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

OCTOBER 1, 1976

MONTANA STATE LEGISLATURE

ENVIRONMENTAL QUALITY COUNCIL

HELENA, MONTANA

CONTENTS

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.

> Dr. Wambolt: Yes, I certainly do feel a native species is important in reclamation...native species...are the most productive ones I think we can hope to reestablish...when talking in terms of full reclamation I feel that native species have got to be a criteria...the long term considerations favor the native species as being most likely to hold the site in spite of drought, insects or disease.

In short, the native vegetation has evolved through the rigors of life on the northern plains and consequently is the best adapted to withstand those rigors as they recur again and again.

Finally, the grazing demonstration is not in keeping with the spirit of the reclamation act and its rules because of its implied emphasis on livestock weight gain and beef production. The act says

> the operator shall...provide a suitable permanent diverse vegetative cover capable of feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation.

The emphasis here is distinctly placed on the ability of the vegetation to withstand normal grazing pressure rather than on the ability of the grazing animals to add weight. Clearly the high-yield syndrome of the agriculturalist is misplaced in strip mined land restoration work, particularly on the fragile, immature soils of early successional stages. At these stages livestock production should be secondary to establishment of a stable soils complex and a "permanent diverse vegetative cover." Any results emphasizing production seem irrelevant to the act if they proceed from anything but the act's "permanent diverse" cover.

VI. ANALYSIS OF THE ROSEBUD PROTECTIVE ASSOCIATION'S OBJECTIONS TO THE GRAZING DEMONSTRATION

Legally and ecologically, the overall objective of reclamation is to restore disturbed land to whatever use prevailed prior to mining, which in southeastern Montana is predominantly livestock ranching and wildlife production. Ranchers, especially those affected by mining, have a great deal at stake in the relative success of practical reclamation efforts and in the conduct of experimental research toward that end. The experimental design of demonstrations such as the one at Colstrip should therefore take into account the constraints and contingencies of a successful ranching operation. To that end it is useful to analyze the experimental design of the grazing demonstration in light of comments made by a group of southeastern Montana ranchers--the Rosebud Protective Association (21). The following analysis will therefore be from a practical, logistical perspective rather than from the ecological and legal perspectives, which already have been considered.

Basically, all RPA objections to the study are included categorically in two of their statements (21): 1) "The study area is not yet reclaimed according to the current Montana strip mining requirements," and 2) "The intensive, limited use of spoils [called for] in the grazing study is impractical and uneconomical for most ranching operations." Analysis of the study area from ecological and legal perspectives clearly shows that RPA's first categorical objection is essentially valid: The study area has not been reclaimed, either in terms of the act or ecological principles. However, the second categorical objection, which basically involves elements of experimental design, has not been addressed. Each of the important elements in the project design will be analyzed below in terms of ranching logistics and economics.

Fertilization

Fertilizer was applied to the study area in 1972 and again in 1974 during the course of the reclamation process. Although fertilization is not routinely practiced on native rangeland, it may be helpful initially in establishing vegetative cover on reseeded spoils. RPA's objection stems from the fact that forage yields and cattle weight gains were measured only 1 and 2 years, respectively, following the last fertilizer application. RPA maintains that any residual fertilizer would likely enhance production on the spoils and thereby bias the results.

Carryover of fertilizers, at least of the nitrogen component, can be substantial on a year to year basis. Carryover depends largely on precipitation in the growing season, which influences plant growth and nutrient utilization. Under weather conditions prevailing at Havre, Montana, carryover nitrogen can be as little as 27 percent or as great as 86 percent depending on March through June precipitation (25). Assuming normal moisture conditions prevailed at Colstrip in 1974 and 1975, then roughly half of the 45 pounds of nitrogen applied per acre in 1974 (22.5 lbs/acre) may have been carried over to 1975 and half again (11.25 lbs/acre) to 1976. If the same conditions existed in 1972 and 1973, then the carryover from the 1972 and 1974 applications would have been roughly 28.75 pounds per acre (50 x 1/2 x 1/2 x 1/2 + 22.5) in 1975 and 14.37 pounds per acre (50 x 1/2 x 1/2 x 1/2 x 1/2 + 11.25) in 1976. Under wetter than normal conditions, these carryovers would be smaller; under drier than normal conditions, they would be greater.

Although the effect of residual nitrogen cannot be ignored, it probably was not a significant factor contributing to the substantial forage yields realized in 1975. As discussed earlier, reseeded pastures will ordinarily out-produce native range initially, basically because the seedlings are free from competition.

It appears that range fertilization is only marginally profitable except under optimum moisture conditions, relatively low fertilizer cost, and high livestock values (29)(32). Therefore, with an eye toward ranching economics, the use of fertilizers should be avoided in future studies of this nature or at least there must be some assurance that the residual supply has been exhausted prior to production measurements.

Pasture Size

Pastures used for the grazing demonstration range from 4.7 to 16.6 acres. However, pastures of native range in the Colstrip area are typically more than a section (640 acres). Because of the large size of most ranching operations the small pastures used in the study would be impractical in terms of fencing and labor. Moreover, it is common knowledge that smaller pastures allow more efficient utilization of vegetation, which would tend to bias yield measurements if control pastures are substantially larger (9). It is clearly evident that at this time there does not exist enough revegetated, let alone restored, mine spoils with which to conduct a grazing study if the results are to be transferred and applied to actual condtions.

Exotic Vegetation

Vegetation on the demonstration pastures is dominated by introduced species, principally crested wheatgrass, which accounts for 32 percent of the vegetative cover and 50 percent of the dry weight vegetation (5). Crested wheatgrass is palatable to livestock only in early spring (6). The other important species on the site--tall wheatgrass and smooth brome--lend themselves to grazing only in spring or fall, hence pasture use is restricted to these two short periods of the year if cattle are to stay healthy. Under normal ranching procedures, livestock are moved only twice--from winter to summer pasture in spring and back to winter pasture in autumn. The specialized vegetation on the demonstration pastures would require at least four moves per year or one move every two to four months, which would create significant capital and labor problems under full-scale ranching operations (21). Furthermore, a mined area will not always be a small manageable part of a ranching operation. If all or a substantial portion of a ranch is strip mined, which is conceivable, the rancher would have to purchase or rent more land for supplemental feeding if his reclaimed pastures were useful only for a part of a year. The point is that a diverse native vegetation is essential for year-round pasturage.

