EFFECTS OF TIME AND GRAZING REGIME ON REVEGETATION OF NATIVE RANGE AFTER PIPELINE CONSTRUCTION

by

M.A. Naeth and A.W. Bailey

Department of Plant Science

University of Alberta

ABSTRACT

Successful revegetation after pipeline construction in native rangeland requires an effective range management program to expedite a self-sustaining, erosion reducing ground cover.

The study area was located 50 km northeast of Brooks, Alberta. Two early season grazed sites and two late season grazed sites were selected in a pipeline corridor containing pipelines that were installed 3, 12, 16, 21 and 27 years ago.

Even after 26 years, species composition and ground cover over the rights-of-way were significantly different from the undisturbed areas. Grazing regime had a profound effect on all vegetative characteristics evaluated.

INTRODUCTION

Activities associated with transport of Alberta's petroleum resources necessitate pipeline construction. In 1981, there were 180,208 km of pipelines in the province of Alberta (Webb 1982).

Installation of a pipeline disrupts both the soil and the hydrology of an area as well as the flora and fauna associated with it. Each ecosystem reacts differently, thereby varying environmental impacts of pipeline installation and complicating quantification of cause and effect links between pipeline disturbances and such impacts.

Suitable pipeline installation techniques and reclamation procedures for a given ecosystem can be determined only if both the short and long term effects of pipeline construction are understood. Data demonstrating the mechanisms causing these effects have not been adequately documented. Most investigations in agricultural areas have concentrated on arable crop production, but provide inadequate information on ecosystem reconstruction and stabilization in natural uncultivated grasslands.

Optimum productivity on Solonetzic native range will only be attained if pipeline installation and revegetation procedures are based on firm knowledge of and are compatible with that ecosystem's functioning. The need to document and assess the impact of pipeline disturbances on Solonetzic native range ecosystems formed the basis for this study. It had two overall objectives:

1. To document and assess selected ecosystem responses to pipeline installation in native Mixed Prairie rangeland on Solonetzic soils in Southern Alberta.
2. To study the longevity of these selected ecosystem responses.

This presentation deals with two specific objectives:

1. To examine the effects of early and late season grazing on revegetation of pipeline disturbances.
2. To examine the above effects within different zones of construction activity and on different aged pipeline rights-of-way.

METHODOLOGY

Four study sites were located within a natural gas pipeline corridor approximately 10 km east of Princess, Alberta. Sites 1 and 4 were located in NE 15-20-11-4 and NE 16-20-11-4 respectively; and sites 2 and 3 in NW and NE 15-20-11-4 respectively. All four study sites were located within a 4 km distance. Studies were confined to the rights-of-way leased by NOVA, An Alberta Corporation, and to control areas immediately adjacent to the right-of-way (r-o-w). These control areas were utilized for extensively managed beef cattle production by the Eastern Irrigation District (EID).

Each of the four study sites was 100 m by 135 m, spanning five r-o-w with an undisturbed (control) area on either side. These sites were divided into 17 east-west transects representing different areas of pipeline construction activity and different ages of pipelines. Pipelines ranged in diameter from 86 to 107 cm and were installed in 1957, 1963, 1968, 1972 and 1981. Transects included the undisturbed prairie on either side of the pipeline r-o-w, the area directly above each trench, and the work, pipelay and stockpile areas. The area corresponding to the work, pipelay and stockpile transects of the older r-o-w was referred to as the between trenches transects.

The study sites had slopes of less than 2%. Soils were Solodized Solonetz or Brown Solod with prominent blowout patches. Vegetation was of the *Bouteloua-Stipa* (Blue grama-Spear grass) facies of the *Stipa-Bouteloua-Agropyron* (Spear grass-Blue grama-Wheatgrass) faciation. The 1981, 1972 and 1968 r-o-w were seeded to similar mixtures of introduced species including: *Agropyron cristatum, Elymus junceus, Agropyron riparium, Agropyron trachycaulum, Agropyron elongatum, Agropyron trichophorum, Elymus angustus, Medicago* species, *Onobrychis vicaefolia* and *Astragalus cicer* (crested wheatgrass, Russian wildrye, streambank wheatgrass, slender wheatgrass, tall wheatgrass, pubescent wheatgrass, Altai wildrye, alfalfa, sainfoin and cicer milk-vetch). The 1957 and 1963 r-o-w were not seeded. Sites 2 and 3 were in an early season grazed section of the range (grazed from May through July) and sites 1 and 4 were in a late season grazed section (grazed from August through November).

In 1982, transects were subdivided into four subtransects each 25 m in length and spanning the width of the transect. Twelve m^2 quadrats were randomly established in each transect. In 1983, individual transects were divided into 1 m by 1 m subtransects. At each site one hundred 0.10 m^2 (20 cm x 50 cm) quadrats were read in each transect.

In each quadrat ocular estimates of basal area were determined for individual species total live vegetation, total dead vegetation, and bare ground. Frequencies of each species in a quadrat were recorded.

