on control sites so is a persistent introduction to the two parkland sites.

Green needle grass seed was sourced from *Newfield Seeds* in Nipawin, in east central Saskatchewan. The origin of the plants is unknown. Green needle grass formed 29.6% by weight of the seed mix. In the first year it provided 1.4% average cover and peaked at 10.6% cover in the second year after planting. Since then average cover values have declined in the monitoring years, to 1.3% cover. It was not observed on the controls in any year.

June grass from *Prairie Seeds* was observed in trace quantities on the reclaiming RoW in years one, two and five. It was not observed in the second year or in 2010. Natural cover of June grass on the controls was 7.8%. This species is an increaser in heavily grazed pastures.

Non-native sheep fescue was seeded in parkland soils at 5.9% by weight. It was not observed on the RoW in year one but established an average cover of 14.0% by year five and 49.0% on site # 2 by year 14. It has also spread off the pipeline RoW into native rangeland. Cover on control site # 2 was 5.7% in 2010.

6.7 Summary – Seeded Species

6.7.1 Dry Mixedgrass Seed Mixes

Cultivars

- In the Dry Mixedgrass, slender wheatgrass and northern wheatgrass behaved as transition species, establishing in the early years and providing initial cover to stabilize soils, build litter and shelter other seedlings. Both species are diminishing with time to near natural cover levels.
- Western wheatgrass established early but cover has slowly increased over the 14 years. Western wheatgrass persists at greater cover than on the controls.
- Seeded June grass developed a persistent but low cover in the earlier years which has not changed much over time. This species is beneficial for rebuilding diversity and the mid structural layer and is resilient to grazing.
- Green needle grass cover increased steadily over five years in both the Sandy and Solonetzic seed mixes. By year 14, cover levels have declined on Solonetzic sites. However, on Sandy soils, green needle grass cultivars persist at cover levels that are significantly higher than on control sites resulting in higher structure than found on the controls.
- Sand grass (sand reed grass) cultivars developed average cover levels comparable to controls, but their large size creates a persistent increase in structure on the reclaiming RoW relative to the controls.
- Non-native sheep fescue is invasive, increasing in cover slowly but steadily on both healthy and unhealthy rangeland. Sheep fescue may contribute to plant community modification over time.
- A few seeded species did not contribute much cover to the resulting pioneer or successional plant communities. They are alkali bluegrass, Indian rice grass and the non-native species Canada bluegrass.
- After 14 years, persistent cultivars that are still expanding or maintaining relative cover beyond control levels are influencing the trajectory of plant community succession. For instance, a Northern Wheatgrass - Green Needle Grass - Western Wheatgrass community on Dry Mixedgrass Loamy sites and trending to modified communities dominated by sheep fescue.

6.7.2 Mixedgrass Seed Mixes

Wild Harvested Seed

- Establishment of wild harvested rough fescue from two sources (plains rough fescue from *Roes* and likely foothills rough fescue from *Petherbridge*) was very slow initially, but the average cover has increased slowly and steadily on ecological range sites with potential to support rough fescue. Fourteen years after seeding, average cover values of rough fescue on the seeded RoW are more than 50% of the average cover values on the controls.
- Wild harvested June grass performed well, reaching average cover values close to those of the controls by the third year. It performed comparatively better than the June grass cultivar used in the Dry Mixedgrass seed mix.

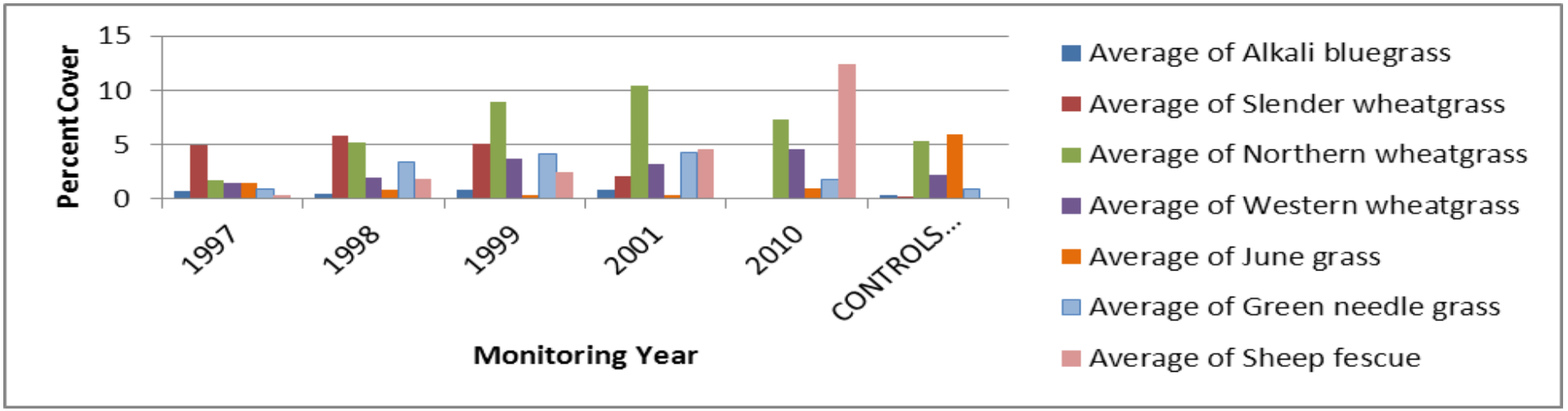
Cultivars

- Similarly to the Dry Mixedgrass seed mixes, the two slender wheatgrass cultivars, *Revenue* and *Adanac*, provided good pioneer and early seral cover and disappeared from the plant community by after 14 years.
- Northern wheatgrass and streambank wheatgrass provided good cover during the first five years and have since declined to comparable average cover values to the controls. The seeded cultivars are more robust and taller than their natural counterparts.
- Western wheatgrass established early but has slowly increased over the 14 years and persists at seven fold higher cover than on the controls.
- Green needle grass is only present at low cover levels on a limited number of the native rangeland controls. The seeded cultivar provided good cover during the first five years, but is persisting well beyond natural cover levels (19 fold more) after 14 years. This grass cultivar is taller and more robust than the surrounding native vegetation, creating persistent taller structure and differences in composition of the successional plant community.
- After 14 years, persistent cultivars which are still expanding or maintaining relative cover beyond levels on the controls are influencing the trajectory of plant community succession, for instance, a mid-seral Green Needle Grass - Northern Wheatgrass - June Grass community on Mixedgrass Limy sites (Figure 8-4) and a mid-seral Northern Wheatgrass - Western Wheatgrass – Needle-and-Thread on Mixedgrass Loamy sites (Figure 8-5).

Table 6-1 Express Seed Mix 4 Dry Mixedgrass Prairie Solonetzic Soils

Species	seeds/g	PLS	est%	PLS/m2	plt/m2	kg/ha	%/wt	total kg
Western wheatgrass	242	92	25	20	5	0.9	7.8	737
Slender wheatgrass *Revenue*	353	83	25	18	5	0.6	5.4	515
Slender wheatgrass *Adanac*	353	86	25	25	6	0.8	7.1	676
Streambank wheatgrass	344	92	25	61	15	1.9	16.7	1589
Northern wheatgrass	345	92	25	24	6	0.8	6.5	620
Green needle grass *(MB)*	398	88	10	40	4	1.1	9.9	937
Green needle grass *(AB)*	398	81	10	40	4	1.2	10.7	1017
Sheep fescue	1498	88	5	200	10	1.5	13.1	1244
June grass *Prairie Seeds*	3300	80	5	200	10	0.8	6.5	621
Alkali bluegrass	2022	53	5	200	10	1.9	16.1	1530
Totals				**829**	**75**	**12**	**100**	**9486**

Figure 6-1 Dry Mixedgrass Solonetzic Soil Seed Mix 4 - Species Cover Over Time

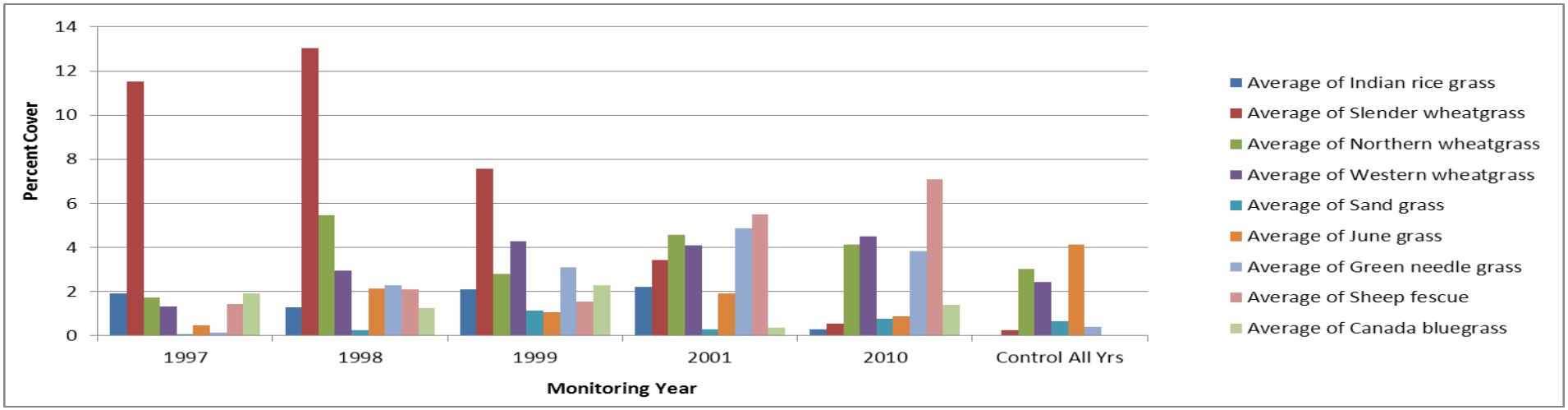


Average % Cover of Seeded Species for all Sites seeded to Mix 4: Sites 7, 8, 12, 14, 15, 18, 28, 29, 33, 34

Table 6-2 Express Seed Mix 3 Dry Mixedgrass Prairie Sandy Soils

Species	seeds/g	PLS	est%	PLS/m2	plt/m2	kg/ha	%/wt	total kg
Streambank wheatgrass	344	92	25	26	6	0.8	5.4	324
Northern wheatgrass	345	92	25	24	6	0.8	5.1	302
Western wheatgrass	242	92	25	24	6	1.1	7.2	431
Slender wheatgrass *Revenue*	353	83	25	16	4	0.5	3.7	218
Slender wheatgrass *Adanac*	353	85	25	24	6	0.8	5.3	316
Prairie sand reed *ND95*	603	61	10	42	4	1.1	7.6	455
Prairie sand reed *Goshen*	603	82	10	34	3	0.7	4.6	277
Green needle grass *Blight*	398	88	10	40	4	1.1	7.7	457
Indian rice grass	518	86	10	200	20	4.5	30.1	1796
Sheep fescue	1498	88	5	200	10	1.5	10.2	607
Canada bluegrass	5555	80	2	500	10	1.1	7.5	450
June grass *Prairie Seeds*	3300	80	5	221	11	0.8	5.6	335
Totals				**1351**	**91**	**15**	**100**	**5,968**

Figure 6-2 Dry Mixedgrass Sandy Soil Seed Mix 3 - Species Cover Over Time

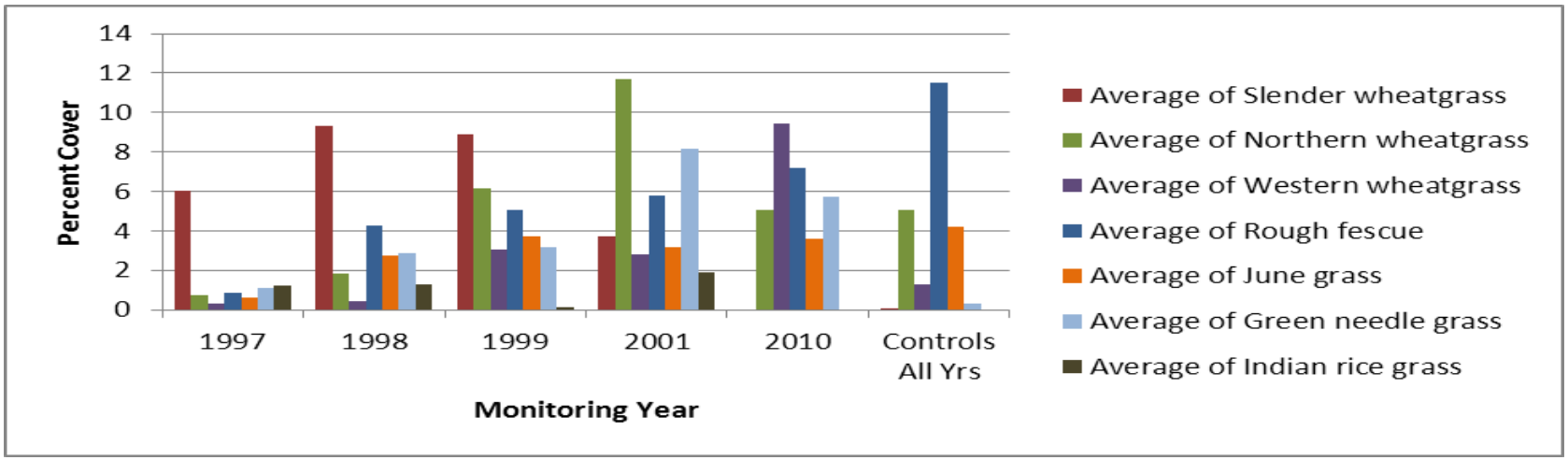


Average % Cover of Seeded Species for all Sites Seeded to this Mix: Sites #s 6, 11, 13, 16, 35

Table 6-3 Express Seed Mix 2 Rough Fescue - Mixedgrass Transition Prairie

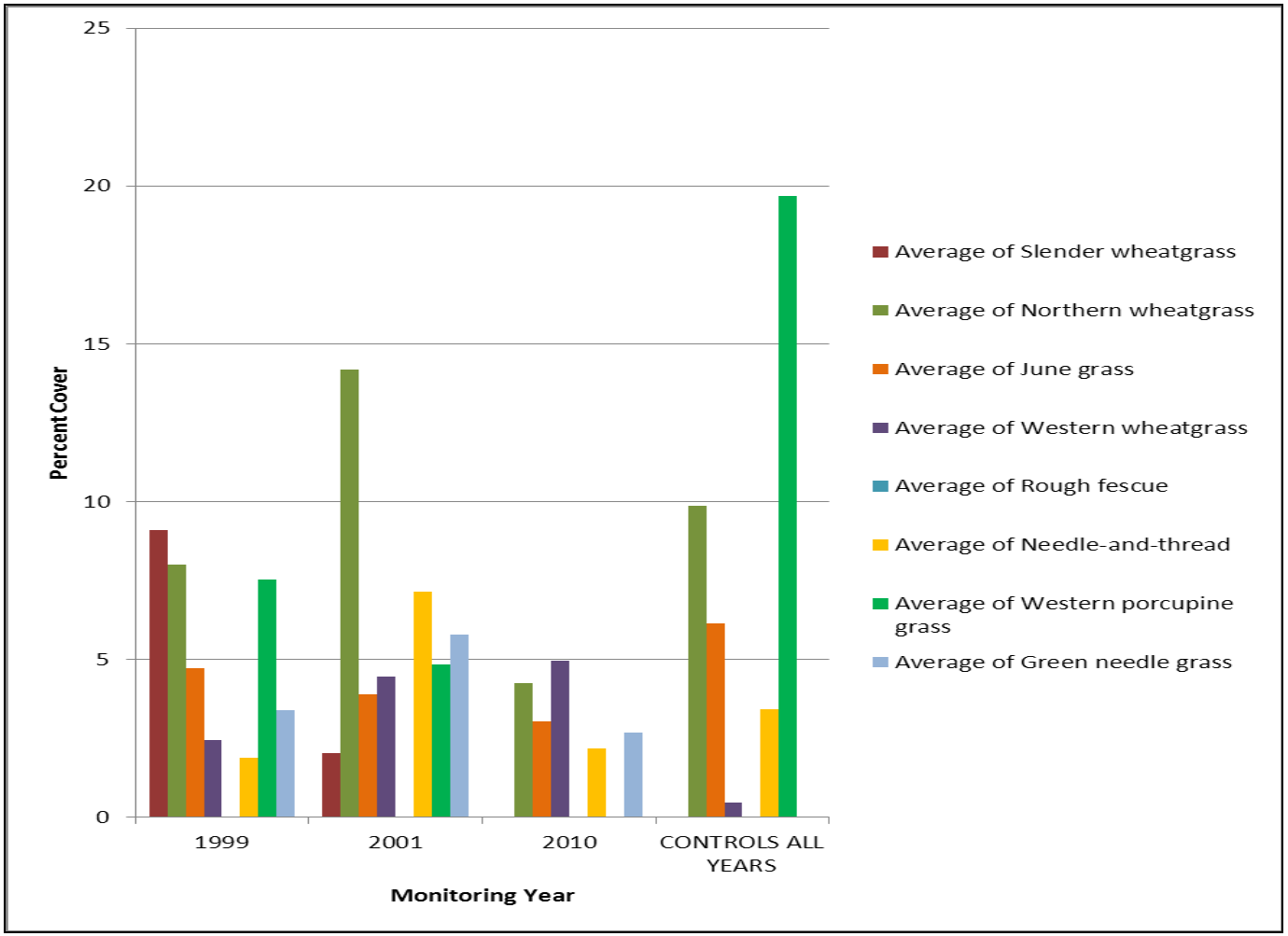
Species	seeds/g	PLS	est%	PLS/m2	plt/m2	kg/ha	%/wt	total kg
Streambank wheatgrass	344	92	25	60	15	1.9	16.3	664
Northern wheatgrass	345	92	25	24	6	0.8	6.5	265
Western wheatgrass	242	92	25	24	6	1.1	9.3	377
Slender wheatgrass *Revenue*	353	83	25	20	5	0.7	5.9	239
Slender wheatgrass *Adanac*	353	86	25	28	7	0.9	7.9	323
Green needle grass *Blight*	398	88	10	43	4	1.2	10.4	425
Indian rice grass	518	86	10	50	5	1.1	9.7	393
June grass *Gillespie*	3300	84	10	71	7	0.3	2.2	89
Plains rough fescue *Roes*	386	77	10	25	3	0.8	7.3	296
Rough fescue *Petherbridge*	386	77	10	85	8	2.9	24.6	1000
Totals				**429**	**66**	**12**	**100**	**4,069**

Figure 6-3 Mixedgrass Seed Mix 2 - Species Cover Over Time



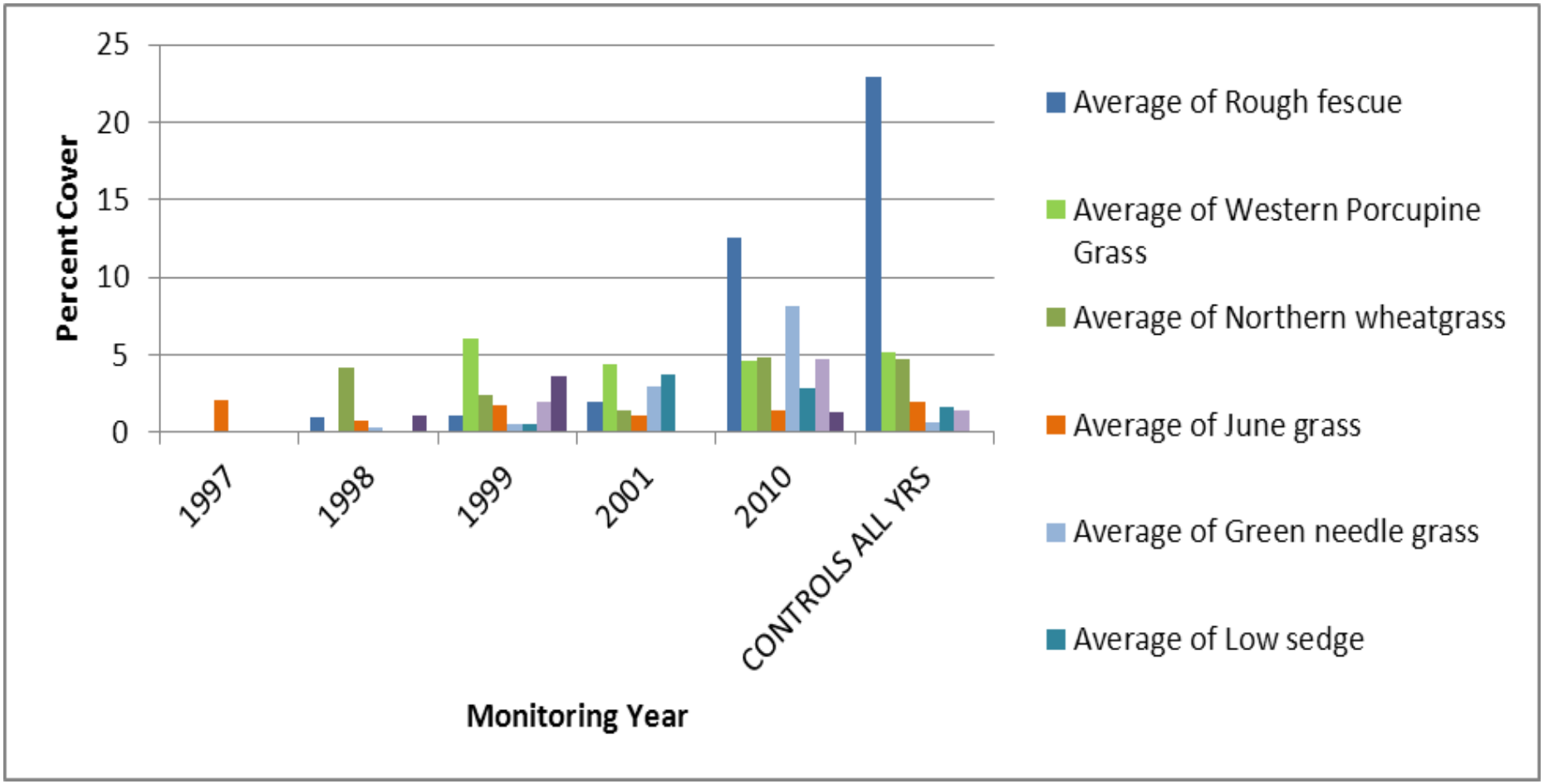
Average % Cover of Seeded Species for all Sites Seeded to Mix 4: Sites #s 4, 21, 22, 23, 25

Figure 6-4 Seed Mix 2* +Rough Fescue+Needle-and-thread 5:6:6 – Species Cover Over Time



No rough fescue or Indian rice grass was observed on or off RoW for sites 54 and 55 (western porcupine grass is from seed bank).
5 kgs per ha Seed Mix 2 drill seeded; and then broadcast seeding of rough fescue 6 kgs per ha and needle-and-thread 6 kgs per ha and then accurolled.
* See Table 6-3 for a list of seeded species

Figure 6-5 Seed Trial – 100% Rough Fescue - Species Cover Over Time

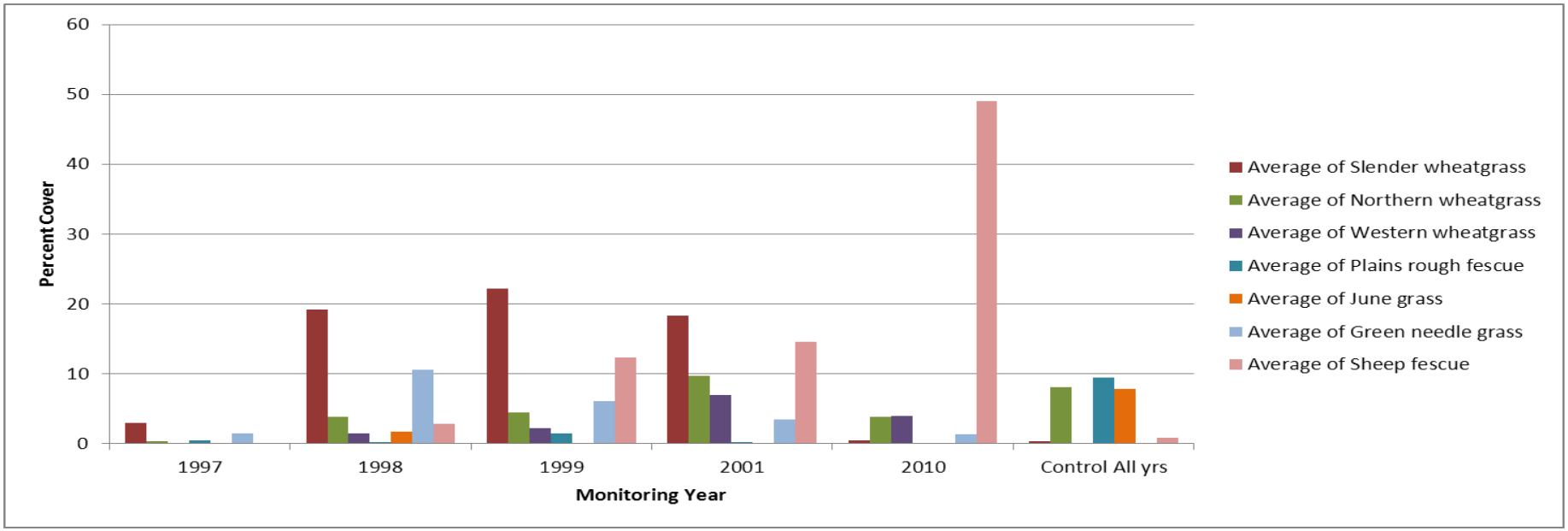


Average % Cover of Seeded Species for site seeded to 100% rough fescue only: Site #s 53, 56, 57
Seeded to wild-harvested rough fescue only; at 12 kgs per ha with Accuroller and straw crimped.

Table 6-4 Express Seed Mix 1 Aspen Parkland

Species	seeds/g	PLS	est%	PLS/m2	plt/m2	kg/ha	%/wt	total kg
Streambank wheatgrass	344	92	25	28	7	0.9	5.8	124
Northern wheatgrass	345	97	25	27	7	0.8	5.3	113
Western wheatgrass	242	92	25	20	5	0.9	5.9	126
Slender wheatgrass *Revenue*	353	83	25	20	5	0.7	4.4	96
Slender wheatgrass *Adanac*	353	86	25	28	7	0.9	6	129
Green needle grass *Newfield*	398	95	10	172	17	4.5	29.6	636
June grass *Prairie Seeds*	3300	90	10	200	20	0.7	4.4	94
Sheep fescue	1498	88	5	120	6	0.9	5.9	127
Plains rough fescue *Roes*	386	77	20	150	30	5	32.8	704
Totals				**764**	**104**	**15**	**100**	**2,149**

Figure 6-6 Parkland Seed Mix 1 Species Cover Over Time



Average % Cover of Seeded Species for all Sites Seeded to this Mix: Sites #s 1, 2

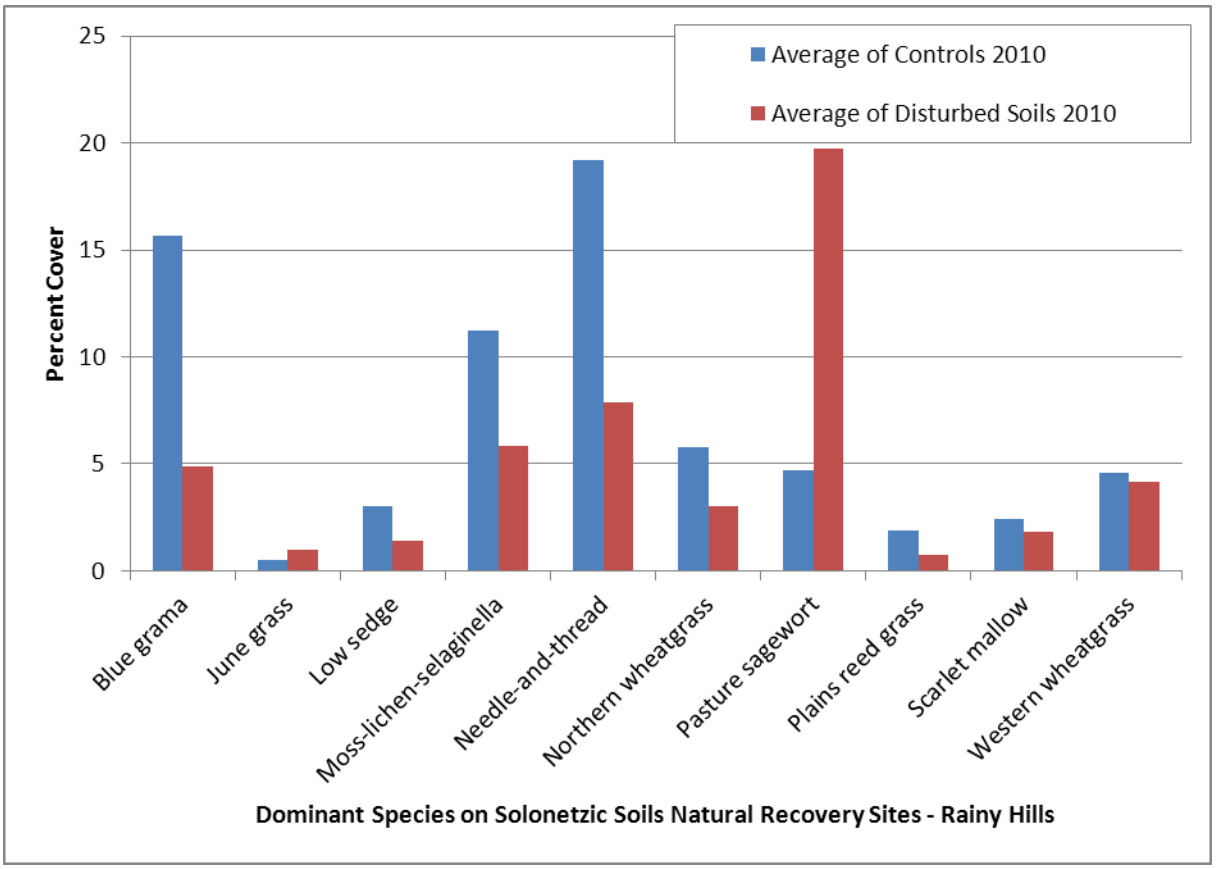
7 VEGETATION ESTABLISHMENT ON NATURAL RECOVERY TRIALS

Natural recovery trials were established at four upland locations on the pipeline RoW, two on Solonetzic soils in the Dry Mixedgrass, one on Sandy soils in the Dry Mixedgrass and one on Loamy soils in the Mixedgrass. Sites were selected on relatively level terrain where site stability due to slopes was not an issue and soil exposure to wind erosion was minimized.

7.1 Dry Mixedgrass Blowout – Solonetzic Soils (Rainy Hills)

Figure 7-1 illustrates the cover of the 10 most common plant species on the controls and the reclaiming RoW in 2010, 13 years after construction. The data is comprised of four monitoring sites on Solonetzic soils in the Rainy Hills (sites 46-49). Final clean-up occurred in June 1997 after fall construction the previous year. There are some notable differences in cover. Blue grama provides three times more cover on the controls compared to the disturbed soils. Needle-and-thread cover on the controls is more than double the cover on the disturbed soils. The disturbance forb pasture sagewort is present on the RoW at four times the cover levels of the controls. The moss-lichen-selaginella groundcover provides double the cover on the controls, but is notably present on the RoW. The other species represented in Figure 7-1 have comparable cover levels between controls and disturbed soils after 13 years recovery.

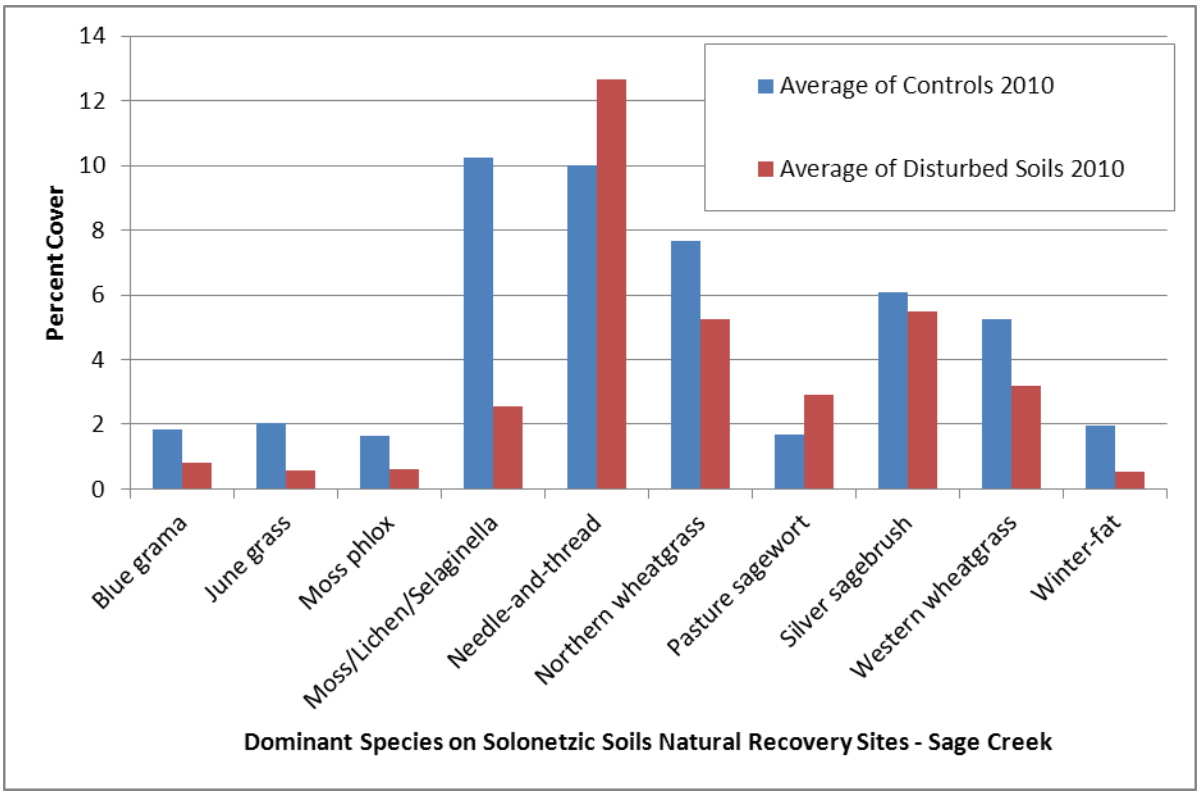
Figure 7-1 Species Cover on Solonetzic Soils Natural Recovery Site in 2010 – Rainy Hills



7.2 Dry Mixedgrass Blowout – Solonetzic Soils (Sage Creek)

Figure 7-2 illustrates the cover of the 10 most common plant species on the controls and the reclaiming RoW in 2010, 14 years after construction. The data is comprised of five monitoring sites on Solonetzic soils in Sage Creek (sites 58-62). Final clean-up occurred in fall of 1996, after construction in September of the same year. The dominant species have comparable levels of cover between the controls and the disturbed soils of the RoW. The exception is the relative cover of the groundcover layer of moss, lichen and prairie selaginella, which is much lower on the disturbance.

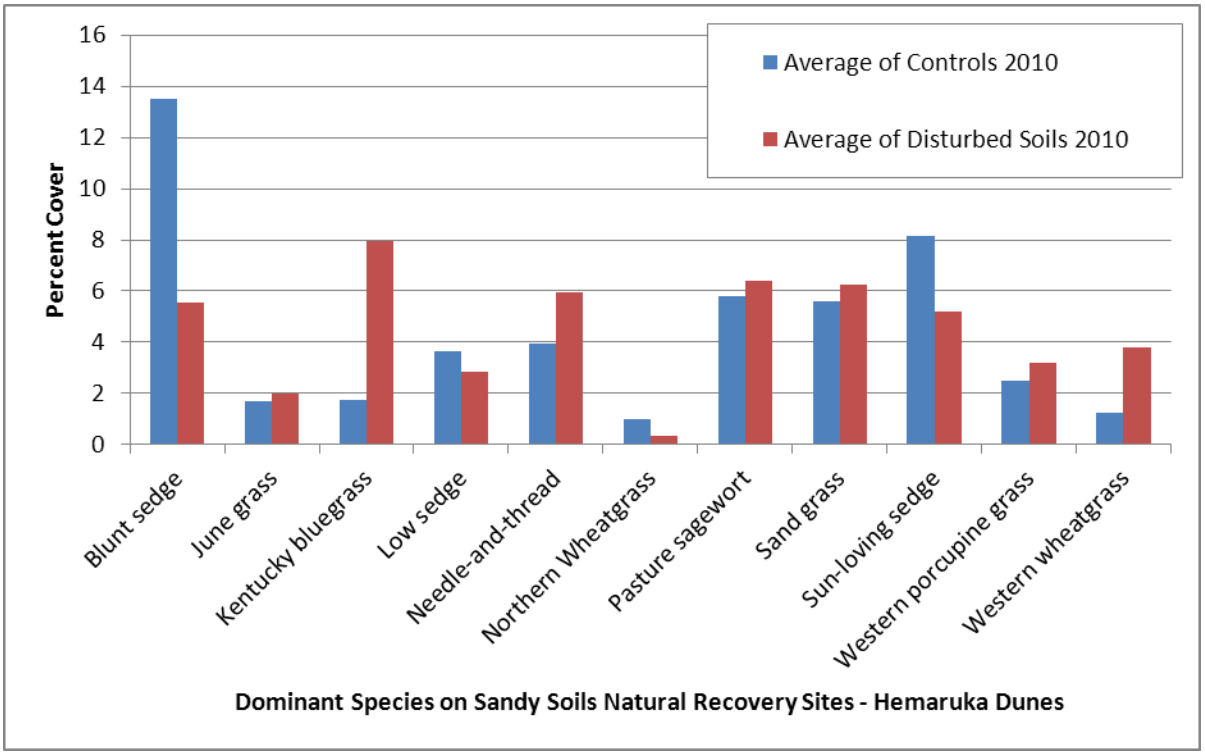
Figure 7-2 Species Cover on Solonetzic Soils Natural Recovery Site in 2010 – Sage Creek



7.3 Dry Mixedgrass Sandy Soils (Hemaruka Dunes)

Figure 7-3 illustrates the cover of the 11 most common plant species on the controls and the reclaiming RoW in 2010. The data is comprised of six monitoring sites on sandy soils in the Hemaruka Dunes (sites 40-45). Composition and cover are very similar between disturbed and undisturbed soils with the exception of two grazing increaser species. Blunt sedge (*Carex obtusata*) is dominant on the controls and Kentucky bluegrass (*Poa pratensis*), an introduced rhizomatous species, is dominant on the disturbed soils.

Figure 7-3 Species Cover on Sandy Soils Natural Recovery Site in 2010 – Hemaruka Dunes

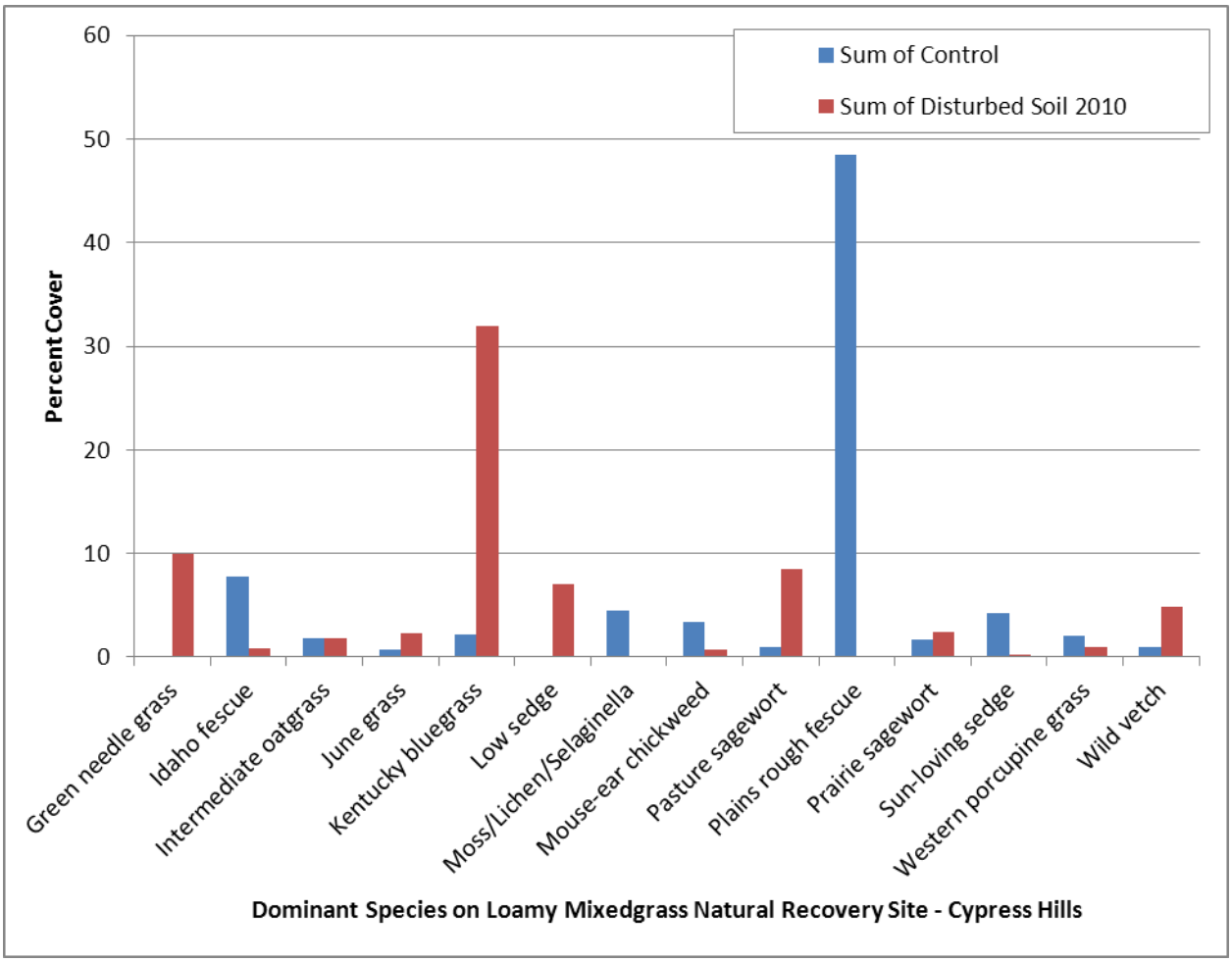


7.4 Mixedgrass Loamy Soils (Cypress Hills)

Due to concerns about the ability of desirable colonizing species to establish quickly enough to control erosion and the risk of invasive non-native species establishing on Loamy Mixedgrass soils in the Cypress Hills, only one site was left to recover naturally (site 57). The site was straw crimped in the fall of 1996. Figure 7-4 illustrates the cover of the most common species on the controls and on the recovering RoW in 2010, 14 years later. Figure 7-4 illustrates the composition of the control and the revegetating RoW. The relative cover of species on and off the disturbance is different for many species. The biggest differences are the lack of rough fescue cover on the RoW compared to 48.5% cover off RoW and the presence of Kentucky bluegrass at 32% cover on the disturbed soils compared to 2.2% cover on the controls. Other prominent increasers on the RoW are low sedge and pasture sagewort.

This site is summer grazed and is close to a cattle trail across the top of a butte. Cows camped on the RoW in the first few years after construction and grazing pressure on the reclaiming RoW was heavy during the summers.

Figure 7-4 Species Cover on Loamy Mixedgrass Natural Recovery Site in 2010 – Cypress Hills



7.5 Discussion – Natural Recovery

In the long term, native plant species established on all the natural recovery sites. Cultivars are absent from the plant communities establishing on the disturbed topsoils, which results in better potential to match adjacent undisturbed communities in terms of composition and the structural characteristics of local plants. The 10 to 14 species that provide the most cover on the controls are also represented on the disturbed soils for Dry Mixedgrass sites (Figures 7-1, 7-2 and 7-3). On all Dry Mixedgrass sites there was significant establishment of needle grasses and wheatgrasses that are dominant in the reference plant community state.

The Mixedgrass site had less consistency between the most prominent species on the disturbance and on the controls (Figure 7-4). Natural recovery was problematic on the Mixedgrass plains rough fescue site. Exposed topsoil remained relatively bare for the first three years, lacking the flush of colonizing annuals typical of Dry Mixedgrass sites. After 14 years, plains rough fescue is notably absent from the plant community. Although diverse, the plant community does not reflect the proportional cover of species in the reference plant community. This result highlights the additional challenge of re-establishing rough fescue on disturbed topsoils.

Timing of topsoil replacement is an important factor in the outcome of the natural recovery trials. The best results in terms of reflecting the composition and cover levels of the surrounding undisturbed prairie were on Dry Mixedgrass sites where soils were replaced before the following growing season. The cover of key species for the Dry Mixedgrass, blue grama and needle-and-thread, were greatly reduced on the Rainy Hills sites where topsoils were stored through the winter and re-handled once conditions were dry enough in late spring.

There was an increase of undesirable non-native Kentucky bluegrass at the two sites where it was present on the controls. This species is able to capitalize on disturbances and expand cover when it is present in undisturbed grasslands.

The timing and duration of livestock grazing can also affect the success of natural recovery, particularly in plains rough fescue plant communities. Summer grazing has detrimental effects on seedling survival.

8 PLANT COMMUNITY SUCCESSION ON RECLAIMING DISTURBANCES

For the analysis of succession, sites were grouped by Natural Subregion (NSR) and ecological range site (ERS) and the succession of natural recovery and seeded treatments are compared within these similar climate / physiography / soils units. Dry Mixedgrass Loamy and Blowout / Solonetzic ERS groups and the Mixedgrass Limy and Loamy ERS groups had enough samples to be included in the analysis.

A number of successional plant communities were differentiated within each group. Reclaiming sites are generally progressing from early to late seral communities (see Table 5-1 for definitions of seral stages) with successional progress variously influenced by range health, non-native perennial species and climate. Almost none of the monitored sites are equivalent in composition, structure or range health to the offsite control areas or to reference sites described in the Range Plant Community Guides (Adams et al. 2004, Adams et al. 2005), although many are trending in this direction.

The accompanying figures illustrate the observations that clustered together based on similarities in species composition (an observation is the data from one site in a particular year (e.g. site 6 in 1999)). The plant community was named based on the species that were present most frequently and provided the most cover. The "Group Number" associated with each plant community references a more detailed description of the community found in Appendix C. At the base of each column in the figures are two measures of species diversity, species richness and Shannon's diversity indices (for more detail see Appendix C).

8.1 Dry Mixedgrass – Blowouts/Solonetzic Ecological Range Sites

Figure 8-1 shows the plant communities that developed over time on both seeded and unseeded Solonetzic range sites in the Dry Mixedgrass.

There are four pioneer communities, three dominated by annual weeds including knotweed, summer cypress and lamb's quarters. These communities were observed on both seeded and unseeded sites, primarily in the first three years after disturbance. A fourth pioneer plant community, found only on seeded sites, is dominated by slender wheatgrass, a seeded colonizing grass. The number of years each site remains in a pioneer state depends on climate, the presence of invasive species, grazing pressure, and the health of the surrounding rangeland. Seeded sites remained in a pioneer stage for one to three years, unseeded sites one to four years.

Two early seral plant communities were identified on Solonetzic Dry Mixedgrass range sites. Both are dominated by the native perennial disturbance forb, pasture sagewort, and the colonizing native perennial grass, needle-and-thread. One community included all the seeded sites. A second community, in which June grass was also prominent, included only unseeded natural recovery sites. Most of the reclaiming plant communities remained in an early successional state for two to five years after disturbance.

Two sites clustered into a late mid-seral Needle-and-Thread - Pasture Sagewort - Northern Wheatgrass community. The cover of grasses is greater than that of disturbance forbs such as the sageworts; and decreaser grasses are present as a small component of the cover.

Late seral plant communities are characterized by a dominance of decreaser grasses, the presence of infill species and no more than one structural layer missing. Two late seral communities were identified; a Western Porcupine Grass - Western Wheatgrass - Pasture Sagewort community is linked to seeded sites in the cooler moister region on the north end of the Dry Mixedgrass Natural Subregion. Seed mix species, including western wheatgrass, June grass, northern wheatgrass and sheep fescue are still prominent in this community. A second community of Western Wheatgrass – Pasture Sage is found primarily on unseeded sites in later years.

The use of non-native sheep fescue in the seed mixes is resulting in the expansion of this undesirable non-native species. As this species has continued to expand on many sites, the essential character of the community is moving towards a modified non-native state.

Two plant communities were identified as primarily native plant communities where non-native sheep fescue from the seed mix is increasing in the longer term. This trend was not evident at year five, but is at year 14 after disturbance. Average cover values for sheep fescue for Groups 6 and 7 are 18.4% cover (five observations) and 8% cover (three observations). The successional state of these revegetating communities is described as "trending to modified" with non-native species increasing over time and occupying > 5% of the total live cover. The succession time scale to this state is as little as five years and as many as 20 years or more. The inclusion of sheep fescue in the seed mix has changed the successional pathway of this reclaiming grassland community.

After 14 years of growth, the successional status of six seeded sites monitored in the Dry Mixedgrass Solonetzic soils are as follows;

Early seral	1 site
Late seral	1 site
Trending to modified	4 sites

Of the five unseeded natural recovery sites, two remain early seral plant communities and three are late seral plant communities in 2010. One unstripped spoil storage area was monitored in 2010. It is a late mid-seral plant community.

8.2 Dry Mixedgrass – Loamy Ecological Range Sites

Figure 8-2 shows the plant communities that developed over time on both seeded and unseeded Loamy range sites in the Dry Mixedgrass.

There are two pioneer communities, both of which are comprised of seeded sites in the first years post-disturbance. One community has seeded slender wheatgrass as the dominant colonizing species and the other has an annual introduced forb, summer cypress, establishing as the dominant cover. All the natural recovery sites on Loamy soils, including unstripped spoil storage areas and disturbed soils, begin their recovery at the early seral stage, rather than reverting to a pioneer stage.

The three early seral plant communities are dominated by unseeded native species. Seeded sites are associated with two communities, one of which is dominated by pasture sagewort and the other by low sedge. Natural recovery sites in the Sage Creek area are dominated by a native early seral plant community of Narrow-Leaved Goosefoot - Pasture Sagewort - Northern Wheatgrass, species which are likely present in the seed bank, either as seed (goosefoot species, etc.) or as root fragments which will have survived the short-term disturbance to topsoil. These early seral plant communities are prevalent between one and three years post-disturbance.

The cluster analysis indicates two mid-seral plant communities present on seeded sites, mostly between two and five years after topsoil disturbance. One community is comprised primarily of seeded species; Northern Wheatgrass - Green Needle Grass - Western Wheatgrass. In the other mid-seral community, infill of nonseeded colonizing grass species from the seed bank produce a plant community dominated by needle-and-thread and pasture sagewort, as well as seeded green needle grass. These mid-seral communities are prevalent between two and three years after disturbance, but linger in some cases for five to 14 years.

Most unseeded sites progressed directly from early seral to late mid-seral plant communities. Two of the three sites where spoil was stored directly on the grass begin their recovery at the late mid-seral successional stage. The two plant communities identified by the cluster analysis are; June Grass - Pasture Sagewort - Northern Wheatgrass; and Needle-and-Thread Grass - Pasture Sagewort.

After 14 years of growth, the successional status of seven seeded sites monitored in Dry Mixedgrass Loamy soils are as follows;

Early seral	1 site	- after 10 years (reseeded in 2004)
Mid-seral	3 sites	- one after 10 years (reseeded in 2004) and two after 14 years
Late mid-seral	1 site	- after 14 years
Trending to modified	2 sites	- one after 10 years (reseeded in 2004)) and one after 14 years

The six unseeded sites (including three unstripped spoil storage sites and three natural recovery sites) were all at a late mid-seral successional stage by year five. Only three of these sites were monitored in 2010.

8.3 Dry Mixedgrass – Sandy Ecological Range Sites

Figure 8-3 shows the plant communities that developed over time on six unseeded natural recovery sites on disturbed topsoils (sites 40N – 45N) and an unstripped travel lane (site 5T) in Sandy range sites as identified by GVI. No sites seeded to the Dry Mixedgrass Sandy soil mix occur in mapped Sandy ecological range sites at the scale of GVI mapping. The first two years of data collection on four of the six natural recovery sites was also not used.

The unstripped travel lane site is a heavily grazed pasture and the plant community (Buckbrush – Sun-Loving Sedge - Pasture Sagewort) remains as a mid-seral plant community dominated by increaser species during all of the monitoring years.

The six natural recovery sites of the Hemaruka Dunes progress from pioneer plant communities in the first year or two to early seral and late seral communities in the third year.

The pioneer community is dominated by an exotic annual weed, lamb's quarters, and rhizomatous native perennials.

The early seral community is dominated by an introduced annual mustard. The native perennial grass western porcupine grass and pasture sagewort are establishing on the RoW. The late seral plant communities are characterized by the dominance of Western Porcupine Grass - Pasture Sagewort - Sand Grass or an association of Needle-and-Thread - Blunt Sedge - Sand grass.

By year five all of the sites have developed to late seral plant communities dominated by needle-and-thread or western porcupine grass. One site (40N) is clustering with a mid-seral plant community, but this is likely due to the high cover of buckbrush on this site.

Figure 8-1 Plant Community Succession on Dry Mixedgrass Solonetzic Ecological Range Sites

		Pioneer			→	Early Seral	→	Mid-seral	Late Mid-seral	Late Seral	→	Trending to Modified	
**	Site # *	*Group 8: Slender Wheatgrass-Northern Wheatgrass-Pasture Sagewort*	*Group 9: Common Knotweed - Pasture Sagewort - Slender Wheatgrass*	*Group 10: Nuttall's Atriplex / Knotweed sp.- Pasture Sagewort*	*Group 11: Summer Cypress-Lamb's quarters-Slender Wheatgrass*	*Group 12: Pasture Sagewort-Needle-and-Thread Grass*	*Group 3: Pasture Sagewort-Needle-and-Thread Grass - June Grass*	*Group 4: Northern Wheatgrass-Pasture Sagewort-Western Wheatgrass*	*Group 5: Needle-and-Thread Grass - Pasture Sagewort-Northern Wheatgrass*	*Group 1: Western Porcupine Grass - Western Wheatgrass - Pasture Sagewort*	*Group 2: Western Wheatgrass -Pasture Sagewort*	*Group 7: Sheep Fescue - Northern Wheatgrass –Pasture Sagewort /Moss and Lichens*	*Group 6 - Sheep Fescue-Pasture Sagewort-Northern Wheatgrass*
Seeded Sites (yr)	6D	97, 98								99, '01			10
	7D		97		98, 99	10					01		
	8D	97, 99				98				10		01	
	28D	97										98, 10	99, '01
	29D	97				98		99, 01					10
	34D					98, 99			97, 01				10
Unseeded Sites (yr)	30N		01	97, 98		99					10		
	9S				97			98	99, 01, 10				
	27S						97, 98, 99, 01						
	32T						99, '01	97, 98					
	46N					98, 99, '01, 10							
	47N					98, 99, '01					10		
	48N					99, '01	98, 10						
	49N					98, 99, '01					10		
Diversity Index		2.07	1.88	1.09	1.92	1.62	2.19	1.79	1.85	2.53	2.11	2.07	1.94
Average Richness		16.0	14.0	9.5	16.3	12.4	14.2	12.6	11.6	21.0	15.5	18.0	14.8

* Site Number Modifiers: D=disturbed topsoil, N=natural recovery site, S=unstripped spoil storage area, T=unstripped travel lane

** The observation year is recorded for the plant community at each site

Figure 8-2 Plant Community Succession on Dry Mixedgrass Loamy Ecological Range Sites

		Pioneer →		Early Seral →			Mid-seral →		Late Mid-seral →		Late Seral	Trending to Modified
***	Site # **	Group 5: Summer Cypress-Slender Wheatgrass	Group 3: Slender Wheatgrass - Western Wheatgrass - Northern Wheatgrass	Group 4: Low Sedge -Pasture Sagewort	Group 6: Pasture Sagewort - Northern Wheatgrass	Group 8: Narrow-lved Goosefoot - Pasture Sagewort - Northern Wheatgrass	Group 2: Northern Wheatgrass - Green Needle grass - Western Wheatgrass	Group 11: Needle-and-Thread Grass - Green Needle Grass - Pasture Sagewort	Group 7: June Grass - Pasture Sagewort - Northern Wheatgrass	Group 9: Needle-and-Thread grass - Pasture Sagewort	Group 10: Needle-and-Thread grass - Northern Wheatgrass	Group 1: Sheep Fescue - Northern Wheatgrass
Seeded Sites (yr)	10D											10
	11D			97	98, 99			10*		01		
	12D		97		10*		98, 99, 01					
	13D		97, 99				98, 10					01
	14D	97, 98					99, 01, 10					
	15D		97					98, 99			01	10*
	35D		97					98, 99		10		01
Unseeded Sites (yr)	10S			97, 98, 99						01, 10		
	31S								97		98, 99, 01	
	36S								97, 98	99, 01		
	60N					98		99		01, 10		
	61N					98, 99					01, 10	
	63N				97, 99	98				01		
Diversity Index		0.72	1.43	1.67	1.98	1.99	1.87	2.07	2.14	1.75	1.68	1.55
Average Richness		4.5	9.4	13.2	14.2	11.5	12.2	15.5	14.3	13.0	10.5	9.5

* Reseeded in 2004

** Site Number Modifiers: D=disturbed soil, N=natural recovery site, S=unstripped spoil storage area

*** The observation year is recorded for the plant community at each site

Figure 8-3 Plant Community Succession on Dry Mixedgrass Sandy Ecological Range Sites

		Pioneer	Early Seral	Mid-seral	Late Seral →		
***	Site# *	Group 4: Prairie Rose - Lamb's Quarters - Prairie Sagewort	Group 6: Tansy Mustard - Western Porcupine Grass - Pasture Sagewort	Group 1: Buckbrush - Sun-Loving Sedge - Pasture Sagewort	Group 5: Western Porcupine Grass - Pasture Sagewort - Sand Grass	Group 2: Needle-and-Thread - Pasture Sagewort - Kentucky Bluegrass	Group 3: Needle-and-Thread - Blunt Sedge - Sand Grass
Unseeded Sites (yr) **	5T			97, 98, 99, 01, 10			
	40N			10	98, 99, 01		
	41N				98, 99, 01	10	
	42N				01		98, 99, 10
	43N				01		98, 99, 10
	44N	97	99		01	98, 10	
	45N	97, 98	99		01	10	
Diversity Index		1.14	2.06	1.98	1.95	2.36	2.37
Avg. Richness		11.0	17.0	18.2	16.0	18.5	22.7

* Site Number Modifiers: N=natural recovery site, T=unstripped travel lane

** The observation year is recorded for the plant community at each site

8.4 Mixedgrass – Limy Ecological Range Sites

Figure 8-4 illustrates the progress of revegetation on four seeded sites and one unstripped spoil storage area on Limy range sites in the Cypress Hills. All the seed mixes included at least 31.9% by weight rough fescue (Seed Mix 2). The seed mix for site 23 was Seed Mix 2; the mix to site 54 included 50% of Seed Mix 2 plus 25% needle-and-thread and 25% wild harvested rough fescue. The seed mix for site 57 was 100% wild harvested rough fescue. There is some uncertainty about the treatment at site 56.

The pioneer plant community was only distinguished by the common presence of June grass, with a few other species present at low constancy. Less than 10% green cover was present for this group.

An early seral community is characterized by the prominence of pasture sagewort and the establishment of plains rough fescue, northern wheatgrass and trace cover of the needle grasses. A second early seral community developed on the sites seeded to pure rough fescue, dominated by the annual exotic weed common knotweed and the perennial disturbance forb pasture sagewort. Seeded rough fescue is present at 2.3% cover on 75% of the sites. Western porcupine grass and other infill colonizers are establishing from the seedbank.

A mid-seral community comprised primarily of species present in Seed Mix 2 developed between the third and 14th year of growth. Green needle grass, northern wheatgrass, June grass, pasture sagewort and western wheatgrass are prominent.

A late seral community characterized by an average percent cover of 29.7% plains rough fescue was differentiated for the site seeded to 100% plains rough fescue and for an unstripped spoil storage area situated within a Plains Rough Fescue – Western Porcupine Grass – Sedge community (MGA1). The spoil storage area maintained this late seral state from the first year after disturbance, illustrating a definite advantage to not stripping soils where possible. The disturbed and seeded soils site transitioned to this state by 14 years post-construction on healthy rangeland.

After 14 years of growth, the successional status of the four seeded sites in Mixedgrass Limy soils are as follows;

Early seral	1 site
Mid-seral	2 sites
Late seral	1 site

The one unstripped spoil storage area maintained a late seral state.

Figure 8-4 Plant Community Succession on Mixedgrass Limy Ecological Range Sites

		Pioneer	Early Seral →		Mid-seral	Late Seral
**	Site # *	Group 3: June Grass	Group 2: Pasture Sagewort - Plains Rough Fescue - Northern Wheatgrass	Group 4: Common Knotweed - Pasture Sagewort - Western Porcupine Grass	Group 1: Green Needle Grass - Northern Wheatgrass - June Grass	Group 5: Plains Rough Fescue - Western Wheatgrass - Northern Wheatgrass
Seeded Sites (yr)	23D		97, 98, 10		99, 01	
	54D				98, 99, 01, 10	
	56D	97, 98		99, 01	10	
	57D	97	98	99, 01		10
Unseeded Sites (yr)	26S					97, 98, 99, 01, 10
Diversity Index		1.56	2.17	2.19	2.24	1.98
Avg. Richness		9.3	17.5	20.2	16.6	16.2

* Site Number Modifiers: D=disturbed topsoil, S=unstripped spoil storage area
** The observation year is recorded for the plant community at each site

8.5 Mixedgrass – Loamy Ecological Range Sites

Six seeded sites and three unseeded sites are included in the Loamy soils cluster analysis for Mixedgrass Loamy soils. Figure 8-5 illustrates the five plant communities differentiated, their successional status on reclaiming sites and the progression of each site over time.

An early seral community on Loamy sites is characterized by the dominance of the disturbance forb pasture sagewort, the persistence of the colonizing seed mix grass species slender wheatgrass and the low cover of other establishing long-lived native grasses. This plant community persisted for five years on a site subjected to heavy summer grazing on the RoW. It was also found in years two and three on other seeded sites. Plains rough fescue is present at 3.4% cover with a constancy of 71.4%. Western porcupine grass is colonizing from the seedbank.

A mid-seral plant community dominated by wheatgrass species and desirable decreasers at low cover values developed in years three through 14 on seeded sites and in years one through five on an unstripped spoil storage area. A second mid-seral plant community is identified in monitoring years five and 14 on both a seeded site and an unseeded natural recovery site where Kentucky bluegrass is dominant. This invasive exotic grass is present on the undisturbed controls. Expression of Kentucky bluegrass in the stand is expected to vary with moisture but should not take over as long as the range stays in healthy condition.

An unstripped travel lane on Loamy Mixedgrass soils supports a late mid-seral community of Western Porcupine Grass - Northern Wheatgrass - Wild Vetch for the five year period that it was monitored. One seeded site also supports this plant community after five years of growth.

By year 14, four seeded sites are at a late seral stage, characterized by prominence of the slow to establish decreaser species rough fescue. This group includes observations from three sites seeded to Seed Mix 2, one site seeded to pure rough fescue, and one natural recovery site.

After 14 years of growth, the successional status of seeded sites in Mixedgrass Loamy soils are as follows;

Mid-seral	2 sites
Late seral	4 sites

One unseeded natural recovery site on Loamy soils migrated from a late seral plains rough fescue plant community in 1999 to a mid-seral Kentucky bluegrass community in 2010. Kentucky bluegrass is present as a component of the rough fescue grassland adjacent to the disturbance in proximity to a cattle trail. Cover values of Kentucky bluegrass are typically high in wet years but are reduced in dry years and in pastures with improved range health.

The unstripped spoil storage area did not revert to a pioneer community after disturbance but remained as a mid-seral plant community for five years thereafter. Similarly, an unstripped travel lane remained as a late mid-seral plant community for five years after disturbance. These two sites were not monitored in 2010.

Figure 8-5 Plant Community Succession on Mixedgrass Loamy Ecological Range Sites

		Early Seral	Mid-seral	→	Late Mid-seral	Late Seral
**	Site #*	**Group 3: Pasture Sagewort - June Grass - Wild Vetch**	**Group 1: Northern Wheatgrass - Western Wheatgrass – Needle-and-Thread**	**Group 5: Kentucky Bluegrass - Low Sedge - Pasture Sagewort**	**Group 2: Western Porcupine Grass - Northern Wheatgrass - Wild Vetch**	**Group 4: Plains Rough Fescue - Northern Wheatgrass - Pasture Sagewort**
Seeded Sites (yr)	20D		10			
	21D	97, 98, 99, 01				10
	24D					10
	25D	98			01	97, 99, 10
	53D	99		01		98, 10
	55D	98	99, 01, 10			
Unseeded Sites (yr)	20S		97, 98, 99, 01			
	24T				97, 98, 99, 01	
	52N			01, 10		98, 99
Diversity Index		2.18	2.04	1.44	2.08	2.16
Avg. Richness		14.9	13.2	11.8	22.7	18.1

* Site Number Modifiers: D=disturbed topsoil, N=natural recovery site, S=unstripped spoil storage area, T=unstripped travel lane

** The observation year is recorded for the plant community at each site

8.6 Discussion – Plant Community Succession

The plant community ordination analysis indicates that positive successional change is occurring on most seeded and unseeded disturbed soils in the long term (Table 8-1). Forty percent of all sites where soils were disturbed developed into a late seral plant community after 14 years. Grazing influences in the successional progress of revegetating sites are discussed in Section 9. There are not enough sample replicates for strong comparisons between unseeded and seeded sites.

Table 8-1 Comparison of Seral Stage on Seeded-Unseeded Exposed Topsoils after 14 Years

Treatment **	Seral Stage on Revegetating Disturbed Topsoils in 2010				
	Early Seral	Mid-seral	Late Mid-seral	Late Seral	Trending to Modified
DMG - Solonetzic: Seeded	1			1	4
DMG - Solonetzic: Unseeded	2			3	
DMG - Loamy: Seeded	1*	3*	1		2*
DMG - Loamy: Unseeded			3		
DMG - Sandy: Seeded	n/a	n/a	n/a	n/a	n/a
DMG - Sandy: Unseeded		1		5	
MG - Limy: Seeded	1	2		1	
MG - Limy: Unseeded	n/a	n/a	n/a	n/a	n/a
MG - Loamy: Seeded		2		4	
MG - Loamy: Unseeded		1			

* One of these sites was reseeded in 2004
** DMG = Dry Mixedgrass; MG = Mixedgrass

8.6.1.1 Seeded Soils

Unfortunately the use of sheep fescue in the Dry Mixedgrass seed mixes has resulted in 50% of these sites trending to modified plant communities over 14 years. Only one site developed into a late seral native plant community. This site is dominated by the desirable infill species western porcupine grass and seeded species are not prominent.

Good results were achieved on Loamy Mixedgrass soils in the Cypress Hills, where no non-native species were present in the seed mixes. Four of the six seeded sites developed into a late seral plant community dominated by rough fescue and trending towards the MGA1 reference community for these sites. None of the seeded species are present beyond natural levels. Part of the reason for the success of these sites is likely their location in very large pastures with lower grazing pressure and little presence of invasive species, little fragmentation and few routine sources for introducing invasive species. Two sites remain as mid-seral communities in 2010, with seeded northern and western wheatgrass dominant and characteristic off RoW species such as the needle grasses and rough fescue still at very low cover.

For seeded sites that remain as early or mid-seral plant communities after 14 years (both in the Mixedgrass and the Dry Mixedgrass), pasture sagewort (a persistent native disturbance forb) or seeded cultivars (including green needle grass, northern wheatgrass or western wheatgrass) are still dominant, often beyond levels found in the controls.

8.6.1.2 Unseeded Soils

Seventy-eight percent of sites on disturbed Dry Mixedgrass soils that were not seeded support late mid-seral to late seral communities after 14 years.

Three of five natural recovery sites on Dry Mixedgrass Solonetzic soils support a late seral plant community dominated by western wheatgrass and pasture sagewort after 14 years. Two remain as early seral communities with pasture sagewort still dominant.

Of the two Loamy Dry Mixedgrass natural recovery sites, one is a late mid-seral Needle-and-Thread – Pasture Sagewort community and the other is a late seral Needle-and-Thread – Northern Wheatgrass community.

The six natural recovery sites on Sandy soils all re-established to a late seral Western Porcupine Grass – Pasture Sagewort community by the fifth year. By year 14, five of the sites shifted to two different late seral needle-and-thread communities. One site shifted to a mid-seral stage Buckbrush - Sun-Loving Sedge community.

Only one unseeded natural recovery trial was established in dark brown Loamy Mixedgrass soils in the Cypress Hills due to their severe climate, erosion concerns and uncertainty about the ability of this area to successfully revegetate. This site had very little cover for the first three years and was subject to summer grazing. The bare RoW attracted cattle. Although in the analysis the developing plant community clustered with a late seral community in years two and three, it shifted into a community dominated by Kentucky bluegrass (an invasive exotic species) in years five and 14.

8.6.1.3 Unstripped Spoil Storage Areas and Travel Lanes

The successional stage of the plant communities present on unstripped spoil storage areas and travel lanes are shown in Table 8-2. All the communities remained native plant communities and most did not revert to a pioneer stage. These sites were observed to have a range of seral stages immediately following construction. Once disturbed, many maintained the same plant community cover over five years. Some sites have maintained the same plant community over the 14 year recovery period. Only three of the ten sites were resurveyed in 2010. Progress towards more mature seral stages is generally not occurring.

Table 8-2 Seral Stage on Unstripped Spoil and Travel Lane Sites after 14 Years

Unstripped Construction Areas *	Site # **	Seral Stage on Revegetating Unstripped Soils in 2010				
		Pioneer	Early Seral	Mid-seral	Late Mid-seral	Late Seral
DMG - Solonetzic: Spoil	9S	97		98	99, 01	
DMG - Solonetzic: Spoil	27S		97, 98, 99, 01			
DMG - Solonetzic: Travel Lane	32T		99, 01	97, 98		
DMG - Loamy: Spoil	10S		97, 98, 99		01, 10	
DMG - Loamy: Spoil	31S				97	98, 99, 01
DMG - Loamy: Spoil	36S				97, 98, 99, 01	
DMG - Sandy: Travel Lane	5T			97,98,99,01,10		
MG - Limy: Spoil	26S					97,98,99,01,10
MG - Loamy: Spoil	20S			97, 98, 99, 01		
MG - Loamy: Travel Lane	24T				97, 98, 99, 01	

* DMG = Dry Mixedgrass; MG = Mixedgrass

** Site Number Modifiers: S=unstripped spoil storage area, T=unstripped travel lane

9 RANGE HEALTH EFFECTS ON RECLAIMING NATIVE PRAIRIE

Range health is a measure of the land's ability to: produce green vegetation; maintain the physical stability of the site and the soils; capture, store and release water; cycle energy and nutrients; and support a diversity of plant species that function together in a sustainable way (Adams et al. 2009). These ecological processes are damaged by disturbance to soils, vegetation cover or the hydrologic characteristics of a plant community (Gibson 2009). Changing climate and invasive non-native species have increasing influence on the composition of plant communities responding to disturbance (Gibson 2009). The health of the range before disturbance affects the ability of a disturbed area to respond and can affect the outcome of restoration. Ultimately, impacts to plant community integrity will impact the provision of ecological services.

Range health was measured both on the disturbance and the associated controls in 2010. Health assessments included measures of ecological status (as indicated by the species composition on the site), plant community structure, litter, site stability, soil exposure and the presence of noxious weeds (Adams et al. 2009).

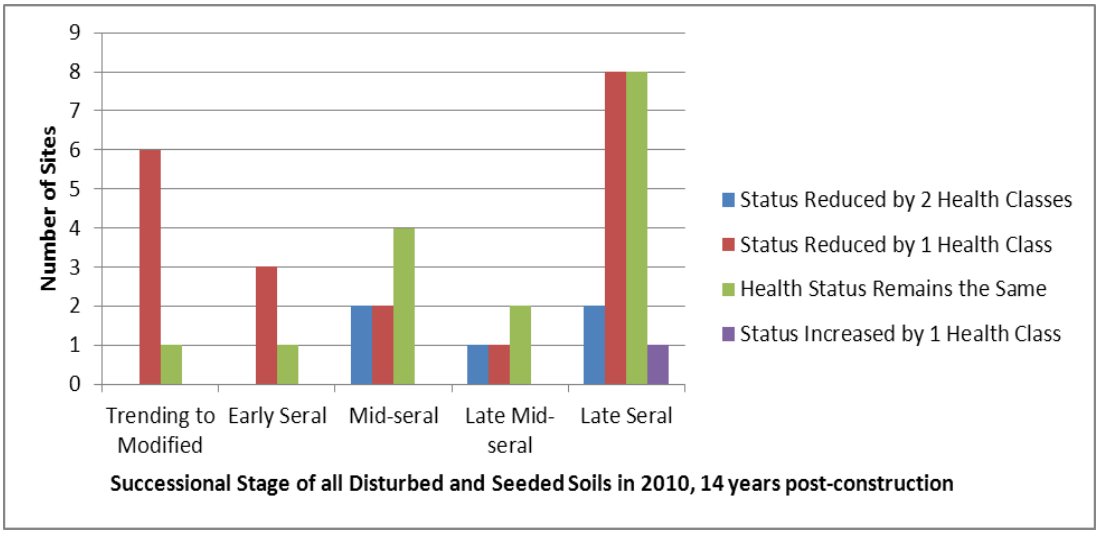
9.1 Ecological Status

The chart in Figure 9-1 groups sites of the same successional stage in 2010 and illustrates whether ecological status on the reclaiming RoW is the same as the associated control, or if it differs. For instance, of the four reclaiming sites at an early seral stage, one has the same ecological status score as the associated control. Three sites have lower (by one level) scores than the associated controls for each site. Therefore, in these pastures, the ecological status of the plant community on the reclaiming RoW is reduced compared to the adjacent control.

Figure 9-1 illustrates that 43% of the sites (42) in this comparison have the same ecological status as the adjacent pasture. Another 43% of the sites have reduced ecological status compared to the adjacent control. Scores dropped by two health classes for 11% of the sites and increased by one health class at one site.

This comparison includes all sites where soils were disturbed and either allowed to revegetate naturally or seeded. There were no discernable differences between the range health status of seeded sites and the natural recovery sites after 14 years. This figure also shows that 45% of the sites on disturbed soils have now developed into late seral plant communities of varying ecological status.

Figure 9-1 Ecological Status and Seral Stage of Reclaiming Sites on Disturbed Topsoils



9.2 Plant Community Structure

Another important component of range health is plant community structure. Healthy native rangeland communities include tall, mid, low and ground cover structural layers. Diversity in the canopy structure provides resilience to fluctuations in grazing pressure and climate events, promotes energy flow and nutrient cycling, and protects the ground surface from erosion (Adams et al. 2009). A consistent observation from all the reclaiming sites on disturbed soils is the continuing lack of a groundcover layer after 14 years. On unhealthy range sites, a further structural layer is usually missing as well. For reclaiming sites with the best range health scores, the tall, mid and low structural layers are present.

After 14 years, bare soil was still more prevalent on the recovering RoW than on the undisturbed control, which contributed to reduced health scores. Typically prairie selaginella (*Selaginella densa*), and to a lesser extent mosses and lichen are the major components of this layer. Litter values were also diminished with increased grazing pressure and lower range health scores.

9.3 Invasive Species

Establishment of invasive species from the seedbank or through infill has only been an issue at a few monitoring sites (although they are a small subset of the RoW). Kentucky bluegrass is the dominant cover at two natural recovery sites in the Mixedgrass that are used as summer pasture. Crested wheatgrass is also establishing on two southern sites in the Dry Mixedgrass where it is present off RoW. The large pastures in the expansive areas of native prairie in the southern portion of the Express Pipeline route are relatively free of introduced species. Further north, where there is increased landscape fragmentation and cultivation, introduced species are more common.

9.4 Interacting Variables

Range health was generally better in larger pastures and on public land. Smaller pastures and private land, particularly on more northern portions of the RoW, tended to have reduced range health scores. In smaller pastures the disturbed RoW takes up proportionally more of the available land which can put further pressure on both the undisturbed and disturbed portions of the area. The droughts experienced during the recovery period can also exacerbate grazing impacts on the recovering RoW, particularly in smaller pastures.

10 DIVERSITY AFTER DISTURBANCE

10.1 Diversity of Growth Form Groups

An assessment was made of the diversity over time of three growth forms of interest (annual forbs, perennial forbs, and graminoids) on disturbed topsoil on the Express RoW in the Dry Mixedgrass and Mixedgrass combined. The assessment compares the relationship between the diversity of species on a site (represented by Shannon's Diversity Index) and the proportion of a site occupied by each growth form, measured by foliar cover. The details of the analysis are presented in Appendix E.

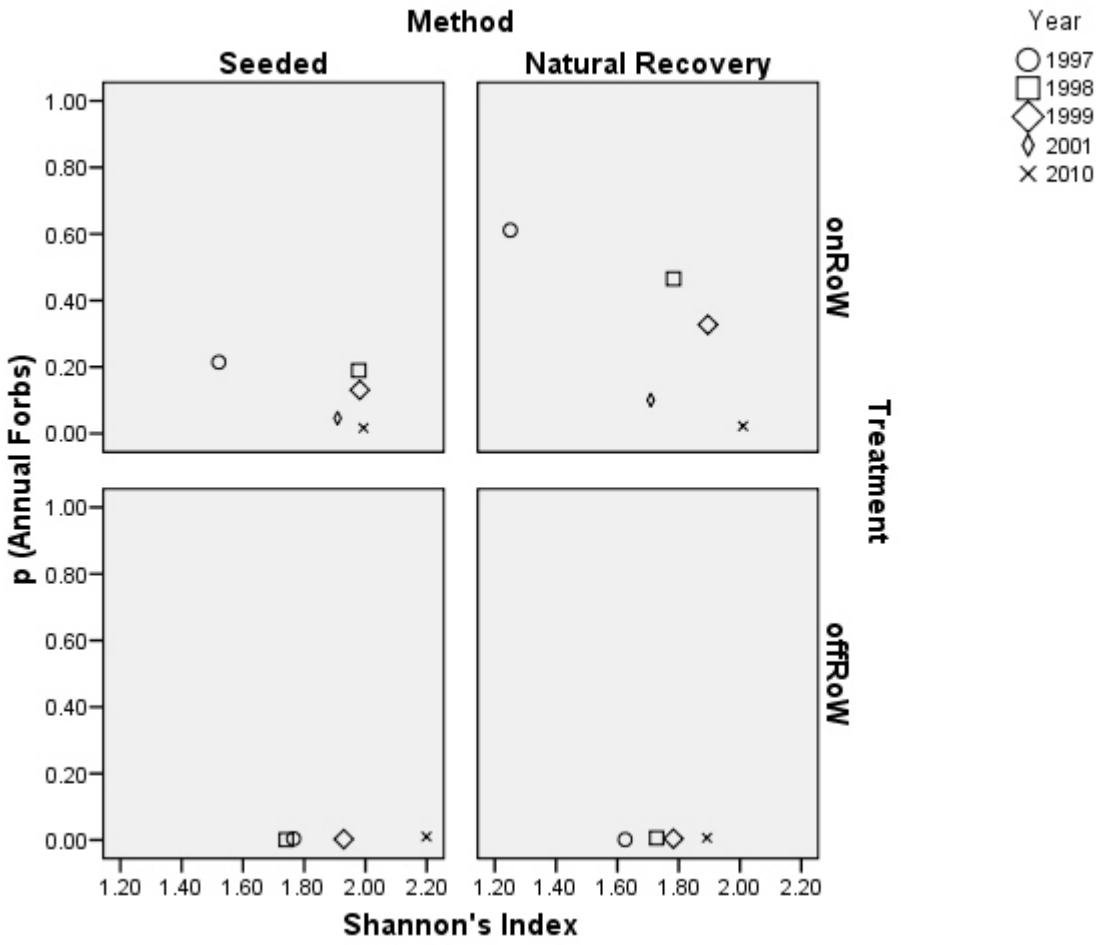
The largest proportion of the first year (or pioneer) vegetation is made up of annual forbs, particularly for natural recovery sites where they form approximately 60% of the cover present (Figure 10-1). On seeded sites they occupy a smaller proportion of the stand (~20%) with the colonizing seeded grass species slender wheatgrass taking up more of the species space. In the succeeding two years, the proportion of annual forb cover decreases to about 40% on natural recovery sites and to about 15% on seeded sites while the proportion of perennials increases. By 2010, annual forbs form a very small proportion of the species present on seeded and natural recovery sites, comparable to the controls.

The proportion of the reclaiming plant communities composed of perennial forbs does not vary much over time or between seeded sites or undisturbed controls, where they make up about 20% of cover (Figure 10-2). They represent somewhat more of the stand (~30%) in natural recovery sites in years two through five after disturbance.

Perennial graminoids (primarily grasses and sedges) form about 70% to 80% of the cover on controls (Figure 10-3). On seeded sites, graminoids consistently form between 60% and 70% of the cover present. Graminoid cover is relatively low in the first year after disturbance but increases steadily over time. However, 14 years following disturbance, the proportion of graminoid cover is greater on undisturbed controls compared to seeded disturbances on the RoW.

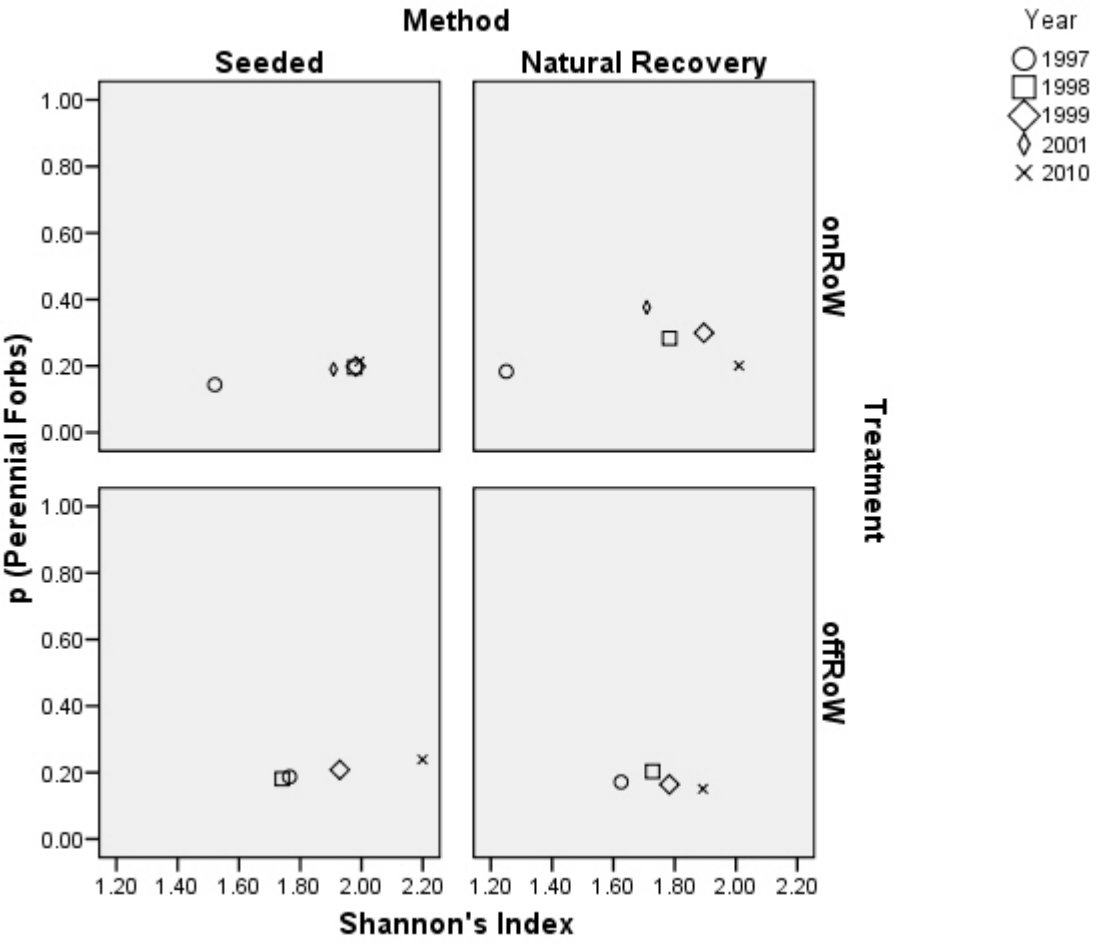
The cover of graminoids on natural recovery sites follows quite a different pattern over time (Figure 10-3). One year after the disturbance, species diversity and cover of graminoids was relatively low. Fourteen years after disturbance, in 2010, both species diversity and cover of graminoids on the recovering RoW were comparable to the control.

