

RECLAIMED GRASSLAND MANAGEMENT
FOR INCREASED PLANT DIVERSITY

A Research Proposal Submitted
to the North Dakota Industrial Commission
by the Animal and Range Sciences Department
of the North Dakota Agricultural Experiment Station
and the Lignite Energy Council

Principal Investigator

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Date: March 20, 2000

Amount Requested: \$32,250

Project Duration: 3 years

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ABSTRACT

The research objective is to evaluate livestock grazing and haying strategies to improve plant species diversity and seasonal balance of reclaimed native grasslands. This research proposal is a request for extension of a project initiated in May 1997 with a final report issued in March 2000.

Re-establishment of diverse and seasonally balanced native grasslands is difficult to achieve. Despite direct respread of topsoil, increased availability of native seed stock and seed mixes strongly favoring warm-season grass species, reclamation specialists and researchers have noted the need for aggressive, post-establishment management practices to maintain or improve plant species diversity and seasonal balance of recently reclaimed grasslands. However, except for the initial research we conducted between 1997 and 2000, little information exists on the effects of cattle grazing on reclaimed grasslands.

In our initial research effort we located grazed reclaimed grasslands on the BNI, Freedom and Indian Head Mines. Despite the differences in grazing management, we concluded that cattle grazing increased basal cover of warm-season grasses and improved diversity and seasonal balance of the grazed grasslands. We initiated early season cattle grazing on the Falkirk, Freedom and Glenharold Mines in 1997 but, to date, can only state that plant species trends appear promising on these grasslands.

The project will commence May 1, 2000. Data will be collected over three field seasons with a final report due April 30, 2003. Major participants of this study are range scientists and graduate and undergraduate students associated with the NDSU Animal and Range Sciences Department and member organization of the Lignite Energy Council.

Project Summary

NDAC 69-05.2-22-07(4)(a) states that revegetation success of native grassland and tame pastureland will be determined based on productivity, ground cover, diversity, seasonality and permanence. Of these regulatory requirements, the re-establishment of plant diversity and seasonal balance is often the most difficult to satisfy (Hatton et al. 1986, Krabbenhoft et al. 1991). Despite the initial diversity of reclaimed native grasslands, they often become heavily dominated by aggressive cool-season grass species after only a few growing seasons following grassland re-establishment (Williamson 1984, Nilson et al. 1985, Hirsch and Nilson 1990, Kirby et al. 2000). In an attempt to diversify and balance plant species of reclaimed native grasslands, a research project was initiated in 1997 with the objective to evaluate cattle grazing and haying strategies on plant species diversity and seasonal balance of reclaimed grasslands.

A final report of the initial research project was submitted in March 2000 and will be summarized here. Early season grazing of cattle was begun on reclaimed grasslands of the Falkirk and Freedom Mines in 1997 and the Glenharold Mine in 1998. Conflicting results have been identified in the early progress of this research. Plant species diversity and seasonal balance have not improved after three years on the Falkirk Mine. The reclaimed grassland of this mine was re-established six to eight years prior to grazing. We speculate that grazing was implemented too many years following re-establishment and warm-season grasses have declined sufficiently in number so as not to be able to take advantage of the preferential grazing treatment. In contrast, grazing was implemented two to five years post-establishment of grasslands on the Freedom and Glenharold Mines with these grasslands receiving aggressive weed and hay management treatments in the years prior to grazing. Both of these grazed grasslands had diverse and seasonally balanced plant species compositions with herbaceous yields and alpha diversities exceeding reference area "standards". Despite the short time interval, plant species trends appear promising on these early summer grazed reclaimed grasslands.

The research has only evaluated two years of grazing to date. Cline (1999) evaluated reclaimed grasslands that had been grazed for four or more years and stated that many years of grazing may be necessary to improve species diversity and seasonal balance. This research proposal requests three additional years to evaluate early season grazing effects on reclaimed grasslands of the Falkirk, Freedom and Glenharold Mines.

