Revegetation of Wellsite Disturbances on Fescue Prairie in East-Central Alberta. [*]**Add Figures

by

Jay Woosaree and Michelle Pahl
Alberta Research Council
Bag 4000, Vegreville, Alberta. T9C 1T4

Introduction

Past methods of revegetating disturbed land in Alberta, using a limited number of commercially-available species, have resulted in a net loss of biodiversity. Many commercial forage species are highly competitive and their use in the past have not allowed original prairie species to return to reclaimed sites. In some cases, these forage species have migrated from reclaimed areas and invaded the surrounding native prairie. Smooth brome grass, alfalfa, crested wheatgrass, Kentucky bluegrass, and Canada bluegrass are all considered invasive plants of natural habitats (White et al. 1995). Alteration of the plant community from native mixed prairie to crested wheatgrass or Russian wildrye has been found to significantly reduce soil quality (Dormaar et al. 1995). The use of these forage species in reclamation has resulted in landscape fragmentation incompatible with land-use objectives on rangelands or in conservation areas. At present, these species are not recommended and most wellsites located on native prairie are revegetated with a limited mix of available native grass cultivars. However, species diversity and compatibility of reclaimed areas with the surrounding native vegetation has not appreciably increased with the use of this species mix. Problems associated with disturbances of native prairie have been compounded by a poor understanding of grassland ecosystem processes and practices used to recover them. As a result, industry and government have indicated that improved methods of revegetation of wellsite disturbances and new guidelines for determining reclamation success were required. Most native plant species are less aggressive than forage species used in the past, however, their ability to facilitate recovery of native prairie on disturbed sites is unknown and requires documentation.

Project Goal

The goal of this project was to develop practical methods of revegetating wellsite disturbances on native prairie that will eventually return the site to sound ecological structure and function similar to that of the surrounding undisturbed prairie within an acceptable period of time. This five-year field study takes a revised look at what constitutes successful reclamation on abandoned wellsites.

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Practical means the method can be applied under operational conditions with good chances of success at reasonable cost.

Ecological Structure means the site will have soils and vegetation resembling that of native prairie but were not necessarily identical.

Ecological Function means maintaining the integrity of prairie ecosystem processes such as nutrient cycling, biomass production, etc.

Acceptable Period of Time means that other reclamation objectives will be taken into consideration including economic and social values.

Recovery of disturbed lands occurs through natural processes collectively referred to as ecological succession. In the past, land reclamation efforts have focused mainly on a single objective, ie. controlling soil erosion. This often resulted in reclaimed landscapes that were not compatible with the surrounding areas. Current changes in public perceptions have caused a corresponding change in reclamation objectives to include ecological considerations. Natural recovery processes act extremely slowly, often in excess of 10 years, and allow considerable potential for erosion to occur. Although erosion control is still of prime importance, current land reclamation efforts must also attempt to manipulate successional processes to accelerate recovery of these disturbed areas. Over time, reclaimed sites should blend with the surrounding undisturbed landscape both from an aesthetic and resource-use point of view.

Research approach

The Northern Fescue Prairie and the Dry Mixed Grass Prairie have been selected for study because of the volume of industrial activities occurring on them. The northern fescue grassland project was further broken down into sub-projects based on soil and plant community type: (1) mesic Chernozemic sites and (2) sandy sites.
Due to the new guidelines regarding minimum disturbance on native prairie, suitable full-scale disturbances were difficult to find. In the summer of 1997, three wellsites were selected within one of the sub-projects which focus on sandy sites.
Six sites were established (Figure 1) including three wellsites on mesic Chernozemic soils (1996) and three on sandy soil within the Dark Brown Soil zone (1997). Because the plant communities were very different on these two soil types, two studies were initiated in this sub-project. Five revegetation treatments were applied to each site representing varying degrees of species diversity and resemblance of the undisturbed plant community (Table 1).

Results

The soil stripping, storage, and replacement procedures used in the construction and reclamation of the well sites had few effects on soil parameters. The greatest effects due

to disturbance were an increase in available soil nitrogen, nitrification and increased microbial activity (data not shown). Re-assessment of soil parameters in year five of the study will evaluate the ability of treatments to ameliorate recovery of soil processes to pre-disturbance levels.

To gain an understanding of plant community dynamics on the revegetated sites, an index of relative importance for each species or species group was determined for each treatment and compared over two years. Importance values reflect how species or species groups dominated each treatment stand.

