AN ECOLOGICAL ANALYSIS OF THE MONTANA AGRICULTURAL EXPERIMENT STATION'S LIVESTOCK GRAZING DEMONSTRATION ON RESEEDED SURFACE MINE SPOILS NEAR COLSTRIP, MONTANA

AN EQC STAFF REPORT

BY

LOREN L. BAHLS

ECOLOGIST

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REP. THOMAS O. HAGER,
CHAIRMAN

JOHN W. REUSS,
EXECUTIVE DIRECTOR

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I. INTRODUCTION

At its meeting on August 27, 1976 the Montana Environmental Quality Council requested the staff ecologist to review the controversial grazing demonstration on reseeded strip mine spoils at Colstrip. This is a report of findings from that review.

The demonstration is being conducted by the tax-supported Montana Agricultural Experiment Station (MAES). The project is the subject of two June, 1976 preliminary reports (5)(15), which provided most of the background information upon which this analysis is based. They are attached as Appendixes A and B. The principal critic of the grazing study is the Rosebud Protective Association (RPA). Its views of the demonstration are in a paper titled "Critique of the Grazing Study" (21) (Attached as Appendix C) and in assorted letters and newspaper articles.

The conduct of research is a fundamental freedom in an academic setting and is never to be subjected to whimsical interference. But considering the many thousands of acres yet to be mined, reclamation research is critically important to the people of Montana, particularly to the agricultural community. Moreover, it is inextricably allied with the scientific disciplines and goals of range management and grassland ecology. The following analysis thus presumes that reclamation research, to be valid, effective, and responsive to the well-being of the people and their environment, must 1) build upon recognized principles of ecology, 2) reflect the reclamation goals specified by the Legislature, and 3) be applicable to agricultural operations as they are practiced in the study area. The context of this analysis is therefore ecological, legal and practical.

II. HISTORY

The Montana Reclamation Act

The Montana Strip and Underground Mine Reclamation Act (Sec. 50-1034, R.C.M. 1947) was passed by the Legislature in 1973. Language of the act pertinent to this analysis is in Appendix D. Rules pursuant to the act were adopted by the State Board of Land Commissioners. Language of the rules pertinent to this analysis is in Appendix E.

The study area itself was strip mined long before the Reclamation Act was passed, consequently it is not subject to its provisions. However, MAES personnel clearly indicate that work conducted there can 1) be applied in general to all mine spoils where reclamation work is required by law and 2) be used to judge the effectiveness of rules promulgated under the reclamation act (5)(15). Specifically, the MAES appears to take issue with Sec. 26-2.10 (10)-S10350(2) of the rules, which requires the reestablishment "...of predominantly native species..." (see Appendix E).

The Montana Agricultural Experiment Station and the Reclamation Research Program

The MAES is a joint state and federally-funded institution headquartered at Montana State University in Bozeman. Its purpose is to conduct research related to agriculture, natural resources, and rural life (17). Attached to the MAES is the Reclamation Research Program whose leader is R. L. Hodder. Funding of the Reclamation Program was described by Dr. Hodder in response to a question during the 1975 House Natural Resources Committee Oversight Hearing on Implementation of the Reclamation Act (18):

Rep. Fred Fishbaugh: Do you receive any funding from these (coal) companies to help in this (research) process?

Dr. Hodder: Yes, we do. What we receive from a private industry, oil companies as well as coal companies, provides us with our stable source of income. We are now getting some federal funding but this, although it is considerable in amount, I don't consider it the constant source of funding such as our private money is.

Using public and private funding, the MAES Reclamation Research Program conducts most of the reclamation research in Montana.

The Grazing Project

MAES reclamation research began at Colstrip in 1968 with a supporting grant from Western Energy Company, a subsidiary of Montana Power Company (23). Perhaps the first public announcement of the present grazing demonstration was by Hodder at the April, 1975 oversight hearing (18):

> Pasture fences are presently being constructed so that the first controlled grazing studies may take place on revegetated spoils this season. This project is a cooperative effort between local ranchers, Society for Range Management and the Montana Agricultural Experiment Station.