Plant densities over the 1981 r-o-w were determined to quantify the establishment of introduced species and invasion by native species. In each site, four seeded rows were randomly selected in each of the following transects: 1981 trench, pipelay, work and stockpile. Twenty-five 1.0 m segments were randomly selected along each seeded row, and the number of introduced and native plants were counted in each row segment.

Chi square was used to test departure from expected values and to determine the homogeneity of two species with respect to frequency and cover.

RESULTS

The ground cover of the undisturbed prairie consisted of approximately 50% live vegetation, 30% dead vegetation (litter) and 20% bare ground. *Selaginella densa* (little club moss) was the dominant species, often comprising over 50% of the live vegetation. Dominant grasses included *Bouteloua gracilis, Koeleria cristata* and *Stipa* species (predominantly *Stipa comata* with small amounts of *Stipa spartea* var. *curtiseta*). Together these three grasses represented up to 12% of the total ground cover, occurring with a mean frequency of 64%. Forbs were abundant, predominantly *Artemisia frigida* (a half-shrub), *Opuntia polyacantha, Phlox hoodii* and *Sphaeralcea coccinea* (pasture sage, prickly-pear cactus, moss phlox and scarlet mallow). Over 99% of the species were native.

Season of grazing had a substantial effect on vegetative composition. With early season grazing there was a decrease in live vegetation and an increase in litter and bare ground. In general, late season grazing resulted in increased basal area of many grasses and forbs.

With pipeline disturbance, botanical composition and ground cover changed significantly. The trenching disturbance was the most destructive compared to the grading and stockpiling operations of the other r-o-w transects.

Immediately following pipeline construction, vegetation declined to nearly 0.0% of the ground cover over the trench transect (Figure 1), and near 5% over the other disturbed transects. Species in all transects of the 1981 r-o-w had very low covers and frequencies. Over 95% of the species present had mean basal areas of less than 1% and approximately 60% had frequencies of less than 10%.

During the first year, vegetative cover over the trench had increased to approximately 5% of the ground cover (Figure 2). The 1972 trench had approximately 10% vegetative cover and approximately 90% bare ground. Over time vegetative cover increased on disturbed areas. Vegetative cover of the 1957, 1963 and 1968 r-o-w was approximately 40%. This compares with 20% bare ground from the undisturbed native rangeland.

Other disturbed transects of the 1981 r-o-w had less bare ground than did the trench transect in some sites. The work and stockpile transects in both years of the study often had nearly twice as much vegetative ground cover as the trench area did. The pipelay transect tended to have values between the trench and the other disturbed transects. The between trenches transect near the 1972 r-o-w had more vegetation than did the 1972 trench. Areas between the 1957, 1963 and 1968 trenches had basal areas similar to those of the adjacent trenches.

Over time the effect of grazing had a compounding effect with that of the pipeline disturbance. Older r-o-w under late season grazing tended to have less bare ground and more live vegetation and litter than did early season grazed sites (Figure 2).

Late season grazed sites had approximately four times as many native species over the 1981 r-o-w as did early season grazed sites. Although introduced species numbers were higher in late season grazed sites as well, the variability was high making the differences non-significant.

The effect of grazing regime on revegetation is most obvious when comparing the frequency and basal area of ***Agropyron cristatum*** (crested wheatgrass) and ***Descurainia sophia*** (flixweed). ***Agropyron cristatum*** dominated the 1968 and 1972 r-o-w under a late season grazing regime (Figure 3), but was only a minor component of the vegetative composition under early season grazing. No other introduced species had persisted and native species invasion had been accomplished only by a few ruderals. ***Agropyron cristatum*** was a dominant species under both grazing regimes immediately after a disturbance but within a year, frequency and basal area were decreasing under early season grazing.

Similar data were collected for ***Descurainia sophia***. In 1982 ***Descurainia sophia*** dominated the 1981 r-o-w under a late season grazing regime, but under early season grazing the species was a relatively minor component of the vegetation (Figure 4). Similar patterns were observed for ***Koeleria cristata. Bouteloua gracilis*** and ***Hordeum jubatum*** (wild barley) tended to increase significantly under an early season grazing regime.

Few introduced species were present on the 1957 r-o-w, but large numbers of native species, particularly forbs, were present with both high covers and frequencies. The 1963, 1968 and 1972 r-o-w were similar in native species composition to that of the 1957 r-o-w. However, the number of introduced species dramatically increased in these trench areas.

In all sites, species composition of the 1957 r-o-w was not significantly different from that of the undisturbed transects. The 1981 trench transect was most similar to the 1981 pipelay transect. Under an early season grazing regime, the 1963, 1968 and 1972 r-o-w were more similar in botanical composition to the 1957 r-o-w than to the 1981 r-o-w or the undisturbed prairie. Under a late season grazing regime, these transects were significantly different from all other transects.

DISCUSSION

The trench area had more introduced species and generally had more species with lower basal area and frequency compared to those of the other transects. These other transects were not trenched, but only graded, and therefore more hospitable for regrowth from species with their roots still intact, or partially buried. This was particularly true for the forbs.