Mesic Chernozemic Sites

All seeded treatments established well in the year of seeding (1997). The importance of weeds was dramatically higher in the Natural Recovery treatment than on all the other treatments (Figure 2a). This result is not surprising considering that species planted in each of the seeded treatments were likely to compete for site resources (water, nutrients, light) and thus prevented weeds from establishing. Although the importance of weeds of all seeded treatments was higher than that of the Reference (undisturbed control), little difference in the importance of weeds was found among seeded treatments. This may reflect a similar degree of competitiveness among seeded treatments. In addition, the importance of native forbs was also higher in the Natural Recovery treatment equaling that found for the Reference (Figure 2b). As for weed species, the importance of native forbs on all seeded treatments were essentially the same. Importance of native forbs on all treatments was relatively high in comparison to the Reference. Surprisingly, results suggest that different seed treatments did little to impede native forb establishment but did hinder establishment of weeds. Importance of weeds or native forbs was not associated with importance of wheat grasses, the most competitive species group.

Rough fescue is the characteristic grass of the fescue grasslands. The same rate of rough fescue (pure live seed) was included in all seeded treatments. Results show that the importance of rough fescue was much lower than the importance of wheat grasses on all seeded treatments (Figure 2d). In addition, the importance of rough fescue appeared to be diminishing over time. The present findings are not entirely unexpected since rough fescue is a very slow growing species and other grass species were expected to grow faster and increase their cover and importance relative to rough fescue. However, the rate of decline in the importance of rough fescue does appear to be associated with importance of wheat grasses. The Reclamation treatment had highest importance of wheat grasses and the sharpest decline in the importance of rough fescue over the two years. The Simple treatments had the lowest importance of wheat grasses and least decline in the importance of rough fescue.

Sandy Sites Sites

Establishment for all seeded species was slow on sandy sites and many grasses, such as Indian rice grass only emerged in the second year after seeding (1998). The importance of weeds was higher in the Natural Recovery treatment than on all the other treatments (Figure 3a), however weed levels were high for all treatments compared with the Reference (undisturbed control). This reflected the low, overall establishment of seeded species on sandy sites allowing weedy species to establish within all seeded treatments. However, the importance of weeds appears to be sharply declining over time in the Reclamation treatment. In addition, the importance of native forbs was also higher in the Natural Recovery treatment equaling that found for the Reference (Figure 3b). Little difference was found in the importance of native forbs among seeded treatments.

Sand reed grass is an important species on sandy sites within Fescue Grasslands sub-region. The same rate of sand reed grass (pure live seed) was included in all seeded treatments. Results show that the importance of sand reed grass was only slightly lower than the importance of wheat grasses on all seeded treatments (Figure 3d). Importance of sand reed grass is increasing over time in the Simple treatment, which appears to be related to the importance of wheat grasses in 1998. The Simple treatments had the lowest importance of wheat grasses and greatest increase in the importance of sand reed grass.

Conclusions

Species composition on natural recovery areas were far less consistent and succession far less directed than for the seeded treatments. In this study, the natural recovery treatment was more variable within and especially among sites than the seeded treatments. In addition, weeds were more prevalent on natural recovery areas and few of the dominant grass species had established within three years.

Cross-seeding can be an effective method for reducing the effect of inter-specific competition on the species emergence. In this study, dominance based on importance values of the indicator species (rough fescue for the mesic sites and sand grass for the sandy sites) were similar across all seeded treatments. However, changes in dominance over time may occur in relation to other competitive species included in the seed mix.

Results to date indicate that native seed mixes have the potential for both effective site stabilization and establishing a more "ecologically compatible" plant community on well site disturbances. However, many important species of Fescue Grasslands were not available to include in this study. Limited availability and range of native species poses a continuing problem for native prairie revegetation.

Benefits

1) For continued access to endangered native prairie ecosystems, the petroleum industry must be able to demonstrate low operational impact on native prairie to other stakeholders (land owners, conservationists, government bodies, etc.).
2) More effective revegetation leading to native prairie conservation.
3) Lower reclamation costs (potential).
4) Revegetation guidelines directly applicable to native prairie.
5) Forum for discussion and education among all stakeholders.

Acknowledgments

We gratefully acknowledge Ms. Heather Gerling, Public Land Management Branch, Alberta Agriculture Food and Rural Development (AAFRD) and the Native Prairie Revegetation Committee for the initiation and support of this project. Special thanks go to Mr. Pat Porter, Public Lands Management Branch, AAFRD for help with finding appropriate sites, Mr. Andy Hammermeister for supplying this project with seed of American vetch, and to Mr. Darryl Hass of PanCanadian Petroleum Ltd. for his assistance, encouragement, and support.