Figure 10-1 Annual Forb Diversity on Seeded and Natural Recovery Sites



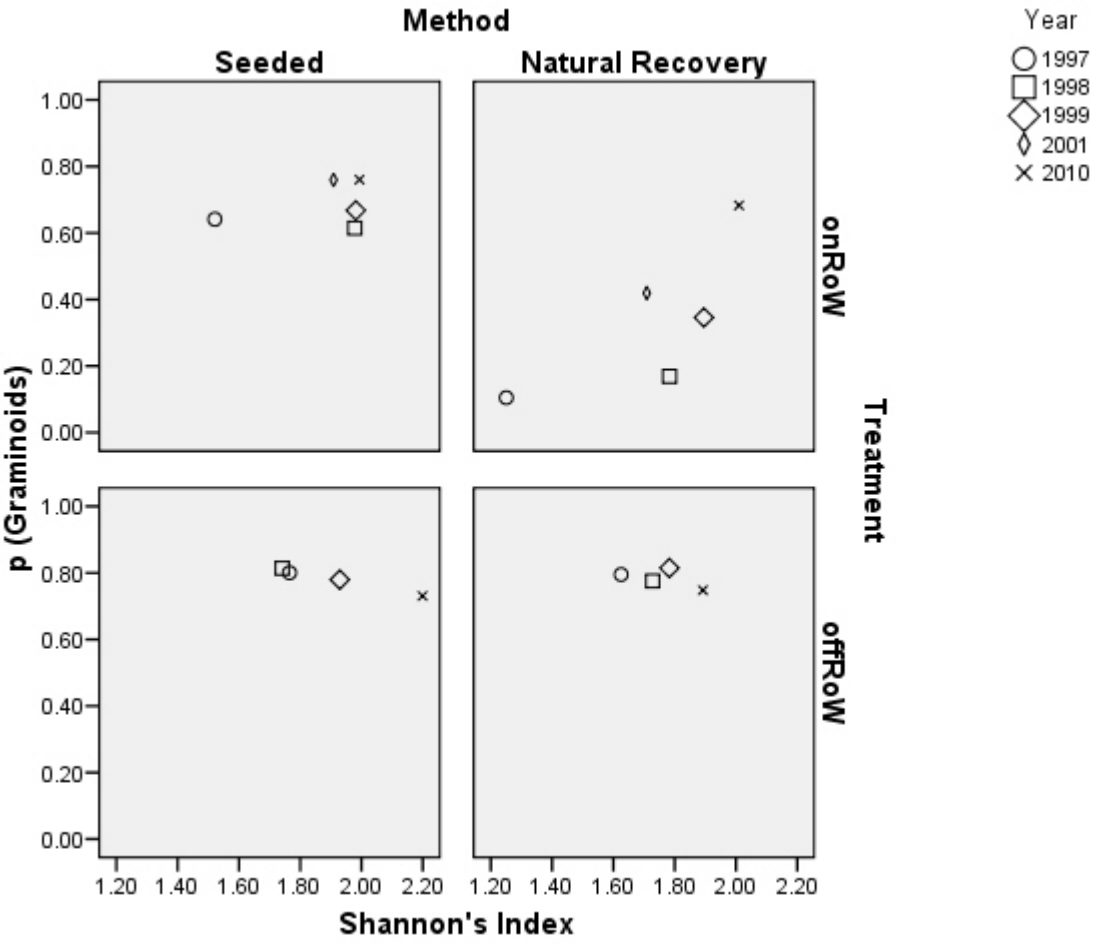
p = the proportion of cover composed of annual forbs

Figure 10-2 Perennial Forb Diversity on Seeded and Natural Recovery Sites



p = the proportion of cover composed of perennial forbs

Figure 10-3 Graminoid Diversity on Seeded and Natural Recovery Sites



p = the proportion of cover composed of graminoids

11 ROUGH FESCUE SOD SALVAGE TRIALS

A very detailed analysis of the two sod salvage trial sites for the first two growing seasons post-construction (1997 and 1998) was conducted as part of a Master's thesis and is presented in Petherbridge 2000. Data gathered in 2010 supports several key observations that provide practical guidance for decisions regarding this reclamation technique.

11.1 Parkland - Hardisty Sites

Groves of aspen dominated plant communities interspersed with patches of plains rough fescue grasslands on south and east facing slopes typifies the Hardisty site. The sod salvage trial site was located in grassland on a loamy ecological range site. Plains rough fescue occupied an average of 23% of the cover and Kentucky bluegrass, a non-native invasive grass species, was present at an average cover value of 30% prior to the construction of the pipeline in 1996.

The construction of the TCPL Keystone Pipeline in 2009/2010 has encroached on the eastern edge of the sod salvage trial sites at the Hardisty location. The TCPL RoW is located adjacent to the Express RoW to minimize further disturbance in native prairie by utilizing existing pipeline corridors. The TCPL RoW construction removed the remainder of the original patch of rough fescue grassland where the trials were conducted and where the control measurements had been taken in the Petherbridge study.

The purpose of the trial site was to determine if plains rough fescue could survive the salvage procedure. Petherbridge indicated that by 1998 the rough fescue component of the salvaged sod had completely disappeared. It is important to note that the undisturbed native plant community at the Hardisty site is more degraded and remains in an earlier successional phase compared to the Manyberries site.

Two sod salvage trial areas were assessed at the Hardisty site in 2010. The control assessed in 2010 was located to the west of the Express RoW on a similar Loamy ecological range site just south of the ASRD Windy Lake Range Reference Exclosure. The control is located within the same fenced grazing management unit as the Express pipeline RoW. Range health scores for both sites on RoW and at the control were in the unhealthy range. Low scores were due to the percent cover of invasive non-native species, lack of structure in the stand and low litter levels.

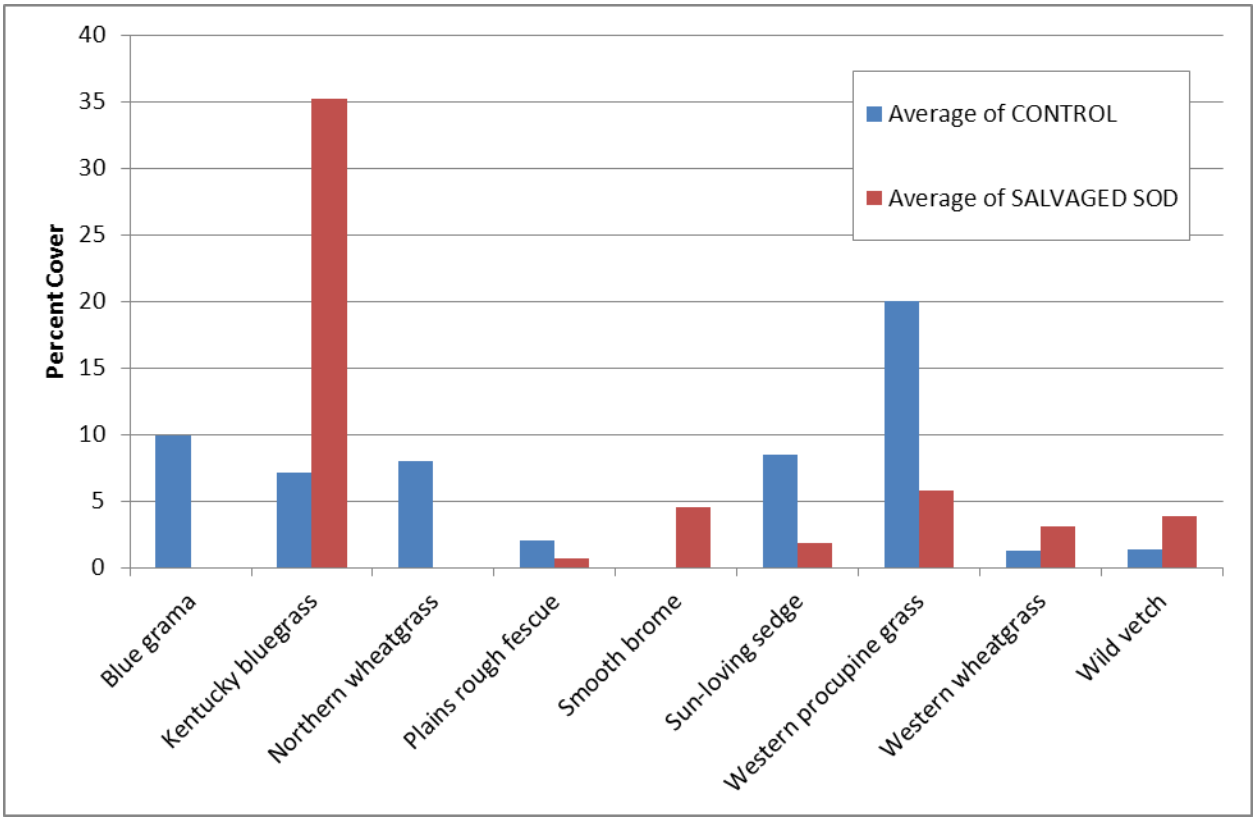
Figure 11-1 illustrates the average percent cover of the dominant species on the two sod salvage trial areas and the single control site assessed in 2010. Average percent cover of plains rough fescue on the salvaged sod is less than 1% compared to 2% at the control in 2010. Invasive non-native grasses are now prominent on the salvaged sod. Kentucky bluegrass dominates both of the sod salvage trial areas assessed at 34% and 37% compared to 7% at the control. Smooth brome has increased since the 1998 Petherbridge assessment and now represents 1% and 8% of the cover on the salvaged sod compared to 0% in the control. The figure also illustrates a reduction in the native bunchgrasses and an increase in the rhizomatous grass species compared to the control. Appendix G: Tables 1 and 2 provide the data to support this interpretation. These findings are consistent with the initial observations of the Petherbridge 2000 report.

Species diversity (number of species recorded in the micro-plots) differed between the control and the sod salvage areas mainly in the amount and type of non-native species recorded. Alfalfa (*Medicago sativa*), Canada thistle (*Cirsium arvense*) and smooth brome were recorded in the sod salvage areas but not in the control. Kentucky bluegrass was present at much higher values on the sod salvage areas compared to the control.

Key learnings include:

- The sod salvage procedure favoured the recovery and increase in shallow rooted, rhizomatous non-native grasses over the deep rooted native bunch grasses.
- The presence of invasive non-native grasses such as Kentucky bluegrass and smooth brome in the stand prior to disturbance severely limits the success of the sod salvage procedure.

Figure 11-1 Dominant Species on Salvaged Sod after 14 Years Recovery – Parkland Sites



Data includes one 2010 control site and two 2010 salvaged sod monitoring Sites.

11.2 Mixedgrass - Manyberries Sites

The Manyberries site is located in a plains rough fescue dominated grassland. The reference plant community for this location in the Mixedgrass Range Plant Community Guide (Adams, et al 2005) is MGA1 Plains Rough Fescue - Western Porcupine Grass - Sedge. Plains rough fescue was dominant with an average cover value of 57%, with sun-loving sedge (*Carex pennsylvanica*) co-dominant at 22% prior to disturbance by pipeline construction. Kentucky bluegrass was not recorded prior to construction of the pipeline in 1996.

Three areas where the sod had been salvaged were assessed in 2010. Site 1 is located in a Limy ecological range site. The range health score on RoW is “healthy with problems” due to the presence of lowered litter values and bare soil. Range health at the control is rated as “healthy”.

Sites 2 and 3 are located in Loamy ecological range sites. Range health scores on RoW at both sites scored in the "unhealthy" range due to the presence of invasive non-native species, lack of structure in the stand and reduced litter values. Off RoW, at both control locations, the range health scores were in the healthy range.

Figure 11-2 illustrates the average percent cover of the dominant species on Site 1 (Limy soils, on RoW and Control) and the average percent cover of the dominant species on Sites 2 and 3 (Loamy soils, on RoW and controls). In 2010 percent cover of plains rough fescue was higher at the Limy soil site, both on the control and on the ROW treatment area compared to the Loamy soil sites. The cover of plains rough fescue within the sod salvage area was higher in the Limy soils at Site 1 (28% at the control and 20% within the sod salvage area.). At Sites 2 and 3, on Loamy soils, the amount of plains rough fescue within the sod salvage area was lower compared to the controls (averaging 20% at the controls compared to 8% within the sod salvage area). Kentucky bluegrass, an aggressive, shallow rooted non-native species, is co-dominant with plains rough fescue within the salvaged sod at all three sites, occurring at 9% cover on the Limy soils and 16% cover on the Loamy soils. Off RoW on the controls it was found only at Site 1 at less than 1% cover. Appendix G: Tables 3, 4 and 5 provide the data to support this interpretation.

Species diversity (number of species recorded in the micro-plots) did not appear to be significantly different between the control and sod salvage sites with the exception of Site 3, which had the highest percent cover of Kentucky bluegrass. However, the cover of species with strongly rhizomatous or spreading roots expanded in the sod (including prairie sagewort, yarrow, western wheatgrass, wild vetch). There is also a reduction in the native bunchgrasses in the sod transplant areas compared to the control at each site.

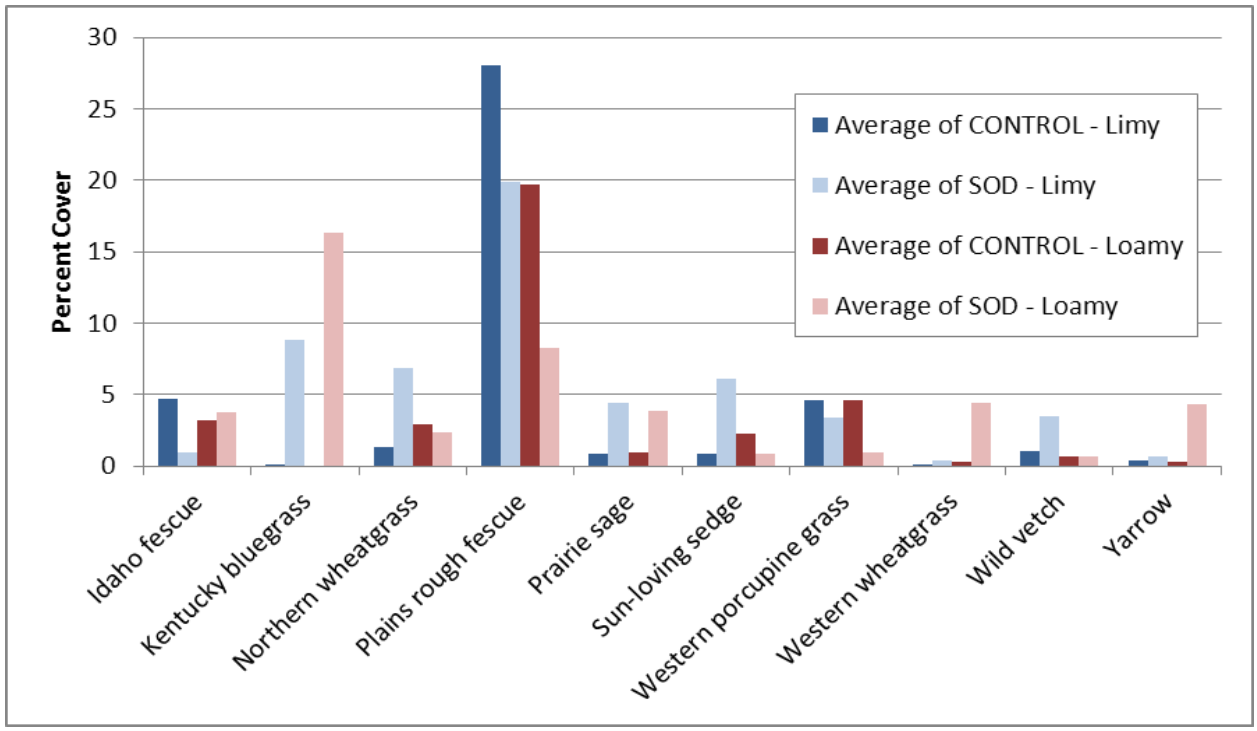
Kentucky bluegrass is a shallow rooted sod forming grass that is highly competitive, reproducing from crowns, rhizomes and prolific seed. It appears to have the ability to increase in cover more readily in moist Loamy soils than in the less fertile, immature Limy soils. Plains rough fescue has survived the salvage procedure at all three sites, as demonstrated in Petherbridge 2000. However, it is the encroachment of Kentucky bluegrass over the extended timeframe that is of interest in the long term. Only trace amounts (less than 1% in Site 1 only) of Kentucky bluegrass were encountered in the undisturbed control sites. Therefore seed from off RoW sources such as the county road bar ditches may have been transported to the site by a number of possible means such as the wind, surface water flow, vehicles, including construction equipment, livestock, or wildlife etc.

On two sites where sod blocks were replaced on a shallow side slope in Loamy soils, subtle changes in water flow through the soils may have also created subtle microsite differences that favour the expansion of Kentucky bluegrass.

Key learnings include:

- Plains rough fescue plants can survive the transplant procedure in the long term;
- Range health plays an important role in transplant success over the long term;
- Kentucky bluegrass can colonize the sod transplant areas from outside sources or seedbank and adjacent vegetation, competing with the recovering plains rough fescue and associated native bunch grasses; and
- Loamy range sites appear to be more susceptible to Kentucky bluegrass invasion then drier, less fertile Limey range sites.

Figure 11-2 Dominant Species on Salvaged Sod after 14 Years Recovery – Mixedgrass Sites



Data includes:

Limy soils - one 2010 control site and one 2010 salvaged sod site

Loamy soils – two 2010 control sites and two 2010 salvaged sod sites.

12 KEY RESULTS AND RECOMMENDATIONS

12.1 Restoration Planning

- Sites where long-lived seeded species matched those present naturally on the surrounding rangeland had the best chance of establishing and persisting over time.
- New tools for planning restoration of native prairie after disturbance will identify ecological site characteristics and target plant communities for restoration planning. Tools include the Range Plant Community Guides (ASRD 2004, 2005), Grassland Vegetation Inventory (GVI) Specifications (ASRD and LandWise Inc. 2010) and Range Health Assessment for Grassland, Forest and Tame Pasture (Adams et al. 2009).
- There may be more options for restoration in healthy rangeland. Diminished range health or high grazing intensity can hinder recovery. This is more evident in smaller pastures where grazing management practices can be constrained. In these situations, seeding and short term fencing are likely to produce better outcomes than natural recovery.
- Other factors that appear to hinder restoration are periods of drought, competition from noxious weeds, and infill from invasive non-native species such as Kentucky bluegrass, smooth brome and crested wheat grass.

12.2 Seed Mixes

- Avoid seeding persistent species that are not present naturally on the same ecological range site (ERS). For example, green needle grass was used at higher than natural cover levels and it persists in the long term, creating lasting differences in plant community composition and structure.
- Non-native sheep fescue is invasive and should not be used for restoration. Sheep fescue increased in cover slowly and steadily on both healthy and unhealthy rangeland. Sheep fescue may contribute to plant community modification over time.
- It is important to plan for different structural layers when designing a seed mix and include a variety of species with tall, mid and low structural characteristics. Diverse structure improves range health and builds ecological resilience.
- Some cultivars are much taller and more robust than local plants, creating persistent differences in plant community structure on the revegetating disturbance. Persistent cultivars that developed taller structure on the RoW are green needle grass, sand grass (sand reed grass), northern wheatgrass and western wheatgrass.
- It is very important to use seed with genetic origin that is compatible with the area of the project. Many of the cultivars available during the mid-1990s when Express was built have genetic origins thousands of miles to the east and south. Some cultivars were not hardy and others were aggressive, taking up too much of the canopy space, preventing infill of desirable species and altering the plant community composition in the long term. The common aggressive cultivars on Express were green needle grass, western wheatgrass and northern wheatgrass. Care should be taken to use plants of local origin.
- Seed sourced from local seed houses may be from plants whose genetic origins are very far away. It is important to ask and get confirmation of genetic origin. A number of suitable cultivars have been developed for Alberta by the Alberta Research Council (ARC), now Alberta Innovates (AI). Locally adapted Ecovars have been developed by Ducks Unlimited and a number of smaller local producers also develop and grow locally sourced plant materials. Many of these seed sources are marketed by local seed houses. Similar recommendations apply for wild harvested seed.

- Slender wheatgrass in a useful short term cover crop, providing erosion control and shade for slower growing species and disappearing for the most part by year five, leaving space for infill by other species.
- Do not use non-native species for native prairie restoration unless they are annual cover crops that are guaranteed not to persist more than one year or reseed.

12.3 Natural Recovery

- Natural recovery techniques were successful in establishing native plant communities in the Dry Mixedgrass Natural Subregion. Cultivars are absent from the reclaiming plant communities, which results in better potential to match off RoW communities in terms of composition and the structural characteristics of local plants. The result is a native plant community rather than a community of native cultivars.
- The timing of topsoil replacement is an important factor in the outcome of natural recovery as a revegetation strategy. Topsoil replacement in the fall or during dormant conditions before the first post-construction growing season is recommended.
- The presence of undesirable non-native species such as Kentucky bluegrass prior to disturbance can negatively affect the outcome of natural recovery as a revegetation strategy. Seeding may be a better option on invaded sites.
- The timing and duration of livestock grazing can also affect the success of natural recovery, particularly in plains rough fescue plant communities. Protecting sites from grazing during spring and summer in the first few years can be beneficial.
- Natural recovery is more risky on moist, Loamy sites in the Mixedgrass Natural Subregion and on sites where invasive species are present in the pre-disturbance plant community.

12.4 Sod Salvage

- Plains rough fescue plants can survive a transplant procedure in the long term where sod of sufficient depth and quality is used.
- Range health plays an important role in transplant success over the long term. Shallow-rooted, rhizomatous, non-native grasses such as Kentucky bluegrass or smooth brome can colonize the sod transplant areas, competing with the recovering plains rough fescue and severely limiting the success of the sod salvage procedure.
- Loamy range sites appear to be more susceptible to Kentucky bluegrass invasion than drier, less fertile range sites.
- Restoring surface contours when replacing sod is challenging. Raised or lowered surface profiles in the sods can change surface drainage and result in changes to plant associations on the sod blocks over time.
- Sod salvage is very labour intensive and not recommended for mitigating industrial scale disturbance.

12.5 Communication of Restoration Commitments and Strategies from Construction to Operations

- Remedial repairs and seeding may be required on projects up to ten years after construction. It is important to communicate restoration goals, commitments and strategies agreed to for construction to the operations team. A failure to communicate reclamation commitments made at the restoration design phase is a problem experienced on Express.

12.6 Assessing Restoration Progress

- Patience is required to restore native grassland communities. The 14 year post-construction monitoring on Express indicates that succession is still on-going and range health on the disturbances is improving, but is lower than the surrounding rangeland.

12.7 Revegetation Monitoring Guidelines for Native Prairie

- The newly developed assessment GVI descriptors (ASRD and LandWise Inc. 2010) and Range Plant Community Guides (ASRD 2004, 2005) are useful tools for monitoring and describing the progress of restoration and provide a standardized context for understanding potential outcomes for restored grasslands.
- Assessing range health on reclaiming sites provides standards for measuring site stability, plant community structure, presence of noxious weeds, ecological function, and resilience to climate events or other disturbances.
- Establish paired plots on the disturbance and on undisturbed controls on comparable ecological range sites with similar site conditions (e.g. slope aspect, drainage, management). Use standard range inventory protocols for Alberta to produce quantitative data that can be compared with data used to develop rangeland plant community descriptions and with other restoration studies.
- Repeatable photographs of the revegetating site are useful qualitative indicators of site condition and succession.
- Monitoring should be repeated several times until restoration goals are achieved.

12.8 The Importance of Long-term Follow-up Monitoring

There is an increasing public awareness of the remaining native grassland ecosystems and the ecological goods and services they provide for Albertans. Regional Land Use Plans will set thresholds and limits on surface disturbance to native landscapes. The amount of industrial activity taking place in native grasslands has increased dramatically since the early 1990s. If we are to conserve what remains of our native prairie for future generations then we must continue to improve our reclamation and revegetation practices in native prairie landscapes. Our focus must shift from reclamation to restoration. Ecological restoration is defined as “the process of re-establishing the structure, function and integrity of native ecosystems and their habitats” (Jackson et al. 1995).

The “2010 Reclamation Criteria for Wellsites and Associated Facilities for Native Grasslands” (Alberta Environment 2010) places greater emphasis on native grassland vegetation as an indicator of equivalent land capability. Equivalent Land Capability is defined in the 2010 Criteria “as the condition in which ecosystem processes are functioning in a manner that will support the production of goods and services consistent in quality and quantity as present prior to disturbance”.

Time is an important factor in the process of recovery from industrial disturbance in native grasslands. Extended timeframe monitoring until restoration goals are achieved, using standardized methods of evaluation provides the opportunity to reflect on construction and reclamation procedures used in the past and make informed choices that will improve future restoration potential.

The results of the Express monitoring 14 years after construction indicate that significant changes may occur after the first five years of reclamation both in positive and negative directions. There is very little information available on the long term efficacy of various native grassland reclamation techniques in the Natural Subregions of Alberta. Long term monitoring is needed to contribute to our understanding of whether restoration of native vegetation communities is possible, and if so, in what situations and over what timeframe. There is very little data on native plant community successional pathways following industrial disturbance in the long term. It is necessary to continue to develop best management practices and appropriate revegetation strategies for industrial disturbances in native prairie to promote industry stewardship on increasingly pressured prairie landscapes.

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Appendix A Glossary of Terms

Blowouts: refers to ecological range sites with eroded surface pits reflecting the presence of abundant Solonetzic (hard pan) soils.

Chernozemic: Dominated by the accumulation of organic matter from the decomposition of grasses and forbs, typically of Grassland plant communities. Chernozemic soils have normal development of soil horizons (A, B, C) and the topsoil (Ah, Ap) is more than 10 cm thick.

Climax: the final or stable biotic community in a successional series; it is self perpetuating and in equilibrium with the physical habitat.

Cultivar: is a plant variety which has undergone genetic restrictions through selection by plant breeders, and which has been registered by a certifying agency. **Native plant cultivars** in this report refer to cultivars produced from native grass species.

Decreaser: Highly productive, palatable plants that are dominant species in reference plant communities. They decrease in relative abundance as grazing pressure or disturbance related activity increases.

Ecological Range Site: A distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation. In a grassland environment, **range site** refers to a broader description of soil and landscape (e.g. loamy, clayey, sandy, choppy sand hills etc.), that might be further subdivided into ecological sites due to differences in plant community potential.

Ecological status: is the degree of similarity between the present plant community and the **reference plant community**.

Forb: Primarily broad-leaved flowering plants with net-like veins. For the purpose of simplifying identification, the category can be broadened to include those parallel-veined plants with brightly colored flowers such as orchids or lilies.

Graminoid: Refers to plants which have hollow, jointed stems and leaves in two rows (ranks). Flowers are usually perfect with seeds borne between two scales (palea and lemma). Commonly referred to as grasses.

Increaser: Plant species that normally increase in relative abundance as the decreasers decline. They are commonly shorter , less productive species and more resistant to grazing and other disturbances.

Lentic: this terms means *standing* or *still water* (i.e. lakes, wetands and sloughs).

Limy: refers to ecological range sites with eroded or immature soils with free lime (CaCO3) at the soil surface. Soils pH generally .7.5.

Loamy: refers to ecological range sites with medium to moderately –fine textured soils.

Lotic: this term means *flowing water* (i.e. streams or rivers).

Natural Subregion (NSR): Natural Subregions are subdivisions of a Natural Region, generally characterized by vegetation, climate, elevation, and latitudinal or physiographic differences within a given Region. There are 21 Natural Subregions in Alberta, four of which comprise the Grassland Natural Region.

Overflow: The ecological range site subject to water spreading and sheet flow. Typically on gentle inclines or terraces prone to stream overflow.

Plant Community: refers to an assemblage of plants occurring together at any point in time, thus denoting no particular successional status. A mixture of plant species that interact with one another.

Rangeland: is land supporting indigenous or introduced vegetation that is either grazed or has the potential to be grazed and is managed as a natural ecosystem.

Rangeland Health: the ability of rangeland to perform certain key functions. Those key functions include: productivity, site stability, capture and beneficial release of water, nutrient cycling, and plant species diversity.

Reference Plant Community: is the term used for the potential natural community or climax community. It is the plant community that is the expression of the ecological site potential under light disturbance. It is used in range health assessment as the basis for comparison, hence the term "reference".

Riparian: is the term used to define the transitional area between the aquatic part of a lotic or lentic system and the adjacent upland system.

Sands: refers to the ecological range site with very coarse textured soils and not on a duned landscape.

Sandy: refers to the ecological range site with sandy loam, moderately coarse textured soils.

Seral: refers to species or communities that are eventually replaced by other species or communities.

Solonetzic: Dominated by hard-pan subsoil or B horizons that are hard when dry and a sticky mass of low permeability when wet. Solonetzic soils are high in sodium and typically have columnar or prismatic macro-structure.

Succession: the gradual replacement of one plant community by another, over time.

Sucessional pathways: describe the predictable pathway of change in the plant community as it is subjected to types and levels of disturbance over time.

Seral stages: are each step along a sucessional pathway. Seral stages begin at the pioneer stage of **early seral** , and progress upward in sucession to **mid-seral,** then **late seral** and finally the climax or **reference plant community.**

Appendix B

Intermediate Vegetation Analysis Results – Treatments and Controls - January 2011

Cluster Analysis, Non-metric Multidimensional Scaling Ordination and Indicator Species Analyses for Ecological Range Site Type by Natural Subregion

Laura Hickman, Jane Lancaster, Barry Adams and Marilyn Neville

Introduction

Data from the Express Pipeline Vegetation Monitoring Project's 1997, 1998, 1999, 2001 and 2010 sampling years are investigated here in order to determine whether successional trends can be discerned over the elapsed 13 years since construction. Objectives of the assessment include identification of vegetation outcomes on naturally recovered vs. seeded sites and also identification of any persisting effects of non-native seeded species.

The analyses presented in this interim report show the intermediate analyses for the Dry Mixedgrass, Mixedgrass and Central Parkland Natural Subregions. Data include observations from both control and treatment locations. Cluster analysis, non-metric multidimensional scaling and indicator species analysis were used to assign individual observations to community groups in order to assess successional progress.

Since the November 2010 preliminary report in this series, the ecological range site (ERS) categorizations were reclassified according to expert opinion and historical site knowledge (Jane Lancaster). This reclassification has reduced the number of ERSs discussed within this report. The ERSs listed below have undergone further analysis in this round. Note that an "observation" is a site X year monitoring occurrence (e.g. 1998 data from Site #44 is one observation).

The following ERS groups are included in the analysis:

- Mixedgrass:
  - Loamy (48 observations)
  - Limy and related sites (41 observations; this group included LoLi, LiBlO, LoLiBlO, LiTB and Li sites

- Dry Mixedgrass:
  - Sandy and related sites (58 observations)
  - Blowout (118 observations)
  - Loamy (110 observations)
  - Overflow (33 observations

The following ERS groups are not included in the analysis due to small sample sizes:

- Central Parkland: *all sites lumped together (25 observations as sample size was not sufficient for any ERS to be broken out individually for analysis)*

- Mixedgrass:
  - *Blowout (8) and Overflow (9) had too few replicates to be included in analyses*

- Dry Mixedgrass:
  - *Thin Breaks (16), Badlands (6) and Lentic (12) had too few replicates to be included in analyses*

Each included ecological range type was analyzed individually using cluster analysis, non-metric multidimensional scaling ordination and indicator species analysis. These are organized alphabetically below by natural subregion.

Methods

For information on the data collection methods used as part of the Express Pipeline Vegetation Monitoring Project, please see the main body of the Express Pipeline Revegetation Monitoring Project 2010 report. The analyses described below were carried out in PCORD (version 5.17; McCune and Mefford 2006) and are outlined in full by Hickman (2010).

The cluster analysis performed was a hierarchical, agglomerative clustering method in PCORD used for initial vegetation community group classification. This method of community group classification identifies vegetation communities by characteristic species combinations (Jongman et al. 1995). Hierarchical methods find groups that are composed of subgroups and produce dendrograms where the axis is measured in percent information remaining; agglomerative methods build groups from the bottom to a single top group composed of all sample units (McCune and Grace 2002). Cluster analyses were performed using Ward's group linkage method and the relative Euclidean distance measure (McCune and Grace 2002).

Dendrograms are presented below to illustrate the community groups interpreted from the data. Dendrogram branches were subjectively trimmed for community group identification based on ecological interpretation of sample unit (dis)similarity within and among clusters at different levels of percent information remaining (Kent and Coker 1992). The community group identification within each ecological range type was also supported by the complimentary analyses described below.

Ordination methods graphically summarize complex species relationships among observations by aligning observations in a pattern along multiple axes (dimensions) (McCune and Grace 2002). Nonmetric multidimensional scaling (NMS) is "currently one of the most defensible techniques" (McCune and Grace 2002) and is favoured for its increased computational power over other ordination methods such as principal components analysis and detrended correspondence analysis. The Sorenson (Bray-Curtis) distance measure was and ordination parameters utilized included two to three axes, random starting configurations, 250 runs with real data, 500 iterations, a stability criterion of 0.00001, and solution selection based on low stress (<15) and the stability criterion (examination of a plot of stress vs. iteration number; McCune and Grace 2002).

Indicator species analysis (ISA; Dufrene and Legendre 1997) also supported dendrogram pruning decisions. ISA evaluates the faithfulness (i.e. is the species present at every sample unit within the group?) and exclusivity (i.e. does the species occur only within the group and not at sample units within other groups?) of each species, producing an indicator value (IV) for each species in each group (McCune and Grace 2002). Statistical significance was evaluated by a Monte Carlo method (1000 randomized runs) with the null hypothesis being that the maximum IV is no larger than would be expected by chance. The number of significant indicators (species with $p \leq 0.05$) and the average of all species' p-values were then each plotted against the number of clusters (i.e. how far left or right the cluster analysis dendrogram is pruned), with the ideal number of dendrogram clusters corresponding to high total and average significance.

Presented below are the interim dendrogram figures, illustrating the community groups identified based on control and treatment observation data. NMS diagrams are included to illustrate the strength of community grouping based on various treatment categories (such as seed treatment, time since treatment, etc). Indicator species analysis plots described above are provided to illustrate support for the number of community groups identified for each ecological range site.

Dry Mixedgrass Natural Subregion

Blowouts (BlO)

Sites #6-9, 27-30, 32, 34, 46-49.

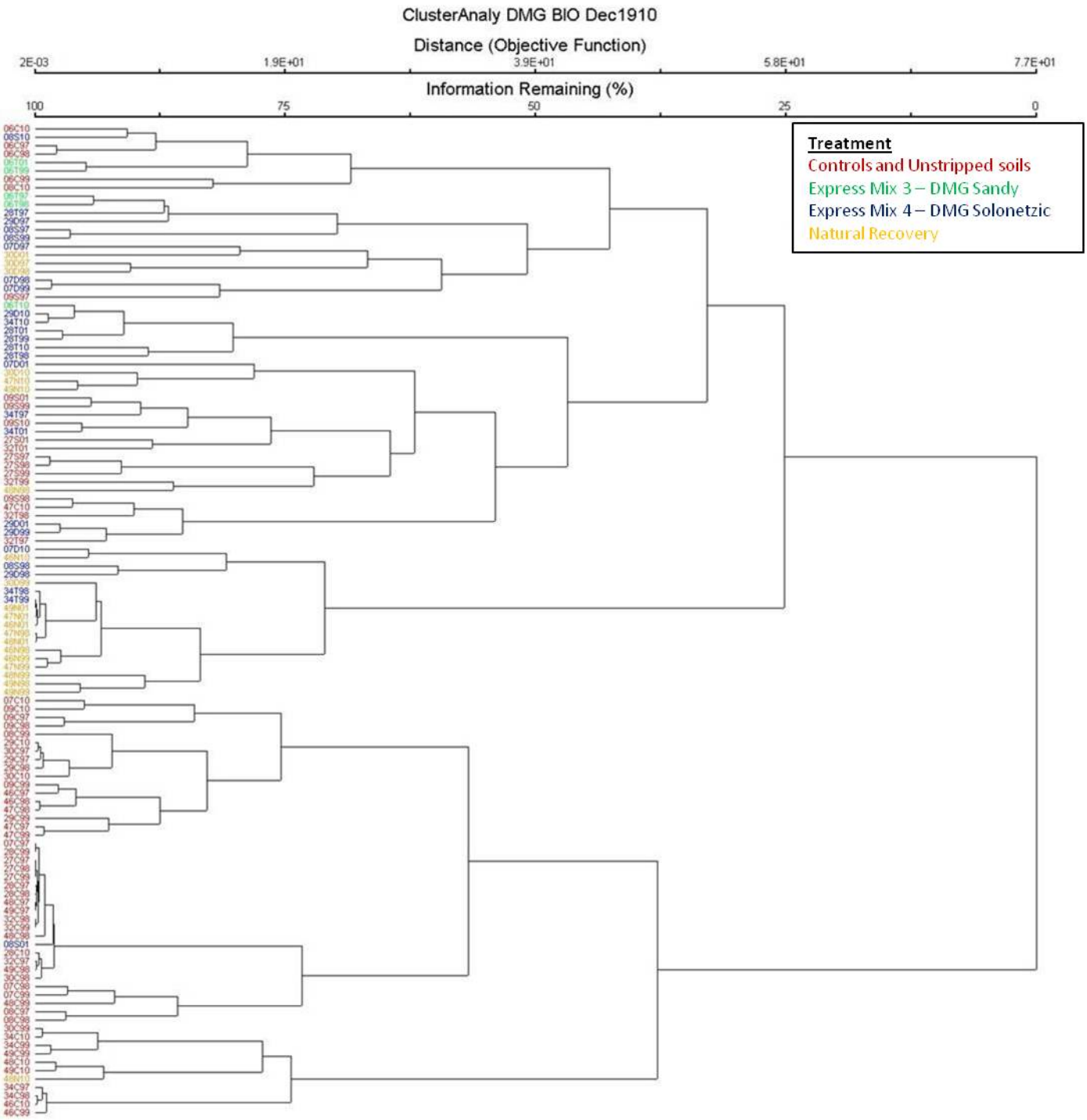
The majority of control observations were distinct from the treatment observations. Sites that were disturbed and naturally recovered (SeedRev #5 shown in yellow below) also seemed to cluster together, although a number of distinct clusters of natural recovery observations resulted, rather than one large cluster. The variable "Year" did not appear to drive any grouping of observations; no successional patterns were observed as the main distinction was between control and disturbed or treated sites.

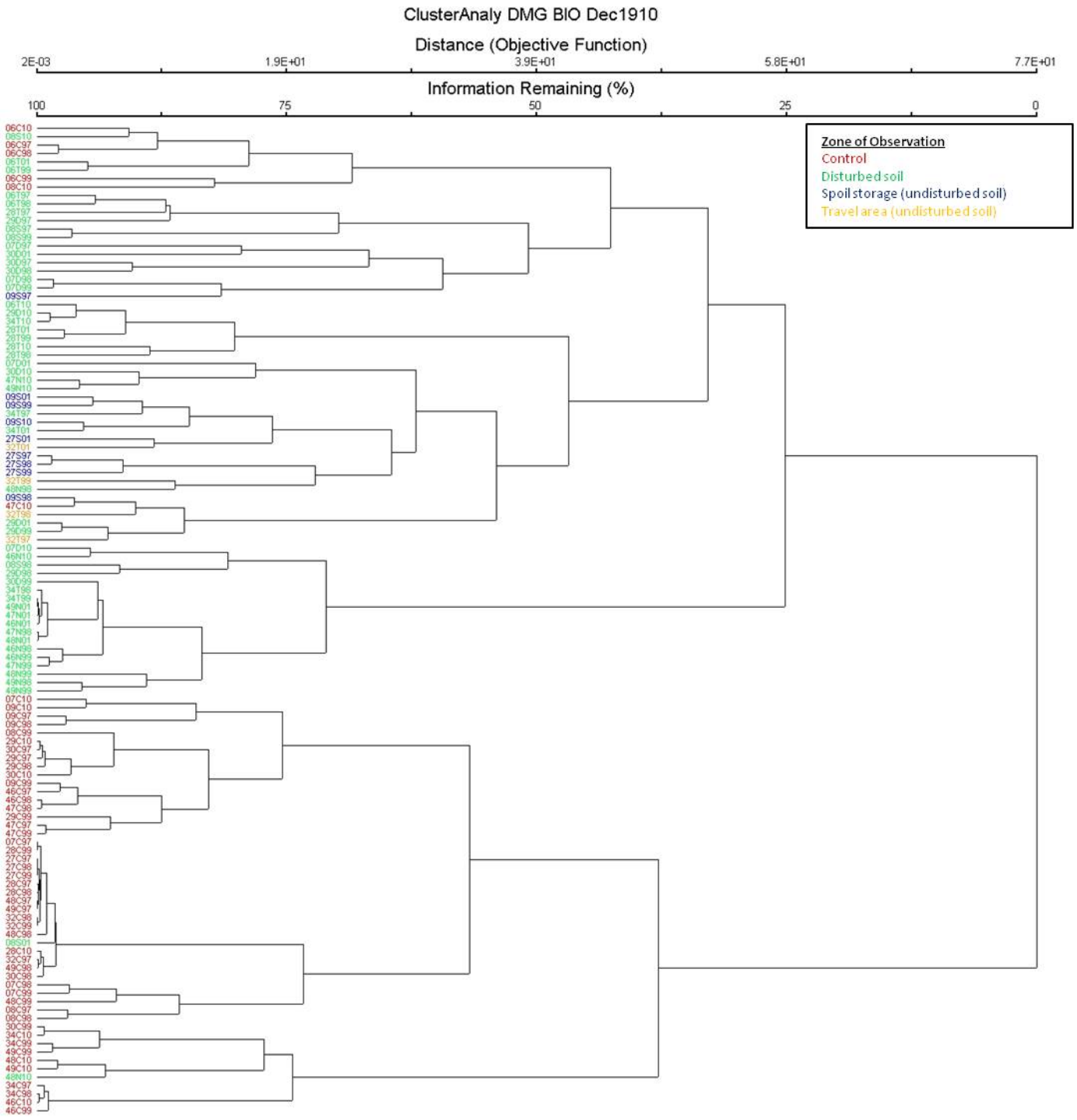
Cluster Analysis

Percent chaining is 1.68%, which is very good (ideal is <10%). This means there were a number of distinct groups to further investigate.

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score 2010	Control Range Health Score 2010	Control Plant Community Code	Control Plant Community Name
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15)/3	DMG Sandy	45	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10)/3	DMG Solonetzic	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/3	DMG Solonetzic	72	75	DMGA16	Western wheatgrass-sedge-Needle-and-thread
09S	Spoil	None - not stripped	fall 96	Berry Creek Plain	HDY(10)/2	DMG Solonetzic	41	63	DMGA15	Wheat grass - needle-and-thread - June grass
27S	Spoil	None - not stripped	fall 96	?	HDY(10)/3	DMG Solonetzic	x	no		
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/4	DMG Solonetzic	no	75	DMGA35	Needle-and-thread - June grass - blue

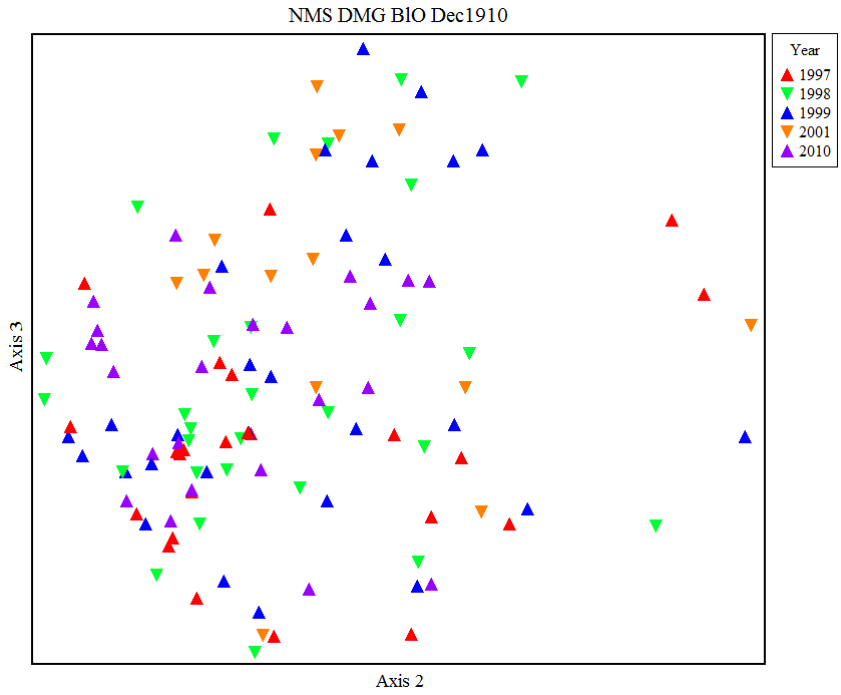
Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score 2010	Control Range Health Score 2010	Control Plant Community Code	Control Plant Community Name
										grama grass
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/4	DMG Solonetzic	72	84	DMGA15	Wheat grass - needle-and-thread - June grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	DMG Solonetzic	66	85	DMGA15	Wheat grass - needle-and-thread - June grass
32T	Travel	None - not stripped	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	69	no		
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	no	59	DMGA3	Needle-and-thread - June grass - blue grama grass
46N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	41	100	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
47N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	84	84	DMGA15	Wheat grass - needle-and-thread - June grass
48N	Disturbed soil	NR	summer 97	Rainy Hills Upland	DHS(10)/3	DMG Solonetzic	72	75	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
49N	Disturbed soil	NR	summer 97	Rainy Hills Upland	ROL(10)/3	DMG Solonetzic	47	84	DMGA48	Blue grama - needle-and-thread

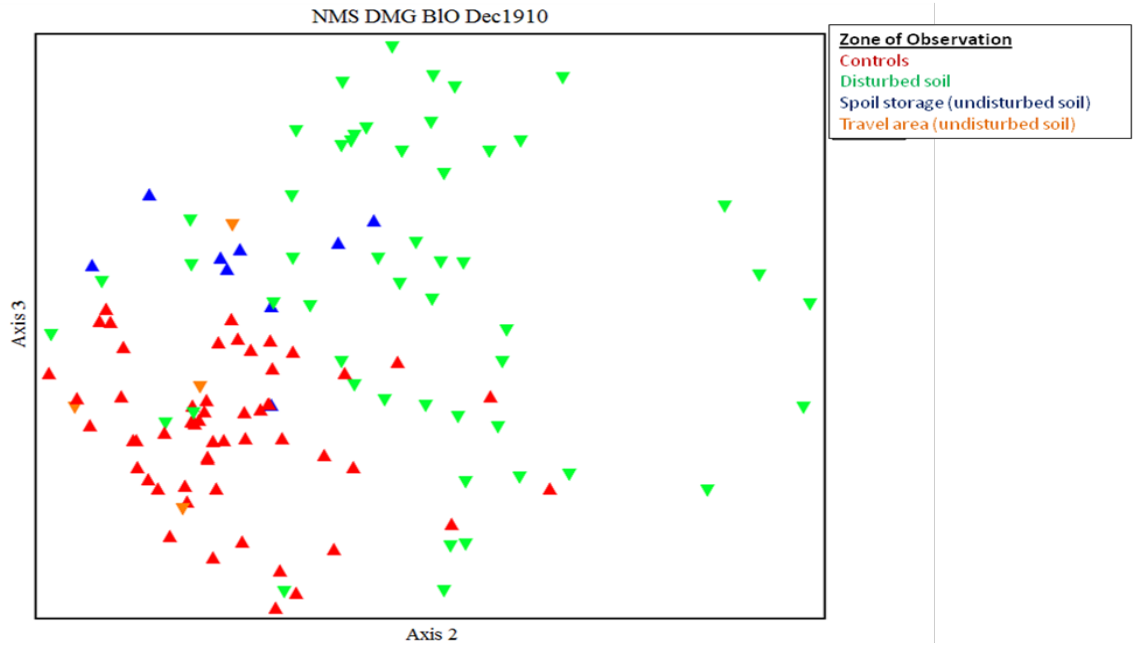

ClusterAnaly DMG BIO Dec1910
Distance (Objective Function)
2E-03
1.9E+01
3.9E+01
5.8E+01
7.7E+01
Information Remaining (%)
100
75
50
25
0
Treatment
Controls and Unstripped soils
Express Mix 3 – DMG Sandy
Express Mix 4 – DMG Solonetzic
Natural Recovery


ClusterAnaly DMG BIO Dec1910
Distance (Objective Function)
2E-03
1.9E+01
3.9E+01
5.8E+01
7.7E+01
Information Remaining (%)
100
75
50
25
0
Zone of Observation
Control
Disturbed soil
Spoil storage (undisturbed soil)
Travel area (undisturbed soil)

NMS Ordination

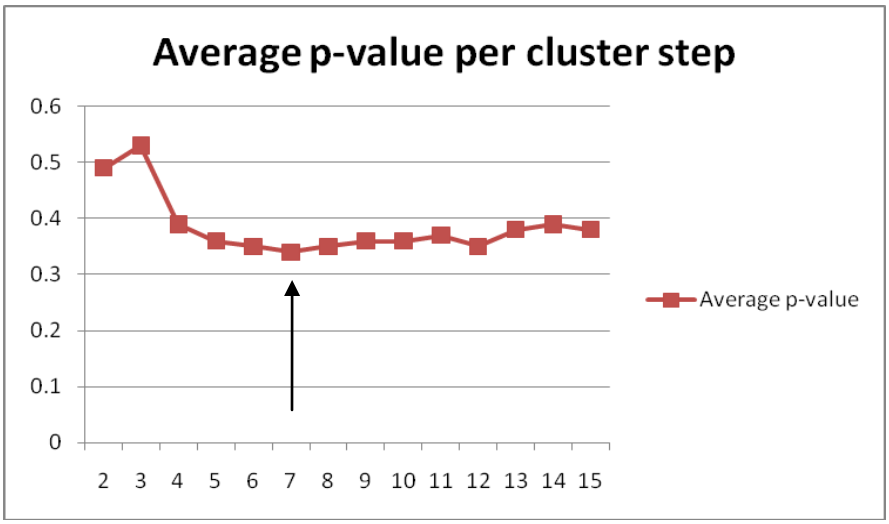
NMS results were useful but not strong. Stress was 15.6 (<10 is ideal, but 10-20 produces useable results if interpreted with caution). A 3D solution was recommended with axes accounting for 77.6% of the variation. The strongest axes were 1 (31.3%) and 2 (25.4%). Each of the preceding metrics has improved from the preliminary report, likely as a result of the reassignment of some sites' ERSs.

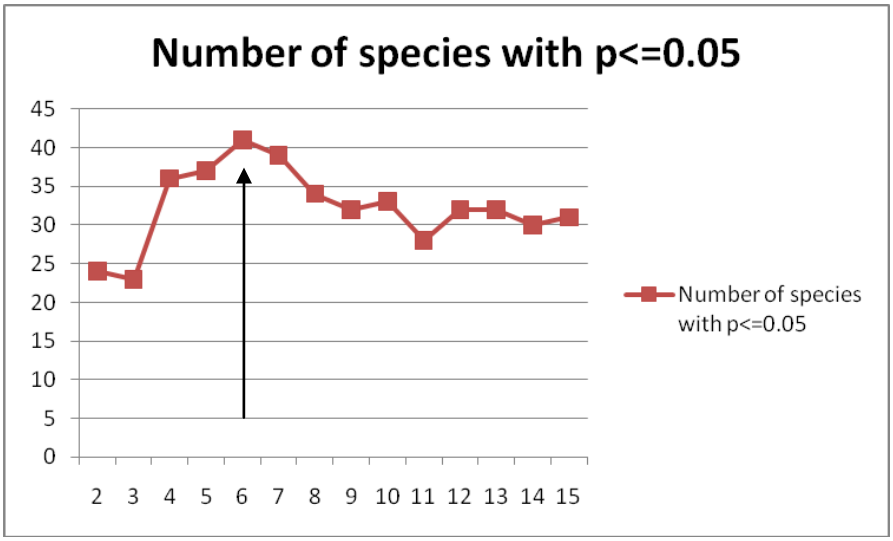


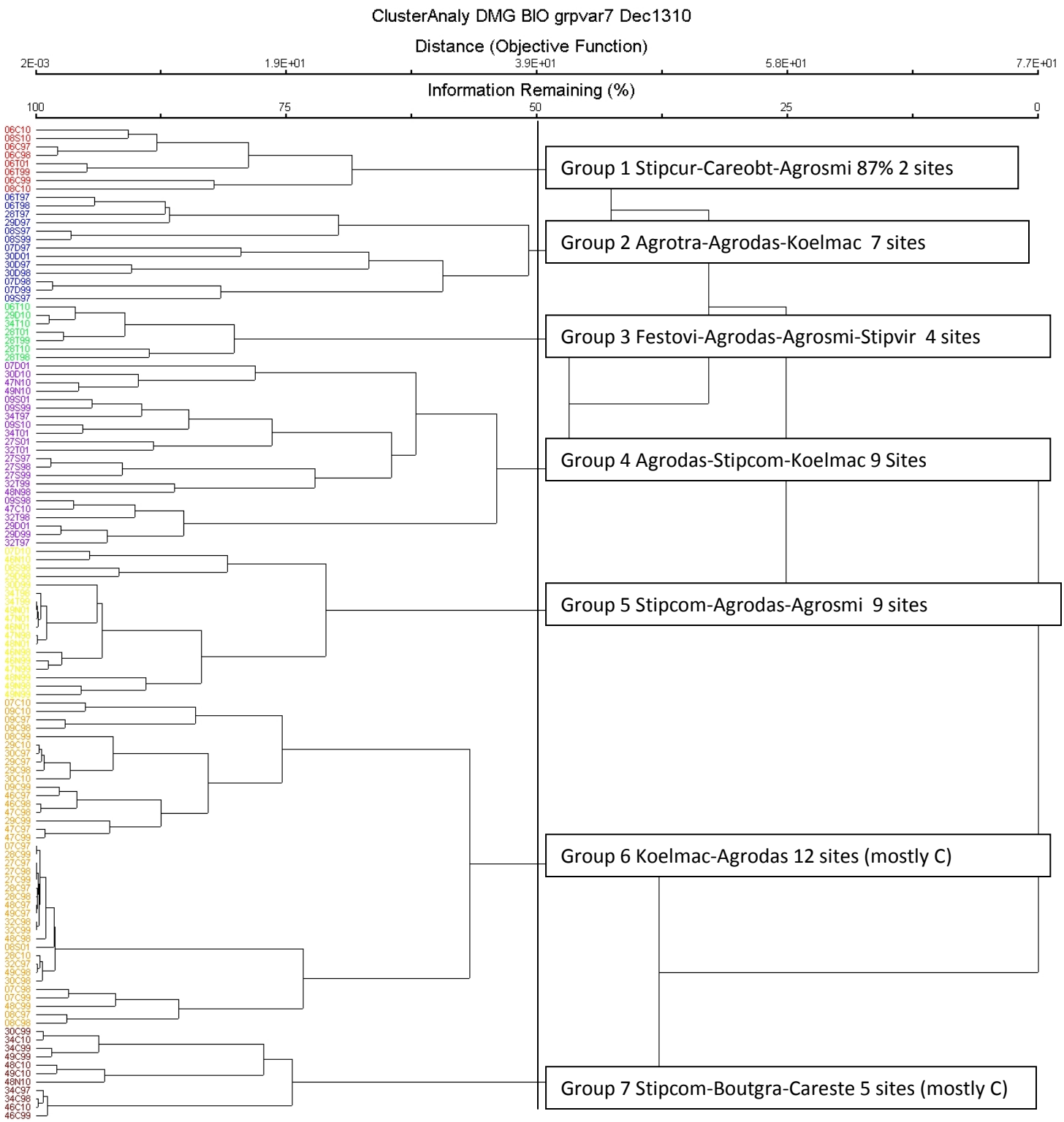


Indicator Species Analysis

The criterion provided by ISA indicated that the dendrogram could be trimmed at either 6 or 7 groups. The lowest average p-value for all species occurred at 7 groups while the highest number of species with an IV p-value of <= 0.05 coincided at 6 groups. The dominant species of the resulting groups were analyzed and it was found that a distinct group emerged when 7 clusters were examined, so the dendrogram was thus trimmed at 7 groups.






ClusterAnaly DMG BIO grpvar7 Dec1310
Distance (Objective Function)
2E-03
1.9E+01
3.9E+01
5.8E+01
7.7E+01
Information Remaining (%)
100
75
50
25
0
Group 1 Stipcur-Careobt-Agrosmi 87% 2 sites
Group 2 Agrotra-Agrodas-Koelmac 7 sites
Group 3 Festovi-Agrodas-Agrosmi-Stipvir 4 sites
Group 4 Agrodas-Stipcom-Koelmac 9 Sites
Group 5 Stipcom-Agrodas-Agrosmi 9 sites
Group 6 Koelmac-Agrodas 12 sites (mostly C)
Group 7 Stipcom-Boutgra-Careste 5 sites (mostly C)

Community Group Identification

The first group on the dendrogram shown above is a late seral plant community from the northern end of the dry mixed grass comprised of control observations and a few observations from treatments sites that were not disturbed (travel and spoil storage sites where the soil was not stripped). It resembled Group 2, which was a group of treatment observations and also resembled the control Groups 6 and 7 in that there was high cover of moss and lichens and pasture sagewort.

Group 1: Blunt sedge - Western wheatgrass - June grass		
	Average Cover (%)	Constancy
CAREOBT	12.7	100
AGROSMI	5.5	100
KOELMAC	4.9	100
STIPCUR	17.2	87.5
Moss and Lichens	5.8	87.5
ARTEFRI	5.8	87.5

Control observations: 5
Disturbed soil observations (stripped and seeded): 2

Sites 06C97, 06C98, 06C99, 06C10
06D01
08C10
08D10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15)/3	DMG Sandy	45	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/3	DMG Solonetzic	72	75	DMGA16	Western wheatgrass-sedge-Needle-and-thread

The second dendrogram group is a pioneer to early seral community from the northern end of the dry mixed grass similar to the first except it lacked a moss and lichen layer and contained a dominance of slender wheatgrass rather than western porcupine grass. The group also differed in that it contained a mixture of observations that had been stripped and not stripped and no control observations were included.

Group 2: Slender wheatgrass – Pasture sagewort Northern wheatgrass		
	Average Cover (%)	Constancy
AGROTRA	7.0	84.6
AGRODAS	2.4	76.9
KOELMAC	1.6	76.9
ARTEFRI	3.4	100

Disturbed soil observations - seeded: 9
Disturbed soil observations – not seeded: 3
Spoil observations: 1 (not stripped)

Sites 06D97, 06D98
07D97, 07D98, 07D99
08D97, 08D99
09S97
28D97
29D97
30N97, 30N98, 30N01

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15)/3	DMG Sandy	45	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10)/3	DMG Solonetzic	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/3	DMG Solonetzic	72	75	DMGA16	Western wheatgrass-sedge-Needle-and-thread
09S	Spoil	None - not stripped	fall 96	Berry Creek Plain	HDY(10)/2	DMG Solonetzic	41	63	DMGA15	Wheat grass - needle-and-thread - June grass
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/4	DMG Solonetzic	72	75	DMGA35	Needle-and-thread - June grass - blue grama grass
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/4	DMG Solonetzic	66	84	DMGA15	Wheat grass - needle-and-thread - June grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	DMG Solonetzic	69	85	DMGA15	Wheat grass - needle-and-thread - June grass

Sites included in Group 3 received treatment with Seed Mix #3 or #4. Grass species present indicate an influence from the seed mix applied.

Group 3: Sheep fescue - Northern wheatgrass – Pasture sagewort		
	Average Cover (%)	Constancy
FESTOVI	15.5	100
AGRODAS	8.3	100
AGROSMI	3.8	100
STIPVIR	3.4	85.7
Moss and Lichens	3.6	71.4
ARTEFRI	6.8	100

Disturbed soil observations - seeded: 6

Sites 06D10
28D98, 28D99, 28D10
29D10
34D10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15)/3
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/4
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/4
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/3

The fourth group includes a large number of sites with a variety of treatments and time periods post-construction. A moss and lichen layer was absent.

Group 4: Pasture sage - Northern wheatgrass - Needle-and-thread		
	Average Cover (%)	Constancy
AGRODAS	6.6	95
STIPCOM	5.6	91
KOELMAC	2.5	86
ARTEFRI	6.7	100

Disturbed soils – stripped and seeded: 6
Disturbed soils – Naturally recovered: 3
#Unstripped spoil storage area: 7
Unstripped travel lane observations: 4
Control observations: 1

Sites 07D01, 09S98, 09S99, 09S10, 27S97, 27S98, 27S99, 27S01, 29D99, 29D01, 30N10, 32T97, 32T98, 32T99, 32T01, 34D97, 34D01, 47N10, 47C10, 48N98, 49N10

Site	Disturb-ance Zone	Seed Mix	Final Clean -up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10) /3	DMG Solonetzic	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
09S	Spoil	not stripped	fall 96	Berry Creek Plain	HDY(10) /2	DMG Solonetzic	41	63	DMGA15	Wheat grass - needle-and-thread - June grass
27S	Spoil	not stripped	fall 96	?	HDY(10) /3	DMG Solonetzic	X	no		
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /4	DMG Solonetzic	66	84	DMGA15	Wheat grass - needle-and-thread - June grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	DMG Solonetzic	69	85	DMGA15	Wheat grass - needle-and-thread - June grass
32T	Travel	not stripped	fall 96	Wildhorse Plain	HUK(10) /3	DMG Solonetzic	X	no		
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /3	DMG Solonetzic	41	59	DMGA3	Needle-and-thread - June grass - blue grama grass
47N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	HUK(10) /3	DMG Solonetzic	72	84	DMGA15	Wheat grass - needle-and-thread - June grass
48N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	DHS(10) /3	DMG Solonetzic	47	75	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
49N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	ROL(10)/ 3	DMG Solonetzic	43	84	DMGA48	Blue grama - needle-and-thread

The fifth group is composed of both seeded and natural recovery sites, largely from two to five years post-construction. Pasture sagewort is the dominant cover species. It was similar to the fourth group in that soils at all sites were disturbed and a moss and lichen layer was absent.

Group 5: Pasture sagewort - Needle-and-thread grass		
	Average Cover (%)	Constancy
ARTEFRI	21.6	100
STIPCOM	3.9	88.9
AGRODAS	2.9	77.8
AGROSMI	2.0	72.2

Disturbed soils – stripped and seeded: 5

Disturbed soils – naturally recovered observations: 12

Sites	
07D10	34T98, 34T99
08D98	46N98, 46N99, 46N01, 46N10,
29D98	47N98, 47N99, 47N01,
30N99	48N99, 48N10
	49N98, 49N99, 49N01

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10)/3	DMG Solonetzic	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/3	DMG Solonetzic	72	75	DMGA16	Western wheatgrass-sedge-Needle-and-thread
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/4	DMG Solonetzic	66	84	DMGA15	Wheat grass - needle-and-thread - June grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	DMG Solonetzic	69	85	DMGA15	Wheat grass - needle-and-thread - June grass
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	41	59	DMGA3	Needle-and-thread - June grass - blue grama grass
46N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	84	100	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
47N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	72	84	DMGA15	Wheat grass - needle-and-thread - June grass
48N	Disturbed soil	NR	summer 97	Rainy Hills Upland	DHS(10)/3	DMG Solonetzic	47	75	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
49N	Disturbed soil	NR	summer 97	Rainy Hills Upland	ROL(10)/3	DMG Solonetzic	43	84	DMGA48	Blue grama - needle-and-thread

The sixth group is the largest control group.

Group 6: Moss and lichen - June grass-Northern wheatgrass		
	Average Cover (%)	Constancy
KOELMAC	5.5	100
AGRODAS	8.6	94.9
Moss and Lichen	49.7	100
ARTEFRI	5.5	89.7

Control observations: 38
Disturbed and seeded observations: 1

07C97, 07C98, 07C99, 07C10
08C97, 08C98, 08C99, 08D01
09C97, 09C98, 09C99, 09C10
27C97, 27C98, 27C99,
28C97, 28C98, 28C99, 28C10
29C97, 29C98, 29C99, 29C10
30C97, 30C98, 30C10
32C97, 32C98, 32C99,
46C97, 46C98
47C97, 47C98, 47C99,
48C97, 48C98, 48C99,
49C97, 49C98

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10)/3	DMG Solonetzic	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/3	DMG Solonetzic	72	75	DMGA16	Western wheatgrass-sedge-Needle-and-thread
09S	Spoil	None - not stripped	fall 96	Berry Creek Plain	HDY(10)/2	DMG Solonetzic	41	63	DMGA15	Wheat grass - needle-and-thread - June grass
27S	Spoil	None - not stripped	fall 96	?	HDY(10)/3	DMG Solonetzic	X	no		
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/4	DMG Solonetzic	72	75	DMGA35	Needle-and-thread - June grass - blue grama grass
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/4	DMG Solonetzic	66	84	DMGA15	Wheat grass - needle-and-thread - June grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	DMG Solonetzic	69	85	DMGA15	Wheat grass - needle-and-thread - June grass
32T	Travel	None - not stripped	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	x	no		
46N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	84	100	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
47N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	72	84	DMGA15	Wheat grass - needle-and-thread - June grass
48N	Disturbed soil	NR	summer 97	Rainy Hills Upland	DHS(10)/3	DMG Solonetzic	47	75	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
49N	Disturbed soil	NR	summer 97	Rainy Hills Upland	ROL(10)/3	DMG Solonetzic	43	84	DMGA48	Blue grama - needle-and-thread

The seventh group contained one naturally recovered site and different dominant native grasses than the sixth group.

Group 7: Needle-and-thread - Blue grama - Low sedge		
	Average Cover (%)	Constancy
STIPCOM	19.8	100
BOUTGRA	14.8	100
CARESTE	3.0	100
Moss and Lichen	19.3	100
ARTEFRI	6.4	90.9

Control observations: 10
Natural recovery observations: 1 (stripped)

30C99
34C97, 34C98, 34C99, 34C10
46C99, 46C10
48N01, 48C10
49C99, 49C10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	DMG Solonetzic	69	85	DMGA15	Wheat grass - needle-and-thread - June grass
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	41	59	DMGA3	Needle-and-thread - June grass - blue grama grass
46N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	84	100	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
48N	Disturbed soil	NR	summer 97	Rainy Hills Upland	DHS(10)/3	DMG Solonetzic	47	75	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
49N	Disturbed soil	NR	summer 97	Rainy Hills Upland	ROL(10)/3	DMG Solonetzic	43	84	DMGA48	Blue grama - needle-and-thread

Loamy (Lo)

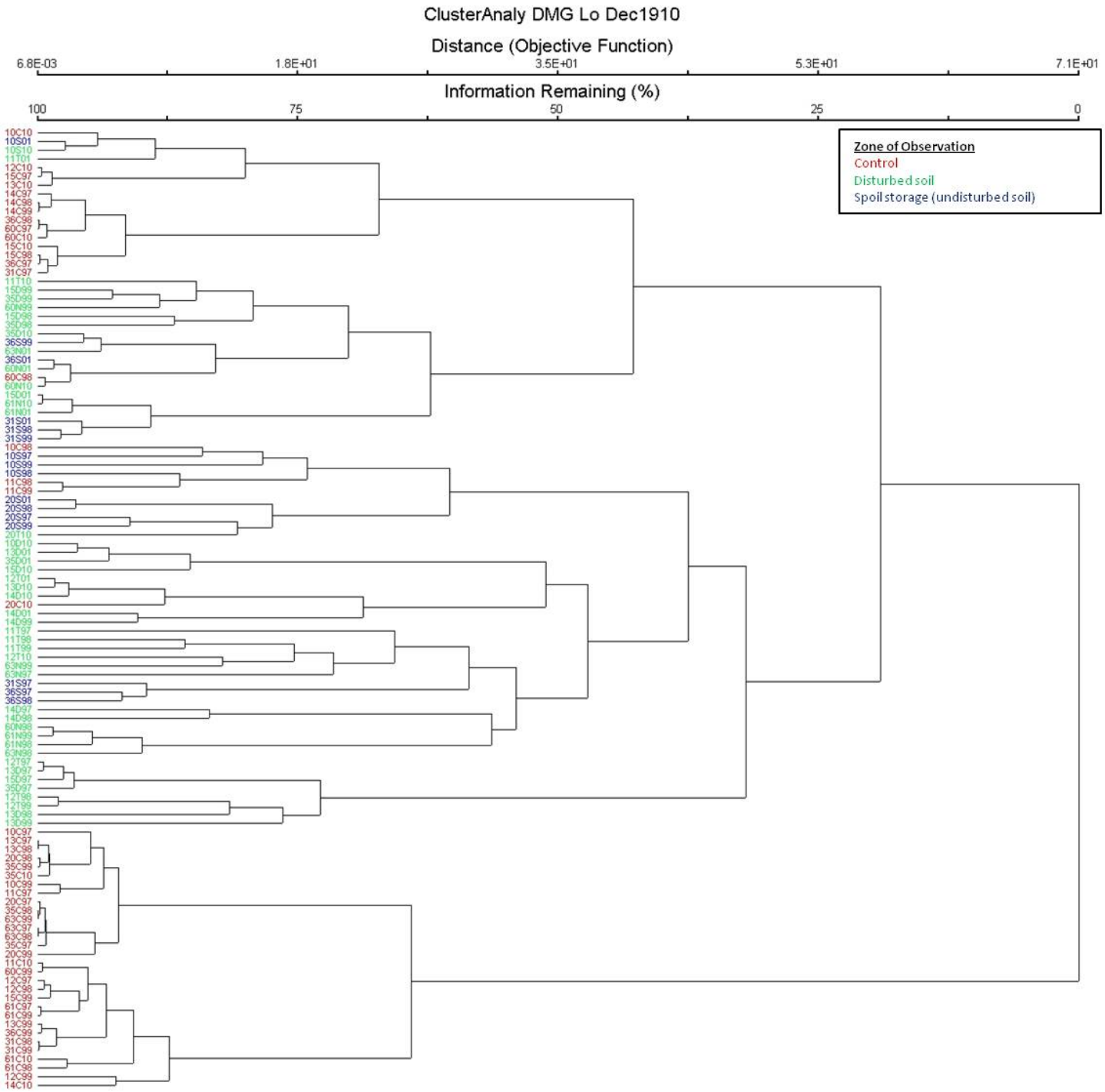
Sites #10-15, 20, 31, 35, 36, 60, 61, 63.

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
10S	Spoil (97,98,99,01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		x	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		64	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	Reseeded in 2004 to same seed mix; REMOVE 2010 RoW sample data??	47	47	DMGA3-Degraded	Needle-and-thread-June grass-blue grama grass (degraded)
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10)/3-4 Sol	this site spot reseeded in 2004; REMOVE 2010 RoW sample data??	36	75	DMGA3	Needle-and-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/3-4		46	100	DMGA47	Needle-and-thread - blue grama - northern wheatgrass
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3		63	71		Needle-&-thread - June Grass - Western hweatgrass
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	Reseeded in 2004 to the same seed mix	x	60	DMGA3	Needle-and-thread - June grass - blue grama grass
20S	Spoil	None - not stripped	fall 96	Cypress Slope	PUR(10)/3-4	Based on species comp, this is in the Fescue/Mixedgrass Transition - maybe seed mix 2 as there is no Festovi here.	x	72	MGA1	Plains rough fescue - western porcupine grass - sedge
20D	Disturbed soil	2	fall 96	Cypress Slope	PUR(10)/3-4	Based on species comp, this is in the Fescue/Mixedgrass Transition - maybe seed mix 2 as there is no Festovi here.	68	72	MGA1	Plains rough fescue - western porcupine grass - sedge
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10)/3		x	no		
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10)/2-3		40	82	DMGA2	Needle-and-thread - wheatgrass

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10)/4		x	no		
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	75	97	DMGA3	Needle-and-thread - June grass - blue grama grass
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	78	88	DMGA2	Needle-and-thread - wheatgrass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3		x	x		

Cluster Analysis

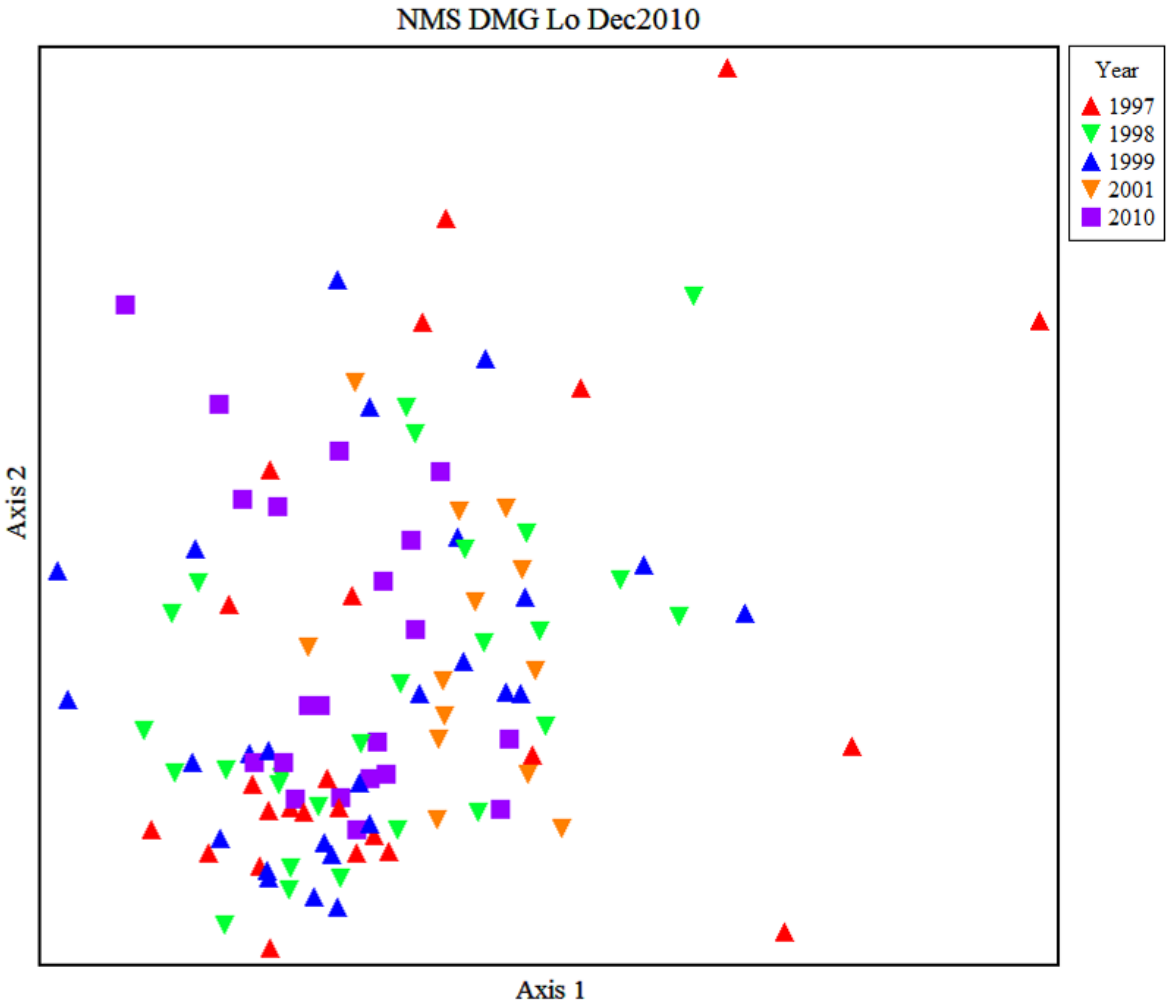
Percent chaining is 1.38%, which is quite good (ideal is <10%). As with the Dry Mixedgrass Blowout dataset, no apparent grouping of observations by year (indicating a successional pattern) or seed mix treatment were observed. Rather, the dominant pattern was a separation of control (red; zone 1) and disturbed or treated sites.

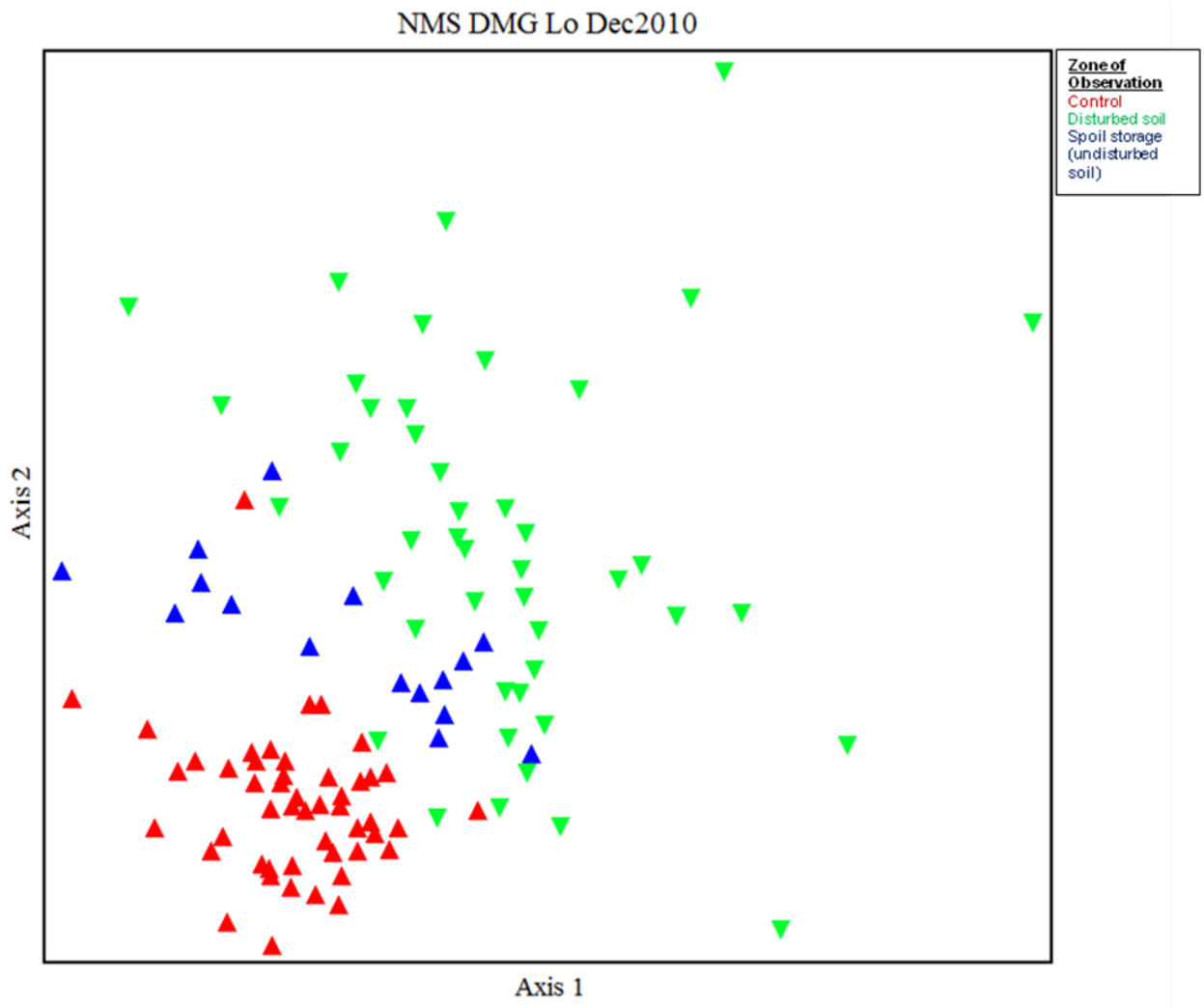


NMS Ordination

A 2D ordination solution was recommended for this dataset. This result included a barely acceptable stress level of 20.0, meaning the results should be used very conservatively (<10 is ideal, but 10-20 produces useable results if interpreted with caution). The cumulative variance accounted for by the three axes was 69.2%, which is moderately good: axis 1 (32.9%) and axis 2 (36.3%). Overall, these metrics were reduced from those of the Loamy group identified in the preliminary report.

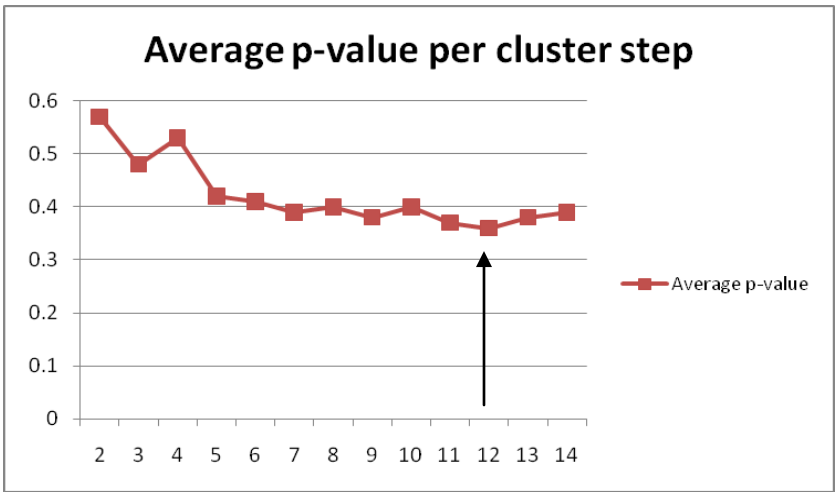
No apparent trend relating to year of sampling is immediately observable, but the trend of grouping of control sites is again visible:

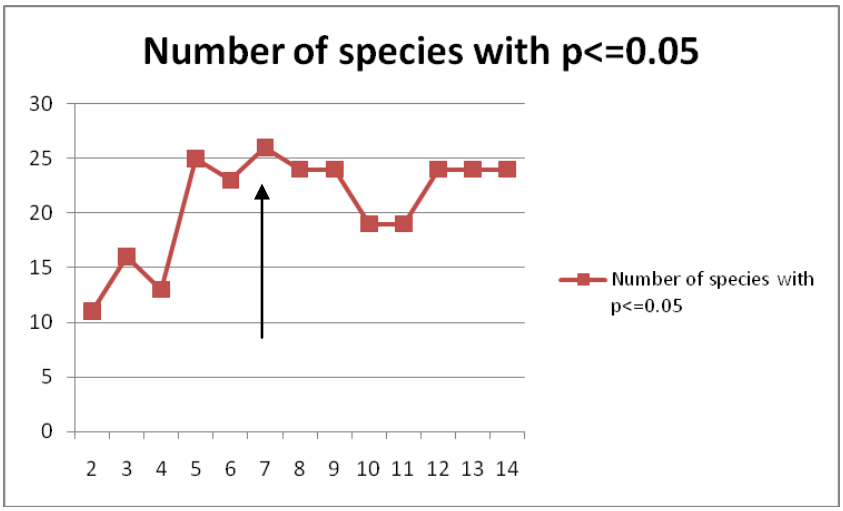


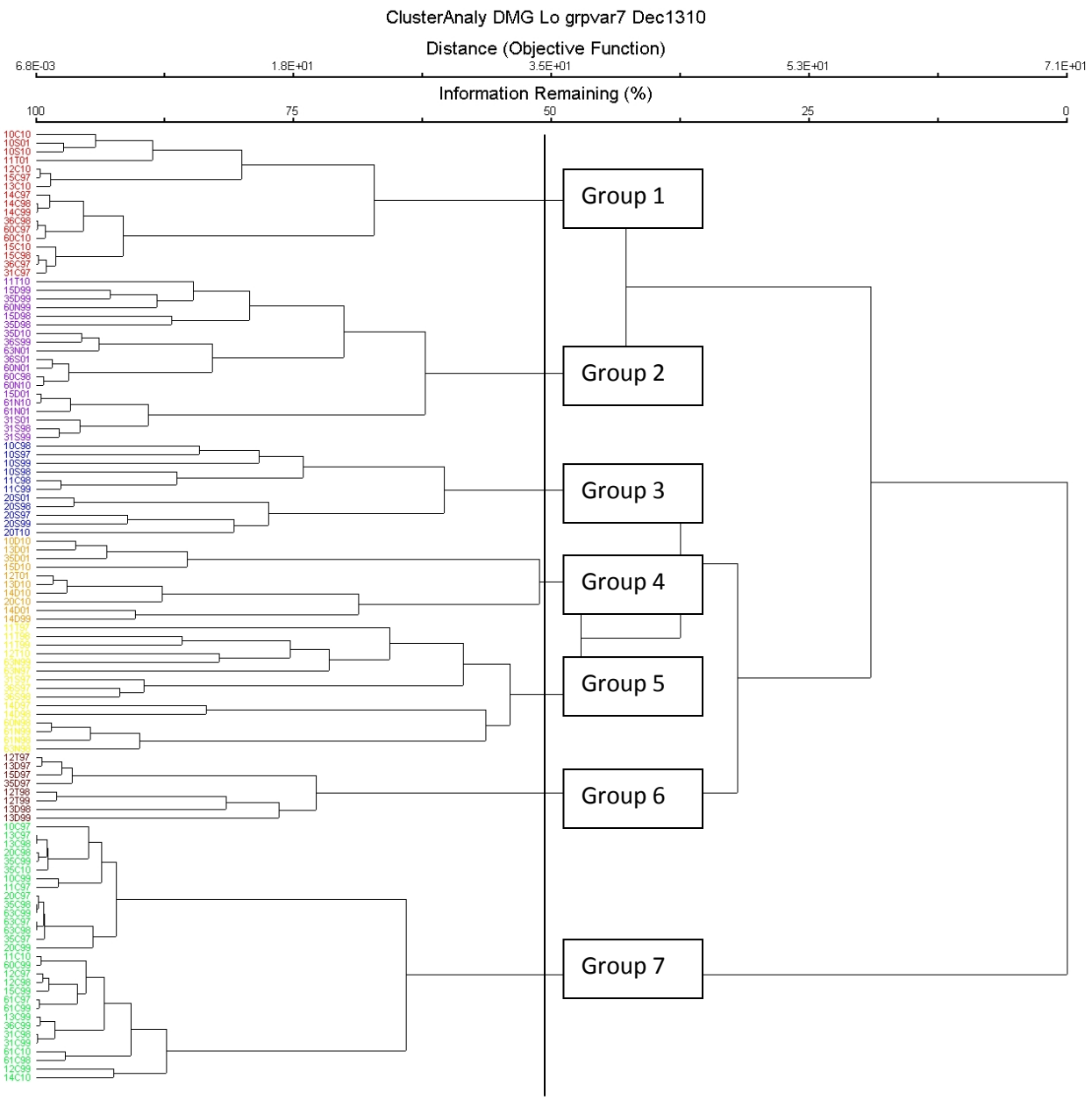


Indicator Species Analysis

The criterion provided by ISA indicated that the dendrogram could be trimmed at either 7 or 12 groups. The lowest average p-value for all species occurred at 12 (0.36) groups while the highest number of species with an IV p-value of <= 0.05 coincided at 7 groups (26). The dendrogram was subsequently trimmed at 7 groups for simplicity, but 12 groups can be analyzed in the future if necessary.