The higher basal area and frequency for many species and the large number of native species under late season grazing reflect the susceptibility of some species to early season grazing.

The majority of the species present are cool season forms. They begin growth in late March or early April, are heading or flowering in June, and have completed seed maturation by July. By August, most vegetation will be dormant or cured. These cool season species will be most affected by early season grazing. Severe defoliation during early stages of phenological development is often detrimental to seed production and even to the survival of some species, whose only means of reproduction is through seed. Species that can reproduce vegetatively are also stunted after severe defoliation because energy must be put into rebuilding photosynthetic parts and carbohydrate reserves necessary for winter survival.

Early maturing species that are late season grazed have a distinct advantage for survival over those that are grazed early in the season. By July and August, most early maturing species are entering summer dormancy and thus are usually more resistant to grazing. Some species, such as those of the *Stipa* genus, have very prickly seeds which are unpalatable to cattle. Species such as *Agropyron cristatum* are also coarse and unpalatable. Many of the forbs are declining in vigour, maturing seeds, or have already cured by the time late season grazing begins. Thus only later maturing species and those that experience autumn regrowth will be sensitive to grazing at this time. Grazing in late autumn will detrimentally affect these species which have not built sufficient carbohydrate reserves for winter survival, and those reproducing from seed, whose seed matures late in the season. With late season grazing, the native species on the work and stockpile areas could partially recuperate from the disturbance. Species in the early season grazed sites would be defoliated and trampled at a time when they were most vulnerable because of their low energy reserves. Thus many weedy species if early season grazed would not survive whereas those that were late season grazed would have time to recover from the pipeline disturbance before being subjected to the pressures of grazing. The trench area was the most severely disturbed, and would likely take longer to recover. Plant roots and Native seeds were not on the trench and only introduced seeds were present. These seeds are often planted late in the season and would not likely germinate as readily as the plants that were already present on the other transects would recuperate, thus accounting for the smaller number of plants over the trench transect.

Descurainia sophia is palatable in early spring but unpalatable by summer. *Koeleria cristata* (June grass) is a vigorous native invader as its prominence in the disturbed transects indicates. *Koeleria* reseeds bared areas readily, and because it begins growing early in the spring, can take advantage of the early spring moisture reserves (Coupland 1950).

The 1968 and 1972 r-o-w were seeded to a mixture containing *Agropyron cristatum* during the final stages of pipeline construction. *Agropyron cristatum* generally does not suffer frost damage nor winter kills and is highly drought resistant due to its extensive root system. It is also an excellent weed competitor. These characteristics make *Agropyron cristatum* a species well suited to eventual dominance of a disturbed area. Studies involving *Agropyron cristatum* on Mixed Prairie indicated that when *Agropyron cristatum* was grazed early in the spring native dominants expanded and competed successfully (Hubbard 1949).

The 1981 disturbance transects were dominated by introduced and native invaders, or weedy species. The older pipeline disturbances had many more native species, with loss of dominance by the introduced species. With time, the disturbed areas appear to be approaching the vegetative character of the undisturbed transects, but even after 26 years, there are still significant differences in botanical composition.

The large number of forbs present indicate the efficiency of these species in secondary succession. Forbs are generally more efficient than grasses in using environmental resources, such as wind, for the dissemination of seeds, and soil moisture and nutrients for germination and growth.

Data such as those presented in Figure 1 can be somewhat misrepresentative. If the basal area of *Selaginella densa* is taken into consideration, then the undisturbed live vegetation provided by other species is similar to those for older disturbed transects. Since *Selaginella densa* is unpalatable, the productivity of the area may not be dramatically reduced by pipeline disturbance, except over the 1981 r-o-w. Within 15 years the amount of live vegetation over the trenches has returned to near predisturbed conditions. Other transects of the r-o-w appear to approach these conditions within 10 years. Thus it appears that there is a fairly rapid return to predisturbed levels of palatable forage under the proper grazing regime. From a soil conservation point of view, this is not so. Although *Selaginella densa* is an unpalatable species, it does provide protection from erosion. The time required for *Selaginella densa* to invade these areas is not known. If many years are required, perhaps the protection against erosion would be provided by increased cover from the more palatable species that could increase in basal area under proper range management, making the presence of *Selaginella densa* unnecessary from a conservation view point and undesirable from a livestock grazier's point of view.

The r-o-w is attractive to the cattle because it often offers fresh palatable species. Cattle grazing the same range over a period of years tend to be attracted to the r-o-w each spring and often use it as a camping ground. Dugouts near the r-o-w also increase activity near the r-o-w long after the area has been grazed.

CONCLUSIONS AND RECOMMENDATIONS

Pipeline construction activities and subsequent operation of the line have a profound effect on the rangeland ecosystem. The most obvious effect is the reduction or removal of the vegetative cover over the r-o-w. The grazing regime imposed on the rangeland affects vegetative characteristics and thus affects reclamation efforts.