Project Description

The hypothesis of this research is that time-specific livestock grazing or haying can maintain young or improve older established reclaimed grasslands' plant species diversity and seasonal balance while maintaining productivity and basal cover. Techniques that influence initial stand density and seasonal balance are understood and generally practiced by reclamation specialists in North Dakota (Williamson 1984, Krabbenhoft et al. 1993, Kirby et al. 2000). However, at the initiation of this research little was known concerning the maintenance of the initial stand diversity or seasonal balance of reclaimed grasslands. Additionally, there is no information concerning secondary succession and permanence of grazed reclaimed grasslands.

Experience of the past two decades has shown that most native grassland re-establishment efforts succeed in the early years in developing diverse and seasonally balanced grass stands. However, without pro-active management of re-establishment grasslands such as mowing, haying and grazing, the stands generally fail to maintain diversity and seasonal balance required during the 10-year reclamation liability period. Failure to manage reclaimed grasslands results in additional reclamation costs in materials, labor, lease costs and bonding if performance standards are not met. Considering the added costs and time, it is important to quickly recognize deficiencies in species diversity and seasonal balance of developing re-established grasslands.

The research is being conducted on the Falkirk, Freedom and Glenharold Mines. The grazing studies are being conducted in sections 36, 12 and 9 of the Falkirk, Freedom and Glenharold Mines, respectively. Each selected reclaimed grassland has been grazed 2 or 3 years in the early summer (late May to early July). Cattle numbers differ for each mine but stocking rates have averaged between 0.5 and 0.8 AUMs/ac (animal unit months). The hayed treatment is located in section 34 of the Falkirk Mine and hayed by August 1 each year. The grazed reclaimed grasslands are being directly compared to grazed native reference grasslands on each mine in order that land-release comparisons can be made each year.

Data collected annually are frequency, basal cover and diversity of vegetation on both reclaimed and reference grasslands. Approximately 3000 points are collected on each grassland from random transects using a ten-pin point-frame method (Army and Schmid 1942). Herbaceous yields are estimated each year by clipping 20 or more 0.25 m² quadrats in portable exclosures located in each grazed grassland. Alpha diversity is estimated with the Shannon-Wiener index using natural logarithms (Shannon and Weaver 1973).

Standards of Success

The standards for success of this research project will be a final report. The final report will document and recommend grazing and haying methodologies to achieve desired diversity and seasonal balance of plant species. Grazing recommendations will specify season (dates) and stocking rate necessary to achieve positive results. Annual comparisons of grazed reclaimed data and reference area "standards" will be conducted simulating "bond release" reporting. The ultimate success of this research will be to achieve "bond release" standards of productivity, basal cover, diversity and seasonal balance on grazed reclaimed native grasslands as rapidly as possible.

Background

The principal investigator has been working in mined-land reclamation since 1988. The prior funded research has included the evaluation of soil depth and quality relationships for successful grassland reclamation, reclaimed wetlands, plant diversity levels and indices for reclaimed grasslands, recolonization of vesicular-arbuscular micorrhizae, drought effects on reclaimed grasslands, improving the use of Range Site Guides for reclamation evaluation, establishment techniques for successful grassland and woodland reclamation and prescribed grazing and haying strategies for improving plant species diversity and seasonal balance of reclaimed grasslands. A total of 16 reports have been written for various local, regional and national publications.

Prior reports have discussed the need for post-establishment management of reclaimed grasslands to improve species diversity and seasonal balance (Nilson et al. 1985, Nilson and Hirsch 1989, Hirsch and Nilson 1990). They suggested that spraying glyphosate, burning or prescription mowing be conducted on reclaimed grasslands to reduce cool-season grass competitiveness. Livestock grazing has been reported for limited mixture seedings of cool-season grasses (Ries and Hofmann 1984, Hofmann and Ries 1988), but only recently have data been available for grazing of reclaimed native grasslands (Cline 1999). Cline's (1999) data appears positive for the improvement of species diversity and seasonal balance of reclaimed native grasslands through early season cattle grazing.