Average p-value per cluster step
0.6
0.5
0.4
0.3
0.2
0.1
0
2 3 4 5 6 7 8 9 10 11 12 13 14
Average p-value


Number of species with p<=0.05
30
25
20
15
10
5
0
2 3 4 5 6 7 8 9 10 11 12 13 14
Number of species with p<=0.05


ClusterAnaly DMG Lo grpvar7 Dec1310
Distance (Objective Function)
6.8E-03
1.8E+01
3.5E+01
5.3E+01
7.1E+01
Information Remaining (%)
100
75
50
25
0
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6
Group 7

Community Group Identification

The dominant species for the overall Lo dataset were characteristically native grasses, with FESTOVI becoming dominant in one group. STIPVIR also emerges as a dominant species for a group.

The first of seven groups identified by the ISA had a large number of control sites within it.

Group 1: Needle-and-thread Low sedge - June grass		
	Average Cover (%)	Constancy
STIPCOM	28.1	100
CARESTE	6.2	100
KOELMAC	6.3	94.1
BOUTGRA	7.4	82.4
Moss and lichens	18.8	100

Control observations: 14
Unstripped spoil storage area observations: 2
Disturbed soils – seeded: 1

10C10, 10S01, 10S10
11D01
12C10
13C10
14C97, 14C98, 14C99
15C97, 15C98, 15C10
31C97
36C97, 36C98
61C97, 61C10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
10S	Spoil (97,98,99,01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		X	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		64	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	Reseeded in 2004 to same seed mix; REMOVE 2010 RoW sample data??	47	47	DMGA3-Degraded	Needle-and-thread-June grass-blue grama grass (degraded)
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10)/3-4 Sol	this site spot reseeded in 2004; REMOVE 2010 RoW sample data??	36	75	DMGA3	Needle-and-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/3-4		46	100	DMGA47	Needle-and-thread - blue grama - northern wheatgrass
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3		63	71		Needle-&-thread - June Grass - Western hweatgrass
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	Reseeded in 2004 to the same seed mix	X	60	DMGA3	Needle-and-thread - June grass - blue grama grass
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10)/3		X	no		
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10)/4		X	no		
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	78	88	DMGA2	Needle-and-thread - wheatgrass

The second group consisted of mostly disturbed sites, so the moss and lichen layer was missing. However, the presence of native grasses and the inclusion in the group of control and no-stripped spoil sites likely indicates good recovery among these sites.

Group 2: Needle-and-thread - Pasture sagewort - Northern wheatgrass		
	Average Cover (%)	Constancy
STIPCOM	14	100
AGRODAS	4.8	84.2
KOELMAC	1.4	78.9
ARTEFRI	5.9	100

Disturbed and seeded soils observations: 7
Unstripped spoil storage area observations: 5
Control observations: 1
Disturbed natural recovery observations: 6

Sites:

11D10
15D98, 15D99, 15D01
31S98, 31S99, 31S01
35D98, 35D99, 35D10
36S01, 36S99
60C98, 60N99, 60N01, 60N10
61N01, 61N10
63N01

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	Reseeded in 2004 to same seed mix; REMOVE 2010 RoW sample data??	47	47	DMGA3-Degraded	Needle-and-thread-June grass-blue grama grass (degraded)
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	Reseeded in 2004 to the same seed mix	X	60	DMGA3	Needle-and-thread - June grass - blue grama grass
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10)/3		X	no		
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10)/2-3		40	82	DMGA2	Needle-and-thread - wheatgrass
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10)/4		X	no		
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	75	97	DMGA3	Needle-and-thread - June grass - blue grama grass
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	78	88	DMGA2	Needle-and-thread - wheatgrass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3		X			

The third group consisted largely of control and unstripped sites and thus was dominated by native grasses. The moss and lichen layer was present on a majority of sites at 6% average cover on 63.6% of the sites.

Group 3: Western wheatgrass-Blue grama - June grass		
	Average Cover (%)	Constancy
AGROSMI	10.6	100
BOUTGRA	9.5	90.9
KOELMAC	1.9	90.9

Control observations: 3
Unstripped spoil storage area observations: 7
Disturbed and seeded soils observations: 1

Sites: 10C98, 10S97, 10S98, 10S99
11C98, 11C99
20S01, 20S97, 20S98, 20S99,
20D10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
10S	Spoil (97,98,99,01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		X	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		64	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	Reseeded in 2004 to same seed mix; REMOVE 2010 RoW sample data??	47	47	DMGA3-Degraded	Needle-and-thread-June grass-blue grama grass (degraded)
20S	Spoil	None - not stripped	fall 96	Cypress Slope	PUR(10)/3-4	Based on species comp, this is in the Fescue/Mixedgrass Transition - maybe seed mix 2 as there is no Festovi here.	X	72	MGA1	Plains rough fescue - western porcupine grass - sedge
20D	Disturbed soil	2	fall 96	Cypress Slope	PUR(10)/3-4	Based on species comp, this is in the Fescue/Mixedgrass Transition - maybe seed mix 2 as there is no Festovi here.	68	72	MGA1	Plains rough fescue - western porcupine grass - sedge

The fourth group contained a majority of disturbed and seeded sites. Most are observations five and 14 years after construction in 2001 and 2010; seed mix still dominant. It was dominated by FESTOVI and STIPVIR, in addition to wheat grasses.

Group 4: Northern wheatgrass - Green needle grass - Sheep fescue		
	Average Cover (%)	Constancy
AGRODAS	14.7	100
STIPVIR	4.3	90
FESTOVI	11.8	80
AGROSMI	3.2	90
ARTEFRI	3.8	80

Disturbed soils - seeded observations: 9
Control observations: 1

Sites 10D10
12D01
13D01, 13D10
14D99, 14D01, 14D10
15D10
20C10 – no festovi at this site
35D01

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
10S	Spoil (97,98,99, 01,10)	not stripped	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy		X	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy		64	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10) /3-4 Sol	this site spot reseeded in 2004; REMOVE 2010 RoW sample data??	36	75	DMGA3	Needle-and-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/ 3-4		46	100	DMGA47	Needle-and-thread - blue grama - northern wheatgrass
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3		63	71		Needle-&-thread - June Grass - Western hweatgrass
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	Reseeded in 2004 to the same seed mix	X	60	DMGA3	Needle-and-thread - June grass - blue grama grass
20S	Spoil	None - not stripped	fall 96	Cypress Slope	PUR(10) /3-4	Based on species comp, this is in the Fescue/Mixedgrass Transition - maybe seed mix 2 as there is no Festovi here.	X	72	MGA1	Plains rough fescue - western porcupine grass - sedge
20D	Disturbed soil	2	fall 96	Cypress Slope	PUR(10) /3-4	Based on species comp, this is in the Fescue/Mixedgrass Transition - maybe seed mix 2 as there is no Festovi here.	68	72	MGA1	Plains rough fescue - western porcupine grass - sedge
35D	Disturbed soil	Sod salvage Site	fall 96	Wildhorse Plain	ANO(10) /2-3		40	82	DMGA2	Needle-and-thread - wheatgrass

The fifth group was made up of sites that were stripped and the group did not present many obviously dominant grass species. All are early seral recovery sites, seeded and unseeded. A number of other grass and forb species were present in addition to those listed below; however, they were of constancy 66.7 or lower.

Group 5: Northern wheatgrass - Pasture sagewort		
	Average Cover (%)	Constancy
AGRODAS	3.7	80
ARTEFRI	8.1	86.7

Disturbed and seeded soils observations: 6
Unstripped spoil storage area observations: 3
Disturbed and naturally recovered soils observations: 6

Sites: 11D97, 11D98, 11D99
12D10
14D97, 14D98
31S97
36S97, 36S98
60N98
61N98, 61N99
63N97, 63N98, 63N99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	Reseeded in 2004 to same seed mix; REMOVE 2010 RoW sample data??	47	47	DMGA3-Degraded	Needle-and-thread-June grass-blue grama grass (degraded)
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10)/3-4 Sol	this site spot reseeded in 2004; REMOVE 2010 RoW sample data??	36	75	DMGA3	Needle-and-thread - June grass - blue grama grass
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3		63	71		Needle-&-thread - June Grass - Western hweatgrass
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10)/3		X	no		
35D	Disturbed soil	Sod salvage Site	fall 96	Wildhorse Plain	ANO(10)/2-3		40	82	DMGA2	Needle-and-thread - wheatgrass
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10)/4		X	no		
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	75	97	DMGA3	Needle-and-thread - June grass - blue grama grass
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	78	88	DMGA2	Needle-and-thread - wheatgrass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3		X			

The sixth group is a pioneer to early seral community comprised of stripped and seeded sites and also didn't possess any dominant species that were of 100% constancy.

Group 6: Slender wheatgrass - Northern wheatgrass - Green needle grass		
	Average Cover (%)	Constancy
AGROTRA	19.5	100
AGRODAS	7.1	87.5
STIPCOM	3.2	87.5
KOELMAC	0.5	87.5
ARTEFRI	3.1	75

Disturbed and seeded soils observations 8

Sites 12D97, 12D98, 12D99
13D97, 13D98, 13D99
15D97
35D97

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10)/3-4 Sol	this site spot reseeded in 2004	36	75	DMGA3	Needle-and-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/3-4		46	100	DMGA47	Needle-and-thread - blue grama - northern wheatgrass
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	Reseeded in 2004 to the same seed mix	X	60	DMGA3	Needle-and-thread - June grass - blue grama grass
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10)/2-3		40	82	DMGA2	Needle-and-thread - wheatgrass

The seventh group possessed the majority of control sites for this dataset. There were observations from 1997 to 2010 within this group.

Group 7: June grass - Needle-and-thread - Blue grama		
	Average Cover (%)	Constancy
KOELMAC	5.7	100
STIPCOM	15.9	96.7
BOUTGRA	7.3	90
Moss and Lichens	47.3	100

Control observations: 30

Sites: 10C97, 10C99
11C97, 11C10
12C97, 12C98, 12C99
13C97, 13C98, 13C99
14C10
15C99
20C97, 20C98, 20C99
31C98, 31C99
35C97, 35C98, 35C99, 35C10
36C99
60C97, 60C99, 60C10
61C98, 61C99
63C97, 63C98, 63C99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
10S	Spoil (97,98,99,01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		x	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/4 Sandy		64	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	Reseeded in 2004 to same seed mix; REMOVE 2010 RoW sample data??	47	47	DMGA3-Degraded	Needle-and-thread-June grass-blue grama grass (degraded)
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10)/3-4 Sol	this site spot reseeded in 2004; REMOVE 2010 RoW sample data??	36	75	DMGA3	Needle-and-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/3-4		46	100	DMGA47	Needle-and-thread - blue grama - northern wheatgrass
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3		63	71		Needle-&-thread - June Grass - Western hweatgrass
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	Reseeded in 2004 to the same seed mix	x	60	DMGA3	Needle-and-thread - June grass - blue grama grass

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Comments	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
20S	Spoil	None - not stripped	fall 96	Cypress Slope	PUR(10)/3-4	Based on species comp, this is in the Fescue/Mixedgrass Transition - maybe seed mix 2 as there is no Festovi here.	x	72	MGA1	Plains rough fescue - western porcupine grass - sedge
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10)/3		x	no		
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10)/2-3		40	82	DMGA2	Needle-and-thread - wheatgrass
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10)/4		x	no		
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	75	97	DMGA3	Needle-and-thread - June grass - blue grama grass
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	Discard data for 1997 - change in sampling protocol thereafter	78	88	DMGA2	Needle-and-thread - wheatgrass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3		x			

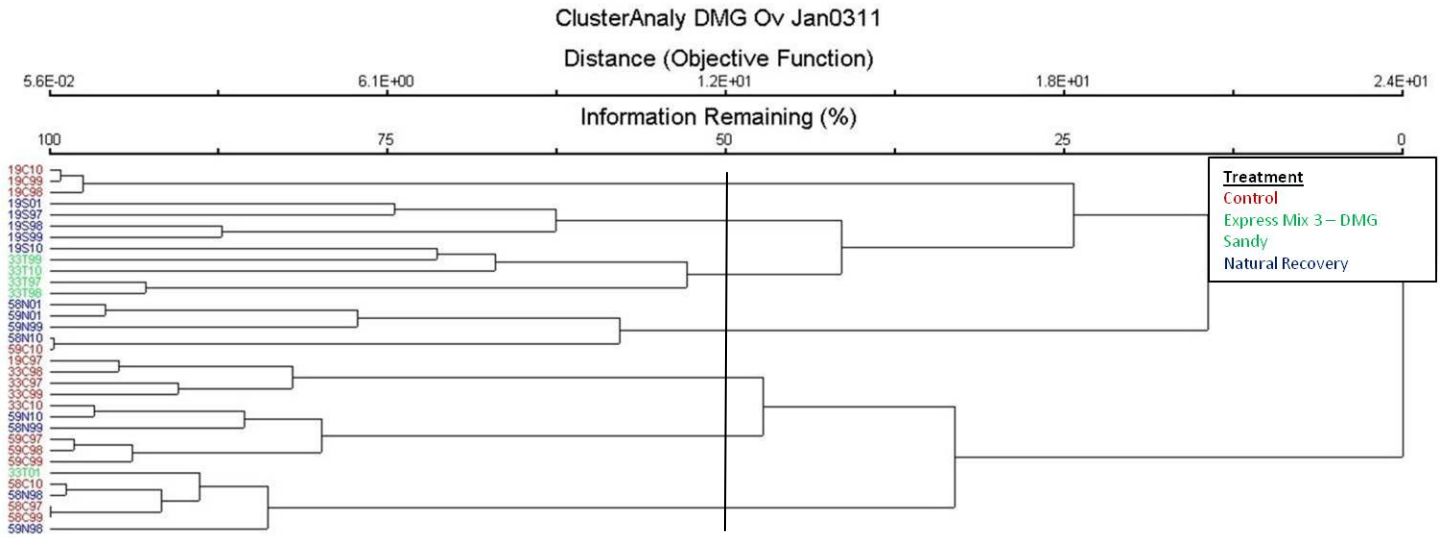
Overflow (Ov)

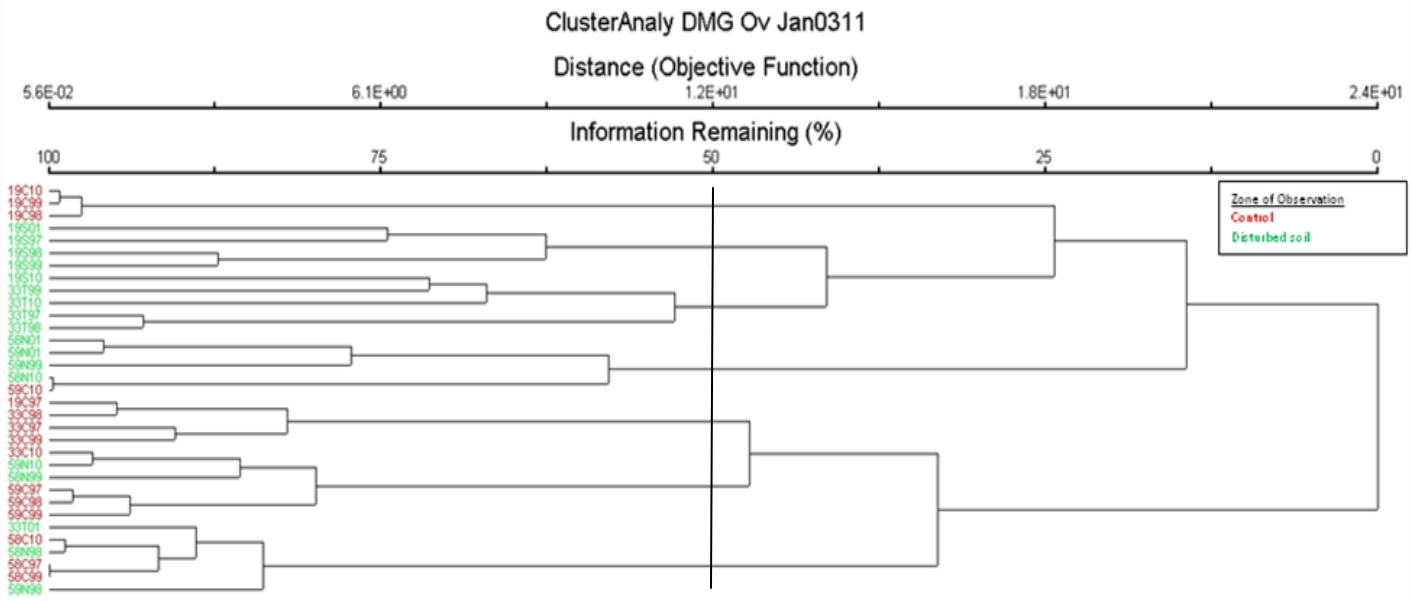
Sites #19, 33, 58 and 59.

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
19N	Disturbed soil	NR	spring 97	Bindloss Plain	HMS(5)/4-5	DMG Solonetzic	32	42	DMGA24-Degraded	Silver sagebrush/needle-and-thread - western wheat grass - blue grama grass (degraded)
33D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/3	DMG Solonetzic	53	50		Crested wheatgrass - blue grama - selaginella
58N	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	95	85	DMGC1	Silver sagebrush/western wheatgrass
59N	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	47	32	DMGC1	Silver sagebrush/western wheatgrass

Cluster Analysis

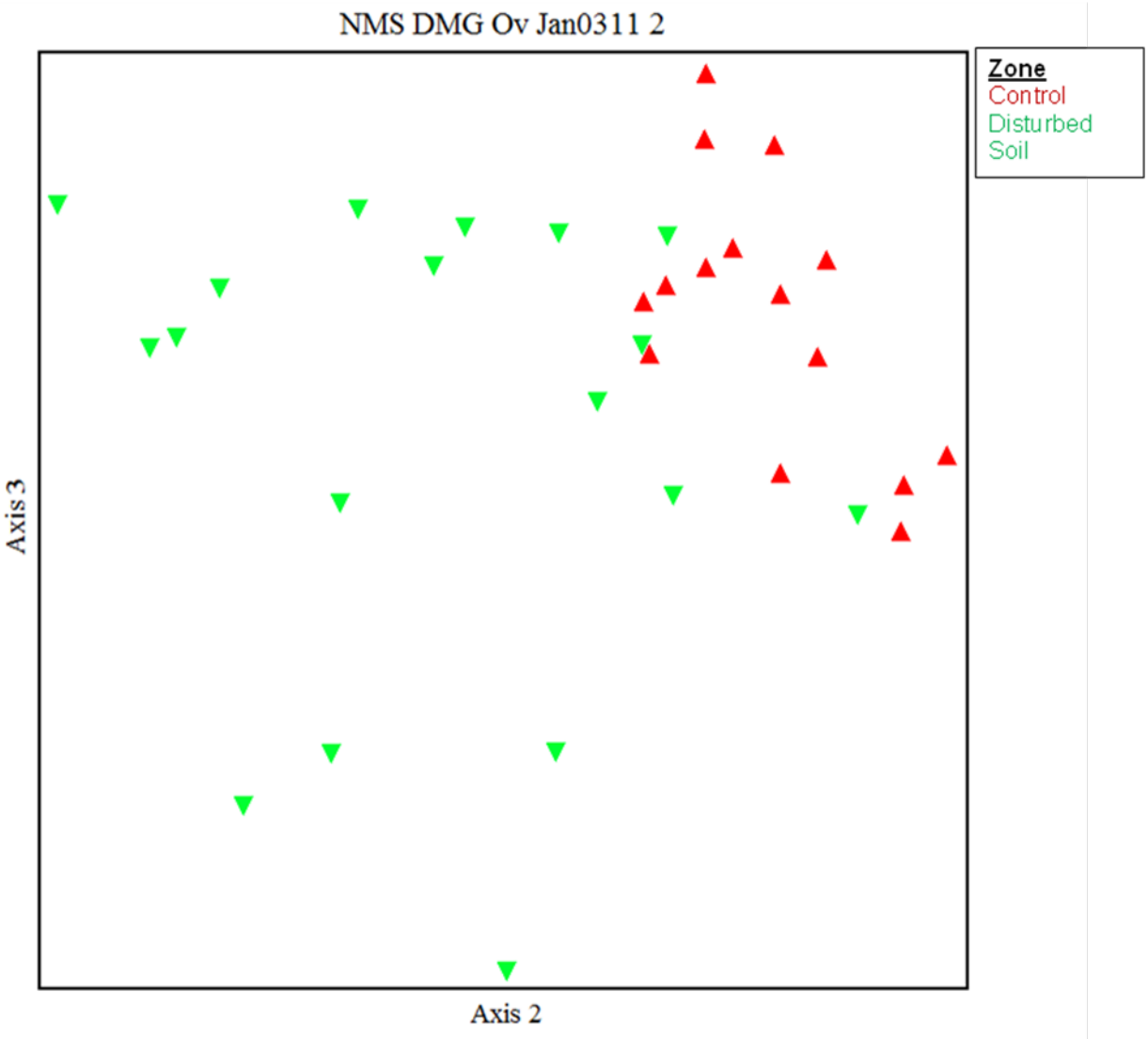
Percent chaining is 2.54%, which is very good (ideal is <10%). Groups 1-5 appeared to correspond to differing seed mix treatments; however, groups 6 and 7 were composed of observations of mixed seed mix treatment. Groups 1-5 were also mostly distinct in control or disturbed/treated observations, while Groups 6 and 7 were of mixed identities. Once again, there was not a successional trend observed when sites were analyzed by year.





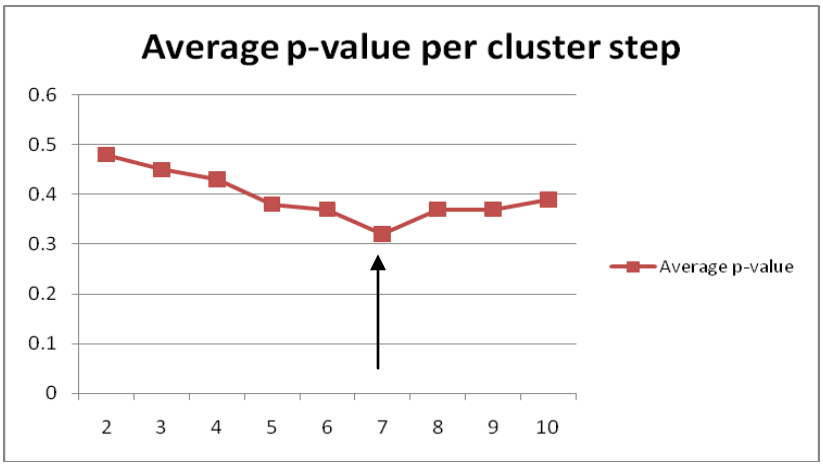
NMS Ordination

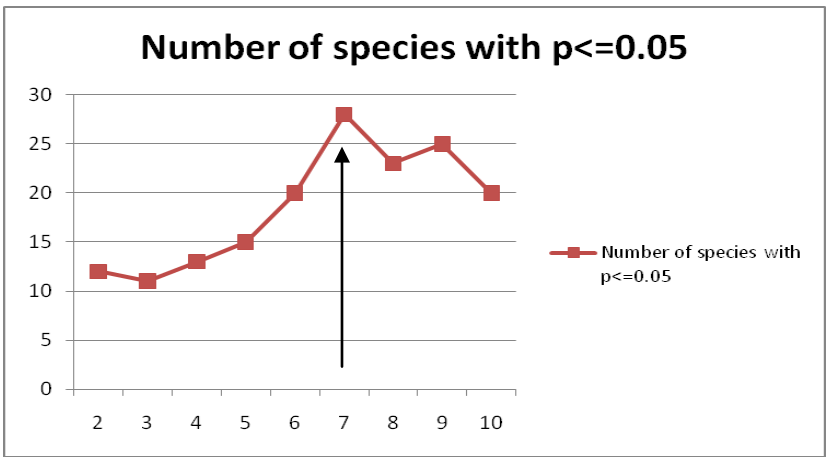
The ordination produced a 3D solution with acceptable stress (13.3). The cumulative variation accounted for in the solution was good at 77.9%, with axes 2 (37.5%) and 3 (25.5%) being the strongest. Each of these metrics were slightly reduced from the sites assigned to the overflow ERS in the preliminary report, despite sample size being increased. Again, controls appeared to be mostly distinct from the disturbed/treated observations.

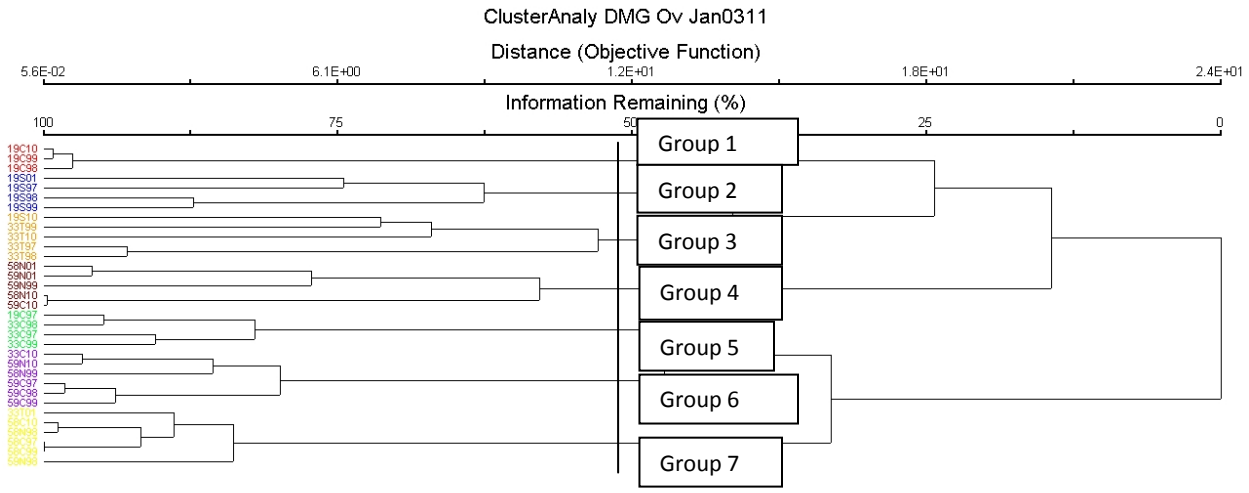

NMS DMG Ov Jan0311 2
Zone
Control
Disturbed
Soil
Axis 3
Axis 2

Indicator Species Analysis

ISA identified a solution of seven clusters by the objective criterion of having the lowest average p-value for indicator values (0.32) and the highest number of indicator species (28).







Community Group Identification

The dominant species for the first group of sites are below. The group was only made up of 1998, 1999 and 2010 observations for Site 19.

Group 1: Blue grama – Low sedge - Western wheatgrass		
	Average Cover (%)	Constancy
BOUTGRA	18.1	100
CARESTE	12.0	100
AGROSMI	10.3	100
Moss and Lichens	1.3	100

Control observations: 3
Sites: 19C98 19C99 19C10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
19N	Disturbed soil	NR	spring 97	Bindloss Plain	HMS(5)/4-5	DMG Solonetzic	32	42	DMGA24-Degraded	Silver sagebrush/needle-and-thread - western wheat grass - blue grama grass (degraded)

The second group is made up of 1997, 1998, 1999 and 2001 observations for the paired spoil site at Site 19. The community differs greatly from that of the controls in Group 1. The group had a low number of species present overall and most species in the group only had a constancy of 50. It is anticipated that the sites have high bare soil cover.

Group 2: Tumble grass		
	Average Cover (%)	Constancy
SCHEPAN	3.0	100
CHENPRA	2.7	75
STIPVIR	1.2	75

Disturbed and naturally recovered soils observations: 4
Sites: 19N97 19N98 19N99 19N01

The third group had slightly more species present than Group 3, but these species were also mostly of 20 and 40% constancy. This group was also comprised entirely of observations from stripped sites.

Group 3: Green needle grass		
	Average Cover (%)	Constancy
STIPVIR	5.2	80
AGROSMI	3.6	60

Disturbed and seeded soils observations: 4
Disturbed and naturally recovered soils observations: 1
Sites: 19N10
33D97 33D98 33D99 33D10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
33D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/3	DMG Solonetzic	53	50		Crested wheatgrass - blue grama - selaginella

The fourth group was comprised of control and naturally recovered sites, but was dominated only by silver sagebrush, with other grass and forb species only reaching 60% constancy.

Group 4: Silver sagebrush		
	Average Cover (%)	Constancy
ARTECAN	11.0	100

Control observations: 1
Natural recovery observations: 4

Sites: 58N01 58N10
59N99 59N01 59C10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	ERS	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
58N	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	95	85	DMGC1	Silver sagebrush/western wheatgrass
59N	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	47	32	DMGC1	Silver sagebrush/western wheatgrass

The fifth group was the only one to be composed entirely of control sites.

Group 5: June grass - Northern wheatgrass - Blue grama		
	Average Cover (%)	Constancy
KOELMAC	12.1	100
AGRODAS	10.2	100
BOUTGRA	10.1	100
Moss and Lichens	8.0	100
ARTEFRI	6.7	100

Control observations: 4

Sites: 19C97
33C97 33C98 33C99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
19N	Disturbed soil	NR	spring 97	Bindloss Plain	HMS(5)/4-5	DMG Solonetzic	32	42	DMGA24-Degraded	Silver sagebrush/needle-and-thread - western wheat grass - blue grama grass (degraded)
33D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/3	DMG Solonetzic	53	50		Crested wheatgrass - blue grama - selaginella

The sixth group was dominated by control sites. Some natural recovery sites are clustering with the controls.

Group 6: Silver sagebrush / Northern wheatgrass-Blue grama		
	Average Cover (%)	Constancy
ARTECAN	2.7	83.3
AGRODAS	16.2	100
BOUTGRA	5.7	83.3
CARESTE	4.8	83.3
POASAND	3.5	83.3
Moss and Lichens	26.6	100
ARTEFRI	4.9	83.3

Control observations: 5
Disturbed and naturally recovered soils observations: 1

Sites: **33C10**
58N99
59C97 59C98 59C99 **59N10**

Site	*Disturbance Zone*	*Seed Mix*	*Final Clean-up Date*	*Ecodistrict*	*Express Soil Data*	*Express version of Natl Subregn & Soil*	*ERS*	*Control Range Health Score*	*Control Plant Community Code*	*Control Plant Community Name*
33D	*Disturbed soil*	*4*	*fall 96*	*Wildhorse Plain*	*HUK(5)/3*	*DMG Solonetzic*	*53*	*50*		*Crested wheatgrass - blue grama - selaginella*
58N	*Disturbed soil*	*NR*	*fall 96*	*Wildhorse Plain*	*ROL(10)/3*	*DMG Solonetzic*	*95*	*85*	*DMGC1*	*Silver sagebrush/western wheatgrass*
59N	*Disturbed soil*	*NR*	*fall 96*	*Wildhorse Plain*	*ROL(10)/3*	*DMG Solonetzic*	*47*	*32*	*DMGC1*	*Silver sagebrush/western wheatgrass*

The seventh group was made up of 50% control sites and 50% recovered stripped sites, which shows that the disturbed sites have recovered well.

Group 7: Silver sagebrush/Northern wheatgrass-Western wheatgrass		
	Average Cover (%)	Constancy
ARTECAN	4.9	83.3
AGRODAS	24.7	100
AGROSMI	5.1	83.3
KOELMAC	1.6	83.3
Mosses and Lichens	4.8	83.3
ARTEFRI	1.1	83.3

Disturbed and seeded observations: 1
Control observations: 3
Naturally recovered observations: 2 (stripped)

Sites: 33D01
58C97 58C99 58C10 58N98
59N98

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
33D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/3	DMG Solonetzic	53	50		Crested wheatgrass - blue grama - selaginella
58N	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	95	85	DMGC1	Silver sagebrush/western wheatgrass
59N	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	47	32	DMGC1	Silver sagebrush/western wheatgrass

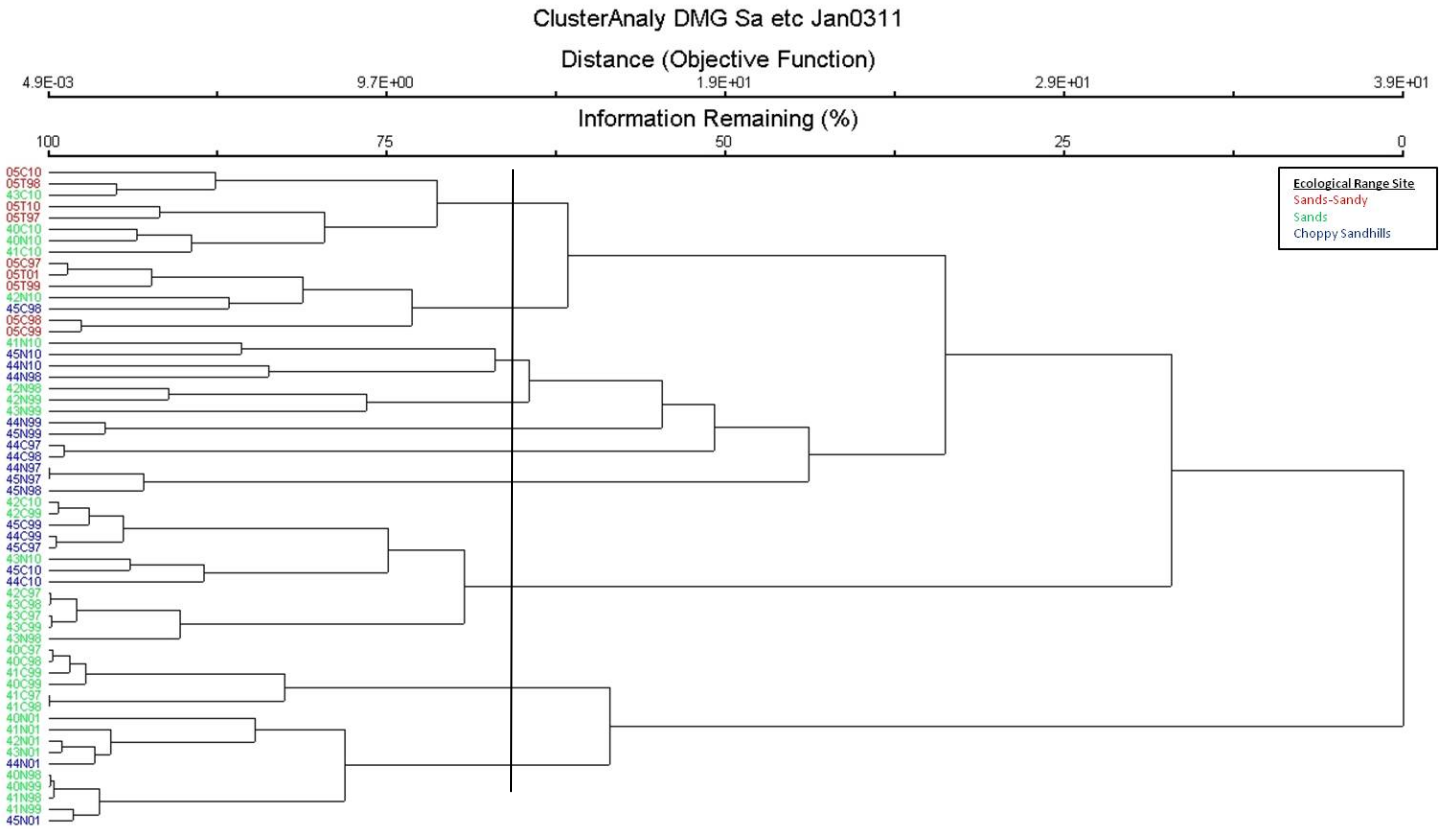
Sandy and related sites (Sa)

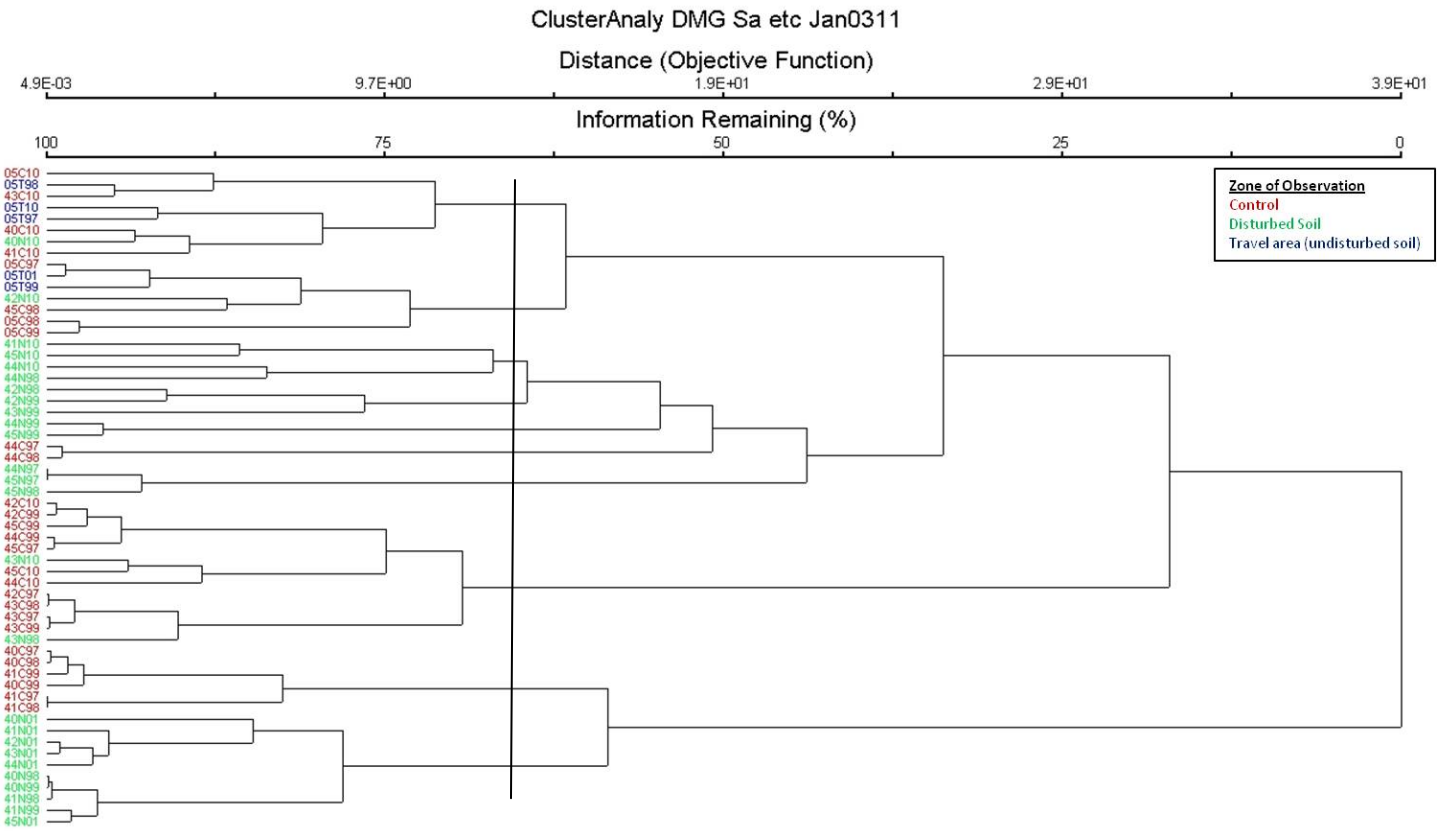
Sites #5, 40-45.

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subr'gn & Soil	ERS	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
05T	Travel	None - not stripped	fall 96	Sounding Creek Plain	RIB(10)/3	DMG Sandy	Sa	19	34	DMGA13-Degraded	Western porcupine grass - needle-and-thread - sand grass (degraded)
40N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	Sa	84	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
41N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	Sa	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
42N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	Sa	57	60	No good fit	Blunt sedge - sun-loving sedge - needle-and-thread
43N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	Sa	X	x	No good fit	Sun-loving sedge - Blunt sedge - needle-and-thread
44N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	CS	X	x	No good fit	Blunt sedge - low sedge - needle-and-thread
45N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	CS	X	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread

Cluster Analysis

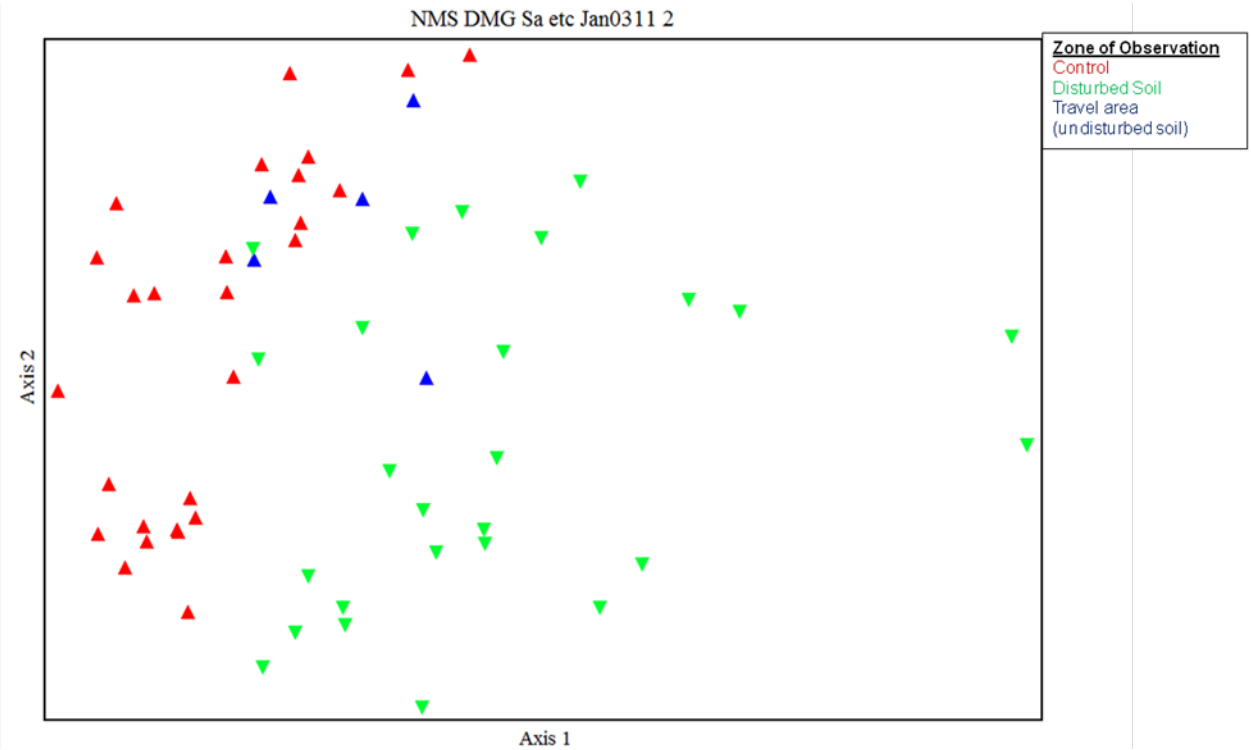
Percent chaining is 2.27%, which is good (ideal is <10%). The Sandy dataset was actually made up of three related ecological range sites; however the clusters did not appear to be based on these ERS groups, so the decision to pool these sites was supported. Neither seeding nor year of observation seemed to influence the clustering of the groups in this dataset. The groups were not strictly divided based on control or disturbance/treatment either.





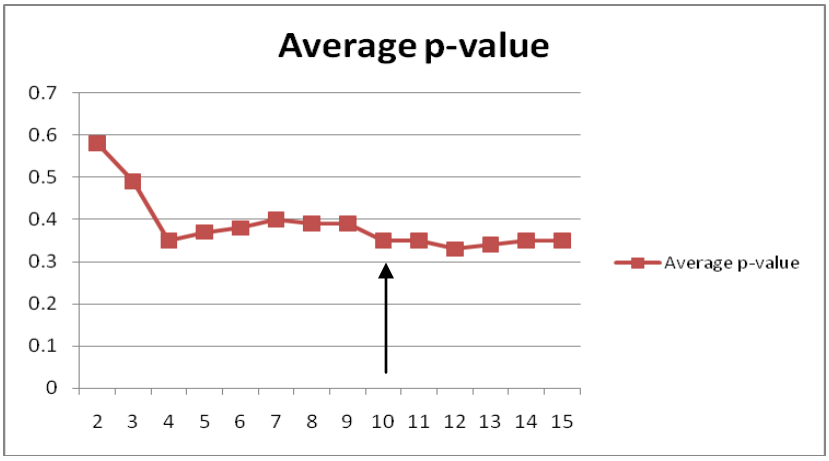
NMS Ordination

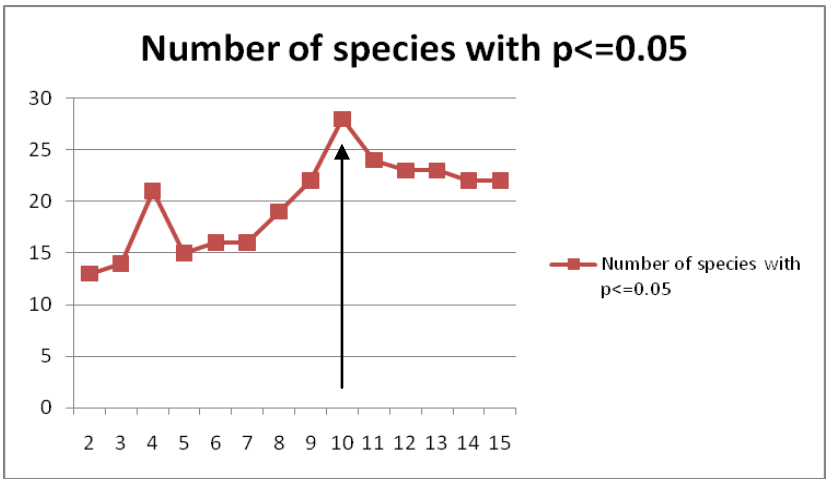
The ordination produced a 3D solution with moderate but acceptable stress (14.8). The cumulative variation accounted for in the solution was good at 76.3%, with axes 1 (32.4%) and 2 (22.9%) being the strongest. Once again, it can be observed that there is not as strict of a distinction between control observations (red) and disturbed/treated observations (green, blue) as there have been in other datasets.

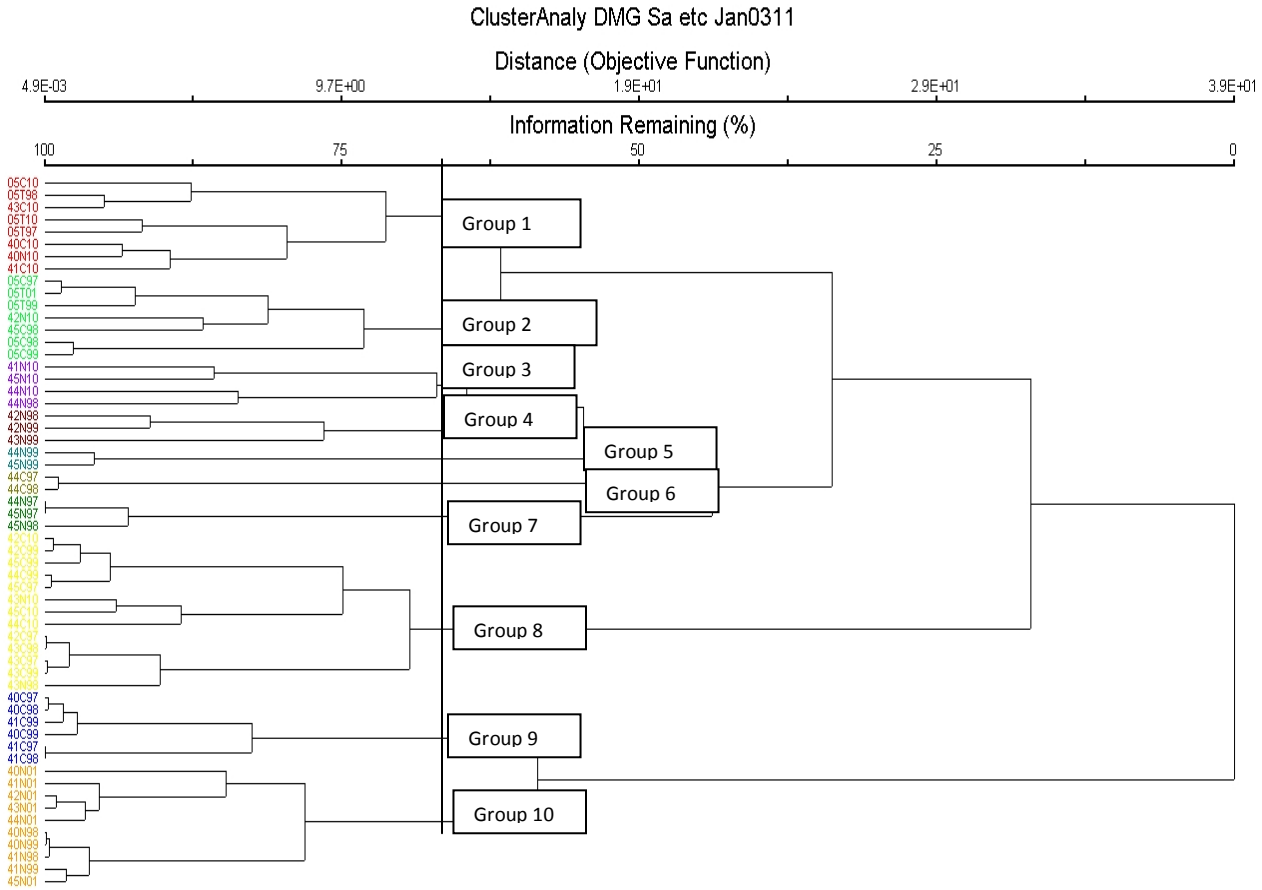


Indicator Species Analysis

ISA identified a solution of 10 clusters by the objective criterion of having the lowest average p-value for indicator values (0.35) and the highest number of indicator species (28).




Number of species with p<=0.05
30
25
20
15
10
5
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15
Number of species with p<=0.05


ClusterAnaly DMG Sa etc Jan0311
Distance (Objective Function)
4.9E-03
9.7E+00
1.9E+01
2.9E+01
3.9E+01
Information Remaining (%)
100
75
50
25
0
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6
Group 7
Group 8
Group 9
Group 10

Community Group Identification

The first group is comprised of non-stripped travel sites and control sites. The dominant species is the shrub, buckbrush.

Group 1: Buckbrush / Low sedge – Pasture sagewort - Western porcupine grass		
	Average Cover (%)	Constancy
CARESTE	10.4	100
POAPRAT	8.6	87.5
STIPCUR	3.7	100
SYMPOCC	17.4	100
ARTEFRI	8.7	100

Control observations: 4
Unstripped travel lane observations: 3
Disturbed and naturally recovered soils observations: 1

Sites: 05T97, 05T98, 05T10, 05C10
40N10, 40C10
41C10
43C10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
40N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	84	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
41N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
43N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Sun-loving sedge - Blunt sedge - needle-and-thread
05T	Travel	None - not stripped	fall 96	Sounding Creek Plain	RIB(10)/3	DMG Sandy	19	34	DMGA13-Degraded	Western porcupine grass - needle-and-thread - sand grass (degraded)

The second group is also made up of control and disturbed sites and contains the same dominant forbs, but it also has a moss and lichen layer.

Group 2: Low sedge - June grass - Western wheatgrass		
	Average Cover (%)	Constancy
CARESTE	30.3	100
KOELMAC	7.2	100
AGROSMI	5.1	100
Moss and Lichens	2.3	100
SYMPOCC	13.7	85.7
ARTEFRI	9.3	100

Control observations: 4
Unstripped travel lane observations: 2
Disturbed and naturally recovered observations: 1

Sites: 05C97 05C98 05C99
05T99 05T01
42N10
45C98

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
05T	Travel	None - not stripped	fall 96	Sounding Creek Plain	RIB(10)/3	DMG Sandy	19	34	DMGA13-Degraded	Western porcupine grass - needle-and-thread - sand grass (degraded)
42N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	57	60	No good fit	Blunt sedge - sun-loving sedge - needle-and-thread
45N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread

The third group is dominated by native grasses and is comprised entirely of naturally recovered observations.

Group 3: Needle-and-thread – Sand reed grass – Kentucky bluegrass		
	Average Cover (%)	Constancy
POAPRAT	7.9	100
STIPCOM	7.2	100
CALALON	4.9	100
ARTELUD	6.8	100

Disturbed and naturally recovered soils observations: 4

Sites: 41N10 45N10 44N98 44N10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Natl Subrn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
41N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
44N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Blunt sedge - low sedge - needle-and-thread
45N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread

The fourth group is comprised of three naturally recovery observations. In addition to the species noted below, each site had a record of HORDJUB, which may have contributed to the identification of these observations as a unique cluster.

Group 4: Needle-and-thread grass-Western porcupine grass-CALALON		
	Average Cover (%)	Constancy
STIPCOM	15.4	100
STIPCUR	9.4	100
CALALON	6.0	100
CHENPRA	1.5	100

Naturally recovered observations: 3

Sites: 42N98 42N99 43N99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Natl Sub'n & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
42N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	57	60	No good fit	Blunt sedge - sun-loving sedge - needle-&-thread
43N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Sun-loving sedge - Blunt sedge - needle-&-thread

The fifth group is a small group, comprised by just two observations. An initial analysis was made to see if combining these small clusters was warranted, however initial observations were that each cluster was sufficiently distinct. Further analysis may be warranted.

Group 5: Western porcupine grass-AGROTRA-forbs		
	Average Cover (%)	Constancy
STIPCUR	8.8	100
AGROTRA	2.8	100
DESCSOP	18.3	100
ARTEFRI	8	100
LEPIDEN	8	100
RUMEACE	3	100

Naturally recovered observations: 2

Sites: 44N99
45N99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	ERS	Control Plant Community Code	Control Plant Community Name
44N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	CS	No good fit	Blunt sedge - low sedge - needle-and-thread
45N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	CS	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread

The sixth group is comprised of two control observations and was likely identified due to the dominance of a few forb species.

Group 6: Carex-CALALON		
	Average Cover (%)	Constancy
CARESTE	14.8	100
CALALON	5.6	100
ARTEFRI	12.4	100
GALIBOR	2.7	100
SOLIMIS	1.3	100

Control observations: 2

Sites: 44C97 44C98

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	ERS	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
44N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	CS	x	No good fit	Blunt sedge - low sedge - needle-and-thread

The seventh group is made up of three naturally recovered observations and must be of high bare soil cover due to low number of species presence and cover. Most species other than those noted below were of 33% constancy.

Group 7: Low vegetation coverage		
	Average Cover (%)	Constancy
CHENALB	9.2	100
ARTELUD	0.7	100
ROSAARK	0.6	100

Naturally recovered observations: 3

Sites: 44N97
45N97 45N98

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	ERS	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
44N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	CS	x	No good fit	Blunt sedge - low sedge - needle-and-thread
45N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	CS	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread

The eighth group is the largest of the two identified clusters that are dominated by control observations. One natural recovery site is also grouping with the controls.

Group 8: Blunt sedge – Sand reed grass - June grass		
	Average Cover (%)	Constancy
CAREOBT	44.8	100
CALALON	22.2	100
KOELMAC	2.8	92.3
ARTEFRI	3.6	76.9

Control observations: 11
Disturbed and naturally recovered observations: 2

Sites: 42C97 42C99 42C10
43C97 43C98 43C99 43N98 43N10
44C99 44C10
45C97 45C99 45C10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
42N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	57	60	No good fit	Blunt sedge - sun-loving sedge - needle-and-thread
43N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	X	x	No good fit	Sun-loving sedge - Blunt sedge - needle-and-thread
44N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	X	x	No good fit	Blunt sedge - low sedge - needle-and-thread
45N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread

The ninth group is dominated by the species listed below.

Group 9: Western porcupine grass – Blunt sedge - Sand reed grass		
	Average Cover (%)	Constancy
STIPCUR	36	100
CALALON	18	100
CAREXOBT	19.1	100
ROSAARK	3.7	100

Control observations: 6

Sites: 40C97 40C98 40C99
41C97 41C98 41C99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
40N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	84	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
41N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass

The tenth group is a late-seral community made up of naturally recovered observations that are dominated by desirable native species. The clustering of these sites into a group may be due to the presence of a few forb species noted below.

Group 10: Western porcupine grass-CALALON		
	Average Cover (%)	Constancy
STIPCUR	27.9	100
CALALON	3.7	100
ARTEFRI	9.7	100
ARTELUD	5.7	90
AGROSMI	2.1	80
SOLIMIS	1.6	70
CHENPRA	1.1	70

Disturbed and naturally recovered observations: 10

Sites: 40N98 40N99 40N01
41N98 41N99 41N01
42N01
43N01
44N01
45N01

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express version of Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
40N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	84	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
41N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
42N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy		60	No good fit	Blunt sedge - sun-loving sedge - needle-and-thread
43N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Sun-loving sedge - Blunt sedge - needle-and-thread
44N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Blunt sedge - low sedge - needle-and-thread
45N	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread

Mixedgrass Natural Subregion

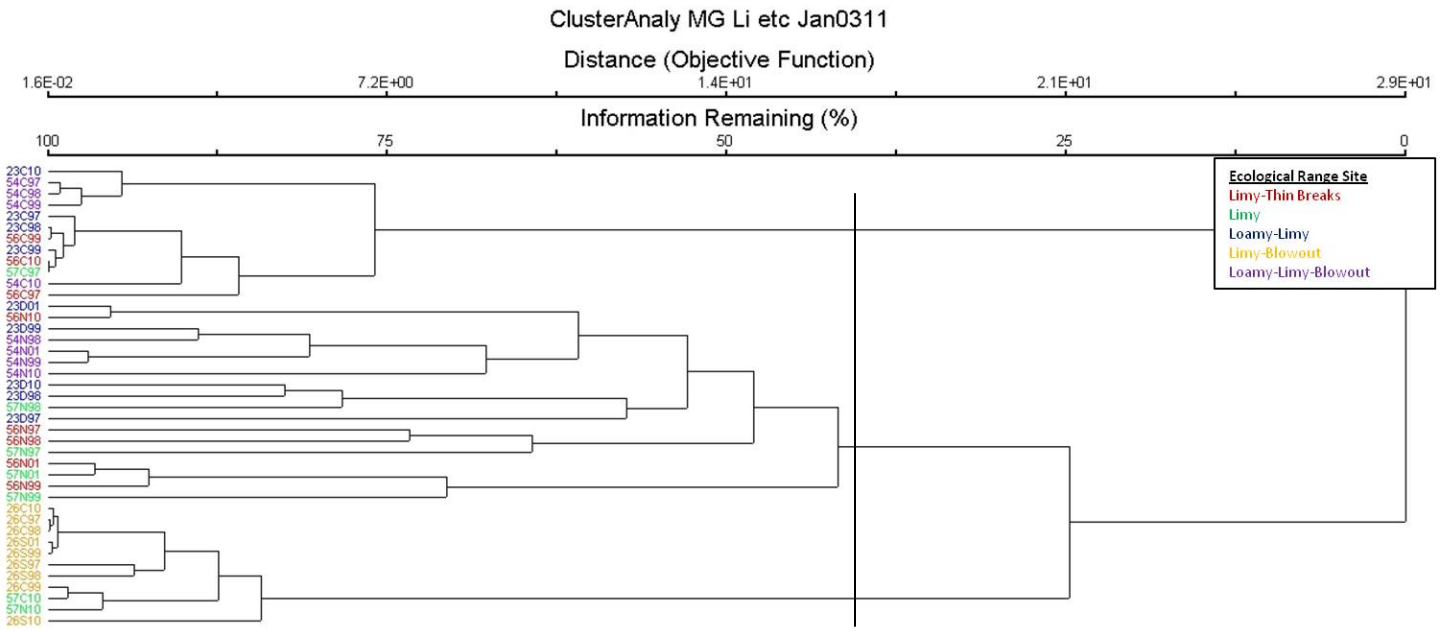
Limy and related sites (Li)

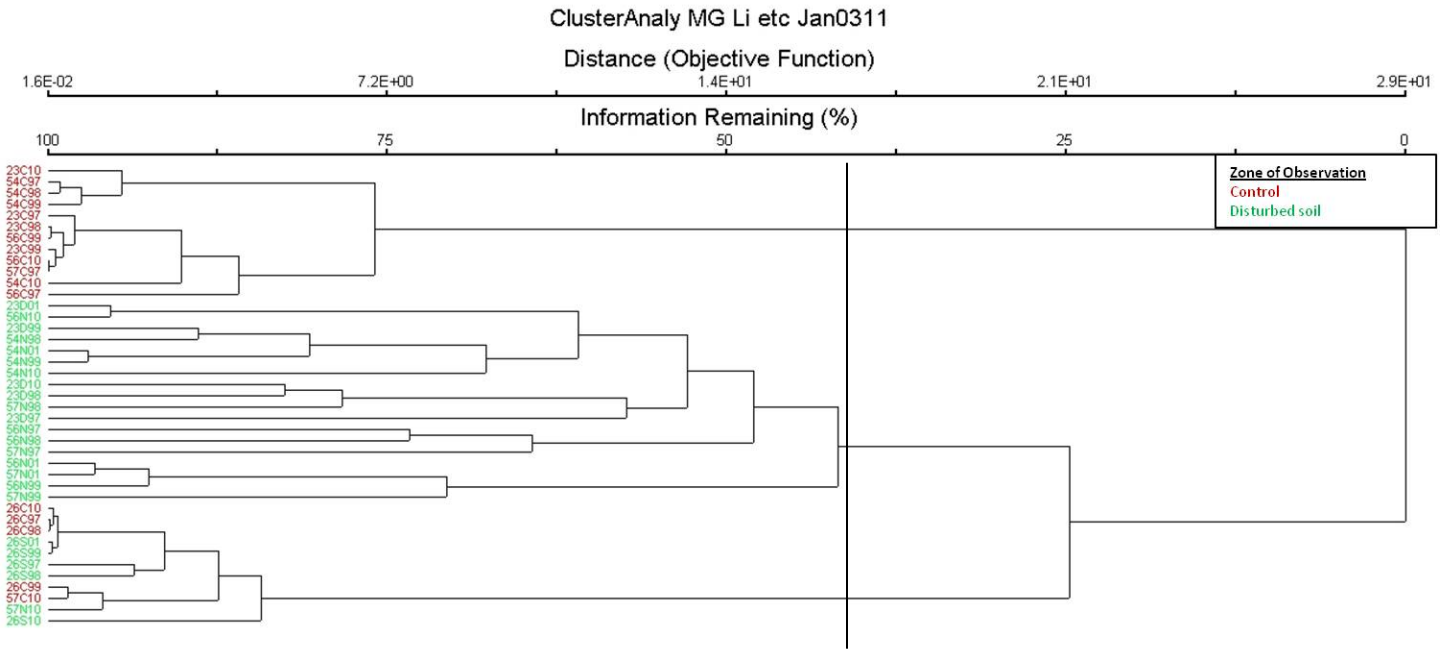
Sites #23, 26, 54, 56 and 57.

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subregn & Soil	ERS	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
23D	Disturbed soil	2	fall 96	Cypress Hills	stPUR (10)/4-5	Fescue/ MG Transition	Lo/Li	43	47	MGA3	Needle-and-thread - June grass
26D	Disturbed soil	2	fall 96	Cypress Hills	stHKR (10)/4-5	Fescue/ MG Transition	Li-BlO	X	87	MGA1	Plains rough fescue - western porcupine grass - sedge
54D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10) /3-4	Fescue/ MG Transition	Lo/Li-BlO	x	75	DMGA2	Needle-and-thread - wheatgrass
56D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	Fescue/ MG Transition	Li-TB	45	43	MGA3	Needle-and-thread - June grass
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	Fescue/ MG Transition	Li	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

Cluster Analysis

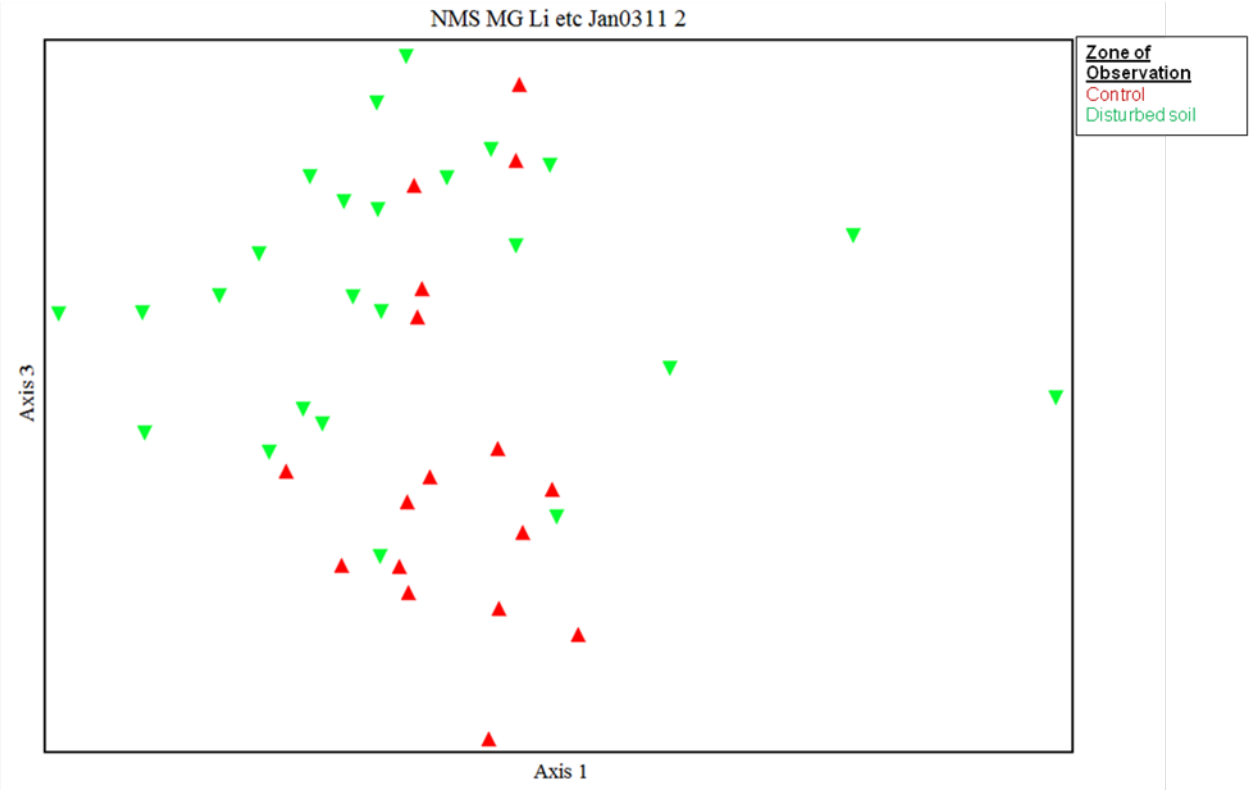
Percent chaining is 5.56%, which is good (ideal is <10%). The Limy dataset was actually made up of five related ecological range sites, however with the exception of the Li-BlO sites, the clusters did not appear to be based on these ERS groups, so the decision to pool these sites was supported. Seeding and year do not appear to have played a role in the clustering of observations. It is apparent however that there is one group comprised of control sites, one comprised of disturbed/treated sites, and one of mixed identity.





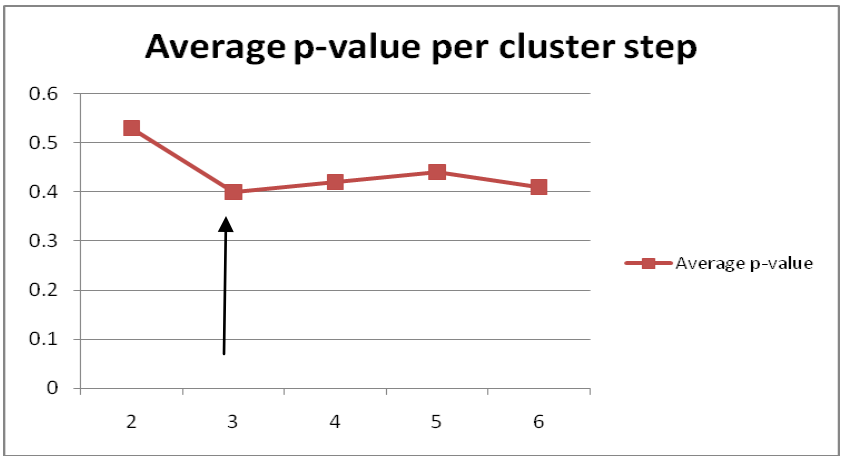
NMS Ordination

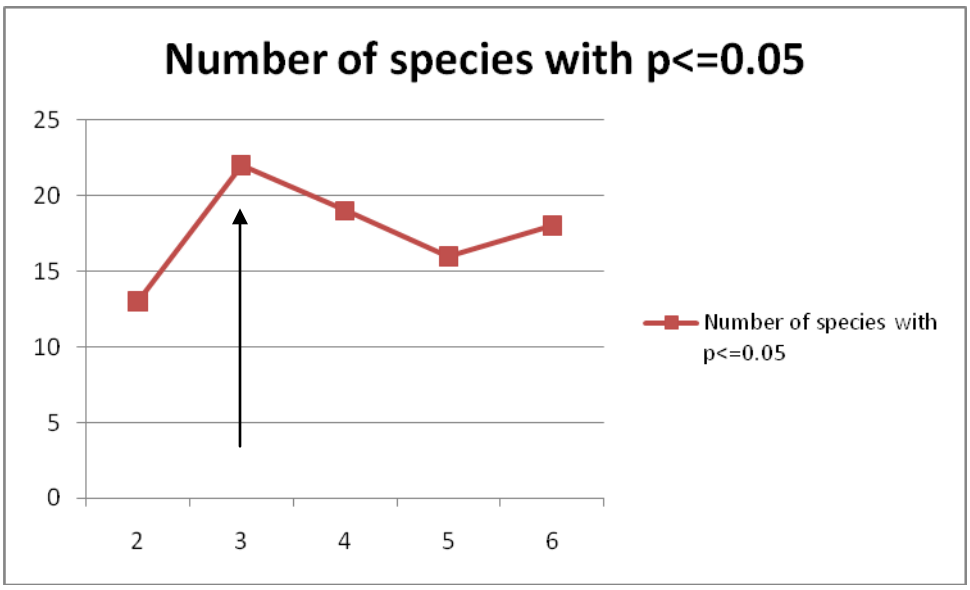
The ordination produced a 3D solution with acceptable stress (13.5). The cumulative variation accounted for in the solution was moderate at 65.9%, with axes 1 (22.3%) and 3 (22.1%) being the strongest, although the axes were effectively evenly distributed in variance accounted for by each.

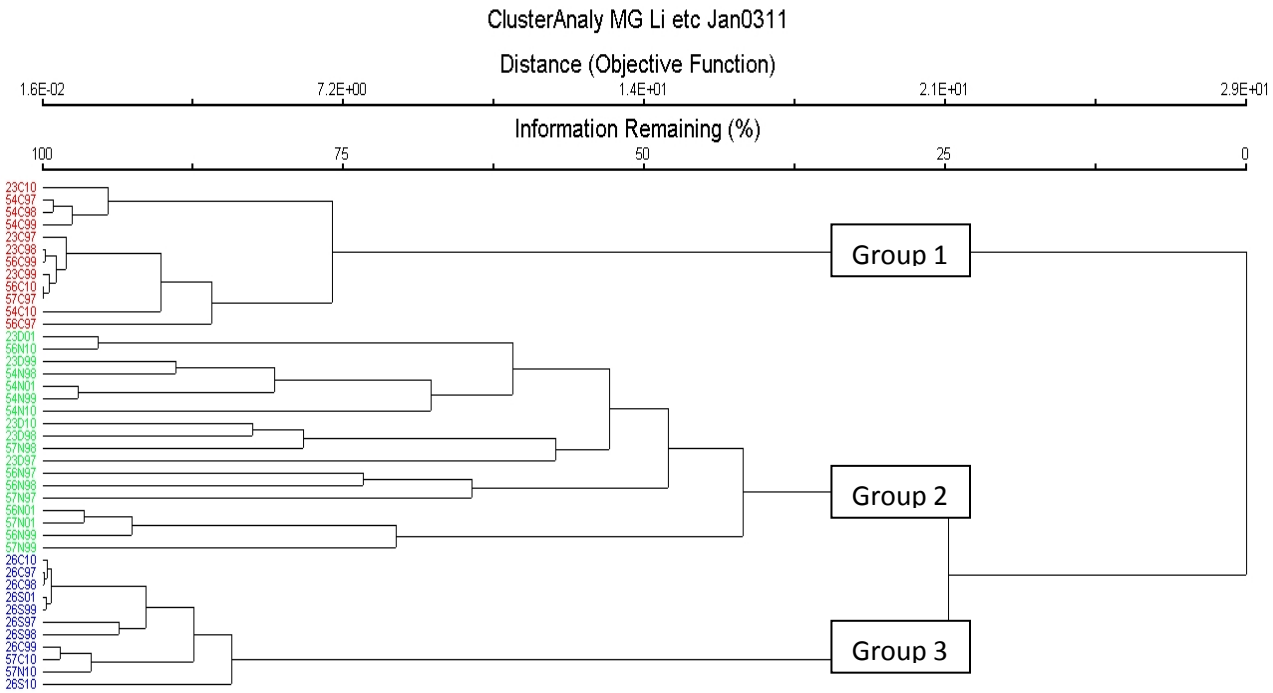

NMS MG Li etc Jan0311 2
Zone of Observation
Control
Disturbed soil
Axis 3
Axis 1

Indicator Species Analysis

ISA identified a solution of seven clusters by the objective criterion of having the lowest average p-value for indicator values (0.4) and the highest number of indicator species (22).






ClusterAnaly MG Li etc Jan0311
Distance (Objective Function)
1.6E-02
7.2E+00
1.4E+01
2.1E+01
2.9E+01
Information Remaining (%)
100
75
50
25
0
23C10
54C97
54C98
54C99
23C97
23C98
56C99
23C99
56C10
57C97
54C10
56C97
23D01
56N10
23D99
54N98
54N01
54N99
54N10
23D10
23D98
57N98
23D97
56N97
56N98
57N97
56N01
57N01
56N99
57N99
26C10
26C97
26C98
26S01
26S99
26S97
26S98
26C99
57C10
57N10
26S10
Group 1
Group 2
Group 3

Community Group Identification

The first group is comprised entirely of control observations and is dominated by the species noted below. It should be noted that despite the fact that these control sites did not receive seed mix treatment, 41.7% of the sites in the group recorded cover of FESTHAL, which was a seed mix treatment on Site 57 in this dataset. This presence on control sites either indicates natural occurrence, spread of seed mix, or observer misidentification. Expert opinion is required to determine which of these may be the case.

Group 1: Northern wheatgrass-June grass		
	Average Cover (%)	Constancy
AGRODAS	5.7	83.3
KOELMAC	3.6	83.3
Moss and Lichen	47.3	100
PHLOHOO	3.2	100
ARTEFRI	2.6	91.7

Control observations: 12

Sites: 23C97 23C98 23C99 23C10
54C97 54C98 54C99 54C10
56C97 56C99 56C10
57C97

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
23D	Disturbed soil	2	fall 96	Cypress Hills	stPUR(10)/4-5	Fescue/ MG Transition	43	47	MGA3	Needle-and-thread - June grass
56D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	Fescue/ MG Transition	45	43	MGA3	Needle-and-thread - June grass
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	Fescue/ MG Transition	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

The second group was comprised entirely of disturbed sites. Most were treated with Seed Mix 2.

Group 2: June grass-Green needle grass-Northern wheatgrass		
	Average Cover (%)	Constancy
KOELMAC	2.9	94.4
STIPVIR	4.4	83.3
AGRODAS	4	83.3
ARTEFRI	5.4	83.3

Disturbed and seeded soils observations: 5

Disturbed and naturally recovered soils observations: 13 (stripped)

Sites: 23D97 23D98 23D99 23D01 23D10
54D98 54D99 54D01 54D10
56D97 56D98 56D99 56D01 56D10
57D97 57D98 57D99 57D01

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
23D	Disturbed soil	2	fall 96	Cypress Hills	stPUR(10) /4-5	Fescue/ MG Transitio n	43	47	MGA3	Needle-and-thread - June grass
54D	Disturbed soil	1:1 Festhal: Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10) /3-4	Fescue/ MG Transitio n	x	75	DMGA2	Needle-and-thread - wheatgrass
56D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	Fescue/ MG Transitio n	45	43	MGA3	Needle-and-thread - June grass
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	Fescue/ MG Transitio n	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

The third group is comprised of both control observations and sites seeded to either mix 2 or pure plains rough fescue.

Group 3: Plains rough fescue - Northern wheatgrass		
	Average Cover (%)	Constancy
FESTHAL	39.4	100
AGRODAS	4.8	100
CAREOBT	3.3	81.8
Moss and Lichens	3.4	81.8

Control observations: 5

Stripped and seeded soils observations: 5

Disturbed and naturally recovered soils observations: 1

Sites: 26C97 26C98 26C99 26C10 26D97 26D98 26D99 26D01 26D10 57C10 57D10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
26D	Disturbed soil	2	fall 96	Cypress Hills	stHKR(10)/4-5	Fescue/ MG Transition	x	87	MGA1	Plains rough fescue - western porcupine grass - sedge
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	Fescue/ MG Transition	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

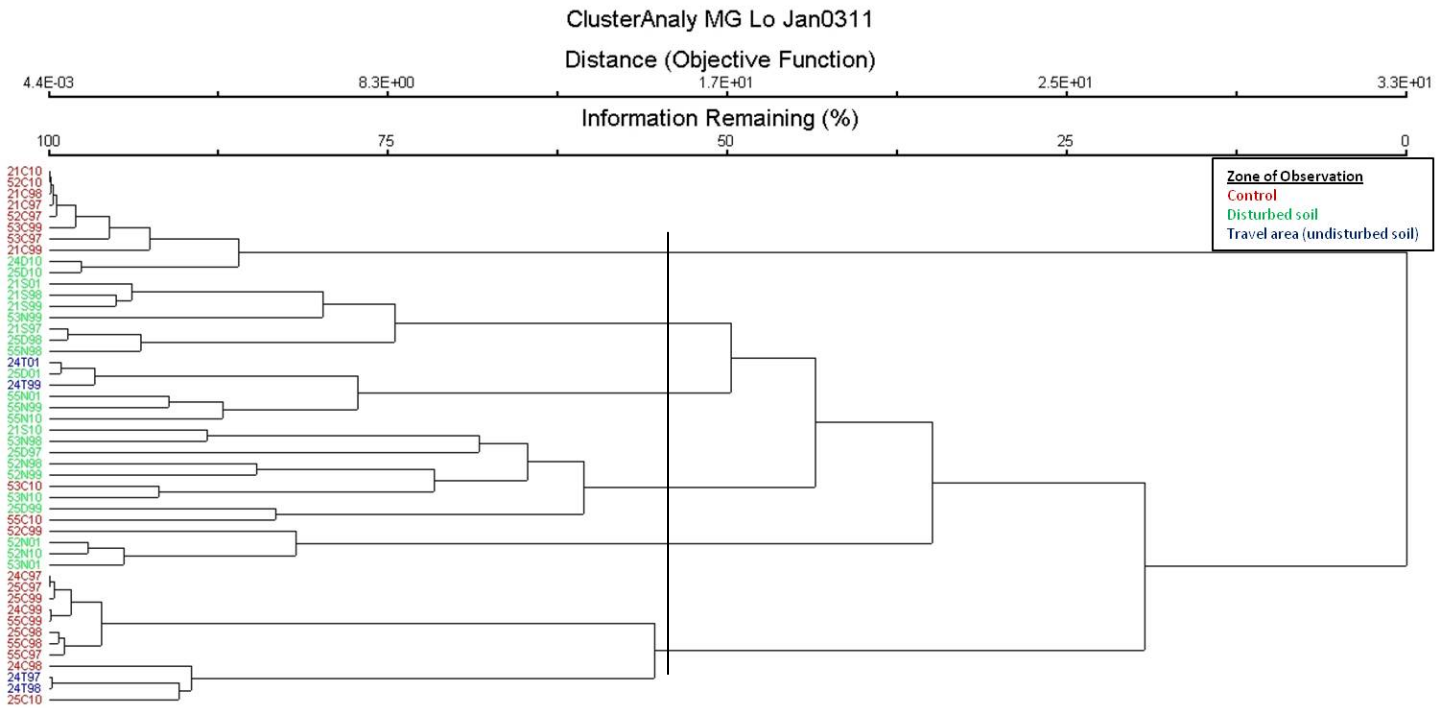
Loamy (Lo)

Sites #21, 24, 25, 52, 53 and 55.

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10) /3-4	Fescue/ MG Transition	40	70	MGA1	Plains rough fescue - western porcupine grass - sedge
24T	Travel (97,98,99,01)	None - not stripped	fall 96	Cypress Hills	PUR(10) /5-6	Fescue/ MG Transition	X	no		
24D	Disturbed soil (2010)	2	fall 96	Cypress Hills	PUR(10) /5-6	Fescue/ MG Transition	84	no		
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20) /3-4	Fescue/ MG Transition	67	88	MGA2	Western porcupine grass - plains rough fescue
52N	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10) /3-4	Fescue/ MG Transition	41	87	MGA1	Plains rough fescue - western porcupine grass - sedge
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10) /3-4	Fescue/ MG Transition	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge
55D	Disturbed soil	1:1 Festhal :Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10) /3-4	Fescue/ MG Transition	70	59	NGF	No good fit

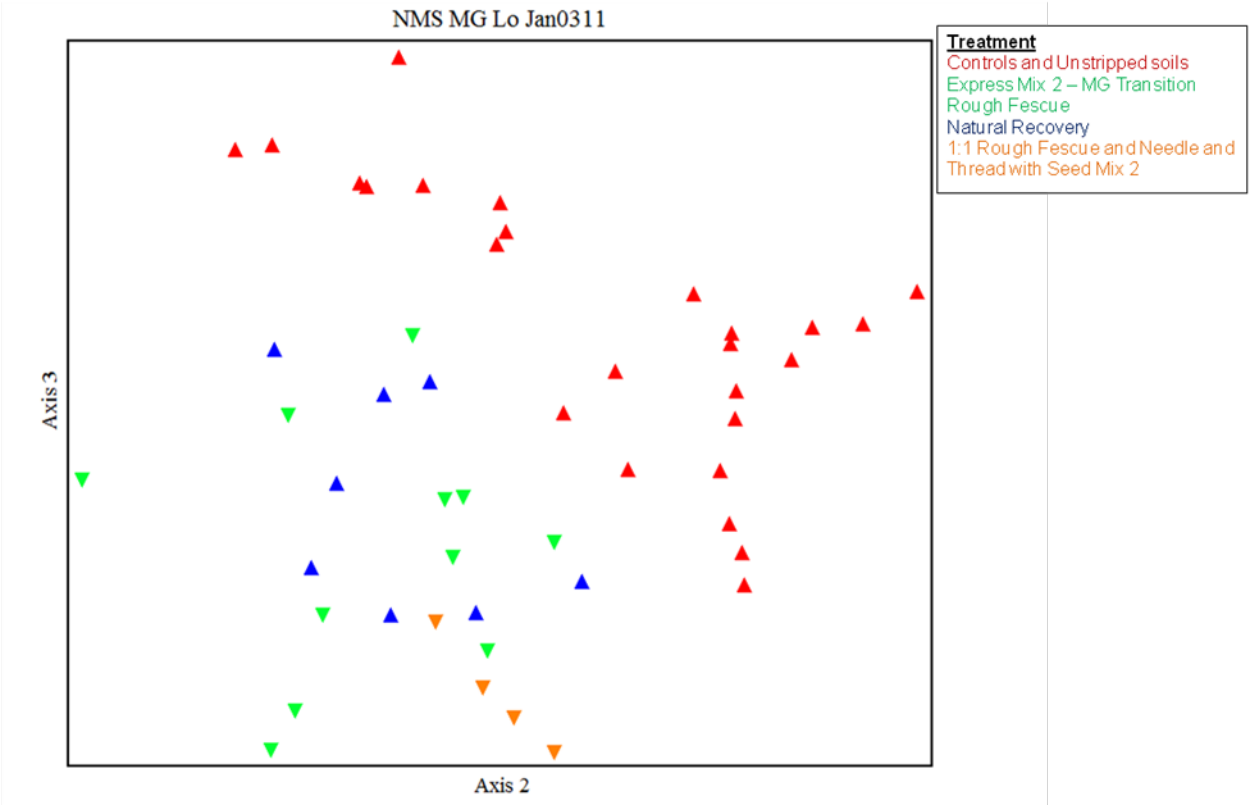
Cluster Analysis

Percent chaining is 4.98%, which is good (ideal is <10%). As is the case for all of the other datasets, the only observable trend for delineation of observations into groups/clusters is a moderate differentiation between control and disturbed/treated observations.