Although grazing slows revegetation progress, if properly managed it can be used to aid in weed control and enhance revegetative efforts without the detrimental economical implications that no grazing might have.

Based on the findings in this research the following recommendations are put forth:

Although fencing and weed control would be the most desirable way of establishing a ready ground cover, the high cost of this type of reclamation imposes more practical considerations.

The most economical alternative appears to be a properly managed grazing regime to return the land back to its inital use. It is important to know what the end land use will be and what grazing management is likely to be employed. Early season grazing eliminates or reduces weeds such as ***Descurainia sophia*** that readily colonize disturbed areas. It also reduces the dominating influence of ***Agropyron cristatum***. However, this grazing regime decreases vegetative cover and increases the amount of bare ground which has serious consequences in soil erosion. ***Agropyron cristatum*** has been considered a desirable species capable of increasing native range productivity. If so, then it must be grazed earlier in the season to ensure its palatability yet not grazed for so long at a high intensity that it is eliminated. Reducing both the stocking rate and the period of grazing for the first few years following revegetation would be beneficial. Rangeland should not be only autumn or spring grazed, but these regimes should be rotated periodically.

Dugouts must not be constructed near the r-o-w and other forms of passive control such as locating salt licks away from the r-o-w should be employed.

ACKNOWLEDGEMENTS

Funding by the Alberta Environmental Centre (AEC), Vegreville is gratefully acknowledged. NOVA, An Alberta Corporation and the Eastern Irrigation District (EID) are also acknowledged for access to their rights-of-way and adjacent undisturbed areas respectively.

Ms. B.M. Lardner provided valuable technical assistance during the study, particularly during the field season. Her efforts and interest in the project are gratefully acknowledged. Ms. W. Power is acknowledged for drafting of the figures.

REFERENCES

Coupland, R.T. 1950. Ecology of mixed prairie in Canada. Ecol. Monog. 20:272-315.

Hubbard, W.A. 1949. Results of studies of crested wheatgrass. Sci. Agr. 29:385-395.

Webb, C. 1982. The impacts of linear developments, resource extraction and industry on the agricultural land base. ECA. 82-17/IB25. Env. Council of Alta. Edmonton, Alta. 87 pp.