Qualifications

Principal Investigator:

Donald R. Kirby

- Present Position: Professor, Animal and Range Sciences Department
North Dakota State University, Fargo, ND 58105
- Education: B.S. Range and Wildlife Management
Humboldt State University, 1974
- M.S. Natural Resources Management
Humboldt State University, 1976
- Ph.D. Range Sciences
Texas A&M University, 1980
- Experience: 1976-1980 Research Technician
Texas A&M University
1980-1986 Assistant Professor, NDSU
1986-1992 Associate Professor, NDSU
1992-present Professor, NDSU
- Research Experience:
1988-2000 Conducted competitive funded research in grassland and
wetland reclamation, noxious weed control, grazing
management, range improvement and development
1980-2000 Completed 19 graduate student research programs
1980-2000 Published over 60 research articles
1980-2000 Received over \$1 million in grants

Value to North Dakota

The results from this research will be available for use by the members of the Lignite Energy Council, North Dakota Public Service Commission, western mined-land reclamation specialists, and private and public land managers throughout western North and South Dakota and eastern Montana. The mining industry will benefit from this research by receiving recommendations on management of reclaimed lands to meet bond release regulatory standards. Additionally, the results from this research should prove the permanence of reclaimed grasslands under the typical post-bond land use, livestock grazing.

Some public land management agencies in North Dakota have expressed interest in the results of this research and many more may become interested also. The U.S. Fish and Wildlife Service, Ducks Unlimited and The Nature Conservancy have shown an interest in the results of this study. Others such as the Bureau of Reclamation, U.S. Forest Service, North Dakota Game and Fish, State Land Department all manage surface grasslands in the state may benefit from this research.

The productivity and permanence of these reclaimed grassland stands is also of primary concern to the livestock industry of the state. Cattle sales approach \$500 million annually in North Dakota and approximately 80% of the diets of cattle are either grazed or harvested forages, mainly grass. Results from this study will be used to make recommendations for the appropriate use of reclaimed grasslands for livestock grazing including stocking rates, season of use, grazing system, etc.

Management

This research effort will mirror the previous project. The principal investigator in conjunction with the cooperating reclamation specialists will supervise the project to completion. Annual reports will be filed each April with the funding agencies with the final report filed on or before April 2003.

Timetable

This research project is a continuance of a previous research effort and will be completed in the requested three years of funding.

May 1, 2000 - April 30, 2001

- a. Annually collected vegetation data will be summarized and added to the previous three years of data.
- b. Annual report will be written.

May 1, 2001 - April 30, 2002

- a. & b. Same as in year 1.

May 1, 2002 - April 30, 2002

- a. Collect annual vegetation data.
- b. Complete data analyses.
- c. Write annual report.
- d. Prepare manuscripts, papers for publication of results.

Budget: Year 1.

Budget for May 1, 2000 - April 30, 2001

		<u>Matching</u> Lignite Research Council	<u>Matching</u> Lignite Energy Council	<u>Matching</u> NDSU	Total
A. Salary					
Principal Investigator	200			6,000	6,000
Research Specialist	400			6,000	6,000
Graduate Student	1,000	5,000	5,000		10,000
Undergraduate Student	500	2,000	2,000		4,000
B. Employee Benefits		250	250	3,240	3,740
(27% of salary P.I., R.S., 10% undergrad. student, 1% grad. students)					
C. Field, Lab, Office Supplies		500	500		1,000
D. Travel, Housing		3,000	3,000		6,000
E. Indirect Costs		<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
TOTAL		\$10,750	\$10,750	\$15,740	\$37,240

Budget: Year 2.

Budget for May 1, 2001 - April 30, 2002

	Hours	<u>Matching</u> Lignite Research Council	<u>Matching</u> Lignite Energy Council	<u>Matching</u> NDSU	Total
A. Salary					
Principal Investigator	200			6,000	6,000
Research Specialist	400			6,000	6,000
Graduate Student	1,000	5,000	5,000		10,000
Undergraduate Student	500	2,000	2,000		4,000
B. Employee Benefits		250	250	3,240	3,740
(27% of salary P.I., R.S., 10% undergrad. student, 1% grad. students)					
C. Field, Lab, Office Supplies		500	500		1,000
D. Travel, Housing		3,000	3,000		6,000
E. Indirect Costs		<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
TOTAL		\$10,750	\$10,750	\$15,740	\$37,240

Budget: Year 3.