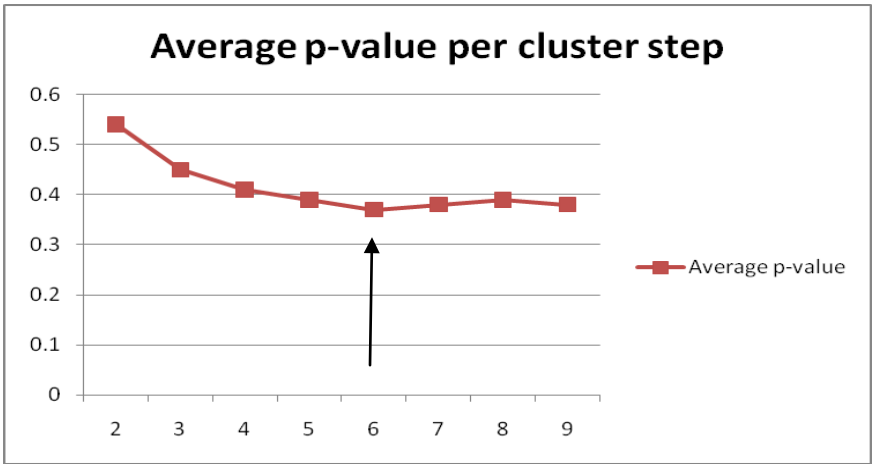
NMS Ordination

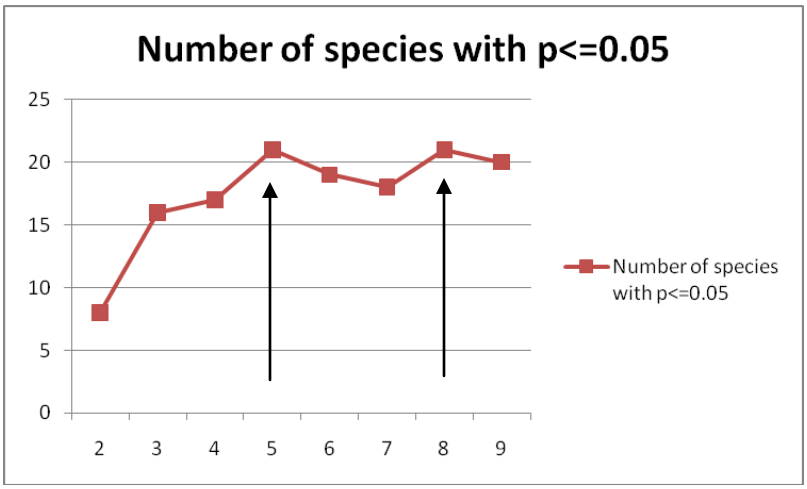
The ordination produced a 3D solution with acceptable stress (14.3). The cumulative variation accounted for in the solution was good at 72.8%, with axes 2 (27.0%) and 3 (29.8%) being the strongest. The figure below shows a slight but not strong grouping of observations according to seed treatment.

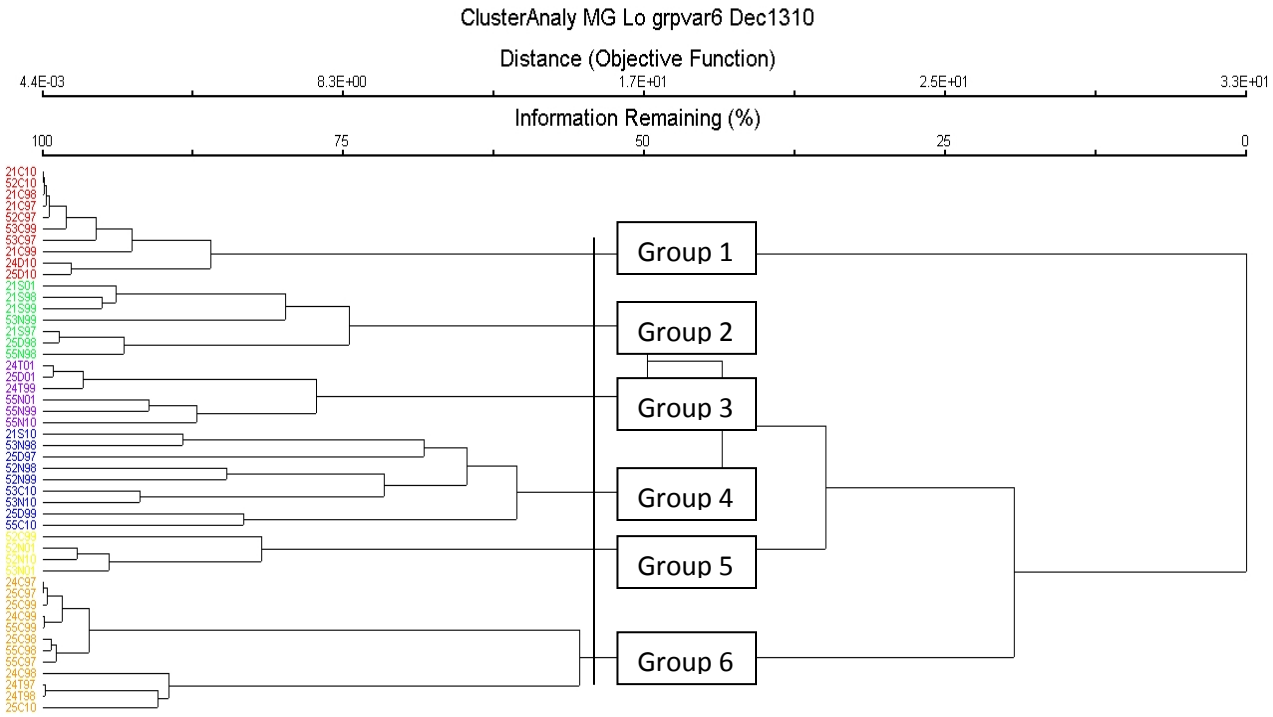

NMS MG Lo Jan0311
Axis 3
Axis 2
Treatment
Controls and Unstripped soils
Express Mix 2 – MG Transition
Rough Fescue
Natural Recovery
1:1 Rough Fescue and Needle and Thread with Seed Mix 2

Indicator Species Analysis

ISA identified three possible solutions by which to trim the dendrogram in this case. Both clusters 5 and 8 offered a high number of indicator species (21), while 6 clusters had the lowest average p-value for indicator values (0.37). Six clusters were pursued for further analysis as the middle-point of these three options.






ClusterAnaly MG Lo grpvar6 Dec1310
Distance (Objective Function)
4.4E-03
8.3E+00
1.7E+01
2.5E+01
3.3E+01
Information Remaining (%)
100
75
50
25
0
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6

Community Group Identification

The first group is comprised of mostly control observations and displays a dominance of FESTHAL, despite these sites not being treated with that special seed mix.

Group 1: Plains rough fescue - Northern wheatgrass - Western porcupine grass		
	Average Cover (%)	Constancy
FESTHAL	42.7	100
AGRODAS	3.7	100
STIPCUR	4.7	90
Moss and Lichens	6.2	90

Control observations: 8
Disturbed and seeded soils observations: 2

Sites: 21C97 21C98 21C99 21C10
24D10
25D10
52C97 52C10
53C97 53C99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Natl Subregn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10) /3-4	Fescue/ MG Transition	40	70	MGA1	Plains rough fescue - western porcupine grass - sedge
24D	Disturbed soil (2010)	2	fall 96	Cypress Hills	PUR(10) /5-6	Fescue/ MG Transition	84	no		
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20) /3-4	Fescue/ MG Transition	67	88	MGA2	Western porcupine grass - plains rough fescue
52N	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10) /3-4	Fescue/ MG Transition	41	87	MGA1	Plains rough fescue - western porcupine grass - sedge
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10) /3-4	Fescue/ MG Transition	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge

The second group is comprised of early seral disturbed sites that were either treated with Seed Mix 2 or naturally recovered.

Group 2: Pasture sagewort - June grass-Slender wheatgrass - Western porcupine grass		
	Average Cover (%)	Constancy
KOELMAC	4.5	100
AGROTRA	10.2	85.7
STIPCUR	7.2	85.7
ARTEFRI	11.7	100

Disturbed and seeded soils observations: 5
Disturbed and naturally recovered observations: 2

Sites: 21D97 21D98 21D99 21D01
25D98
53D99
55D98

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10)/ 3-4	Fescue/ MG Transition	40	70	MGA1	Plains rough fescue - western porcupine grass - sedge
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/ 3-4	Fescue/ MG Transition	67	88	MGA2	Western porcupine grass - plains rough fescue
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10)/ 3-4	Fescue/ MG Transition	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge
55D	Disturbed soil	1:1 Festhal: Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/ 3-4	Fescue/ MG Transition	70	59	NGF	No good fit

The third group also is comprised of sites that were either treated with Seed Mix 2 (minority) or naturally recovered (majority).

Group 3: Northern wheatgrass – Pasture sagewort - June grass		
	Average Cover (%)	Constancy
AGRODAS	15.1	100
KOELMAC	2.7	100
ARTEFRI	4	100

Unstripped travel lane observations: 2
Disturbed and seeded soils observations: 1
Disturbed and naturally recovered soils observations: 3

Sites: 24T99 24T01
25D01
55D99 55D01 55D10

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
24T	Travel (97,98,99,01)	None - not stripped	fall 96	Cypress Hills	PUR(10)/ 5-6	Fescue/ MG Transition	x	no		
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/ 3-4	Fescue/ MG Transition	67	88	MGA2	Western porcupine grass - plains rough fescue
55D	Disturbed soil	1:1 Festhal: Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/ 3-4	Fescue/ MG Transition	70	59	NGF	No good fit

The fourth group, again, was treated with either Seed Mix 2 or natural recovery. More species are present in this group that in Group 3, however other than those listed below, they are all of low constancy/average cover.

Group 4: Pasture sagewort - Northern wheatgrass		
	Average Cover (%)	Constancy
AGRODAS	2.7	100
Moss and Lichens	3	77.8
ARTEFRI	3.3	100
VICAME	2.1	100

Disturbed and seeded soils observations: 3
Disturbed and naturally recovered soils observations: 4
Control observations: 2

Sites: 21D10 53D98 53D10 53C10
25D97 25D99 55C10
52N98 52N99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10)/ 3-4	Fescue/ MG Transition	40	70	MGA1	Plains rough fescue - western porcupine grass - sedge
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/ 3-4	Fescue/ MG Transition	67	88	MGA2	Western porcupine grass - plains rough fescue
52N	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10)/ 3-4	Fescue/ MG Transition	41	87	MGA1	Plains rough fescue - western porcupine grass - sedge
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10)/ 3-4	Fescue/ MG Transition	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge
55D	Disturbed soil	1:1 Festhal: Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/ 3-4	Fescue/ MG Transition	70	59	NGF	No good fit

The fifth group is small and is composed of the two natural recovery sites in loamy soils in the mixed grass. Kentucky bluegrass is dominant.

Group 5: Kentucky bluegrass - Prairie sagewort		
	Average Cover (%)	Constancy
POAPRAT	26.4	100
AGRODAS	1	100
Moss and Lichens	3	77.8
ARTELUD	3.2	100
TARAOFF	1.1	100

Disturbed and natural recovered soils observations: 3
Control observations: 1

Sites: 52C99 52N01 52N10 53D01

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
52N	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10)/ 3-4	Fescue/ MG Transitio n	41	87	MGA1	Plains rough fescue - western porcupine grass - sedge
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10)/ 3-4	Fescue/ MG Transitio n	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge

The sixth group is comprised mainly of control observations. Two unstripped travel lane sites are clustering with the controls.

Group 6: Western porcupine grass - Northern wheatgrass		
	Average Cover (%)	Constancy
STIPCUR	31.4	100
AGRODAS	6	100
Moss and Lichens	39.2	91.7
VICIAME	2	100

Control observations: 10
Unstripped travel lane observations: 2

Sites: 24C97 24C98 24C99 24T97 24T98
25C97 25C98 25C99 25C10
55C97 55C98 55C99

Site	Disturbance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Express Natl Subn & Soil	Reveg Range Health Score	Control Range Health Score	Control Plant Community Code	Control Plant Community Name
24T	Travel (97,98,99,01)	None - not stripped	fall 96	Cypress Hills	PUR(10)/ 5-6	Fescue/ MG Transitio n	x	no		
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/ 3-4	Fescue/ MG Transitio n	67	88	MGA2	Western porcupine grass - plains rough fescue
55D	Disturbed soil	1:1 Festhal: Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/ 3-4	Fescue/ MG Transitio n	70	59	NGF	No good fit

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Appendix C

Final Vegetation Analysis Results – Treatments – No Controls February 2011

Cluster Analysis, Non-metric Multidimensional Scaling Ordination and Indicator Species Analyses for Ecological Range Site Type by Natural Subregion

Laura Hickman, Jane Lancaster, Barry Adams and Marilyn Neville

Background

Data from the Express Pipeline Vegetation Monitoring Project's 1997, 1998, 1999, 2001 and 2010 sampling years are investigated here in order to determine whether successional trends can be discerned over the elapsed 14 years since construction. Objectives of the assessment include identification of vegetation outcomes on naturally recovered vs. seeded sites and also identification of any persisting effects of non-native seeded species.

The analyses presented in this report show the final analyses for loamy and blowout/solonetzic ecological range sites (ERS) for the Dry Mixedgrass and Mixedgrass Natural Subregions. The Express Pipeline Vegetation Monitoring Project also included some data from sites within the Central Parkland Natural Subregion; however, there was not a large enough sample size from these sites to pursue the same analyses.

The analysis has gone through a number of iterations since the November 2010 preliminary report in this series. The January 2011 intermediate report reported results following dataset updates to the ERS categorizations where reclassifications according to field observations, expert opinion and historical site knowledge were made (Jane Lancaster). That reclassification reduced the number of ERSs discussed within the report due to consolidations of ERS groups, and elimination of some ERS with low sample size. Both controls and treatment data were included in the preliminary and intermediate reports but not in this final report.

The dry mixed grass loamy and blowout/solonetzic ERS groups and the mixed grass limy and loamy groups were carried forward for the final analysis presented in this report. The final analysis focussed only on the treatment observations, eliminating control observations so as to provide a clearer analysis of the movement of treated sites among plant communities over time. This focus on treatment observations again limited the sample size further and in some cases, discussed in more detail below, may limit the reliability of results where groups were close to or less than 30 observations.

Note that an "observation" is a site x year monitoring occurrence (e.g. 1998 data from Site #44 is one observation).

Introduction

The following lists outline the ERS groupings used for the treatment observation data. No control data is reported here.

Included in the analyses:

- Dry Mixedgrass:
    - Blowout (118 observations (full); 64 observations (treatments only))
    - Loamy (110 observations (full); 56 observations (treatments only))
    - Sandy and related sites (58 observations (full); 31 observations (treatments only))
    - Overflow (33 observations (full); 18 observations (treatments only))
- Mixedgrass:
    - Loamy (48 observations (full); 32 observations (treatments only))
    - Limy and related sites (41 observations (full); 24 observations (treatments only); this group included LoLi, LiBlO, LoLiBlO, LiTB and Li sites)

Not included in the analyses:

- Central Parkland:
    - *25 observations as sample size was not sufficient for any ERS to be broken out individually for analysis – no analysis undertaken*
- Dry Mixedgrass:
    - *Thin Breaks (16), Badlands (6) and Lentic (12) had too few replicates to be included in analyses*
- Mixedgrass:
    - *Blowout (8 observations (full)) and Overflow (9 observations (full)) had too few replicates to be included in analyses*

Each included ecological range type was analyzed individually using cluster analysis, non-metric multidimensional scaling ordination and indicator species analysis. These are organized alphabetically below by natural subregion. The number of "treatments only" observations represent the final sample size for the analyses presented in this report. Dry Mixedgrass Blowout, Loamy and Sandy groups presented good results; Dry Mixedgrass Overflow and Mixedgrass Loamy and Limy groups presented results that must be interpreted with caution (discussed in more detail below).

Methods

For information on the data collection methods used as part of the Express Pipeline Vegetation Monitoring Project, please see the main body of the Express Pipeline Revegetation Monitoring Project 2010 report. The analyses described below were carried out in PCORD (version 5.17; McCune and Mefford 2006) and are outlined in full by Hickman (2010).

The cluster analysis performed was a hierarchical, agglomerative clustering method in PCORD used for initial vegetation community group classification. This method of community group classification identifies vegetation communities by characteristic species combinations (Jongman et al. 1995). Hierarchical methods find groups that are composed of subgroups and produce dendrograms where the axis is measured in percent information remaining; agglomerative methods build groups from the bottom to a single top group composed of all sample units (McCune and Grace 2002). Cluster analyses were performed using Ward's group linkage method and the relative Euclidean distance measure (McCune and Grace 2002).

Dendrograms are presented below to illustrate the community groups interpreted from the data. Dendrogram branches were subjectively trimmed for community group identification based on ecological interpretation of sample unit (dis)similarity within and among clusters at different levels of percent information remaining (Kent and Coker 1992). The community group identification within each ecological range type was also supported by the complimentary analyses described below.

Ordination methods graphically summarize complex species relationships among observations by aligning observations in a pattern along multiple axes (dimensions) (McCune and Grace 2002). Nonmetric multidimensional scaling (NMS) is "currently one of the most defensible techniques" (McCune and Grace 2002) and is favoured for its increased computational power over other ordination methods such as principal components analysis and detrended correspondence analysis. The Sorenson (Bray-Curtis) distance measure was selected and ordination parameters utilized included two to three axes, random starting configurations, 250 runs with real data, 500 iterations, a stability criterion of 0.00001, and solution selection based on low stress (<15) and the stability criterion (examination of a plot of stress vs. iteration number; McCune and Grace 2002).

Indicator species analysis (ISA; Dufrene and Legendre 1997) also supported dendrogram pruning decisions. ISA evaluates the faithfulness (i.e. is the species present at every sample unit within the group?) and exclusivity (i.e. does the species occur only within the group and not at sample units within other groups?) of each species, producing an indicator value (IV) for each species in each group (McCune and Grace 2002). Statistical significance was evaluated by a Monte Carlo method (1000 randomized runs) with the null hypothesis being that the maximum IV is no larger than would be expected by chance. The number of significant indicators (species with $p \leq 0.05$) and the average of all species' p-values were then each plotted against the number of clusters (i.e. how far left or right the cluster analysis dendrogram is pruned), with the ideal number of dendrogram clusters corresponding to high total and average significance.

Presented below are the final dendrogram figures, illustrating the community groups identified based on control and treatment observation data. NMS diagrams are included to illustrate the strength of community grouping based on various treatment categories (such as seed treatment, time since treatment, etc). Indicator species analysis plots described above are provided to illustrate support for the number of community groups identified for each ecological range site.

Dry Mixedgrass Natural Subregion

DMG Blowouts (BlO)

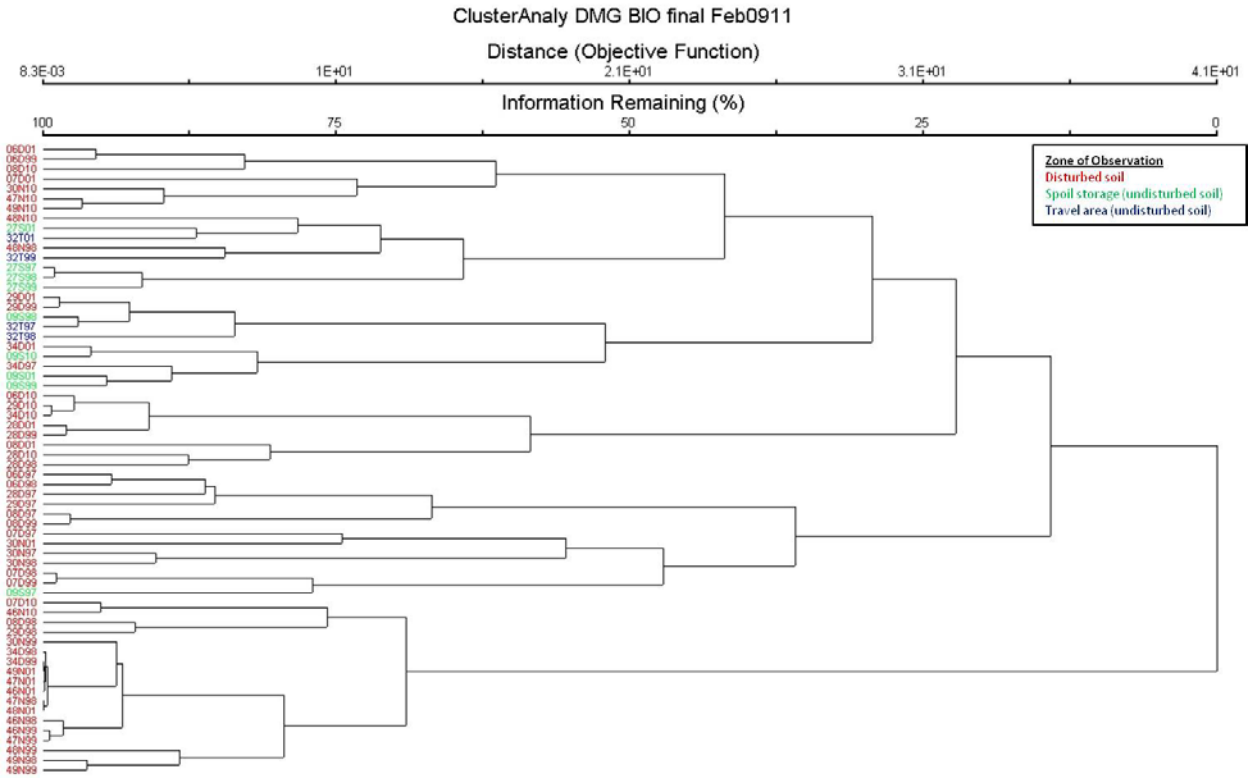
Sites #6D, 7D, 8D, 9S, 27S, 28D, 29D, 30N, 32T, 34D, 46N, 47N, 48N, 49N.

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15) /3	45	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10) /3	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/ 3	72	75	DMGA1 6	Western wheatgrass-sedge-needle and thread
09S	Unstripped Spoil Storage	no	fall 96	Berry Creek Plain	HDY(10) /2	41	63	DMGA1 5	Wheat grass - needle-&-thread - June grass
27S	Unstripped Spoil Storage	no	fall 96	?	HDY(10) /3	no	no		
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/ 4	72	75	DMGA3 5	Needle-&-thread - June grass - blue grama grass
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /4	66	84	DMGA1 5	Wheat grass - needle-&-thread - June grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	69	85	DMGA1 5	Wheat grass - needle-&-thread - June grass
32T	Unstripped Travel Lane	no	fall 96	Wildhorse Plain	HUK(10) /3	no	no		
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /3	41	59	DMGA3	Needle-&-thread - June grass - blue grama grass
46N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	HUK(10) /3	84	100	DMGA4 7	Needle-&-thread - blue grama - northern-wheatgrass
47N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	HUK(10) /3	72	84	DMGA1 5	Wheat grass - needle-&-thread - June grass

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
48N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	DHS(10) /3	47	75	DMGA4 7	Needle-&-thread - blue grama - northern-wheatgrass
49N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	ROL(10)/ 3	43	84	DMGA4 8	Blue grama - needle-&-thread

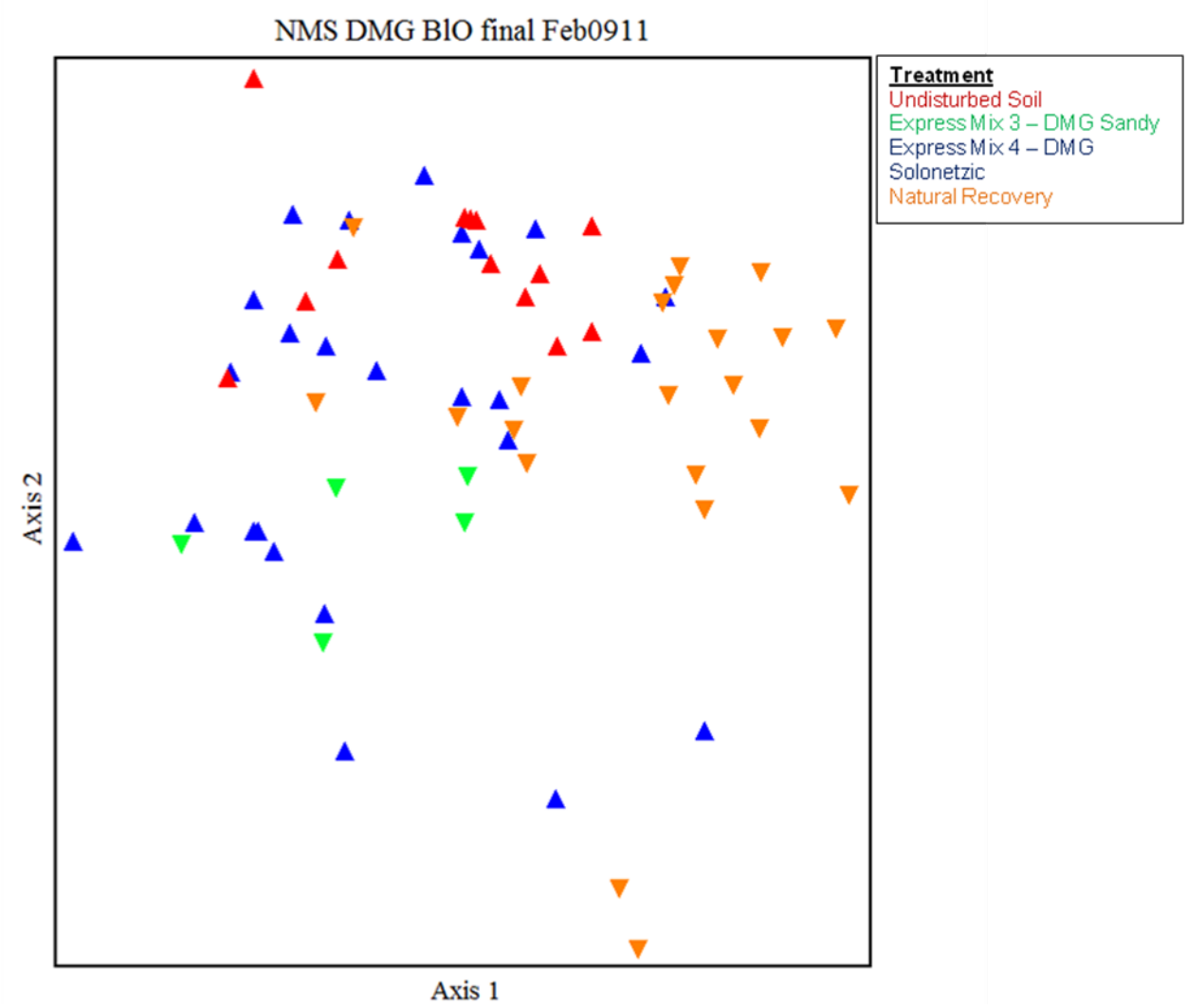
DMG Blowout Cluster Analysis

Percent chaining is 2.77%, which is very good (ideal is <10%). This means there were a number of distinct groups to further investigate.



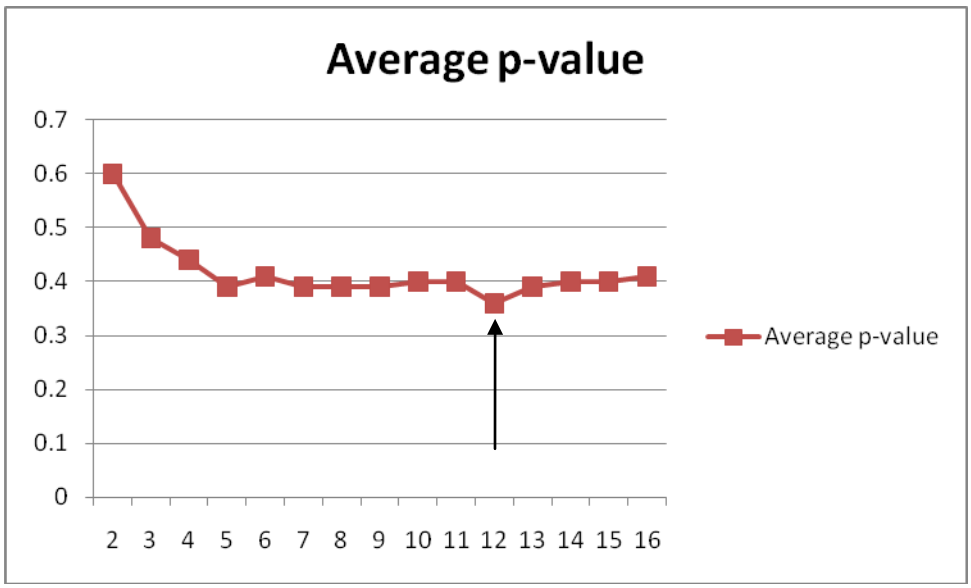
DMG Blowout NMS Ordination

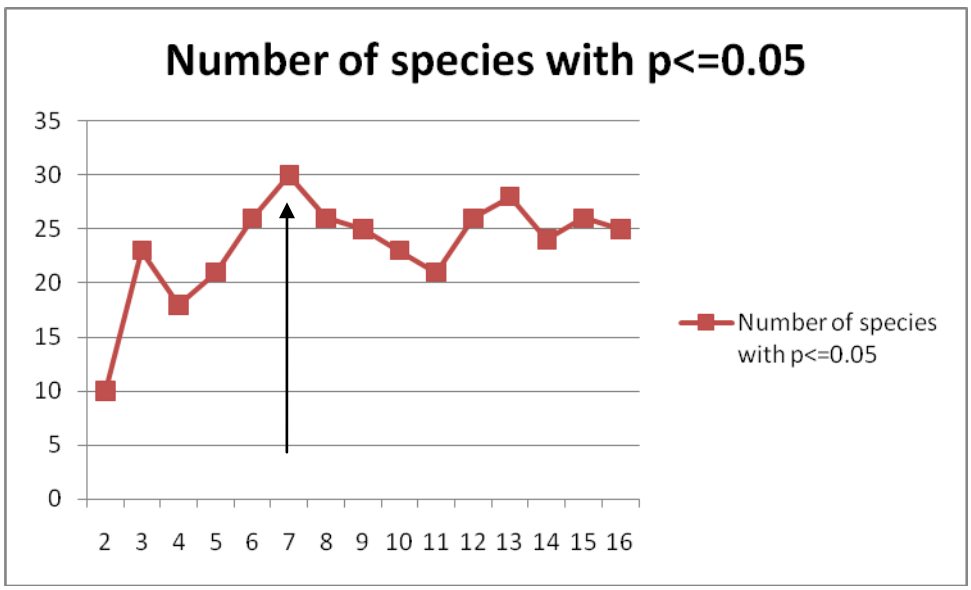
NMS results were useful but not strong. Stress was 16.1 (<10 is ideal, but 10-20 produces useable results if interpreted with caution). A 3D solution was recommended with axes accounting for 75.5% of the variation. The strongest axes were 2 (34.2%) and 1 (23.2%). Each of the preceding metrics is similar to that reported in the intermediate report, indicating that the reduced sample size in the treatment-only analysis has still produced acceptable results.

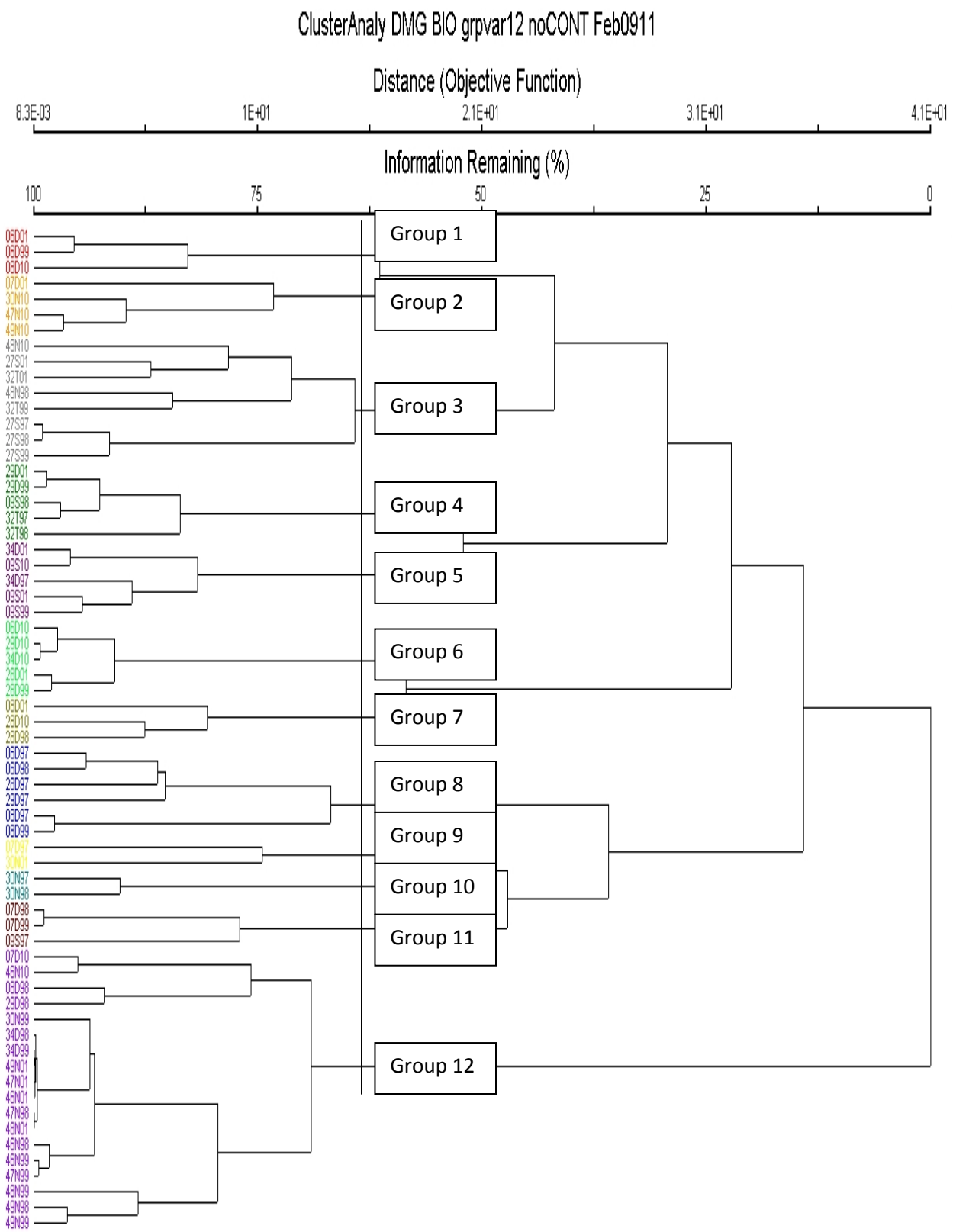


DMG Blowout Indicator Species Analysis

The criterion provided by ISA indicated that the dendrogram could be trimmed at either 7 or 12 groups. The lowest average p-value for all species occurred at 12 groups (0.36) while the highest number of species with an IV p-value of <= 0.05 coincided at 7 groups (30). The 12 group result was selected due to its ability to identify a western porcupine grass community.






ClusterAnaly DMG BIO grpvar12 noCONT Feb0911
Distance (Objective Function)
8.3E-03
1E+01
2.1E+01
3.1E+01
4.1E+01
Information Remaining (%)
100
75
50
25
0
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6
Group 7
Group 8
Group 9
Group 10
Group 11
Group 12
06D01
06D99
08D10
07D01
30N10
47N10
49N10
48N10
27S01
32T01
48N98
32T99
27S97
27S98
27S99
29D01
29D99
09S98
32T97
32T98
34D01
09S10
34D97
09S01
09S99
06D10
29D10
34D10
28D01
28D99
08D01
28D10
28D98
06D97
06D98
28D97
29D97
08D97
08D99
30N97
30N98
07D98
07D99
09S97
07D10
46N10
06D98
29D98
30N99
34D98
34D99
49N01
47N01
46N01
47N98
48N01
46N98
46N99
47N99
48N99
49N98
49N99

DMG Blowout Community Group Identification

For the following groupings, and throughout this report, all species with a constancy >= 80 are listed and the first three are used in the group name according to the Shrub/Grass-Forb format used by Alberta Sustainable Resource Development (e.g. Adams et al. 2004). The species richness and Shannon's diversity indices reported with each community group are averages for each observation within the group, as calculated in PC-ORD (species richness = the average number of non-zero elements).

The first group is a late seral community composed of sites which were seeded. The group is dominated by western porcupine grass from the seedbank and other desirable native graminoids. This group is formed by sites on the northern end of the dry mixed grass in the Berry Creek Plain ecodistrict. However, it is a small group comprised of only three mid to late year observations. Site #6 was treated with seed mix #3, while site #8 was treated with seed mix #4.

Group 1: Western porcupine grass-Western wheatgrass-Pasture sagewort
Avg. Richness = 21.0; Shannon's Diversity Index = 2.53

	Average Cover (%)	Constancy
STIPCUR	18.8	100
AGROSMI	12.0	100
ARTEFRI	9.0	100
CAREOBT	4.6	100
KOELMAC	3.6	100
AGRODAS	2.9	100
FESTOVI	2.1	100
POAJUNC	0.9	100

6D99, 6D01
8D10
Disturbed observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15) /3	45	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/ 3	72	75	DMGA1 6	Western wheatgrass-sedge-needle and thread

The second group is a late seral community with a dominant cover of western wheatgrass. It is comprised mainly of late year naturally recovered observations. It is one of the few treatment communities in the analysis with consistent presence of a moss and lichen layer (2.4% cover), but it also still has prominent cover of pasture sagewort, a native disturbance forb species.

Group 2: Western wheatgrass -Pasture sagewort Avg. Richness = 15.5; Shannon's Diversity Index = 2.11		
	Average Cover (%)	Constancy
AGROSMI	15.7	100
ARTEFRI	6.8	100
Moss and Lichens	2.4	100
KOELMAC	1.5	100

7D01
30N10
47N10
49N10
Disturbance observations: 1
Naturally recovered observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10) /3	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	69	85	DMGA15	Wheat grass - needle-&-thread - June grass
47N	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10) /3	72	84	DMGA15	Wheat grass - needle-&-thread - June grass
49N	Disturbed soil	NR	summer 97	Rainy Hills Upland	ROL(10)/ 3	43	84	DMGA48	Blue grama - needle-&-thread

The third group is a larger group comprised of unseeded sites, including naturally recovery treated disturbance sites, and sites that did not have the soil disturbed. Observations are from among all years. The community is considered to be early seral due to the high cover provided by pasture sagewort, a native disturbance forb species.

Group 3: Pasture sagewort-Needle and thread grass-June grass Avg. Richness = 14.2; Shannon's Diversity Index = 2.19		
	Average Cover (%)	Constancy
ARTEFRI	6.1	100
STIPCOM	5.3	100
KOELMAC	4.2	100
SPHACOC	3.1	100
AGRODAS	1.8	100
PHLOHOO	3.8	87.5
CARESTE	3.3	87.5
CALAMON	2.7	87.5

48N98, 48N10
27S97, 27S98, 27S99
32T99, 32T01
Travel observations: 2
Naturally recovered observations: 2
Spoil observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
27S	Unstripped Spoil Storage	no	fall 96	?	HDY(10) /3	no	no		
32T	Unstripped Travel Lane	no	fall 96	Wildhorse Plain	HUK(10) /3	no	no		
48N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	DHS(10) /3	47	75	DMGA4 7	Needle-&-thread - blue grama - northern-wheatgrass

The fourth group is a mid-seral community comprised of early to mid year observations. None of the sites were seeded except for site #29, which was treated with seed mix #4.

Group 4: Northern wheatgrass- Pasture sagewort-Western wheatgrass Avg. Richness = 12.6; Shannon's Diversity Index = 1.79		
	Average Cover (%)	**Constancy**
AGRODAS	15.4	100
ARTEFRI	3.2	100
AGROSMI	2.1	80
STIPCOM	1.9	80
SPHACOC	0.7	80

29D99, 29D01
9S98
32T97, 32T98
Travel observations: 2
Spoil observations: 1
Disturbed observations: 2

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
09S	Unstripped Spoil Storage	no	fall 96	Berry Creek Plain	HDY(10) /2	41	63	DMGA15	Wheat grass - needle-&-thread - June grass
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /4	66	84	DMGA15	Wheat grass - needle-&-thread - June grass
32T	Unstripped Travel Lane	no	fall 96	Wildhorse Plain	HUK(10) /3	no	no		

The fifth group is a late mid-seral community comprised of observations from all years. While the spoil site was not seeded, site #34 was disturbed and treated with seed mix #4.

Group 5: Needle and thread grass-Pasture sagewort-Northern wheatgrass Avg. Richness = 11.6; Shannon's Diversity Index = 1.85		
	Average Cover (%)	**Constancy**
STIPCOM	11.1	100
ARTEFRI	11.1	100
AGRODAS	8.2	100
STIPVIR	5.1	100
FESTOVI	2.9	100
AGROSMI	1.9	80
SPHACOC	0.2	80

34D97, 34D01
9S99, 9S01, 9S10
Spoil observations: 1
Disturbed observations: 2

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
09S	Unstripped Spoil Storage	no	fall 96	Berry Creek Plain	HDY(10) /2	41	63	DMGA15	Wheat grass - needle-&-thread - June grass
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /3	41	59	DMGA3	Needle-&-thread - June grass - blue grama grass

The sixth group is comprised of mid to late year observations of seed mix species from seed mixes #3 and 4, which contained sheep fescue seed. The sites are now dominated by a cover of sheep fescue and pasture sagewort is still prominent. The community is described as "trending to modified" since cover of this non-native invasive species has increased over time to occupy more than 5% of the total live cover on the site.

Group 6: Sheep fescue-Pasture sagewort-Northern wheatgrass Avg. Richness = 14.8; Shannon's Diversity Index = 1.94		
	Average Cover (%)	**Constancy**
FESTOVI	18.4	100
ARTEFRI	7.6	100
AGRODAS	5.1	100
AGROSMI	4.3	100
STIPVIR	3.8	100
Moss and Lichens	0.2	80

6D10
28D99, 28D01
29D10
34D10
Disturbed observations: 5

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15) /3	45	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/ 4	72	75	DMGA3 5	Needle-&-thread - June grass - blue grama grass
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /4	66	84	DMGA1 5	Wheat grass - needle-&-thread - June grass
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /3	41	59	DMGA3	Needle-&-thread - June grass - blue grama grass

The seventh group is also a "trending to modified" community with sheep fescue providing the most cover at 8% cover along with other seed mix species,. This group differs from group #6 above in that the moss and lichens layer is far more established. The cover of moss and lichen on control site 28 is also among the highest of the plots.

Group 7: Sheep fescue-Northern wheatgrass-Pasture sagewort/Moss and Lichens

Avg. Richness = 18.0; Shannon's Diversity Index = 2.07

	Average Cover (%)	Constancy
Mosses and Lichens	18.6	100
FESTOVI	8.0	100
AGRODAS	5.2	100
ARTEFRI	3.2	100
AGROSMI	2.7	100
KOELMAC	0.9	100
CARESTE	0.4	100

8D01

28D98, 28D10

Disturbed observations: 3

Naturally recovered observations: 1

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/ 3	72	75	DMGA1 6	Western wheatgrass-sedge-needle and thread
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/ 4	72	75	DMGA3 5	Needle-&-thread - June grass - blue grama grass

The eighth group is a pioneer community, characterized by high cover of the colonizing seed mix species, slender wheatgrass. Other seeded species from mixes 3 and 4 are also establishing. Note that later year observations from the sites included in this group are grouped with modified plant community groups #6 and 7 above, indicating the increased dominance of sheep fescue over time.

Group 8: Slender wheatgrass-Northern wheatgrass-Pasture sagewort
Avg. Richness = 16.0; Shannon's Diversity Index = 2.07

	Average Cover (%)	Constancy
AGROTRA	13.3	100
AGRODAS	4.2	100
ARTEFRI	2.6	100
KOELMAC	3.4	83.3
FESTOVI	2.2	83.3

6D97, 6D98
8D97, 8D99
28D97
29D97
Disturbed observations: 6

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15) /3	45	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/ 3	72	75	DMGA1 6	Western wheatgrass-sedge-needle and thread
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/ 4	72	75	DMGA3 5	Needle-&-thread - June grass - blue grama grass
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /4	66	84	DMGA1 5	Wheat grass - needle-&-thread - June grass

The ninth group is has a high amount of bare ground and is a pioneer community due to primary coverage by annual, disturbance forb species. Note that this is a small group comprised of only two observations

Group 9: Common knotweed - Pasture sagewort - Slender wheatgrass Avg. Richness = 14.0; Shannon's Diversity Index = 1.88		
	Average Cover (%)	Constancy
POLYARE	6.7	100
ARTEFRI	2.6	100
AGROTRA	0.3	100
KOELMAC	0.3	100

7D97
30N01
Disturbed observations: 1
Naturally recovered observations: 1

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10) /3	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	69	85	DMGA15	Wheat grass - needle-&-thread - June grass

The tenth group is comprised of only two observations from a single naturally recovered site and again is a pioneer community dominated by weedy, annual forb species.

Group 10: Nuttall's Atriplex / Knotweed sp.-Pasture sagewort Avg. Richness = 9.5; Shannon's Diversity Index = 1.09		
	Average Cover (%)	Constancy
POLYSPP	15.2	100
ARTEFRI	8.8	100
ATRINUT	4.5	100
STIPCOM	0.2	100

30N97, 30N98
Naturally recovered observations: 2

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	69	85	DMGA15	Wheat grass - needle-&-thread - June grass

The eleventh group is a pioneer community, dominated by weedy, annual native forb species.

Group 11: Summer cypress-Lamb's quarters-Slender wheatgrass Avg. Richness = 16.3; Shannon's Diversity Index = 1.92		
	Average Cover (%)	Constancy
KOCHSCO	28.7	100
CHENALB	3.6	100
AGROTRA	3.5	100
AGROSMI	3.0	100
ARTEFRI	1.8	100
STIPVIR	0.8	100

7D98, 7D99
9S97
Spoil observations: 1
Disturbed observations: 2

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10) /3	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
09S	Unstripped Spoil Storage	no	fall 96	Berry Creek Plain	HDY(10) /2	41	63	DMGA15	Wheat grass - needle-&-thread - June grass

The twelfth group is an early seral community, representing a large number of observations from primarily two to five years post-disturbance, on both seeded and unseeded sites. Several observations are from the drought year of 2001, 5 years post-construction. The group is characterized by the prominence of pasture sagewort, a disturbance adapted native perennial forb. While there is a diversity of species represented within this community, most species' constancy is low.

Group 12: Pasture sagewort-Needle and thread grass
Avg. Richness = 12.4; Shannon's Diversity Index = 1.62

	Average Cover (%)	Constancy
ARTEFRI	23.7	100
STIPCOM	3.8	88.9

7D10
8D98
29D98
30N99
34D98, 34D99

46N98, 46N99, 46N01, 46N10
47N98, 47N99, 47N01
48N99, 48N01
49N98, 49N99, 49N01

Disturbed observations: 5
Naturally recovered observations: 13

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10) /3	39	62	No good fit	Northern wheatgrass - low sedge - June grass - western porcupine grass
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/ 3	72	75	DMGA1 6	Western wheatgrass-sedge-needle and thread
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /4	66	84	DMGA1 5	Wheat grass - needle-&-thread - June grass
30N	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	69	85	DMGA1 5	Wheat grass - needle-&-thread - June grass
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10) /3	41	59	DMGA3	Needle-&-thread - June grass - blue grama grass
46N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	HUK(10) /3	84	100	DMGA4 7	Needle-&-thread - blue grama - northern-wheatgrass
47N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	HUK(10) /3	72	84	DMGA1 5	Wheat grass - needle-&-thread - June grass
48N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	DHS(10) /3	47	75	DMGA4 7	Needle-&-thread - blue grama - northern-wheatgrass
49N	Disturbed soil	NR	summ er 97	Rainy Hills Upland	ROL(10)/ 3	43	84	DMGA4 8	Blue grama - needle-&-thread

DMG Blowout Succession Table

		Pioneer →				Early Seral →		Mid-seral	Late Mid-seral	Late Seral →		Trending to Modified	
Treatment	Site #	*Group 8: AGROTRA-AGRODAS-ARTEFRI*	*Group 9: POLYARE-ARTEFRI-AGROTRA*	*Group 10: ATRINUT/ POLYSPP-ARTEFRI*	*Group 11: KOCHSCO-CHENALB-AGROTRA*	Group 12: ARTEFRI-STIPCOM	Group 3: ARTEFRI-STIPCOM-KOELMAC	Group 4: AGRODAS-ARTEFRI-AGROSMI	Group 5: STIPCOM-ARTEFRI-AGRODAS	Group 1: STIPCUR-AGROSMI-ARTEFRI	Group 2: AGROSMI-ARTEFRI	*Group 7: Sheep fescue-Northern wheatgrass-Pasture sagewort/Moss and Lichens*	Group 6 - Sheep fescue-Pasture sagewort-Northern wheatgrass
Seeded Sites	6D	97, 98								99, '01			10
	7D		97		98, 99	10					01		
	8D	97, 99				98				10		01	
	28D	97										98, 10	99, '01
	29D	97				98		99, 01					10
	34D					98, 99			97, 01				10
Unseeded Sites	30N		01	97, 98		99					10		
	9S				97			98	99, 01, 10				
	27S						97, 98, 99						
	32T						99, '01	97, 98					
	46N					98, 99, '01, 10							
	47N					98, 99, '01					10		
	48N					99, '01	98, 10						
	49N					98, 99, '01					10		
Diversity Index		2.07	1.88	1.09	1.92	1.62	2.19	1.79	1.85	2.53	2.11	2.07	1.94
Avg. Richness		16.0	14.0	9.5	16.3	12.4	14.2	12.6	11.6	21.0	15.5	18.0	14.8

DMG Blowout Succession Table – Sites Seeded with Seed Mixes 3 and 4

		Pioneer			Early Seral	Mid-seral	Late Mid-seral	Late Seral		Trending to Modified	
Treatment	Site #	*Group 8: Slender wheatgrass-Northern wheatgrass-Pasture sagewort*	*Group 9: Common knotweed - Pasture sagewort - Slender wheatgrass*	*Group 11: Summer cypress-Lamb's quarters-Slender wheatgrass*	*Group 12: Pasture sagewort-Needle and thread grass*	*Group 4: Northern wheatgrass-Pasture sagewort-Western wheatgrass*	*Group 5: Needle and thread grass-Pasture sagewort-Northern wheatgrass*	*Group 1: Western porcupine grass-Western wheatgrass-Pasture sagewort*	Group 2: Western wheatgrass - Pasture sagewort	*Group 7: Sheep fescue-Northern wheatgrass-Pasture sagewort/Moss and Lichens*	*Group 6 - Sheep fescue-Pasture sagewort-Northern wheatgrass*
Seeded Sites	6D	97, 98						99, '01			10
	7D		97	98, 99	10				01		
	8D	97, 99			98			10		01	
	28D	97								98, 10	99, '01
	29D	97			98	99, 01					10
	34D				98, 99		97, 01				10
Diversity Index		2.07	1.88	1.92	1.62	1.79	1.85	2.53	2.11	2.07	1.94
Avg. Richness		16.0	14.0	16.3	12.4	12.6	11.6	21.0	15.5	18.0	14.8

DMG Blowout Succession Table – Un-seeded Sites including Natural Recovery, Unstripped Spoil Storage and Unstripped Travel Lanes

		Pioneer			Early Seral		Mid-seral	Late Mid-seral	Late Seral
Treatment	Site #	*Group 9: Common knotweed - Pasture sagewort - Slender wheatgrass*	*Group 10: Nuttall's Atriplex / Knotweed sp.- Pasture sagewort*	*Group 11: Summer cypress-Lamb's quarters-Slender wheatgrass*	*Group 12: Pasture sagewort-Needle and thread grass*	Group 3: Pasture sagewort-Needle-and-thread grass - June grass	Group 4: Northern wheatgrass- Pasture sagewort-Western wheatgrass	*Group 5: Needle and thread grass-Pasture sagewort-Northern wheatgrass*	Group 2: Western wheatgrass -Pasture sagewort
Unseeded Sites	30N	01	97, 98		99				10
	9S			97			98	99, 01, 10	
	27S					97, 98, 99			
	32T					99, '01	97, 98		
	46N				98, 99, '01, 10				
	47N				98, 99, '01				10
	48N				99, '01	98, 10			
	49N				98, 99, '01				10
Diversity Index		1.88	1.09	1.92	1.62	2.19	1.79	1.85	2.11
Avg. Richness		14.0	9.5	16.3	12.4	14.2	12.6	11.6	15.5

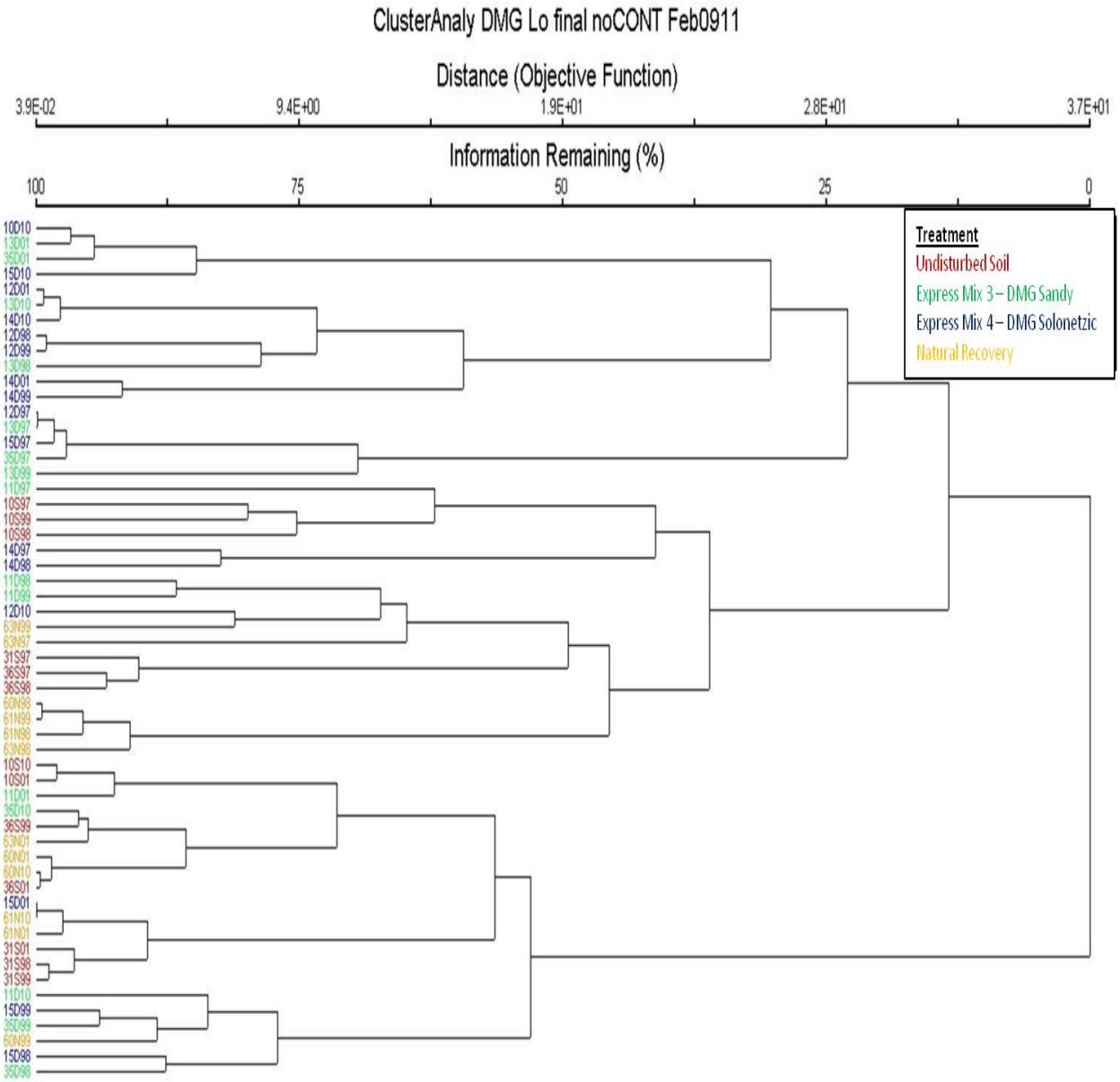
DMG Loamy (Lo)

Sites #10D, 10S, 11D, 12D, 13D, 14D, 15D, 31S, 35D, 36S, 60N, 61N, 63N.

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
10S	Spoil (97,98,99, 01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	no	87	DMGA2-Degraded	Needle-&-thread - wheatgrass (degraded)
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	64	87	DMGA2-Degraded	Needle-&-thread - wheatgrass (degraded)
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	47	47	DMGA3-Degraded	Needle and thread-June grass-blue grama grass (degraded)
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10) /3-4 Sol	36	75	DMGA3	Needle-&-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/ 3-4	46	100	DMGA47	Needle-&-thread - blue grama - northern wheatgrass
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3	63	71		Needle-&-thread - June Grass - Western wheatgrass
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	x	60	DMGA3	Needle-&-thread - June grass - blue grama grass
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10) /3	no	no		
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10) /2-3	40	82	DMGA2	Needle-&-thread - wheatgrass
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10) /4	no	no		
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	75	97	DMGA3	Needle-&-thread - June grass - blue grama grass
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	78	88	DMGA2	Needle-&-thread - wheatgrass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	no	no		

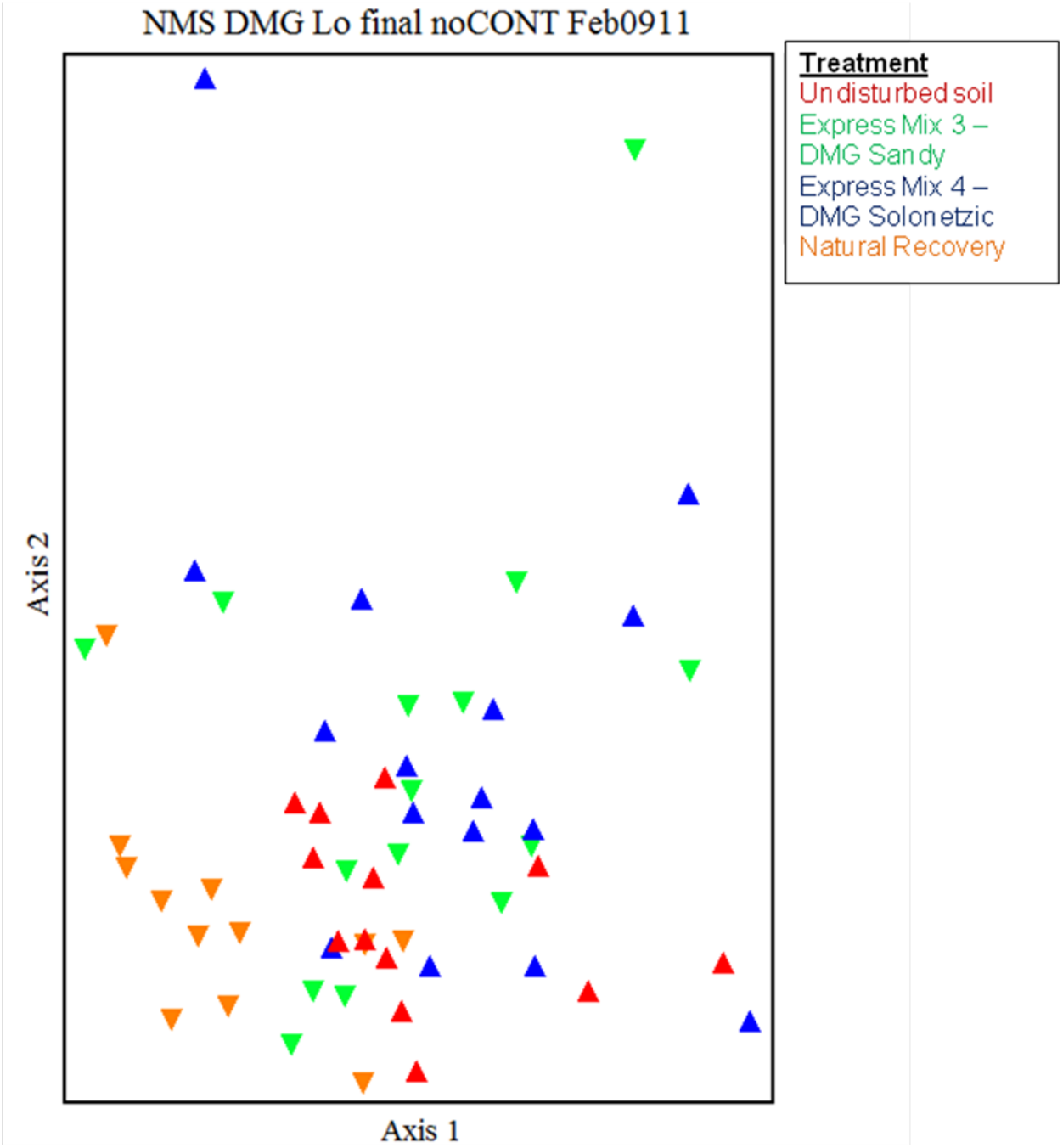
DMG Loamy Cluster Analysis

Percent chaining is 1.74%, which is quite good (ideal is <10%). There was no apparent grouping of observations by year, but there may be a slight influence by seed mix treatment observed.



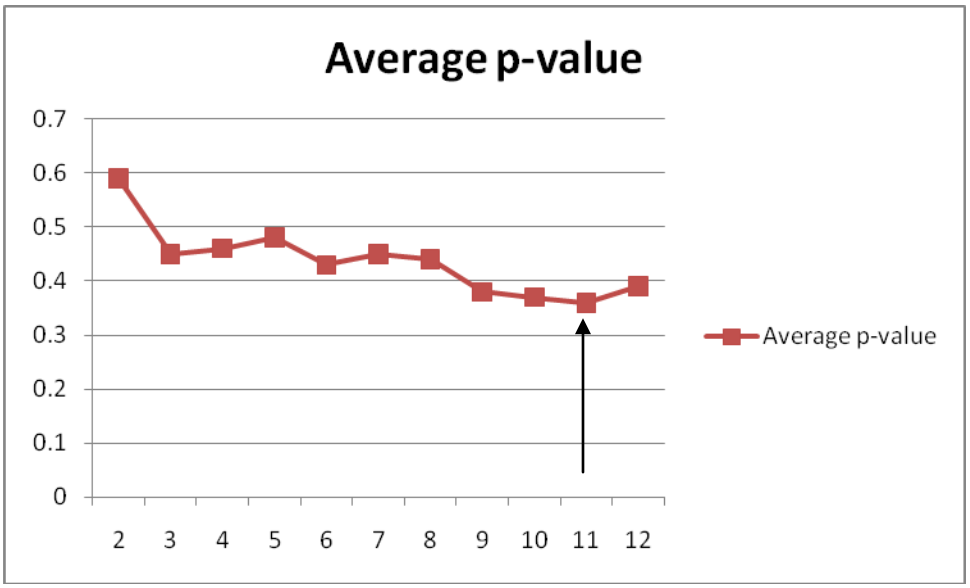
DMG Loamy NMS Ordination

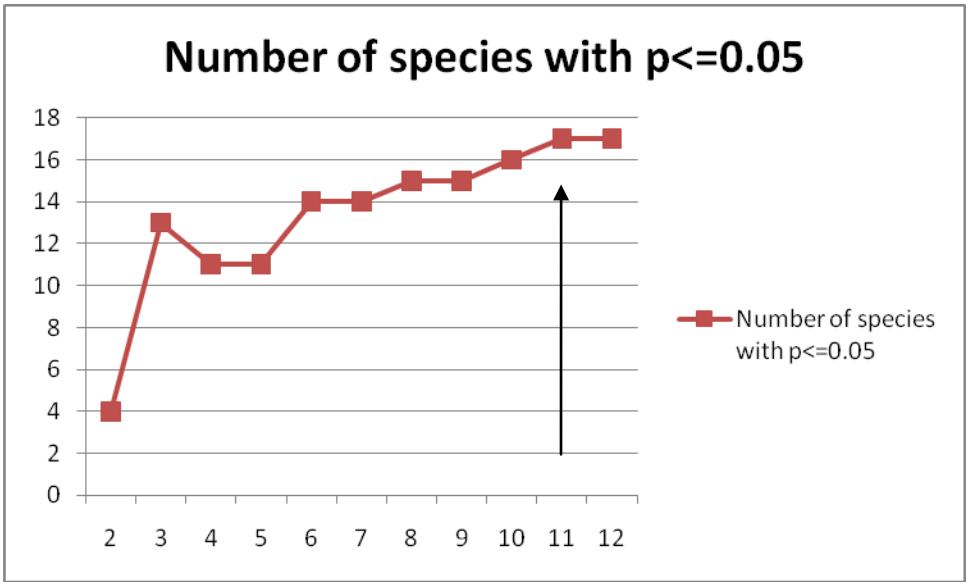
NMS results were useful but not strong. Stress was 15.0 (<10 is ideal, but 10-20 produces useable results if interpreted with caution). A 3D solution was recommended with axes accounting for 73.9% of the variation. The strongest axes were 1 (25.7%) and 2 (24.8%), although the third axis was almost equally weighted (23.5%). These results indicate an improvement from the intermediate analysis where only a 2D solution was recommended, indicating that more structure within the data was apparent. This could be because the removal of the control observations removed the strong grouping effect from the presence (control) and absence (treatment) of the moss and lichen layer.

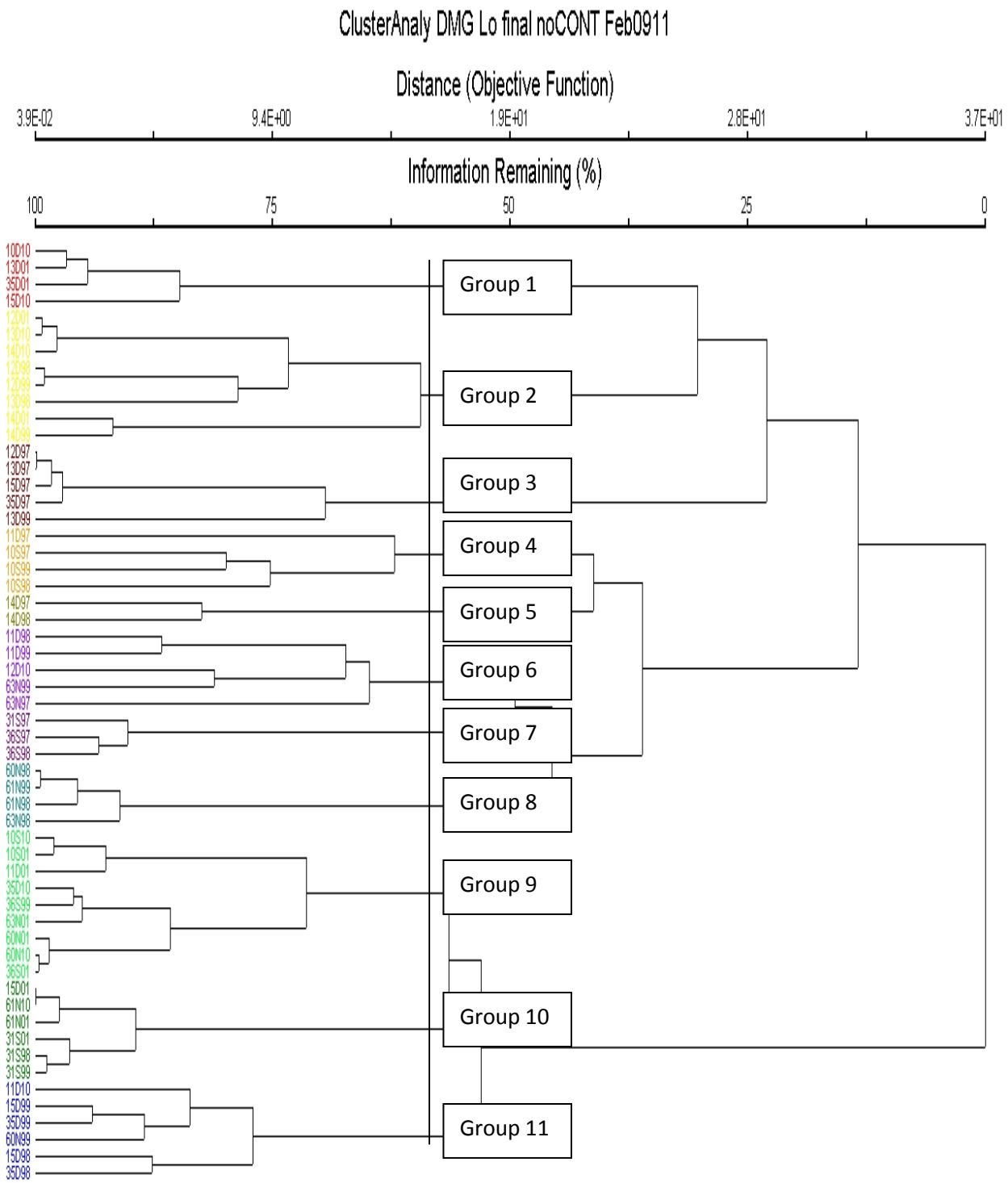


DMG Loamy Indicator Species Analysis

The criterion provided by ISA indicated that the dendrogram could be trimmed at 11 groups. The lowest average p-value for all species was 0.36 for 11 groups while the highest number of species with an IV p-value of <= 0.05 coincided at 11 groups as well (17).






ClusterAnaly DMG Lo final noCONT Feb0911
Distance (Objective Function)
3.9E-02
9.4E+00
1.9E+01
2.8E+01
3.7E+01
Information Remaining (%)
100
75
50
25
0
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6
Group 7
Group 8
Group 9
Group 10
Group 11

DMG Loamy Community Group Identification

The first of the 11 groups identified by the ISA was a plant community trending to modified, that is clearly dominated by the seeded Sheep fescue and characterized by observations five and 14 years post-disturbance (2001 and 2010) when this species seems to have established and increased in prominence. The disturbed and seeded sites have low species diversity.

Group 1: Sheep fescue - Northern wheatgrass Avg. Richness = 9.5; Shannon's Diversity Index = 1.55		
	Average Cover (%)	**Constancy**
FESTOVI	25.3	100
AGRODAS	6.2	100

10D10
13D01
15D10 – reseeded in 2004
35D01
Disturbed observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	64	87	DMGA2-Degraded	Needle-&-thread - wheatgrass (degraded)
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/ 3-4	46	100	DMGA47	Needle-&-thread - blue grama - northern wheatgrass
15D	Disturbed soil	4 – reseeded in 2004	fall 96	Foremost Plain	scMAB(10)/3	x	60	DMGA3	Needle-&-thread - June grass - blue grama grass
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10) /2-3	40	82	DMGA2	Needle-&-thread - wheatgrass

The second group is a mid-seral plant community, characterized by the prominence of grasses in the seed mix. Green needle grass and sheep fescue are both dominant species. All three sites were reclaimed and seeded in spring of the year following construction. Observations between two and 14 years post-construction are included in this group.

Group 2: Northern wheatgrass-Green needle grass-Western wheatgrass Avg. Richness = 12.2; Shannon's Diversity Index = 1.87		
	Average Cover (%)	Constancy
AGRODAS	19.7	100
STIPVIR	6.4	100
AGROSMI	3.1	100
ARTEFRI	4.0	87.5
FESTOVI	2.8	87.5

12D98, 12D99, 12D01
13D98, 13D10
14D99, 14D01, 14D10
Disturbed observations: 8

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10) /3-4 Sol	36	75	DMGA3	Needle-&-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/ 3-4	46	100	DMGA4 7	Needle-&-thread - blue grama - northern wheatgrass
14D	Disturbed soil	4	spring 97	Foremost Plain	scroll (10)/2-3	63	71		Needle-&-thread - June Grass - Western wheatgrass

The third group is a pioneer plant community composed of the seed mix during primarily the first year of growth as it colonizes the disturbed soils of the ROW. The group contains early year observations from 1997 and 1999. Sites 12 and 13 later moved into Group 2, in which primary colonizers like slender wheatgrass have decreased and more persistent seeded species are more prominent.

Group 3: Slender wheatgrass-Western wheatgrass-Northern wheatgrass Avg. Richness = 9.4; Shannon's Diversity Index = 1.43		
	Average Cover (%)	Constancy
AGROTRA	5.4	100
AGROSMI	1.4	80
AGRODAS	0.9	80
STIPVIR	0.6	80
FESTOVI	0.6	80
KOELMAC	0.3	80

12D97
13D97, 13D99
15D97
35D97
Disturbed observations: 5

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10) /3-4 Sol	36	75	DMGA3	Needle-&-thread - June grass - blue grama grass
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/ 3-4	46	100	DMGA47	Needle-&-thread - blue grama - northern wheatgrass
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	x	60	DMGA3	Needle-&-thread - June grass - blue grama grass
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10) /2-3	40	82	DMGA2	Needle-&-thread - wheatgrass

The fourth group is an early seral stage plant community comprised of observations one to three years post-disturbance. The majority are from one unstripped spoil storage area. Both sites were heavily grazed during these years which may explain the dominance of increaser species low sedge and pasture sagewort. No native grass species are dominant.

Group 4: Low sedge-Pasture sagewort Avg. Richness = 13.2; Shannon's Diversity Index = 1.67		
	Average Cover (%)	**Constancy**
CARESTE	8.8	100
ARTEFRI	1.7	100

10S97, 10S98, 10S99
11D97
Disturbed observations: 1
Spoil observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
10S	Spoil (97,98,99,01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	no	87	DMGA2-Degraded	Needle-&-thread - wheatgrass (degraded)
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	47	47	DMGA3-Degraded	Needle and thread-June grass-blue grama grass (degraded)

The fifth group is pioneer plant community characterized by the annual weed kochia (summer cypress) and comprised only of early year observations from site #14. Site #14 was reclaimed the spring following construction and seeded with Seed Mix 4, which included two cultivars of slender wheatgrass, the only other constant species for this group. There were very few other species present on the site for these observation years.

Group 5: Summer cypress-Slender wheatgrass Avg. Richness = 4.5; Shannon's Diversity Index = 0.72		
	Average Cover (%)	**Constancy**
KOCHSCO	15.8	100
AGROTRA	0.8	100

14D97, 14D98
Disturbed observations: 2

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3	63	71		Needle-&-thread - June Grass - Western wheatgrass

The sixth group is an early seral plant community identified in the analysis of this ERS. It is characterized by the dominance of pasture sagewort, a disturbance adapted native forb. Numerous other species are present in this group at 20-60% constancy.

Group 6: Pasture sagewort-Northern wheatgrass Avg. Richness = 14.2; Shannon's Diversity Index = 1.98		
	Average Cover (%)	**Constancy**
ARTEFRI	10.7	100
AGRODAS	1.5	80

11D98, 11D99

12D10

63N97, 63N99

Disturbed observations: 3

Natural recovery observations: 2

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	47	47	DMGA3-Degraded	Needle and thread-June grass-blue grama grass (degraded)
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10) /3-4 Sol	36	75	DMGA3	Needle-&-thread - June grass - blue grama grass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	no	no		

The seventh group is identified as a mid-seral plant community present on areas where spoil was stored directly on the prairie. The group is comprised only of three observations from treatment sites where the soil was not disturbed. Grasses and sedges have re-established from the seed and propagule bank. Note that moss and lichen cover was low (0.1% average cover) in this group.

Group 7: June grass - Pasture sagewort - Northern wheatgrass Avg. Richness = 14.3; Shannon's Diversity Index = 2.14		
	Average Cover (%)	Constancy
KOELMAC	10.2	100
ARTEFRI	5.8	100
AGRODAS	5.7	100
CALAMON	4.3	100
STIPCOM	3.7	100
CARESTE	3.4	100

31S97
36S97, 36S98
Spoil observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10) /3	no	no		
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10) /4	no	no		

The eighth group is an early seral plant community composed of natural recovery sites. Dominant species include a native weedy annual , disturbance-adapted pasture sagewort and northern wheatgrass. This group is comprised of observations two and three years post-construction.

Group 8: Narrow-leaved goosefoot - Pasture sagewort - Northern wheatgrass

Avg. Richness = 11.5; Shannon's Diversity Index = 1.99

	Average Cover (%)	Constancy
CHENPRA	13.7	100
ARTEFRI	12.4	100
AGRODAS	7.0	100
PHLOHOO	1.4	100

60N98
61N98, 61N99
63N98
Natural recovery observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	75	97	DMGA3	Needle-&-thread - June grass - blue grama grass
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	78	88	DMGA2	Needle-&-thread - wheatgrass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	no	no		

The ninth group is a late mid-seral plant community due to its dominance by a native increaser grasses. There is cover provided in the 11-77% constancy range by other species for this group (high diversity but low constancy). It includes a mix naturally recovered, disturbed soils, unstripped spoil storage areas and two seeded areas, five and 14 years post-construction.

Group 9: Needle and thread grass - Pasture sagewort
Avg. Richness = 13.0; Shannon's Diversity Index = 1.75

	Average Cover (%)	Constancy
STIPCOM	17.6	100
ARTEFRI	7.8	100

10S01, 10S10
11D01
35D10
36S99, 36S01
60N01, 60N10
63N01
Spoil observations: 4
Disturbed observations: 2
Naturally recovered observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
10S	Spoil (97,98,99, 01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	no	87	DMGA2-Degraded	Needle-&-thread - wheatgrass (degraded)
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	47	47	DMGA3-Degraded	Needle and thread-June grass-blue grama grass (degraded)
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10) /2-3	40	82	DMGA2	Needle-&-thread - wheatgrass
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10) /4	no	no		
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	75	97	DMGA3	Needle-&-thread - June grass - blue grama grass
63N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	no	no		

The tenth group is a late seral plant community occurring on primarily unstripped and natural recovery sites. The native decreaser grasses needle and thread grass and northern wheatgrass are dominant. Numerous other species provide cover in this community in the range of 16-66% constancy.

Group 10: Needle and thread grass-Northern wheatgrass-Pasture sagewort Avg. Richness = 10.5; Shannon's Diversity Index = 1.68		
	Average Cover (%)	Constancy
STIPCOM	11.4	100
AGRODAS	10.2	100
ARTEFRI	2.7	100

15D01
31S98, 31S99, 31S01
61N01, 61N10,
Disturbed observations: 1
Naturally recovered observations: 2
Spoil observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	x	60	DMGA3	Needle-&-thread - June grass - blue grama grass
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10)/3	no	no		
61N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	78	88	DMGA2	Needle-&-thread - wheatgrass

The 11th group is a mid-seral plant community composed primarily of native grass species in the seed mix. The group is comprised of primarily of observations two and three years' post-construction, and all sites except the naturally recovered site subsequently progressed to community groups with greater sheep fescue coverage with time. The naturally recovered site progressed to later seral native plant communities.

Group 11: Needle and thread grass-Green needle grass-Pasture sagewort
Avg. Richness = 15.5; Shannon's Diversity Index = 2.07

	Average Cover (%)	Constancy
STIPCOM	7.9	100
STIPVIR	6.3	100
ARTEFRI	5.7	100
AGROSMI	1.6	100
KOELMAC	1.1	100
FESTOVI	2.4	83.3
AGRODAS	2.2	83.3

11D10 – reseeded in 2004
15D98, 15D99
35D98, 35D99
60N99
Disturbed observations: 5
Naturally recovered observations: 1

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
11D	Disturbed soil	3 reseeded in 2004	fall 96	Berry Creek Plain	BVL(10)/ 4 Sandy	47	47	DMGA3-Degraded	Needle and thread-June grass-blue grama grass (degraded)
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	x	60	DMGA3	Needle-&-thread - June grass - blue grama grass
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10) /2-3	40	82	DMGA2	Needle-&-thread - wheatgrass
60N	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10) /3	75	97	DMGA3	Needle-&-thread - June grass - blue grama grass

DMG Loamy Succession Table

		Pioneer →		Early Seral →			Mid-seral →		Late Mid-seral →		Late Seral	Trending to Modified
Treatment	Site#	**Group 5: Summer cypress-Slender wheatgrass**	**Group 3: Slender wheatgrass-Western wheatgrass-Northern wheatgrass**	**Group 4: Low sedge-Pasture sagewort**	**Group 6: Pasture sagewort-Northern wheatgrass**	**Group 8: Narrow-leaved goosefoot - Pasture sagewort - Northern wheatgrass**	**Group 2: Northern wheatgrass-Green needle grass-Western wheatgrass**	**Group 11: Needle and thread grass-Green needle grass-Pasture sagewort**	**Group 7: June grass - Pasture sagewort - Northern wheatgrass**	**Group 9: Needle and thread grass - Pasture sagewort**	**Group 10: Needle and thread grass-Northern wheatgrass-Pasture sagewort**	**Group 1: Sheep fescue - Northern wheatgrass**
Seeded Sites	10D											10
	11D			97	98, 99			10*		01		
	12D		97		10*		98, 99, 01					
	13D		97, 99				98, 10					01
	14D	97, 98					99, 01, 10					
	15D		97					98, 99			01	10*
	35D		97					98, 99		10		01
Unseeded Sites	10S			97, 98, 99						01, 10		
	31S								97		98, 99, 01	
	36S								97, 98	99, 01		
	60N					98		99		01, 10		
	61N					98, 99					01, 10	
	63N				97, 99	98				01		
Diversity Index		0.72	1.43	1.67	1.98	1.99	1.87	2.07	2.14	1.75	1.68	1.55
Avg. Richness		4.5	9.4	13.2	14.2	11.5	12.2	15.5	14.3	13.0	10.5	9.5

*Reseeded in 2004

DMG Loamy Succession Table – Sites Seeded with Seed Mixes 3 and 4

		Pioneer →		Early Seral →		Mid-seral →		Late Mid-seral	Late Seral	Trending to Modified
Treatment	Site#	Group 5: Summer cypress-Slender wheatgrass	Group 3: Slender wheatgrass-Western wheatgrass-Northern wheatgrass	Group 4: Low sedge-Pasture sagewort	Group 6: Pasture sagewort-Northern wheatgrass	Group 2: Northern wheatgrass-Green needle grass-Western wheatgrass	Group 11: Needle and thread grass-Green needle grass-Pasture sagewort	Group 9: Needle and thread grass - Pasture sagewort	Group 10: Needle and thread grass-Northern wheatgrass-Pasture sagewort	Group 1: Sheep fescue - Northern wheatgrass
Seeded Sites	10D									10
	11D			97	98, 99		10*	01		
	12D		97		10*	98, 99, 01				
	13D		97, 99			98, 10				01
	14D	97, 98				99, 01, 10				
	15D		97				98, 99		01	10*
	35D		97				98, 99	10		01
Diversity Index		0.72	1.43	1.67	1.98	1.87	2.07	1.75	1.68	1.55
Avg. Richness		4.5	9.4	13.2	14.2	12.2	15.5	13.0	10.5	9.5

*Reseeded in 2004

DMG Loamy Succession Table – Un-seeded Sites including Natural Recovery, Unstripped Spoil Storage and Unstripped Travel Lanes

		Early Seral →			Mid-seral	Late Mid-seral →		Late Seral
Treatment	Site#	**Group 4: Low sedge-Pasture sagewort**	**Group 6: Pasture sagewort-Northern wheatgrass**	**Group 8: Narrow-leaved goosefoot - Pasture sagewort - Northern wheatgrass**	**Group 11: Needle and thread grass-Green needle grass-Pasture sagewort**	**Group 7: June grass - Pasture sagewort - Northern wheatgrass**	**Group 9: Needle and thread grass - Pasture sagewort**	**Group 10: Needle and thread grass-Northern wheatgrass-Pasture sagewort**
Unseeded Sites	10S	97, 98, 99					01, 10	
	31S					97		98, 99, 01
	36S					97, 98	99, 01	
	60N			98	99		01, 10	
	61N			98, 99				01, 10
	63N		97, 99	98			01	
Diversity Index		1.67	1.98	1.99	2.07	2.14	1.75	1.68
Avg. Richness		13.2	14.2	11.5	15.5	14.3	13.0	10.5

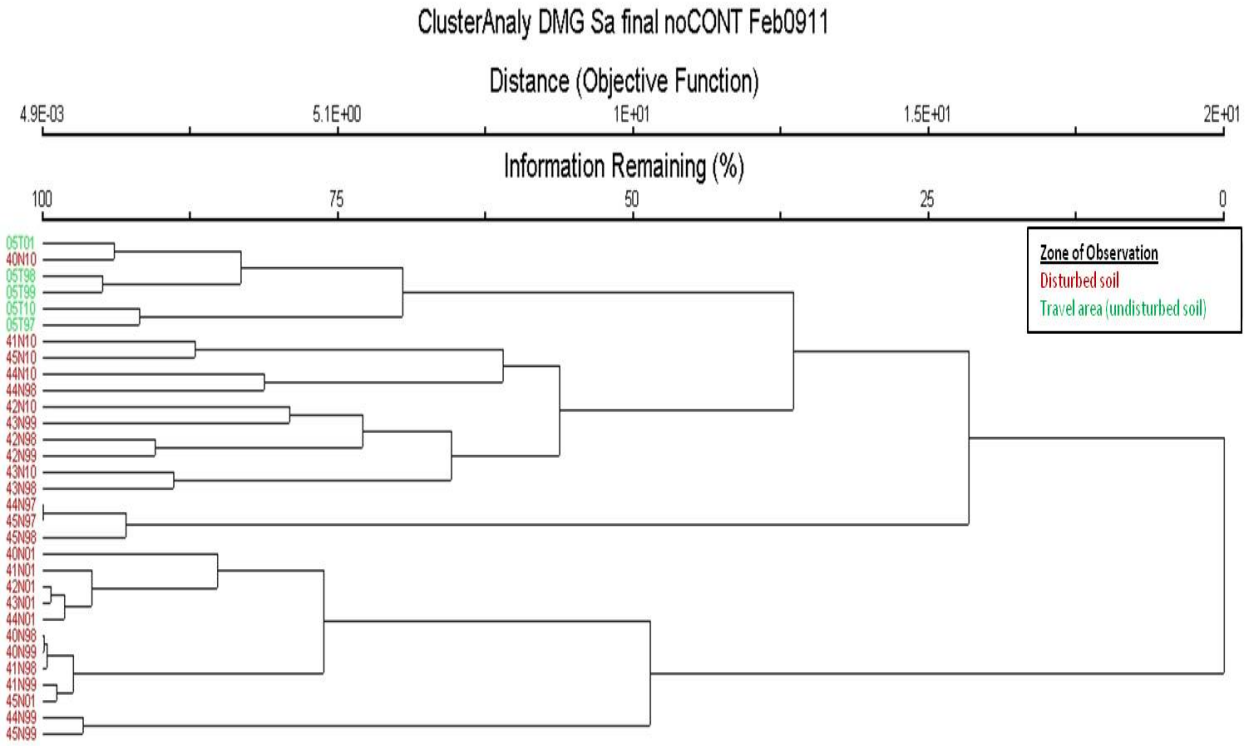
DMG Sandy and related sites (Sa)

Sites #5T, 40N, 41N, 42N, 43N, 44N, 45N.