Test Animals

The test animals in use in the MAES grazing demonstration are yearling steers. The reasoning behind the choice of steers rather than cows-calves, which are used in nearly all Colstrip ranching operations, was "to eliminate... any complicating effects of cow estrous cycle and/or calf nutrition on grazing patterns." (5) Furthermore, steers were used because, as Dr. Hodder puts it (7), "research shows they more accurately reflect a true response to vegetation. Cows and calves are more a reaction to how good a bull is, rather than vegetation." On the other hand, in developing the norm for an A.U.M. (Animal Unit Month), a cow and a calf is considered one animal unit. Although a steer is roughly equivalent to three-quarters of an animal unit in terms of pounds of forage consumption, a steer may put on more weight than the cow-calf combination because of lower energy demands (9). Furthermore, yearling heifers would indicate the effects of forage on breeding whereas steers could not (21).

Steers were consciously chosen by MAES personnel to eliminate extraneous physiological factors, and for this they should not be criticized. However, because weight gain comparisons are invalid at this early stage of succession, the use of steers would not have been necessary. Their selection was unfortunate in that it removed the demonstration one step further from the realities of ranching in southeastern Montana.

Agriculture in the Colstrip, Decker and Sarpy Creek areas tends to be of an extensive rather than of an intensive nature. An economic agricultural unit covers a large area, usually measured in sections. The system relies heavily on natural mechanisms of fertility, productivity and regulation and on natural energy and nutrients.

Collectively the various elements in the experimental design of the MAES grazing demonstration permit application of the results only to a much more intensive and closely managed confined feeding operation. Not only would such an operation be impractical and uneconomical from a ranching standpoint, it would be undesirable from an ecological standpoint.

VII. FINDINGS

General

1. The conduct of reclamation research is of vital importance to people of Montana, particularly to the agricultural community.

2. The MAES Reclamation Research Program conducts most of the reclamation research performed in Montana.

3. The MAES Reclamation Research Program has been conducting a grazing demonstration on reseeded strip mine spoils near Colstrip since early 1975, an objective of which is to compare livestock weight gains on reseeded pasture with those obtainable on native range.

Ecological

1. Natural succession from pioneer to climax stages in the semiarid West requires from 20 to 40 years.

2. The stage of development reached by the reseeded MAES experimental pastures falls far short of the site's natural equilibrium, based on species composition, dominance and richness.

3. Experimental reclamation has not only speeded up the successional process, it has also bypassed some early but important steps.

4. Dramatically high initial forage yields on the reseeded spoils could have been easily predicted based on a release of the newly established plants from vegetative competition, analogous to the pioneer stage of community succession.

5. Because of dominance by exotic species, the reseeded experimental pastures will probably move toward a disclimax having a lower productivity than the site's natural equilibrium.

6. Reseeding apparently was successful in establishing a stand of perennial vegetation capable of retarding erosion from all but the most severe of storms.

7. The "heavy" and "moderate" grazing treatments proposed on the reseeded spoils may be excessive for such an immature stage of succession on a drastically disturbed site.

Legal

1. The MAES grazing demonstration at Colstrip is not bound to compliance with the Montana Strip and Underground Mine Reclamation Act.

2. MAES personnel have implied applicability of findings from the grazing demonstration to all strip mined land subject to the Montana Strip and Underground Mine Reclamation Act.

3. At this time, the MAES grazing demonstration is not successful when judged by criteria set forth in the reclamation act and its accompanying rule; it has not restored the site with a "permanent diverse vegetative cover of predominantly native species."

4. The emphasis on livestock weight gain is misplaced and premature; the demonstration site has not achieved vegetative equilibrium and the legal focus is clearly on the vegetation's ability to withstand grazing rather than on the grazing animal's response to the vegetation.

Practical

1. Ranchers affected by mining have a great deal at stake in the success of reclamation efforts and in the conduct of reclamation research.

2. The experimental design of the grazing demonstration did not take into account the practical and economic constraints of ranching in southeastern Montana.

3. Residual fertilizer may not have been a significant factor contributing to the substantial forage yields realized on the reseeded spoils in 1975.

4. There does not exist at this time enough revegetated mine spoils on which to conduct a grazing study, the results of which could be transferred and applied in actual ranching operations.

5. A diverse native vegetation is essential for providing year-round pasturage.

VIII. DISCUSSION AND CONCLUSIONS

The conduct of the MAES Colstrip grazing demonstration appears to be guided by neither ecological, legal, nor practical considerations. The reclamation procedures employed bear considerable resemblance to those used in reseeding highway rights-of-way, and for that purpose--quick establishment of a vegetative cover to retard erosion--they are probably adequate. However, roadside vegetation need not withstand the test of grazing nor meet the detailed requirements set forth in the reclamation act. It is obvious that an entirely different set of ground rules applies to restoration of strip-mined rangeland.

There is a real danger that results of irrelevant and misleading reclamation research could become the norm if the MAES demonstration is publicly accepted. Tacit approval at this time of the Colstrip grazing study or of the direction of the entire Reclamation Research Program--if it proves unresponsive to the needs and goals of the state--may lead to substantial weakening of the reclamation act and rule. At this time all reclamation research by the MAES is sponsored by federal and private sources. It is presumptive, therefore, to expect the Reclamation Research Program to be any more responsive to state needs without substantial direction and funding from the Legislature.

Successful reclamation is so vitally important to the future of Montana and the northern Great Plains that research programs, practitioners and proposals ought to be subjected to the same scrutiny given to other research of regional or national importance, namely peer review. The entire program should be subject to professional audit by a panel of scientific experts from outside the Montana State University campus. Thereafter, any proposal for reclamation research submitted under the auspices of the Montana Agricultural Experiment Station should be made available for review by natural resource experts, as well as by those officials responsible for administration of the reclamation act, and by local ranchers and conservation officers.

The experiment analyzed here is only one among many by the Reclamation Research Program of the Montana Agricultural Experiment Station. Whether it is representative of the general direction taken by the program cannot be ascertained without a more more extensive and exhaustive review. If, following a professional audit, it does prove to be representative, then a general reorientation and redirection of the Reclamation Research Program would be justified.