Budget for May 1, 2002 - April 30, 2003

		<u>Matching</u> Lignite Research Council	<u>Matching</u> Lignite Energy Council	<u>Matching</u> NDSU	Total
A. Salary					
Principal Investigator	200			6,000	6,000
Research Specialist	400			6,000	6,000
Graduate Student	1,000	5,000	5,000		10,000
Undergraduate Student	500	2,000	2,000		4,000
B. Employee Benefits		250	250	3,240	3,740
(27% of salary P.I., R.S., 10% undergrad. student, 1% grad. students)					
C. Field, Lab, Office Supplies		500	500		1,000
D. Travel, Housing		3,000	3,000		6,000
E. Indirect Costs		<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
TOTAL		\$10,750	\$10,750	\$15,740	\$37,240

Matching Funds

Matching funds are identified in the budget as **Matching** from the Lignite Energy Council and North Dakota State University.

Tax Liability

The applicants of this proposed research are employees of North Dakota State University and the state of North Dakota; therefore, this section does not apply.

Literature Cited

- Amy, A.C. and A.R. Schmid. 1942. A study of the inclined point quadrat method of botanical analysis of pasture mixtures. *J. Amer. Soc Agron.* 34:238-247.
- Cline, Thomas. 1999. Species composition trends following grazing of reclaimed grasslands. M.S. Thesis. North Dakota State University, Fargo.
- Hatton, T.J., S.L. Durham and N.E. West. 1986. Estimating components of plant community diversity on mined lands. p. 102-105. *In: D. Williams and S.E. Fisher (eds.). Proc. Annual Meet. Soc. For Surface Mining and Reclam., Denver, Colo.*
- Hirsch, K.J. and D.J. Nilson. 1990. Use of glyphosate and interseeding to improve seasonality of reclaimed grasslands. *In: Proc. Fifth Symp. on Surface Coal Mine Reclam. on the Great Plains. Billings, Mont.*
- Hofmann, L. and R.E. Ries. 1988. Vegetation and animal production from reclaimed mined land pastures. *Agron. J.* 80:40-44.
- Kirby, D.R., T.F. Cline, K.D. Krabbenhoft, J. Friedlander and J. Kramer. 2000. Livestock grazing effects on reclaimed grasslands. *Proc. 2000 Billings Land Reclama. Symp., Billings, MT.*
- Krabbenhoft, K., D. Kirby, M. Biondini and D. Nilson. 1991. Plant diversity patterns on North Dakota mined lands. p. 555-561. *In: W.R. Oaks and J. Bowden (eds.). Proc. Nat. Meet. Amer. Soc. Surface Mining and Reclam., Princeton, W.V.*
- Krabbenhoft, K.D., D.R. Kirby and D.J. Nilson. 1993. Effects of reclamation technique on stand maturation in western North Dakota. p. 52-61. *In: Proc. Sixth Symp. on Surface Coal Mine Reclam. on the Great Plains. Billings, Mont.*

Nilson, D.J., R.L. Williamson, J.C. Thompson and J.E. Shultz. 1985. Techniques used to establish, maintain and enhance grassland seasonal variety. In: Proc. Second Annual Meet. Amer. Soc. Surface Mining and Reclam., Denver, Colo.

Nilson, D.J. and K.J. Hirsch. 1989. Diversity and seasonal variety in reclaimed native grasslands. In: Conf. Proc., Reclamation, A Global Perspective. Calgary, Alberta.

Ries, R.E. and L. Hofmann. 1984. Pasture and hayland: Measures of reclamation success. *Miner. Environ.* 6:85-90.

Shannon, C.E. and W. Weaver. 1973. *Mathematical theory of communication*. Univ. of Ill. Press, Urbana.

Williamson, R.L. 1984. Re-establishing North Dakota grasslands after mining with emphasis on seasonality and use of native species. *J. Soil and Water Conserv.* 39:387-391.