

EVALUATING THE SUCCESS OF RECLAIMED GRASSLANDS

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:

Donald R. Kirby, Ph.D.  
Associate Professor  
Animal and Range Sciences Dept.  
North Dakota State University

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## ABSTRACT

The objective of this research proposal is to provide a long-term data base in order to better evaluate grassland reclamation success and review regulations determining that success.

NDAC 69-05.2-22-07(4)(a) states that success of revegetation on native grassland and tame pastureland will be determined based on diversity, seasonality, ground cover, and permanence, as well as productivity. In addition to soil factors (quality, depth, spoil), cultural techniques used in seeding and establishment and post-establishment growing conditions, especially precipitation, determine the resultant plant assemblages and composition across reclaimed grassland landscapes. Long-term monitoring is mandatory to assess the interactions of edaphic, topographic, biotic, cultural and climatic factors and processes responsible for the successful development of permanent, stable, reclaimed grassland communities.

The results of this study will better identify those factors contributing to the success of grassland reclamation over a longer developmental period. This study will complement completed and ongoing mined land research in soils and vegetation monitoring by NDSU (Land Reclamation Research Center and Animal and Range Sciences Department).

The project will commence September 1, 1992. Data will be collected over three field seasons with a final report due September 1, 1996. Major participants will be range scientists, graduate and undergraduate students associated with the NDSU Animal and Range Sciences Department and member organizations of the Lignite Energy Council. Total project cost requested from the North Dakota Industrial Commission is \$13,500.

## **Project Summary.**

The purpose of this research is to provide a long-term data base upon which to evaluate grassland reclamation success and the regulations determining that success.

Soil replacement is a critical first step in the reclamation process of coal mined lands. However, the amount of soil needed to return the mined land to productive use depends on a variety of factors, including soil depth and quality, spoil quality, topography and topographic position, etc. If excess soil is replaced, reclamation costs will increase without a concurrent improvement in reclamation success, while too little soil replacement may lead to decreased productivity and stability.

NDAC 69-05.2-22-07(4)(a) states that success of revegetation on native and tame grassland will be determined based on vegetative diversity, seasonality, ground cover, permanence and productivity. In addition to soil factors, seeding mixtures and techniques and post-establishment growing conditions, especially growing season precipitation, dictate the spatial heterogeneity of plant assemblages across reclaimed grassland landscapes. The maturation of edaphic, topographic and biotic (plant and animal) processes to produce a stable, complex reclaimed grassland landscape occurs over numerous years, often decades.

Two recent studies on reclaimed mined land on the Glenharold Mine support the need for long-term data gathering. Seeding date (early or late) and mulch source (native or slough hay) were evaluated as establishment practices on a sands reclaimed area seeded between 1981 and 1983. Initial vegetation analysis in 1987 indicated the late seeding date and native hay mulch improved the seasonality and diversity of reclaimed grasslands (Krabbenhoft et al. 1993). However, after ten years (1991), post-establishment maturation of all stands studied indicated similar vegetative seasonalities and diversities.

Drought effects on a reference and reclaimed (1979) silty site were compared between predrought (1983-1987) and drought (1988-1990) periods (Frarck et al. 1992).

The authors concluded that drought tended to repress localized diversification of established plant communities on reclaimed grasslands more than similar native rangeland. In addition, Frarck (1992) reported depressed herbaceous yields due to drought on a reclaimed grassland but no significant change in herbaceous yield on adjacent native range.

From the preceding local studies and many throughout the Great Plains, it would appear that long-term monitoring of reclaimed grassland landscapes is a necessity to properly assess reclamation success and improve reclamation regulations for the industry.

### **Project Description.**

The basic premise of this research is that success of grassland reclamation on reconstructed landscapes is related to long-term edaphic, topographic, biotic, and climatic inputs. Vegetative characteristics of reclaimed grasslands, such as yield, basal cover, diversity and others, require time to establish complex plant associations fully utilizing the available resources (light, space, water, etc.). Long-term monitoring is necessary to adequately assess reestablished grassland success on mined lands as is evident given the 10 year regulatory (bond) period to successfully reestablish grasslands.