IX. EQC STAFF RECOMMENDATIONS

1. The Vice President for Research at Montana State University, the Director of the Experiment Station and the Leader of the Reclamation Research Program should:

   a. Establish a panel composed of nationally recognized experts representing a cross section of the scientific disciplines involved in reclamation research whose initial purpose would be to conduct an external professional audit of the MAES Reclamation Research Program. In order to assure an impartial review the panel should not include anyone affiliated with Montana State University.

   b. Request that a report of the audit be submitted to the Environmental Quality Council prior to the 1979 Legislative Session.

   c. Retain the Panel as a peer review group for critical scientific analysis of any proposal for reclamation research submitted under the auspices of the Montana Agricultural Experiment Station.

2. The Leader of the Reclamation Research Program should review all research proposals and experimental designs with the Administrator of the Reclamation Division, Department of State Lands, prior to commencement of research.

3. The Leader of the Reclamation Research Program should establish a committee of ranchers and county conservation officers in each locality where research is practiced in order to provide a forum for local input to the design and conduct of research projects.

4. The Administrator of the Reclamation Division, Department of State Lands, should be urged to retain bonding for revegetated spoils until substantial proof is submitted that such land has been restored according to all significant ecological, legal and practical criteria.

5. The Leader of the Reclamation Research Program should prepare and submit a proposal for a long-term strip-mined land restoration study using exclusively native seed, including seed from pioneer as well as perennial grass species, and to include in that study proposal a minimum of two treatments:

   a. initial simultaneous seeding of all species, and

   b. step-by-step seeding according to the successional stage of development reached and the adequacy of natural seed sources.

6. The Leader of the Reclamation Research Program should restructure the present grazing demonstration to measure the successional response of the seeded vegetation to light controlled grazing and to put emphasis on the measurement of changes in soil and plant parameters, including soil organic matter. Failure to restructure the study in this manner would be cause for a subsequent recommendation to sever the study from the auspices of the Montana Agricultural Experiment Station.

7. The Leader of the Reclamation Research Program should keep for every study an account of the costs for fertilizer, fencing, water tanks, labor, pumping facilities, and other elements of intensive ranching used in the study, as well as income that would accrue from sale of agricultural products produced on experimental plots.

8. The Administrator of the Reclamation Division, Department of State Lands, should identify research priorities related to reclaiming strip-mined lands as required in Sec. 2, Article IX of the Montana Constitution and the Montana Strip and Underground Mine Reclamation Act. These priorities should indicate areas where research is needed in response to reclamation requirements in the Constitution and the reclamation act, and should be forwarded to the Legislature in the form of requests for research funds at the earliest possible date.

X. LITERATURE CITED

1. Anonymous. 1976. "Ranchers' organization contends mine reclamation study can hurt." The Billings Gazette, September 5.

2. Associated Press. 1976. "Ranchers coalition issues criticism of grazing study." Missoulian, June 14.

3. Associated Press. 1976. "Rosebud Assn. protests Experiment Station tests." Great Falls Tribune, September 7.

4. Box, T. W. 1976. "Reclamation standards not applied equally to all disturbances." Symposium on Reclamation of Drastically Disturbed Lands, Ohio Agricultural Research and Development Center, Wooster.

5. DePuit, E. J. June 1976. "Plant response and livestock performance on coal mine spoils pastures: a statement of proposed research." Animal & Range Sciences Department, Montana Agricultural Experiment Station, Montana State University, Bozeman.

6. Dubbs, A. L. 1966. "Yield, crude protein, and palatability of dryland grasses in central Montana." Montana Agricultural Experiment Station, Bulletin 604. Central Montana Branch Station, Moccasin.

7. Ell, F. J. 1976. "Ranchers: Colstrip reclamation experiment unfair." The Billings Gazette, June 13.

8. Everson, A. C. 1969. "Replacement of native plant communities with introduced communities and its impact on ecosystem function." In Dix, R. L. and R. G. Biedleman, eds., The Grassland Ecosystem: A Preliminary Synthesis. International Biological Program, Colorado State University, Fort Collins.

9. Hemmer, D., Montana Department of State Lands, Helena. Memo dated August 16, 1976 to Kathy Van Hook, Montana Energy Advisory Council, Helena.

10. Komberec, T. J. 1976. "Range relationships of mule deer, elk, and cattle in a rest-rotation grazing system during winter and spring." Final Job Report, Research Project No. W-120-R-6, 7, Montana Department of Fish and Game, Helena.

11. Lauenroth, W. K., J. L. Dodd, R. K. Heitschmidt, and R. G. Woodmansee. 1975. "Biomass dynamics and primary production in mixed prairie grasslands in southeastern Montana: baseline data for air pollution studies." In Clark, W. F., ed., Proceedings of the Fort Union Coal Field Symposium, Volume 5, Terrestrial Ecosystems Section, Eastern Montana College, Billings.

12. Lewis, J. K. 1969. "Range management viewed from the ecosystem framework." In Van Dyne, G. M., ed., The Ecosystem Concept in Natural Resources Management, Academic Press, N. Y.

13. McRae, W. D. 1976. "Rosebud answers Hodder." Editorial Page, The Billings Gazette, June 22.

14. McRae, W. D., Rosebud Protective Association, Forsyth, Montana. Letter dated June 24, 1976 to Lt. Governor Bill Christiansen.

15. Meyn, R. L. and R. P. Young. June 1976. "Reseeding mine spoils to sustain itself and support livestock." Montana Agricultural Experiment Station, Capsule Information Series, Number 11. Montana State University, Bozeman.

16. Montana Department of Natural Resources and Conservation. 1974. "Draft Environmental Impact Statement on Colstrip Electric Generating Units 3 & 4, 500 Kilovolt Transmission Lines & Associated Facilities. Volume Three-B, Power Plant--Appendixes. Energy Planning Division, Helena.

17. Montana Environmental Quality Council. In Press. "Montana's Renewable Resources Today and Tomorrow." Fifth Annual Report (1976). MEQC, Helena.

18. Montana House of Representatives. 1975. Oversight Hearing on Implementation of the Montana Strip Mining and Reclamation Act. Natural Resources Committee, April 4. Reprinted by the Montana Environmental Quality Council, Helena.