A little over a year later the demonstration was described as follows (15) : "This study is intended to be a cooperative effort supported by local ranchers, industry (Western Energy Company) and other interested parties." It is not known whether the Society for Range Management is still cooperating in the project or why Western Energy was not mentioned initially.

The Rosebud Protective Association (RPA) is a Forsyth-based group of ranchers affiliated with the Northern Plains Resource Council, which is headquartered in Billings. In June 1976 the RPA announced that its members had not been allowed to examine results of MAES work for 1975 or to secure a copy of proposed work--this despite repeated requests. RPA members said they felt ignored except for being approached "at several other times" for use of cattle and native range in support of the project (13)(14). Later in June 1976 a "Statement of Proposed Research" (5) was issued by the MAES in Bozeman (Appendix A). According to the statement, work in 1975 consisted of acquisition of baseline data on reseeded spoils and limited grazing "to determine...relative palatability as late summer and fall pasturage." Five specific objectives of the field trials at Colstrip were listed:

1. Evaluate the quality and palatability of the given vegetation produced exclusively on spoils with livestock use throughout the grazing period from early spring through late fall.

2. Determine the relative merits of season-long grazing of the given spoils vegetation vs. a complementary spoils-rangeland grazing system.

3. Determine the degree and significance of compaction of spoil material caused by trampling effects of livestock.

4. Collect data on the successional response of these particular mine spoil plant communities that occurs under a given system of livestock grazing.

5. Evaluate the influence of grazing on mine spoils vegetation in scatter of seed, plant productivity, accumulation of organic matter and soil fertility.

Objectives 1 and 2 are considered by the MAES as "short-term goals" and objectives 3 through 5 are "long-term goals." MAES added:

> The overall, long-term objective of the proposed research is to determine if <u>this particular spoil vegetation</u> as produced in the reclamation process is as productive, stable and useful as that which existed on native range previous to disturbance by surface mining for coal. (emphasis added)

In contrast to the limited applicability communicated by this statement, the following passage, from another MAES report, implies much broader application (15): "Can reseeded mine spoils sustain itself and support livestock? This is a question scientists of the Reclamation Group at the Montana Agricultural Experiment Station are attempting to answer with research at Colstrip, Mont."

Following the "Statement of Proposed Research" by MAES in June, the RPA issued a series of public criticisms of the project (1)(2)(3)(7)(21), the significant points of which are analyzed below. Consequently, the Montana Energy Advisory Council, at the request of the RPA (14), began an investigation of the controversy, soliciting input from the Department of State Lands (9) and from the Vice President for Research at Montana State University (24).

III. ECOLOGICAL BACKGROUND

> Reclamation in Montana basically consists of understanding as many of nature's processes as possible and then speeding those processes up...
>
> --Mike Grende, Western Energy Company (18)

Successful restoration of disturbed land, whether restored by nature or man or both, is necessarily grounded in principles of ecological science. The most important operating principle is that of ecological succession. Hence, as ecological criteria for judging the degree of success of restoration efforts, characteristics of successional end points as well as the timing of successional stages are to be relied on. The basic information needed is obtainable in the literature concerning the semiarid West.

Ecological succession is the orderly process of change involving a sequence of plant and animal communities in a given area (20). Succession typically begins with a disturbed habitat on which plants, animals and their physical environment interact to prepare the site for successively more complex and stable biological communities. The initial stages of succession are called pioneer communities; the final or mature community is the climax. In range management or the restoration of disturbed soil the climax is the logical target.

The grassland climax is characterized by a diverse array of native perennial grasses. This diversity lends stability, which permits the community to maintain equilibrium under varying conditions. For example a mixture of drought-resistant and cool and warm-season varieties provides the native grassland with flexibility in response to climate and weather changes. The climax community produces about as much organic matter as it consumes; energy flux is maximum. The community exists in nearly a steady state (12). On the other hand, pioneer communities are often preponderantly annual weeds, dominated by a few species, and characterized by instability and disequilibrium. Finally, pioneer communities exhibit rapid accrual of vegetative weight, which often causes them to be more productive than climax communities in terms of vegetative growth harvestable by livestock and humans. This is particularly true on reseeded pastures and cropland, which are essentially contrived pioneer communities.