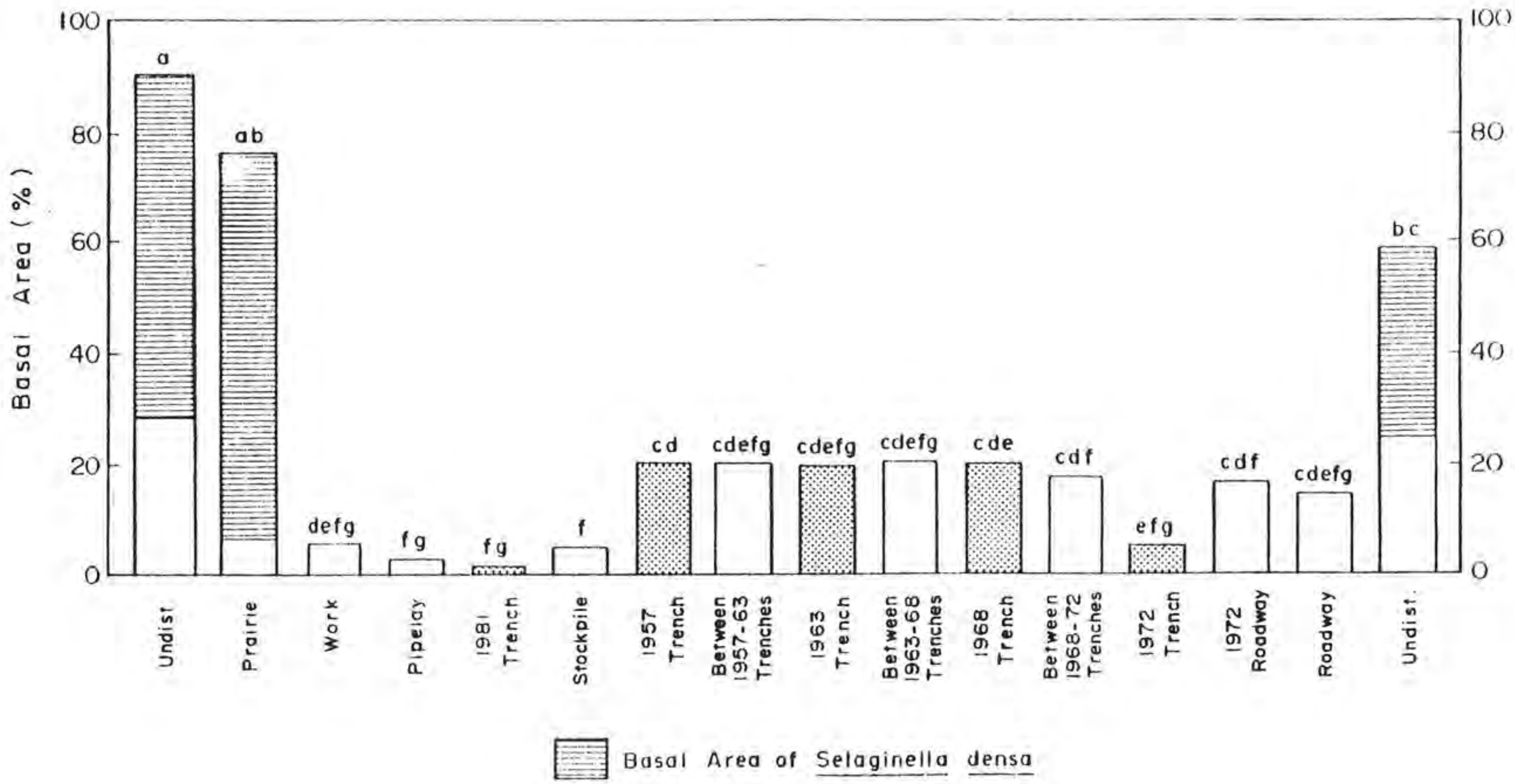

Figure 1. Mean percent live vegetation in June, 1982 (data are mean of three sites). Same letters denote no significant difference (Chi square test; $p<0.05$)).

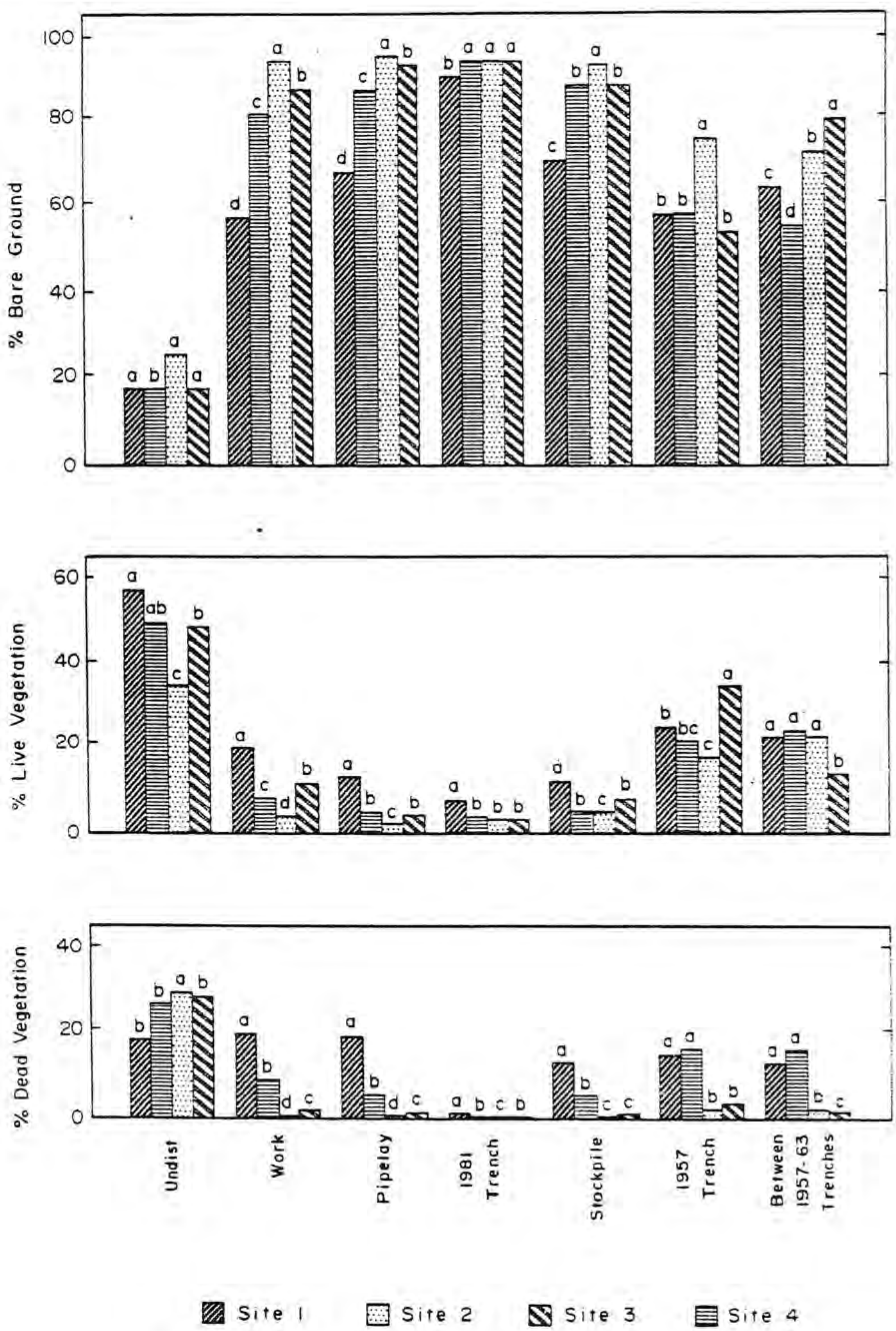

Figure 2. Mean percent ground cover in June, 1983. Same letters denote no significant difference (Chi square test; $p<0.05$).