19. Morris, M. S. and R. E. Lovegrove. 1975. "The topographic and edaphic distribution of several plant communities of warm and cool season species in southeastern Montana." In Clark, W. F., ed., Proceedings of the Fort Union Coal Field Symposium, Volume 5, Terrestrial Ecosystems Section, Eastern Montana College, Billings.

20. Odum, E. P. 1959. Fundamentals of Ecology. W. B. Saunders Co., Philadelphia.

21. Rosebud Protective Association. August 1976. "Critique of the grazing study." RPA, Forsyth, Montana.

22. Ross, R. L., E. P. Murray, and J. G. Haigh. 1973. "Soil and vegetation inventory of near-pristine sites in Montana." U. S. Department of Agriculture, Soil Conservation Service, Bozeman.

23. Sindelar, B. W., R. L. Hodder, and M. E. Majerus. 1973. "Surface mined land reclamation research in Montana." Montana Agricultural Experiment Station, Research Report 40. Montana State University, Bozeman.

24. Solomon, S., Montana Energy Advisory Council, Helena. Telephone conversation on August 31, 1976 with Loren Bahls, Montana Environmental Quality Council, Helena.

25. Stauber, M. S., O. Burt, and H. Houlton, 1975. "Economics of crested wheatgrass fertilization at Havre, Montana." In Proceedings of the Range Fertilization Symposium, Montana Agricultural Experiment Station, Research Report 70, Montana State University, Bozeman.

26. Taylor, J. E., W. C. Leininger, and R. J. Fuchs. 1975. "Baseline vegetational studies near Colstrip." In Clark, W. F., ed., Proceedings of the Fort Union Coal Field Symposium, Volume 5, Terrestrial Ecosystems Section, Eastern Montana College, Billings.

27. Thornburg, A. A. 1976 "Adapted plant materials essential for reclamation." Symposium on Reclamation of Drastically Disturbed Lands, Ohio Agricultural Research and Development Center, Wooster.

28. Wambolt, C. L. 1974. "Range grazing systems." Montana Cooperative Extension Service, Bulletin 340. Montana State University, Bozeman.

29. Wambolt, C. L. 1975. "Experiment Station Conference and Range Fertilization Symposium" In Proceedings of the Range Fertilization Symposium, Montana Agricultural Experiment Station, Research Report 70, Montana State University, Bozeman.

30. Wambolt, C. L. 1976. "Montana range seeding guide." Montana Cooperative Extension Service, Bulletin 347. Montana State University, Bozeman.

31. Westinghouse Environmental Systems Department. 1973. "Montana strip mining permit application by Western Energy Company." WESD, Pittsburgh, Pennsylvania.

32. Wight, J. R. 1975. "A summary of range fertilization research conducted by the Northern Plains Soil and Water Research Center." In Proceedings of the Range Fertilization Symposium, Montana Agricultural Experiment Station, Research Report 70, Montana State University, Bozeman.

245

XI. APPENDIXES

Appendix A.

PLANT RESPONSE AND LIVESTOCK PERFORMANCE ON COAL MINE SPOILS PASTURES

A Statement of Proposed Research

by

Edward J. DePuit

Animal & Range Sciences Department
Montana Agricultural Experiment Station
Montana State University
Bozeman, Montana 59715

Program Leader: R.L. Hodder

June, 1976

Introduction

The initial intent of revegetating mine spoils is to achieve soil stabilization; the ultimate purpose is to create a useful and productive vegetative cover. The Montana Stripmining and Reclamation Law of 1973 requires that reclaimed spoils must ultimately be capable of withstanding the tests of time, weather and proper post-mining grazing by livestock and wildlife, and that the forage cover must be as productive, stable and useful as that which existed on native range previous to disturbance by surface mining for coal. Subsequent interpretation of the law has required the seeding of predominantly native plant species as a means to achieve this goal, a regulation presumably forwarded in cognizance of the principle that such native species are best adapted for survival under climatic conditions of the region. Such native species, however, are also best adapted to existing soils of the region, as developed under this climate regime, and it is recognized by many that such soils are difficult or impossible to recreate in a short term following surface mining. Establishment of native, climax vegetation on spoils sites, which in effect represent a new and completely altered soil medium for plant growth, has thus often been slow, while considerably more rapid vegetation establishment has been achieved using various introduced species. In a research sense, it would therefore be very beneficial to gain knowledge on the stability and productivity of revegetated areas made up of introduced species as well as those areas successfully seeded to native species.

At the Western Energy Company Rosebud Mine near Colstrip, a considerable acreage of successfully revegetated spoils has developed since being seeded 3 to 4 years ago. This acreage was seeded previous to the 1973 reclamation law to a mixture of native and introduced plant species. Although a predominantly native seed mixture was planted (9 native of 16 total species seeded),introduced species now dominate the established plant community. These areas thus present an ideal situation for the evaluation of stability and productivity of introduced plant species on spoils under the projected local post-mining land use, livestock grazing. It is hoped that similar revegetated spoils areas composed of predominantly native vegetation will develop for similar evaluation in the future; such areas are simply not available at present.

Numerous studies have been conducted to compare productivity of reseeded pastures with native range. Data available from the eastern United States on productivity of spoils vegetation do not apply directly to eastern Montana; however, the U.S. Range Livestock Experiment Station, Miles City, Montana, has compared grazing values of reseeded pastures with native range and has established norms of native range vegetation and livestock productivity determined over years of time. These data are supported by mean weights of vegetative production derived from many decades of study throughout the existence of the Station. The present study will compare the quality of established, primarily introduced spoil vegetation grazed in two given sequences during a growing season with established norms from the U.S. Range Livestock, Montana Experiment Station at Miles City until substantial data are accumulated directly applicable to the locality of Colstrip, the location of this investigation.

Objectives

The overall, long-term objective of the proposed research is to determine if this particular spoil vegetation 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. Specific objectives for the field trials at Colstrip during this study are as follows:

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 spoil vegetation in scatter of seed, plant productivity, accumulation of organic matter and soil fertility.