Two types of succession are described depending on the initial condition of the habitat or the degree of disturbance. Primary succession occurs on a site not previously occupied by a biological community, i.e., a newly exposed rock or sand surface. Secondary succession occurs on a site from which a community was removed, such as a plowed field or a cutover forest. Of the two types, primary succession is slower because of the relatively inhospitable nature of the initial physical environment.

It is important to note that succession does not occur in a vacuum. On grasslands, animals--particularly grazing animals--play a key role in directing the process. However, too much grazing pressure applied too early can result in disclimax, a state of retarded succession that can prevent the site from achieving the mature, diverse and stable condition characteristic of healthy climax communities in the same area. Grassland communities on the northern Great Plains evolved under intermittent, seasonally timed grazing pressure applied by bison and other native herbivores--the type of grazing emulated by the rest-rotation and deferred-rotation livestock grazing systems in use today (28).

Generally speaking, the drier the climate the slower the rate of succession. On the semiarid Great Plains natural successional patterns have been described by a number of researchers and summarized by Odum (20). The basic pattern involves four successive stages: 1) annual weed stage (2 to 5 years); 2) short-lived grass stage (3 to 10 years); 3) early perennial grass stage (10 to 20 years); and 4) climax grass stage (20 to 40 years). In the Colstrip area, strip mine spoils abandoned by the Northern Pacific Railway (now Burlington Northern) in 1933 are now reported to have a plant community hardly distinguishable from the surrounding native grassland, according to Mike Grende, Western Energy Company reclamation expert. This 42-year successional history included 17 years of "pretty heavy grazing" and was without benefit of topsoil salvage, artificial seeding, fertilization or irrigation (18). Starting from bare ground, it therefore takes from 20 to 40 years to establish a climax grassland, the time depending primarily on moisture and grazing pressure, but also seed sources, soil fertility and other factors.

In summary, natural succession is a slow, directional change in physical habitat as well as in biological communities. It proceeds from a relatively productive, though floristically simple and unstable state, to a progressively less productive (in terms of harvestable output) though more diverse and stable condition. The rate of succession depends both on the degree of initial disturbance as well as on ecological factors operating during the process.

IV. ANALYSIS OF THE GRAZING DEMONSTRATION FROM AN ECOLOGICAL PERSPECTIVE

The site of the MAES project was strip mined, backfilled and contoured ending in 1971. Topsoil apparently was not salvaged. In May 1972 the site was seeded with 16 pounds per acre of native seed in 9 species and 18 pounds per acre of non-native seed in 7 species. The site was fertilized with both nitrogren and phosphate in 1972 and again in 1974 at rates of 50 and 45 pounds per acre, respectively, for each primary nutrient.

The three-year-old plant community on the reseeded pastures in 1975 consisted of 28 species. The dominant species by weight were 1) crested wheatgrass (50 percent), 2) smooth brome (13 percent), and 3) tall wheatgrass (10 percent) among the grasses, and yellow sweetclover (percentage unknown) among the forbs. Tall wheatgrass was not present in the original seed mixture. Other perennial grasses contributed only 3 percent to the total plant community biomass.

Plant composition data from six climax grasslands in southeastern Montana are presented in Table 1 for comparative purposes. Only those species are listed that contributed at least 10 percent by weight in any one community.

Table 1. Summary of dominant climax species on 6 near-pristine grassland sites near Hardin, Ekalaka and Forsyth, Montana.