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
05T	Travel	None - not stripped	fall 96	Sounding Ck Plain	RIB(10)/3	19	34	DMGA13-Degraded	Western porcupine grass - needle-&-thread - sand grass (degraded)
40N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	84	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
41N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
42N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	57	60	No good fit	Blunt sedge - sun-loving sedge - needle-&-thread
43N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Sun-loving sedge - Blunt sedge - needle-&-thread
44N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - needle-&-thread
45N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-&-thread

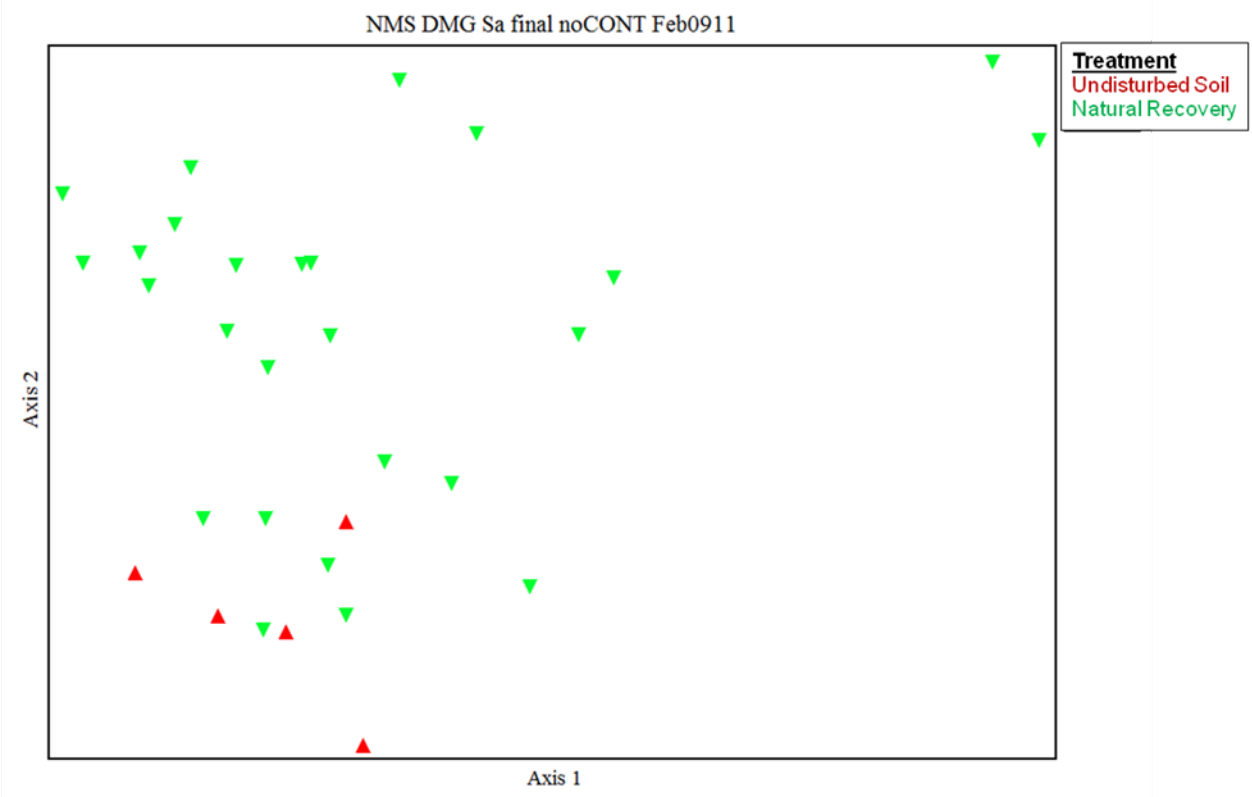
DMG Sandy Cluster Analysis

Percent chaining is 4.99%, which is good (ideal is <10%). The Sandy dataset was actually made up of three related ecological range sites; however the clusters did not appear to be based on these ERS groups, so the decision to pool these sites was supported, as per the intermediate report. In this case where only the treatment observations were analyzed, the site that was seed mix treated was distinct from naturally recovered observations, with the exception of one naturally recovered observation that grouped with the travel observations.



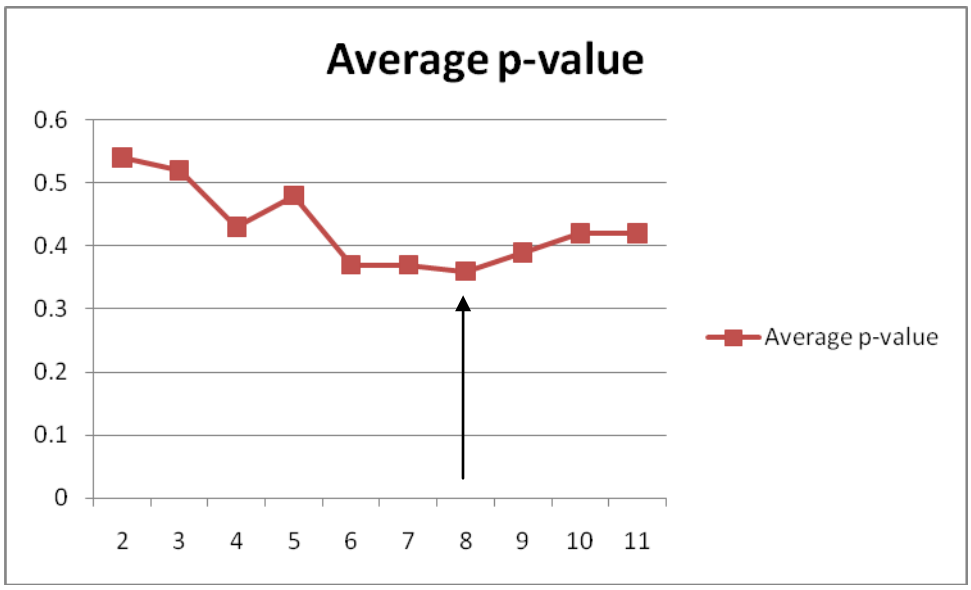
DMG Sandy NMS Ordination

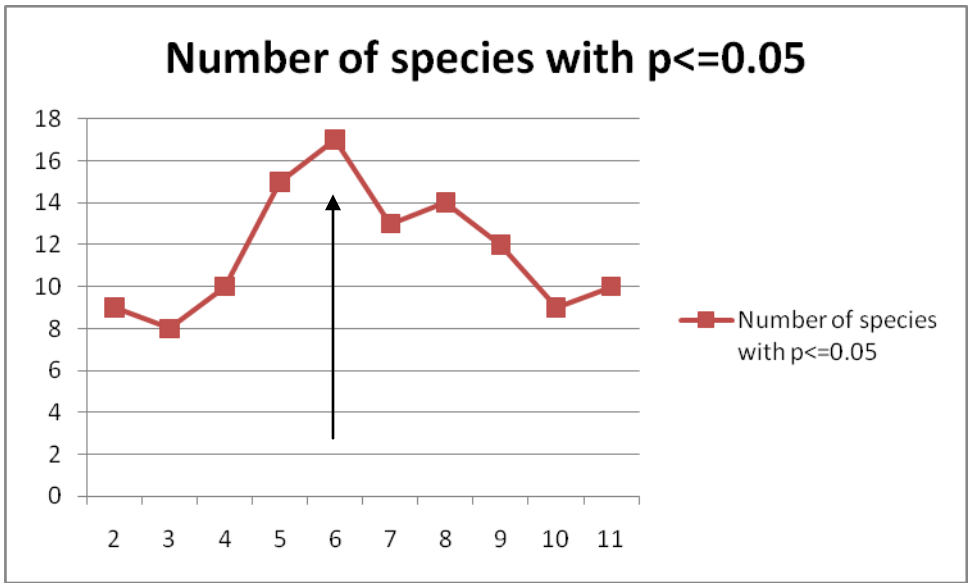
The ordination produced a 3D solution with acceptable stress (11.9). The cumulative variation accounted for in the solution was good at 76.0%, with axes 1 (36.4%) and 2 (27.6%) being the strongest.

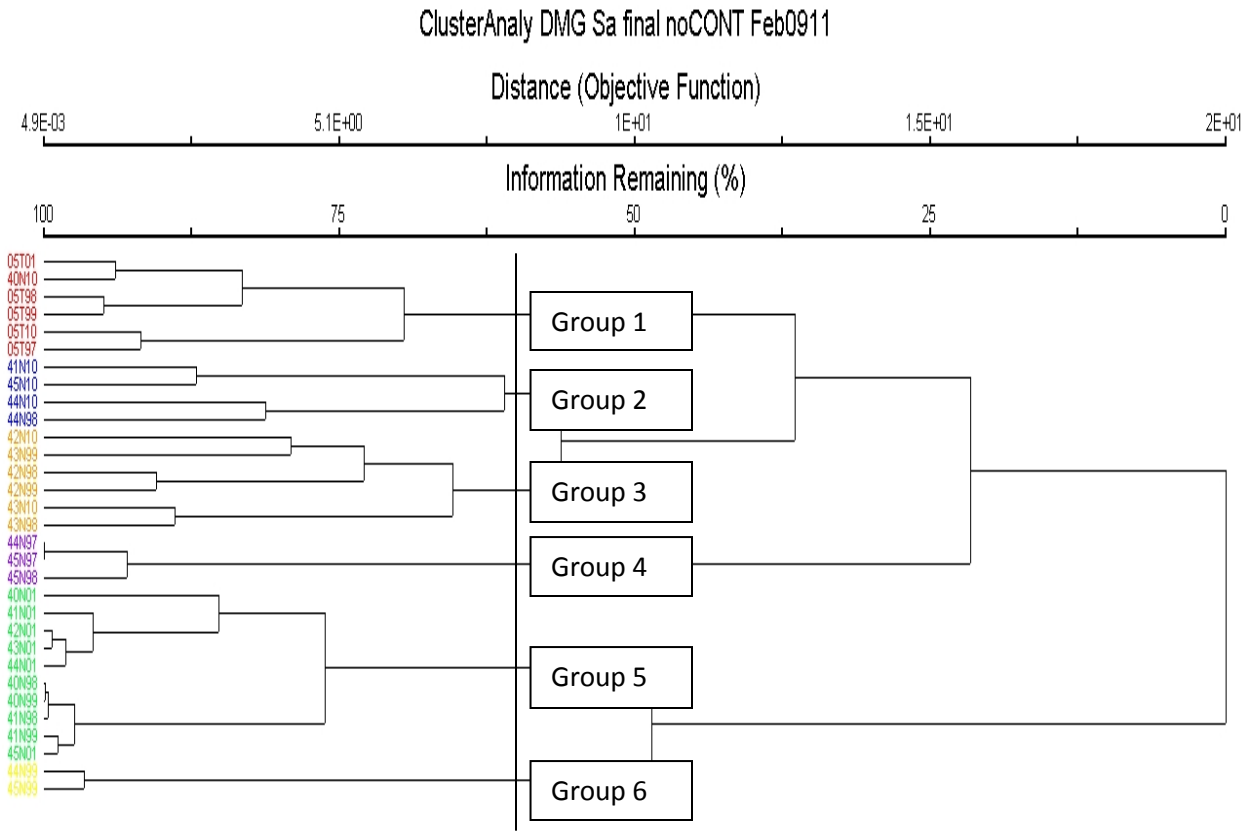


DMG Sandy Indicator Species Analysis

ISA identified solutions of 6 or 8 groups, with the lowest average p-value for indicator values at 8 groups (0.36) and the highest number of indicator species for 6 groups (17). The 8 group solution resulted in half of the groups being composed of only two observations, so the results presented here are for the 6 group solution.






ClusterAnaly DMG Sa final noCONT Feb0911
Distance (Objective Function)
4.9E-03
5.1E+00
1E+01
1.5E+01
2E+01
Information Remaining (%)
100
75
50
25
0
05T01
40N10
05T98
05T99
05T10
05T97
41N10
45N10
44N10
44N98
42N10
43N99
42N98
42N99
43N10
43N98
44N97
45N97
45N98
40N01
41N01
42N01
43N01
44N01
40N98
40N99
41N98
41N99
45N01
44N99
45N99
Group 1
Group 2
Group 3
Group 4
Group 5
Group 6

DMG Sandy Community Group Identification

The first group is comprised almost exclusively of site #5, which is an unstripped travel lane site in a heavily grazed pasture with high cover of increaser species. Dominant species includes buckbrush and Kentucky bluegrass and the group is mid-seral in composition. Natural recovery site # 40 may be clustering with this site because of the presence of buckbrush and other species with 100% constancy.

Group 1: Buckbrush/Sun-loving sedge-Pasture sagewort Avg. Richness = 18.2; Shannon's Diversity Index = 1.98		
	Average Cover (%)	Constancy
CAREPEN	18.5	100
SYMPOCC	18.3	100
ARTEFRI	9.6	100
ARTELUD	2.8	100
STIPCUR	2.6	100
POAPRAT	10.0	83.3
KOELMAC	4.2	83.3
AGROSMI	2.8	83.3

5T97, 5T98, 5T99, 5T01, 5T10
40N10
Travel observations: 5
Naturally recovered observations: 1

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
05T	Travel	None - not stripped	fall 96	Sounding Ck Plain	RIB(10)/3	19	34	DMGA13-Degraded	Western porcupine grass - needle-&-thread - sand grass (degraded)
40N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	84	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)

The second group is comprised of mostly late year observations on naturally recovered treatments. The group is a late seral plant community dominated by needle & thread, Kentucky bluegrass and pasture sagewort. The prominence of Kentucky bluegrass in 2010 is likely to be a short-term moisture response, with needle-and-thread being dominant in drier years.

Group 2: Needle and thread grass - Pasture sagewort - Kentucky bluegrass
Avg. Richness = 18.5; Shannon's Diversity Index = 2.36

	Average Cover (%)	Constancy
POAPRAT	7.9	100
STIPCOM	7.2	100
ARTEFRI	6.8	100
CALALON	4.9	100
AGROSMI	3.0	100
KOELMAC	1.5	100

41N10
44N98, 44N10
45N10
Naturally recovered observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
41N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
44N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - needle-&-thread
45N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-&-thread

The third group is a late seral plant community dominated by decreaser native grasses and is comprised entirely of mid to late year naturally recovered observations. Diversity is high for this late seral community.

Group 3: Needle and thread grass-Blunt sedge-Sand grass Avg. Richness = 22.7; Shannon's Diversity Index = 2.37		
	Average Cover (%)	**Constancy**
STIPCOM	13.6	100
CAREOBT	10.2	100
CALALON	7.9	100
STIPCUR	6.9	100
ARTEFRI	4.1	100
CAREPEN	6.3	83.3
ROSAWOO	3.5	83.3
AGOSGLA	0.8	83.3

42N98, 42N99, 42N10
43N98, 43N99, 43N10,
Naturally recovered observations: 6

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
42N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	57	60	No good fit	Blunt sedge - sun-loving sedge - needle-&-thread
43N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Sun-loving sedge - Blunt sedge - needle-&-thread

The fourth group is a pioneer plant community group, comprised of three early post-disturbance naturally recovery observations. The dominant species is an introduced weedy annual, lamb's quarters, , with other native species represented at between 33 and 66% constancy.

Group 4: Prairie rose/Lamb's quarters-Prairie sage Avg. Richness = 11.0; Shannon's Diversity Index = 1.14		
	Average Cover (%)	Constancy
CHENALB	9.2	100
ARTELUD	0.7	100
ROSAARK	0.6	100

44N97
45N97, 45N98
Naturally recovered observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
44N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - needle-&-thread
45N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-&-thread

The fifth group is a late seral plant community group, comprised of observations on natural recovery sites two, three and five years post-construction. This community shifted to two other late seral community groups dominated by needle-and-thread during the 14 year post-construction monitoring year. Disturbance forbs are still prominent but there is lots of other forb diversity as well. Further discussion with Express Project experts is required.

Group 5: Western porcupine grass-Pasture sagewort-Sand grass
Avg. Richness = 16.0; Shannon's Diversity Index = 1.95

	Average Cover (%)	Constancy
STIPCUR	27.9	100
ARTEFRI	9.7	100
CALALON	3.7	100
ARTELUD	5.7	90
AGROSMI	2.1	80

40N98, 40N99, 40N01 42N01
41N98, 41N99, 41N01 43N01
44N01 45N01
Naturally recovered observations: 10

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
40N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	84	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
41N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	68	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
42N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	57	60	No good fit	Blunt sedge - sun-loving sedge - needle-&-thread
43N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Sun-loving sedge - Blunt sedge - needle-&-thread
44N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - needle-&-thread
45N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-&-thread

The sixth group is a weedy, early seral plant community defined by the dominance of the introduced annual tansy mustard (flixweed). It is a small group comprised of two observations, three years post-construction.

Group 6: Tansy mustard-Western porcupine grass-Pasture sagewort Avg. Richness = 17.0; Shannon's Diversity Index = 2.06		
	Average Cover (%)	Constancy
DESCSOP	18.3	100
STIPCUR	8.8	100
ARTEFRI	8.0	100
LEPIDEN	8.0	100
RUMEACE	3.0	100
AGROTRA	2.6	100
EQUILAE	2.5	100
CHENALB	1.2	100
KOELMAC	0.3	100
CAREOBT	0.3	100

44N99
45N99
Naturally recovered observations: 2

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
44N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - needle-&-thread
45N	Disturbed soil	NR	fall 96	Sounding Ck Plain	VST(10)/2-3	x	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-&-thread

DMG Sandy Succession Table

		Pioneer	Early Seral	Mid-seral	Late Seral →		
Treatment	Site#	Group 4: Prairie rose/Lamb's quarters-Prairie sage	Group 6: Tansy mustard-Western porcupine grass-Pasture sagewort	Group 1: Buckbrush/Sun-loving sedge-Pasture sagewort	Group 5: Western porcupine grass-Pasture sagewort-Sand grass	Group 2: Needle and thread grass - Pasture sagewort - Kentucky bluegrass	Group 3: Needle and thread grass-Blunt sedge-Sand grass
Un-seeded Sites	5T			97, 98, 99, 01, 10			
	40N			10	98, 99, 01		
	41N				98, 99, 01	10	
	42N				01		98, 99, 10
	43N				01		98, 99, 10
	44N	97	99		01	98, 10	
	45N	97, 98	99		01	10	
Diversity Index		1.14	2.06	1.98	1.95	2.36	2.37
Avg. Richness		11.0	17.0	18.2	16.0	18.5	22.7

Mixedgrass Natural Subregion

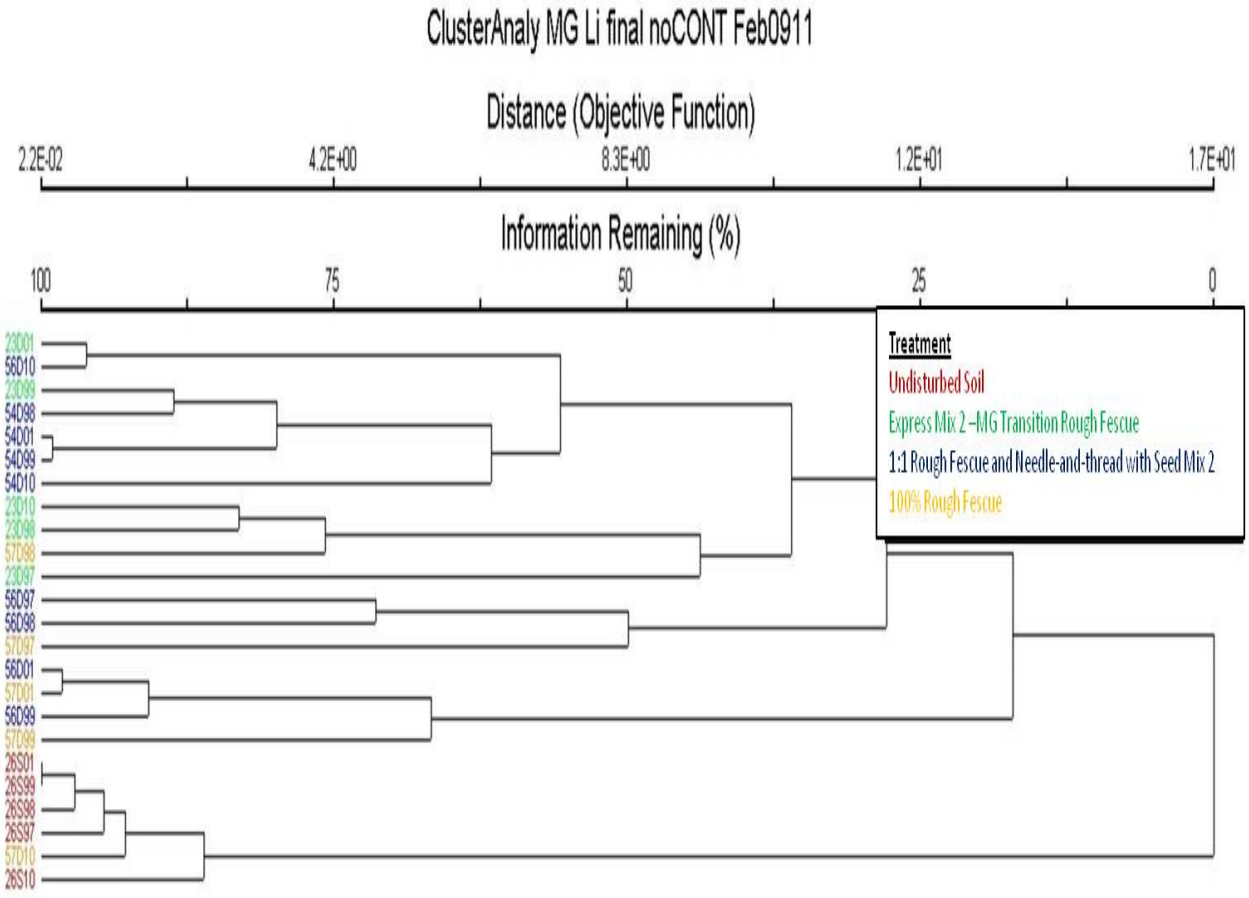
Limy and related sites (Li)

Sites #23D, 26S, 54D, 56D, 57D

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
23D	Disturbed soil	2	fall 96	Cypress Hills	stPUR(10)/4-5	43	47	MGA3	Needle-&-thread - June grass
26S	Spoil	None - not stripped	fall 96	Cypress Hills	stHKR(10)/4-5	no	no	MGA1	Plains rough fescue - western porcupine grass - sedge
54D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/3-4	x	75	DMGA2	Needle-&-thread - wheatgrass
56D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	45	43	MGA3	Needle-&-thread - June grass
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

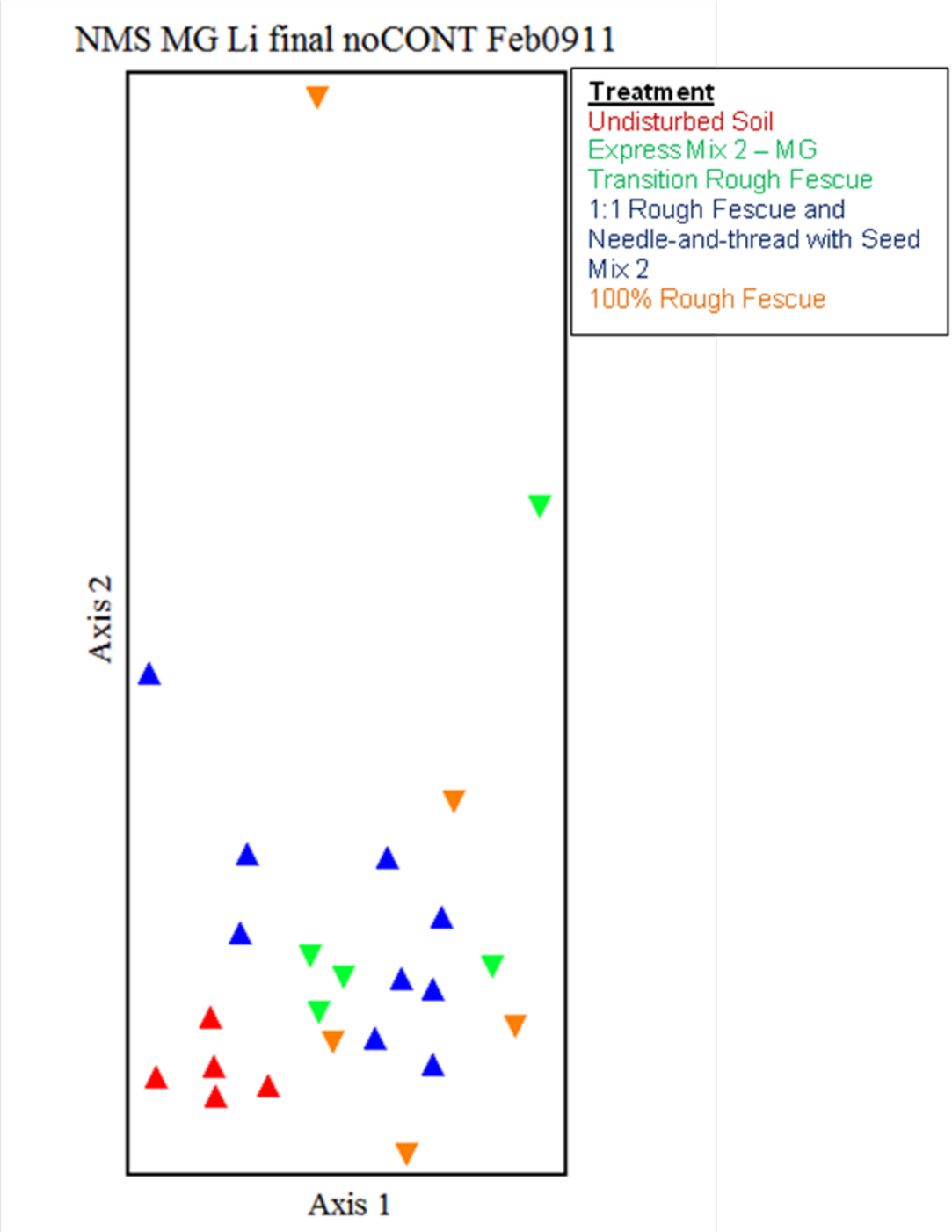
MG Limy Cluster Analysis

Percent chaining is 10.70%, which is just over the ideal target of <10%. The Limy dataset was actually made up of five related ecological range sites, however with the exception of the Li-BlO sites, the clusters identified within the preliminary report did not appear to be based on these ERS groups, so the decision to pool these sites was supported in the intermediate report.



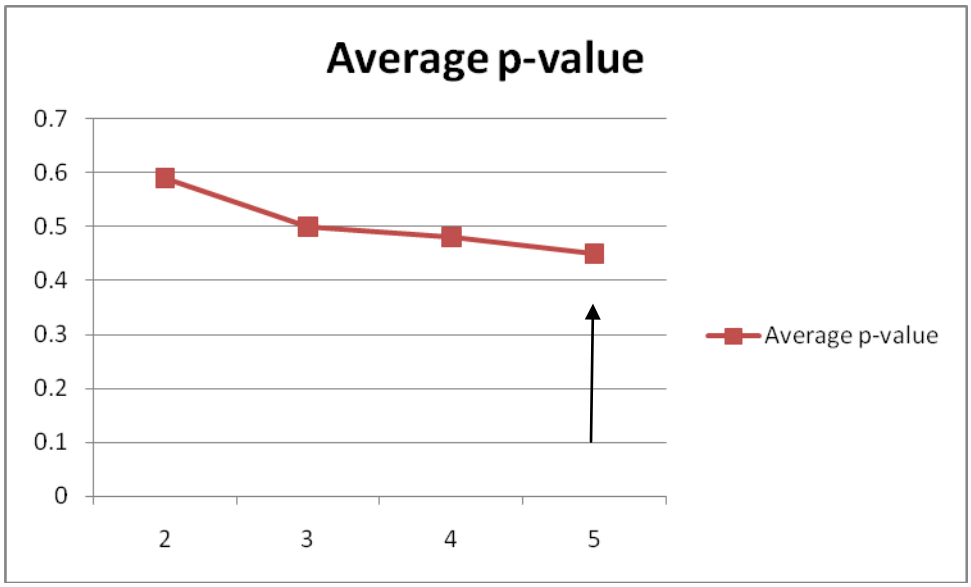
MG Limy NMS Ordination

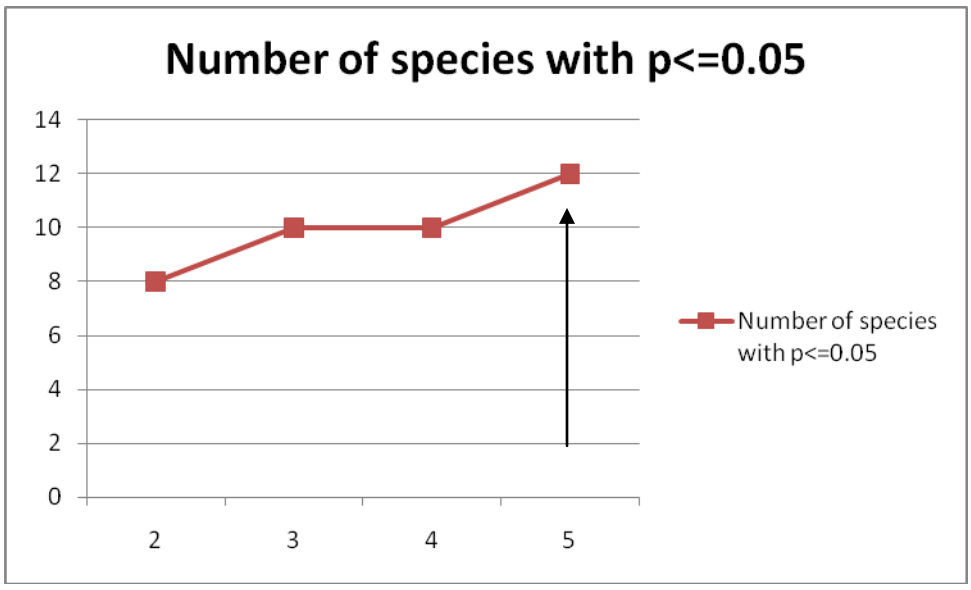
The ordination produced a 2D solution with acceptable stress (13.75). The lack of a 3D solution is likely due to the fact that only 24 observations were included in this analysis, which excluded control observations. The cumulative variation accounted for in the solution was low to moderate at 57.2%, with axis 1 accounting for 20.7% and axis 3 accounting for 36.5%.

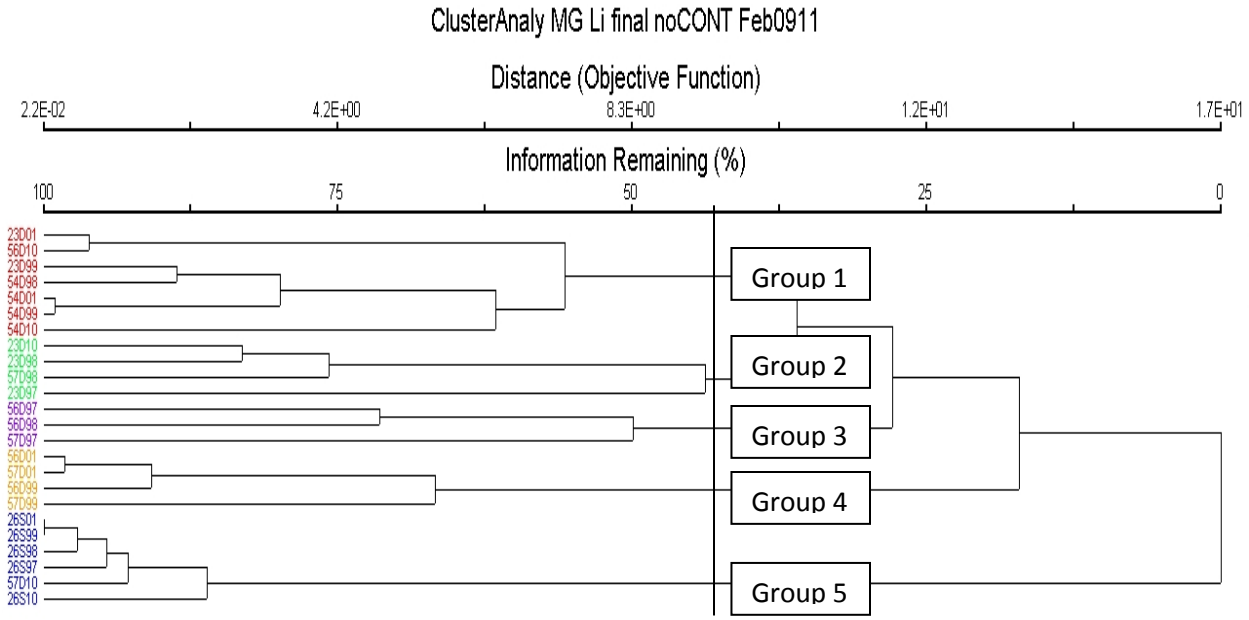


MG Limy Indicator Species Analysis

ISA identified a solution of five clusters, with the lowest average p-value for indicator values (0.45) and the highest number of indicator species (12). Note that five groups is also the maximum number of groups that could be identified from this analysis without further groups being comprised of only one observation. Also, the above metrics are higher and lower, respectively, than those for other ERS analyses completed with larger sample sizes.






ClusterAnaly MG Li final noCONT Feb0911
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4.2E+00
8.3E+00
1.2E+01
1.7E+01
Information Remaining (%)
100
75
50
25
0
23D01
56D10
23D99
54D98
54D01
54D99
54D10
23D10
23D98
57D98
23D97
56D97
56D98
57D97
56D01
57D01
56D99
57D99
26S01
26S99
26S98
26S97
57D10
26S10
Group 1
Group 2
Group 3
Group 4
Group 5

MG Limy Community Group Identification

Group 1 is a mid-seral plant community comprised primarily of mid and later year observations of seed mix species and a seeding of 100% plains rough fescue. The sites are all high in the Cypress Hills.

Group 1: Green needle grass-Northern wheatgrass-June grass Avg. Richness = 16.6; Shannon's Diversity Index = 2.24		
	Average Cover (%)	Constancy
STIPVIR	9.0	100
AGRODAS	7.2	100
KOELMAC	5.6	100
ARTEFRI	4.7	100
AGROSMI	3.5	85.7
CARESTE	0.8	85.7

23D99, 23D01
54D98, 54D99, 54D01, 54D10,
56D10
Disturbed observations: 7

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
23D	Disturbed soil	2	fall 96	Cypress Hills	stPUR(10)/4-5	43	47	MGA3	Needle-&-thread - June grass
54D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/3-4	x	75	DMGA2	Needle-&-thread - wheatgrass
56D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	45	43	MGA3	Needle-&-thread - June grass

	AVG	*CONST*
FESTHAL	*4.3*	*42.9*
STIPCUR	*4.1*	*71.4*
STIPCOM	*1.9*	*57.1*

Group 2 is an early seral plant community comprised of mid to late year disturbed sites. The group is dominated by the disturbance forb pasture sagewort but seeded species and colonizing grasses such as Stipas also establishing. Range health likely contributes to the ranking for the later year site with poor range health on and off the disturbance. Interestingly, mid year observations for site #23 moved to the STIPVIR dominated group.

Group 2: Pasture sagewort - Plains rough fescue - Northern wheatgrass Avg. Richness = 20.2; Shannon's Diversity Index = 2.19		
	Average Cover (%)	**Constancy**
ARTEFRI	6.2	100
FESTHAL	3.0	100
AGRODAS	1.4	100
KOELMAC	0.8	100

23D97, 23D98, 23D10
57D98
Disturbed observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
23D	Disturbed soil	2	fall 96	Cypress Hills	stPUR(10)/4-5	43	47	MGA3	Needle-&-thread - June grass
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

	AVG	CONST
FESTHAL	3.0	100.0
STIPCUR	0.3	25.0
STIPCOM	2.8	50.0

The third group is an early seral plant community dominated by only June grass, with few other species present and those only at 33% constancy. This group has less than 10% total green cover. Site 57 was seeded to 100% plains rough fescue and site 56 was sseded to seed mix 2, which had 20% plains rough fescue and 50% slender wheatgrass.

Group 3: June grass		
Avg. Richness = 9.3; Shannon's Diversity Index = 1.56		
	Average Cover (%)	**Constancy**
KOELMAC	1.2	100

56D97, 56D98
57D97
Disturbed observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
56D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	45	43	MGA3	Needle-&-thread - June grass
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

	AVG	CONST
FESTHAL	0.6	33.3
STIPCUR	0.0	0.0
STIPCOM	0.0	0.0

The fourth group is and early seral plant community due to its dominance of introduced weeds and native disturbance forb species. Seeded grasses and infill colonizers like western porcupine grass are establishing but cover is low. The small group is comprised again of mid year disturbed sites. Again, these sites were both treated with seed mixes containing Plains rough fescue, and in this case, that species is present at 2.3% average cover and 75% constancy.

Group 4: Common knotweed - Pasture sagewort - Western porcupine grass
Avg. Richness = 17.5; Shannon's Diversity Index = 2.17

	Average Cover (%)	Constancy
POLYARE	13.0	100
ARTEFRI	10.0	100
STIPCUR	4.1	100
STIPVIR	2.6	100

56D99, 56D01
57D99, 57D01
Disturbed observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
56D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	45	43	MGA3	Needle-&-thread - June grass
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10) /3-4	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

	AVG	CONST
FESTHAL	2.3	75.0
STIPCUR	4.1	100.0
STIPCOM	0.1	25.0

The fifth group is a late seral plant community comprised of observations from an unstripped spoil storage area and a site seeded to 100% plains rough fescue. Plains rough fescue is the dominant cover species in each of the observations. A diversity of other native grass and forb species are also present

Group 5: Plains rough fescue-Western wheatgrass-Northern wheatgrass Avg. Richness = 16.2; Shannon's Diversity Index = 1.98		
	Average Cover (%)	**Constancy**
FESTHAL	29.7	100
AGROSMI	6.3	100
AGRODAS	5.6	100
VICIAME	1.4	100
CAREPEN	5.3	83.3
ARTELUD	2.3	83.3
ACHIMIL	1.3	83.3

26S97, 26S98, 26S99, 26S01, 26S10

57D10

Spoil observations: 5

Disturbed observations: 1

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Eco-district	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
26S	Spoil	None - not stripped	fall 96	Cypress Hills	stHKR(10)/4-5	no	no	MGA1	Plains rough fescue - western porcupine grass - sedge
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	65	75	MGA1	Plains rough fescue - western porcupine grass - sedge

	AVG	CONST
FESTHAL	29.7	100.0
STIPCUR	3.7	66.7
STIPCOM	0.0	0.0

MG Limy Succession Table

		Pioneer	Early Seral →		Mid-seral	Late Seral
Treatment	**Site #**	**Group 3: June grass**	**Group 2: Pasture sagewort - Plains rough fescue - Northern wheatgrass**	**Group 4: Common knotweed - Pasture sagewort - Western porcupine grass**	**Group 1: Green needle grass- Northern wheatgrass- June grass**	**Group 5: Plains rough fescue- Western wheatgrass- Northern wheatgrass**
Seeded Sites	23D		97, 98, 10		99, 01	
	54D				98, 99, 01, 10	
	56D	97, 98		99, 01	10	
	57D	97	98	99, 01		10
Un seeded Sites	26S					97, 98, 99, 01, 10
Diversity Index		1.56	2.17	2.19	2.24	1.98
Avg. Richness		9.3	17.5	20.2	16.6	16.2

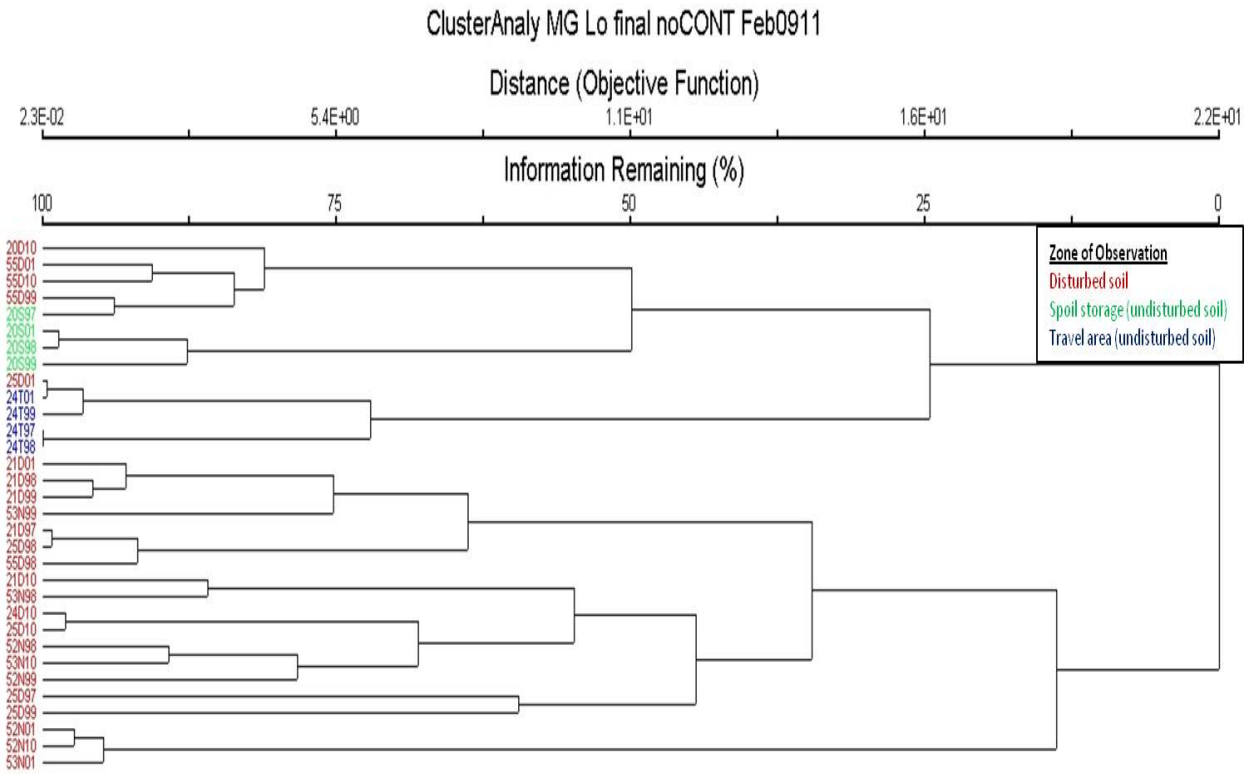
MG Loamy (Lo)

Sites #20D, 20S, 21D, 24D, 24T, 25D, 52N, 53D, 55D

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Comm. Code	Control Plant Community Name
20S	Spoil	None - not stripped	fall 96	Cypress Slope	PUR(10) /3-4	68	72	MGA1	Plains rough fescue - western porcupine grass - sedge
20D	Disturbed soil	2	fall 96	Cypress Slope	PUR(10) /3-4		72	MGA1	Plains rough fescue - western porcupine grass - sedge
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10) /3-4	40	70	MGA1	Plains rough fescue - western porcupine grass - sedge
24T	Travel (97,98,99, 01)	None - not stripped	fall 96	Cypress Hills	PUR(10) /5-6	no	no		
24D	Disturbed soil (2010)	2	fall 96	Cypress Hills	PUR(10) /5-6	84	no		
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20) /3-4	67	88	MGA2	Western porcupine grass - plains rough fescue
52N	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10) /3-4	41	87	MGA1	Plains rough fescue - western porcupine grass - sedge
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10) /3-4	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge
55D	Disturbed soil	1:1 Festhal: Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10) /3-4	70	59	NGF	No good fit

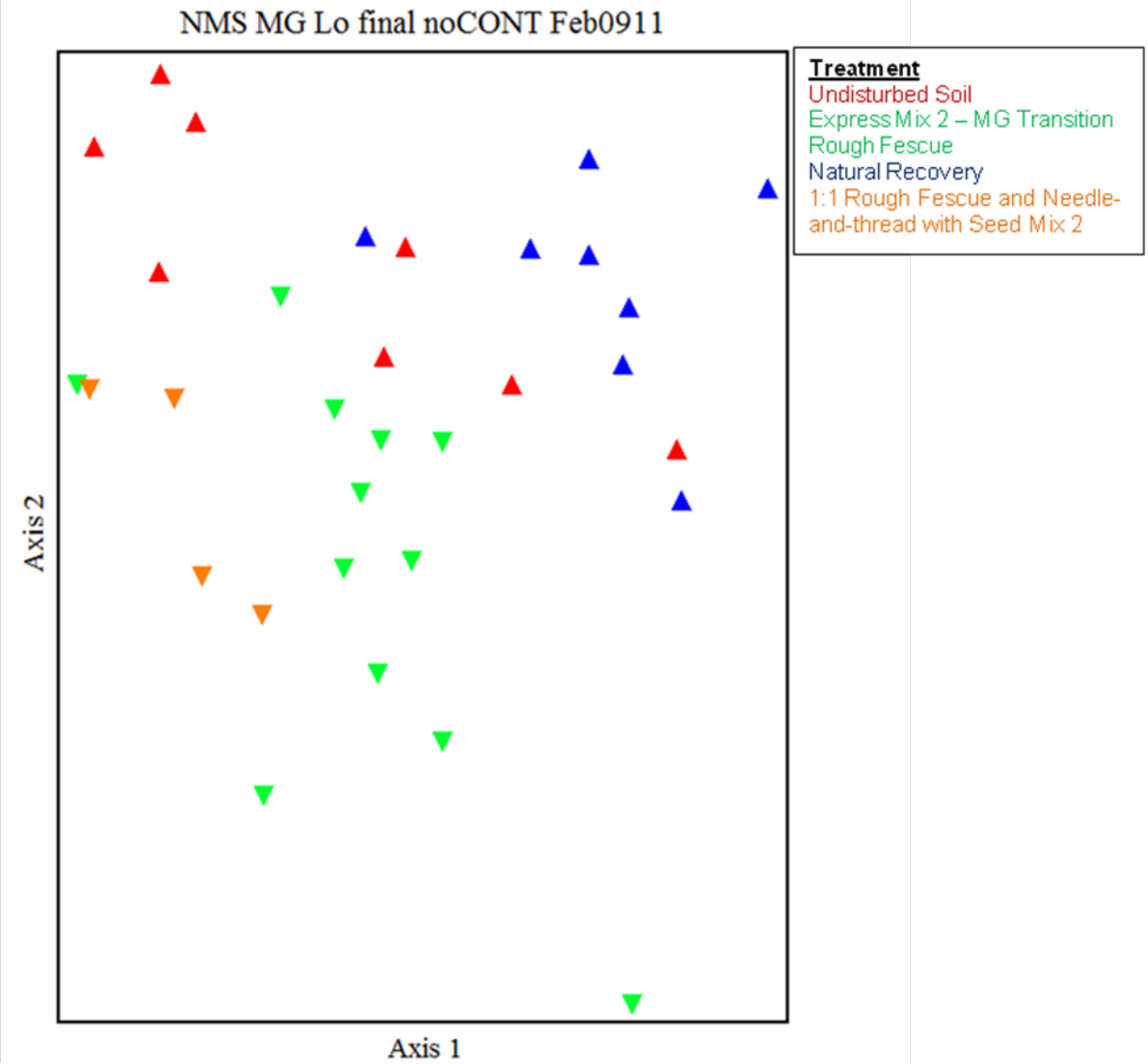
MG Loamy Cluster Analysis

Percent chaining is 4.36%, which is good (ideal is <10%). Although the number of clusters selected for analysis did not isolate these groups, the dendrogram below shows that observations from unseeded spoil site #20 and travel site #24 were clustered fairly distinctly.



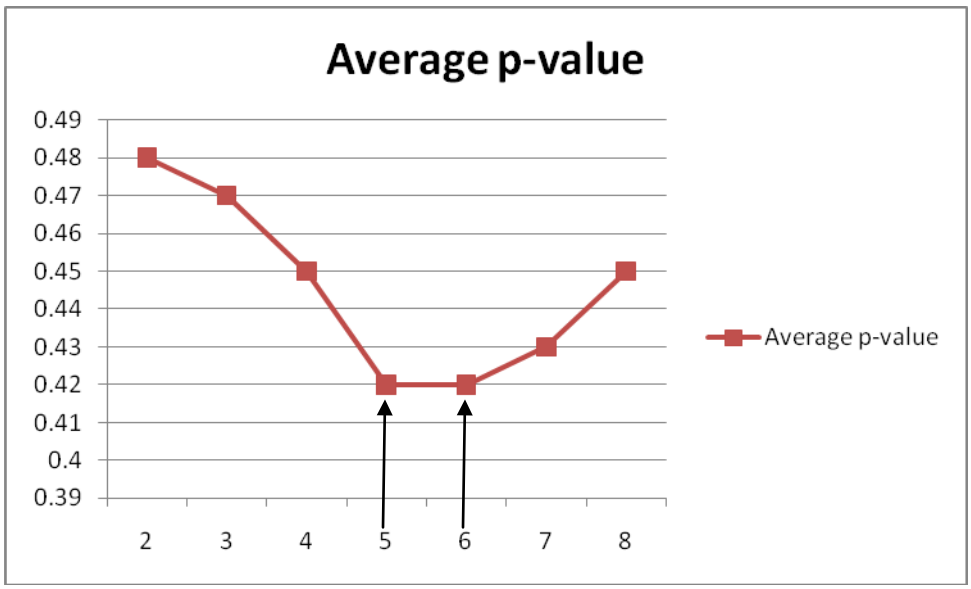
MG Loamy NMS Ordination

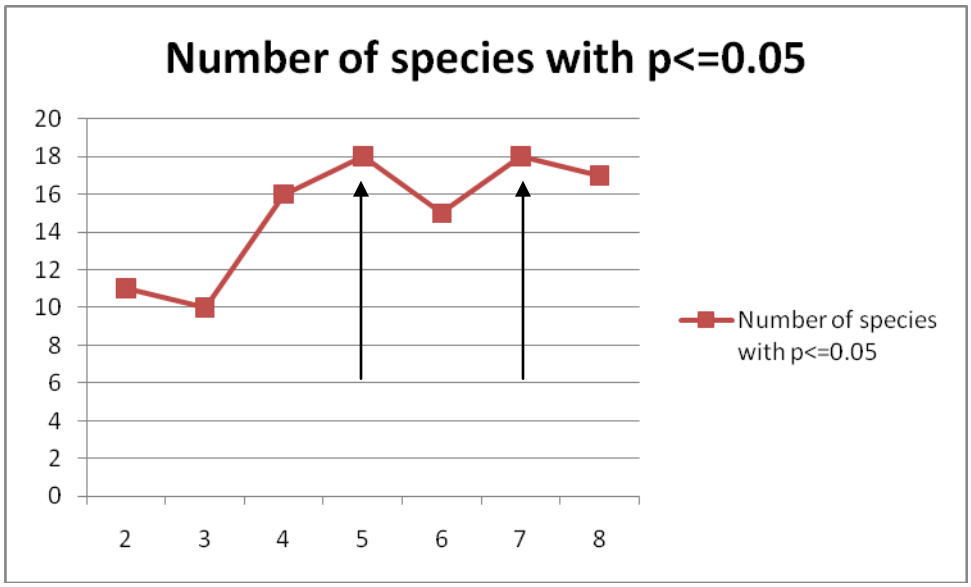
The ordination actually recommended a 4D solution, however a 3D solution is the maximum graphable. The stress for the solution was acceptable good at 10.7. The cumulative variation accounted for in the solution however was low at 54.7%, with axes 2 (23.8%) and 1 (17.2%) being the strongest. This low cumulative result is likely because of the missing fourth axis required for the preferred 4D solution.

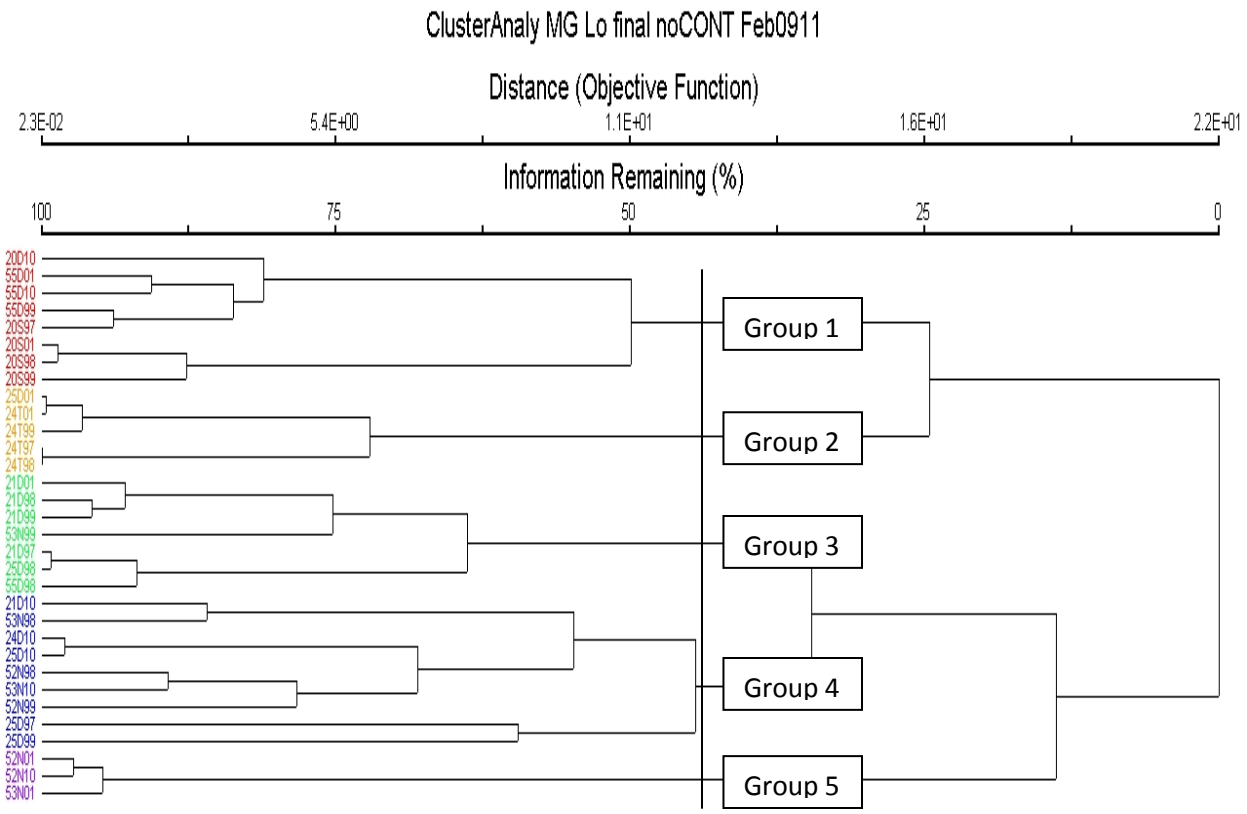


MG Loamy Indicator Species Analysis

ISA was interpreted to identify five groups as the optimal number of clusters in this dataset. Both metrics, average p-value and number of significant species had two point at which optimal values were observed, however this coincided at the five group level (average p-value = 0.42; total number of significant species = 18).






ClusterAnaly MG Lo final noCONT Feb0911
Distance (Objective Function)
2.3E-02
5.4E+00
1.1E+01
1.6E+01
2.2E+01
Information Remaining (%)
100
75
50
25
0
20D10
55D01
55D10
55D99
20S97
20S01
20S98
20S99
25D01
24T01
24T99
24T97
24T98
21D01
21D98
21D99
53N99
21D97
25D98
55D98
21D10
53N98
24D10
25D10
52N98
53N10
52N99
25D97
25D99
52N01
52N10
53N01
Group 1
Group 2
Group 3
Group 4
Group 5

MG Loamy Community Group Identification

The first group is a mid-seral plant community dominated by native wheatgrass species, with desirable decreasers present at low cover values. Its majority is comprised of multi-year observations from unstripped spoil storage areas and stripped and seeded soils..

Group 1: Northern wheatgrass-Western wheatgrass-Needle and thread grass Avg. Richness = 13.2; Shannon's Diversity Index = 2.04		
	Average Cover (%)	**Constancy**
AGRODAS	10.5	100
AGROSMI	8.1	100
STIPCOM	3.0	87.5
CARESTE	2.6	87.5
KOELMAC	1.8	87.5

20D10
20S97, 20S98, 20S99, 20S01
55D99, 55D01, 55D10
Disturbed observations: 4
Spoil observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Community Code	Control Plant Community Name
20S	Spoil	None - not stripped	fall 96	Cypress Slope	PUR(10)/3-4	68	72	MGA1	Plains rough fescue - western porcupine grass - sedge
20D	Disturbed soil	2	fall 96	Cypress Slope	PUR(10)/3-4		72	MGA1	Plains rough fescue - western porcupine grass - sedge
55D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/3-4	70	59	NGF	No good fit

	AVG	CONST
FESTHAL	0.1	12.5
STIPCUR	0.3	12.5
STIPCOM	3.0	87.5

Group 2 is a late mid-seral community with desirable decreaser infill species western porcupine grass providing the most cover. Most observations are from an unstripped travel lane site but two are from sites seeded to seed mix 2.

Group 2: Western porcupine grass-Northern wheatgrass-American vetch Avg. Richness = 11.8; Shannon's Diversity Index = 1.44		
	Average Cover (%)	Constancy
STIPCUR	15.1	100
AGRODAS	15.0	100
VICIAME	1.1	100
KOELMAC	2.0	80

24T97, 24T98, 24T99, 24T01
25D01
Disturbed observations: 1
Travel observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Community Code	Control Plant Community Name
24T	Travel (97,98,99,01)	None - not stripped	fall 96	Cypress Hills	PUR(10)/5-6	no	no		
24D	Disturbed soil (2010)	2	fall 96	Cypress Hills	PUR(10)/5-6	84	no		
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/3-4	67	88	MGA2	Western porcupine grass - plains rough fescue

	AVG	CONST
FESTHAL	0.4	60.0
STIPCUR	15.1	100.0
STIPCOM	0.0	0.0

The third group is an early seral community due to dominance of the disturbance forb pasture sagewort, the persistence of the colonizing seed mix grass species slender wheatgrass and the low cover of other establishing long-lived grasses. Cover from slender wheatgrass is due to seeding mix 2 at sites #21, 25 and 55. Western porcupine grass is colonizing from the seedbank. Interestingly, although plains rough fescue appears for the observations where it was seeded as part of Seed Mix 2, it does not appear for site #55 where it was the only species seeded, however 1998 was is early for the establishment of this species.

Group 3: Pasture sagewort - June grass - American vetch
Avg. Richness = 14.9; Shannon's Diversity Index = 2.18

	Average Cover (%)	Constancy
ARTEFRI	11.7	100
KOELMAC	4.5	100
VICIAME	2.1	100
AGROTRA	10.2	85.7
STIPCUR	7.2	85.7
AGRODAS	4.8	85.7

21D97, 21D98, 21D99, 21D01
25D98
53D99
55D98
Disturbed observations: 6
Naturally recovered observations: 1

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Community Code	Control Plant Community Name
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10)/3-4	40	70	MGA1	Plains rough fescue - western porcupine grass - sedge
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/3-4	67	88	MGA2	Western porcupine grass - plains rough fescue
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10)/3-4	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge
55D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/3-4	70	59	NGF	No good fit

	AVG	CONST
FESTHAL	3.4	71.4
STIPCUR	7.2	85.7
STIPCOM	0.8	14.3

The fourth group is late seral community with a prominence of the slow to establish decreaser species plains rough fescue. This group includes observations from sites seeded to mix 2 and from natural recovery sites from a range of time frames post-construction, particularly 14 years post-construction.

Group 4: Plains rough fescue-Northern wheatgrass-Pasture sagewort Avg. Richness = 18.1; Shannon's Diversity Index = 2.16		
	Average Cover (%)	Constancy
FESTHAL	7.6	100
AGRODAS	3.4	100
ARTEFRI	3.4	100
VICIAME	1.7	100
KOELMAC	1.4	88.9

21D10 52N98, 52N99
24D10 53D98, 53D10
25D97, 25D99, 25D10,
Disturbed observations: 5
Natural recovery observations: 4

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Community Code	Control Plant Community Name
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10)/3-4	40	70	MGA1	Plains rough fescue - western porcupine grass - sedge
24D	Disturbed soil (2010)	2	fall 96	Cypress Hills	PUR(10)/5-6	84	no		
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/3-4	67	88	MGA2	Western porcupine grass - plains rough fescue
52N	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10)/3-4	41	87	MGA1	Plains rough fescue - western porcupine grass - sedge
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10)/3-4	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge

	AVG	CONST
FESTHAL	7.6	100.0
STIPCUR	1.7	77.8
STIPCOM	1.5	22.2

Group 5 is small and consists of observations from two natural recovery sites in the Cypress Hills. Vegetation cover was very low in the first few years and the pasture is grazed in the summer. This group has a high number of species with greater than 80% constancy. It is a mid-seral plant community. Sites are close to a cattle trail and range health is poor at these sites.

Group 5: Kentucky bluegrass-Low sedge-Pasture sagewort Avg. Richness = 22.7; Shannon's Diversity Index = 2.08		
	Average Cover (%)	Constancy
POAPRAT	20.1	100
CARESTE	6.7	100
ARTEFRI	3.4	100
ARTELUD	2.2	100
STIPCUR	1.7	100
AGRODAS	1.2	100
KOELMAC	1.1	100
DANTINT	0.7	100
TARAOFF	0.6	100
AGROSMI	0.5	100

52N01, 52N10
53D01
Natural recovery observations: 3

Site	Disturb-ance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Reveg Range Health 2010	Control Range Health 2010	Control Plant Community Code	Control Plant Community Name
52N	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10)/3-4	41	87	MGA1	Plains rough fescue - western porcupine grass - sedge
53D	Disturbed soil	100% Festhal	fall 96	Cypress Slope	PUR(10)/3-4	50	55	MGA1	Plains rough fescue - western porcupine grass - sedge

	AVG	CONST
FESTHAL	0.1	66.7
STIPCUR	1.7	100.0
STIPCOM	0.7	33.3

MG Loamy Succession Table

		Early Seral	Mid-seral →		Late Mid-seral	Late Seral
Treatment	**Site #**	**Group 3: Pasture sagewort - June grass - American vetch**	**Group 5: Kentucky bluegrass-Low sedge-Pasture sagewort**	**Group 1: Northern wheatgrass-Western wheatgrass-Needle and thread grass**	**Group 2: Western porcupine grass-Northern wheatgrass-American vetch**	**Group 4: Plains rough fescue-Northern wheatgrass -Pasture sagewort**
Seeded Sites	20D			10		
	21D	97, 98, 99, 01				10
	24D					10
	25D	98			01	97, 99, 10
	55D	98		99, 01, 10		
Un-seeded Sites	20S			97, 98, 99, 01		
	24T				97, 98, 99, 01	
	52N		01, 10			98, 99
	53D	99	01			98, 10
Diversity Index		2.18	2.08	2.04	1.44	2.16
Avg. Richness		14.9	22.7	13.2	11.8	18.1

Appendix D Species List

Code	Scientific Name	Common Name	Form
ACHIMIL	Achillea millefolium L.	Common yarrow	forb
AGOSGLA	Agoseris glauca (Pursh) Raf.	Yellow false dandelion	forb
AGROALB	Agropyron albicans Scribn. & Smith	Awned northern wheat grass	grass
AGRODAS	Elymus lanceolatus ssp. lanceolatus	Northern wheatgrass	grass
AGROPEC	Agropyron pectiniforme (R. & S.)	Crested wheat grass	grass
AGROREP	Elytrigea repens var. repens	Quack grass	grass
AGROSCA	Agrostis scabra (Willd.)	Rough hair grass	grass
AGROSIB	Agropyron sibiricum (Willd.) Beauv.	Siberian wheatgrass	grass
AGROSMI	Agropyron smithii Rydb.	Western wheatgrass	grass
AGROSUB	Elymus trachycaulus var. subsecundus	Awned wheatgrass	grass
AGROTRA	Elymus trachycaulus var. trachycaulus	Slender wheatgrass	grass
ALLITEX	Allium textile Nels. & Macbr.	Prairie onion	forb
ALOPAEQ	Alopecurus aequalis (Sobol.)	Short-awned foxtail	grass
ALOPCAR	Alopecurus carolinianus Walt.	Carolina foxtail	grass
AMARALB	Amaranthus albus L.	Tumbleweed	forb
AMARRET	Amaranthus retroflexus L.	Red-root pigweed	forb
AMARSP.	Amaranthus species	Amaranth species	forb
AMELALN	Amelanchier alnifolia (Nutt)	Saskatoon	shrub
ANDRSEP	Androsace septentrionalis L.	Northern fairy candelabra	forb
ANEMMUL	Anemone multifida Poir.	Cut-leaved anemone	forb
ANEMPAT	Anemone patens L.	Prairie crocus	forb
ANTEAPR	Antennaria aprica Greene	Low everlasting	forb
ANTEMIC	Antennaria microphylla Rydb.		forb
ANTENEG	Antennaria neglecta (Greene)	Broad-leaved everlasting	forb
ANTEPAR	Antennaria parvifolia Nutt.	Small-leaved everlasting	forb
ANTESP.	Antennaria spp	Everlasting species	forb
ARABHIR	Arabis hirsuta	Hairy rock cress	forb
ARABHOL	Arabis holboellii Hornem.	Reflexed rock cress	forb
ARENCON	Arenaria congesta Nutt.	Rocky-ground sandwort	forb
MOEHLAT	Moehringia lateriflora (L.) Fenzl.	Blunt-leaved sandwort	forb
ARENSP.	Arenaria species	Sandowrt species	forb
ARISLON	Aristida longiseta Steud.	Red three-awn	grass

Code	Scientific Name	Common Name	Form
ARNIFUL	Arnica fulgens Pursh	Shining arnica	forb
ARNISOR	Arnica sororia Greene	Twin arnica	forb
ARTECAM	Artemesia campestris L.	Plains wormwood	forb
ARTECAN	Artemesia cana Pursh	Silver sagebrush	shrub
ARTEFRI	Artemesia frigida Willd.	Pasture sagewort	forb
ARTELUD	Artemesia ludoviciana Nutt.	Prairie sagewort	forb
ARTESP.	Artemesia spp	Sagewort species	forb
ASTECIL	Aster ciliolatus (Lindl.)	Lindley's aster	forb
ASTEERI	Aster ericoides L. ssp. pansus (Blake) A.G. Jones	Tufted white prairie aster	forb
ASTEFAL	Aster falcatus Lindl.	Creeping white prairie aster	forb
ASTESP.	Aster spp	Aster species	forb
ASTRBIS	Astragalus bisulcatus (Hook.) A. Gray	Two-grooved milk vetch	forb
ASTRCRA	Astragalus crassicarpus Nutt.	Ground-plum	forb
ASTRDAS	Astragalus dasyglottis Fisch ex. DC.	Purple milk vetch	forb
ASTRGIL	Astragalus gilviflorus Sheldon	Cushion milk vetch	forb
ASTRMIS	Astragalus missouriensis Nutt.	Missouri milk vetch	forb
ASTRPEC	Astragalus pectinatus	Narrow-leaved Milk-vetch	forb
ASTRSP.	Astragalus spp	Milk vetch species	forb
ASTRSTR	Astragalus striatus Nutt.	Ascending purple milk vetch	forb
ATRINUT	Atriplex nuttallii S. Wats.	Nuttall's atriplex	shrub
ATRISP.	Atriplex species	Saltbush species	forb
ATRITRU	Atriplex truncata	Saltbush	forb
AXYRAMA	Axyris amaranthoides L.	Russian pigweed	forb
BARBSP.	Barbarea species	Cress species	forb
BECKSYZ	Beckmannia syzigachne ((Steud) Fern))	Slough grass	grass
BOTRSP.	Botrychium sp.	Grape fern	fern
BOUTGRA	Bouteloua gracilis (HBK.) Lag.	Blue grama	grass
BRASSP.	Brassica sp.	Mustard	forb
BROMINE	Bromus inermis (Leyss.)	Awnless brome	grass
CALACAN	Calamagrostis canadensis ((Michx.) Beauv.)	Bluejoint	grass
CALALON	Calamovilfa longifolia (Hook.) Scribn.	Sand grass	grass
CALAMON	Calamagrostis montanensis Scribn.	Plains reed grass	grass
CAMPROT	Campanula rotundifolia (L.)	Common Bluebell	forb
CAREDOU	Carex douglasii Boott.	Douglas sedge	sedge

Code	Scientific Name	Common Name	Form
CAREFIL	Carex filifolia Nutt.	Thread-leaved sedge	sedge
CAREOBT	Carex obtusata (Lilj.)	Blunt sedge	sedge
CAREPEN	Carex pensylvanica Lam.	Sun-loving sedge	sedge
CAREPRA	Carex prairea (Dewey)	Prairie sedge	sedge
CARESP.	Carex sp.	Sedge species	sedge
CARESTE	Carex stenophylla Wahl.	Low sedge	sedge
CAREVIR	Carex viridula (Michx.)	Green sedge	sedge
CERAARV	Cerastium arvense L.	Field mouse-ear chickweed	forb
CERANUT	Cerastium nutans Raf.	Long-stalked mouse-ear chickweed	forb
CERASP.	Cerastium sp.	Mouse-ear chickweed species	forb
CHENALB	Chenopodium album L. var. album	Lamb's-quarters	forb
CHENFRE	Chenopodium fremontii S.Wats.var. fremontii	Fremont's goosefoot.	forb
CHENLEP	Chenopodium leptophyllum	Narrow-leaved goosefoot	forb
CHENPRA	Chenopodium pratericola Rydb.	Desert goosefoot	forb
CHENSAL	Chenopodium salinum Standl.	Oak-leaved goosefoot	forb
CHENSP.	Chenopodium sp.	Goosefoot speices	forb
CHRYNAU	Chrysothamnus nauseosus (Pall.) Britt.	Rabbitbrush	shrub
CHRYVIL	Heterotheca villosa (Pursh) Shinners	Golden aster	forb
CIRSARV	Cirsium arvense ((L.) Scop.)	Canada thistle	forb
CIRSFLO	Cirsium flodmanii (Rydb.) Arthur	Flodman's thistle	forb
CIRSSP.	Cirsium species	Thistle species	forb
CIRSUND	Cirsium undulatum	Wavy-leaved thistle	forb
CIRSVUL	Cirsium vulgare (Savi.) Ten.	Bull thistle	forb
COLLLIN	Collomia linearis Nutt.	Narrow-leaved collomia	forb
COMAUMB	Comandra umbellata (L.) Nutt.	Bastard toadflax	forb
CONVARV	Convolvulus arvensis	field bindweed	forb
CORYVIV	Coryphantha vivipara (Nutt.) Britt. & Rose	Cushion cactus	forb
CREPINT	Crepis intermedia	Intermediate hawk's-beard	forb
CREPTEC	Crepis tectorum (L.)	Annual hawk's-beard	forb
CRYPSP.	Cryptantha sp.	Cryptanthe species	forb
DACTSP.	Dactylis glomerata	Orchard grass	grass
DANTINT	Danthonia intermedia Vasey	Intermediate oat grass	grass
DANTSP.	Danthonia species	Oat grass species	grass
DANTUNI	Danthonia unispicata (Thrub.) Munro	One-spike oat grass	grass

Code	Scientific Name	Common Name	Form
DESCCES	Deschampsia cespitosa (L.) Beauv.	Tufted hair grass	grass
DESCPIN	Descurainia pinnata	Green tansy mustard	forb
DESCRIC	Descurainia richardsonii (Sweet) O.E. Schulz	Grey tansy mustard	forb
DESCSOP	Descurainia sophia (L.) Webb	Flixweed	forb
DESCSP.	Descurainia species	Mustard species	forb
DISTSTR	Distichlis stricta (Torr.) Rydb.	Salt Grass	grass
DRABNEM	Draba nemorosa	Yellow Whitlow-grass	forb
DRABSP.	Draba sp.	Whitlow-grass species	forb
ECHICRU	Echinochloa crusgalli (L.) Beauv.	Barnyard Grass	grass
ELEOACI	Eleocharis acicularis (L.) R. & S.	Needle spike-rush	gram
ELEOPAL	Eleocharis palustris (L.) R. & S.	Creeping spike-rush	graminoid
EQUIARV	Equisetum arvense (L.)	Common horsetail	horsetail
EQUIHYE	Equisetum hyemale (L.)	Common scouring-rush	horsetail
EQUILAE	Equisetum laevigatum A. Br.	Smooth scouring rush	horsetail
EQUISP.	Equisetum species	Horsetail species	horsetail
EQUIVAR	Equisetum variegatum Schleich.	Variegated horsetail	horsetail
ERIGCAE	Erigeron caespitosus Nutt.	Tufted fleabane	forb
ERIGCOM	Erigeron compositus Pursh	Compound-leaved fleabane	forb
ERIGPUM	Erigeron pumilus Nutt.	Hairy fleabane	forb
ERIGSP.	Erigeron sp.	Fleabane species	forb
ERIOFLA	Eriogonum flavum Nutt.	Yellow umbrella-plant	graminoid
ERODCIC	Erodium cicutarium (L.) L'Her.	Stork's-bill	forb
ERYSINC	Erysimum inconspicuum (S. Wats.) MacM	Small-flowered rocket	forb
EUPHGLY	Euphorbia glyptosperma Engelm.	Ridge-seeded spurge	forb
EUPHSP.	Euphorbia species	Spurge species	forb
EUROLAN	Eurotia lanata (Pursh) Moq.	Winter-fat	forb
FESTHAL	Festuca hallii (Vasey) Piper	Plains rough fescue	grass
FESTIDA	Festuca idahoensis Elmer	Bluebunch fescue	grass
FESTOCT	Vulpia octoflora	Six-weeks fescue	grass
FESTOVI	Festuca ovina L.	Sheep fescue	grass
FESTSAX	Festuca saximontana Rydb.	Rocky mountain fescue	grass
FESTSP.	Festuca sp.	Fescue species	grass
GAILARI	Gaillardia aristata Pursh	Gaillardia	forb
GALIBOR	Galium boreale (L.)	Northern bedstraw	forb

Code	Scientific Name	Common Name	Form
GALITRI	Galium triflorum (Michx.)	Sweet-scented bedstraw	forb
GAURCOC	Gaura coccinea Pursh	Scarlet butterflyweed	forb
GEUMTRI	Geum triflorum Pursh	Three-flowered avens	forb
GLYCLEP	Glycyrrhiza lepidota (Nutt.) Pursh	Wild licorice	grass
GNAPULI	Gnaphalium uliginosum	Low cudweed	forb
GRINSQU	Grindelia squarrosa (Pursh) Dunal	Gumweed	forb
GUTISAR	Gutierrezia sarothrae	Broomweed	forb
HAPLSPI	Haplopappus spinulosus (Pursh) DC.	Spiny ironplant	forb
HEDEHIS	Hedeoma hispidum Pursh	Pennyroyal	forb
HELIANN	Helianthus annuus L.	Common annual sunflower	forb
HELIHOO	Helictotrichon hookeri (Scribn.) Henr.	Hooker's oat grass	grass
HETEVIL	Heterotheca villosa (Pursh) Shinners	Golden aster	forb
HEUCRIC	Heuchera richardsonii R.Br.	Richardson's alumroot	forb
HORDJUB	Hordeum jubatum L.	Foxtail barley	grass
HYMERIC	Hymenoxys richardsonii (Hook.) Cockerell	Colorado rubber-plant	forb
IVAAXIL	Iva axillaris Pursh	Povertyweed	forb
JUNCBAL	Juncus balticus Willd.	Wire rush	graminoid
KOCHSCO	Kochia scoparia (L.) Schrad.	Summer-cypress	forb
KOELMAC	Koeleria macrantha (Ledeb.) J.A. Schultes	June grass	grass
LACTPUL	Lactuca pulchella (Pursh) DC.	Common blue lettuce	forb
LACTSER	Lactuca serriola L.	Prickly lettuce	forb
LAPPOCC	Lappula occidentalis (S. Wats.) Greene	Western bluebur	forb
LAPPSP.	Lappula species	Bluebur species	forb
LAPPSQU	Lappula squarrosa (Retz.) Dumort	Bluebur	forb
LEPIDEN	Lepidium densiflorum Schrad.	Common pepper-grass	forb
LEPIRAM	Lepidium ramosissimum A. Nels.	Branched pepper-grass	forb
LEPISP.	Lepidium species	Pepper-grass species	forb
LESQSP.	Lesquerella species	Bladderpod species	forb
LIATPUN	Liatris punctata Hook.	Dotted blazingstar	forb
LINULEW	Linum lewisii Pursh	Wild blue flax	forb
LINURIG	Linum rigidum Pursh	Yellow flax	forb
LINUSP.	Linum species	Flax species	forb
LITHINC	Lithospermum incisum Lehm.	Narrow-leaved puccoon	forb
LITHOCC	#N/A	#N/A	#N/A

Code	Scientific Name	Common Name	Form
LOMAFOE	Lomatium foeniculaceum	Hairy-fruited wild parsley	forb
LOMAMAC	Lomatium macrocarpum	Long-fruited wild parsley	forb
LYGOJUN	Lygodesmia juncea (Pursh) D. Don	Skeletonweed	forb
MACHSP.	Machaeranthera species	Machaeranthera species	forb
MEDIFAL	Medicago falcata L.	Yellow lucerne	forb
MEDISAT	Medicago sativa L.	Alfalfa	forb
MELIOFF	Melilotus officinalis (L.) Lam.	Yellow sweet-clover	forb
MELISP.	Melilotus species	Sweet-clover species	forb
MONONUT	Monolepis nuttalliana (Schultes) Greene	Spear-leaved goosefoot	forb
MUHLCUS	Muhlenbergia cuspidata (Torr.) Rydb.	Plains muhly	grass
MUHLRIC	Muhlenbergia richardsonis (Trin.) Rydb.	Mat muhly	grass
MUHLSP.	Muhlenbergia sp.	Muhly species	grass
MYOSMIN	Myosurus minimus L.	Least mousetail	forb
OENOSP.	Oenothera sp.	Evening-primrose species	forb
OPUNPOL	Opuntia polyacantha Haw.	Prickly-pear	cactus
OROBFAS	Orobanche fasciculata Nutt.	Clustered broom-rape	forb
ORTHLUT	Orthocarpus luteus - Nutt.	Owl-clover	forb
ORYZHYM	Oryzopsis hymenoides (R. & S.) Ricker	Indian rice grass	grass
OXYTDEF	Oxytropis deflexa (Pall.) DC.	Reflexed locoweed	forb
OXYTMON	Oxytropis monticola A. Gray	Late yellow locoweed	forb
OXYTSER	Oxytropis sericea Nutt.	Early yellow locoweed	forb
OXYTSP.	Oxytropis sp.	Locoweed species	forb
PENSALB	Penstemon albidus Nutt.	White beardtongue	forb
PENSNIT	Penstemon nitidus Dougl. ex Benth.	Smooth blue beardtongue	forb
PENSPRO	Penstemon procerus Dougl. ex Grah.	Slender blue beardtongue	forb
PENSSP.	Penstemon sp.	Beardtongue species	forb
PETAPUR	Petalostamon purpureum (Vent.) Rydb.	Purple prairie-clover	forb
PHLOHOO	Phlox hoodii Richards.	Moss phlox	forb
PLANELO	Plantago elongata	Narrow-leaved plantain	forb
PLANPAT	Plantago patagonica Jacq.	Pursh's plantain	forb
PLANSP.	Plantago sp.	Plantain species	forb
POAARID	Poa arida Vasey	Plains bluegrass	grass
POACANB	Poa canbyi (Scribn.) Piper	Canby bluegrass	grass
POACOMP	Poa compressa L.	Canada bluegrass	grass

Code	Scientific Name	Common Name	Form
POACUSI	Poa cusickii Vasey	Early bluegrass	grass
POAINTE	Poa interior Rydb.	Inland bluegrass	grass
POAJUNC	Poa juncifolia Scribn.	Alkali bluegrass	grass
POAPRAT	Poa pratensis (L.)	Kentucky bluegrass	grass
POASAND	Poa sandbergii Vasey	Sandberg bluegrass	grass
POASP.	Poa species	Bluegrass species	grass
POLYARE	Polygonum arenastrum Jord. ex Bor.	Common knotweed	forb
POLYCOC	Polygonum coccineum Muhl.	Water smartweed	forb
POLYCON	Polygonum convolvulus L.	Wild buckwheat	forb
POLYSP.	Polygonum sp.	Knotweed species	forb
POLYVIV	Polygonum viviparum L.	Alpine bistort	forb
POTEANS	Potentilla anserina L.	Silverweed	forb
POTEFRU	Potentilla fruticosa L.	Shrubby cinquefoil	forb
POTEGRA	Potentilla gracilis Dougl. ex Hook.	Graceful cinquefoil	forb
POTEHIP	Potentilla hippiana Lehm.	Woolly cinquefoil	forb
POTENOR	Potentilla norvegica L.	Rough cinquefoil	forb
POTEPEN	Potentilla pensylvanica L.	Prairie cinquefoil	forb
POTESP.	Potentilla species	Potentilla species	forb
PSORARG	Psoralea argophylla Pursh	Silverleaf psoralea	forb
PSORESC	Psoralea esculenta Pursh	Indian breadroot	forb
PUCCNUT	Puccinellia nuttalliana (Schult.) A.S. Hitchc.	Nuttall's salt-meadow grass	grass
RATICOL	Ratibida columnifera (Nutt.) Wooton & Standl.	Prairie coneflower	forb
RHUSTRI	Rhus trilobata Nutt.	Skunkbush	shrub
ROSAARK	Rosa arkansana Porter	Prairie rose	shrub
ROSASP.	Rosa species	Rose species	shrub
ROSAWOO	Rosa woodsii Lindl.	Common wild rose	shrub
RUBUIDA	Rubus idaeus L.	Wild red raspberry	shrub
RUMEACE	Rumex acetosa L.	Green sorrel	forb
RUMESP.	Rumex sp.	Dock species	forb
RUMEVEN	Rumex venosus	Sand dock	forb
SALSKAL	Salsola kali L.	Russian thistle	forb
SARCVER	Sarcobatus vermiculatus (Hook.) Torr.	Greasewood	shrub
SCHEPAN	Schedonnardus paniculatus (Nutt.) Trel.	Tumble grass	grass
SETAVIR	Setaria viridis (L.) Beauv.	Green foxtail	grass

Code	Scientific Name	Common Name	Form
SHEPCAN	Shepherdia canadensis (L.) Nutt.	Canada buffaloberry	shrub
SILEDRU	Silene drummondii Hook.	Drummond's cockle	forb
SISYALT	Sisymbrium altissimum L.	Tumbling mustard	forb
SITAHYS	Elymus elymoides	Squirreltail	grass
SOLASP.	Solanum species	Tomatoe species	forb
SOLATRI	Solanum triflorum Nutt.	Wild tomato	forb
SOLIMIS	Solidago missouriensis Nutt.	Low goldenrod	forb
SOLIRIG	Solidago rigida L.	Stiff goldenrod	forb
SOLISP.	Solidago species	Goldenrod species	forb
SONCSP.	Sonchus species	Sow-thistle species	forb
SPARGRA	Spartina gracilis	Alkali cord grass	grass
SPHACOC	Sphaeralcia coccinea (Pursh) Rydb.	Scarlet mallow	moss
SPIRALB	Spirea alba Du Roi	Narrow-leaved meadowsweet	shrub
SPORCRY	Sporobolis cryptandrus (Torr.) A. Gray	Sand dropseed	forb
STELLON	Stellaria longifolia (Muhl)	Long leaved chickweed	forb
STELSP.	Stellaria species	Sandwort species	forb
STIPCOM	Stipa comata Trin.& Rupr.	Needle-and-thread	grass
STIPCUR	Stipa curtiseta (A.S. Hitchc.) Barkworth	Western porcupine grass	grass
STIPVIR	Stipa viridula Trin.	Green needle grass	grass
SUAEMOQ	Suaeda moquinii (Torr.) Greene	Moquin's sea-blite	shrub
SYMPOCC	Symphoricarpos occidentalis Hook.	Buckbrush	shrub
TARAOFF	Taraxacum officinale Weber	Common dandelion	forb
THERRHO	Thermopsis rhombifolia (Nutt.) Richards.	Golden bean	forb
THLAARV	Thlaspi arvense L.	Stinkweed	forb
TOWNPAR	Townsendia parryi D.C. Eat	Parry's townsendia	forb
TRAGDUB	Tragopogon dubius Scop.	Common goat's-beard	forb
TRIFREP	Trifolium repens L.	White clover	forb
TRITAES	Triticum aestivum L.	Common wheat	grass
UTRIVUL	Utricularia vulgaris L.	Common bladderwort	forb
VEROPER	Veronica peregrina L.	Hairy speedwell	forb
VICIAME	Vicia americana Muhl.	Wild vetch	forb
VIOLADU	Viola adunca J.E. Smith	Early blue violet	forb
VIOLCAN	Viola canadensis (L.)	Western Canada violet	forb
VIOLNUT	Viola nuttallii Pursh	Yellow prairie violet	forb

Code	Scientific Name	Common Name	Form
VIOLSP.	Viola species	Violet species	forb
VULPOCT	Vulpia octoflora (Walt.) Rydb.	Six-weeks fescue	grass
XANTSTR	Xanthium strumarium L.	Cocklebur	forb
ZIGAELE	Zigadenus elegans Pursh	White camas	forb
ZIGAVEN	Zigadenus venenosus S. Wats	Death camas	forb

Appendix E

Diversity of Growth Forms on Revegetating Exposed Topsoils

Prepared by Ross Adams

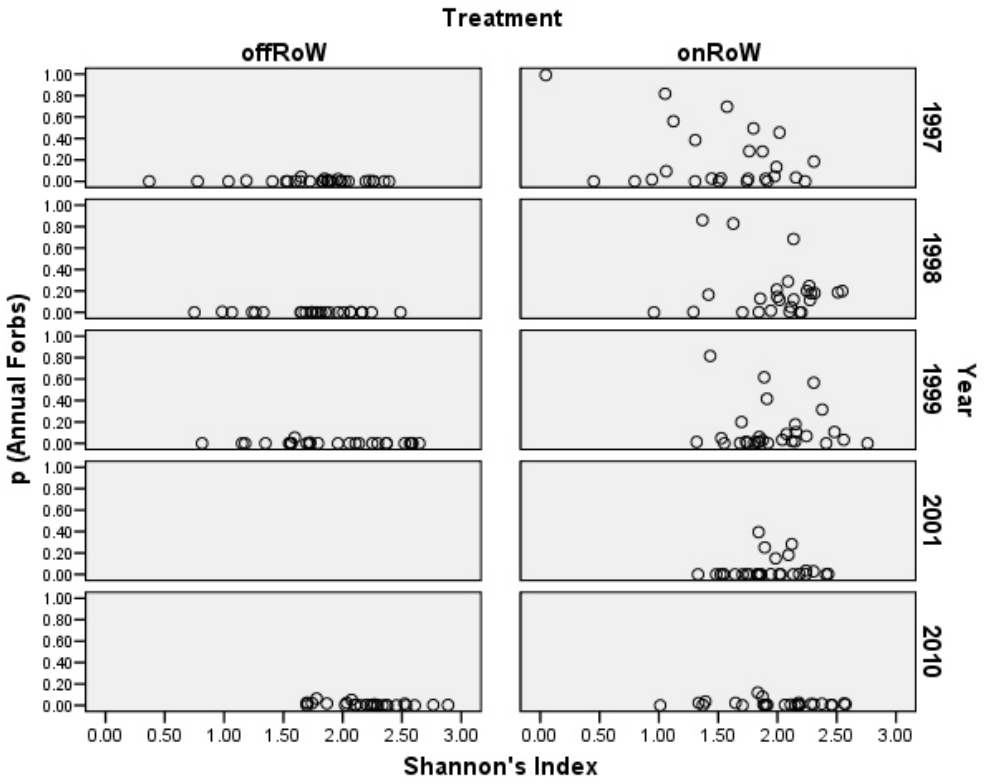
Diversity-Cover Plots

The following three plots were made by calculating the Shannon index (S) for each site, and then plotting S against the proportion (p) of cover of the type indicated for each plot the axes. These plots are based on sites in the Dry Mixed Grass subregion.