Methods and Procedures

Study Area

The grazing area is located at the extreme northern portion of Pit No. 6 at the Rosebud Mine (Western Energy Company) near Colstrip, Montana. This area was part of the first land disturbed by the reactivation of mining by the Western Energy Company in Pit No. 6. Overburden removal, coal extraction, backfilling, and shaping were completed at the study area in 1971. These operations created a rolling terrain of knolls and depressions with gently sloping surfaces of 3:1 or less gradient. In the spring of 1972, the Company prepared the site for seeding. The steeper slopes (those of about 3:1) were treated by the creation of large surface depressions or "dozer basins" for the purpose of erosion control and enhancement of vegetative growth (Sindelar, et al., 1974). Slopes of lesser gradient were prepared for seeding by either "chiseling" with a chisel plow or "gouging" with a custom-designed disc plow. These methods are also described in Sindelar et al. (1974). Immediately after seedbed preparations in May, 1972, a mixture of native and introduced grasses, shrubs, and legumes was seeded by air at the rate of about 38 kg/ha (34 lbs/A). The approximate contents of this mixture are given in Table 1. Fertilizer was also aerially applied at about 50 pounds of nitrogen and 50 pounds of phosphorus (as P_2O_5) per acre. The area was refertilized in 1974 at 45 pounds per acre each of nitrogen and P_2O_5 phosphorus.

Table 1. The approximate composition and rate of application of the seed mixture applied by air to the Controlled Grazing Study area.

Species		Rate p.l.s. kg/ha	lbs/A
Crested wheatgrass	*Agropyron cristatum*	3.4	3
Thickspike wheatgrass*	*Agropyron dasystachyum*	3.4	3
Western wheatgrass*	*Agropyron smithii*	4.5	4
Smooth bromegrass	*Bromus inermis*	5.6	5
Orchard grass	*Dactylis glomerata*	2.2	2
Green needlegrass*	*Stipa viridula*	2.2	2
Ladak alfalfa	*Medicago sativa*	1.1	1
Cicer milkvetch	*Astragalus cicer*	2.2	2
Eski sainfoin	*Onobrychis viciaefolia*	3.4	3
Fourwing saltbush*	*Atriplex canescens*	2.2	2
Prairie sandreed grass*	*Calamovilfa longifolia*	1.1	1
Indian ricegrass*	*Oryzopsis hymenoides*	1.1	1
Yellow sweetclover	*Melilotus officinales*	2.2	2
Greasewood*	*Sarcobatus vermiculatus*	1.1	1
Antelope Bitterbrush*	*Purshia tridentata*	1.1	1
Big sagebrush*	*Artemisia tridentata*	1.1	1
		37.9	34

*Native to Montana

Baseline data including vegetation and soil characteristics were collected during 1975. A portion of the available acreage has been grazed to determine its relative palatability as late summer and fall pasturage. Vegetation in the experimental pastures now consists of a productive mixture of predominantly introduced grasses and legumes. The area is nearly fully occupied by plant growth. The exceptions are a few areas (less than 100 m^2) devoid of vegetation where seed apparently was not broadcast. Major plant species are crested wheatgrass, smoothbrome, tall wheatgrass, and Ladak alfalfa. Upon closer examination, the grazing area supports a more varied flora (Table 2) although many of the component species constitute only minor percentages of total plant production. It is interesting to note that many plant species, some perennial native grasses in particular, have invaded the area or have developed from seed brought in during the spoil shaping process. The species composition present in years to come may thus be different from that found in 1975. A closely documented study such as this will clearly determine the trends in plant composition that occur with grazing pressure.

Table 2. Species composition list for the Plant Quality Evaluation Study, summer 1975.

Scientific Name	Common Name
Grasses	
Bromus inermis	Smooth brome
Agropyron cristatum	Crested wheatgrass
Agropyron elongatum	Tall wheatgrass
Bromus japonicus	Japanese brome
Stipa comata	Needle-and-thread
Agropyron dasystachyum	Thickspike wheatgrass
Hordeum jubatum	Foxtail barley
Agropyron trachycaulum	Slender wheatgrass
Dactylis glomerata	Orchard grass
Bromus tectorum	Cheatgrass
Bouteloua gracilis	Blue grama
Forbs	
Melilotus officionalis	Yellow sweetclover
Astragalus cicer	Cicer milkvetch
Onobrychis viciaefolia	Sainfoin
Psoralea argophylla	Silverleaf scurfpea
Lactuca spp.	Wild lettuce
Ambrosia psilotachya	Western ragweed
Cirsium undulatum	Wavyleaf thistle
Artemisia ludoviciana	Cudweed sagewort
Glycyrrhiza lepidota	Wild licorice
Medicago sativa	Alfalfa
Solidago missouriensis	Goldenrod
Sphaeralcea coccinea	Scarlet globemallow
Shrubs	
Atriplex canescens	Fourwing saltbush
Gutierrezia sarothrae	Broom snakeweed
Yucca glauca	Soapweed or yucca
Artemisia frigida	Fringed sagewort
Artemisia dracunculus	False-tarragon sagewort

Vegetative production in the initial six experimental pastures (to be described below under Experimental Design) during the 1975 growing season varied from a low of 1764 kg/ha (1574 lbs/A) in pasture . 3 to a high of 2823 kg/ha (2518 lbs/A) in pasture o. 2 (Table 3). Overall, the total vegetative production averaged 2249 kg/ha (2006 lb/A). Above-ground production levels such as these estimated in the pastures were from 1½ to 2 times those typically found at native range sites near Colstrip during 1975. Lauenroth, et al. (1975) found from 350 to 1000 kg/ha total above-ground biomass on native range sites near Colstrip. A range of 698 kg/ha on an *Agropyron spicatum/Koeleria cristata* community to 1830 kg/ha on a *Stipa comata/Bouteloua curtipendula* community was determined from early July, 1975 clippings near Colstrip by Munshower, DePuit, and Newman (1976). Similar figures for a variety of community types were found during earlier premining range surveys (Westinghouse Electric, 1973). Production at the Rangeland Fertilization Study in 1974 (Meyn, et al., 1975) on deferred, unfertilized, ungrazed rangeland in excellent range condition averaged 1589 kg/ha (1417 lbs/A).