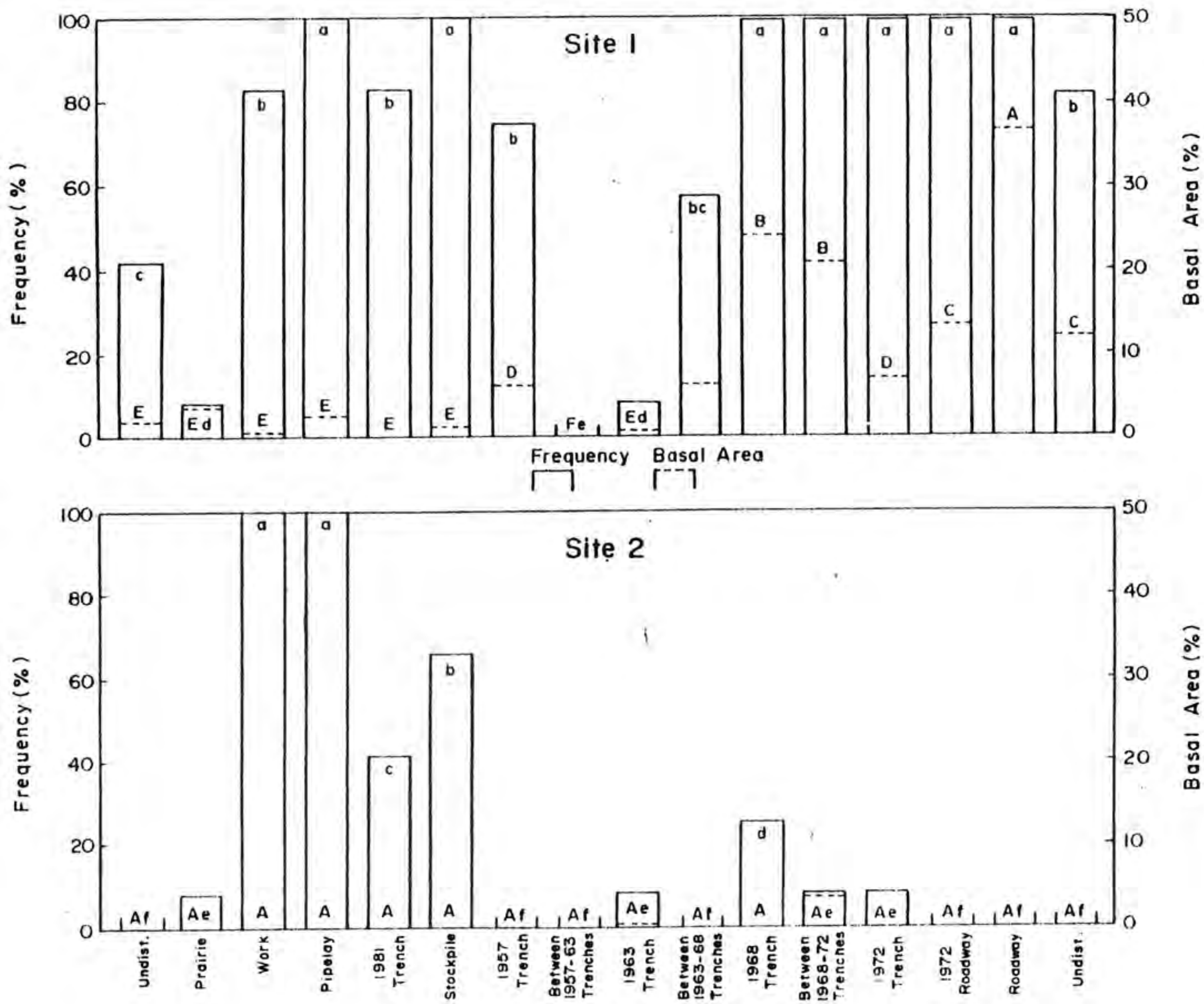

Figure 3. Mean frequency and basal area of *Agropyron cristatum* in June, 1982, in late season grazed (upper) ar rly season grazed (lower) sites. Same letters denote no significa. fference (Chi square test, $p<0.05$).