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At last a special thank you to our colleagues Byron James and Denise Pewarchuk.

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Table 1. Description of treatments, Fescue Grasslands project.

Treatment	Description
Reference (Control)	undisturbed prairie to which the treatments were compared
Reclamation	a simple, 2 species mix, - low diversity, competitive species
Diverse	a diverse seed mix including over 15 species of early and late successional stages
Simple	a simple native grass mix consisting of species dominant in the undisturbed community - low/moderate diversity
Natural Recovery	no seeding - natural secondary succession

Figure 1. Map of Native Prairie Revegetation Research Project (Fescue Grassland sub-project) study area and example of study site layout.

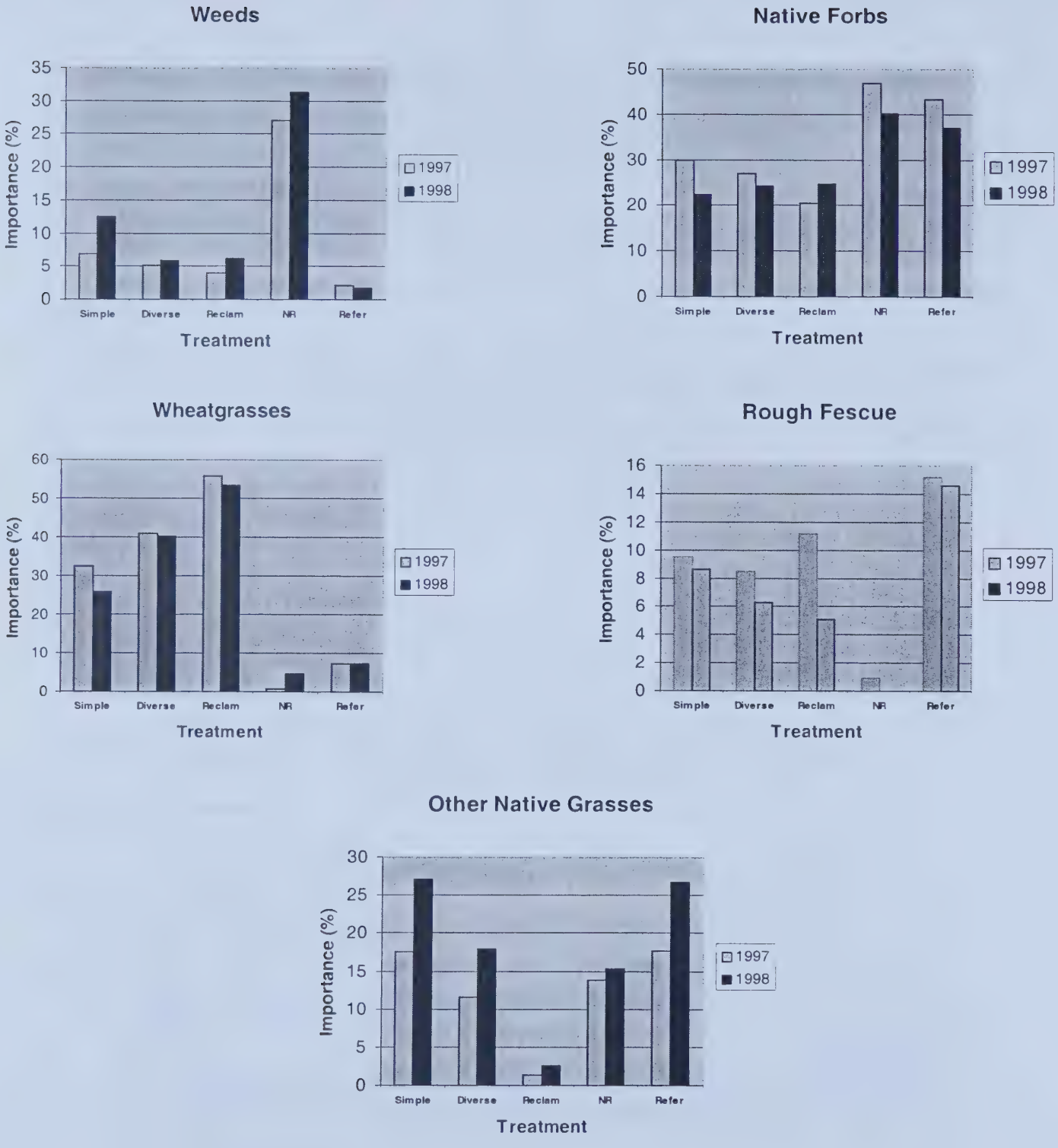

Figure 2. Importance value of selected plant groups on Mesic Chernozemic sites, Fescue Grassland Prairie sub-project (a. weeds, b. native forbs, c. wheatgrasses, d. rough fescue, and e. other native grasses).