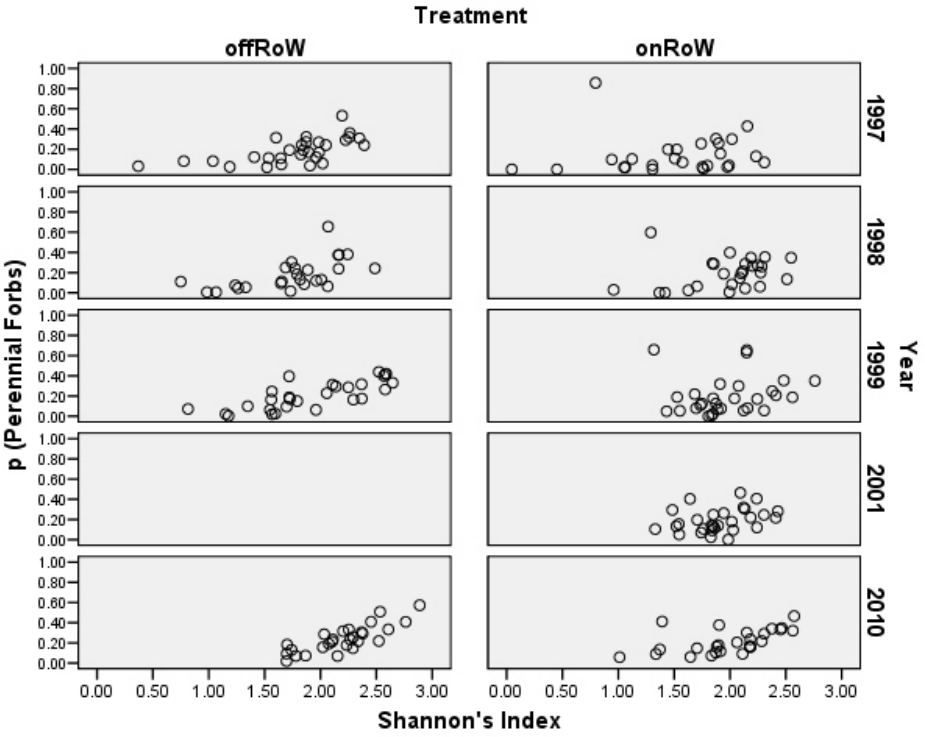
These plots show forbs and graminoids to have a complementary relationship, with forb cover increasing with increasing diversity, and graminoid cover decreasing with increasing diversity.

Annual forbs represent a very small proportion of cover in controls, but considerably more in the early years for on RoW sites with disturbed topsoils. The distribution of on RoW points over the years with respect to annual forbs illustrates the trends in the t-tests for richness of annual forbs.

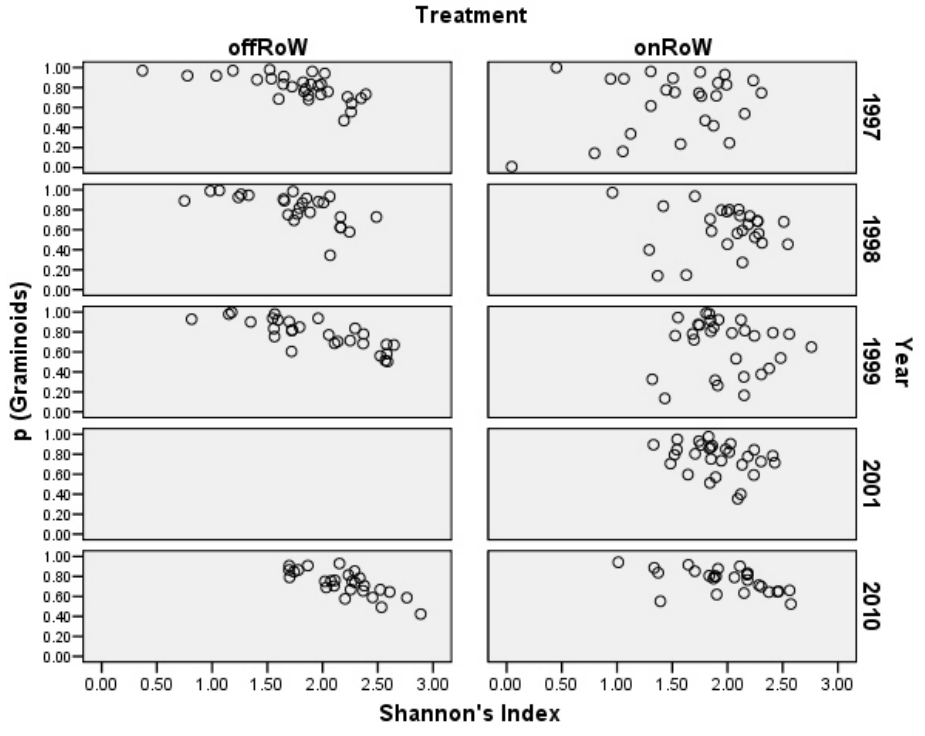
Seeded Sites – Annual Forbs



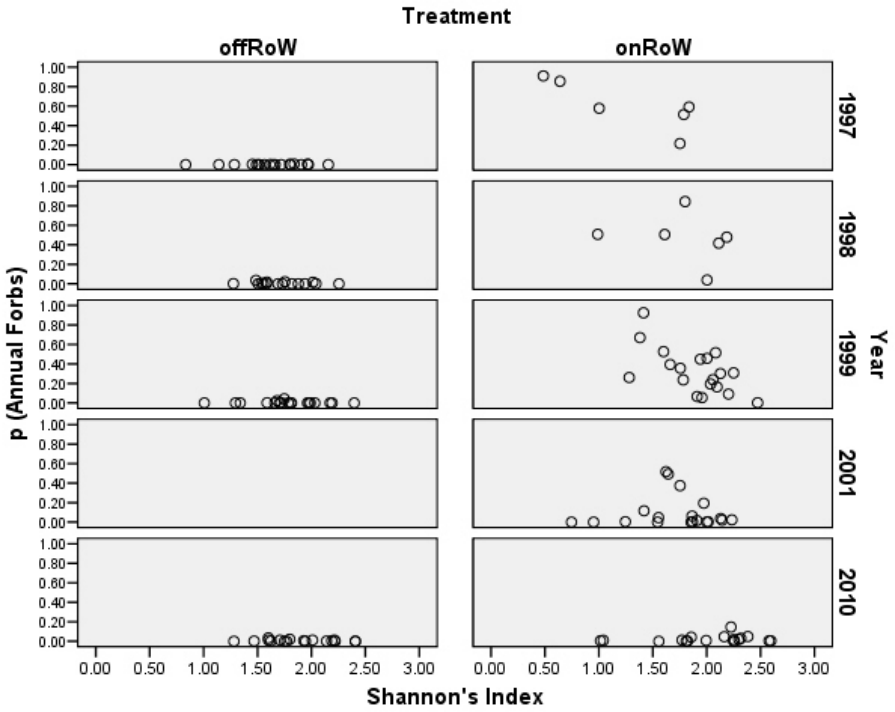
Seeded Sites – Perennial Forbs



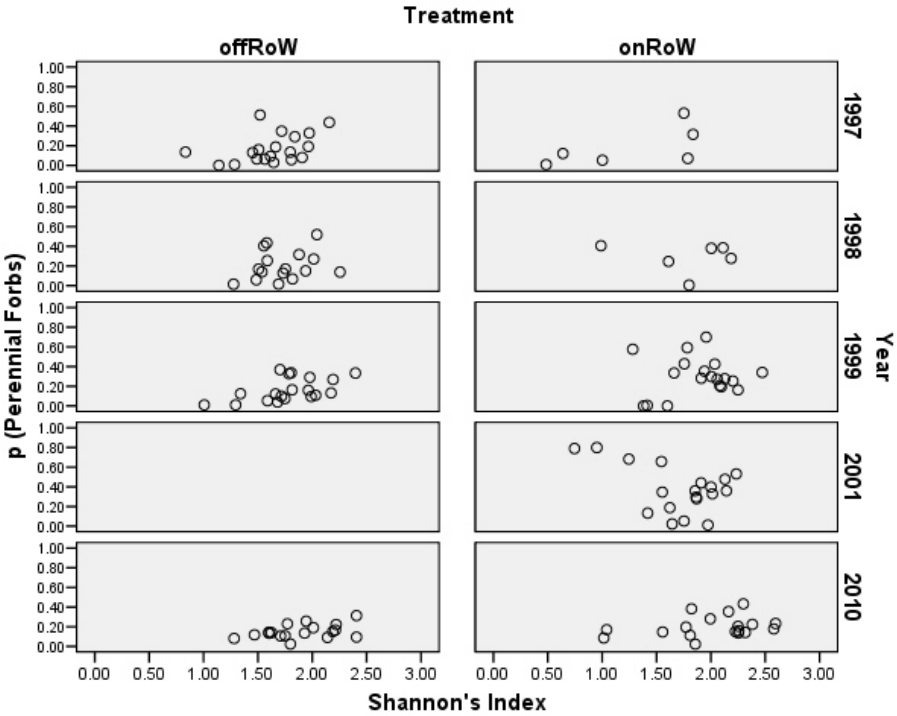
Seeded Sites - Graminoids



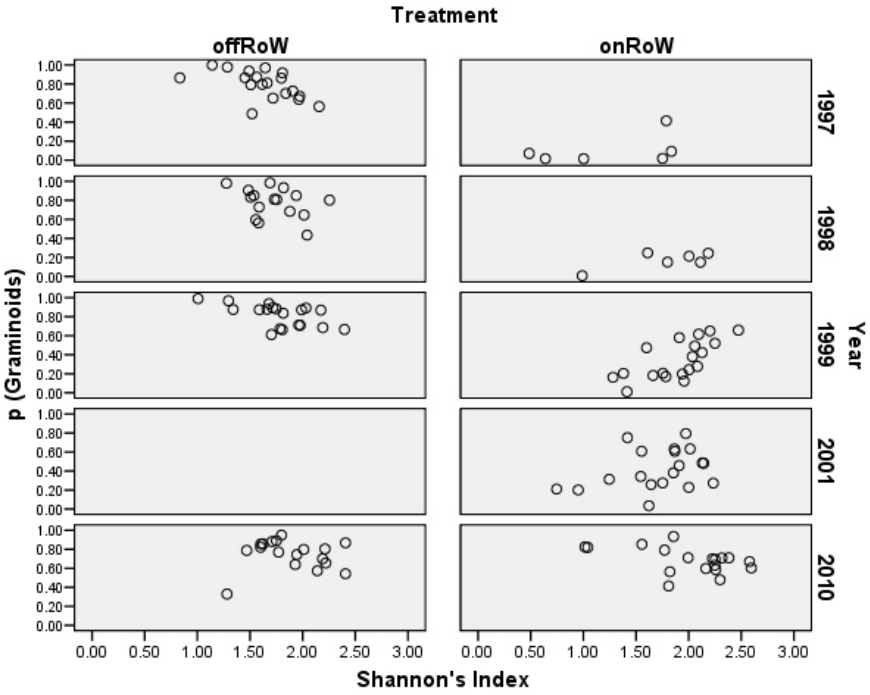
Natural Recovery – Annual Forbs



Natural Recovery – Perennial Forbs



Natural Recovery – Graminoids

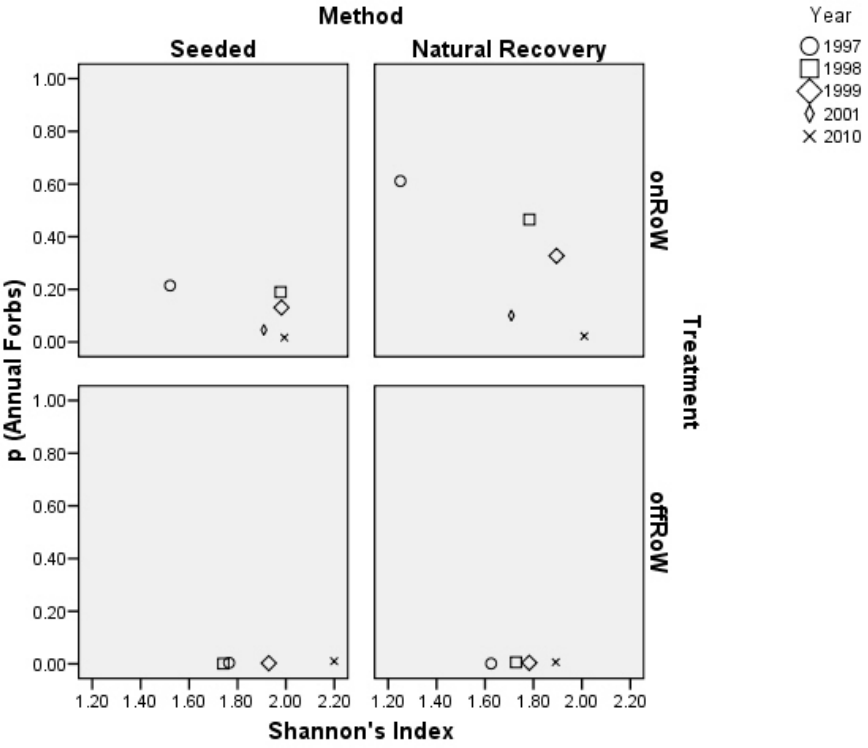


Trajectory Plots

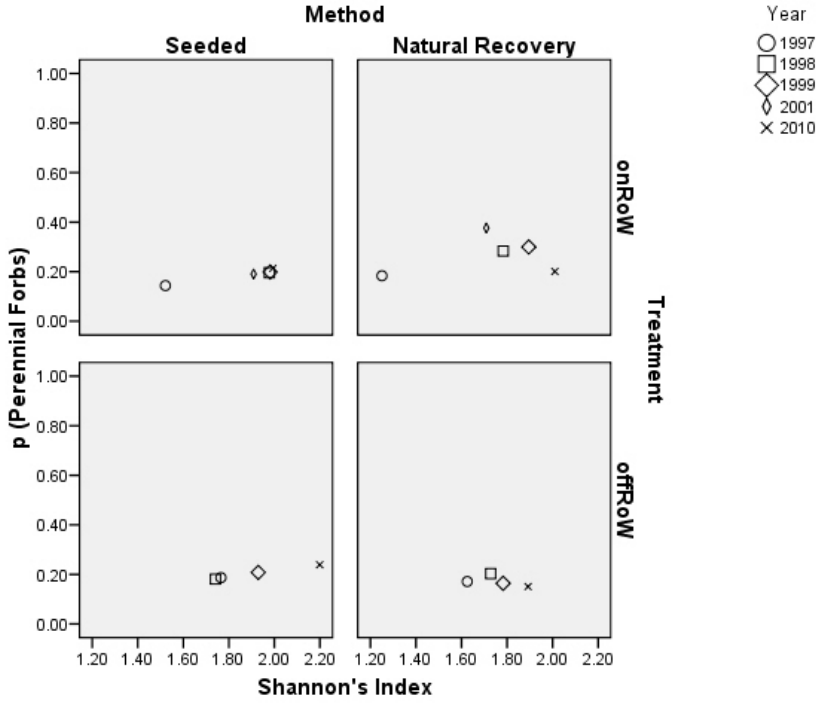
First off, in case I haven't mentioned it yet, the plots with species richness on the x-axis refer to total site richness, not richness of specific forms of vegetation.

The most eye-catching difference in the trajectory plots since the cull of the natural recovery sites for 97 and 98 is probably the increase in the proportion of annual forb cover in on RoW sites. The change is due to the fact that the points that remain have rather high cover of annual forbs in 97 and 98 compared to the sites that were removed. Despite the large increase in 97 and 98 for the Annual Forb trajectory, the trajectory is more or less the same as that seen in earlier versions of these plots.

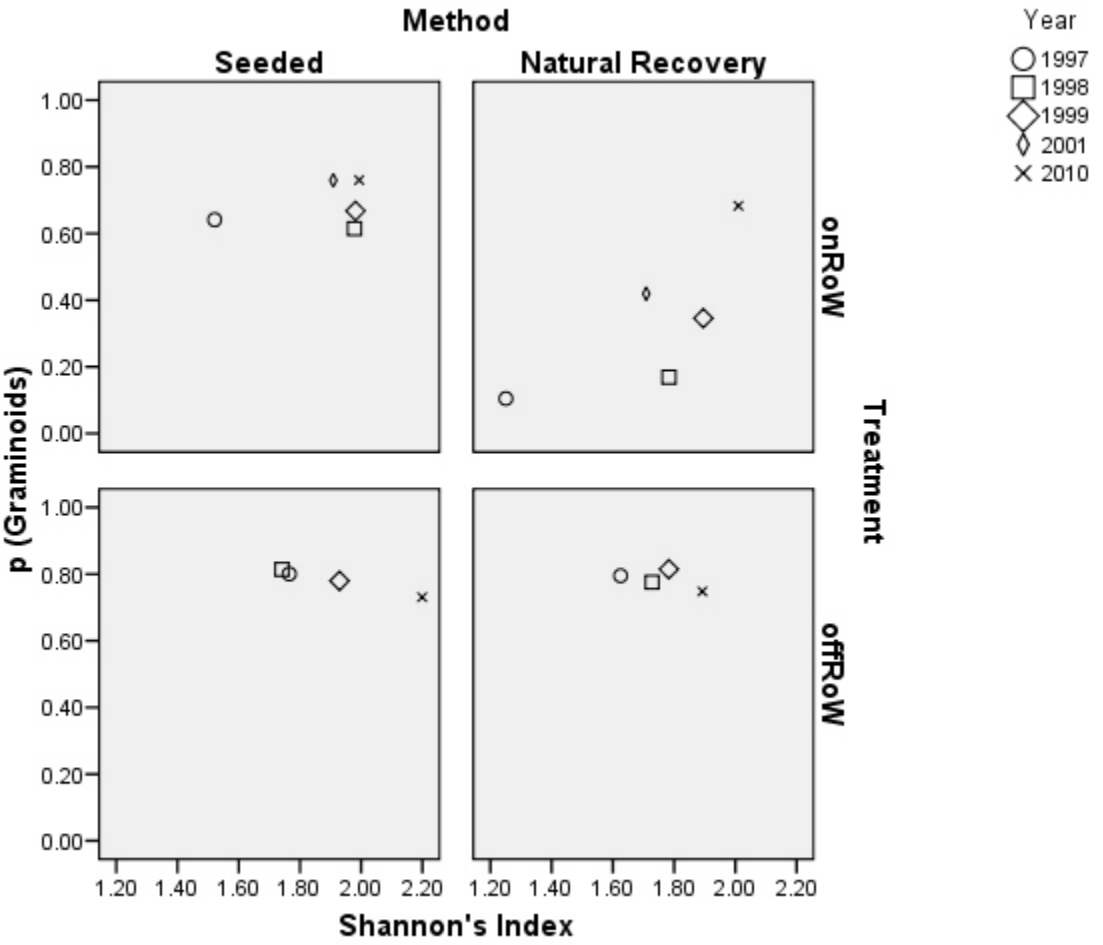
Shannon's Index – Annual Forbs



Shannon's Index – Perennial Forbs



Shannon's Index – Graminoids



Species richness figures are presented in the main body of the report in Section 10.

The assessment compares the relationship between the diversity of species on a site (represented by Shannon's Diversity Index) and the proportion of a site occupied by each growth form, measured by foliar cover.

Appendix F Vegetation Data By Site Over Time

Table 2. Percent Cover of Vegetation at Site 2.

Site 2 (Aspen Parkland) **KP: 47+900**
Soil Stripping: Full width **Seeded spring 97 (mix #1)**
Sample area: Travel lane **ERS: Loamy**

																2010 Range Health					
																28				47	
Control (1997-99)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**									
Mean % cover[1] 104.8(8.7)		Mean % cover[1] 21.1(0)		Mean % cover[1] 97.8(0)		Mean % cover[1] 55.4(5.4)		Mean % cover[1] 29.3 (0.4)		Mean % cover[1] 0.0 (0.0)		Mean % cover[1] 0.0 (0.0)									
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**								
CAREOBT	39.15	SALSKAL	6.25	AGROTRA	26.50	AGROTRA	21.56	FESTOVI	10.20	FESTOVI	49.00	CAREPEN	10.00								
AGRODAS	12.65	AGROTRA	5.35	ARTEFRI	24.50	DESCSOP	11.00	AGROTRA	9.10	AGROSMI	4.00	STIPCUR	9.90								
ARTEFRI	11.80	CHENSP	3.75	STIPVIR	18.25	FESTOVI	7.81	STIPVIR	2.40	AGRODAS	3.80	KOELMAC	8.00								
STIPCUR	9.50	STIPVIR	2.50	AGRODAS	7.75	AGRODAS	5.06	AGROSMI	2.10	ARTEFRI	3.00	FESTOVI	5.70								
CAREPEN	8.63	FESTHAL	0.90	DESCSOP	7.05	STIPVIR	4.38	STIPCUR	1.50	AGROREP	2.40	CAREOBT	5.20								
KOELMAC	7.15	ARTEFRI	0.70	SALSKAL	4.55	ARTEFRI	4.19	AGRODAS	1.40	STIPVIR	1.30	ARTEFRI	3.80								
FESTHAL	5.25	AGRODAS	0.55	FESTOVI	2.50	AGROALB	0.38	ARTEFRI	0.50	TARAOFF	0.80	CARESTE	2.90								
BOUTGRA	4.63	BOUTGRA	0.25	VICIAME	1.50	POAPRAT	0.32	FESTHAL	0.50	AGROTRA	0.50	AGRODAS	1.60								
ERIGCAE	1.48	DESCSP	0.25	ASTRSP	0.75	CARESTE	0.31	AGROREP	0.40	CAREPEN	0.20	ANEMPAT	1.40								
ANEMPAT	1.33	KOELMAC	0.10	CHENALB	0.30	ARTELUD	0.06	CAREPEN	0.40	BROMINE	0.10	CALAMON	1.10								
POAPRAT	0.78	CARESTE	0.05	KOELMAC	0.30	TARAOFF	0.06	CARESTE	0.20			VICIAME	0.60								
AGROTRA	0.75	OXYTSP	0.05	ARTECAM	0.25	VICIAME	0.06	ASTRDAS	0.10			ASTRMIS	0.50								
ASTRSP	0.40	SETAVIR	0.05	FESTHAL	0.25			BROMINE	0.10			PHLOHOO	0.50								
COMAUMB	0.30			POTENOR	0.25			CAREOBT	0.10			SOLIMIS	0.50								
VICIAME	0.20			ASTECIL	0.05			KOELMAC	0.10			ASTRDAS	0.20								
SOLIMIS	0.18							MUHLCUS	0.10			BOUTGRA	0.20								
CALAMON	0.15							VICIAME	0.10			POAPRAT	0.20								
ACHIMIL	0.13											POTEPEN	0.20								
CHENSP	0.03																				
PHLOHOO	0.03																				
POTEPEN	0.03																				

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	69.50		1.00		1.10		25.30		70.30		n/a		n/a
Moss/Lichen	8.70		0.00		0.00		5.40		0.40		0.40		6.20
Bare Soil	2.78		89.00		73.50		29.70		3.00		1.00		2.40

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way prominence values averaged over 3 years, 1997, 1998 and 1999.

Table 3. Percent Cover of Vegetation at Site 3.

Site 3 (Aspen Parkland) **KP: 59+300**
Soil stripping: Double blade width **seeded fall 96 (mix #1)**
Sample area: Spoil **ERS: Blowouts**

Control (1997-99)2		On RoW (1997)		On RoW (1998)		On RoW (1999)		On RoW (2001)		2010 Range Health: On RoW (2010) 43		Control (2010) 47	
Mean % cover[1] 51.5(18.9)		Mean % cover[1] 24.9(0.1)		Mean % cover[1] 43.5(0.1)		Mean % cover[1] 60.7(0.1)		Mean % cover[1] 84.1 (1.6)		Mean % cover[1] 0.0 (0.0)		Mean % cover[1] 0.0 (0.0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREPEN	10.13	CAREOBT	9.00	CAREPEN	15.75	ERIGPUM	13.25	STIPCUR	19.60	ARTEFRI	8.00	STIPCUR	12.40
STIPCUR	9.90	ASTEFAL	4.36	ARTEFRI	7.55	CAREPEN	10.05	KOELMAC	13.80	CARESTE	7.70	CAREPEN	11.00
CARESP	7.63	KOELMAC	2.71	KOELMAC	4.55	AGROSMI	7.05	ARTEFRI	8.90	CAREPEN	7.10	ANTEPAR	10.00
ANTEAPR	6.58	AGROSCA	2.29	ASTEFAL	3.60	KOELMAC	5.30	ANTEAPR	8.60	AGROSMI	5.10	CAREOBT	4.50
FESTHAL	3.60	ASTRDAS	2.14	ACHIMIL	2.85	CARESP	4.05	ACHIMIL	5.70	ANTEPAR	5.00	KOELMAC	3.60
ARTEFRI	2.10	ACHIMIL	1.21	STIPCUR	2.40	ASTEFAL	4.00	CAREPEN	4.80	AGRODAS	4.90	FESTHAL	3.30
ANEMPAT	2.05	ANTESP	0.86	ASTRDAS	1.75	ACHIMIL	3.55	CARESTE	4.80	STIPCUR	4.00	AGROSMI	3.00
ARTELUD	1.88	AGROSMI	0.50	FESTHAL	1.00	FESTHAL	3.10	FESTHAL	3.60	CAREOBT	3.80	ARTEFRI	2.60
KOELMAC	1.75	SOLIMIS	0.43	ANTESP	0.95	STIPVIR	3.00	ASTEERI	3.30	ACHIMIL	3.60	ANEMPAT	2.20
AGRODAS	1.50	STIPCUR	0.43	CAREOBT	0.75	STIPCUR	2.15	STIPVIR	3.30	KOELMAC	2.00	ARTELUD	1.90
AGROSMI	0.93	ARTELUD	0.36	SOLIMIS	0.55	ARTEFRI	1.55	ARTELUD	2.10	ARTELUD	1.70	CARESTE	1.70
HETEVIL	0.88	ARTEFRI	0.07	CALAMON	0.40	ANEMPAT	1.50	ANEMPAT	1.80	ANEMPAT	1.50	BOUTGRA	1.50
CERAARV	0.45	CAMPROT	0.07	AGROSMI	0.30	ANTEAPR	0.55	AGROSCA	1.50	AGROSCA	0.80	ROSAARK	1.20
SOLIMIS	0.43	CERAARV	0.07	HYMERIC	0.25	AGROTRA	0.30	AGROSMI	1.50	POAJUNC	0.70	AGRODAS	0.60
ERIGPUM	0.35	GALIBOR	0.07	PHLOHOO	0.25	PHLOHOO	0.25	AGRODAS	0.60	GALITRI	0.60	ACHIMIL	0.50
ACHIMIL	0.30	MUHLSP	0.07	BOUTGRA	0.05	ROSAARK	0.25	GRINSQU	0.30	CALALON	0.50	THERRHO	0.50
AGROTRA	0.30	STIPVIR	0.07			SOLIMIS	0.25			LIATPUN	0.40	ASTEFAL	0.40
AGROSCA	0.28									VICIAME	0.40	ORTHLUT	0.40
POTEHIP	0.25									FESTHAL	0.30	CERAARV	0.30
ANDRSEP	0.03									GRINSQU	0.30	GALIBOR	0.30
ASTRDAS	0.03									POTEHIP	0.30	POAJUNC	0.30
CALAMON	0.03									LEPIRAM	0.20	AGROTRA	0.20
GALIBOR	0.03									ORTHLUT	0.20	TARAOFF	0.20
GUTISAR	0.03									TARAOFF	0.20	TRIFREP	0.20
POAJUNC	0.03									CAMPROT	0.10	ANDRSEP	0.10
THERRHO	0.03											CALAMON	0.10
												CAMPROT	0.10
												CHENPRA	0.10
												HELIHOO	0.10
												LEPIDEN	0.10
												PHLOHOO	0.10
												POAPRAT	0.10

Mean % cover	Control (97-99)	On RoW (1997)	On RoW (1998)	On RoW (1999)	On RoW (2001)	On RoW (2010)	Control (2010)
Litter	37.88	12.90	9.10	22.80	24.20	n/a	n/a
Moss/Licher	18.93	0.10	0.10	0.10	1.60	9.90	8.50
Bare Soil	0.10	72.10	50.50	54.80	27.80	5.70	1.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.

[2] Off right-of-way prominence values averaged over 3 years, 1997, 1998 and 1999.

Table 4. Percent Cover of Vegetation at Site 4.

Site 4 (Fescue / Mixed Grass transition) **KP: 79+400 (Northern Fescue)**
Soil stripping: Blade width **Seeded fall 1996 (mix #2)**
Sample area: Ditch **ERS: Blowouts**

										2010 Range Health			
										72		100	
Control (1997-99)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 76.8(21)		Mean % cover[1] 18.1(0)		Mean % cover[1] 53.8(0)		Mean % cover[1] 103.1(0)		Mean % cover[1] 79 (1)		Mean % cover[1] 0.0 (0.0)		Mean % cover[1] 0.0 (0.0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREPEN	11.63	AGROTRA	10.83	ARTEFRI	11.50	ARTEFRI	24.00	ARTEFRI	31.30	ARTEFRI	16.40	STIPCUR	19.50
FESTHAL	11.58	ARTEFRI	2.67	AGROTRA	9.55	MONONUT	15.75	STIPVIR	17.30	STIPCUR	15.20	CAREOBT	13.00
CAREOBT	9.80	AGROSMI	0.92	THLAARV	2.70	DESCSOP	15.30	KOELMAC	9.60	AGRODAS	7.10	SYMPOCC	7.80
STIPCUR	7.35	FESTHAL	0.67	AGRODAS	2.30	AGROSMI	10.31	ORYZHYM	7.80	KOELMAC	7.10	FESTHAL	6.50
ANEMPAT	5.18	RUMESP	0.50	KOCHSCO	1.80	AGROTRA	7.75	FESTHAL	6.60	FESTHAL	6.30	ARTELUD	5.50
AGRODAS	4.58	CAREPEN	0.42	ACHIMIL	1.50	STIPVIR	5.00	AGRODAS	2.10	AGROSMI	5.40	ARTEFRI	4.20
ACHIMIL	4.50	CHENSP	0.42	CAREOBT	0.90	STIPCUR	4.75	AGROPEC	1.80	CARESTE	5.00	AGRODAS	4.10
SYMPOCC	4.40	GRINSQU	0.42	KOELMAC	0.80	AGROREP	4.65	CAREPEN	1.00	STIPVIR	4.20	CARESTE	3.60
KOELMAC	4.13	SYMPOCC	0.42	FESTHAL	0.70	KOELMAC	3.10			DISTSTR	2.50	THERRHO	2.90
THERRHO	3.90	STIPVIR	0.33	DISTSTR	0.45	CAREPEN	2.35			AGROPEC	1.30	AGROSMI	2.20
JUNCBAL	2.35	AGRODAS	0.25	AGROSMI	0.31	AGROPEC	2.00			BROMINE	0.70	AGROTRA	1.90
GALIBOR	1.78	KOELMAC	0.25	CHENALB	0.30	CAREOBT	1.55			SOLIMIS	0.40	ANEMPAT	1.70
POAJUNC	1.65	SOLATRI	0.08	ASTEERI	0.25	AGRODAS	1.50			CAREOBT	0.30	KOELMAC	1.50
AGROSMI	1.10			SOLIMIS	0.25	RUMESP	1.50			ACHIMIL	0.20	ACHIMIL	1.00
LITHINC	1.00			STIPCOM	0.25	DISTSTR	0.75					ORTHLUT	0.90
HELIHOO	0.75			STIPVIR	0.15	FESTHAL	0.65					ANTEAPR	0.80
ASTRSTR	0.38			DESCSOP	0.10	KOCHSCO	0.65					JUNCBAL	0.80
SOLIMIS	0.25			STIPCUR	0.10	THLAARV	0.35					CERAARV	0.60
ANDRSEP	0.13			MEDISAT	0.05	BROMINE	0.25					CAREPEN	0.50
ARTEFRI	0.05			POLYARE	0.05	POLYARE	0.25					GALIBOR	0.50
BOUTGRA	0.03			SYMPOCC	0.05	CHENALB	0.05					ANDRSEP	0.30
												ASTRDAS	0.20
												SOLIMIS	0.20
												DRABNEM	0.10
												MUHLRIC	0.10

Mean % cover	**Control (97-99)**	**On RoW (1997)**	**On RoW (1998)**	**On RoW (1999)**	**On RoW (2001)**	**On RoW (2010)**	**Control (2010)**
Litter	80.75	1.20	6.30	19.50	26.50	n/a	n/a
Moss/Licher	21.00	0.00	0.00	0.00	1.00	1.10	3.70
Bare Soil	1.13	93.30	52.30	50.00	17.30	1.20	0.30

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way prominence values averaged over 3 years, 1997, 1998 and 1999.

Table 5. Percent Cover of Vegetation at Site 5.

Site 5: (Dry Mixed Grass - Sandy soil) **KP: 103+800**
Soil stripping: Blade width **Not seeded**
Sample area: Travel lane **ERS: Sand**

										2010 Range Health			
										19		34	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 109.2(1.1)		Mean % cover[1] 61.1(0)		Mean % cover[1] 67.4(0)		Mean % cover[1] 125.1(0.1)		Mean % cover[1] 81.0(0.6)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREPEN	37.53	POAPRAT	16.43	ARTEFRI	18.75	CAREPEN	29.69	CAREPEN	35.80	SYMPOCC	32.50	SYMPOCC	27.70
CARESP	20.63	SYMPOCC	13.21	CAREPEN	17.50	SYMPOCC	23.44	SYMPOCC	17.20	POAPRAT	22.50	CAREOBT	22.20
SYMPOCC	18.00	CAREPEN	12.14	SYMPOCC	11.25	POAJUNC	21.25	POAPRAT	12.20	ARTELUD	13.50	ARTEFRI	17.10
AGROSMI	9.68	CARESTE	6.43	AGROSMI	10.60	ARTEFRI	18.19	ARTEFRI	6.80	ARTEFRI	5.90	POAPRAT	10.50
KOELMAC	9.38	COLLLIN	5.79	KOELMAC	7.00	KOELMAC	14.69	CERAARV	2.70	STIPCUR	3.50	ARTELUD	2.10
ARTEFRI	7.38	AGROSMI	1.43	CAREOBT	6.75	STIPCUR	4.06	KOELMAC	1.50	CAREPEN	2.30	KOELMAC	1.50
STIPCUR	3.40	ARTEFRI	1.07	CARESTE	1.55	AGROSMI	2.81	AGROSUB	1.10	AGROSUB	1.80	STIPCUR	1.50
CERAARV	1.08	KOELMAC	1.07	FESTSAX	1.50	CAREOBT	2.56	STIPCUR	0.60	ROSAWOO	1.70	AGROSMI	0.90
SOLIMIS	0.75	CHENSP	0.79	SOLIMIS	0.55	CERAARV	2.19	AGROSMI	0.50	AGROTRA	1.00	BROMINE	0.70
GALIBOR	0.28	CERAARV	0.71	ARTELUD	0.30	SOLIMIS	1.88	ARTELUD	0.50	KOELMAC	1.00	CAREPEN	0.70
POAPRAT	0.25	SOLIMIS	0.71	DESCSOP	0.30	STIPCOM	1.88	SOLIMIS	0.40	GALIBOR	0.90	GALIBOR	0.70
AGRODAS	0.13	ROSAWOO	0.43	CERAARV	0.25	COLLLIN	0.88	AGROSCA	0.30	CAREOBT	0.80	AGROSUB	0.50
AGROSCA	0.13	AGROSCA	0.36	POAPRAT	0.25	AGROTRA	0.31	CARESTE	0.30	VICIAME	0.70	CAREPRA	0.50
ARTELUD	0.13	ARTELUD	0.14	CHENPRA	0.10	HORDJUB	0.31	POASP	0.30	BROMINE	0.60	VICIAME	0.40
FESTSAX	0.13	FESTSAX	0.14	STIPCUR	0.10	POAARID	0.31	VICIAME	0.30	COLLLIN	0.30	CARESTE	0.20
THERRHO	0.13	LINULEW	0.07	AGROTRA	0.05	ARTELUD	0.13	CAMPROT	0.20			CARESP	0.10
VICIAME	0.13	POASAND	0.07	ERYSINC	0.05	CHENPRA	0.13	ANDRSEP	0.10			CHENSP	0.10
ANDRSEP	0.08	STIPCUR	0.07	VICIAME	0.05	DESCSOP	0.13	PENSPRO	0.10				
		VICIAME	0.07			ANDRSEP	0.06						
						FESTHAL	0.06						

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	49.50		23.21		24.00		42.81		59.90		n/a		n/a
Moss/Lichen	1.08		0.00		0.00		0.13		0.60		0.00		0.00
Bare Soil	2.20		60.00		38.25		16.25		0.40		0.00		0.20

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 6. Percent Cover of Vegetation at Site 6.

Site 6 (Fescue - Mixed Grass transition) **KP: 79+400 (Northern Fescue)**
Soil stripping: Blade width **Seeded fall 1996 (mix #2)**
Sample area: Travel lane **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										45		87-100	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 87.5 (9.9)		Mean % cover[1] 73.5(0)		Mean % cover[1] 78.3(0)		Mean % cover[1] 99.3(0)		Mean % cover[1] 87.0(1.5)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREOBT	23.75	AGROTRA	23.57	AGROTRA	14.50	STIPCUR	20.00	ARTEFRI	16.40	FESTOVI	24.70	STIPCUR	22.00
STIPCUR	22.81	POACOMP	9.29	AGRODAS	10.00	AGROSMI	15.00	AGROSMI	16.00	ARTEFRI	13.40	ARTEFRI	15.40
ACHIMIL	9.58	AGROSMI	6.43	CHENALB	8.00	CAREOBT	8.50	STIPCUR	14.40	AGROSMI	7.50	BOUTGRA	12.00
KOELMAC	7.11	FESTOVI	5.71	AGROSMI	7.75	ARTEFRI	7.00	GRINSQU	6.60	CARESTE	5.40	CAREOBT	6.50
ARTEFRI	6.94	CHENALB	4.64	ARTEFRI	7.00	AGROSIB	6.25	CAREOBT	5.30	POACOMP	4.90	KOELMAC	6.50
AGRODAS	5.28	SISYALT	4.29	DESCSOP	5.50	AGROTRA	6.00	KOELMAC	4.80	KOELMAC	3.00	AGRODAS	6.10
MUHLRIC	3.53	AGRODAS	3.21	FESTOVI	5.50	DISTSTR	6.00	AGRODAS	4.10	POAJUNC	2.40	CARESTE	6.00
AGROSMI	1.42	ORYZHYM	2.86	KOELMAC	5.50	POACOMP	5.50	DISTSTR	3.90	POAPRAT	1.50	AGROSMI	2.70
ASTEFAL	1.33	ARTEFRI	2.57	POACOMP	3.75	ANEMPAT	4.50	AGROTRA	3.80	STIPVIR	1.50	THERRHO	1.50
CAREPEN	1.25	ACHIMIL	2.50	STIPCUR	3.00	ACHIMIL	4.00	FESTOVI	2.10	MUHLRIC	1.00	SOLIMIS	1.30
BOUTGRA	1.00	POLYSP	2.50	DISTSTR	1.75	DESCSOP	3.25	POACOMP	1.80	AGRODAS	0.70	STIPCOM	1.00
GRINSQU	0.83	DESCSOP	2.14	GRINSQU	1.50	AGRODAS	3.00	BOUTGRA	1.50	AGROSCA	0.70	ANEMPAT	0.80
ASTRSTR	0.72	KOELMAC	2.14	LITHINC	1.50	SOLIMIS	3.00	CALALON	1.50	ACHIMIL	0.30	CAREPEN	0.50
SPARGRA	0.44	AGROSCA	0.36	CHENPRA	0.50	FESTOVI	1.75	LITHINC	1.50	ANDRSEP	0.30	CARESP	0.50
AGROSCA	0.42	BOUTGRA	0.36	MEDIFAL	0.50	KOELMAC	1.75	STIPVIR	1.50	CARESP	0.30	SYMPOCC	0.50
ANEMPAT	0.28	CALALON	0.36	POASAND	0.50	CALAMON	1.50	AGROSCA	0.60	DANTSP	0.30	TRAGDUB	0.50
CALAMON	0.19	DISTSTR	0.36	SISYALT	0.50	POAJUNC	1.50	POAJUNC	0.60	STIPCUR	0.30	ACHIMIL	0.40
ARNISOR	0.17	CAREOBT	0.07	AGROSIB	0.25	POHLNUT	0.50	CHENALB	0.30	BOUTGRA	0.20	STIPVIR	0.40
AGROSUB	0.14			CAREOBT	0.25	CHENALB	0.10	HORDJUB	0.30	POTEPEN	0.20	COMAUMB	0.30
POASAND	0.14			CAREPEN	0.25					CONVARV	0.10	FUNGI	0.30
SOLIMIS	0.14									TARAOFF	0.10	ANDRSEP	0.20
ALLITEX	0.03											PHLOHOO	0.20
												ORTHLUT	0.10

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	67.08		16.43		11.50		74.75		48.10		n/a		n/a
Moss/Lichen	9.86		0.00		0.00		0.00		1.50		0.10		3.60
Bare Soil	0.03		81.79		57.25		27.75		25.30		0.30		0.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 7. Percent Cover of Vegetation at Site 7.

Site7 (Dry Mixed Grass - Solonetzic soil) **KP: 136+500 (Youngstown)**
Soil stripping: Blade width **Seeded fall 1996 (mix #4)**
Sample area: Ditch **ERS: Blowouts/Solonetzic**

										2010 Range Health:			
										39		62	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 38.3 (30.2)		Mean % cover[1] 24 (0)		Mean % cover[1] 55 (0)		Mean % cover[1] 90.2 (0)		Mean % cover[1] 63.5 (1)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREPEN	12.38	POLYARE	6.50	KOCHSCO	18.25	KOCHSCO	59.06	AGROSMI	13.80	ARTEFRI	16.40	ARTEFRI	21.00
STIPCUR	7.90	ARTEFRI	4.43	CHENALB	6.05	DISTSTR	5.00	GRINSQU	11.90	CARESTE	10.20	AGRODAS	14.50
ARTEFRI	4.93	HORDJUB	4.29	AGROTRA	4.70	DESCSOP	4.75	AGROREP	8.10	AGROSMI	7.40	CARESTE	13.40
KOELMAC	4.70	CHENALB	2.21	POLYARE	2.30	ARTEFRI	4.44	DISTSTR	6.80	AGRODAS	4.80	KOELMAC	10.50
AGRODAS	2.10	GRINSQU	2.14	AGROSMI	1.75	POLYARE	4.25	HORDJUB	5.10	FESTOVI	3.00	STIPCUR	8.10
AGROSMI	1.38	SOLATRI	2.14	DESCSOP	1.75	AGROTRA	2.81	ARTEFRI	3.60	GRINSQU	1.90	BOUTGRA	3.80
CARESTE	1.18	AGROTRA	0.50	DISTSTR	1.75	MONONUT	2.63	AGRODAS	3.30	KOELMAC	1.70	ORTHLUT	1.90
BOUTGRA	0.88	ARTELUD	0.43	MEDISAT	1.75	LEPISP	2.25	KOELMAC	2.10	STIPVIR	1.60	AGROSMI	1.50
ARTELUD	0.75	AGROPEC	0.36	THLAARV	1.70	HORDJUB	1.88	AXYRAMA	1.80	AGROSUB	0.50	POASAND	0.80
DISTSTR	0.73	POAJUNC	0.36	HORDJUB	1.55	STIPCUR	1.44	FESTOVI	1.80	DISTSTR	0.50	DISTSTR	0.70
GRINSQU	0.38	KOELMAC	0.14	AGRODAS	1.50	AGROSMI	0.44	AGROSCA	1.50	AGROTRA	0.20	GRINSQU	0.70
POAJUNC	0.28	MEDISAT	0.14	LAPPSQU	1.50	CAREPEN	0.25	POAJUNC	1.50	BOUTGRA	0.20	POAJUNC	0.50
CALAMON	0.15	STIPVIR	0.14	CAREPEN	0.65	CHENALB	0.25	CAREPEN	1.20	CHENSAL	0.10	ACHIMIL	0.40
MUHLRIC	0.15	FESTOVI	0.07	POAJUNC	0.30	AGROSUB	0.13	AGROTRA	0.90	POLYARE	0.10	AGROTRA	0.30
SOLIMIS	0.15			ARTEFRI	0.25	KOELMAC	0.13	HAPLSPI	0.10			SOLIMIS	0.20
POLYARE	0.08			STIPCUR	0.25	CREPTEC	0.06					ANTEAPR	0.10
AGROTRA	0.05			AGROPEC	0.05	POAJUNC	0.06					MUHLRIC	0.10
ACHIMIL	0.03			STIPVIR	0.05	STIPVIR	0.06					TARAOFF	0.10
ANTESP	0.03					THLAARV	0.06						
ARNIFUL	0.03												
CHENPRA	0.03												
LEPIRAM	0.03												
MYOSMIN	0.03												
POLYCON	0.03												
ZIGAVEN	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	42.88		2.50		1.75		19.06		12.60		n/a		n/a
Moss/Lichen	30.25		0.00		0.00		0.00		1.00		1.00		5.20
Bare Soil	6.70		83.57		58.50		27.81		38.40		34.00		0.50

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 8. Percent Cover of Vegetation at Site 8.

Site 8 (Dry Mixed Grass - Solonetzic soil) **KP: 146+100**
Soil Stripping: Full width **Seeded fall 96 (mix #4)**
Sample area: Spoil **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										72		75	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 66.8 (36.8)		Mean % cover[1] 38 (0)		Mean % cover[1] 55 (0)		Mean % cover[1] 31.3 (0)		Mean % cover[1] 26.4 (1.8)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
AGRODAS	19.40	DISTSTR	12.57	ARTEFRI	15.31	DISTSTR	10.06	AGROTRA	7.90	STIPCUR	22.00	AGRODAS	8.20
DISTSTR	11.05	AGROTRA	6.79	AGRODAS	12.19	AGROTRA	9.38	POAJUNC	4.70	ASTEFAL	5.50	ASTEFAL	8.10
ACHIMIL	5.83	AGRODAS	5.36	AGROTRA	8.75	AGRODAS	3.13	AGRODAS	3.50	ANTEPAR	5.10	CAREOBT	6.20
CAREOBT	4.88	KOELMAC	4.00	DISTSTR	8.50	AGROSMI	2.81	ASTEFAL	2.20	AGROSMI	5.00	ANTEPAR	5.80
CARESTE	4.38	AMARALB	2.14	STIPCUR	5.06	POAJUNC	1.94	DISTSTR	1.80	KOELMAC	4.30	DISTSTR	4.10
CAREPEN	3.88	HORDJUB	2.14	KOELMAC	2.69	STIPVIR	1.88	GRINSQU	1.70	ACHIMIL	4.20	FESTOVI	3.20
ANTEPAR	3.75	SOLASP	2.14	FESTOVI	0.75	STIPCUR	0.63	ACHIMIL	1.10	ARTEFRI	3.70	KOELMAC	2.70
AGROSMI	2.25	ARTEFRI	0.57	MACHSP	0.69	AGROSUB	0.31	FESTOVI	1.10	MUHLRIC	2.80	ARTEFRI	2.20
PUCCNUT	2.25	ACHIMIL	0.36	POAJUNC	0.63	HORDJUB	0.31	AGROSMI	0.50	CARESTE	2.40	ACHIMIL	1.20
POAJUNC	1.78	CHENSP	0.36	AGROSMI	0.06	ARTEFRI	0.13	SOLIMIS	0.40	FESTOVI	2.30	CARESTE	0.90
ARTEFRI	1.65	KOCHSCO	0.36	BOUTGRA	0.06	ASTEFAL	0.13	STIPVIR	0.40	TARAOFF	2.30	AGROSMI	0.80
MUHLCUS	1.63	RATICOL	0.36	CHENPRA	0.06	FESTOVI	0.13	ARTEFRI	0.30	AGRODAS	1.50	STIPVIR	0.70
FESTSAX	0.95	FESTOVI	0.14	HELIHOO	0.06	POLYARE	0.13	FESTHAL	0.20	CALALON	1.20	GRINSQU	0.40
BOUTGRA	0.75	ASTEERI	0.07	SALSKAL	0.06	AXYRAMA	0.06	AGROSCA	0.10	SYMPOCC	1.10	ANEMPAT	0.30
KOELMAC	0.68	GRINSQU	0.07			BOUTGRA	0.06	ANTEAPR	0.10	DACTSP	0.80	POAJUNC	0.30
ASTEERI	0.43	STIPVIR	0.07			CAREPEN	0.06	CAREOBT	0.10	RATICOL	0.80	GALIBOR	0.20
GRINSQU	0.25	SYMPOCC	0.07			CHENPRA	0.06	CARESTE	0.10	GRINSQU	0.70	SILEDRU	0.20
ASTEFAL	0.18					MONONUT	0.06	CHENPRA	0.10	AGROSCA	0.50	SOLIMIS	0.20
AGROSCA	0.13							KOELMAC	0.10	POAJUNC	0.50	AGROSCA	0.10
CAREDOU	0.13									DESCSOP	0.30	AGROSUB	0.10
PENSPRO	0.13									CAREOBT	0.10	CALAMON	0.10
POASAND	0.13									CAREPEN	0.10	GEUMTRI	0.10
SOLIMIS	0.13									CERAARV	0.10	HEUCRIC	0.10
CHENPRA	0.08											MUHLRIC	0.10
FESTHAL	0.05											PHLOHOO	0.10
CERANUT	0.03											POTEHIP	0.10
GEUMTRI	0.03											SYMPOCC	0.10
LEPIDEN	0.03											TARAOFF	0.10
MUHLRIC	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	47.13		3.14		2.75		8.75		83.20		n/a		n/a
Moss/Lichen	36.75		0.07		0.06		0.94		33.80		2.30		4.60
Bare Soil	0.20		85.36		74.69		55.94		1.80		1.60		0.60

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 9. Percent Cover of Vegetation at Site 9.

Site 9 (Dry Mixed Grass - Solonetzic soil) **KP: 170+000**
Soil stripping: Double blade width **Seeded fall 96 (mix #4)**
Sample area: Spoil **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										41		63	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 89.7 (23.3)		Mean % cover[1] 45 (0)		Mean % cover[1] 49 (0)		Mean % cover[1] 80.0 (0)		Mean % cover[1] 65.1 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
AGRODAS	20.75	KOCHSCO	8.93	AGRODAS	19.50	ARTEFRI	26.25	AGRODAS	17.10	STIPCOM	21.80	STIPCUR	13.00
STIPCOM	11.88	SISYALT	8.93	ARTEFRI	7.00	STIPCOM	14.75	STIPVIR	12.30	FESTOVI	9.10	CARESTE	12.60
ARTEFRI	11.53	AGROSMI	6.79	STIPCOM	6.75	AGRODAS	11.25	ARTEFRI	12.20	STIPVIR	7.20	AGRODAS	6.00
CALAMON	10.00	CHENALB	4.64	KOELMAC	4.75	AGROTRA	5.25	STIPCOM	10.00	ARTEFRI	6.90	ARTEFRI	4.70
KOELMAC	10.00	STIPCOM	4.64	CALAMON	2.00	MONONUT	5.00	POAJUNC	6.30	AGRODAS	5.00	STIPCOM	4.70
SELADEN	9.13	AGRODAS	4.29	AGROSMI	1.75	STIPVIR	4.75	AGROSMI	3.00	AGROSMI	1.80	KOELMAC	3.50
CARESP	6.88	AGROTRA	2.86	KOCHSCO	1.55	FESTOVI	4.50	AGROTRA	1.50	CARESTE	0.70	AGROSMI	2.40
CAREPEN	6.50	STIPVIR	2.14	CAREOBT	1.50	AGROSMI	3.25	GUTISAR	1.50	KOELMAC	0.30	CAREOBT	2.30
AGROSMI	3.13	ARTEFRI	0.79	GUTISAR	1.50	POAJUNC	3.00	FESTOVI	0.90	STIPCUR	0.30	SYMPOCC	2.00
SPHACOC	2.00	PUCCNUT	0.71	SPHACOC	1.50	KOCHSCO	1.75	SPHACOC	0.30	BOUTGRA	0.20	TARAOFF	0.90
STIPCUR	2.00	FESTOVI	0.36	PHLOHOO	0.25	SPHACOC	0.25			SPHACOC	0.10	SPHACOC	0.80
AGROSUB	1.50	KOELMAC	0.36	POACANB	0.25							CALAMON	0.70
PHLOHOO	1.50											STIPVIR	0.50
POACANB	0.88											AGROSCA	0.10
SOLIMIS	0.88											AGROSUB	0.10
POASAND	0.13											ANTEPAR	0.10
TARAOFF	0.13											BOUTGRA	0.10
												MUHLRIC	0.10

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	85.63		4.00		45.50		62.00		31.20		n/a		n/a
Moss/Lichen	15.38		0.00		0.00		0.00		0.00		1.70		12.50
Bare Soil	0.13		92.14		59.50		40.50		34.90		26.00		0.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 10. Percent Cover of Vegetation at Site 10.

Site 10 (Dry Mixed Grass - Solonetzic soil) **KP: 182+700**
Soil stripping: Blade width **Seeded fall 1996 (mix #4)**
Sample area: Spoil **ERS: Loamy**

										2010 Range Health			
										64		87	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 82.5(52.4)		Mean % cover[1] 74.8(0.1)		Mean % cover[1] 50.3(0)		Mean % cover[1] 75.3(0.3)		Mean % cover[1] 31.0(0.7)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREPEN	21.63	CAREPEN	13.21	AGROSMI	19.00	CARESTE	27.81	STIPCOM	12.20	STIPCOM	25.80	STIPCOM	18.30
CARESTE	15.00	STIPCUR	12.14	CAREPEN	11.80	STIPCUR	24.69	CARESTE	7.00	BOUTGRA	13.50	STIPCUR	11.10
ARTEFRI	13.53	AGRODAS	10.00	BOUTGRA	7.50	AGROSMI	11.56	BOUTGRA	4.50	CARESTE	11.00	BOUTGRA	10.10
STIPCUR	7.00	BOUTGRA	7.50	STIPCOM	5.30	BOUTGRA	4.44	AGRODAS	2.60	AGROSMI	10.50	CARESTE	8.40
CALAMON	6.93	KOELMAC	7.50	KOELMAC	2.25	ARTEFRI	2.25	ARTEFRI	1.30	ARTEFRI	8.80	AGROSMI	7.50
AGROSMI	6.05	CARESTE	4.29	ARTEFRI	1.80	CAREPEN	2.19	GAURCOC	0.80	LYGOJUN	0.80	CAREPEN	4.00
STIPCOM	5.25	ANEMPAT	2.29	CARESTE	1.00	GAURCOC	1.19	HAPLSPI	0.80	CAREPEN	0.60	AGRODAS	3.90
KOELMAC	3.03	ARTEFRI	2.14	GAURCOC	0.90	KOELMAC	0.44	CAREPEN	0.60	GUTISAR	0.30	KOELMAC	2.30
BOUTGRA	1.80	HAPLSPI	2.14	LITHINC	0.25	ANEMPAT	0.38	KOELMAC	0.60	PHLOHOO	0.30	ARTEFRI	2.20
AGROSUB	0.88	STIPCOM	2.14	ANEMPAT	0.10	PHLOHOO	0.13	ASTRPEC	0.30	SPHACOC	0.30	SPHACOC	1.20
GAURCOC	0.53	GAURCOC	0.79	SOLIMIS	0.10	CHENPRA	0.06	CALAMON	0.20	AGRODAS	0.20	RATICOL	0.80
PHLOHOO	0.50	AGROSMI	0.36	ANDRSEP	0.05	HAPLSPI	0.06	PHLOHOO	0.10	ANEMPAT	0.10	PHLOHOO	0.40
ANEMPAT	0.25	SOLIMIS	0.36	LYGOJUN	0.05	PUCCNUT	0.06			HETEVIL	0.10	LYGOJUN	0.30
HAPLSPI	0.05	SPHACOC	0.36			SOLIMIS	0.06			STIPCUR	0.10	MUHLRIC	0.30
CHENSP	0.03	VICIAME	0.36									ASTRDAS	0.10
VICIAME	0.03	AGROTRA	0.07										
		CALAMON	0.07										
		PHLOHOO	0.07										

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	28.38		14.07		1.45		11.56		34.80		n/a		n/a
Moss/Lichen	52.38		0.07		0.00		0.25		0.70		0.80		0.80
Bare Soil	0.13		56.14		73.25		41.25		30.00		2.30		2.30

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 11. Percent Cover of Vegetation at Site 11.

Site 11 (Dry Mixed Grass - Sandy soil) **KP: 196+000 (North of Red Deer River)**
Soil stripping: Full width **Seeded fall 1996 (mix#3)**
Sample area: Travel lane **ERS: Loamy**

										2010 Range Health			
										47		47	
Control (1997-99)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 42.0(22.1)		Mean % cover[1] 7.6(0)		Mean % cover[1] 25.6(0)		Mean % cover[1] 56.9(0)		Mean % cover[1] 64.4 (1)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
BOUTGRA	11.15	CHENALB	4.29	CALAMON	4.50	ARTEFRI	12.56	STIPCOM	14.60	STIPVIR	12.80	STIPCOM	11.70
CAREPEN	9.65	CARESTE	2.21	STIPVIR	3.35	PHLOHOO	11.56	PHLOHOO	12.70	CARESTE	8.60	KOELMAC	8.30
AGROSMI	7.75	ARTEFRI	0.71	PHLOHOO	3.30	ASTESP	8.44	BOUTGRA	10.60	STIPCOM	5.80	BOUTGRA	4.40
STIPCUR	4.88	CALAMON	0.21	ARTEFRI	3.25	KOCHSCO	7.94	CARESTE	7.50	ARTEFRI	5.00	PHLOHOO	3.00
CALALON	2.75	STIPVIR	0.14	CAREPEN	2.55	HETEVIL	4.69	KOELMAC	4.50	AGROREP	4.60	ERIGCAE	2.60
STIPCOM	1.63	PHLOHOO	0.07	KOELMAC	2.00	CALAMON	3.75	RATICOL	3.40	AGROSMI	2.80	AGRODAS	2.50
AGRODAS	1.10			KOCHSCO	1.95	SALSKAL	1.94	SCHEPAN	3.00	AGROTRA	2.70	ARTEFRI	2.40
CHENPRA	0.75			BOUTGRA	1.50	AGROREP	1.88	ARTEFRI	2.40	FESTOVI	2.30	HETEVIL	1.90
LYGOJUN	0.75			LAPPSQU	1.50	STIPVIR	1.88	AGROREP	1.80	POACOMP	2.00	CAREOBT	1.50
KOELMAC	0.68			AXYRAMA	0.55	CAREPEN	0.63	CAREPEN	1.50	CAREOBT	1.20	ASTRDAS	1.20
CARESTE	0.33			AMARRET	0.40	KOELMAC	0.44	AGRODAS	0.60	BOUTGRA	1.00	SPHACOC	1.10
PHLOHOO	0.25			AGRODAS	0.25	AGRODAS	0.31	ASTEERI	0.30	KOELMAC	0.90	RATICOL	0.80
CALAMON	0.18			POLYARE	0.05	STIPCUR	0.31	GAURCOC	0.30	DESCSOP	0.60	LYGOJUN	0.50
HEDEHIS	0.08					AGROTRA	0.13	LYGOJUN	0.30	TARAOFF	0.60	ANTEPAR	0.20
AGROTRA	0.03					CARESTE	0.06			CHENPRA	0.20	HAPLSPI	0.20
KOCHSCO	0.03					CHENPRA	0.06			SPHACOC	0.20	CIRSUND	0.10
MUHLCUS	0.03					MONONUT	0.06			CERAARV	0.10	LITHINC	0.10
STIPVIR	0.03					POLYARE	0.06			HETEVIL	0.10		
						SETAVIR	0.06						
						SISYALT	0.06						
						STIPCOM	0.06						

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	69.00		0.79		3.15		8.75		26.50		n/a		n/a
Moss/Lichen	22.13		0.00		0.00		0.00		1.00		0.50		9.40
Bare Soil	0.33		93.93		71.75		64.69		43.30		3.80		0.80

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 12. Percent Cover of Vegetation at Site 12.

Site 12 (Dry Mixed Grass - Solonetzic soil) **KP: 203+500**
Soil stripping: Double blade width **Seeded late spring 1997 (mix #4)**
Sample area: Travel lane **ERS: Loamy**

										2010 Range Health			
										36		75	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 71.1 (41.6)		Mean % cover[1] 8 (0)		Mean % cover[1] 73 (0)		Mean % cover[1] 82.0 (0)		Mean % cover[1] 70.2 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	19.25	AGROTRA	5.00	AGROTRA	19.75	AGRODAS	26.50	AGRODAS	31.30	ARTEFRI	25.70	BOUTGRA	16.20
BOUTGRA	10.38	AGROSMI	0.75	AGRODAS	17.50	AGROTRA	19.25	STIPVIR	13.60	FESTOVI	7.50	STIPCOM	14.20
KOELMAC	9.38	AGRODAS	0.50	CHENALB	8.25	STIPVIR	11.50	AGROTRA	8.30	AGROREP	6.60	CARESTE	6.00
AGROSMI	6.38	FESTOVI	0.35	STIPVIR	6.25	ARTEFRI	10.25	FESTOVI	7.40	STIPVIR	5.50	KOELMAC	3.60
STIPVIR	5.75	KOELMAC	0.25	ARTEFRI	6.00	AGROSMI	8.25	AGROSMI	6.00	RATICOL	3.30	ARTEFRI	2.60
AGRODAS	5.25	OPUNPOL	0.25	HORDJUB	3.75	POAJUNC	3.75	ARTEFRI	3.30	AGROSMI	3.20	CALAMON	1.40
SPHACOC	4.88	PUCCNUT	0.25	FESTOVI	3.25	FESTOVI	1.75	OPUNPOL	0.30	AGRODAS	1.50	POASAND	1.00
HETEVIL	2.75	STIPVIR	0.25	AGROSMI	3.00	CREPTEC	0.25			CARESTE	1.00	STIPCUR	1.00
CARESTE	2.63	ARTEFRI	0.05	POAJUNC	3.00	KOELMAC	0.25			OPUNPOL	1.00	CAREOBT	0.80
OPUNPOL	1.88			BOUTGRA	1.50	SALSKAL	0.25			HETEVIL	0.80	CHENALB	0.80
ASTRSTR	0.75			SISYALT	0.25					DESCSOP	0.20	HETEVIL	0.70
HAPLSPI	0.75									SPHACOC	0.20	AGRODAS	0.40
LIATPUN	0.75									STIPCOM	0.20	LYGOJUN	0.30
LITHINC	0.13											PLANELO	0.10
LYGOJUN	0.13												
PHLOHOO	0.13												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	76.63		0.70		55.00		75.75		88.00		n/a		n/a
Moss/Lichen	41.63		0.00		0.00		0.00		0.00		4.40		1.60
Bare Soil	7.50		97.50		50.00		31.75		10.40		21.00		0.30

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 13. Percent Cover of Vegetation at Site 13.

Site 13 (Dry Mixed grass - Sandy soil) **KP: 249+100 (Rainy Hills)**
Soil Stripping: Full width **Seeded late spring 1997 (mix #3)**
Sample area: Ditch **ERS: Loamy**

										2010 Range Health			
										46		100	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 29.2(67.6)		Mean % cover[1] 0.5(0)		Mean % cover[1] 57.8(2.1)		Mean % cover[1] 30.9(0)		Mean % cover[1] 44.3 (1)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	15.00	AGROTRA	0.36	CHENSAL	16.55	AGROREP	9.38	FESTOVI	11.30	AGRODAS	19.90	STIPCOM	21.70
PHLOHOO	4.95	KOELMAC	0.07	AGROTRA	10.50	AGROTRA	6.63	ARTEFRI	7.90	FESTOVI	7.90	BOUTGRA	16.30
KOELMAC	3.30			AGRODAS	8.25	POACOMP	5.94	STIPVIR	6.90	STIPVIR	4.80	ARTEFRI	5.80
CARESTE	1.90			STIPVIR	5.00	AGROSMI	4.25	AGRODAS	5.10	CALALON	3.50	THERRHO	3.50
AGRODAS	1.70			ARTEFRI	4.75	AGRODAS	2.25	ORYZHYM	4.20	AGROSMI	2.40	CALALON	2.50
SPHACOC	0.85			ERYSINC	3.75	STIPVIR	1.00	STIPCOM	3.80	ARTEFRI	2.20	CARESTE	2.40
BOUTGRA	0.68			POACOMP	2.25	FESTOVI	0.63	AGROSMI	2.40	TRAGDUB	0.80	CREPTEC	0.70
AGROTRA	0.40			KOELMAC	2.00	LAPPOCC	0.38	AGROREP	1.20	CARESTE	0.40	TRAGDUB	0.60
ARTEFRI	0.23			ORYZHYM	1.75	AGROALB	0.13	AGROTRA	1.20	HETEVIL	0.40	HETEVIL	0.50
ARTELUD	0.15			AGROSMI	1.50	AGROSUB	0.13	KOELMAC	0.30	CREPTEC	0.20	KOELMAC	0.50
AGROSMI	0.03			CALALON	0.50	KOELMAC	0.13			KOELMAC	0.20	PHLOHOO	0.30
				FESTOVI	0.40	CALALON	0.06					POASAND	0.30
				STIPCOM	0.25	ORYZHYM	0.06					CALAMON	0.20
												ARTECAN	0.10
												SOLIMIS	0.10

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	25.25		9.07		8.75		17.81		21.90		n/a		n/a
Moss/Lichen	67.63		0.00		1.65		0.00		1.00		2.90		6.20
Bare Soil	0.78		87.14		62.25		50.31		50.60		15.80		2.20

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 14. Percent Cover of Vegetation at Site 14.

Site 14 (Dry Mixed Grass - Solonetzic soil) **KP: 270+800**
Soil stripping: Double blade width **Seeded late spring 1997 (mix #4)**
Sample area: Ditch **ERS: Loamy**

										2010 Range Health			
										63		71	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 80 (11)		Mean % cover[1] 6 (0)		Mean % cover[1] 80 (0)		Mean % cover[1] 52.5 (0)		Mean % cover[1] 35.7 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	35.75	KOCHSCO	6.25	CHENPRA	38.00	SALSKAL	11.75	SALSKAL	9.90	AGRODAS	38.50	KOELMAC	12.60
KOELMAC	16.63	AGROTRA	0.05	KOCHSCO	25.25	AGRODAS	7.50	AGRODAS	8.40	STIPVIR	2.30	STIPCOM	11.10
SELADEN	8.25			STIPVIR	6.75	LAPPOCC	6.50	STIPCOM	4.50	AGROSMI	2.00	AGROSMI	9.20
CARESTE	5.43			AGRODAS	3.00	SISYALT	6.25	STIPVIR	4.50	ARTEFRI	1.90	CARESTE	2.80
POASAND	4.88			LAPPOCC	3.00	AGROTRA	4.50	MONONUT	3.90	FESTOVI	1.70	SPHACOC	2.70
SPHACOC	3.13			MONONUT	3.00	KOCHSCO	3.75	ARTEFRI	3.30	MEDISAT	1.70	PLANPAT	2.60
AGRODAS	2.63			AGROTRA	1.50	STIPVIR	3.25	AGROSMI	0.30	AGROPEC	1.50	CIRSUND	2.50
AGROSMI	1.63					AGROSMI	1.50	AGROTRA	0.30	STIPCOM	1.00	ANTEPAR	1.90
PLANPAT	1.30					ERIGCAE	1.50	CHENALB	0.30	SPHACOC	0.90	ACHIMIL	1.00
CALAMON	0.25					HORDJUB	1.50	FESTOVI	0.30	KOELMAC	0.40	AGROPEC	1.00
						KOELMAC	1.50			POLYARE	0.40	TARAOFF	0.70
						MONONUT	1.50			TRAGDUB	0.40	BOUTGRA	0.40
						SPHACOC	1.50			CREPTEC	0.30	GRINSQU	0.40
										POASAND	0.30	ARTEFRI	0.20
										SOLIMIS	0.30		
										CARESTE	0.20		
										BOUTGRA	0.10		
										CHENSP	0.10		
										PLANPAT	0.10		
										TARAOFF	0.10		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	51.13		0.50		71.00		24.00		10.10		n/a		n/a
Moss/Lichen	11.25		0.00		0.00		0.00		0.00		7.60		2.50
Bare Soil	22.63		97.50		31.50		73.75		85.40		15.10		4.70

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 15. Percent Cover of Vegetation at Site 15.

Site 15 (Dry Mixed Grass - Solonetzic soil) **KP: 285+000**
Soil stripping: Double blade width **Seeded fall 1996 (mix #4)**
Sample area: Ditch **ERS: Loamy**

										2010 Range Health			
										n/a		60	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 63 (40)		Mean % cover[1] 15 (0)		Mean % cover[1] 21 (0)		Mean % cover[1] 24.5 (0)		Mean % cover[1] 13.6 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	25.47	AGROTRA	6.07	STIPCOM	6.75	AGRODAS	5.83	STIPCOM	4.80	FESTOVI	54.00	STIPCOM	21.00
BOUTGRA	14.18	AGROSMI	2.14	AGROTRA	3.55	STIPVIR	5.00	AGRODAS	4.50	AGROSMI	8.30	BOUTGRA	8.20
CARESTE	12.35	STIPVIR	1.50	AGRODAS	2.50	STIPCOM	4.44	ARTEFRI	1.90	AGRODAS	2.50	AGROSMI	4.00
KOELMAC	6.82	KOELMAC	1.07	CHENPRA	2.35	ARTEFRI	3.94	KOELMAC	0.80	CARESP	0.60	KOELMAC	3.00
AGRODAS	1.35	POAJUNC	1.07	LAPPSP	2.00	AGROSMI	1.78	FESTOVI	0.70	ZIGAELE	0.50	SPHACOC	2.90
POASAND	1.00	AGRODAS	0.71	FESTOVI	1.15	FESTOVI	1.17	STIPVIR	0.70	TRAGDUB	0.20	CARESTE	2.10
GAURCOC	0.97	STIPCOM	0.71	STIPVIR	0.85	KOELMAC	0.56	GAURCOC	0.20	CHENSP	0.10	AGOSGLA	1.60
AGROSMI	0.47	FESTOVI	0.64	KOELMAC	0.70	MONONUT	0.44			SPHACOC	0.10	VICIAME	1.50
CALAMON	0.44	CHENSP	0.36	AGROSMI	0.55	BOUTGRA	0.28					TRAGDUB	1.00
VICIAME	0.21	XANTSTR	0.36	BOUTGRA	0.10	GAURCOC	0.28					AGRODAS	0.40
		ARTEFRI	0.29	ARTEFRI	0.05	POAJUNC	0.28					CALAMON	0.10
		ARTELUD	0.07	ASTRSP	0.05	ASTRSP	0.06						
		CARESTE	0.07	CAREPEN	0.05	AXYRAMA	0.06						
				TARAOFF	0.05	CHENPRA	0.06						
				XANTSTR	0.05	DESCSOP	0.06						
						LAPPOCC	0.06						
						LEPISP	0.06						
						POLYARE	0.06						
						SALSKAL	0.06						
						VICIAME	0.06						

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	65.00		30.00		1.25		8.06		19.50		n/a		n/a
Moss/Lichen	40.15		0.00		0.00		0.00		0.00		0.00		0.20
Bare Soil	0.00		64.64		86.75		59.17		48.00		1.60		1.50

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 16. Percent Cover of Vegetation at Site 16.

Site 16 (Dry Mixed Grass - Sandy soil)
Soil stripping: Full width
Sample area: Travel lane

KP: 299+450 (North slope of South Saskatchewan River)
Seeded fall 1996 (mix #3)
ERS: Thin Breaks

Control (1997-99)2		On RoW (1997)		On RoW (1998)		On RoW (1999)		On RoW (2001)		2010 Range Health: On RoW (2010) 78		2010 Range Health: Control (2010) 69	
Mean % cover[1] 90.5(1.3)		Mean % cover[1] 59.7(0)		Mean % cover[1] 58.5(0)		Mean % cover[1] 62.8(0)		Mean % cover[1] 67.5 (0)		Mean % cover[1] 0.0 (0.0)		Mean % cover[1] 0.0 (0.0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	23.75	AGROTRA	25.00	AGROTRA	31.75	AGROTRA	25.00	STIPVIR	15.40	STIPCOM	24.00	BOUTGRA	24.80
MUHLCUS	11.82	KOCHSCO	9.64	SALSKAL	8.75	ORYZHYM	10.50	AGROTRA	12.10	BOUTGRA	9.70	STIPCOM	11.00
BOUTGRA	10.91	ORYZHYM	6.79	AGRODAS	7.00	AGRODAS	8.00	AGRODAS	10.90	AGROSMI	6.00	AGROSMI	7.40
EUROLAN	9.09	TRITAES	5.36	ORYZHYM	4.75	CALALON	5.50	SALSKAL	8.90	ASTRPEC	2.50	ARTECAN	5.30
AGRODAS	7.50	AGRODAS	4.64	STIPCOM	3.00	SALSKAL	3.75	STIPCOM	8.30	DESCPIN	2.00	CAREFIL	4.50
KOELMAC	7.05	CHENALB	4.64	AGROSMI	1.50	STIPVIR	3.75	ORYZHYM	6.80	OPUNPOL	2.00	CALALON	1.00
CAREFIL	5.45	LAPPOCC	2.14	ECHICRU	0.25	AGROSMI	1.75	AGROSMI	2.10	ARTECAN	1.60	ARTEFRI	0.70
STIPVIR	3.07	ARTEFRI	0.36	KOCHSCO	0.25	ARTEFRI	1.50	ARISLON	1.50	ORYZHYM	1.50	LEPIDEN	0.50
PHLOHOO	2.05	ECHICRU	0.36	SISYALT	0.25	KOELMAC	1.50	LAPPSP	1.20	TRAGDUB	1.00	ORYZHYM	0.50
ARTECAN	1.70	STIPCOM	0.36	TRITAES	0.25	STIPCOM	1.50	FESTOVI	0.30	LEPIDEN	0.50	PLANELO	0.50
OPUNPOL	1.70	STIPVIR	0.36							SPHACOC	0.50	SPHACOC	0.30
ARTEFRI	1.48									DRABNEM	0.40	CHENSP	0.20
AGROSMI	0.91									CALALON	0.30	CARESTE	0.10
SPHACOC	0.80									LIATPUN	0.30	CORYVIV	0.10
ARISLON	0.68									PLANELO	0.30	LAPPOCC	0.10
CALALON	0.68									ROSAARK	0.30		
LIATPUN	0.68									ACHIMIL	0.10		
POASAND	0.68									ARENCON	0.10		
CARESTE	0.23									CHENPRA	0.10		
CHENPRA	0.11									TARAOFF	0.10		
COMAUMB	0.11												
ALLITEX	0.02												

Mean % cover	Control (97-99)	On RoW (1997)	On RoW (1998)	On RoW (1999)	On RoW (2001)	On RoW (2010)	Control (2010)
Litter	59.77	63.60	58.30	54.50	38.20	n/a	n/a
Moss/Licher	1.25	0.00	0.00	0.00	0.00	7.10	4.80
Bare Soil	31.36	26.10	46.50	50.50	45.60	22.00	13.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way prominence values averaged over 3 years, 1997, 1998 and 1999.

Table 19. Percent Cover of Vegetation at Site 19.

Site 19 (Dry Mixed Grass - Solonetzic soil) **KP: 326+600**
Soil stripping: Full width **Not Seeded**
Sample area: Spoil **ERS: Ov**

										2010 Range Health			
										32		42	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 55 (2)		Mean % cover[1] 4 (0)		Mean % cover[1] 28 (0)		Mean % cover[1] 39.4 (0)		Mean % cover[1] 16.5 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
BOUTGRA	14.62	SCHEPAN	0.85	CHENPRA	8.80	KOCHSCO	19.25	SPORCRY	5.70	STIPVIR	15.00	BOUTGRA	25.50
CARESTE	12.82	AMARALB	0.80	KOCHSCO	7.50	HORDJUB	6.50	SCHEPAN	3.90	AGROSMI	11.50	AGROSMI	9.70
KOELMAC	10.68	CHENSP	0.75	CHENALB	4.00	STIPVIR	4.00	AGRODAS	1.60	STIPCOM	9.00	CARESTE	8.10
AGROSMI	6.21	BOUTGRA	0.50	SCHEPAN	3.50	SCHEPAN	3.80	CHENPRA	1.50	CARESTE	4.30	SHEPCAN	3.00
AGRODAS	4.91	CHENALB	0.25	DESCSOP	0.70	AGROSMI	3.50	STIPCOM	1.10	FESTOCT	1.50	FESTOCT	2.80
GAURCOC	1.79	OPUNPOL	0.25	AMARALB	0.50	CHENPRA	0.55	CHENALB	0.60	TRAGDUB	1.40	STIPVIR	2.50
SCHEPAN	1.35	AGRODAS	0.05	POLYARE	0.50	STIPCOM	0.55	STIPVIR	0.60	POASAND	0.80	STIPCOM	1.20
STIPCOM	0.59	STIPCOM	0.05	HELIANN	0.30	LEPIDEN	0.50	HELIANN	0.30	SHEPCAN	0.70	HEDEHIS	0.90
POASAND	0.50			KOELMAC	0.30	KOELMAC	0.25	LAPPOCC	0.30	TARAOFF	0.70	POASAND	0.60
KOCHSCO	0.32			LEPIDEN	0.30	SALSKAL	0.25	AXYRAMA	0.20	AGROTRA	0.50	TARAOFF	0.60
ARTEFRI	0.21			LAPPSP	0.25	DESCSOP	0.10	DESCRIC	0.20	BOUTGRA	0.50	KOELMAC	0.50
LAPPSP	0.18			SPORCRY	0.25	AMARALB	0.05	OPUNPOL	0.20	LACTSER	0.40	SPHACOC	0.40
CHENPRA	0.15			VULPOCT	0.10	CALAMON	0.05	CAREOBT	0.10	SPHACOC	0.40	ATRINUT	0.30
MONONUT	0.15			DRABSP	0.05	LAPPOCC	0.05	HORDJUB	0.10	ANDRSEP	0.20	ALLITEX	0.20
OPUNPOL	0.15			OPUNPOL	0.05			POLYARE	0.10			OPUNPOL	0.20
PETAPUR	0.09			STIPVIR	0.05							PLANPAT	0.20
VULPOCT	0.09											GNAPULI	0.10
CHENALB	0.06												
LEPIDEN	0.06												
AMARSP	0.03												
DESCSOP	0.03												
ERIOFLA	0.03												
GUTISAR	0.03												
PLANPAT	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	8.97		0.00		0.10		2.10		18.40		n/a		n/a
Moss/Lichen	2.00		0.00		0.00		0.00		0.00		0.60		1.30
Bare Soil	45.88		97.50		90.00		53.25		53.20		43.50		15.70

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 20. Percent Cover of Vegetation at Site 20.