Established grassland stands (4 years or older) including reference (native) areas of silty, sandy and thin claypan soils were selected for study on the Glenharold and Baukol Noonan Mines between 1988 and 1991. A total of forty transects (10 points per transect) were located on these sites such that the entire topoedaphic sequence (soil quality/depth, topography, aspect) were considered. Data collected at each point (400 total) included:

1. Physical soil properties (to 48 inches)
  - a. topsoil and subsoil depth
  - b. texture

- c. bulk density
- d. hydraulic conductivity
- e. saturation percentage
2. Chemical soil properties (to 48 inches)
  - a. SAR
  - b. EC
  - c. pH
3. Topographic position
  - a. aspect
  - b. slope position
4. Weather data
  - a. precipitation
  - b. temperature
5. Vegetation measurements
  - a. live basal cover
  - b. species diversity
  - c. yield

We propose to continue monitoring weather and vegetation at these sites and establish 60 to 80 new points on the Coteau Mine and Knife River Properties, Beulah, ND. Complete soil, topography, weather and vegetation data as stated alone will be collected at each new site. The data will be subjected to multivariate analyses (principle components, cluster and discriminant) to determine a minimum soil depth, given a specific soil/spoil quality, that will meet reclamation standards for vegetation production, cover and species diversity.

North Dakota State University has a full range of facilities and equipment available to conduct and complete this project. Personal and mainframe computers, including necessary software and statistical packages, are readily available. Soil

processing (dryers, grinders) and characterization will be accomplished utilizing the Soil Science Department's Soil Characterization Laboratory in Waldron Hall. Thousands of soil samples are processed annually by this facility. Vegetation sampling and processing (drying and weighing) can be accomplished at both the Animal and Range Sciences Department, NDSU, and at facilities provided by members of the Lignite Energy Council. In addition, the members of the lignite Energy Council will provide access to sites, on-site personnel to assist in locating and monitoring sites and any specialized equipment if necessary to complete data collection.

The major objective of this research is to provide long-term monitoring data of reclaimed grassland sites to improve the reconstruction and reestablishment processes in order to increase the economic competitiveness of North Dakota lignite. This objective will be achieved by reviewing present soil removal and replacement requirements, which lead to major reclamation costs, and their applicability to rangeland reclamation.

#### **Standards of Success.**

The standard for success of this research effort will be a final report to the North Dakota Industrial Commission and Lignite Research Council documenting the interactions of edaphic, biotic and climatic factors on the establishment of grasslands for reclamation of mined lands.

#### **Background.**

The investigators in this proposal have been working in reclamation research since 1988. The major emphasis of this research was to further define the relationships between soil depth, soil and spoil quality, and reclaimed grassland productivity and species diversity. Data gathered between 1988 and 1990 indicated that no strong correlation was apparent for any vegetative variable, yield, cover and alpha diversity and topsoil or total suitable plant growth material depths. Numerous statistical procedures were tested and it was determined that soil depth/quality and

vegetation relationships could not be described using a straight forward relationship using the present data set (1988-1990). In 1991, further research was conducted to more adequately sample selected shallow topsoil and suitable plant growth material depths. It is felt that this data set will allow description of a relationship between soil depth/quality factors and vegetative characteristics. The statistical procedures are being conducted at this time with a final report due in June 1992.

In addition to this study, the principal investigators have written numerous reports (10) including recolonization of vesicular-arbuscular micorrhizae on mined lands, plant diversity indices and their applicability to mined lands, definition of a land classification system for reclaimed mined lands, effects of drought on reclaimed grasslands, and establishment technique effects on the success of reclaimed grasslands.

In 1991, the investigators received a three year grant from the U.S. Geological Survey to study the hydrological and ecological dynamics of a created seasonal wetland on the Falkirk Mine, Underwood, ND. At present wetland creation has little scientific formulation on which to base confidence in lost function replacement, hence the need for this research.

### **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 Science  
Texas A&M University, 1980



Experience: 1974-1976 Research Assistant, Humboldt State University  
1976-1978 Research Technician, Texas A&M University  
1978-1980 Research Assistant, Texas A&M University  
1980-1986 Assistant Professor (NDSU)  
1986-1992 Associate Professor (NDSU)  
1992-present Professor of Range Science (NDSU)

Research Experience:

1988-1992 Conducting competitive funded research in grassland reclamation and recreated wetlands in cooperation with the Land Reclamation Research Center and the members of the Lignite Energy Council  
1980-1992 Completed 13 graduate research programs  
1977-1992 Published 25 research articles  
1974-1992 Received over \$250,000 in grants

Cooperating Investigator:

Kelly D. Krabbenhoft

Present Position: Research Specialist, Animal and Range Sciences Department, North Dakota State University, Fargo, ND 58105

Education: B.A. Biology  
Moorhead State University, 1989  
M.S. Animal and Range Sciences  
North Dakota State University, 1991

Experience: 1988-1989 Research Technician, NDSU  
1989-1991 Research Assistant, NDSU  
1991-present Research Specialist, NDSU