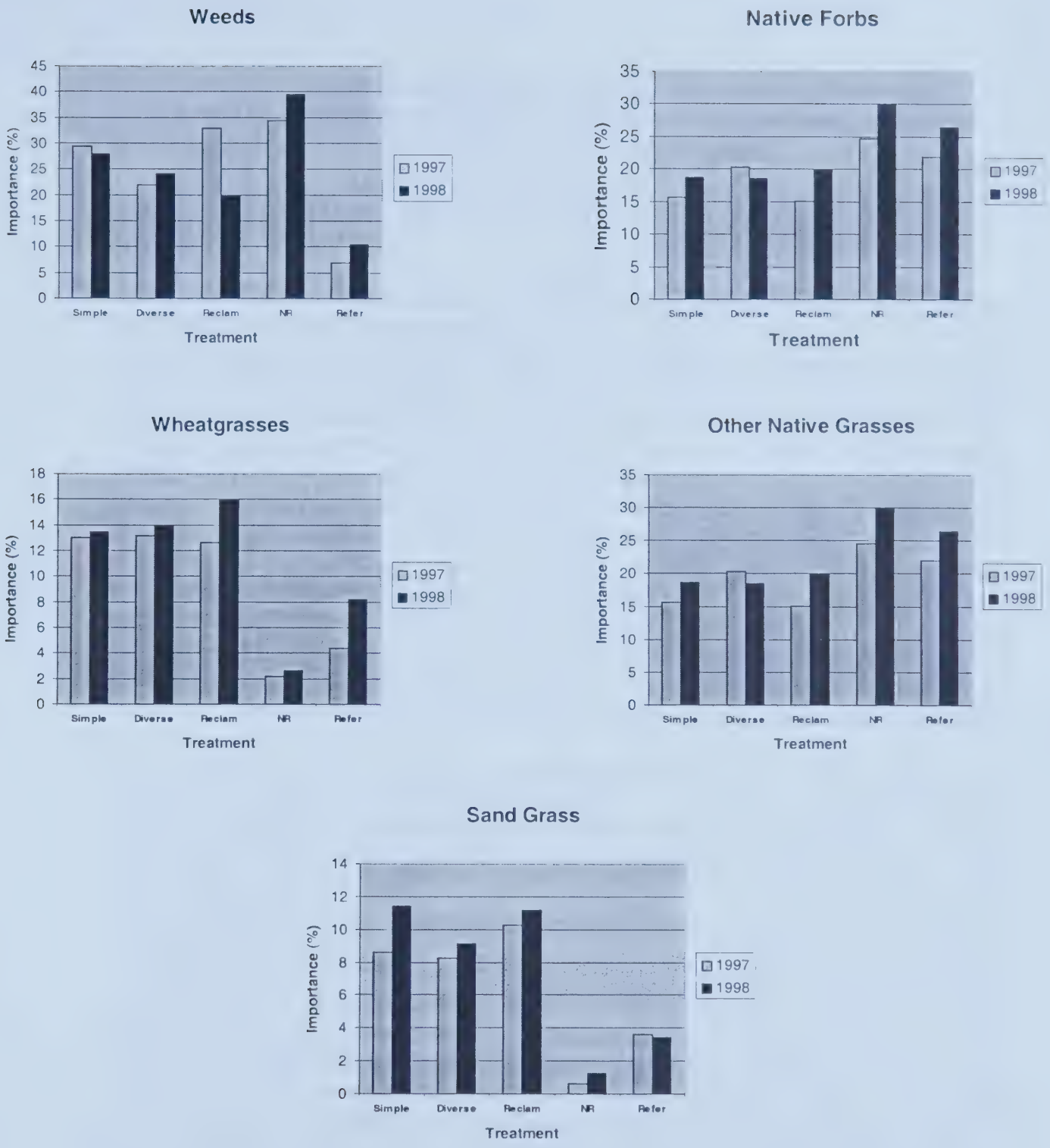

Figure 3. Importance value of selected plant groups on Sandy Sites, Fescue Grassland Prairie sub-project (a. weeds, b. native forbs, c. wheatgrasses, d. sand reed grass, and e. other native grasses).

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