Species	Percent Composition by Weight						
	Site						
	1	2	3	4	5	6	Average
Bluebunch wheatgrass	5	16	--	25	25	50	20
Threadleaf sedge	25	34	25	--	7	10	17
Needleandthread	25	9	3	--	15	15	11
Western wheatgrass	10	18	T	19	10	T	10
Prairie junegrass	5	3	1	10	15	5	6
Prairie sandreed	--	--	26	--	T	--	4
Big sagebrush	10	--	--	10	5	--	4
Perennial forbs	5	3	27	15	10	10	12

T indicates trace
-- indicates species was not present

Source: Reference 22.

In comparing the composition of these climax communities with that of the reseeded demonstration community, two things are immediately evident: 1) the two classes of communities have no dominant species in common and 2) the climax communities are rarely dominated by a single species, as is the reseeded community. Needleandthread was the only typically dominant climax grass found on the reseeded pasture, where it was insignificant on a weight basis. Single grass species seldom accounted for more than 25 percent of total plant weight at any single site among the native grassland communities, indicating a more equitable distribution of the site's resources under a climax condition.

Species richness may be used as a criterion for assessing progress in establishing vegetative diversity. On 21 different native rangeland--not necessarily climax--sites in southeastern Montana (11)(16)(19)(31), the number of species per site varied from 24 to 80 with an average of 48 and a median of 49. The number of species on the reseeded pasture at Colstrip in 1975 was 28. Taylor and his associates at Montana State University (26) have proposed a more precise measurement of grassland species diversity, which takes into account not only the number of species but also the number of individuals in each species. Unfortunately, data are not available to allow for this more detailed comparison. It is evident, however, that species richness on the reseeded pasture fell below that encountered on most native range.

The quantity of converted solar energy that can be transferred to livestock or people may be increased many times by replacement of a native community with an introduced community (8). The introduced community is analogous to the pioneer stage of ecological succession in which plants are temporarily released from competition and production outstrips community respiration and consumption. It should come as no surprise, therefore, that vegetational production on the reseeded pastures tested by MAES was from 1 1/2 to 2 times that typically found at native range sites near Colstrip during 1975 (5), regardless of fertilizer applications. As succession proceeds, however, net production is bound to fall, quite possibly to levels below those on adjacent native range.

Without salvage of topsoil, growth of the grazing demonstration pastures will probably more nearly approximate primary rather than secondary succession. Under such initially inimical conditions it is remarkable that a stand of predominantly perennial grasses has been established in the space of three years. Total plant cover, though less than on nearby native range (55 percent compared with 71 percent), is probably sufficient to retard erosion from all but the most severe storms. In addition to the perennial grasses, yellow sweetclover--the most common forb--is useful as a soil builder and stabilizer and as food for livestock and big game animals (10). However, the reseeded vegetation would not support such species as pronghorn or mule deer the year round; nor would it support the diversity of wildlife that exists on native range.

Reclamation and reseeding efforts on the demonstration pastures at Colstrip essentially short-circuited natural vegetative succession in eliminating the annual weed and short-lived grass stages, which ordinarily require 5 to 15 years to complete. From an ecological perspective, this is perhaps the most disturbing element of current reclamation efforts in southeastern Montana. Pioneer stages play an important yet poorly understood role in preparing a site for natural vegetative equilibrium. The reseeded plant community arose without benefit of these precursors. It does not resemble nearby native grassland communities either in composition or in species richness. With a history of mining and seeding with exotics, vegetation on these pastures will probably approach a disclimax rather than a climax condition.

Not only has reclamation at the MAES testing site speeded up the successional process, it has bypassed some early but important steps. Consequently, the end product probably will not possess the diversity, stability, flexibility or productivity of healthy native rangeland. Assuming that these attributes are desirable, agriculturally as well as ecologically, then seed must be predominantly from native sources. Moreover, native pioneer plants may need to be seeded or encouraged initially in order to prepare the site naturally for annual and then perennial grasses. According to A. A. Thornburg of the Soil Conservation Service (27):

> The objective of many reclamation plantings in drier regions appears to be to return the area to climax vegetation. But in almost every instance, the soils are not the same as before the disturbance occurred, and it would seem that species lower in the successional stage may be better adapted and more easily established in many cases.