In the spoils pasture complex, crested wheatgrass is presently the dominant perennial grass. It is followed in descending order by smooth bromegrass, tall wheatgrass, and miscellaneous other grass species (Table 3). Various legumes and forbs are the dominant nongrass component. Shrubs and annual grasses comprise only a minor portion of the standing biomass. Table 4 presents the approximate species composition of the above-mentioned plant groups by individual pastures and their respective production averages. There appear to be some notable differences in species composition among pastures which may have bearing on the term of grazing that will constitute proper use. Crested wheatgrass appears to be significantly more dominant in the center pastures (2 through

5) than the outside pastures (1 and 6). There also seem to be some notable differences in legume and forb content among pastures. With future study, the importance of these differences in species composition will be determined. The variation on species composition as determined from these baseline data show the necessity for a replicated study. There is much less chance of bias being entered into determination of treatment effects--the differences between heavy, moderate, and no grazing.

Table 3. Standing vegetative biomass[1] (lbs/A-dry weight) at the Plant Quality Evaluation Study at Colstrip on July 24, 1975.

Species	Pasture Number 1	2	3	4	5	6	Ave.
Smooth brome	242	387	166	242	277	286	267
Crested wheatgrass	784	1401	950	1214	901	744	999
Tall wheatgrass	240	248	132	241	205	177	207
Other perennial grasses	176	41	53	55	43	26	66
Annual grass	36	18			70	9	22
Legumes and forbs	589	424	269	325	284	763	442
Shrubs	___	___	4	2	12	2	3
Total standing biomass	2066	2518	1574	2079	1792	2008	2006

[1]This includes only the current year's live growth at the date of measurement. All standing dead material was removed from the samples.

Table 4. Species composition (in percent dryweight biomass) by pasture number at the Plant Quality Evaluation Study at Colstrip, July 24, 1975.

	Pasture Number						
Species	1	2	3	4	5	6	Mean
Smooth brome	11.7	15.4	10.5	11.6	15.5	14.3	13.2
Crested wheatgrass	37.9	55.6	60.3	58.4	50.2	37.1	49.9
Tall wheatgrass	11.6	9.9	8.4	11.6	11.4	8.8	10.3
Other perennial grasses	85.	1.6	3.4	2.7	2.4	1.3	3.3
Annual grasses	1.8	0.7	--	--	3.9	0.4	1.1
Legumes and forbs	28.5	16.8	17.2	15.6	15.9	38.0	22.0
Shrubs	--	--	0.2	0.1	0.7	0.1	0.2
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5 presents plant cover data for the initial six experimental pastures during 1975. The relationship of canopy cover estimates among smooth brome, crested wheatgrass, and tall wheatgrass parallel that of plant production among these same species. Crested wheatgrass provides the dominant cover (32 percent) followed by smooth bromegrass (10 percent) and tall wheatgrass (8 percent). Bare ground constitutes 45 percent on the average. At a nearby native rangeland site, bare ground averaged 29 percent (Meyn, et al., 1975). Legumes comprise a sizable 14 percent of the total plant cover. As in production estimates, annual grasses, shrubs, and forbs make up only a minor portion of the stand.

Table 5. Estimated percent cover of vegetation, litter, and bare ground by pasture at the Plant Quality Evaluation Study Colstrip, July 23, 1975.

	Pasture Number						
Species or cover type	1	2	3	4	5	6	Mean
Perennial grasses	36	54	48	59	60	42	50
Smooth brome	6	7	8	11	15	13	10
Crested wheatgrass	21	36	33	42	38	24	32
Tall wheatgrass	9	11	7	6	7	5	8
Annual grasses	7	3	3	4	7	9	6
Legumes	22	9	11	13	10	16	14
Shrubs	2	3	2	3	2	3	2
Forbs	3	2	3	2	3	5	3
Litter	40	50	52	52	56	53	51
Bare gound	56	45	43	40	43	41	45

Cover estimates based on 40 Daubenmire frames per pasture--a transect of 20 on the north aspect and a transect of 20 on the south aspect.

The quality of the forage as it stood in mid-summer 1975 was determined by analysis of total digestable nutrients (TDN). The results of these analyses are presented in Table 6. No significant differences in plant analyses appeared between the forage samples from the experimental pastures and the published records of the National Academy of Sciences (1971). Protein contents reported by the National Academy of Sciences (1971) for yellow sweetclover, tall wheatgrass, and crested wheatgrass are greater than samples from this study, but these differences could easily to attributed to differences in maturity of the compared forage samples. Differences in crude fiber are related to the stage of plant maturity.

Table 6. Analysis of forage samples collected on July 24, 1975, for total digestable nutrients.

Plant Species	Moist.	Protein	Fats	Ash	Crude Fiber	NFE[1]	TDN[2]
	Analysis (% or kg per 100 kg)						
Tall wheatgrass	6.2	5.6	3.3	6.1	37.7	41.1	67
Crested wheatgrass	6.5	2.2	1.9	3.6	38.4	47.4	68
Sweetclover	9.0	11.5	1.9	7.9	18.6	51.1	68
Smoothbrome	5.8	7.9	3.2	7.9	32.9	42.3	67

[1]Nitrogen free extract, found by subtraction

[2]Total digestable nutrients. Calculated by the formula:
TDN=protein (0.75) + crude fiber (.5) + NFE (.9) + fats (2.25), where the coefficients represent digestability.

Particular soil characteristics of the spoils pastures have been initially determined. Soil samples were taken of the surface 30 cm of soil within the study area on November 11, 1974 and on March 24, 1975 to determine basic phsyical and chemical characteristics that might have bearing on future pasture management plans. An Oakfield sampler was used to extract soil cores. Each sample consisted of a composite of 6-8 cores from a given location. The basic elements of plant nutrition, as shown in Table 7, do not appear to be limiting. Soil sampling will be continued in the future to determine the effects of grazing.

Bulk density samples were obtained of soil at about the 15 cm depth. Each spoils pasture was stratified according to recognizable physiographic or vegetative units that were most likely to be compacted by livestock trampling. This was felt to be preferable over a completely random location of points

Table 7. Some basic chemical and physical porperties of the soil in the grazing study area, Colstrip, MT.

Date	NO_3-N	NH_4-N	Analyses P[1] (ppm)	K meq/100g	Texture[2]
11-11-74	9.1 (3)	--	9.9 (3)		
4-24-75	3.1 (6)	10.8 (6)	2.4 (6)	0.24 (6)	Silt loam

[1]Bicarbonate extraction method

[2]Estimated

Numbers in parentheses are the number of samples taken

which could not later be resampled. Ten samples were taken within each chosen area with a small, commercially available bulk density sampler. The average densities are presented in Table 8. The degree of surface compaction as indexed by bulk density (before grazing) at the 15 cm depth between physiographic or vegetative components does not differ widely; the largest average difference is only 0.09 g/cm^3. Bulk density on the pre-grazed pastures averaged 1.25 g/cm^3 while those on the control pastures averaged 1.29 g/cm^3. The effects of livestock grazing on soil compaction can only be determined after repeated sampling is taken of soil in the chosen pasture areas. The greatest impact is expected along fence lines and in the bottom of wet areas.