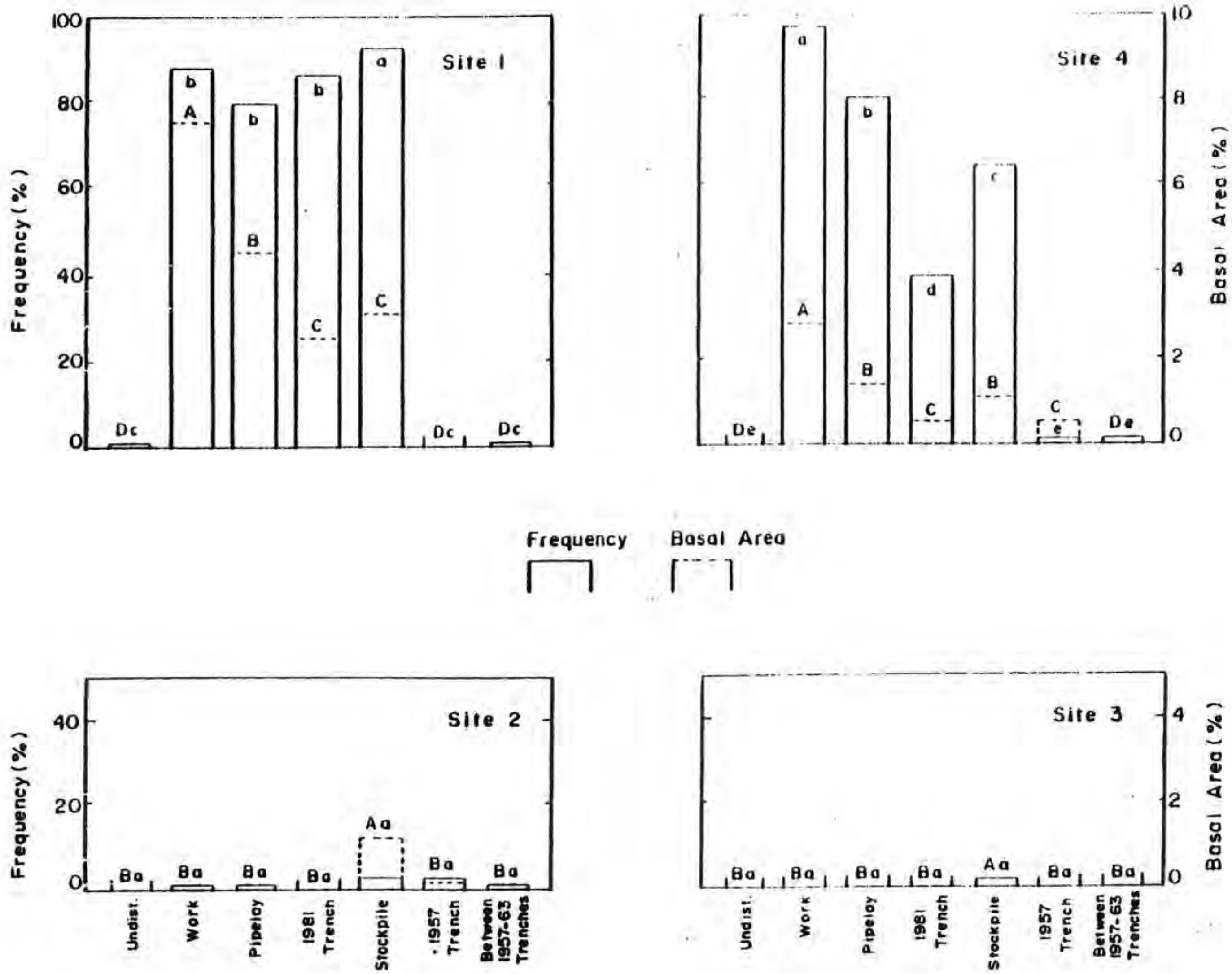

Figure 4. Mean frequency and basal area of *Descurainia sophia* on late season grazed (upper) and early season grazed (lower) sites in June, 1983. Same letters denote no significant difference (Chi square test; $p<0.05$).

CLRA

NINTH ANNUAL MEETING
CANADIAN LAND RECLAMATION ASSOCIATION

RECLAMATION IN MOUNTAINS, FOOTHILLS AND PLAINS: DOING IT RIGHT!

AUGUST 21-24, 1984
Calgary, Alberta, Canada

CANADIAN LAND RECLAMATION ASSOCIATION

NINTH ANNUAL MEETING

RECLAMATION IN MOUNTAINS, FOOTHILLS AND PLAINS

DOING IT RIGHT!

AUGUST 21 - 24, 1984

CONVENTION CENTRE

CALGARY, ALBERTA

A C K N O W L E D G E M E N T S

These proceedings are the result of dedication and commitment of many people including members of the Canadian Land Reclamation Association, technical contributors within and outside Canada, industrial organizations and government bodies. The contribution of all these groups to the Ninth Annual Meeting is gratefully acknowledged.