Site 20 (Fescue - Mixed Grass transition) **KP: 79+400 (Northern Fescue)**
Soil stripping: Blade width **Seeded fall 1996 (mix #2)**
Sample area: Ditch **ERS: Loamy**

										2010 Range Health			
										68		72	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 62.2(58.9)		Mean % cover[1] 43.2(0)		Mean % cover[1] 60.7(0)		Mean % cover[1] 69.4(0)		Mean % cover[1] 49.2(2.8)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	12.78	AGRODAS	13.93	BOUTGRA	14.80	AGRODAS	20.79	BOUTGRA	18.00	AGROSMI	15.20	AGRODAS	17.10
AGRODAS	11.45	AGROSMI	8.93	AGROSMI	12.25	BOUTGRA	13.14	CARESTE	6.30	STIPVIR	10.10	POAPRAT	12.00
BOUTGRA	10.30	AGROTRA	5.43	AGRODAS	9.25	CAREPEN	12.57	AGRODAS	6.00	AGRODAS	6.20	AGROSMI	3.80
POASAND	7.65	CARESTE	4.29	CARESTE	5.75	AGROSMI	10.71	AGROSMI	5.40	TRAGDUB	4.30	TRAGDUB	2.80
CARESTE	5.78	VICIAME	3.21	SPHACOC	5.00	VICIAME	3.00	STIPCOM	4.20	VICIAME	1.70	STIPVIR	2.10
KOELMAC	5.10	ASTRDAS	2.93	POACUSI	3.65	STIPCOM	2.86	KOELMAC	3.60	TARAOFF	1.50	CALAMON	1.40
AGROSMI	3.43	KOELMAC	2.29	TARAOFF	3.00	POACUSI	2.57	ARTEFRI	3.00	CARESTE	1.40	ARTEFRI	1.10
ARTEFRI	2.45	BOUTGRA	1.21	VICIAME	2.80	KOELMAC	1.21	SPHACOC	2.70	CAREOBT	1.30	CAREOBT	0.90
SPHACOC	1.18	LIATPUN	0.36	STIPCOM	2.00	SPHACOC	0.71			DESCRIC	0.90	TARAOFF	0.80
MUHLRIC	0.75	STIPVIR	0.21	ASTRDAS	0.80	TARAOFF	0.57			FESTHAL	0.70	ACHIMIL	0.60
TARAOFF	0.55	MEDISAT	0.07	KOELMAC	0.65	ASTRDAS	0.50			AGROREP	0.10	VICIAME	0.40
VICIAME	0.20	SPHACOC	0.07	CHENLEP	0.35	GAILARI	0.36					STIPCOM	0.30
CAREPEN	0.18	STIPCOM	0.07	DESCSOP	0.05	ANTESP	0.07					AGOSGLA	0.10
ANTESP	0.13					ARTEFRI	0.07					ANEMMUL	0.10
CALAMON	0.13					CALAMON	0.07						
GAURCOC	0.13					CHENLEP	0.07						
ASTRDAS	0.03					DESCSOP	0.07						
OROBFAS	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	53.50		27.86		13.75		51.43		59.90		n/a		n/a
Moss/Lichen	58.88		0.00		0.00		0.00		2.80		0.00		0.50
Bare Soil	0.45		72.14		45.00		31.07		29.00		3.80		1.50

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 21. Percent Cover of Vegetation at Site 21.

Site 21 (Fescue - Mixed Grass transition) **KP: 351+000 (Foothills Fescue)**
Soil stripping: Full width **Seeded fall 1996 (mix #2)**
Sample area: Spoil **ERS: Loamy**

										2010 Range Health			
										40		70	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 97.4(7.3)		Mean % cover[1] 29.4(0)		Mean % cover[1] 69.3(0)		Mean % cover[1] 102.5(0)		Mean % cover[1] 74.6(0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
FESTHAL	48.25	AGROTRA	13.21	ARTEFRI	17.00	AGROTRA	12.75	ARTEFRI	18.90	ARTEFRI	15.80	FESTHAL	42.50
FESTIDA	14.75	ARTEFRI	4.29	AGROTRA	10.75	ARTEFRI	11.50	AGRODAS	14.90	CARESTE	15.20	FESTIDA	7.20
STIPCUR	5.88	STIPVIR	3.21	STIPVIR	7.00	FESTHAL	11.00	STIPCUR	13.10	AGROSMI	7.30	CAREPEN	3.80
ARTELUD	5.25	ORYZHYM	2.86	KOELMAC	6.75	AGRODAS	10.75	AGROTRA	6.00	AGRODAS	4.50	AGRODAS	2.40
AGRODAS	4.75	CIRSARV	2.14	FESTHAL	6.25	STIPCUR	8.25	GUTISAR	3.30	STIPVIR	3.90	KOELMAC	2.10
CAREOBT	3.13	KOELMAC	1.43	AGRODAS	6.00	POAPRAT	6.75	ARTELUD	3.00	STIPCUR	3.40	CAREOBT	1.70
KOELMAC	2.25	FESTHAL	0.79	STIPCUR	6.00	VICIAME	5.75	FESTHAL	3.00	POAPRAT	3.20	ARTELUD	1.60
ANTEPAR	1.63	VICIAME	0.71	CAREOBT	3.25	KOELMAC	4.75	KOELMAC	1.80	STIPCOM	2.40	AGROSMI	1.20
ARENCON	1.03	AGRODAS	0.36	ORYZHYM	3.00	GUTISAR	3.75	ORYZHYM	1.80	TARAOFF	1.40	DANTUNI	1.20
CAREPEN	1.00	THERRHO	0.36	AGROSCA	1.50	LITHINC	3.75	AGROSMI	1.50	VICIAME	1.40	CERAARV	1.00
DANTUNI	1.00			VICIAME	1.00	THERRHO	3.75	ANTEPAR	1.50	KOELMAC	1.20	STIPCUR	1.00
MUHLRIC	1.00			POASAND	0.25	ARTELUD	3.00	CAREOBT	1.50	SPHACOC	1.20	ANEMPAT	0.90
ACHIMIL	0.88			SOLIMIS	0.25	CARESP	3.00	PHLOHOO	1.50	ANDRSEP	0.90	DANTINT	0.90
ANEMPAT	0.88					POTEPEN	3.00	POTEPEN	1.50	GUTISAR	0.90	SOLIMIS	0.70
ASTEFAL	0.88					STIPVIR	3.00	VICIAME	0.60	FESTHAL	0.80	THERRHO	0.70
VICIAME	0.88					CAREOBT	1.75	CARESTE	0.30	DANTUNI	0.70	ANTEAPR	0.60
DANTINT	0.75					AGROSCA	1.50	POASAND	0.30	POTEPEN	0.70	VICIAME	0.60
MUHLCUS	0.75					DANTUNI	1.50	POLYSP	0.10	THERRHO	0.70	ARENCON	0.40
STIPVIR	0.75					FESTOVI	1.50			ASTRDAS	0.50	POAPRAT	0.40
AGROSMI	0.65					HELIHOO	1.50			CAREPEN	0.20	ASTRDAS	0.10
ARNIFUL	0.25									DRABNEM	0.10		
ARTEFRI	0.25												
CALAMON	0.13												
CERAARV	0.13												
LITHINC	0.13												
SELADEN	0.13												
THERRHO	0.13												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	93.38		1.36		38.25		66.50		43.00		n/a		n/a
Moss/Lichen	7.25		0.00		0.00		0.00		0.00		0.90		2.10
Bare Soil	0.00		97.50		66.75		41.00		28.80		14.00		0.60

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 22. Percent Cover of Vegetation at Site 22.

Site 22 (Fescue - Mixed Grass transition) **KP: 360+000 (Cypress Hills)**
Soil stripping: Blade width **Seeded fall 1996 (mix #2)**
Sample area: Ditch **ERS: Overflow**

										2010 Range Health			
										60		62	
Control (1997-99)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 81.9 (36.8)		Mean % cover[1] 30.2(0)		Mean % cover[1] 50.6(0)		Mean % cover[1] 77.6(0)		Mean % cover[1] 59.7 (0)		Mean % cover[1] 0.0 (0.0)		Mean % cover[1] 0.0 (0.0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
KOELMAC	17.63	GRINSQU	7.50	AGROTRA	10.75	ARTEFRI	23.00	AGRODAS	23.00	AGROSMI	22.00	AGRODAS	5.60
AGRODAS	12.50	AGROTRA	5.71	ARTEFRI	8.25	AGROTRA	12.00	ARTEFRI	14.30	STIPVIR	17.00	CERAARV	4.70
ACHIMIL	11.97	ARTEFRI	4.64	FESTHAL	5.75	AGRODAS	10.50	AGROSMI	5.40	CARESTE	8.30	FESTHAL	4.60
CAREOBT	6.05	AGRODAS	2.86	CHENSAL	5.25	FESTHAL	6.55	STIPVIR	4.80	KOELMAC	6.90	KOELMAC	4.60
POAARID	5.66	ORYZHYM	2.86	KOELMAC	5.25	ATRINUT	6.25	FESTHAL	3.30	STIPCUR	5.00	AGROSMI	4.50
GRINSQU	4.34	STIPVIR	1.50	GRINSQU	4.50	KOELMAC	6.00	POAPRAT	1.80	TARAOFF	4.00	CARESTE	4.50
POAJUNC	4.34	FESTHAL	1.29	POLYARE	4.50	POLYARE	5.25	STIPCUR	1.80	ARTEFRI	3.40	ANTEAPR	3.30
AGROSMI	4.08	KOELMAC	0.86	CAREPEN	2.00	POAPRAT	3.00	AGROTRA	1.50	AGRODAS	2.40	GRINSQU	2.50
GAILARI	2.37	AGROSMI	0.71	STIPCUR	1.50	STIPVIR	3.00	MUHLRIC	1.50	GRINSQU	2.00	ACHIMIL	2.40
POASAND	2.24	CIRSARV	0.71	AGRODAS	0.50	MONONUT	1.50	POAJUNC	1.50	SOLIMIS	1.70	POAARID	2.20
SOLIMIS	1.97	POLYSP	0.71	CAREOBT	0.25	GRINSQU	0.25	GRINSQU	0.30	FESTHAL	1.00	POAPRAT	1.60
ANTEPAR	1.58	CAREOBT	0.36	ERODCIC	0.25	STIPCUR	0.25	KOELMAC	0.30	ANDRSEP	0.80	CAREPEN	1.40
ARTEFRI	1.05	ERODCIC	0.36	HELIHOO	0.25			SPHACOC	0.20	HETEVIL	0.50	SOLIMIS	1.40
ASTRSTR	0.82			LITHINC	0.25					ACHIMIL	0.40	ARTECAN	1.00
ARTELUD	0.79			SOLIMIS	0.25					LACTSER	0.40	SILEDRU	0.30
ASTEFAL	0.79			STIPVIR	0.25					GNAPULI	0.30	VICIAME	0.30
BOUTGRA	0.79			SYMPOCC	0.25					TRAGDUB	0.30	ARTEFRI	0.10
MUHLRIC	0.79									ERYSINC	0.20	DANTUNI	0.10
POTEANS	0.79									MUHLRIC	0.20	STIPCOM	0.10
STIPVIR	0.79									POLYARE	0.10	TARAOFF	0.10
ARTECAN	0.13												
CALAMON	0.13												
CERAARV	0.13												
POTEPEN	0.13												
LITHINC	0.03												

Mean %	**Control**	**On RoW (1997)**	**On RoW (1998)**	**On RoW (1999)**	**On RoW (2001)**	**On RoW (2010)**	**Control (2010)**
Litter	53.03	48.20	28.50	57.30	38.40	n/a	n/a
Moss/Licher	27.11	0.00	0.00	0.00	0.00	0.20	26.10
Bare Soil	26.32	58.90	69.30	45.30	48.10	2.80	2.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way prominence values averaged over 3 years, 1997, 1998 and 1999.

Table 23. Percent Cover of Vegetation at Site 23.

Site 23 (Fescue - Mixed Grass transition) **KP: (365+000) (Cypress Hills)**
Soil stripping: Full width **Seeded fall 1996 (mix #2)**
Sample area: Ditch **ERS: Loamy/Li**

										2010 Range Health			
										43		47	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 57 (67)		Mean % cover[1] 6 (0)		Mean % cover[1] 49 (6)		Mean % cover[1] 47 (0)		Mean % cover[1] 69 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCUR	14.40	SALSKAL	5.00	ARTEFRI	13.05	AGROTRA	11.79	STIPVIR	18.20	STIPCOM	10.60	STIPCUR	8.50
FESTHAL	8.40	AGROTRA	0.43	FESTHAL	5.55	AGRODAS	8.00	FESTHAL	14.60	ARTEFRI	7.80	THERRHO	6.20
CARESTE	4.35	AMARRET	0.36	SALSKAL	5.55	FESTHAL	5.71	AGRODAS	8.70	FESTHAL	6.10	ARTEFRI	4.80
KOELMAC	4.05	KOELMAC	0.21	STIPVIR	5.25	HORDJUB	5.57	AGROTRA	7.90	AGROSMI	5.40	FESTHAL	4.70
PHLOHOO	3.15	ARTEFRI	0.14	AGROTRA	4.55	AGROSMI	5.00	AGROSMI	6.90	AGROPEC	3.50	HETEVIL	2.90
THERRHO	2.50	CARESTE	0.14	GRINSQU	3.75	KOELMAC	4.64	GUTISAR	3.80	AGRODAS	3.20	FESTIDA	2.50
HETEVIL	2.20	FESTHAL	0.14	AGROSMI	1.75	GUTISAR	2.14	KOELMAC	3.60	GUTISAR	2.50	ARENCON	2.30
ARTEFRI	2.00	AGRODAS	0.07	ORYZHYM	1.75	STIPVIR	1.07	ARTEFRI	2.50	TARAOFF	2.50	KOELMAC	1.80
ANTEAPR	1.88	CHENALB	0.07	POAJUNC	1.55	DESCSOP	0.86	STIPCUR	2.10	KOELMAC	1.60	PHLOHOO	1.80
CALAMON	1.75	STIPVIR	0.07	AMARRET	1.50	ARTEFRI	0.43	BOUTGRA	0.30	CARESTE	1.50	CARESTE	1.10
ANTEPAR	1.65			CHENALB	1.50	CARESTE	0.43	GRINSQU	0.30	ANDRSEP	1.00	AGRODAS	1.00
ERIGPUM	1.65			HORDJUB	1.50	ORYZHYM	0.36	POAJUNC	0.30	ARENCON	1.00	ASTRMIS	1.00
BOUTGRA	1.60			AGRODAS	0.25	STIPCUR	0.36			ASTEFAL	1.00	COMAUMB	1.00
AGRODAS	1.48			HELIHOO	0.25	POLYARE	0.14			CAREOBT	1.00	ERIGCAE	1.00
COMAUMB	0.93			KOELMAC	0.25	ASTEFAL	0.07			STIPCUR	1.00	POACUSI	0.50
POASAND	0.78			SETAVIR	0.15					ASTRSP	0.80	SOLIMIS	0.50
ANEMPAT	0.75			EUPHSP	0.10					THERRHO	0.60	CAREPEN	0.30
CAREFIL	0.75			CARESTE	0.05					CAREFIL	0.50	BOUTGRA	0.20
CAREPEN	0.75			GUTISAR	0.05					GRINSQU	0.30	CAREOBT	0.20
POACUSI	0.63									ACHIMIL	0.20	STIPCOM	0.10
ARABHOL	0.33									FESTOVI	0.20	TARAOFF	0.10
ARENCON	0.20									ANTEPAR	0.10		
ASTRDAS	0.15												
ASTEFAL	0.13												
GAILARI	0.13												
GEUMTRI	0.13												
POAJUNC	0.13												
SOLIMIS	0.03												
SPHACOC	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	29.38		24.64		7.50		31.07		62.10		n/a		n/a
Moss/Lichen	66.73		0.00		6.25		0.00		0.00		2.30		6.60
Bare Soil	1.85		78.57		47.75		48.21		13.70		6.80		3.50

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 24. Percent Cover of Vegetation at Site 24.

	Site 24 (Fescue - Mixed Grass transition)	**KP: 370+000 (Mixed Grass - Cypress Hills)**
	Soil stripping: Blade width	**Seeded fall 1996 (#2)**
	Sample area: Ditch in 2010	**ERS: Loamy**

2010 Range Health	
84	n/a

Control (1997-1999)2		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1]		Mean % cover[1]		Mean % cover[1]	
Species	**% Prom.**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCUR	44.00	FESTHAL	15.00	N/A	
CARESTE	3.98	AGROSMI	4.10		
KOELMAC	1.65	AGRODAS	3.20		
AGRODAS	1.63	STIPVIR	3.00		
ERIGCAE	1.15	VICIAME	2.30		
VICIAME	0.45	ARTEFRI	2.10		
PHLOHOO	0.40	AGOSGLA	0.70		
CALAMON	0.18	ARTECAN	0.70		
ACHIMIL	0.15	STIPCUR	0.70		
FESTHAL	0.15	KOELMAC	0.50		
GAURCOC	0.15	CARESTE	0.40		
POASAND	0.15	TARAOFF	0.40		
ARTEFRI	0.13	CAMPROT	0.30		
CAREFIL	0.13	ACHIMIL	0.20		
HAPLSPI	0.13				
HELIHOO	0.13				
SPHACOC	0.13				
ANTEAPR	0.03				
Litter	46.88		n/a		n/a
Moss/Lichen	65.50		0.00		
Bare Soil	0.00		3.90		

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.

[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 25. Percent Cover of Vegetation at Site 25.

Site 25 (Fescue - Mixed Grass transition) **KP: 375+000 (Cypress Hills)**
Soil stripping: Double blade width **Seeed fall 1996 (mix #2)**
Sample area: Ditch **ERS: Loamy**

										2010 Range Health			
										67		88	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 66.8(47.9)		Mean % cover[1] 11.3(0.1)		Mean % cover[1] 29.8(0.2)		Mean % cover[1] 24.4(0)		Mean % cover[1] 22.9 (1.7)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCUR	39.56	CHENSP	5.71	AGROTRA	11.00	STIPCOM	10.69	AGRODAS	9.90	FESTHAL	20.50	STIPCUR	27.30
AGRODAS	5.82	AMARALB	2.14	ARTEFRI	4.55	STIPVIR	3.75	STIPCUR	4.30	AGRODAS	8.90	FESTHAL	10.00
BOUTGRA	3.82	FESTHAL	1.29	STIPCUR	4.25	STIPCUR	2.94	AGROTRA	3.30	TARAOFF	8.60	GEUMTRI	5.50
FESTHAL	2.97	VICIAME	0.50	FESTHAL	3.00	ARTELUD	2.19	FESTHAL	1.40	KOELMAC	7.80	VICIAME	5.50
STIPCOM	2.21	KOELMAC	0.43	ORYZHYM	1.80	ARTEFRI	1.38	ARTEFRI	1.30	AGROSMI	6.60	AGRODAS	5.20
CAREPEN	2.06	ORYZHYM	0.43	STIPVIR	1.75	FESTHAL	1.25	FESTIDA	0.90	STIPCUR	4.00	ARTECAN	3.00
CARESP	1.94	STIPVIR	0.36	KOELMAC	0.80	VICIAME	0.44	STIPVIR	0.60	ARTECAN	3.90	KOELMAC	2.50
KOELMAC	1.88	ARTEFRI	0.21	VICIAME	0.50	ORYZHYM	0.38	KOELMAC	0.50	ACHIMIL	2.10	CARESTE	2.20
ARTEFRI	1.53	ACHIMIL	0.07	AMARALB	0.45	GUTISAR	0.31	VICIAME	0.30	ANTEAPR	2.10	TARAOFF	2.10
ACHIMIL	1.41	AGRODAS	0.07	AGRODAS	0.25	POAJUNC	0.31	CARESTE	0.20	STIPVIR	1.70	ARNIFUL	2.00
POACUSI	1.24	SETAVIR	0.07	BOUTGRA	0.25	POLYARE	0.31	AGROSCA	0.10	GEUMTRI	1.00	ARTEFRI	2.00
PHLOHOO	0.97			CAREPEN	0.25	AGROTRA	0.13	AGROSMI	0.10	CARESTE	0.80	ACHIMIL	1.70
VICIAME	0.91			HELIHOO	0.25	CHENSP	0.13			VICIAME	0.70	AGROSMI	1.10
ARNISOR	0.15			TARAOFF	0.25	FESTOVI	0.13			ARTEFRI	0.60	STIPVIR	1.00
ERIGCAE	0.15					AGRODAS	0.06			TRAGDUB	0.60	ASTRDAS	0.90
GAURCOC	0.09					KOELMAC	0.06			MUHLRIC	0.50	CAREOBT	0.90
ANTEAPR	0.03									ANDRSEP	0.40	PHLOHOO	0.90
CALAMON	0.03									ARNIFUL	0.40	ANTEAPR	0.50
GEUMTRI	0.03											ARENCON	0.50
POASAND	0.03											ERIGCOM	0.50
												SPHACOC	0.50
												GAILARI	0.40
												CERAARV	0.20
												LOMAMAC	0.10

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	56.91		41.79		16.50		8.75		50.10		n/a		n/a
Moss/Lichen	47.94		0.14		0.10		0.00		1.70		0.50		3.80
Bare Soil	0.03		66.79		57.75		41.25		13.60		8.00		2.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 26. Percent Cover of Vegetation at Site 26.

Site 26 (Fescue - Mixed Grass transition) **KP: 379+550 (Foothills Fescue)**
Soil stripping: Double blade width **Seeded fall 1996 (mix #2)**
Sample area: Spoil **ERS: Li-BIO**

										2010 Range Health			
										n/a		87	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 101.6(6.4)		Mean % cover[1] 43.5(0.3)		Mean % cover[1] 70.6(0)		Mean % cover[1] 103.8(0)		Mean % cover[1] 92.5(0.3)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
FESTHAL	63.63	FESTHAL	17.14	FESTHAL	25.00	FESTHAL	54.50	FESTHAL	50.00	FESTHAL	12.00	FESTHAL	40.50
STIPCUR	6.00	CAREOBT	10.71	CAREPEN	15.75	AGRODAS	9.00	AGROSMI	8.30	OXYTDEF	8.30	DANTINT	8.00
CAREOBT	4.55	AGROSMI	9.64	AGRODAS	9.00	KOELMAC	6.00	CAREPEN	8.10	AGROSMI	6.50	CAREPEN	2.90
CAREPEN	3.50	ARTELUD	2.14	KOELMAC	7.75	CAREPEN	5.00	STIPCUR	4.80	TARAOFF	5.90	ARNIFUL	1.30
AGRODAS	3.38	CAREPEN	2.14	AGROSMI	6.75	CAREOBT	4.75	AGRODAS	4.20	THERRHO	4.00	ARTELUD	0.60
GEUMTRI	3.13	AGRODAS	1.07	ARTELUD	3.75	STIPCUR	4.50	CAREOBT	2.40	ACHIMIL	3.70	ANTEPAR	0.40
PHLOHOO	2.63	ACHIMIL	0.36	CAREOBT	1.25	ARNIFUL	3.75	ARTELUD	1.80	STIPCUR	3.00	VICIAME	0.30
KOELMAC	2.50	VICIAME	0.36	VICIAME	0.50	ARTELUD	3.75	ANEMPAT	1.50	ANTEPAR	2.20	AGRODAS	0.20
ACHIMIL	2.38			ACHIMIL	0.25	AGROSMI	3.50	ANTEPAR	1.50	ARTELUD	2.20	CARESTE	0.20
ANEMPAT	2.38			ARTEFRI	0.25	ACHIMIL	2.50	DANTINT	1.50	AGRODAS	1.90	HELIHOO	0.20
VICIAME	2.00					ARENCON	1.50	GALIBOR	1.50	KOELMAC	1.50	STIPCUR	0.20
ARTEFRI	1.88					POACUSI	1.50	POTEGRA	1.50	VICIAME	1.10	TARAOFF	0.20
CALAMON	1.75					VICIAME	1.25	STIPVIR	1.50	CAREPEN	1.00	ACHIMIL	0.10
POACANB	0.75					CALAMON	0.50	VICIAME	1.20	STIPVIR	1.00	ANEMPAT	0.10
CERAARV	0.50					TARAOFF	0.50	ACHIMIL	0.90	FESTIDA	0.90	ASTRDAS	0.10
AGROSMI	0.13					ANDRSEP	0.25	CALAMON	0.60	ANDRSEP	0.70	CAREOBT	0.10
ANTEPAR	0.13					ARTEFRI	0.25	ARENCON	0.30	CARESTE	0.70	DRABNEM	0.10
OXYTMON	0.13					PHLOHOO	0.25	ARNIFUL	0.30	DANTINT	0.50	KOELMAC	0.10
POTEGRA	0.13					TOWNPAR	0.25	OXYTMON	0.30	GRINSQU	0.30		
POTEPEN	0.13					ZIGAVEN	0.25	POACUSI	0.30	ARTEFRI	0.10		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	95.00		21.07		52.50		72.25		73.10		n/a		n/a
Moss/Lichen	6.38		0.36		0.00		0.00		0.30		4.20		0.30
Bare Soil	0.13		68.93		55.00		27.75		15.30		68.60		0.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 27. Percent Cover of Vegetation at Site 27.

Site 27 (Dry Mixed Grass - Solonetzic soil) **KP: 390+200**
Soil stripping: Double blade width **Seeded fall 1996 (mix #4)**
Sample area: Spoil **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										n/a		n/a	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 34 (82)		Mean % cover[1] 27 (0)		Mean % cover[1] 31 (0)		Mean % cover[1] 37.1 (0)		Mean % cover[1] 65.9 (7.7)		No Data		No Data	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
ARTEFRI	8.75	KOELMAC	7.86	KOELMAC	11.75	ARTEFRI	7.86	PHLOHOO	18.40				
KOELMAC	5.43	ARTEFRI	3.64	ARTEFRI	5.80	CALAMON	7.00	STIPCOM	13.80				
PHLOHOO	3.60	BOUTGRA	2.86	SPHACOC	2.70	KOELMAC	6.50	ARTEFRI	10.40				
STIPCOM	3.30	CALAMON	2.57	CARESTE	2.25	CARESTE	5.07	SPHACOC	6.30				
ANTEPAR	3.18	STIPCOM	2.50	CALAMON	2.05	AGRODAS	3.14	AGRODAS	3.40				
CALAMON	3.00	ERIGCAE	2.14	PHLOHOO	1.65	STIPCOM	3.00	KOELMAC	3.30				
CARESTE	2.43	CARESTE	1.93	STIPCOM	1.65	FESTOVI	2.21	CALAMON	2.70				
BOUTGRA	1.60	AGRODAS	1.21	AGRODAS	0.80	PHLOHOO	1.21	ANTEPAR	2.10				
AGRODAS	1.03	SPHACOC	1.21	ANTESP	0.80	SPHACOC	0.57	BOUTGRA	2.10				
HETEVIL	0.88	POTEPEN	0.43	AGROSMI	0.55	STIPVIR	0.36	CARESTE	2.10				
SPHACOC	0.65	PHLOHOO	0.21	BOUTGRA	0.30	ANTESP	0.07	POASAND	0.60				
POASAND	0.15	ANTESP	0.14	POTEPEN	0.25	POAJUNC	0.07	GAURCOC	0.40				
CAREPEN	0.13	AGROSMI	0.07	AGROTRA	0.15			GEUMTRI	0.30				
POTEPEN	0.08	GRINSQU	0.07										
AGROSMI	0.03	POAJUNC	0.07										
GRINSQU	0.03												
POTEGRA	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	31.75		38.21		7.10		16.43		38.60		n/a		n/a
Moss/Lichen	81.88		0.00		0.00		0.00		7.70				
Bare Soil	0.00		65.00		55.75		55.00		39.50				

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 28. Percent Cover of Vegetation at Site 28.

Site 28 (Dry Mixed Grass - Solonetzic soil) **KP: 394 + 300**
Soil stripping: Double blade width **Seeded fall 1996 (mix #4)**
Sample area: Travel lane **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										72		75	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 31 (89)		Mean % cover[1] 63 (0)		Mean % cover[1] 44 (9)		Mean % cover[1] 49.4 (0)		Mean % cover[1] 74.7 (0.1)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
KOELMAC	4.65	AGROTRA	19.64	FESTOVI	7.59	FESTOVI	18.21	FESTOVI	31.10	FESTOVI	15.30	STIPCOM	5.00
STIPCUR	4.18	ANEMPAT	11.07	AGRODAS	7.50	AGRODAS	13.21	ARTEFRI	9.00	BOUTGRA	6.70	AGROSMI	4.10
ERIGPUM	3.13	AGROSMI	9.64	ARTEFRI	7.50	ARTEFRI	9.29	STIPCOM	8.70	STIPCOM	5.40	KOELMAC	3.70
ANTEPAR	2.93	KOELMAC	7.86	AGROSMI	5.05	STIPVIR	5.36	STIPVIR	8.70	AGRODAS	4.70	CALAMON	3.00
AGRODAS	2.93	ARTEFRI	5.07	PLANPAT	4.18	PLANPAT	2.36	AGRODAS	7.10	AGROSMI	2.70	CARESTE	2.90
ARENCON	2.35	POAJUNC	5.00	STIPVIR	3.64	AGROTRA	0.50	AGROSMI	3.90	KOELMAC	2.20	PHLOHOO	2.10
STIPCOM	2.25	AGRODAS	1.86	AGROTRA	3.18	AGROSMI	0.21	BOUTGRA	1.80	SPHACOC	2.10	STELSP	1.90
CALAMON	2.10	LAPPOCC	1.14	AGROALB	1.59	POAJUNC	0.14	ANTEPAR	1.50	ARTEFRI	1.70	SPHACOC	1.40
BOUTGRA	2.03	STIPVIR	0.71	GRINSQU	1.36	AGROSUB	0.07	POASAND	1.50	PHLOHOO	1.60	ANTEPAR	1.10
ARTEFRI	1.40	POLYARE	0.36	LAPPOCC	0.77	VICIAME	0.07	AGROTRA	1.00	ASTEERI	0.90	GRINSQU	0.80
CARESTE	0.95	CARESTE	0.07	CALAMON	0.50			KOELMAC	0.30	CALAMON	0.90	BOUTGRA	0.60
HYMERIC	0.75	LITHINC	0.07	CARESTE	0.45			AGROREP	0.10	CARESTE	0.70	VICIAME	0.60
PHLOHOO	0.48			KOELMAC	0.36					ERIGCAE	0.70	AGRODAS	0.50
SPHACOC	0.30			STIPCOM	0.27					PLANSP	0.30	ARTEFRI	0.20
POACANB	0.25			POAJUNC	0.23					VICIAME	0.30	TARAOFF	0.10
POAJUNC	0.13			POLYARE	0.09					ANTEPAR	0.20		
VICIAME	0.13												
AGROSMI	0.05												
ACHIMIL	0.03												
LOMAMAC	0.03												
POACUSI	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	33.13		11.07		2.50		21.43		48.00		n/a		n/a
Moss/Lichen	89.00		0.00		7.73		0.00		0.10		2.60		8.90
Bare Soil	1.88		75.36		52.32		52.14		43.20		11.70		2.20

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 29. Percent Cover of Vegetation at Site 29.

Site 29 (Dry Mixed Grass - Solonetzic soil) **KP: 400+000**
Soil stripping: Double blade width **Seeded fall 1996 (mix #4)**
Sample area: Ditch **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										66		84	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 76.7 (46.1)		Mean % cover[1] 16 (0)		Mean % cover[1] 53 (0)		Mean % cover[1] 46.1 (0)		Mean % cover[1] 40.7 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
AGRODAS	18.88	AGROTRA	5.79	ARTEFRI	13.50	AGRODAS	19.50	AGRODAS	23.00	FESTOVI	9.90	AGRODAS	12.60
BOUTGRA	9.63	STIPVIR	3.57	AGROTRA	7.75	AGROTRA	9.25	ARTEFRI	3.90	AGROSMI	4.40	STIPCOM	5.50
STIPCOM	8.75	FESTOVI	1.86	CHENPRA	6.00	STIPVIR	6.00	FESTOVI	3.60	GUTISAR	3.60	BOUTGRA	2.70
KOELMAC	7.50	AGRODAS	1.79	AGRODAS	5.25	ARTEFRI	3.25	STIPVIR	3.30	ARTEFRI	3.30	ARTECAN	2.50
ARTEFRI	7.25	POAJUNC	0.79	FESTOVI	5.00	AGROSMI	3.00	AGROSMI	2.10	AGRODAS	2.30	THERRHO	1.50
STIPVIR	5.00	KOELMAC	0.64	STIPVIR	4.75	FESTOVI	2.00	CHRYNAU	1.50	STIPVIR	2.20	KOELMAC	1.30
HETEVIL	3.13	ARTEFRI	0.36	KOELMAC	4.25	THERRHO	1.50	GAURCOC	1.50	ARTECAN	1.80	OPUNPOL	0.90
PHLOHOO	3.13	CHENALB	0.36	AGROSMI	3.00	POLYARE	0.50	SYMPOCC	1.50	LIATPUN	0.80	ARTEFRI	0.80
POAJUNC	2.25	STIPCOM	0.36	THERRHO	1.50	CHENPRA	0.25	POAJUNC	0.30	KOELMAC	0.70	CARESTE	0.80
THERRHO	1.63			POAJUNC	0.75	POAJUNC	0.25			THERRHO	0.60	SPHACOC	0.70
SARCVER	1.50			POLYARE	0.25	SPHACOC	0.25			PHLOHOO	0.50	PHLOHOO	0.60
CARESTE	0.93			STIPCOM	0.25	STIPCOM	0.25			GRINSQU	0.30	HETEVIL	0.40
ANTEPAR	0.88					ALLITEX	0.05			SPHACOC	0.30	CHRYNAU	0.30
POTEPEN	0.88									CHRYNAU	0.20	POASAND	0.30
PLANSP	0.78									STIPCOM	0.20	STIPVIR	0.30
ARTECAN	0.75											PLANPAT	0.10
ATRINUT	0.75												
CHRYNAU	0.75												
GEUMTRI	0.75												
POACANB	0.75												
POASAND	0.38												
ACHIMIL	0.13												
AGROSMI	0.13												
ASTEFAL	0.13												
CALAMON	0.13												

Mean %	**Control (97-**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	60.38		0.79		38.25		36.00		33.70		n/a		n/a
Moss/Lichen	41.50		0.00		0.00		0.00		0.00		0.60		6.30
Bare Soil	16.50		97.50		64.25		66.50		48.10		28.00		5.90

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 30. Percent Cover of Vegetation at Site 30.

Site 30 (Dry Mixed Grass - Solonetzic soil) **KP: 403+500 (North of Sage Creek)**
Soil stripping: Blade width **Not seeded - Range Exclosure Site**
Sample area: Ditch **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										69		85	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 41 (52)		Mean % cover[1] 17 (0.1)		Mean % cover[1] 42 (0)		Mean % cover[1] 27.8 (0.05)		Mean % cover[1] 21.1 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
ARTEFRI	11.28	POLYSP	9.25	POLYSP	21.05	ARTEFRI	11.85	POLYARE	6.90	AGROSMI	16.20	AGROSMI	6.10
AGRODAS	7.13	ATRINUT	5.75	ARTEFRI	17.00	POLYARE	4.50	ATRINUT	6.30	ARTEFRI	13.70	AGRODAS	5.40
STIPCOM	7.00	ARTEFRI	0.55	ATRINUT	3.30	KOCHSCO	3.75	POACANB	4.00	AGRODAS	7.30	KOELMAC	3.70
BOUTGRA	5.18	ARTECAM	0.25	KOELMAC	0.25	STIPCOM	3.75	POASAND	0.90	GUTISAR	3.00	STIPCOM	3.00
KOELMAC	4.88	STIPCOM	0.25	CHENSP	0.10	CHENSAL	1.50	ARTEFRI	0.70	ATRINUT	2.50	SPHACOC	2.00
CARESTE	1.75	LEPISP	0.05	AGRODAS	0.05	AGRODAS	0.75	CHENSAL	0.50	POASAND	1.60	POAARID	1.60
AGROSMI	0.78	PLANELO	0.05	LAPPOCC	0.05	ATRINUT	0.30	KOELMAC	0.40	KOELMAC	1.20	ARTEFRI	1.50
GUTISAR	0.75	PLANPAT	0.05	MELIOFF	0.05	KOELMAC	0.30	PHLOHOO	0.40	PHLOHOO	0.60	BOUTGRA	1.20
PHLOHOO	0.58	TRIFREP	0.05	STIPCOM	0.05	AGROSCA	0.25	AGRODAS	0.30	VICIAME	0.60	CARESP	1.20
POASAND	0.43					AGROTRA	0.25	CHENPRA	0.20	CARESTE	0.50	ANTEPAR	1.00
GAURCOC	0.38					POAJUNC	0.25	PLANPAT	0.20	TARAOFF	0.50	ARTECAN	0.50
AGROTRA	0.25					PLANPAT	0.10	AGROTRA	0.10	AGROTRA	0.30	PLANPAT	0.30
ANTEPAR	0.15					AGROSMI	0.05	CARESTE	0.10	POACANB	0.20	PHLOHOO	0.10
PLANPAT	0.15					ALOPCAR	0.05	PLANELO	0.10	ACHIMIL	0.10		
ARTECAN	0.03					CARESTE	0.05			PLANPAT	0.10		
ATRINUT	0.03					PLANELO	0.05						
CERANUT	0.03					TRIFREP	0.05						
OPUNPOL	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	27.00		0.50		1.15		5.20		9.90		n/a		n/a
Moss/Lichen	52.14		0.40		0.00		0.05		0.00		0.20		3.30
Bare Soil	2.80		94.00		74.75		71.25		71.40		18.10		1.80

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 33. Percent Cover of Vegetation at Site 33.

Site 33 (Dry Mixed Grass - Solonetzic soil) **KP: 419+350**
Soil Stripping: Full width **Seeded fall 1996 (mix #4)**
Sample area: Travel lane **ERS: Ov**

										2010 Range Health			
										53		50	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 74 (9)		Mean % cover[1] 14 (0)		Mean % cover[1] 61 (0)		Mean % cover[1] 67.8 (0)		Mean % cover[1] 38.1 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
AGRODAS	11.00	CHENALB	5.36	CHENALB	26.00	DESCSOP	26.25	AGRODAS	13.60	AGROPEC	43.50	AGROPEC	13.80
BOUTGRA	10.50	AGROTRA	4.29	MONONUT	10.75	MONONUT	10.50	CHENALB	6.30	BOUTGRA	6.00	ARTEFRI	11.60
KOELMAC	10.25	AGRODAS	2.14	POLYARE	7.75	AGRODAS	8.25	ASTRBIS	5.30	EUROLAN	3.50	ARTECAN	5.80
ARTEFRI	8.88	STIPVIR	2.14	AGROTRA	6.00	STIPVIR	6.00	STIPVIR	4.50	ARTEFRI	3.10	EUROLAN	5.20
GUTISAR	5.38			DESCSOP	6.00	ASTRBIS	4.50	POLYARE	2.70	AGROSMI	2.30	BOUTGRA	5.00
ATRINUT	5.00			STIPVIR	3.00	POLYARE	4.50	CHRYNAU	1.50	POASAND	2.20	CARESP	4.40
STIPCOM	4.63			ASTRBIS	1.50	AGROSMI	4.00	POAJUNC	1.50	ARTECAN	1.60	POASAND	2.80
ARTECAM	3.88					POAJUNC	1.50	STIPCUR	1.50	SPHACOC	1.30	STIPCOM	2.80
OPUNPOL	2.25					STIPCOM	1.50	AGROSMI	0.60	OPUNPOL	1.00	AGROSMI	2.60
POASAND	2.25					CHENALB	0.30	LAPPSQU	0.60	CARESP	0.90	AGRODAS	0.90
COMAUMB	1.88					KOELMAC	0.25			STIPCOM	0.40	SPHACOC	0.80
CHRYNAU	1.50					LAPPOCC	0.25			CHENSP	0.10	VIOLCAN	0.40
PHLOHOO	1.50									LAPPOCC	0.10	ATRISP	0.30
SPHACOC	1.25									PLANPAT	0.10	KOELMAC	0.30
CARESTE	0.80											STIPVIR	0.20
CORYVIV	0.75												
ERIGSP	0.75												
STIPVIR	0.75												
ASTRSTR	0.25												
VICIAME	0.25												
AGROSMI	0.13												
CALAMON	0.13												
DISTSTR	0.13												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	54.88		0.36		57.25		38.50		24.20		n/a		n/a
Moss/Lichen	9.13		0.00		0.00		0.00		0.00		3.20		15.40
Bare Soil	35.88		97.50		45.00		59.50		64.30		3.90		16.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 34. Percent Cover of Vegetation at Site 34.

Site 34 (Dry Mixed Grass - Solonetzic soil) **KP: 425+000**
Soil stripping: Double blade width **Seeded fall 1996 (mix #4)**
Sample area: Travel lane **ERS: Blowouts/Solonetzic**

										2010 Range Health			
										41		59	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 54 (27)		Mean % cover[1] 24 (0)		Mean % cover[1] 39 (0)		Mean % cover[1] 30.4 (0.15)		Mean % cover[1] 16.3 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	28.75	ARTEFRI	7.21	ARTEFRI	22.75	ARTEFRI	20.00	STIPCOM	5.70	FESTOVI	7.90	BOUTGRA	8.50
BOUTGRA	14.88	SOLASP	5.36	STIPCOM	7.50	STIPCOM	3.50	AGRODAS	4.30	AGROSMI	5.30	STIPCOM	4.90
CARESTE	5.18	AGRODAS	3.57	STIPVIR	4.75	STIPVIR	1.55	ARTEFRI	2.90	ARTEFRI	3.10	ARTEFRI	3.90
KOELMAC	2.28	STIPCOM	3.29	AGRODAS	1.50	FESTOVI	1.30	AGROSMI	1.50	AGRODAS	2.20	ARTECAN	2.20
PHLOHOO	1.08	KOELMAC	1.21	FESTOVI	0.55	AGRODAS	1.25	STIPVIR	0.60	STIPCOM	1.50	SPHACOC	1.40
AGRODAS	0.30	PLANPAT	1.21	GAURCOC	0.35	AGROTRA	1.00	BOUTGRA	0.50	STIPVIR	1.20	AGROSMI	1.30
ARTECAM	0.28	STIPVIR	0.79	AGROSMI	0.30	POAJUNC	0.50	KOELMAC	0.20	ARTECAN	0.70	CAREOBT	1.20
GAURCOC	0.23	AGROTRA	0.71	AGROALB	0.25	KOELMAC	0.40	SPHACOC	0.20	TARAOFF	0.40	CARESTE	1.20
ARTEFRI	0.20	FESTOVI	0.14	POAJUNC	0.25	PLANPAT	0.40	CALAMON	0.10	CAREOBT	0.30	CALAMON	0.90
PLANPAT	0.15	POAJUNC	0.14	KOELMAC	0.15	CARESTE	0.30	CARESTE	0.10	BROMINE	0.20	AGRODAS	0.60
POASAND	0.13	BOUTGRA	0.07	CHENPRA	0.10	AGROSMI	0.15	FESTOVI	0.10	MELISP	0.20	POASAND	0.50
ASTRGIL	0.03	LAPPSP	0.07	AGROTRA	0.05	SOLIMIS	0.05	GRINSQU	0.10	SPHACOC	0.20	ASTRPEC	0.30
HETEVIL	0.03			BOUTGRA	0.05							PHLOHOO	0.20
TARAOFF	0.03			CARESTE	0.05							KOELMAC	0.10
				PLANPAT	0.05								

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	52.88		1.00		1.70		11.00		8.70		n/a		n/a
Moss/Lichen	27.25		0.14		0.00		0.15		0.00		1.10		3.80
Bare Soil	0.48		92.50		68.75		51.75		46.40		58.70		2.50

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 35. Percent Cover of Vegetation at Site 35.

Site 35 (Dry Mixed Grass - Sandy soil) **KP: 429+800 (Onefour)**
Soil stripping: Full width **Seeded fall 1996 (mix #3)**
Sample area: Ditch **ERS: Loamy**

										2010 Range Health			
										40		82	
Control (1997-1999)2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 46 (72)		Mean % cover[1] 16.3(0)		Mean % cover[1] 42.7(0.7)		Mean % cover[1] 32.1(0)		Mean % cover[1] 41.1(0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
BOUTGRA	19.90	AGROTRA	8.75	ARTEFRI	9.00	STIPVIR	8.75	FESTOVI	13.80	ARTEFRI	17.00	STIPCOM	11.70
STIPCOM	12.75	ARTEFRI	3.17	AGROTRA	8.50	STIPCOM	8.19	ARTEFRI	12.10	STIPCOM	16.10	CARESP	9.40
ARTECAM	3.50	FESTOVI	1.50	STIPCOM	7.00	ARTEFRI	6.88	STIPCOM	9.80	AGROSMI	3.80	AGROSMI	6.90
ARTEFRI	1.63	AGRODAS	0.83	FESTOVI	4.60	FESTOVI	5.38	BOUTGRA	2.40	POASAND	1.90	AGRODAS	6.30
KOELMAC	1.63	STIPCOM	0.58	AGROSMI	4.05	KOELMAC	1.44	AGRODAS	2.10	PLANPAT	0.80	KOELMAC	5.80
CARESTE	1.40	KOCHSCO	0.42	STIPVIR	3.05	AGRODAS	0.50	STIPVIR	0.60	FESTOVI	0.50	ANTEPAR	3.40
AGROTRA	1.00	POACOMP	0.33	AGRODAS	1.85	AGROSMI	0.44	CALAMON	0.30	LAPPOCC	0.40	BOUTGRA	2.40
ANTESP	0.93	KOELMAC	0.17	KOCHSCO	1.85	CALALON	0.19			SPORCRY	0.40	ARTEFRI	2.10
ERIGPUM	0.75	STIPVIR	0.17	KOELMAC	1.25	AGROTRA	0.13			KOELMAC	0.20	PHLOHOO	1.90
AGRODAS	0.30	AGROSMI	0.08	CALALON	0.80	CHENALB	0.06			LEPIDEN	0.20	POASAND	1.00
CALAMON	0.30			POACOMP	0.30	HYMERIC	0.06			CHENFRE	0.10	SPHACOC	1.00
ARTELUD	0.25			CHENALB	0.20	LYGOJUN	0.06			SPHACOC	0.10	ASTEFAL	0.80
VICIAME	0.20											ATRINUT	0.40
ACHIMIL	0.13											TARAOFF	0.30
ANDRSEP	0.13												
HETEVIL	0.13												
PENSALB	0.13												
TARAOFF	0.13												
PLANPAT	0.10												
AGROSMI	0.08												
PHLOHOO	0.08												
POASAND	0.05												
SPHACOC	0.05												
POAJUNC	0.03												
POTEHIP	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	51.13		40.00		33.25		30.31		48.00		n/a		n/a
Moss/Lichen	71.75		0.00		0.45		0.00		0.00		0.40		30.00
Bare Soil	0.30		65.83		33.00		25.94		50.20		40.50		9.20

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 37. Percent Cover of Vegetation at Site 40.

Site 40 (Dry Mixed Grass - Sandy soil) **KP: 112 - 114 (Hemaruka Dunes)**
Soil stripping: Blade width **Reclamation Date: 01/11/1996**
Sample area: Stripped RoW **ERS: Sand**

						2010 Range Health			
						84		84	
Control 2		**On RoW (1997)**	**On RoW (1998)**	**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 103.1 (0)		No Data	No Data	Mean % cover[1] 72.2 (0)		Mean % cover[1] 63.4(0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**			**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCUR	36.88			STIPCUR	35.25	ARTEFRI	14.60	CAREPEN	13.70	SYMPOCC	23.70
CAREOBT	18.50			ARTEFRI	7.75	STIPCUR	10.70	SYMPOCC	12.20	CAREPEN	16.50
JUNCBAL	8.75			ARTELUD	4.75	SYMPOCC	9.40	POAPRAT	8.90	STIPCUR	10.80
CALALON	6.63			CALALON	4.50	LACTPUL	8.70	CALALON	8.50	CAREOBT	5.70
GALIBOR	5.88			LACTPUL	4.50	SOLIMIS	5.30	STIPCUR	7.50	POAPRAT	4.00
ROSAARK	3.75			ROSAARK	3.50	CALALON	3.60	ARTEFRI	7.10	SOLIMIS	2.30
ARTEFRI	3.50			SOLIMIS	3.00	ARTELUD	3.00	ROSAWOO	6.20	CALALON	1.50
FESTSAX	2.75			CHENPRA	1.75	GRINSQU	1.50	LACTPUL	2.30	AGROSUB	1.40
POAJUNC	2.38			SYMPOCC	1.75	OENOSP	1.50	ARTELUD	2.10	GALIBOR	0.90
SOLIMIS	2.38			OENOSP	1.50	POAPRAT	1.50	FESTSAX	1.40	ROSAWOO	0.80
CAREPEN	1.88			POAJUNC	1.50	ROSAARK	1.50	AGROSMI	1.20	ANEMPAT	0.70
KOELMAC	1.88			LEPIRAM	0.80	CAREPEN	0.60	AGRODAS	0.50	KOELMAC	0.70
PENSSP	1.00			CAREOBT	0.30	AGROSMI	0.30	CAREOBT	0.40	ARTELUD	0.60
AGRODAS	0.88			AGROSMI	0.25	ARTECAM	0.30	AGROTRA	0.20	GAILARI	0.50
SYMPOCC	0.88			ANDRSEP	0.25	FESTSAX	0.30	POACANB	0.20	JUNCBAL	0.50
AGROSUB	0.75			CHENALB	0.25	HORDJUB	0.30	SOLIMIS	0.10	FESTSP	0.40
ANEMPAT	0.75			DESCSOP	0.25	OXYTSP	0.30			AGRODAS	0.30
CAMPROT	0.75			THERRHO	0.25					ARTEFRI	0.30
HELIHOO	0.75			EQUILAE	0.05					HELIHOO	0.30
POACANB	0.75									LACTPUL	0.30
THERRHO	0.75									AGROSCA	0.20
CALAMON	0.38									ASTEFAL	0.20
EQUIARV	0.25									HEUCRIC	0.20
AGROSCA	0.13									POAJUNC	0.20
										THERRHO	0.20

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	96.88						64.25		36.40		n/a		n/a
Moss/Lichen	0.00						0.00		0.00		1.90		0.20
Bare Soil	1.00						38.25		39.50		0.30		0.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 38. Percent Cover of Vegetation at Site 41.

Site 41 (Dry Mixed Grass - Sandy soil) **KP: 112 - 114 (Hemaruka Dunes)**
Soil stripping: Blade width **Reclamation Date: 01/11/1996**
Sample area: Stripped RoW **ERS: Sand**

																2010 Range Health			
																68		84	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**								**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 108.8 (1.8)		No Data		No Data		Mean % cover[1] 58.1 (0)		Mean % cover[1] 110.7 (0)								Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**							**Species**	**% Cover**	**Species**	**% Cover**
STIPCUR	35.50					STIPCUR	24.00	STIPCUR	33.60							ARTELUD	8.70	CALALON	14.60
CALALON	30.38					ARTELUD	6.25	ARTEFRI	30.00							CALALON	8.50	SYMPOCC	9.20
CAREOBT	19.50					LEPIRAM	5.00	HETEVIL	10.10							STIPCUR	8.00	CAREPEN	7.10
SYMPOCC	5.25					AGROSMI	3.75	ROSAARK	9.60							ROSAWOO	7.80	ARTEFRI	4.70
ARTEFRI	4.63					DESCSOP	3.75	CALALON	8.30							CARESTE	5.50	STIPCUR	3.40
ROSAARK	3.50					CALALON	3.25	AGROSMI	8.10							LACTPUL	4.40	CAREOBT	2.10
ANEMPAT	2.63					LITHINC	3.00	CIRSFLO	3.80							AGROSMI	4.00	KOELMAC	0.60
ASTRSTR	1.88					AGROTRA	1.50	ARTELUD	3.30							POAPRAT	3.50	ROSAWOO	0.50
KOELMAC	1.63					CAREDOU	1.50	CHENPRA	1.80							POACANB	3.00	EQUIHYE	0.40
EQUIARV	1.25					HETEVIL	1.50	LACTPUL	1.50							SYMPOCC	2.60	ANEMPAT	0.30
GALIBOR	0.88					HORDJUB	1.50	CAREPEN	0.30							STIPCOM	2.50	ASTEFAL	0.30
HELIHOO	0.75					ROSAARK	1.50	POASAND	0.30							AGROREP	2.00	CALAMON	0.30
ASTEFAL	0.25					CREPTEC	0.55									AGRODAS	1.30	TRAGDUB	0.30
FESTSAX	0.25					ARTEFRI	0.25									KOELMAC	1.00	CERAARV	0.20
AGROSMI	0.13					CAREOBT	0.25									ARTEFRI	0.50	AGROSUB	0.10
ALLITEX	0.13					CHENPRA	0.25									HELIHOO	0.50	FESTSAX	0.10
POAJUNC	0.13					TARAOFF	0.25									LIATPUN	0.50	HELIHOO	0.10
POASAND	0.13															ASTEFAL	0.30	STIPCOM	0.10
																DESCSOP	0.30		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	96.25						79.50		64.00		n/a		n/a
Moss/Lichen	1.75						0.00		0.00		2.30		0.60
Bare Soil	0.25						19.50		16.10		1.30		0.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 39. Percent Cover of Vegetation at Site 42.

Site 42 (Dry Mixed Grass - Sandy soil) **KP: 112 - 114 (Hemaruka Dunes)**
Soil stripping: Double blade width **Reclamation date: 01/11/96**
Sample area: Stripped RoW **ERS: Sand**

																2010 Range Health			
																57		60	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**								**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 60.5 (0)		No Data		No Data		Mean % cover[1] 46.6 (0)		Mean % cover[1] 46.1 (0)								Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**							**Species**	**% Cover**	**Species**	**% Cover**
CAREOBT	44.88					STIPCOM	10.31	STIPCUR	19.70							CAREPEN	14.70	CAREOBT	34.50
CALALON	23.00					STIPCUR	8.75	ARTEFRI	9.90							STIPCOM	13.50	ROSAWOO	5.10
STIPCUR	9.88					CALALON	8.13	ROSAWOO	4.70							ROSAWOO	11.00	CAREPEN	4.10
FESTHAL	4.63					ARTELUD	6.56	AGROSMI	3.40							ARTEFRI	6.10	SOLIMIS	3.50
ROSAARK	1.13					CREPTEC	2.56	CALALON	1.80							CALALON	5.90	STIPCOM	1.90
JUNCBAL	1.03					ARTEFRI	2.31	GRINSQU	1.50							KOELMAC	4.40	KOELMAC	1.60
KOELMAC	1.00					HORDJUB	1.94	CARESTE	1.00							STIPCUR	3.30	ARTEFRI	1.50
POAJUNC	0.75					SOLIMIS	1.88	CAREPEN	0.80							CAREOBT	2.60	EQUISP	1.50
FESTSAX	0.30					CAREOBT	1.00	SOLIMIS	0.60							CARESTE	2.30	FESTSAX	0.80
GALIBOR	0.25					AGOSGLA	0.69	ARABHIR	0.40							AGROSUB	2.00	AGROSMI	0.40
CALAMON	0.15					DESCSOP	0.69	ARTELUD	0.40							AGROSMI	1.80	CALALON	0.40
CAMPROT	0.15					MONONUT	0.38	KOELMAC	0.40							ARTELUD	1.80	POAARID	0.20
HELIHOO	0.13					ROSAWOO	0.31	AGROSCA	0.30							EQUISP	1.70	ANDRSEP	0.10
ALLITEX	0.03					TARAOFF	0.31	CAREOBT	0.30							THERRHO	1.50	CAMPROT	0.10
ANDRSEP	0.03					ANDRSEP	0.25	SYMPOCC	0.30							AGOSGLA	1.30		
EQUILAE	0.03					CHENPRA	0.19	ANDRSEP	0.10							POAPRAT	1.00		
						LEPIRAM	0.19	FESTSAX	0.10							SOLIMIS	1.00		
						AGRODAS	0.06	JUNCBAL	0.10							CERAARV	0.60		
						FESTHAL	0.06	LEPIDEN	0.10							POAARID	0.50		
								POAPRAT	0.10							POACOMP	0.50		
								POTEPEN	0.10							SYMPOCC	0.50		
																CHENLEP	0.40		
																AGRODAS	0.30		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	53.63						53.13		54.90		n/a		n/a
Moss/Lichen	4.40						0.00		0.00		0.60		0.50
Bare Soil	0.00						22.19		7.40		5.20		0.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 40. Percent Cover of Vegetation at Site 43.

Site 43 (Dry Mixed Grass - Sandy soil) **KP: 112 - 114 (Hemaruka Dunes)**
Soil stripping: Double blade width **Reclamation date: 01/11/96**
Sample area: Stripped RoW **ERS: Sand**

								2010 Range Health			
								n/a		n/a	
Control 2		**On RoW (1997)**	**On RoW (1998)**	**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 160.0 (0.2)		No Data	No Data	Mean % cover[1] 81.7 (0.1)		Mean % cover[1] 33.6 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**			**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREOBT	78.88			LEPIRAM	20.88	STIPCUR	11.40	CAREOBT	28.50	ARTEFRI	14.50
CALALON	48.75			STIPCOM	16.56	ARTEFRI	5.70	ROSAWOO	8.80	CAREPEN	13.00
STIPCUR	25.00			CAREPEN	11.88	ARTELUD	4.20	POAPRAT	8.00	SYMPOCC	9.80
KOELMAC	1.38			CALALON	6.88	ROSAWOO	3.00	AGROSMI	7.90	CAREOBT	8.50
ROSAARK	1.05			CERAARV	5.00	AGROSUB	2.10	ARTEFRI	7.90	POAPRAT	6.50
CALAMON	0.93			CAMPROT	4.69	SYMPOCC	1.60	SYMPOCC	5.70	STIPCOM	6.10
HELIHOO	0.93			STIPCUR	3.75	CALALON	1.20	CALALON	4.90	CERAARV	4.20
FESTSAX	0.80			SOLIMIS	2.50	AGOSGLA	1.10	STIPCOM	3.70	AGRODAS	4.00
STIPCOM	0.75			CHENPRA	2.13	CARESTE	0.70	CARESTE	2.50	HEUCRIC	1.50
ARTEFRI	0.38			CAREOBT	1.94	LEPIDEN	0.40	SOLIMIS	2.00	CARESTE	1.30
CAREPEN	0.25			CHENSP	1.94	SOLIMIS	0.40	KOELMAC	1.60	EQUISP	1.10
VICIAME	0.18			HORDJUB	0.94	ARABHIR	0.30	CAREPEN	1.10	ROSAWOO	1.10
FESTHAL	0.13			ROSAARK	0.75	GRINSQU	0.30	COMAUMB	0.70	KOELMAC	0.80
TARAOFF	0.13			KOELMAC	0.31	KOELMAC	0.30	STIPCUR	0.50	PHLOHOO	0.80
ANDRSEP	0.08			OXYTSER	0.31	POAPRAT	0.30	CERAARV	0.40	STIPCUR	0.70
EQUIHYE	0.08			TARAOFF	0.31	AGROSMI	0.20	POACOMP	0.40	ARTELUD	0.50
EQUILAE	0.05			AGOSGLA	0.19	ANDRSEP	0.20	AGOSGLA	0.30	FUNGI	0.50
ALLITEX	0.03			ARTEFRI	0.19	CAMPROT	0.10	ARTELUD	0.30	SOLIMIS	0.50
BOTRSP	0.03			CREPTEC	0.19	CHENPRA	0.10	CARESP	0.20	CALALON	0.30
BOUTGRA	0.03			ALLITEX	0.06			ANDRSEP	0.10	GALIBOR	0.30
CAMPROT	0.03			BOUTGRA	0.06			FESTSAX	0.10	CAMPROT	0.20
HORDJUB	0.03			CALAMON	0.06					COMAUMB	0.20
				FESTHAL	0.06						
				FESTSAX	0.06						
				MONONUT	0.06						

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	74.38						35.31		41.90		n/a		n/a
Moss/Lichen	0.23						0.06		0.00		0.00		0.00
Bare Soil	0.00						35.00		11.30		5.40		1.20

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 41. Percent Cover of Vegetation at Site 44.

Site 44 (Dry Mixed Grass - Sandy soil) **KP: 112 - 114 (Hemaruka Dunes)**
Soil stripping: Full width **Reclamation date: 01/11/96**
Sample area: Full RoW **ERS: Choppy Sandhills**

										2010 Range Health			
										n/a		n/a	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 58.0 (2.4)		Mean % cover[1] 8.2 (0)		Mean % cover[1] 64.4 (0)		Mean % cover[1] 58.0 (0)		Mean % cover[1] 90.0 (0.8)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREOBT	15.88	CHENALB	7.21	CHENSAL	14.50	DESCSOP	13.50	STIPCUR	26.50	ARTEFRI	16.80	CAREOBT	13.90
CALALON	9.50	KOELMAC	0.36	ARTEFRI	10.55	LEPIDEN	12.05	ARTEFRI	15.88	STIPCOM	11.00	CARESTE	13.10
ARTEFRI	8.93	ARTELUD	0.07	STIPCOM	10.55	STIPCUR	9.25	ARTELUD	14.50	POAPRAT	7.40	STIPCOM	9.90
CARESP	7.43	CALAMON	0.07	DESCSOP	9.00	ARTEFRI	9.05	RUMEACE	8.50	RUMEVEN	6.50	CAREPRA	9.20
KOELMAC	3.65	CAREOBT	0.07	ARTELUD	5.25	RUMEACE	4.55	POAPRAT	5.13	ARTELUD	5.60	CAREPEN	5.30
THERRHO	2.38	POLYARE	0.07	SISYALT	3.25	AGROTRA	3.75	AGROSMI	4.50	ROSAWOO	4.70	CALALON	5.20
SOLIMIS	1.95	ROSAARK	0.07	LEPIDEN	1.80	EQUILAE	3.25	CALALON	3.75	CARESTE	3.70	AGROSMI	4.10
HETEVIL	1.88	STIPCOM	0.07	CHENALB	1.75	CHENALB	0.75	AGROSUB	2.25	AGROSMI	3.60	ROSAWOO	2.80
COMAUMB	1.58			POAPRAT	1.75	POAPRAT	0.75	CHENALB	2.25	CALALON	3.30	GALIBOR	2.60
GALIBOR	1.58			CALALON	1.55	ARTELUD	0.35	ARTECAM	1.88	KOELMAC	2.00	KOELMAC	2.10
CAMPROT	1.00			CAREPEN	1.55	CAREOBT	0.30	HETEVIL	1.88	CAREOBT	1.50	SOLIMIS	2.10
POAPRAT	0.75			THERRHO	1.50	SISYALT	0.25	CAREOBT	1.13	LEPIDEN	1.00	JUNCBAL	1.80
FESTSAX	0.43			RUMEACE	0.25	THERRHO	0.10	LEPIDEN	1.13	HETEVIL	0.60	ARTEFRI	1.35
JUNCBAL	0.35			POLYARE	0.10	KOELMAC	0.05	EQUILAE	0.38	CHENALB	0.30	AGRODAS	1.30
BOUTGRA	0.33			AGROSMI	0.05	LAPPOCC	0.05	KOELMAC	0.38	POASAND	0.30	EQUILAE	0.80
STIPCOM	0.15			COMAUMB	0.05					FUNGI	0.10	FUNGI	0.40
EQUISP	0.10			KOELMAC	0.05					SOLIMIS	0.10	ASTRDAS	0.20
ACHIMIL	0.03											CERAARV	0.20
AGRODAS	0.03												
AGROSMI	0.03												
ARTECAM	0.03												
ASTESP	0.03												
CHENSP	0.03												
CIRSVUL	0.03												
POTEHIP	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	74.25		16.43		9.75		53.75		14.30		n/a		n/a
Moss/Lichen	2.40		0.00		0.00		0.00		0.80		0.00		0.00
Bare Soil	1.53		81.79		33.75		30.80		18.90		9.30		0.30

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 42. Percent Cover of Vegetation at Site 45.

Site 45 (Dry Mixed Grass - Sandy soil) **KP: 112 - 114 (Hemaruka Dunes)**
Soil stripping: Full width **Reclamation date: 01/11/96**
Sample area: Full RoW **ERS: Choppy Sandhills**

										2010 Range Health			
										n/a		n/a	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 60.4 (4.5)		Mean % cover[1] 9.1 (0)		Mean % cover[1] 35.3 (0)		Mean % cover[1] 58.7 (0)		Mean % cover[1] 82.1 (0.9)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
CAREOBT	25.13	CHENALB	7.57	CHENALB	12.83	DESCSOP	23.00	STIPCUR	35.00	POAPRAT	18.80	CAREOBT	16.30
SOLIMIS	12.53	ARTECAM	0.36	ARTEFRI	6.11	STIPCUR	8.25	ARTELUD	16.14	ROSAWOO	9.80	ARTEFRI	12.30
ARTEFRI	7.33	ARTELUD	0.36	CAREPEN	2.33	ARTEFRI	6.85	KOELMAC	8.00	ARTELUD	7.50	CALALON	11.70
CAREPEN	5.50	RUMEACE	0.36	STIPCOM	2.22	LEPIDEN	4.00	CALALON	5.86	CALALON	6.40	ROSAWOO	9.60
KOELMAC	4.30	CAREPEN	0.07	SOLIMIS	1.94	STIPCOM	3.85	ARTEFRI	3.00	RUMESP	4.90	CARESTE	7.50
CALALON	3.78	KOELMAC	0.07	ARTELUD	1.72	ARTECAM	1.75	CHENPRA	2.57	STIPCOM	4.90	STIPCOM	5.70
CAMPROT	3.50	ROSAARK	0.07	CIRSVUL	1.72	EQUILAE	1.75	LEPIDEN	2.57	AGROSMI	4.40	KOELMAC	4.50
ANTEPAR	2.00			ROSAARK	1.72	CHENALB	1.70	SOLIMIS	2.57	KOELMAC	3.10	THERRHO	4.40
COMAUMB	1.90			SISYALT	1.72	AGROTRA	1.50	AGROSUB	2.14	CARESTE	3.00	AGROSMI	2.90
OXYTMON	1.43			OXYTMON	1.67	CERANUT	1.50	CIRSVUL	2.14	CAREPEN	1.80	CAREPEN	2.80
STIPCOM	1.05			CALALON	0.33	HORDJUB	1.50	ROSAARK	0.86	CHENALB	1.10	EQUILAE	0.40
JUNCBAL	0.93			AGROTRA	0.28	RUMEACE	1.50	AGOSGLA	0.43	CERAARV	0.50	AGRODAS	0.30
EQUIVAR	0.90			RUMEACE	0.28	KOELMAC	0.50	AGROSMI	0.43	COMAUMB	0.50	ARTELUD	0.20
ARTECAM	0.80			POLYARE	0.17	CALALON	0.30	HORDJUB	0.43	FUNGI	0.50	CAMPROT	0.20
ROSAWOO	0.75			VICIAME	0.11	CAREOBT	0.30			VICIAME	0.50	GALIBOR	0.10
SPIRALB	0.75			AGROSMI	0.06	ACHIMIL	0.25			CAREOBT	0.20		
THERRHO	0.75			GALIBOR	0.06	CAREPEN	0.10			CARESP	0.10		
ARTELUD	0.43			JUNCBAL	0.06	CREPTEC	0.05			THLAARV	0.10		
FESTHAL	0.15					VICIAME	0.05						
BOUTGRA	0.13												
POACANB	0.13												
POASAND	0.13												
AGROSMI	0.05												
ACHIMIL	0.03												
ANDRSEP	0.03												
CALAMON	0.03												
CERAARV	0.03												
GALIBOR	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	57.75		20.00		13.33		25.00		12.80		n/a		n/a
Moss/Lichen	2.65		0.00		0.00		0.00		0.90		0.10		0.00
Bare Soil	5.40		78.57		33.89		55.00		15.10		16.80		5.50

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 43. Percent Cover of Vegetation at Site 46.

Site 46 (Dry Mixed Grass - Solonetzic soil) **KP: 243.0 - 244.5, 259.0 - 260.0 (Rainy Hills)**
Soil stripping: Blade width **Reclamation date: 27/06/97**
Sample area: Stripped RoW **ERS: Blowouts/Solonetzic**

						2010 Range Health			
						84		100	
Control 2		On RoW (1997)	On RoW (1998)	On RoW (1999)		On RoW (2001)		On RoW (2010)		Control (2010)	
Mean % cover[1] 76.9 (24.5)		No Data	No Data	Mean % cover[1] 77.0 (0)		Mean % cover[1] 62.7 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**			**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	25.63			ARTEFRI	27.50	ARTEFRI	36.10	ARTEFRI	12.80	STIPCOM	32.50
AGRODAS	15.13			STIPCOM	9.75	STIPCOM	9.20	STIPCUR	8.30	BOUTGRA	8.00
KOELMAC	10.25			AGRODAS	9.25	HORDJUB	4.80	AGROSMI	6.90	AGROSMI	4.10
ARTEFRI	6.88			LAPPSQU	9.25	AGRODAS	2.10	CARESTE	5.20	ARTEFRI	4.00
BOUTGRA	5.63			MONONUT	5.25	GRINSQU	1.80	STIPCOM	3.90	TRAGDUB	2.00
CARESTE	4.88			SPHACOC	3.75	AGROSMI	1.50	AGRODAS	3.40	SPHACOC	1.80
AGROSMI	3.25			STIPVIR	3.75	CARESTE	1.50	TARAOFF	2.10	CARESTE	1.70
SPHACOC	1.38			AGROSCA	3.25	CIRSARV	1.50	ARTELUD	1.50	TARAOFF	1.30
CALAMON	1.30			CARESP	1.50	HETEVIL	1.50	STIPVIR	1.30	ANTEAPR	1.00
ARTECAN	0.88			GRINSQU	1.50	POAJUNC	1.50	ANDRSEP	1.00	CALAMON	0.70
ASTRCRA	0.75			HORDJUB	1.50	POASAND	0.90	CREPTEC	0.80	KOELMAC	0.30
STIPCUR	0.75			ANDRSEP	0.25	ACHIMIL	0.30	SPHACOC	0.80	POASAND	0.30
ACHIMIL	0.13			CREPTEC	0.25			TRAGDUB	0.50	CREPINT	0.20
CAREOBT	0.13			KOELMAC	0.25					HORDJUB	0.10
										PHLOHOO	0.10

Mean % cover	Control (97-99)	On RoW (1997)		On RoW (1998)		On RoW (1999)		On RoW (2001)		On RoW (2010)		Control (2010)	
Litter	75.38						58.50		45.50		n/a		n/a
Moss/Lichen	24.48						0.00		0.00		1.10		0.80
Bare Soil	12.88						44.00		38.60		2.90		0.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 44. Percent Cover of Vegetation at Site 47.

Site 47 (Dry Mixed Grass - Solonetzic soil) **KP: 243.0 - 244.5, 259.0 - 260.0 (Rainy Hills)**
Soil stripping: Blade width **Reclamation date: 27/06/97**
Sample area: Stripped RoW **ERS: Blowouts/Solonetzic**

																2010 Range Health			
																72		84	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**								**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 66.8 (40.3)		No Data		No Data		Mean % cover[1] 61.3 (0)		Mean % cover[1] 64.8 (0)								Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**							**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	19.75					ARTEFRI	35.30	ARTEFRI	40.90							AGROSMI	14.50	AGRODAS	19.00
AGRODAS	10.50					MONONUT	8.00	STIPCOM	9.60							AGRODAS	3.30	CARESTE	7.60
KOELMAC	10.13					LAPPSQU	7.50	AGRODAS	7.10							CREPTEC	3.20	STIPCOM	7.20
CALAMON	6.18					STIPCOM	7.00	SPHACOC	1.80							CARESTE	3.10	ARTEFRI	5.70
BOUTGRA	5.13					HORDJUB	3.00	ACHIMIL	1.50							ARTEFRI	2.40	CALAMON	2.50
ARTECAN	4.25					ANDRSEP	0.25	HORDJUB	1.50							STIPCOM	2.20	SPHACOC	2.00
SPHACOC	3.75					CREPTEC	0.25	STIPVIR	1.50							TARAOFF	2.20	AGROSMI	1.70
ARTEFRI	3.40							CARESTE	0.60							TRAGDUB	1.50	ARNISOR	1.40
CARESTE	1.80							LAPPSQU	0.30							KOELMAC	1.30	POASAND	1.10
PHLOHOO	0.88															BOUTGRA	1.20	BOUTGRA	0.90
ACHIMIL	0.75															STIPVIR	1.20	KOELMAC	0.70
POASAND	0.25															ANDRSEP	1.00	PHLOHOO	0.70
																ACHIMIL	0.90	TRAGDUB	0.60
																ERYSINC	0.40	AGROSCA	0.20
																POASAND	0.40	MUHLCUS	0.10
																VIOLSP	0.10		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	66.88						45.25		47.70		n/a		n/a
Moss/Lichen	40.25						0.00		0.00		1.70		2.10
Bare Soil	4.63						54.75		26.50		2.60		0.50

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 45. Percent Cover of Vegetation at Site 48.

Site 48 (Dry Mixed Grass - Solonetzic soil) **KP: 243.0 - 244.5, 259.0 - 260.0 (Rainy Hills)**
Soil stripping: Double blade width **Reclamation date: 27/06/97**
Sample area: Stripped RoW **ERS: Blowouts/Solonetzic**

																2010 Range Health			
																47		75	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**								**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 25.5 (73.6)		No Data		No Data		Mean % cover[1] 40.7 (0)		Mean % cover[1] 56.5 (0.9)								Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**							**Species**	**% Cover**	**Species**	**% Cover**
CAREPEN	9.75					ARTEFRI	12.35	ARTEFRI	43.40							BOUTGRA	16.00	BOUTGRA	21.70
BOUTGRA	7.85					MONONUT	10.00	STIPCOM	3.40							AGROSMI	10.00	STIPCOM	20.20
STIPCOM	5.28					LAPPOCC	5.00	AGROTRA	3.30							ARTEFRI	5.50	AGROSMI	10.10
AGRODAS	4.23					POLYARE	3.05	KOELMAC	1.80							PHLOHOO	4.20	ARTEFRI	4.30
CALAMON	4.18					AGROSMI	3.00	ACHIMIL	1.50							CAREPEN	4.00	SPHACOC	3.60
CARESTE	3.35					HORDJUB	3.00	HORDJUB	1.50							STIPCOM	3.50	CARESTE	1.10
AGROSMI	2.53					CARESTE	1.50	CARESTE	0.60							SPHACOC	3.20	TRAGDUB	0.70
KOELMAC	2.45					SPHACOC	1.50	AGRODAS	0.40							TARAOFF	1.00	TARAOFF	0.30
ANTESP	1.88					STIPCOM	0.50	BOUTGRA	0.30							KOELMAC	0.70	CALAMON	0.20
ARTEFRI	1.88					ACHIMIL	0.25	Bout gra	0.19							STIPVIR	0.50	CAREPEN	0.20
MUHLRIC	0.90					TARAOFF	0.25									AGRODAS	0.30	PHLOHOO	0.20
SPHACOC	0.50					VEROPER	0.15									LAPPOCC	0.20	POASAND	0.20
ARNISOR	0.45					CHENPRA	0.05									TRAGDUB	0.20	AGRODAS	0.10
ACHIMIL	0.15					KOELMAC	0.05									CALAMON	0.10		
POACANB	0.13															POAJUNC	0.10		
DISTSTR	0.03																		
PHLOHOO	0.03																		
POASAND	0.03																		
STIPVIR	0.03																		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	43.63						20.30		20.90		n/a		n/a
Moss/Lichen	43.38						0.00		0.90		4.80		2.40
Bare Soil	0.18						59.25		45.90		16.00		0.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 46. Percent Cover of Vegetation at Site 49.

Site 49 (Dry Mixed Grass - Solonetzic soil) **KP: 243.0 - 244.5, 259.0 - 260.0 (Rainy Hills)**
Soil stripping: Double blade width **Reclamation date: 27/06/97**
Sample area: Stripped RoW **ERS: Blowouts/Solonetzic**

																2010 Range Health			
																43		84	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 34.1 (84.7)		No Data		No Data		Mean % cover[1] 44.8 (0)		Mean % cover[1] 49.3 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
STIPCOM	15.63					ARTEFRI	18.60	ARTEFRI	38.60	AGROSMI	18.10	BOUTGRA	32.00
BOUTGRA	10.00					SPHACOC	7.75	STIPCOM	7.10	STIPCOM	9.20	STIPCOM	16.90
SPHACOC	5.15					LAPPOCC	6.35	AGRODAS	1.50	ARTEFRI	7.50	ARTEFRI	4.70
KOELMAC	3.10					HORDJUB	3.80	MUHLCUS	1.50	AGROPEC	5.00	CALAMON	4.20
CALAMON	2.65					MONONUT	3.50	BOUTGRA	0.30	BOUTGRA	2.90	AGRODAS	4.10
AGROSMI	2.63					AGROSMI	1.50	SPHACOC	0.30	TARAOFF	1.60	AGROSMI	2.50
ARTEFRI	2.50					STIPVIR	1.50			KOELMAC	1.50	SPHACOC	2.30
CARESTE	2.40					STIPCOM	0.50			CAREPEN	0.70	CARESTE	1.70
CAREOBT	1.88					CHENPRA	0.25			DESCSOP	0.40	KOELMAC	1.00
AGRODAS	0.65					CREPTEC	0.25			ERYSINC	0.20	TRAGDUB	0.90
POASAND	0.08					KOELMAC	0.25			TRAGDUB	0.20	TARAOFF	0.30
PHLOHOO	0.05					SALSKAL	0.25			CARESTE	0.10	VIOLNUT	0.30
AGROTRA	0.03					TARAOFF	0.15					POASAND	0.20
						AGROTRA	0.05						
						POTEFRU	0.05						

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	25.75						21.75		34.60		n/a		n/a
Moss/Lichen	66.00						0.00		0.00		5.40		0.80
Bare Soil	0.83						63.00		34.60		10.30		0.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 49. Percent Cover of Vegetation at Site 52.

Site 52 (Fescue - Mixed Grass Transition) **KP: 350.0 - 351.0, 382.0 - 383.5 (Cypress Hills)**
Soil stripping: Blade width **Reclamation date 03/11/96 (Seeded to pure Rough Fescue)**
Sample area: Stripped RoW **ERS: Loamy**

														2010 Range Health			
														41		87	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**						**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 79.8 (11.3)		No Data		No Data		Mean % cover[1] 25.9 (0)		Mean % cover[1] 28.9 (0)						Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**
FESTHAL	51.15					CAREPEN	5.50	POAPRAT	12.30					POAPRAT	32.00	FESTHAL	48.50
POAPRAT	29.53					VICIAME	3.90	ARTELUD	4.00					STIPVIR	10.00	FESTIDA	7.80
ARTELUD	7.65					HORDJUB	3.25	CERAARV	3.80					ARTEFRI	8.50	CAREPEN	4.30
FESTIDA	2.80					STIPCUR	2.00	CARESTE	1.90					CARESTE	7.10	CERAARV	3.40
TARAOFF	1.88					AGRODAS	1.90	MUHLCUS	1.50					VICIAME	4.90	POAPRAT	2.20
ANEMPAT	1.60					STIPVIR	1.80	SYMPOCC	1.00					ANDRSEP	4.30	STIPCUR	2.00
CAREPEN	1.20					ARTEFRI	1.50	SOLIMIS	0.80					ARTELUD	2.40	DANTINT	1.80
CERAARV	0.80					THERRHO	1.50	STIPCUR	0.60					KOELMAC	2.30	ARTELUD	1.70
AGRODAS	0.53					POAPRAT	1.00	AGRODAS	0.50					AGROSUB	2.00	ANEMPAT	1.60
DANTINT	0.53					TARAOFF	0.80	CAREPEN	0.40					STIPCOM	2.00	ANTEAPR	1.40
ACHIMIL	0.15					KOELMAC	0.75	ARTEFRI	0.30					DANTINT	1.80	ARTEFRI	1.00
ANTEPAR	0.15					ARTELUD	0.35	FESTHAL	0.30					AGRODAS	1.50	VICIAME	1.00
ARENCON	0.13					DANTINT	0.30	KOELMAC	0.30					ROSASP	1.50	AGRODAS	0.80
ARNISOR	0.13					ACHIMIL	0.25	POACUSI	0.30					AGROSMI	1.20	ACHIMIL	0.70
DRABSP	0.05					CAREOBT	0.25	TARAOFF	0.20					ANTEAPR	1.00	KOELMAC	0.70
AGROTRA	0.03					CERAARV	0.25	THERRHO	0.20					POTEPEN	1.00	TARAOFF	0.30
ANDRSEP	0.03					FESTHAL	0.25	VICIAME	0.20					STIPCUR	1.00	ANDRSEP	0.20
ANTEAPR	0.03					HELIHOO	0.25	AGROSMI	0.10					FESTIDA	0.80	ARENLAT	0.10
CARESP	0.03					ANDRSEP	0.05	DANTINT	0.10					CERAARV	0.70	CARESTE	0.10
HELIHOO	0.03					CARESP	0.05	MONONUT	0.10					DANTUNI	0.70		
MUHLRIC	0.03													GUTISAR	0.70		
														ACHIMIL	0.30		
														MUHLCUS	0.30		
														TARAOFF	0.30		
														CAREPEN	0.20		
														FESTHAL	0.10		
														SOLISP	0.10		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	97.50						8.10		52.60		n/a		n/a
Moss/Lichen	4.73						0.00		0.00		0.10		4.40
Bare Soil	0.00						50.25		16.00		3.60		0.60

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 50. Percent Cover of Vegetation at Site 53.

Site 53 (Fescue - Mixed Grass Transition) **KP: 350.0 - 351.0, 382.0 - 383.5 (Cypress Hills)**
Soil stripping: Blade width **Reclamation date 03/11/96 (Seeded to pure Rough Fescue)**
Sample area: Stripped RoW **ERS: Loamy**

														2010 Range Health					
														50		55			
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**							
Mean % cover[1] 88.3 (20.3)		No Data		No Data		Mean % cover[1] 81.3 (0)		Mean % cover[1] 40.0 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)							
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**						
FESTHAL	48.24					ARTELUD	21.75	POAPRAT	15.90	FESTHAL	8.00	FESTHAL	11.00						
STIPCUR	11.62					ARTEFRI	15.00	CARESTE	11.00	ARTELUD	4.30	STIPCUR	6.20						
CAREPEN	8.53					STIPCUR	11.25	STIPCUR	3.60	VICIAME	3.70	AGRODAS	3.30						
ACHIMIL	5.29					POAPRAT	7.75	AGRODAS	1.60	ANEMPAT	3.50	ERIGCAE	3.10						
ANEMPAT	4.65					AGROSCA	6.25	THERRHO	1.60	AGRODAS	2.50	CERAARV	3.00						
ARTELUD	4.29					VICIAME	5.75	ARTEFRI	1.50	CAREPEN	2.40	THERRHO	3.00						
AGRODAS	2.94					CERAARV	3.75	TARAOFF	1.20	CARESTE	2.20	VICIAME	3.00						
FESTIDA	2.79					TARAOFF	3.25	MUHLRIC	0.70	CALAMON	1.70	CAREPEN	2.90						
MUHLRIC	2.21					ACHIMIL	1.50	AGROSUB	0.60	ARTEFRI	1.60	ARTELUD	2.20						
ARTEFRI	2.09					ANDRSEP	1.50	KOELMAC	0.60	ANTEPAR	1.40	POAPRAT	2.10						
KOELMAC	2.06					CARESTE	1.50	DANTINT	0.30	CERAARV	1.30	ANEMPAT	2.00						
THERRHO	2.06					KOELMAC	1.50	POTEHIP	0.30	FESTIDA	1.20	ACHIMIL	1.80						
VICIAME	1.91					CAREPEN	0.25	VICIAME	0.30	DANTINT	1.00	KOELMAC	1.70						
AGROSUB	1.76					LITHINC	0.25	AGROSMI	0.20	SOLIMIS	0.80	CARESTE	1.30						
ASTRSTR	1.76							ACHIMIL	0.10	ASTRDAS	0.60	ARTEFRI	0.90						
CERAARV	1.06							ARTELUD	0.10	DANTUNI	0.50	CALAMON	0.90						
GALIBOR	0.88							GEUMTRI	0.10	ANDRSEP	0.40	ASTRDAS	0.80						
AGROTRA	0.44							HETEVIL	0.10	STELLON	0.20	AGROTRA	0.70						
POACANB	0.29							POACUSI	0.10	POACUSI	0.10	SOLIMIS	0.60						
ANTEAPR	0.18							SOLIMIS	0.10			PHLOHOO	0.50						
SOLIMIS	0.15											ANTEPAR	0.40						
PHLOHOO	0.03											DANTINT	0.30						
												ANDRSEP	0.20						
												FESTIDA	0.20						
												POAJUNC	0.10						

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	94.56						59.50		32.50		n/a		n/a
Moss/Lichen	19.50						0.00		0.00		1.60		4.90
Bare Soil	2.50						36.00		41.90		11.00		1.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 51. Percent Cover of Vegetation at Site 54.