Table 8. Baseline bulk density (compaction index) of selected physiographic units within the six experimental pastures at Rosebud Mine, 197-. Data are expressed as g/cm^3.

				Physiographic Unit			
Pasture No.	Average	Fence	Dozer basins	Water catchment (large trough)	Ridge	Central swale	Major slope E,W,N,S
1.	1.26	1.25	1.25	1.29	1.26	--	--
2.	1.19	1.18	1.14	1.17	--	1.24	1.23E
3.	1.32	--	--	--	1.38	--	1.26N
4.	1.29	1.34	--	1.25	1.29	1.28	--
5.	1.26	--	--	--	1.25	--	1.26N 1.28S
6.	1.30	--	--	--	1.28	1.28	1.25N 1.39SE
Average	1.27	1.26	1.20	1.24	1.29	1.26	1.28

Dashed lines indicate that the given physiographic unit was not sampled.

Experimental Design

The general revegetated spoil areas available for grazing were delineated on an aerial photograph and checked by ground reconnaisance to assess their suitability for grazing. The perimeters and shapes of the spoil grazing areas (Figure 1) were constrained by ground conditions. The final locations of the perimeter fences encompassed as much forage as was possible, yet limited the length of fencing to a minimum. As a whole, the grazing areas appeared to be more uniform in terms of degree and age of plant development than any other area within Pit No. 6.

The initial 58 acre pasture area was subdivided into six pastures ranging from 4.7 to 12.2 acres in size (Figure 1) to accomodate a completely

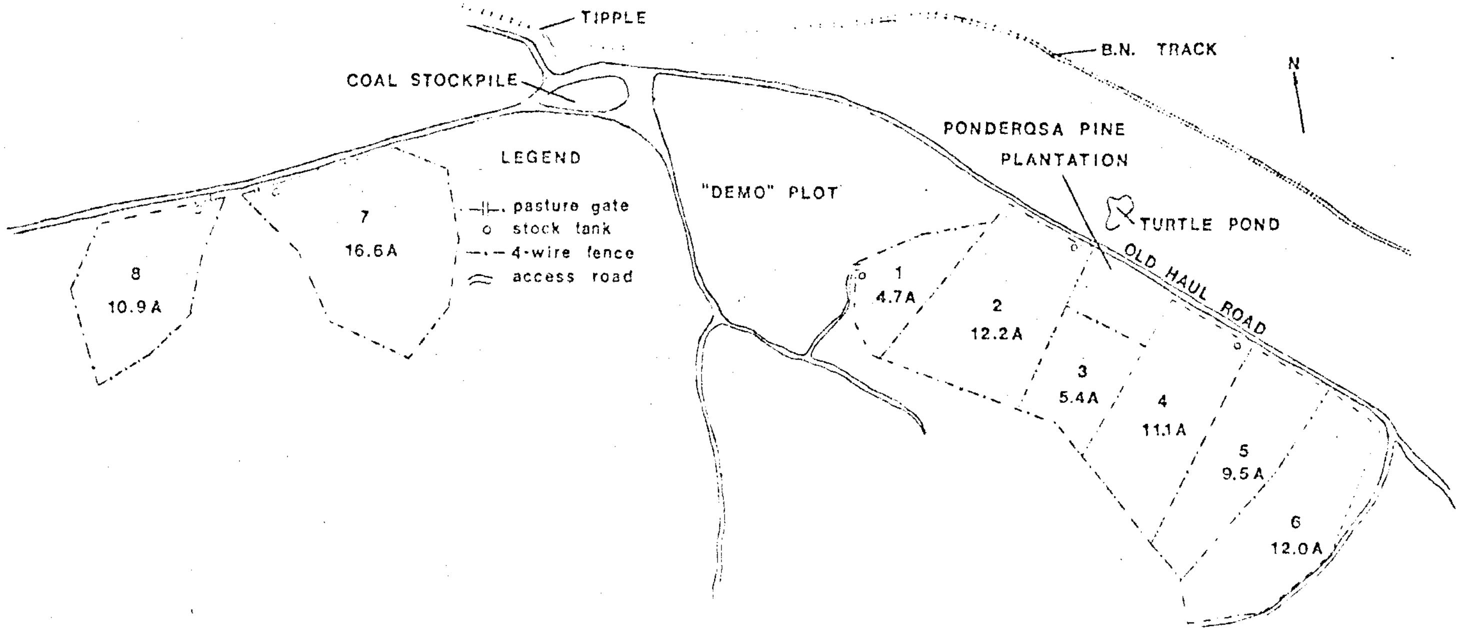


Figure 1: LOCATION OF THE EXPERIMENTAL PASTURES
IN THE WESTERN ENERGY PIT NO. 6 RESEARCH AREA,
NEAR COLSTRIP, MONTANA.

randomized design of two treatments with three replications. The treatments are grazing (65 percent utilization) and no grazing.

Each of pastures 1 through 6 includes both north and south slope elements. An undulating ridgeline runs east and west and through the center of the study area. Rectangular pastures, aside from being adaptable to the study terrain, are efficient from a sampling standpoint and, when compared to other shapes, tend to interfere least with animal distribution patterns (Cook et al., 1962). Watering tanks having a capacity of about 700 gallons were installed in each pasture.

Two additional pastures on revegetated spoils (Pastures 7 and 8) similar in stand characteristics and age to Pastures 1-6 were established during 1976 to serve as summer holding pastures for a portion of the stock. A suitable area of fenced native rangeland (Pasture 9) has been selected for summer pasturage of the remainder of the stock. This rangeland site has been deferred from grazing by livestock for many years. The use of these experimental pastures in this study will be described in later paragraphs.