Thereafter, seeding may have to be accomplished in steps (rather than in one shot) according to the successional stage reached and then only if dissemination of seed from adjacent range proves inadquate. Step-by-step seeding with native plants could accelerate succession while at the same time keep the process on track toward a natural vegetative equilibrium. Although slower, this process will likely generate an end product more akin to a climax than a disclimax.

Light, intermittent grazing by livestock and wildlife, if possible, should be initiated soon after a vegetative cover is established in order to promote natural animal/plant interactions and to build stability into the system so that it will be able to sustain heavier controlled grazing when it matures. On ordinary reseeded pasture grazing can be initiated during the second or third growing season of the newly established stand (30). Strip mine spoils, however, have been subject to far more disturbance and are much more unstable than a pasture that has been prepared for seeding. The "heavy" and "moderate" grazing treatments proposed at Colstrip (5)(15) may be excessive for such an immature stage of succession on a drastically disturbed habitat. In any event, the primary focus should be on the response of the plant community to grazing rather than on the response of grazing animals to the plant community.

V. ANALYSIS OF THE GRAZING DEMONSTRATION FROM A LEGAL PERSPECTIVE

The MAES grazing demonstration at Colstrip is not bound to compliance with the Montana Strip and Underground Mine Reclamation Act because mining was completed at the project site before the act was passed. Nevertheless, the act applies to many thousands of acres of state and private agricultural land that have been or will be dismantled by mining from 1973 onward. Therefore, reclamation research, particularly by a state-supported institution, should be responsive to provisions of the act, which is an expression of public and legislative consensus regarding the conduct of strip mined land reclamation.

The reclamation act includes the following definition:

> Reclamation: backfilling, subsidence, stabilization, water control, grading, highwall reduction, topsoiling, planting, revegetation, and other work to <u>restore</u> an area of land affected by strip mining or underground mining under a plan approved by the department. (emphasis added)

The key word in this definition is the word "restore." Dr. Thadis W. Box, noted mined land reclamation expert and Dean of Utah State University's College of Natural Resources, considers "restoration" to mean that "the exact condition of the site before the disturbance will be replicated after the disturbance." (4) Dr. Box concedes that this "is seldom practical or possible to accomplish completely." Nevertheless, restoration is satisfactory as a target for which to strive in reclamation work; conceivably it is what the Legislature had in mind when it used the word "restore" in the act. Therefore in terms of the act, post-mining restoration of a native range site must be aimed toward reconstructing a natural vegetative equilibrium. The MAES grazing demonstration at Colstrip has not taken this approach.

The act requires the operator to establish a "<u>permanent</u> <u>diverse</u> vegetative cover." (emphasis added) MAES reseeded plots at Colstrip are still low in diversity when compared with nearby native range sites. And, as Dr. Hodder states (18), the vegetation is hardly stable: "Succession wise with the mixtures that we have used there has been a terrifically fast change in vegetative cover almost from year to year in appearance." Moderate to heavy grazing on such an unstable and rapidly evolving vegetational site appears to be premature if that goal is to achieve permanent and diverse cover.

The rules promulgated under the act further require the operator to establish a vegetative cover of "predominantly native species." (emphasis added) Although native species outnumbered non-native species by 9 to 7 in the seed mixture used on the experimental spoils at Colstrip, non-native species outweighed native species in the mixture by 18 pounds to 16 pounds per acre. The resulting community was almost totally dominated by exotics (5). To use such land to address questions of reclamation that now are tied to criteria in the reclamation act seems misleading at best.

Why are native species important? The answer is complex, having to do primarily with evolution and adaptation. Range managers, who work with native plants on a day-to-day basis, perhaps understand better than most. The following testimony was taken at the same reclamation oversight hearing cited earlier (18). The respondent--Dr. Carl Wambolt--is extension range specialist at Montana State University:

> Rep. Dan Kemmis: ...I would like to ask first of all...whether you think the native species are important in reclamation.