Site 54 (Fescue - Mixed Grass Transition) **KP: 350.0 - 351.0, 382.0 - 383.5 (Cypress Hills)**
Soil stripping: Double blade width **Reclamation date: 03/11/96 (Drill seeded to Western Porcupine Grass, Rough Fescue and seed mix #2)**
Sample area: Stripped RoW **ERS: Loamy/Li-BlO**

																2010 Range Health			
																n/a		75	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**								**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 96.3 (23.6)		No Data		No Data		Mean % cover[1] 89.3(0)		Mean % cover[1] 70.7 (0)								Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**							**Species**	**% Cover**	**Species**	**% Cover**
STIPCUR	27.25					AGROTRA	14.25	AGRODAS	12.20							FESTOVI	17.50	STIPCOM	10.80
SELADEN	17.00					STIPCUR	12.50	STIPCUR	9.70							POACUSI	8.30	KOELMAC	5.50
AGRODAS	13.75					FESTOVI	11.25	ARTEFRI	9.30							AGROSMI	5.80	CAREOBT	3.90
CAREOBT	7.75					KOELMAC	9.25	STIPVIR	8.30							CAREOBT	5.80	PENSPRO	3.60
KOELMAC	6.63					AGRODAS	8.50	FESTOVI	7.70							AGRODAS	4.00	AGRODAS	3.40
ARTEFRI	5.50					ARTEFRI	8.50	KOELMAC	5.40							ARTEFRI	3.10	AGROSMI	2.50
ASTEFAL	5.25					STIPVIR	6.00	AGROSMI	4.10							KOELMAC	2.30	ARTEFRI	1.50
ACHIMIL	4.75					VICIAME	5.25	AGROTRA	4.10							STIPVIR	1.50	VICIAME	1.00
MUHLRIC	4.25					POAJUNC	3.75	STIPCOM	3.00							CARESTE	1.30	ACHIMIL	0.70
VICIAME	3.11					STIPCOM	3.25	CERAARV	1.80							STIPCOM	1.10	PHLOHOO	0.50
PHLOHOO	2.63					OXYTMON	3.00	ACHIMIL	1.50							CHRYVIL	0.70	GEUMTRI	0.30
ARENCON	1.63					AGROSMI	1.50	ASTRBIS	1.50							ANDRSEP	0.40	ANDRSEP	0.20
CERAARV	1.63					PENSPRO	1.50	GALIBOR	0.60							GUTISAR	0.30	CERAARV	0.20
GUTISAR	1.63					CARESTE	0.50	AGROSCA	0.30							ACHIMIL	0.20	DANTUNI	0.20
BOUTGRA	0.75					ACHIMIL	0.25	CAREPEN	0.30							PHLOHOO	0.20	TARAOFF	0.20
CAREFIL	0.75							CARESTE	0.30							VICIAME	0.20	ANTEPAR	0.10
ANDRSEP	0.25							PENSPRO	0.30							ERIGCAE	0.10		
ANTEAPR	0.25							VICIAME	0.30										
CALAMON	0.13																		
HYMERIC	0.13																		
POASAND	0.13																		

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	72.92						62.25		47.80		n/a		n/a
Moss/Lichen	37.06						0.00		0.00		0.90		0.80
Bare Soil	3.00						38.00		29.20		12.00		1.70

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 52. Percent Cover of Vegetation at Site 55.

Site 55 (Fescue - Mixed Grass Transition) **KP: 350.0 - 351.0, 382.0 - 383.5 (Cypress Hills)**
Soil stripping: Double blade width **Reclamation date: 03/11/96 (Drill seeded to Western Porcupine Grass, Rough Fescue and seed mix #2)**
Sample area: Stripped RoW **ERS: Loamy**

						2010 Range Health			
						70		59	
Control 2		**On RoW (1997)**	**On RoW (1998)**	**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 94.8 (26.6)		No Data	No Data	Mean % cover[1] 28.7 (0)		Mean % cover[1] 57.4 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**			**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
SELADEN	25.25			AGRODAS	7.50	AGRODAS	16.20	VICIAME	6.10	STIPCOM	14.40
STIPCUR	24.50			AGROTRA	3.95	ARTEFRI	12.40	AGRODAS	4.50	CAREOBT	5.50
AGRODAS	10.88			AGROSMI	3.41	STIPCOM	11.30	ARTEFRI	4.30	DANTUNI	5.20
KOELMAC	7.53			ARTEFRI	3.32	AGROSMI	4.80	AGROSMI	4.10	VICIAME	3.10
BOUTGRA	4.50			FESTOVI	2.64	FESTOVI	3.30	FESTOVI	4.00	AGRODAS	2.50
CAREPEN	4.13			STIPCUR	2.55	STIPVIR	3.30	STIPVIR	3.90	ACHIMIL	2.30
VICIAME	4.05			ASTRBIS	1.36	KOELMAC	2.40	KOELMAC	3.80	PHLOHOO	1.70
ACHIMIL	3.78			SISYALT	1.36	PHLOHOO	1.80	STIPCOM	3.30	CERAARV	1.20
PHLOHOO	3.78			STIPVIR	0.77	SPHACOC	0.90	CARESTE	2.40	BOUTGRA	1.10
ARTEFRI	3.03			POLYARE	0.55	CAREPEN	0.30	ANDRSEP	0.40	KOELMAC	1.10
ANTEPAR	2.50			STIPCOM	0.50	CARESTE	0.30	SPHACOC	0.40	POASAND	1.10
ARENCON	1.88			CAREPEN	0.27	POASAND	0.30	CAREOBT	0.20	AGROSMI	0.90
SPHACOC	1.13			KOELMAC	0.23	POLYARE	0.10	FESTIDA	0.20	CHRYVIL	0.90
CALAMON	1.00			VICIAME	0.09			PHLOHOO	0.20	ARTEFRI	0.80
CAREOBT	0.93			CARESTE	0.05					HYMERIC	0.70
ASTEFAL	0.88			COLLLIN	0.05					CARESTE	0.30
STIPCOM	0.75			GUTISAR	0.05					TARAOFF	0.30
POACUS	0.25			HYMERIC	0.05					ANTEPAR	0.20
AGROSMI	0.13			LOMAMAC	0.05						
CAREFIL	0.13										
CARESTE	0.13										
FESTSAX	0.13										
GEUMTRI	0.13										
GUTISAR	0.13										
POASAND	0.13										

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	65.25						7.05		31.30		n/a		n/a
Moss/Lichen	28.95						0.00		0.00		0.50		4.10
Bare Soil	2.50						51.14		38.40		19.60		0.60

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 53. Percent Cover of Vegetation at Site 56.

Site 56 (Fescue - Mixed Grass Transition)
Soil stripping: Full width
Sample area: Full RoW

KP: 350.0 - 351.0, 382.0 - 383.5 (Cypress Hills)
Reclamation date: 03/11/96 (Seeded to pure Rough Fescue)
ERS: Li-TB

										2010 Range Health			
										45		43	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 60.7 (38.3)		Mean % cover[1] 9.2 (0)		Mean % cover[1] 24.3 (0)		Mean % cover[1] 40.3 (0)		Mean % cover[1] 73.8 (0.1)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
FESTHAL	21.40	CAREPEN	3.33	AGRODAS	6.25	POLYARE	16.60	POLYARE	20.70	STIPVIR	18.50	KOELMAC	3.70
CAREOBT	5.48	MUHLRIC	2.50	PHLOHOO	3.60	AGRODAS	6.85	ARTEFRI	15.10	FESTHAL	10.00	FESTHAL	3.30
AGRODAS	5.10	KOELMAC	1.33	ASTEFAL	3.25	ARTEFRI	5.45	FESTHAL	6.00	VICIAME	6.50	PHLOHOO	2.70
PHLOHOO	4.15	AGROTRA	0.42	CAREPEN	2.35	PHLOHOO	3.05	GUTISAR	5.30	ARTEFRI	4.00	AGRODAS	2.40
ASTEFAL	3.03	PENSNIT	0.42	KOELMAC	2.35	ASTEFAL	1.80	HORDJUB	5.30	STIPCUR	4.00	STIPCUR	1.70
BOUTGRA	2.63	THERRHO	0.42	FESTHAL	1.75	LOMAMAC	1.75	STIPVIR	5.30	HYMERIC	3.90	ARENCON	1.40
ARENCON	2.58	PHLOHOO	0.08	AGROSMI	1.50	KOELMAC	1.55	STIPCUR	4.50	AGRODAS	3.30	ARTEFRI	1.40
CERAARV	2.28			CALAMON	0.85	CALAMON	0.50	CAREPEN	3.80	CARESTE	2.60	CERAARV	1.40
DANTINT	1.88			HYMERIC	0.55	FESTHAL	0.50	ANTESP	3.00	FESTIDA	2.00	HETEVIL	1.40
ASTRDAS	1.83			LOMAMAC	0.30	STIPCUR	0.50	KOELMAC	3.00	GAILARI	2.00	HYMERIC	1.30
ANTESP	1.58			ACHIMIL	0.25	AGROSUB	0.40	CALAMON	1.50	GUTISAR	1.50	ASTEFAL	1.20
CAREPEN	1.25			STIPVIR	0.25	CAREPEN	0.30			KOELMAC	1.20	ACHIMIL	1.10
ARTEFRI	1.20			ARENCON	0.10	OROBFAS	0.30			AGROSMI	1.00	ALLITEX	1.10
LOMAMAC	1.18			AGROTRA	0.05	HYMERIC	0.25			LOMAMAC	1.00	ERIGCAE	1.10
VICIAME	1.08			ANTESP	0.05	VICIAME	0.20			ASTEFAL	0.80	VICIAME	0.80
GEUMTRI	0.90			CERAARV	0.05	DESCSOP	0.15			LIATPUN	0.70	CARESTE	0.60
KOELMAC	0.85			FESTIDA	0.05	PENSNIT	0.05			TARAOFF	0.70	ANTEPAR	0.30
ERIGCAE	0.78			VICIAME	0.05	STIPVIR	0.05			LINULEW	0.60	ASTRDAS	0.30
CALAMON	0.50									GRINSQU	0.50	LINULEW	0.30
ACHIMIL	0.48									SOLIMIS	0.50	LOMAMAC	0.30
STIPCUR	0.38									CALALON	0.20	MUHLRIC	0.30
HYMERIC	0.33									ANDRSEP	0.10	ASTRSTR	0.20
POACUS	0.30									OROBFAS	0.10	CALAMON	0.20
GAILARI	0.25											ANDRSEP	0.10
CARESTE	0.23											GAILARI	0.10
AGROSMI	0.15											GEUMTRI	0.10
MUHLCUS	0.15												
STIPVIR	0.15												
ASTRGIL	0.13												
GALIBOR	0.13												
GUTISAR	0.13												
OXYTMON	0.13												
LINULEW	0.08												
POTEGRA	0.05												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	57.63		15.00		3.60		8.75		19.60		n/a		n/a
Moss/Lichen	62.92		0.00		0.00		0.00		0.10		0.50		32.00
Bare Soil	12.05		85.00		65.25		61.75		67.10		18.00		0.90

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 54. Percent Cover of Vegetation at Site 57.

Site 57 (Fescue - Mixed Grass Transition) — **KP: 350.0 - 351.0, 382.0 - 383.5 (Cypress Hills)**
Soil stripping: Full width — **Reclamation date: 03/11/96 (Seeded to pure Rough Fescue)**
Sample area: Full RoW — **ERS: Li**

										2010 Range Health			
										65		75	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 45.1 (73.7)		Mean % cover[1] 1.1 (0)		Mean % cover[1] 29.1 (1.8)		Mean % cover[1] 70.5 (0)		Mean % cover[1] 43.5 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
FESTHAL	14.65	LITHINC	0.31	POLYSP	5.55	THERRHO	11.25	ARTEFRI	13.60	FESTHAL	19.50	FESTHAL	25.30
DANTUNI	7.45	HYMERIC	0.06	CARESP	5.00	AGROSMI	10.75	POLYARE	7.90	STIPCUR	9.70	STIPCUR	10.50
ANTEUMB	7.05	KOELMAC	0.06	ARTEFRI	3.75	MUHLCUS	9.75	STIPCUR	5.10	AGRODAS	8.60	AGRODAS	8.00
AGRODAS	4.23			AGRODAS	2.05	POLYARE	6.90	STIPVIR	3.60	STIPVIR	6.00	CARESTE	3.90
STIPVIR	4.23			DANTINT	2.05	STIPCUR	6.25	HORDJUB	3.00	KOELMAC	4.70	DANTUNI	3.50
CAREPEN	3.43			ASTESP	1.85	DANTUNI	6.00	SPHACOC	3.00	ARTEFRI	4.50	LOMAMAC	3.50
KOELMAC	2.63			GEUMTRI	1.75	ARTEFRI	5.65	AGRODAS	2.50	VICIAME	4.00	CERAARV	3.30
PHLOHOO	1.68			KOELMAC	1.00	ACHIMIL	2.80	ASTESP	1.50	CARESTI	3.80	CAREOBT	3.20
ASTEFAL	1.50			STIPCOM	0.65	FESTHAL	2.60	GUTISAR	1.50	AGROSMI	2.90	STIPVIR	3.00
ARENCON	1.23			AGROSMI	0.60	ARTELUD	1.75	KOELMAC	0.60	CERAARV	1.00	VICIAME	2.60
BOUTGRA	1.00			AGROTRA	0.60	ASTESP	1.50	FESTOVI	0.30	TARAOFF	0.90	ARENCON	1.90
ASTRDAS	0.93			HELIHOO	0.55	CIRSARV	1.50	GRINSQU	0.30	HETEVIL	0.50	ACHIMIL	1.50
STIPCUR	0.88			ARENCON	0.40	STIPVIR	1.50	POTEGRA	0.30	ANDRSEP	0.40	KOELMAC	1.00
CARESTE	0.75			ASTRDAS	0.35	AGROSUB	0.30	STIPCOM	0.30	ARENCON	0.20	LINULEW	0.70
MUHLCUS	0.75			LINULEW	0.35	CARESP	0.30			POTEPEN	0.20	AGROSMI	0.50
POTEGRA	0.50			ARTELUD	0.30	AGRODAS	0.25					ARTEFRI	0.50
AGROSMI	0.45			POASP	0.30	AGROSCA	0.25					ASTRDAS	0.50
LOMASP	0.43			STIPVIR	0.30	GALIBOR	0.25					FUNGI	0.50
POACANB	0.40			ANTESP	0.25	LAPPOCC	0.25					HYMERIC	0.50
THERRHO	0.40			FESTHAL	0.25	MONONUT	0.25					PHLOHOO	0.40
ACHIMIL	0.30			ACHIMIL	0.05	DESCSOP	0.10					TARAOFF	0.30
CERAARV	0.30			DESCSOP	0.05	GUTISAR	0.10					ARENSP	0.20
HYMERIC	0.30			FESTIDA	0.05	ARENCON	0.05					ARNIFUL	0.20
ARTEFRI	0.28			GALIBOR	0.05	OROBFAS	0.05					HETEVIL	0.20
GEUMTRI	0.28			GUTISAR	0.05	POLYSP	0.05						
PETAPUR	0.15			HYMERIC	0.05	VICIAME	0.05						
AGROSCA	0.13			THERRHO	0.05								
LINULEW	0.13												
POTEHIP	0.13												
VICIAME	0.13												
GAILARI	0.05												
POACUSI	0.05												
SOLIMIS	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	42.50		11.88		7.30		11.25		7.60		n/a		n/a
Moss/Lichen	43.00		0.00		1.75		0.00		0.00		0.80		1.70
Bare Soil	11.90		86.56		60.50		58.25		71.90		9.00		2.30

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 55. Percent Cover of Vegetation at Site 58.

Site 58 (Dry Mixed Grass - Solonetzic soil) **KP: 410.5-412.5 (Sage Creek)**
Soil stripping: Blade width **Reclamation date: 22/10/96**
Sample area: Stripped RoW **ERS: Overflow**

						2010 Range Health			
						95		85	
Control 2		On RoW (1997)	On RoW (1998)	On RoW (1999)		On RoW (2001)		On RoW (2010)		Control (2010)	
Mean % cover[1] 111.5 (17.7)		No Data	No Data	Mean % cover[1] 17.0 (5.1)		Mean % cover[1] 13.2 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**			**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
AGRODAS	42.25			POLYARE	10.00	POLYARE	5.00	ARTECAN	24.20	AGRODAS	16.50
CARESTE/OB	18.90			ARTECAN	2.09	AGRODAS	3.10	AGRODAS	11.40	AGROSMI	8.20
ARTECAN	7.90			AGRODAS	1.64	ARTECAN	2.70	AGROSMI	7.60	ARTECAN	7.80
AGROSMI	7.38			STIPVIR	1.36	CHENPRA	1.00	STIPVIR	2.10	KOELMAC	4.40
POAJUNC	5.90			CHENSAL	1.14	CHENSAL	0.40	ATRINUT	2.00	ARTEFRI	3.40
OPUNPOL	2.50			CARESTE	0.23	ARTEFRI	0.30	SPHACOC	2.00	CARESP	3.10
VICIAME	1.25			POAARID	0.23	ATRINUT	0.30	ASTRBIS	1.10	POAPRAT	2.70
KOELMAC	0.95			CHENPRA	0.14	CALALON	0.20	IVAAXIL	1.00	VICIAME	2.20
ARTEFRI	0.93			ATRINUT	0.05	LAPPOCC	0.10	POASAND	0.90	BOUTGRA	1.50
GAURCOC	0.90			KOCHSCO	0.05	STIPVIR	0.10	VICIAME	0.70	STIPVIR	1.50
ACHIMIL	0.40			LAPPOCC	0.05			POAARID	0.60	SPHACOC	1.20
POASAND	0.28							GUTISAR	0.50	LOMAFOE	0.40
COMAUMB	0.25							ALLITEX	0.40	PHLOHOO	0.40
PHLOHOO	0.13							LIATPUN	0.40	TARAOFF	0.40
STIPVIR	0.13							KOELMAC	0.30	TRAGDUB	0.30
CHENPRA	0.08							TARAOFF	0.10	ACHIMIL	0.20
ASTRDAS	0.05							TRAGDUB	0.10	POHLOBT	0.20
PLANPAT	0.05										
PLANELO	0.03										

Mean % cover	Control (97-99)	On RoW (1997)		On RoW (1998)		On RoW (1999)		On RoW (2001)		On RoW (2010)		Control (2010)	
Litter	61.84						3.44		4.00		n/a		n/a
Moss/Lichen	13.40						12.90		0.00		0.00		2.30
Bare Soil	9.35						79.75		78.10		41.50		4.10

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 56. Percent Cover of Vegetation at Site 59.

Site 59 (Dry Mixed Grass - Solonetzic soil) **KP: 410.5-412.5 (Sage Creek)**
Soil stripping: Blade width **Reclamation date: 22/10/96**
Sample area: Stripped RoW **ERS: Overflow**

						2010 Range Health			
						47		32	
Control 2		**On RoW (1997)**	**On RoW (1998)**	**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 76.7 (40)		No Data	No Data	Mean % cover[1] 44.4 (0)		Mean % cover[1] 12.4 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**			**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
AGRODAS	33.25			LAPPOCC	15.25	POLYARE	3.89	POASAND	5.30	ARTECAN	22.50
CARESTE	9.05			CHENSAL	13.05	ARTECAN	3.22	BOUTGRA	4.80	AGROSMI	7.00
BOUTGRA	8.90			POLYARE	12.05	ARTEFRI	2.22	AGROSMI	4.40	STIPVIR	3.80
ARTEFRI	5.78			ARTECAN	2.60	CHENPRA	2.11	AGRODAS	4.20	AGRODAS	1.80
POASAND	5.18			CHENPRA	0.35	CHENSAL	0.44	ARTECAN	4.10	ARTEFRI	1.60
EUROLAN	2.53			LEPIDEN	0.30	STIPCOM	0.33	EUROLAN	3.00	SPHACOC	1.00
ARTECAN	1.90			ARTEFRI	0.25	PHLOHOO	0.11	STIPCOM	2.90	OPUNPOL	0.50
KOELMAC	1.20			POACANB	0.25	POACANB	0.11	KOELMAC	2.20		
AGROSMI	1.00			STIPCOM	0.25			ARTEFRI	1.80		
PLANPAT	0.90			BARBSP	0.05			CARESTE	1.10		
GAURCOC	0.65							PLANELO	1.10		
OPUNPOL	0.25							CERAARV	0.10		
PHLOHOO	0.18							SPHACOC	0.10		
POLYARE	0.08										
ATRINUT	0.03										
CERANUT	0.03										
LEPIDEN	0.03										

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	34.47						3.55		7.30		n/a		n/a
Moss/Lichen	34.87						0.00		0.00		8.80		0.00
Bare Soil	12.57						68.00		58.00		13.00		65.00

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 57. Percent Cover of Vegetation at Site 60.

Site 60 (Dry Mixed Grass - Solonetzic soil) **KP: 410.5-412.5 (Sage Creek)**
Soil stripping: Double blade width **Reclamation date: 22/10/96**
Sample area: Stripped RoW **ERS: Loamy**

										2010 Range Health					
										75				97	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**			
Mean % cover[1] 89.2 (0)		No Data		No Data		Mean % cover[1] 57.6 (0)		Mean % cover[1] 48.2 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)			
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**		
STIPCOM	29.75					STIPCOM	15.25	STIPCOM	22.70	STIPCOM	23.10	STIPCOM	23.20		
ARTEFRI	10.38					LAPPOCC	12.00	ARTEFRI	11.40	ARTEFRI	2.60	EUROLAN	4.10		
KOELMAC	9.88					ARTEFRI	9.30	HETEVIL	3.80	AGROSMI	2.40	AGROSMI	3.80		
CHENPRA	6.13					STIPVIR	7.50	HORDJUB	3.30	ARTELUD	2.00	KOELMAC	3.10		
SPHACOC	5.38					SPHACOC	3.00	AGRODAS	2.70	SPHACOC	0.50	BOUTGRA	2.80		
AGRODAS	4.38					AGRODAS	2.25	CHENSP	2.20	AGRODAS	0.30	ARTEFRI	2.50		
PHLOHOO	2.50					ERIGCAE	1.75	ERIGCAE	1.50	POHLOBT	0.30	SPHACOC	2.40		
CAREFIL	1.88					HORDJUB	1.50	CARESTE	0.30	TRAGDUB	0.30	CARESP	2.10		
ERIGCAE	1.50					KOELMAC	1.50	STIPVIR	0.30	KOELMAC	0.20	PHLOHOO	1.90		
LAPPOCC	1.50					PHLOHOO	1.50			TARAOFF	0.20	OPUNPOL	1.50		
CARESTE	1.03					POLYARE	1.50			PHLOHOO	0.10	AGRODAS	1.00		
CALAMON	0.88					AGROSMI	0.25					CALAMON	0.70		
HETEVIL	0.88					LEPISP	0.25					LOMAFOE	0.20		
EUROLAN	0.75					CARESTE	0.05					ALLITEX	0.10		
HORDJUB	0.75											POASAND	0.10		
OPUNPOL	0.75														
BOUTGRA	0.13														
LINURIG	0.13														
PLANPAT	0.13														

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	58.88						37.00		26.90		n/a		n/a
Moss/Lichen	23.44						0.00		0.00		0.00		3.20
Bare Soil	33.28						61.75		52.80		11.00		8.20

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 58. Percent Cover of Vegetation at Site 61.

Site 61 (Dry Mixed Grass - Solonetzic soil) **KP: 410.5-412.5 (Sage Creek)**
Soil stripping: Blade width **Reclamation date: 22/10/96**
Sample area: Stripped RoW **ERS: Loamy**

												2010 Range Health			
												78		88	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 76.6 (40.2)		No Data		No Data		Mean % cover[1] 64.6 (0)		Mean % cover[1] 36.1 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**					**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
SELADEN	22.75					CHENPRA	16.75	AGRODAS	16.40	STIPCOM	14.70	STIPCOM	12.60
STIPCOM	20.63					STIPCOM	12.50	STIPCOM	9.20	AGRODAS	10.70	AGRODAS	7.90
ARTEFRI	16.00					ARTEFRI	10.05	ARTEFRI	4.50	ARTEFRI	4.40	AGROSMI	5.90
AGRODAS	10.13					AGRODAS	6.00	CHENSP	3.90	AGROSMI	3.90	BOUTGRA	2.40
BOUTGRA	9.88					SPHACOC	4.75	STIPVIR	1.50	STIPVIR	1.00	SPHACOC	1.90
KOELMAC	9.50					KOELMAC	4.25	POLYARE	0.30	FESTOVI	0.70	KOELMAC	1.70
EUROLAN	4.13					CALAMON	3.00	SPHACOC	0.30	EUROLAN	0.30	EUROLAN	1.30
PHLOHOO	2.00					LAPPOCC	1.75			LIATPUN	0.30	PHLOHOO	0.60
SPHACOC	1.25					EUROLAN	1.50			TARAOFF	0.30	CARESTE	0.50
CALAMON	1.03					PHLOHOO	1.50			CARESTE	0.20		
ERIGCAE	0.75					STIPVIR	1.50			PHLOHOO	0.10		
OPUNPOL	0.75					LEPIRAM	0.50						
CARESTE	0.58					MONONUT	0.50						
POASAND	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	64.25						47.00		29.20		n/a		n/a
Moss/Lichen	36.00						0.00		0.00		0.00		4.60
Bare Soil	10.00						55.25		52.80		19.10		2.20

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 59. Percent Cover of Vegetation at Site 62.

Site 62 (Dry Mixed Grass - Solonetzic soil) **KP: 410.5-412.5 (Sage Creek)**
Soil stripping: Full width **Reclamation date: 22/10/96**
Sample area: Full RoW **ERS: Li**

										2010 Range Health			
										78		85	
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Mean % cover[1] 63.3 (34)		Mean % cover[1] 20.4 (0)		Mean % cover[1] 30 (0)		Mean % cover[1] 30.4 (0)		Mean % cover[1] 66.1 (0)		Mean % cover[1] 0(0)		Mean % cover[1] 0(0)	
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**
BOUTGRA	15.53	ARTEFRI	6.93	ATRINUT	10.80	ARTEFRI	10.75	ATRINUT	19.90	STIPCOM	26.00	STIPCOM	14.20
AGRODAS	7.28	ATRINUT	4.64	ARTEFRI	6.80	GUTISAR	6.55	GUTISAR	11.90	ARTEFRI	2.60	AGRODAS	11.10
ARTEFRI	4.58	ARTELUD	2.14	GUTISAR	2.40	ATRINUT	3.75	STIPCOM	10.00	ARTECAN	1.70	EUROLAN	4.30
ARTECAN	4.28	CHENSP	2.14	AGRODAS	2.25	AGRODAS	1.75	ARTEFRI	7.70	AGRODAS	1.30	BOUTGRA	2.40
STIPCOM	3.28	LAPPSP	2.14	AGROSMI	1.50	STIPCOM	1.55	ARTECAN	4.80	ATRINUT	1.20	SPHACOC	1.80
PHLOHOO	2.58	GUTISAR	0.86	KOELMAC	1.50	ARTELUD	1.50	KOELMAC	4.50	AGROSMI	0.90	AGROSMI	1.40
KOELMAC	2.28	ARTESP	0.50	ARTELUD	1.05	EUPAMAC	1.50	HYMERIC	1.80	OPUNPOL	0.40	PHLOHOO	1.40
CARESTE	1.88	POASAND	0.36	LAPPOCC	0.55	MONONUT	1.50	SPHACOC	1.80	CARESTE	0.30	KOELMAC	1.00
OPUNPOL	1.88	ANTESP	0.07	STIPCOM	0.50	SPHACOC	0.65	PHLOHOO	1.60	TRAGDUB	0.20	ARTEFRI	0.90
ERIGPUM	1.55			CHENLEP	0.45	KOELMAC	0.30	PENSNIT	1.50			ASTEFAL	0.50
CALAMON	1.03			PHLOHOO	0.30	PHLOHOO	0.25	BOUTGRA	0.30			ALLITEX	0.10
POASAND	0.90			SPHACOC	0.30	LEPIDEN	0.10	POASAND	0.30				
AGROSMI	0.78			BOUTGRA	0.25	CARESTE	0.05						
ATRINUT	0.75			HYMERIC	0.25	LESQSP	0.05						
EUROLAN	0.75			CARESTE	0.15	PLANPAT	0.05						
SPHACOC	0.38			LEPIDEN	0.10	POASAND	0.05						
HYMERIC	0.30			ERIGPUM	0.05	SPORCRY	0.05						
PLANPAT	0.30			PLANPAT	0.05								
CAREPEN	0.25			POASAND	0.05								
VICIAME	0.20			STIPVIR	0.05								
ARTELUD	0.15												
ASTRGIL	0.15												
SEEDLING	0.13												
GUTISAR	0.10												
FORBUNK	0.08												
LINULEW	0.05												
LAPPOCC	0.03												
SOLIMIS	0.03												

Mean % cover	**Control (97-99)**	**On RoW (1997)**	**On RoW (1998)**	**On RoW (1999)**	**On RoW (2001)**	**On RoW (2010)**	**Control (2010)**
Litter	33.13	1.40	1.30	5.00	26.50	n/a	n/a
Moss/Lichen	40.75	0.00	0.00	0.00	0.00	0.20	21.50
Bare Soil	23.08	93.90	63.00	77.30	60.20	14.00	6.40

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Table 60. Percent Cover of Vegetation at Site 63.

Site 63 (Dry Mixed Grass - Solonetzic soil) **KP: 410.5-412.5 (Sage Creek)**
Soil stripping: Full width **Reclamation date: 22/10/96**
Sample area: Full RoW **ERS: Loamy**

										2010 Range Health	
										n/a	n/a
Control 2		**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**	**Control (2010)**
Mean % cover[1] 50 (46)		Mean % cover[1] 16.2 (0)		Mean % cover[1] 36.4 (0.4)		Mean % cover[1] 34.5 (0)		Mean % cover[1] 43.1 (0)		No Data	No Data
Species	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**	**Species**	**% Cover**		
BOUTGRA	15.18	CHENSP	5.36	CHENPRA	12.05	LAPPOCC	12.88	STIPCOM	13.10		
AGRODAS	7.80	ARTEFRI	2.21	ARTEFRI	8.30	ARTEFRI	10.00	ARTEFRI	9.80		
ARTEFRI	4.40	LAPPSP	2.14	LAPPOCC	5.50	AGRODAS	5.19	ARTECAN	6.30		
KOELMAC	4.28	OPUNPOL	2.14	AGRODAS	4.55	ATRINUT	2.88	ATRINUT	4.90		
STIPCOM	3.15	PLANPAT	2.14	BOUTGRA	3.30	ARTELUD	1.15	SPHACOC	3.80		
CARESTE	2.30	CALAMON	1.43	CARESP	0.75	CARESTE	0.65	GAURCOC	1.90		
PHLOHOO	1.43	GUTISAR	0.71	PHLOHOO	0.25	CHENPRA	0.38	CALAMON	1.50		
POASAND	0.40	KOELMAC	0.07			ARTECAN	0.19	POASAND	1.20		
SPHACOC	0.33	PHLOHOO	0.07			BOUTGRA	0.19	BOUTGRA	0.60		
POAJUNC	0.28					HYMERIC	0.19				
PLANPAT	0.23					MONONUT	0.19				
EUROLAN	0.15					PHLOHOO	0.19				
OPUNPOL	0.03					STIPCOM	0.19				
						PLANPAT	0.08				
						AGROSMI	0.04				
						POLYARE	0.04				

Mean % cover	**Control (97-99)**	**On RoW (1997)**		**On RoW (1998)**		**On RoW (1999)**		**On RoW (2001)**		**On RoW (2010)**		**Control (2010)**	
Litter	37.13		1.93		4.20		17.31		33.60		n/a		n/a
Moss/Lichen	66.03		0.00		0.30		0.00		0.00				
Bare Soil	3.65		90.36		59.75		69.81		55.40				

[1] Mean percent cover for herbaceous species followed by mean percent cover of moss and lichen in parenthesis.
[2] Off right-of-way cover values averaged over 3 years, 1997, 1998 and 1999.

Appendix G Sod Salvage Data By Site Over Time

Table 1. Percent Cover of Vegetation at Sod Salvage Site 1
Site labels in data: 01nc10, 01nd10
Site SS1 (Parkland) **KP:**
Soil: PUR(10)/4-5 **Sod replacement late fall 1996**
Sample area: Ditch **ERS: Limy**

On RoW (2010)		Off RoW (2010)	
Mean % cover[1] 0		Mean % cover[1] 0	
Species	**% Cover**	**Species**	**% Cover**
POAPRAT	33.50	STIPCUR	20.00
MEDISAT	27.20	BOUTGRA	9.90
TARAOFF	13.60	CAREPEN	8.50
SENECAN	6.10	AGRODAS	8.00
ASTELAE	4.50	POAPRAT	7.10
STIPVIR	4.20	ARTEFRI	2.60
CIRSARV	3.20	ASTRPEC	2.00
LATHOCH	3.00	FESTHAL	2.00
VICIAME	2.80	KOELMAC	2.00
FESTSP	1.40	ANEMPAT	1.50
ACHIMIL	1.20	VICISPA	1.40
FRAGVIR	1.00	AGROSMI	1.30
ASTEFAL	0.90	COMAUMB	1.20
AGROSUB	0.80	SOLIMIS	1.20
BROMINE	0.80	SYMPOCC	1.00
ARTELUD	0.70	ARTELUD	0.90
GEUMALE	0.70	ASTRDAS	0.80
RUBUIDA	0.70	ROSAARK	0.80
SOLICAN	0.50	CAREOBT	0.70
AGROSMI	0.40	HELIHOO	0.70
SONCULI	0.30	SELADEN	0.70
AGROPEC	0.20	ANDRSEP	0.30
CREPTEC	0.20	CARESTE	0.20
ROSAARK	0.20	POTEPEN	0.20
SISYMON	0.20	CALAMON	0.10
SYMPOCC	0.20	CHENPRA	0.10
COLLLIN	0.10	SPHACOC	0.10
FORBUNK	0.10		

Litter	n/a		n/a
Moss/Lichen	0.80		2.90
Bare Soil	0.60		1.30

[1] % cover of all green vascular plants

Table 2. Percent Cover of Vegetation at Sod Salvage Site 2
SitelLabels in data: 02nc10, 02nd10
Site SS2 (Parkland) **KP:**
Soil: PUR(10)/4-5 **Sod replacement late fall 1996**
Sample area: Ditch **ERS: Limy**

On RoW (2010)		Off RoW (2010)	
Mean % cover[1] 0		Mean % cover[1] 0	
Species	**% Cover**	**Species**	**% Cover**
POAPRAT	37.00	STIPCUR	20.00
STIPCUR	11.60	BOUTGRA	9.90
BROMINE	8.20	CAREPEN	8.50
MEDISAT	8.00	AGRODAS	8.00
AGROSMI	5.70	POAPRAT	7.10
VICISPA	5.00	ARTEFRI	2.60
ACHIMIL	3.90	ASTRPEC	2.00
CAREPEN	3.60	FESTHAL	2.00
SOLIMIS	2.30	KOELMAC	2.00
COMAUMB	1.80	ANEMPAT	1.50
FAGOTAR	1.70	VICISPA	1.40
ASTRDAS	1.00	AGROSMI	1.30
AGROSUB	0.60	COMAUMB	1.20
ASTEFAL	0.60	SOLIMIS	1.20
THERRHO	0.50	SYMPOCC	1.00
LACTPUL	0.30	ARTELUD	0.90
ANDRSEP	0.10	ASTRDAS	0.80
CAREOBT	0.10	ROSAARK	0.80
CHENPRA	0.10	CAREOBT	0.70
		HELIHOO	0.70
		SELADEN	0.70
		ANDRSEP	0.30
		CARESTE	0.20
		POTEPEN	0.20
		CALAMON	0.10
		CHENPRA	0.10
		SPHACOC	0.10

Litter	n/a		n/a
Moss/Lichen	0.50		2.90
Bare Soil	8.60		1.30

[1] % cover of all green vascular plants

Table 3. Percent Cover of Vegetation at Sod Salvage Site 3
Site labels in Data Entry: 01sc10, 01sd10
Site SS3 (Parkland) **KP:**
Soil: PUR(10)/4-5 **Sod replacement late fall 1996**
Sample area: Ditch **ERS: Limy**

On RoW (2010)		Off RoW (2010)	
Mean % cover[1] 0		Mean % cover[1] 0	
Species	% Cover	Species	% Cover
FESTHAL	19.90	FESTHAL	28.00
POAPRAT	8.80	FESTIDA	4.70
SYMPOCC	7.80	STIPCUR	4.60
AGRODAS	6.90	SELADEN	3.90
CAREPEN	6.10	SYMPOCC	3.90
ARTELUD	4.40	HETEVIL	1.90
VICIAME	3.50	CAREOBT	1.50
STIPCUR	3.40	AGRODAS	1.30
TARAOFF	2.90	THERRHO	1.20
STIPVIR	2.20	VICIAME	1.10
ANDRSEP	1.90	CERAARV	1.00
ASTRDAS	1.90	ARTELUD	0.90
KOELMAC	1.50	ASTRDAS	0.90
CIRSUND	1.20	CAREPEN	0.90
FESTIDA	1.00	ARENLAT	0.70
ACHIMIL	0.70	ARTEFRI	0.70
GRINSQU	0.70	COMAUMB	0.50
HETEVIL	0.70	HEDYBOR	0.50
AGROTRA	0.60	ACHIMIL	0.40
THERRHO	0.60	DANTINT	0.40
AGROSCA	0.50	CAREFIL	0.30
ARTEFRI	0.50	PHLOHOO	0.30
AGROSMI	0.40	HELIHOO	0.20
SELADEN	0.40	SOLISP	0.20
SOLIRIG	0.40	AGROSMI	0.10
CARESTE	0.30	AGROTRA	0.10
DANTUNI	0.20	CARESTE	0.10
ERIGPHI	0.20	DANTUNI	0.10
ERYSINC	0.20	KOELMAC	0.10
GAURCOC	0.20	MUHLRIC	0.10
HELIHOO	0.10	POAPRAT	0.10
TRAGDUB	0.10	SPHACOC	0.10
		TARAOFF	0.10

Litter	n/a		n/a
Moss/Lichen	1.00		0.60
Bare Soil	6.00		0.50

[1] % cover of all green vascular plants

Table 4. Percent Cover of Vegetation at Sod Salvage Site 4
Site labels in data: 02sc10, 02sd10
Site SS4 (Cypress Hills) **KP:**
Soil: PUR(10)/4-5 **Sod replacement fall 1996**
Sample area: Ditch **ERS: Limy**

On RoW (2010)		Off RoW (2010)	
Mean % cover[1] 0		Mean % cover[1] 0	
Species	**% Cover**	**Species**	**% Cover**
POAPRAT	7.70	FESTHAL	15.50
AGROSMI	6.80	STIPCUR	6.70
FESTIDA	6.80	SELADEN	5.30
TARAOFF	5.70	AGRODAS	5.00
ACHIMIL	4.90	CAREPEN	4.10
ARTELUD	4.00	CERAARV	4.00
GEUMTRI	4.00	THERRHO	3.40
AGRODAS	3.40	DANTUNI	2.50
CARESTE	3.40	CARESTE	2.20
FESTHAL	3.30	ARTELUD	2.00
GUTISAR	3.00	FESTIDA	2.00
CIRSUND	2.50	ASTEFAL	1.70
ASTEFAL	2.20	DANTINT	1.70
POAJUNC	1.90	ASTRDAS	1.40
STIPCUR	1.80	ANEMPAT	1.30
ANDRSEP	1.30	ARTECAN	1.10
CERAARV	1.30	SOLIMIS	1.10
VICIAME	0.60	ARTEFRI	1.00
ANTEPAR	0.50	KOELMAC	0.90
ARTEFRI	0.50	STELLON	0.80
DANTUNI	0.40	VICIAME	0.80
CAREPEN	0.20	AGROSMI	0.70
KOELMAC	0.20	COMAUMB	0.70
ALLITEX	0.10	ACHIMIL	0.50
CALAMON	0.10	PHLOHOO	0.50
CAMPROT	0.10	STIPVIR	0.50
POASAND	0.10	CALAMON	0.40
SELADEN	0.10	ANDRSEP	0.30
		ARNIFUL	0.20
		CASTLUT	0.10
		POAJUNC	0.10
		POASAND	0.10
Litter	n/a		n/a
Moss/Lichen	1.10		4.50
Bare Soil	6.60		0.20

[1] % cover of all green vascular plants

Table 5. Percent Cover of Vegetation at Sod Salvage Site 5

Site SS5 (Cypress Hills) **KP:**
Soil: PUR(10)/4-5 **Sod replacement fall 1996**
Sample area: Ditch **ERS: Limy**
site label in data: 03sc10, 03sd10

On RoW (2010)		Off RoW (2010)	
Mean % cover[1] 0		Mean % cover[1] 0	
Species	**% Cover**	**Species**	**% Cover**
POAPRAT	25.00	FESTHAL	24.00
FESTHAL	13.30	FESTIDA	4.50
ANTEPAR	7.20	CARESTE	2.60
ROSAWOO	4.30	STIPCUR	2.50
ACHIMIL	3.70	SELADEN	2.20
ARTELUD	3.70	ASTEFAL	1.60
KOELMAC	3.40	ERIGCAE	1.20
ARTEFRI	3.20	AGRODAS	0.90
TARAOFF	2.30	ANEMPAT	0.70
AGROSMI	2.10	ARTEFRI	0.50
MUHLRIC	1.70	CAREPEN	0.50
CAREPEN	1.60	LIATPUN	0.50
CERAARV	1.40	VICIAME	0.50
AGRODAS	1.30	CERAARV	0.30
CARESTE	1.00	ACHIMIL	0.20
CIRSUND	0.70	ASTRDAS	0.20
FESTIDA	0.70	ERIGSP	0.20
STIPVIR	0.70	KOELMAC	0.20
VICIAME	0.70	ARENCON	0.10
ASTEFAL	0.60	FORBUNK	0.10
AGROSCA	0.50	PHLOHOO	0.10
DANTINT	0.50	SOLIMIS	0.10
ARNIFUL	0.30		
SYMPOCC	0.30		
CARELAN	0.20		
POAAMPL	0.20		
STIPCUR	0.20		
CAMPROT	0.10		
CASTLUT	0.10		
DANTUNI	0.10		
GUTISAR	0.10		
POAJUNC	0.10		

Litter	n/a		n/a
Moss/Lichen	1.30		2.20
Bare Soil	0.60		0.00

[1] % cover of all green vascular plants

Grassland Range Health Assessment – SCORE SHEET — Government of Alberta

Site _____ **Observer** _____ **Date** _____

LSD _____ **Quarter** _____ **Section** _____ **Township** _____ **Range** _____ **Meridian** _____

Photo # _____ **GPS Coord (NAD 83) Lat.** _____ **Long.** _____

Estimated useable forage production _____

Special Observations (Climate, changes in management) _____

_____

Scoring (Circle appropriate values and add their sum to the score box)

Dominant Species

Grass & grass likes	Cover%	Forbs	Cover%	Shrubs	Cover%	Trees	Cover%

Plant Community Name (code) _____

1. What kinds of plants are on the site? What is the plant community?

1A	40	27	20	15	0	Comments	**Score**
1B			15	8	0		

2. Are the expected plant layers present?

	10	7	3	0	Comments	**Score**

3. Does the site retain moisture? Is the expected amount of plant litter present?

25	13	0	Comments	**Score**

4. Is there accelerated soil erosion? Site normally stable / unstable (circle)

4.1 Erosion Evidence					Comments	**Score**
	10	7	3	0		
4.2 Bare Soil	5	3	1	0	Human caused bare soil (%)_____	
					Moss & lichen cover (%)_____	

5. Are noxious weeds present?

5.1 Cover	5	3	1	0	Dominant species	Cover%	Density Dist.	Infestation Size	**Score**
5.2 Density Distrbution								ac or ha	
	5	3	1	0	Comments				

Grazing Intensity (Estimated long term) ..... Circle U U-L L-M M M-H H
Observed Utilization _____%

Trend *(apparent - Circle):* **Upward** **Downward** **Stable** **Unkown**

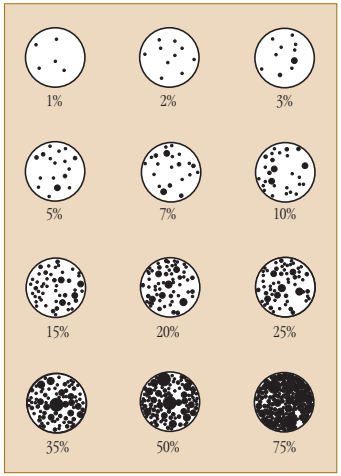
Site Score (Total Score)	**Score**

0% ----------50% ----------75% ---------- 100%

< 50% Unhealthy — 50% - 74% Healthy with Problems — 75 - 100% Healthy

H.2 Range Health Assessment Worksheet

Percent Cover Examples



Density Distribution

Class	Description of abundance in polygon	Distribution	Weeds Score
0	None		3
1	Rare		2
2	A few sporadically occurring individual plants		
3	A single patch		
4	A single patch plus a few sporadically occurring plants		1
5	Several sporadically occurring plants		
6	A single patch plus several sporadically occurring plants		
7	A few patches		
8	A few patches plus several sporadically occurring plants		0
9	Several well spaced patches		
10	Continuous uniform occurrences of well spaced plants		
11	Continuous occurrence of plants with a few gaps in the distribution		
12	Continuous dense occurrence of plants		
13	Continuous occurrence of plants with a distinct linear edge in the polygon		

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Rangeland Health Assessment Litter Thresholds (lb/ac)

Natural Subregion (Soil Zone)	Range Sites	Healthy (Base value and>65%) Average	Healthy (65%)	Healthy but with Problems (65%-35%)	Unhealthy (<35)
Aspen Parkland (Black)	Loamy	1500	(>975)	975 - 525	<525
	Sandy	1100	(>715)	715 - 385	<385
	Sands	800	(>520)	520 - 280	<280
	Choppy sandhills	400	(>260)	260 - 140	<140
Foothills Fescue, Foothills Parkland and Montane (Black)	Thick Black Loamy	1400	(>910)	910 - 490	< 490
	Orthic Black Loamy	1200	(>780)	780 - 420	< 420
	Shallow-to Gravel and Limy	1000	(>650)	650 - 350	<350
	Thin Breaks	500	(>325)	325 - 175	<175
Mixed Grass (Dark Brown)	Loamy (>1100m)*	900	(>585)	585 - 315	<315
	Loamy (<1100m) + Limited	600	(>390)	390 - 210	<210
	Thin Breaks Limey and Shallow to Gravel	300	(>195)	195 - 105	<105
Dry Mixed Grass (Brown)	Loamy	400	(>260)	260 - 140	<140
	Blowout	250	(>160)	160 - 85	<85
	Thin Breaks	150	(>95)	95 - 50	<50

* Elevation > mean greater than

Range Health Assessment

Field Worksheet for Grasslands

What is Rangeland Health?

Range health refers to the ability of rangelands to perform certain important natural functions like:

- produce plant biomass including forage for livestock and wildlife,
- maintain the soil and protect the site from erosion
- capture and beneficially release water,
- cycle nutrients and energy, and
- maintain biological diversity.

Healthy rangelands will provide a long list of goods and services for society. For livestock producers this means sustainable grazing opportunities along with watershed and soil protection.

Why Should I Consider Range Health?

The range health score is a cumulative measure of the 5 factors that you will rate for the representative area of grassland you have selected to monitor. A range health assessment provides a snapshot in time of management impacts on a particular site. Range health monitoring can alert livestock producers to management issues and problems on their rangelands so that management changes can be made.

A Tool for Ranchers and Other Resource Managers

The range health protocol is very similar to the riparian health assessment system that has been developed by the Alberta Cows and Fish Program. Range health builds on the traditional range concept, but like the riparian health assessment, adds additional indicators of important natural processes and functions – things that producers can observe and that are easier to measure than plant community alone. Ranchers, wildlife managers, researchers, the oil and gas industry and other users, are all able to use this tool to successfully judge the health of rangelands.

Government of Alberta

How Do I Assess My Rangeland?

Assessing the health of rangelands involves comparing the ecological functions being performed on a grazed site to a corresponding lightly grazed potential natural plant community or reference plant community (RPC). The RPC shows which native plants are expected to be growing on that kind of site for that particular successional stage. Information on RPC can be derived from a lightly grazed site nearby or in range plant community guides available at www.srd.alberta.ca.

Get a look at as much of the site as possible to ensure that the answers to the questions represent the entire area being represented. You may need to consider subdividing the site into smaller sample areas to provide improved assessment. Alternatively you may decide to only assess a smaller area to represent the site.

Health Categories

Healthy: A health score of 75 or greater.
All of the key functions of health rangeland are being performed.

Healthy with Problems: A health score of 50 to 74%.
Most but not all of the key functions of healthy range are being performed. This score is an early warning that adjustments to management are needed. Recovery to a healthy category can normally be accomplished within a few years.

Unhealthy: A health score of less than 50%.
Few of the functions of healthy range are being performed. Management changes are essential and many years will be required to regain a healthy status..

Need More Information?

This document is an abridged version of the rangeland health assessment.

For more detailed information, please refer to the *"Rangeland Health Assessment for Grassland, Forest and Tame Pasture Field Workbook"* available at your nearest Sustainable Resource Development Lands office or at www.srd.alberta.ca.

Grassland Range Health Questions

Question #1A — What kind of plants are on the site? What's the plant community? (Answer 1A or 1B)

The plant species present on a site will influence the site's ability to perform functions and produce forage. The naturally dominant grasses tend to be the best forage producers whereas heavy grazing pressure can cause a shift to less productive species. Very heavy grazing may result in the invasion of non-native species like Kentucky bluegrass, which lacks drought tolerance and has little value for dormant season grazing. If greater than 70% of the canopy cover consists of non-native species like crested wheat grass, brome, timothy, or Kentucky bluegrass the site should be rated as a modified plant community (Question 1B).

Score: 40 = Plant community closely resembles the natural plant community for the site and alteration due to gazing or other disturbances is minimal. 27 = Plant community shows minor alteration, grazing impact is light to moderate. 20 = Rough fescue is co-dominant with Kentucky bluegrass (or other invasive species). Is an intermediate successional stage where grazing impact is light to moderate. 15 = Plant community shows moderate alteration, grazing impact is moderate to heavy. 15 = Plant community shows significant alteration, grazing impact is heavy to very heavy.

Question #1B — Is the plant community non-native? (Greater than 70% of the canopy cover is non-native species.)

This question reflects the need to identify grassland communities that have been modified to non-native species due to human and/or natural caused disturbances, to an extent where reversion back to the native plant community, regardless of management change or rest is unlikely. Modified communities are most likely to occur in the Montane, Foothills and Parkland subregions. Management of these modified communities should focus on maintaining the health and productivity of the desirable non-native species and preventing occurrence of undesirable weed forage species, nuisance and noxious weeds.

Score: 15 = Site is dominated by desirable and productive non-native species. 8 = Site is a mixture of desirable/productive and weedy/disturbance induced non-native species. Productivity and vigour slightly reduced. 0 = Site is dominated by weedy and disturbance induced non-native species. Productivity, palatability and vigour substantially reduced.

Question #2 — Are the expected layers present?

This question recognizes the various life form layers (tall and medium grasses and forbs; shrubs; mosses and lichens) that occur in a plant community. Each healthy plant community will have a characteristic number of life form layers. If grazing or other disturbances removes or reduces one or more of these layers, the plant community will tend to be less productive and unstable. Examples of things to look for: trampling or excessive shading can reduce moss and lichen; browsing of unpalatable shrubs such as snowberry also indicates a reduced life form layer. Do not downgrade the score for insect damage or drought.

Score: 10 = All life form layers are present; 7 = One life form layer is absent or significantly reduced (reduced by more than 50%). 3 = Two life form layers are absent or significantly reduced. 0 = Three life form layers are absent or significantly reduced.

Question #3 — Does the site retain moisture?

Litter (also called mulch), is the old plant residue left over from previous years' production. Litter protects soil against erosion, enhances forage production and buffers against dry conditions by aiding moisture retention and reducing moisture loss. This question is judged by comparing the litter present with what we would expect to find on the site (see litter thresholds on pack page and by sample raking 1/4m^2 area).

Score: 25 = litter amounts are 65% of normal or greater 13 = litter is 35 - 65% of normal 0 = less than 35%

Question #4 — Is there accelerated soil erosion?

Soil loss is a serious concern since erosion tends to remove the most valuable fractions from the soil (silts, clays and organic matter). Vegetation protects the soil surface from raindrop impact, it detains overland flow, maintains infiltration and permeability and protects the soil surface from erosion. In this question, we compare soil exposure to expected levels for the site and look for evidence of soil erosion beyond natural levels (see percent cover examples on back page).

Score:

Erosion 4.1 10 = no erosion 7 = slight amounts 3 = moderate amounts 0 = extreme amounts

Bare Soil 4.2 5 = less than 10% human-caused 3 = 10 to 20% human-caused 1 = greater than 20 to 50% human-caused 0 = greater than 50% human-caused

Question #5 — Are noxious weeds present?

Weeds normally provide a strong message about range health. They most often invade range where management practices have created available niche space (bare soil, openings in vegetation canopy). These available micro-habitats, normally occupied by range plants, are available to weeds due to over grazing or some other disturbance. Effective grazing management strives to maintain plant vigour and vegetation cover so that all niches are filled by desirable plants and thereby minimize potential for weed invasion (see density distribution table on back page).

Score:

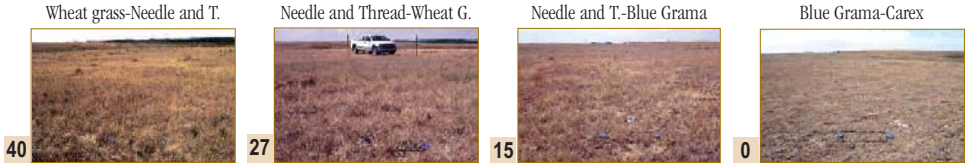
Canopy Cover 5.1 5 = no weeds 3 = less than 1% cover 1 = 1-15% cover 0 = greater than 15% cover

Density Distribution 5.2 5 = no weeds 3 = class 1-3 1 = class 4-7 0 = class 8-12

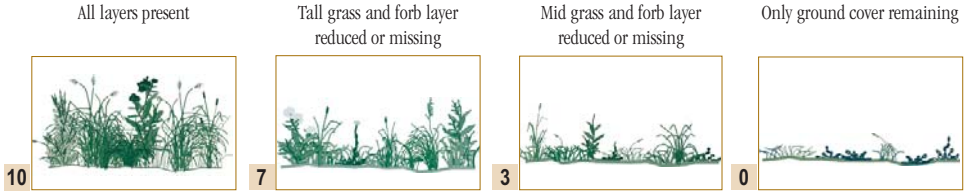
May 2011

Grassland Range Health Visual Aids

Question #1 — What kind of plants are on the site? What's the plant community? (Example for 1A)



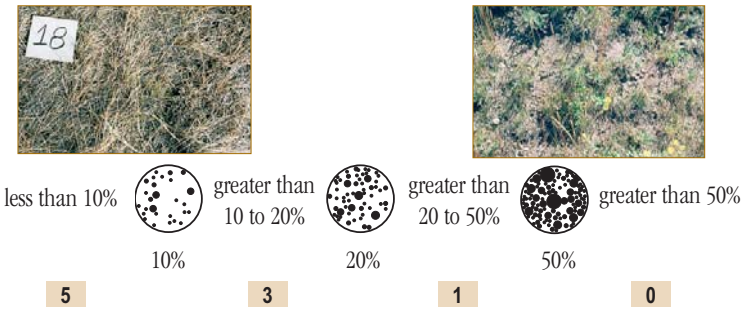
Question #2 — Are the expected plant layers present?



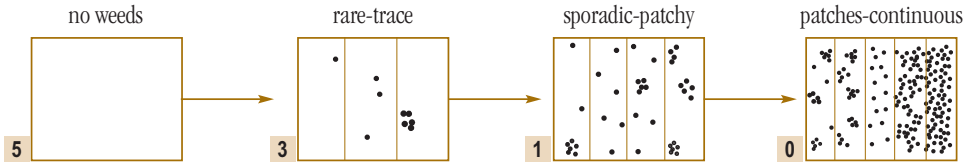
Question #3 — Does the site retain moisture?

SEE Back Page of Booklet for litter threshold examples

Question #4 — Is there accelerated soil erosion? (total exposed soil - natural/expected = human caused bare ground)



Question #5 — Are noxious weeds present?



H3. Range Health Score Sheet Data Summary

Site Code *	Range Health Score Sheet Questions								Grazing Intensity	Observed Utilization	Trend	Range Health Score	Plant Community Code	Plant Community Name
	1A	1B	2.0	3.0	4.1	4.2	5.1	5.2						
02C10	15	0	7	0	10	5	5	5	H	10	Unknown	47		Western porcupine grass-sedge-pasture sagewort (conditional)
02D10	0	0	3	0	10	5	5	5	H	10	Unknown	28		
03C10	15	0	7	0	10	5	5	5	H	5	Unknown	47		Western porcupine grass-sedge-pasture sagewort (conditional)
03S10	15	0	3	0	10	5	5	5	H	20	Stable	43		Western porcupine grass-sedge-pasture sedge (conditional)
04C10	40	0	10	25	10	5	5	5	U	0	Stable	100	MGA1-Conditional	Plains rough fescue - western porcupine grass - sedge (conditional)
04D10	27	0	7	13	10	5	5	5	x	x	x	72		Northern fescue equivalent of dga1
05C10	15	0	3	0	3	3	5	5	x	x	x	34	DMGA13-Degraded	Western porcupine grass - needle-and-thread - sand grass (degraded)
05T10	0	0	3	0	3	3	5	5	H	x	Unknown	19	DMGA13-Degraded	Western porcupine grass - needle-and-thread - sand grass (degraded)
06C10	40-27	0	10	25	10	5	5	5	x	x	x	100-87	No good fit	Western Porcupine grass – blue grama – June grass – blunt sedge (conditional)
06D10	0	0	7	25	0	3	5	5	x	x	x	45		Sheep fescue - western wheatgrass Canada bluegrass
07C10	27	0	10	0	10	5	5	5	x	x	x	62	DMGA15	Wheat grass - needle-and-thread - June grass
07D10	15	8	3	0	3	0	5	5	x	x	x	39	DMGA15-Modified-Degraded	Wheat grass - needle-and-thread - June grass (modified) (degraded)
08C10	15	0	10	25	10	5	5	5	M	0	Unknown	75	DMGA16	Western wheatgrass-sedge-needle and thread
08D10	15	0	7	25	10	5	5	5	L-M	0	Upward	72	DMGA16	Western wheatgrass-sedge-needle and thread (conditional)
09C10	15	0	10	13	10	5	5	5	M-H	25	Unknown	63	DMGA15	Wheat grass - needle-and-thread - June grass
09S10	15	0	3	0	10	3	5	5	M-H	10	Stable	41		Needle and thread-sheep fescue-green needle (conditional)
10C10	27	0	10	25	10	5	5	5	M	x	x	87	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
10D10	27	0	7	13	7	0	5	5	M	x	Stable	64	DMGA2-Degraded	Needle-and-thread - wheatgrass (degraded)
11C10	15	0	7	0	10	5	5	5	M-H	0	Unknown	47	DMGA3-Degraded	Needle and thread-June grass-blue grama grass (degraded)
11D10	15	0	7	0	10	5	5	5	M-H	0	Upward	47	DMGA3	Needle-and-thread - June grass - blue grama grass
12C10	27	0	10	13	10	5	5	5	L-M	0	Unknown	75	DMGA3	Needle-and-thread - June grass - blue grama grass
12D10	15	0	3	0	7	1	5	5	x	0	x	36	DMGA3-(Conditional)	Sheep fescue-wheatgrass-green needle (conditional)
13C10	40	0	10	25	10	5	5	5	L-M	x	Stable	100	DMGA47	Needle-and-thread - blue grama - northern wheatgrass
13D10	15	0	3	25	3	0	5	5	L-M	x	Stable	46		Seed mix
14C10	27	0	7	15	7	5	5	5	M-H	x	Unknown	71		Needle-&-thread - June Grass - Western hweatgrass
14D10	15	0	3	25	7	3	5	5	M-H	x	x	63		Seed mix
15C10	15	0	7	13	10	5	5	5	M-H	40	Unknown	60	DMGA3	Needle-and-thread - June grass - blue grama grass
15D10														
16C10	15	0	10	25	10	5	3	1	M-H	0	Upward	69	DMGA22-Degraded	Needle-and-thread - blue grama grass - June grass (degraded)
16D10	27	0	7	25	10	5	3	1	L-M	x	Upward	78	DMGA22-Conditional	Needle-and-thread - blue grama grass - June grass (conditional)
19C10	15	0	7	0	7	3	5	5	M-H	x	x	42	DMGA24-Degraded	Silver sagebrush/needle-and-thread - western wheat grass - blue grama grass (degraded)
19N10	15	0	3	0	3	1	5	5	M-H	x	Upward	32	DMGA24-Degraded	Silver sagebrush/needle-and-thread - western wheat grass - blue grama grass (degraded)
20C10	15	0	7	25	10	5	5	5	M	0	x	72	MGA1	Plains rough fescue - western porcupine grass - sedge
20D10	15	0	3	25	10	5	5	5	M	0	Unknown	68		Western wheatgrass-green needle- northern wheatgrass (conditional)
21C10	40	0	10	0	10	0	5	5	M	x	x	70	MGA1	Plains rough fescue - western porcupine grass - sedge
21D10	20	0	3	0	7	0	5	5	M-H	x	Upward	40	MGA1	Plains rough fescue - western porcupine grass - sedge
22C10	27	0	10	0	10	5	5	5	M	x	x	62	MGA5	Needle-and-thread grass - plains rough fescue - northern wheatgrass
22D10	15	0	7	13	10	5	5	5	x	x	x	60		
23C10	15	0	7	0	10	5	5	5	M-H	0	Unknown	47	MGA3	Needle-and-thread - June grass
23D10	15	0	3	0	10	5	5	5	M-H	0	Upward	43	MGA3	Needle-and-thread - June grass
24D10	27	0	7	25	10	5	5	5	x	x	x	84	MGA2	Western porcupine grass - plains rough fescue

Site Code *	Range Health Score Sheet Questions								Grazing Intensity	Observed Utilization	Trend	Range Health Score	Plant Community Code	Plant Community Name
	1A	1B	2.0	3.0	4.1	4.2	5.1	5.2						
25C10	40	0	10	13	10	5	5	5	x	x	x	88	MGA2	Western porcupine grass - plains rough fescue
25D10	27	0	7	13	7	3	5	5	x	x	x	67	MGA2	Western porcupine grass - plains rough fescue
26C10	27	0	10	25	10	5	5	5	U-L	0	Unknown	87	MGA1	Plains rough fescue - western porcupine grass - sedge
26S10														
28C10	27	0	10	13	10	5	5	5	x	x	x	75	DMGA35	Needle-and-thread - June grass - blue grama grass
28D10	15	0	7	25	10	5	5	5	x	x	Stable	72	DMGA35	Needle-and-thread - June grass - blue grama grass
29C10	27	0	7	25	10	5	5	5	M	x	Upward	84	DMGA15	Wheat grass - needle-and-thread - June grass
29D10	15	0	3	25	10	3	5	5	M	x	Upward	66		
30C10	40	0	10	13	7	5	5	5	U	0	Stable	85	DMGA15	Wheat grass - needle-and-thread - June grass
30N10	15	0	7	25	7	5	5	5	U	0	Stable	69	DMGA15	Wheat grass - needle-and-thread - June grass
33C10	15	0	10	0	10	5	5	5	x	x	x	50		Crested wheatgrass - blue grama - selaginella
33D10	0	15	3	13	7	5	5	5	x	x	x	53	DMGA17	Needle-and-thread - Sandberg bluegrass
34C10	27	0	7	0	10	5	5	5	M-H	0	Unknown	59	DMGA3	Needle-and-thread - June grass - blue grama grass
34D10	15	0	3	0	10	3	5	5	M-H	x	Unknown	41	DMGA3	Needle-and-thread - June grass - blue grama grass
35C10	40	0	7	13	7	5	5	5	x	x	x	82	DMGA2	Needle-and-thread - wheatgrass
35D10	15	0	7	0	7	1	5	5	x	x	x	40	DMGA15	Wheat grass - needle-and-thread - June grass
40C10	27	0	7	25	10	5	5	5	M	0	Unknown	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
40N10	27	0	7	25	10	5	5	5	M	0	Upward	84		Western porcupine grass - low sedge - Kentucky blue grass (conditional)
41C10	27	0	7	25	10	5	5	5	M	0	Unknown	84	Refer to Metiskow RA	Sand reed grass - sun-loving sedge - western porcupine grass
41N10	15	0	3	25	10	5	5	5	M	0	Upward	68	Refer to Metiskow RA	Sand reed grass - western porcupine grass - low sedge
42C10	15	0	7	13	10	5	5	5	L-M	x	x	60	No good fit	Blunt sedge - sun-loving sedge - needle-and-thread
42N10	27	0	7	0	10	3	5	5	L-M	x	x	57	No good fit	
43C10	x	x	x	x	x	x	x	x	L-M	x	x	x	No good fit	Sun-loving sedge - Blunt sedge - needle-and-thread
43N10	x	x	x	x	x	x	x	x	x	x	x	x	No good fit	
44C10	x	x	x	x	x	x	x	x	x	x	x	x	No good fit	Blunt sedge - low sedge - needle-and-thread
44N10	x	x	x	x	x	x	x	x	x	x	x	x	No good fit	
45C10	x	x	x	x	x	x	x	x	M	x	Upward	x	No good fit	Blunt sedge - low sedge - sand reed grass - needle-and-thread
45N10	x	x	x	x	x	x	x	x	x	x	x	x	No good fit	
46C10	40	0	10	25	10	5	5	5	M	x	Upward	100	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
46N10	27	0	7	25	10	5	5	5	M	x	x	84	DMGA2-Conditional	Needle-and-thread - wheatgrass (conditional)
47C10	27	0	10	25	7	5	5	5	M	x	Upward	84	DMGA15	Wheat grass - needle-and-thread - June grass
47N10	15	0	7	25	10	5	5	5	M	0	Upward	72		
48C10	27	0	10	13	10	5	5	5	M	0	Upward	75	DMGA47	Needle-and-thread - blue grama - northern-wheatgrass
48N10	15	0	7	0	10	5	5	5	L-M	0	Upward	47	DMGA47-Conditional	Needle-and-thread - blue grama - northern-wheatgrass (conditional)
49C10	27	0	7	25	10	5	5	5	M	0	Upward	84	DMGA48	Blue grama - needle-and-thread
49N10	15	0	3	0	10	5	5	5	M	0	Upward	43	DMGA48-Conditional	Blue grama - needle-and-thread (conditional)
52C10	40	0	7	25	10	0	5	0	L-M	x	x	87	MGA1	Plains rough fescue - western porcupine grass - sedge
52N10	15	0	3	0	10	3	5	5	M	x	Unknown	41	MGA1-Conditional-Degraded	Plains rough fescue - western porcupine grass - sedge (conditional) (degraded)
53C10	20	0	10	0	10	5	5	5	M	x	Unknown	55	MGA1	Plains rough fescue - western porcupine grass - sedge
53N10	20	0	7	0	10	3	5	5	M	x	Upward	50	MGA1	Plains rough fescue - western porcupine grass - sedge
54C10	27	0	10	13	10	5	5	5	x	x	x	75	DMGA2	Needle-and-thread - wheatgrass
54N10														

Site Code *	Range Health Score Sheet Questions								Grazing Intensity	Observed Utilization	Trend	Range Health Score	Plant Community Code	Plant Community Name
	1A	1B	2.0	3.0	4.1	4.2	5.1	5.2						
55C10	27	0	7	0	10	5	5	5	M	0	Unknown	59	NGF	No good fit
55N10	27	0	7	13	10	3	5	5	M-H	x	Upward	70		
56C10	15	0	3	0	10	5	5	5	H	0	Unknown	43	MGA3	Needle-and-thread - June grass
56N10	15	0	7	0	10	3	5	5	M-H	0	Unknown	45	MGA3	Needle-and-thread - June grass
57C10	40	0	10	0	10	5	5	5	L-M	x	x	75	MGA1	Plains rough fescue - western porcupine grass - sedge
57N10	40	0	7	0	7	1	5	5	x	x	x	65	MGA1-Conditional	Plains rough fescue - western porcupine grass - sedge (conditional)
58C10	40	0	10	13	7	5	5	5	M	x	Upward	85	DMGC1	Silver sagebrush/western wheatgrass
58N10	40	0	10	25	7	3	5	5	M	0	Upward	95	DMGC1	Silver sagebrush/western wheatgrass
59C10	15	0	3	0	3	1	5	5	L-M	x	Unknown	32	DMGC1	Silver sagebrush/western wheatgrass
59N10	15	0	7	0	10	5	5	5	M-H	x	x	47	DMGC1	Silver sagebrush/western wheatgrass
60C10	40	0	10	25	7	5	5	5	x	x	x	97	DMGA3	Needle-and-thread - June grass - blue grama grass
60N10	27	0	3	25	7	3	5	5	x	x	x	75	DMGA3	Needle-and-thread - June grass - blue grama grass
61C10	40	0	10	13	10	5	5	5	L-M	x	Upward	88	DMGA2	Needle-and-thread - wheatgrass
61N10	27	0	3	25	10	3	5	5	M	x	Unknown	78	DMGA2	Needle-and-thread - wheatgrass
62C10	40	0	7	13	10	5	5	5	x	x	x	85	DMGA5	Needle-and-thread - northern-wheatgrass - plains reed grass
62N10	27	0	3	25	10	3	5	5	x	x	x	78	DMGA5	Needle-and-thread - northern-wheatgrass - plains reed grass

*** D=disturbed soils; N=Natural recovery; S=Spoil storage on grass; T=Travel lane on grass**

Appendix I Site Data & Environmental Variables

I.1 Site Locations

Site #	2010 Survey Date	Easting	Northing (UTM Zone 12 NAD83)	Target Legal Land Description
1	No	485068	5813515	NW 27-40-9-W4
2	28-Jul	484916	5785026	NE 28-37-9-W4
3	28-Jul	486476	5774006	SE-27-36-9 W4
4	29-Jul	487707	5754690	SW26-34-9-W4
5	29-Jul	488121	5730357	SE 11-32-9-W4
6	08-Aug	488150	5711044	SW11-30-9-W4
7	08-Aug	488450	5696252	SW26-28-9-W4
8	30-Jul	488460	5688281	SW 35-27-9-W4
9	30-Jul	487340	5664971	NW 15-25-9-W4
10	26-Jul	485561	5652481	SW 9-24-9-W4
10	26;July	485561	5652481	SW 9-24-9-W4
11	26-Jul	485727	5639333	NW28-22-9-W4
12	10-Aug	482458	5633718	SW 7-22-9-W4
13	10-Aug	484790	5588116	SW 20-17-9-W4
14	10-Aug	484772	5566219	NW 8-15-9-W4
15	11-Aug	491151	5553377	NE35-13-9-W4
16	09-Jul	499662	5542130	NW26-12-8-W4
17	Drop	500277	5540161	NW 23-12-8-W4
18	Drop	501292	5538419	NW 13-12-8-W4
19	09-Jul	516074	5522559	NE 29-10-6-W4
20	28-Jun	521740	5510987	NW 24-9-6-W4
20D	20-Jun	521740	5510987	NW 24-9-6-W4
21	08-Jul	526601	5500462	SW 21-8-5-W4
22	13-Jul	530925	5493200	NE 26-7-5-W4
23	13-Jul	533221	5488096	SW7-7-4-W4
24D	13-Jul	534656	5483597	NW29-6-4-W4
24	13-Jul	534656	5483597	NW29-6-4-W4
25	13-Jul	537767	5479987	SE16-6-4-W4
26	13-Jul	540238	5476931	NW2-6-4-W4
27	Drop	544932	5467743	NW 5-5-3-W4
28	10-Aug	547224	5462995	NE21-4-3-W4

Site #	2010 Survey Date	Easting	Northing (UTM Zone 12 NAD83)	Target Legal Land Description
29	30-Jun	549314	5457505	SE 3-4-3-W4
30	30-Jun	550078	5455397	SW 35-3-3-W4
31	Drop	551634	5449163	SW 12-3-3-W4
32	Drop	551642	5445514	SW 36-2-3-W4
33	10-Aug	552560	5439967	NE 12-2-3-W4
34	10-Aug	551988	5433935	NW24-1-3-W4
35	10-Aug	551440	5431268	SE14-1-3-W4
36	Drop	551490	5431231	NW 6-1-2-W4
40	27-Jul	488559	5721580	NE 11-31-9-W4
41	27-Jul	488566	5721671	NE 11-31-9-W4
42	27-Jul	488528	5720436	SE 11-31-9-W4
43	27-Jul	488557	5720511	SE 11-31-9-W4
44	28-Jul	488550	5722118	SE 14-31-9-W4
45	28-Jul	488506	5722133	SE 14-31-9-W4
46	06-Jul	484784	5589897	SW29-17-9-W4
47	06-Jul	484751	5590126	NW29-17-9-W4
48	06-Jul	484760	5590278	NW29-17-9-W4
49	06-Jul	484835	5590623	NW29-17-9-W4
50	Drop	484570	5577448	NW 17-16-9-W4
51	Drop	484575	5577498	NW 17-16-9-W4
52	05-Jul	526285	5501107	SW21-8-5-W4
53	05-Jul	526355	5501008	SW21-8-5-W4
54	13-Jul	541773	5473186	SW25-5-4-W4
55	13-Jul	541814	5473123	SW25-5-4-W4
56	13-Jul	541355	5473926	NW25-5-4-W4
57	13-Jul	541355	5473926	NW25-5-4-W4
58	29-Jun	551409	5446605	NW36-2-3-W4
59	29-Jun	551522	5446887	NW36-2-3-W4
60	29-Jun	551570	5448157	NW1-3-3-W4
61	29-Jun	551604	5448444	NW1-3-3-W4
62	29-Jun	551598	5448176	NW1-3-3-W4
63	missed	551677	5448203	NW1-3-3-W4
SSS1	07-Jul	527840	5498415	NE 9-8-5-W4
SSS2	07-Jul	527723	5498175	NE 9-8-5-W4
SSS3	08-Jul	527777	5498043	NE 9-8-5-W4
SSS4	29-Jul	485124	5811081	NW15-40-9-W4
SSS5	29-Jul	485126	5811192	NW15-40-9-W4

I.2 Site Data and Environmental Variables

Site Label	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Version of Natural Subregion & Soil	GVI Map Polygon ERS Code	ERS from Data Sheet plus Inference	Code	2010 Data Set
01D	Disturbed soil	1	spring 97		stHND(10)/4	Aspen Parkland	Lo/Len	Lo	1	no
02D	Disturbed soil	1	spring 97	Ribstone Plain	FNR(5)/2-3 Sol	Aspen Parkland	TB-Li/Lo/BdL-Ltc	Lo	1	yes
03S	Spoil	None - not stripped	fall 96		HKR(10)/3 Sol	Aspen Parkland	BlO-Lo/--/Len	BlO		yes
04D	Disturbed soil	2	fall 96	Northern fescue - Castor	HKR(5)/3 Sol	Fescue/ MG Transition	BlO/--/Lo-Len	BlO	2	yes
05T	Travel	None - not stripped	fall 96	Sounding Creek Plain	RIB(10)/3	DMG Sandy	Sa-CS/BlO/Len-Sb	Sa		yes
06D	Disturbed soil	3	fall 96	Berry Creek Plain	YTW(15)/3	DMG Sandy	BlO/Sa-Len-Sb-Ltc	BlO	3	yes
07D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(10)/3	DMG Solonetzic	BlO/--/Lo-TB	BlO	4	yes
08D	Disturbed soil	4	fall 96	Berry Creek Plain	HUK(5)/3	DMG Solonetzic	BlO/TB-Ltc-SL-Len	BlO	4	yes
09S	Spoil	None - not stripped	fall 96	Berry Creek Plain	HDY(10)/2	DMG Solonetzic	BlO/--/Lo-TB	BlO		yes
10S	Spoil (97,98,99,01,10)	None - not stripped	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	DMG Solonetzic	BlO-Lo/--/Len-Li-TB	Lo		yes

Site Label	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Version of Natural Subregion & Soil	GVI Map Polygon ERS Code	ERS from Data Sheet plus Inference	Code	2010 Data Set
10D	Disturbed soil (2010)	4	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	DMG Solonetzic	BlO-Lo/--/Len-Li-TB	Lo	4	yes
11D	Disturbed soil	3	fall 96	Berry Creek Plain	BVL(10)/4 Sandy	DMG Sandy	BlO/--/Li-Len	Lo	3	yes
12D	Disturbed soil	4	spring 97	Rainy Hills Upland	ROL(10)/3-4 Sol	DMG Solonetzic	Lo/BlO/Li-Len	Lo	4	yes
13D	Disturbed soil	3	spring 97	Rainy Hills Upland	TIY(10)/3-4	DMG Sandy	Lo/BlO	Lo	3	yes
14D	Disturbed soil	4	spring 97	Foremost Plain	scROL(10)/2-3	DMG Solonetzic	Lo-BlO	Lo	4	yes
15D	Disturbed soil	4	fall 96	Foremost Plain	scMAB(10)/3	DMG Solonetzic	Lo/Li-LenT/BlO	Lo	4	yes
16D	Disturbed soil	3	fall 96	Foremost Plain	RB(5)/7	DMG Sandy	TB	TB	3	yes
17D	Disturbed soil	NR	fall 96	Foremost Plain	RB(5)/7	DMG Solonetzic	Li	BdL	0	no
18D	Disturbed soil	4	fall 96	Foremost Plain	HMS(5)/7	DMG Solonetzic	BdL-TB/Li/Ov	TB	4	no
19D	Disturbed soil	NR	spring 97	Bindloss Plain	HMS(5)/4-5	DMG Solonetzic	Li-TB/-BdL	Ov		yes
20S	Spoil	None - not stripped	fall 96	Cypress Slope	PUR(10)/3-4	DMG Solonetzic	Lo/Li-BlO/LtcH	Lo		yes
20D	Disturbed soil	2	fall 96	Cypress Slope	PUR(10)/3-4	Fescue/ MG Transition	Lo/Li-BlO/LtcH	Lo	2	yes

Site Label	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Version of Natural Subregion & Soil	GVI Map Polygon ERS Code	ERS from Data Sheet plus Inference	Code	2010 Data Set
21D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10)/3-4	Fescue/ MG Transition	Lo/LtcH-Li/BlO	Lo	2	yes
22D	Disturbed soil	2	fall 96	Cypress Hills	PUR(10)/3-4	Fescue/ MG Transition	BlO-Li/Ov-Lo	Ov	2	yes
23D	Disturbed soil	2	fall 96	Cypress Hills	stPUR(10)/4-5	Fescue/ MG Transition	Lo/Li/LtcH	Li	2	yes
24T	Travel (97,98,99,01)	None - not stripped	fall 96	Cypress Hills	PUR(10)/5-6	Fescue/ MG Transition	Lo/--/LenS	Lo		no
24D	Disturbed soil (2010)	2	fall 96	Cypress Hills	PUR(10)/5-6	Fescue/ MG Transition	Lo/--/LenS	Lo	2	yes
25D	Disturbed soil	2	fall 96	Cypress Hills	PUR(20)/3-4	Fescue/ MG Transition	Lo/BlO	Lo	2	yes
26D	Disturbed soil	2	fall 96	Cypress Hills	stHKR(10)/4-5	Fescue/ MG Transition	Lo/Li-BlO/LtcS	Li-BlO	2	yes
26S	Spoil	None - not stripped	fall 96	Cypress Hills	stHKR(10)/4-5	Fescue/ MG Transition	Lo/Li-BlO/LtcS	Li-BlO		yes
27S	Spoil	None - not stripped	fall 96	?	HDY(10)/3	DMG Solonetzic	BlO/Lo	BlO		yes
28D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/4	DMG Solonetzic	Lo-BlO/Li	BlO	4	yes
29D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/4	DMG Solonetzic	BlO/--/Lo	BlO	4	yes
30D	Disturbed soil	NR	fall 96	Wildhorse Plain	GLS(0)/2	DMG Solonetzic	BlO/Lo	BlO	0	yes

Site Label	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Version of Natural Subregion & Soil	GVI Map Polygon ERS Code	ERS from Data Sheet plus Inference	Code	2010 Data Set
31S	Spoil	None - not stripped	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	Lo/TB/BlO-LtcH	Lo		no
32T	Travel	None - not stripped	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	Lo/BlO	BlO		no
33D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(5)/3	DMG Solonetzic	Ov/Lo-SL-LtcH	Ov	4	yes
34D	Disturbed soil	4	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	Lo/BlO	BlO	4	yes
35D	Disturbed soil	3	fall 96	Wildhorse Plain	ANO(10)/2-3	DMG Sandy	Lo/--/BlO	Lo	3	yes
36S	Spoil	None - not stripped	fall 96	Wildhorse Plain	MAB(10)/4	DMG Solonetzic	Lo/--/BlO	Lo		no
40D	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	BlO/Sa-Len-Sb/CS	Sa	0	yes
41D	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	BlO/Sa-Len-Sb/CS	Sa	0	yes
42D	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	BlO/Sa-Len-Sb/CS	Sa	0	yes
43D	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	BlO/Sa-Len-Sb/CS	Sa	0	yes
44D	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	BlO/Sa-Len-Sb/CS	CS	0	yes
45D	Disturbed soil	NR	fall 96	Sounding Creek Plain	VST(10)/2-3	DMG Sandy	BlO/Sa-Len-Sb/CS	CS	0	yes

Site Label	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Version of Natural Subregion & Soil	GVI Map Polygon ERS Code	ERS from Data Sheet plus Inference	Code	2010 Data Set
46D	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	BlO/Lo	BlO	0	yes
47D	Disturbed soil	NR	summer 97	Rainy Hills Upland	HUK(10)/3	DMG Solonetzic	BlO/Lo	BlO	0	yes
48D	Disturbed soil	NR	summer 97	Rainy Hills Upland	DHS(10)/3	DMG Solonetzic	BlO/Lo	BlO	0	yes
49D	Disturbed soil	NR	summer 97	Rainy Hills Upland	ROL(10)/3	DMG Solonetzic	BlO/Lo	BlO	0	yes
50D	Disturbed soil	NR	summer 97	?	GLS(5)/2	DMG Solonetzic	LenT/LenS/LenA	LenS	0	no
51D	Disturbed soil	NR	summer 97	?	GLS(5)/2	DMG Solonetzic	LenT/LenS/LenA	LenS	0	no
52D	Disturbed soil	NR	fall 1996	Cypress Slope	PUR(10)/3-4	Fescue/ MG Transition	Lo/BlO/LenSP-Li	Lo	0	yes
53D	Disturbed soil	NR	fall 96	Cypress Slope	PUR(10)/3-4	Fescue/ MG Transition	Lo/BlO/LenSP-Li	Lo	0	yes
54D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/3-4	Fescue/ MG Transition	Lo/Li-BlO/LenS	Li	6	yes
55D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/3-4	Fescue/ MG Transition	Lo/Li-BlO/LenS	Lo	6	yes

Site Label	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Version of Natural Subregion & Soil	GVI Map Polygon ERS Code	ERS from Data Sheet plus Inference	Code	2010 Data Set
56D	Disturbed soil	1:1 Festhal:Stipcom + seed mix 2	fall 96	Cypress Hills	HKR(10)/3-4	Fescue/ MG Transition	Li-TB/Ov-LtcS	Li-TB	6	yes
57D	Disturbed soil	100% Festhal	fall 96	Cypress Hills	HKR(10)/3-4	Fescue/ MG Transition	Li-TB/Ov-LtcS	Li	7	yes
58D	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	LenT/SL	Ov	0	yes
59D	Disturbed soil	NR	fall 96	Wildhorse Plain	ROL(10)/3	DMG Solonetzic	SL/LtcS	Ov	0	yes
60D	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	Lo/BlO	Lo	0	yes
61D	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	Lo/Li	Lo	0	yes
62D	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	Lo/BlO	Li	0	yes
63D	Disturbed soil	NR	fall 96	Wildhorse Plain	HUK(10)/3	DMG Solonetzic	Lo/Li	Lo	0	no
SS1	Sod salvage Site	Sod salvage Site	fall 96		PUR(10)/4-5		Lo/BlO-Li/LenSP	Li		yes
SS2	Sod salvage Site	Sod salvage Site	fall 96		PUR(10)/4-5		Lo/BlO-Li/LenSP	Lo		yes
SS3	Sod salvage Site	Sod salvage Site	fall 96		PUR(10)/4-5		Lo/BlO-Li/LenSP	Lo		yes

Site Label	Disturbance Zone	Seed Mix	Final Clean-up Date	Ecodistrict	Express Soil Data	Express Version of Natural Subregion & Soil	GVI Map Polygon ERS Code	ERS from Data Sheet plus Inference	Code	2010 Data Set
SS4	Sod salvage Site	Sod salvage Site	fall 96		HND(15)/4		Lo/Len	Lo		yes
SS5	Sod salvage Site	Sod salvage Site	fall 96		HND(15)/4		Lo/Len	Lo		yes