Research Experience:

1988-1991 Data collection and analysis of reclaimed grasslands  
1991-1992 3 research articles accepted or currently in review from mined land research

**Value to North Dakota.**

The research results from this project will be used by the members of the Lignite Energy Council and mined land regulatory agencies. More than ten years of soils and reclamation research in North Dakota have resulted in recent regulatory changes which address soil replacement requirements. The regulations, and most of the research, have

dealt with providing soil reclamation standards on croplands. These standards do not address some important regulatory requirements related to grassland reclamation. Since soil removal and replacement are major reclamation costs, excess soil handling in the reclamation process beyond that necessary to successfully reclaim a site translates into higher electrical costs and reduced competitiveness of North Dakota lignite. In turn, if too little soil is replaced, the productivity and stability of the reclaimed landscape may be adversely affected. Results of this research will be used to determine what reconstructed soil characteristics and replacement depths are necessary for successful reclamation of grassland areas.

**Management.**

The principal investigator in conjunction with the cooperating investigator will personally supervise the entire project to completion. Semi-annual and annual reports will be filed with the funding agencies each year.

**Timetable.**

September 1, 1992 - August 31, 1993

- a. Select additional sites. Collect soils and vegetation samples
- b. Characterize soils physically and chemically
- c. Summarize and analyze data
- d. Write annual report

September 1, 1993 - August 31, 1994

Continue as above

September 1, 1994 - August 31, 1995

- a. Complete data collection
- b. Complete data analysis
- c. Write final report

**Budget.**

## Proposal Budget for September, 1992 - August, 1993

	Hours	Lignite Research Council	<u>Matching</u> Lignite Energy Council	<u>Matching</u> NDSU	Total
A. Salary					
Principal Investigator	150			3,750	3,750
Cooperating Investigator	150			2,250	2,250
Technicians	500	2,500	2,500		5,000
B. Employee Benefits		250	250	1,600	2,100
					(27% of salary, 10% for technicians)
C. Field and Laboratory Supplies and Laboratory Analyses		2,000	2,000	400	4,400
D. Travel		750	750		1,500
E. Indirect Costs		_____	_____	_____	_____
TOTAL		\$5,500	\$5,500	\$8,000	\$19,000

The level of funding as presented in the budget is the amount necessary to meet the objectives. The research will probably not be initiated without this funding.

**Matching funds.**

These 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.

Proposal Budget for September, 1993 - August, 1994

	Hours	Lignite Research Council	<u>Matching</u> Lignite Energy Council	<u>Matching</u> NDSU	Total
A. Salary					
Principal Investigator	150			3,750	3,750
Cooperating Investigator	150			2,250	2,250
Technicians	500	2,500	2,500		5,000
B. Employee Benefits					
		250	250	1,600	2,100
(27% of salary, 10% for technicians)					
C. Field and Laboratory Supplies and Laboratory Analyses					
		500	500	1,400	3,400
D. Travel					
		750	750		1,500
E. Indirect Costs					
TOTAL		\$4,000	\$4,000	\$8,000	\$16,000

Proposal Budget for September, 1994 - August, 1995

	Hours	Lignite Research Council	<u>Matching</u> Lignite Energy Council	<u>Matching</u> NDSU	Total
<b>A. Salary</b>					
Principal Investigator	150			3,750	3,750
Cooperating Investigator	150			2,250	2,250
Technicians	500	2,500	2,500		5,000
<b>B. Employee Benefits</b>					
		250	250	1,600	2,100
(27% of salary, 10% for technicians)					
<b>C. Field and Laboratory Supplies and Laboratory Analyses</b>					
		500	500	1,400	3,400
<b>D. Travel</b>					
		750	750		1,500
<b>E. Indirect Costs</b>					
		_____	_____	_____	_____
<b>TOTAL</b>		<b>\$4,000</b>	<b>\$4,000</b>	<b>\$8,000</b>	<b>\$16,000</b>

## LITERATURE CITED

Frarck, L.M. 1992. History of Drought and Drought Effects on Reclaimed Grasslands in Western North Dakota. M.S. Thesis. North Dakota State Univ., Fargo.

Frarck, L.M., D.R. Kirby, K.D. Krabbenhoft and D.J. Nilson. 1992. Drought Effects on Reclaimed Grasslands in Western North Dakota. (Abst.) Soc. Range Management. Spokane, Wash.

Krabbenhoft, K., D. Kirby and D. Nilson. 1993. Effects of Reclamation Technique on Stand Maturation in Western North Dakota. (accepted) 1993 Billings Reclamation Symposium, Billings, MT.