In particular, we would like to recognize the financial assistance provided by:

Alberta Environment
Alberta Oil Sands Industry Environmental Association
Alberta Public Affairs Bureau
R. Angus Alberta Limited
BP Canada Inc.
Burnco Rock Products Ltd.
Canadian Land Reclamation Association, Alberta Chapter
Prairie Seeds Ltd.
Westmin Resources Limited

and the support of the meeting by Management and Staff of the following groups:

Alberta Energy Resources Conservation Board
Alberta Sand & Gravel Producers Association
Coal Association of Canada
Canadian Petroleum Association
XV Winter Olympic Organizing Committee
Gregg River Resources Limited
Gulf Canada Limited
Parks Canada
Reid, Crowther and Partners Limited
Bank of Montreal

The Organizing Committee for the Ninth Annual Meeting was:

Chairman	Jennifer Hansen, J. Hansen Consulting
Functions	Lynda Watson, Techman International Limited
Technical Sessions	P.D. Lulman, TransAlta Utilities Corporation
Registration	A.J. Kennedy, Esso Resources Canada Limited
Public Relations	M.K. Ross, Crows Nest Resources Limited
Field Tours	Karen Natsukoshi, Manalta Coal Limited
	Julia Fulford, Fording Coal Limited
Commercial Displays	L.A. Panek, Montreal Engineering Company Ltd.
Audio Visual	A. Schori, Monenco Consultants
Alternate Programs	Holly Quan, TransAlta Utilities Corporation

Citation

The citation of this document in all references is:

1984 Canadian Land Reclamation Association
Ninth Annual Meeting, Calgary, Alberta, August 21st - 24th

CANADIAN LAND RECLAMATION ASSOCIATION
PROCEEDINGS OF THE NINTH ANNUAL MEETING

TABLE OF CONTENTS

Wednesday, August 22

1. Wildland Reclamation and Reforestation of Two Coal Strip Mines in Central Alberta
(J.C. BATEMAN, H.J. QUAN)

2. Successful Introduction of Vegetation on Dredge Spoil
(K.W. DANCE, A.P. SANDILANDS)

3. Planning and Designing for Reclaimed Landscapes at Seton Lake, B.C.
(L. DIAMOND)

4. Reclamation of Urad Molybdenum Mine, Empire, Colorado
(L.F. BROWN, C.L. JACKSON)

5. Effects of Replaced Surface Soil Depth on Reclamation Success at the Judy Creek Test Mine
(A. KENNEDY)

6. Preparation of Mine Spoil for Tree Colonization or Planting
(D.F. FOURT)

7. Control of Surface Water and Groundwater for Terrain Stabilization - Lake Louise Ski Area
(F.B. CLARIDGE, T.L. DABROWSKI, M.V. THOMPSON)

8. Montane Grassland Revegetation Trials
(D.M. WISHART)

9. Development of a Reclamation Technology for the Foothills - Mountain Region of Alberta
(T.M. MACYK)

10. A Study of the Natural Revegetation of Mining Disturbance in the Klondike Area, Yukon Territory
(M.A. BRADY, J.V. THIRGOOD)

11. Landslide Reforestation and Erosion Control in the Queen Charlotte Islands, B.C.
(W.J. BEESE)

12. The Use of Cement Kiln By-Pass Dust as a Liming Material in the Revegetation of Acid, Metal-Contaminated Land
(K. WINTERHALDER)

Thursday, August 23

13. Managing Minesoil Development for Productive Reclaimed Lands
(W. SCHAFER)

14. Reclamation Monitoring: The Critical Elements of a Reclamation Monitorin Program
(R.L. JOHNSON, P.J. BURTON, V. KLASSEN, P.D. LULMAN, D.R. DORAM)

15. Plains Hydrology and Reclamation Project: Results of Five Years Study
(S.R. MORAN, M.R. TRUDELL, A. MASLOWSKI-SCHUTZE, A.E. HOWARD, T.M. MACYK, E.I. WALLICK)

16. Highvale Soil Reconstruction Reclamation Research Program
(M.M. BOEHM, V.E. KLASSEN, L.A. PANEK)

17. Battle River Soil Reconstruction Project: Results Three Years Afte Construction
(L.A. LESKIW)

18. Gas Research Institute Pipeline Right of Way Research Activities
(C.A. CAHILL, R.P. CARTER)

19. Subsoiling to Mitigate Compaction on the North Bay Shortcut Project
(W.H. WATT)

20. Effects of Time and Grazing Regime on Revegetation of Native Range Afte Pipeline Installation
(M.A. NAETH, A.W. BAILEY)

21. Revegetation Monitoring of the Alaska Highway Gas Pipeline Prebuild
(R. HERMESH)

22. Post-Mining Groundwater Chemistry and the Effects of In-Pit Coal Ash Disposal
(M.R. TRUDELL, D. CHEEL, S.R. MORAN)

23. Assessment of Horizontal and Vertical Permeability and Vertical Flow Rates fo the Rosebud - McKay Interburden, Colstrip, Montana
(P. NORBECK)

24. Accumulation of Metals and Radium - 226 by Water Sedge Growing on Uranium Mil Tailings in Northern Saskatchewan
(F.T. FRANKLING, R.E. REDMANN)

25. How Successful is the Sudbury (Ontario) Land Reclamation Program?
(P. BECKETT, K. WINTERHALDER, B. McILVEEN)

26. Methodology for Assessing Pre-Mine Agricultural Productivity
(T.A. ODDIE, D.R. DORAM, H.J. QUAN)

27. An Agricultural Capability Rating System for Reconstructed Soils
(T.M. MACYK)