Pastures 1, 2 and 4 were randomly chosen for spring and fall grazing during the study period. Pastures 3, 5 and 6 will serve as controls. There may be opportunity in later years of the study to utilize the control pastures in grazing trials for objectives other than the present study. It is premature to speculate on these trials since at least three years of grazing on the presently designated pastures may be necessary to achieve the objectives as outlined.

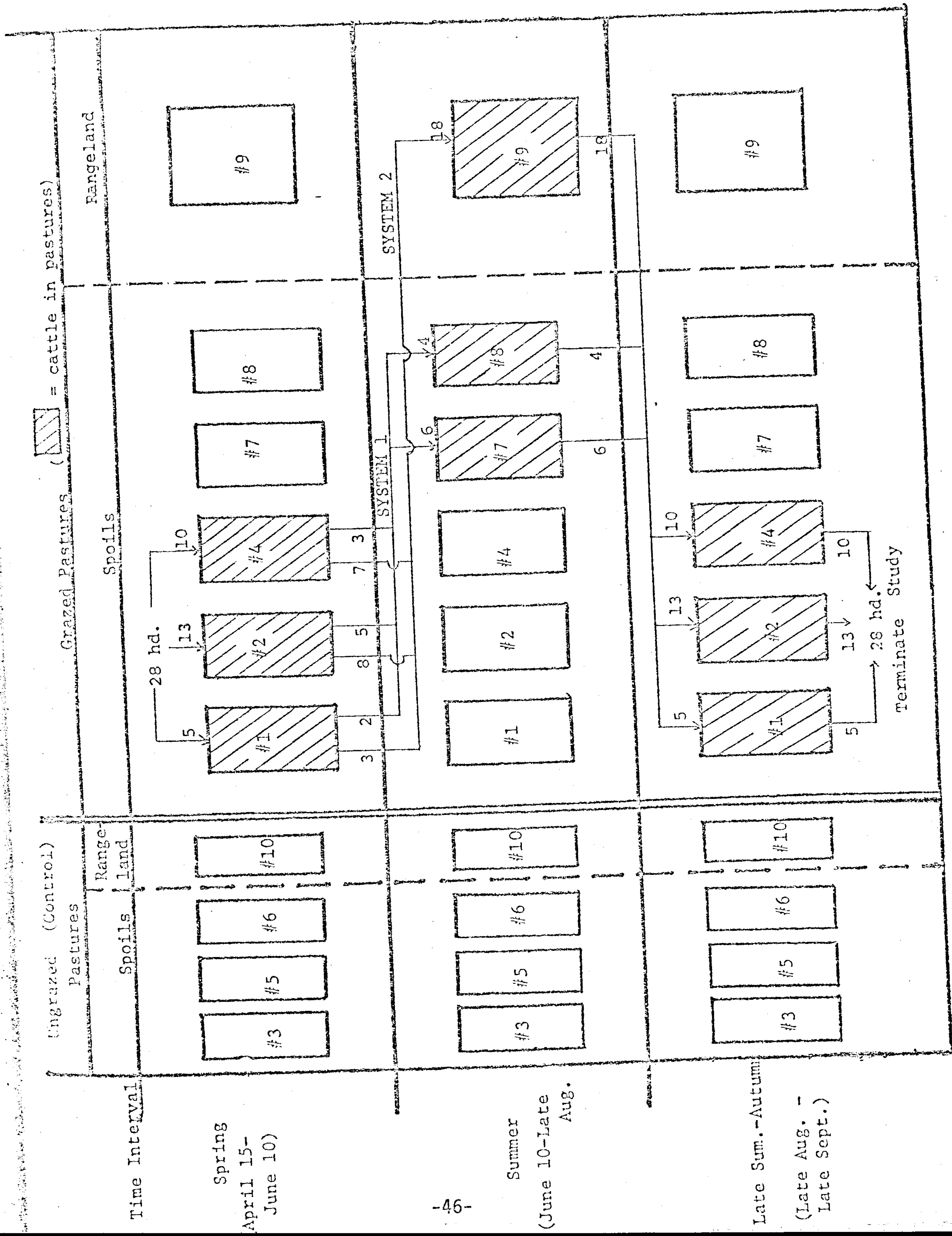
The objectives of this study may be arranged into two categories: 1) short-term goals to be specifically addressed during 1976, and 2) long-term goals to be addressed over a period of three years or longer. Objectives 1 and 2 may be considered short-term goals and 3 through 5 long-term goals. A brief description of procedures used to achieve these objectives follows.

Substantive data pertaining to objectives 1 and 2 will hopefully be obtained during 1976, although it may prove desirable to extend experimental procedures into future years. Twenty-eight yearling steers have been leased from a local rancher for use in this study. Steers were chosen as experimental animals, instead of cows-calves to eliminate from this initial study any complicating effects of cow estrous cycle and/or calf nutrition on grazing patterns. Stocking rates have been calculated according to standardized procedures for each of the spoils pastures to be initially grazed (Nos. 1,2 and 4) based upon the 1975 plant production data and assuming each yearling steer to equal 3/4 animal unit. Based upon these calculations, five steers were placed within Pasture 1, thirteen steers within Pasture 2 and ten steers within Pasture 4 on April 14, 1976, at which time the vegetation was judged to be ready for initial grazing. All animals were ear tagged and weighed during this period.

As will be discussed later, the proper seasons for use for vegetation such as that found on the spoils pastures (i.e. predominantly crested wheatgrass and smooth brome) are spring and autumn. However, it may also be desirable to evaluate livestock performance on such vegetation during the summer months. Therefore, two systems of grazing on spoils vegetation have been designed for 1976, and are diagrammed in Figure 2. System 1 involves livestock grazing continuously on spoils vegetation, albeit within different pastures during different periods, throughout the season. System 2 involves livestock grazing on spoils vegetation initially during spring, rangeland vegetation during early and mid-summer and spoils vegetation again during late summer or autumn.

As described above, the 28 experimental steers were weighed and placed into the designated spoils Pastures 1, 2 and 4 during mid-April, 1976. On June 10, 1976, the steers were removed from these pastures and weighed. Ten steers

Figure2. Diagrammatic representation of 1976 grazing study at Colstrip, Montana.



were then moved to summer pasture under System 1 into spoils pastures 7 and 8 (six into Pasture 7 and four into Pasture 8) (Figure 2). Of these 10 steers, 2 were selected from spring spoils Pasture no. 1, 5 from Pasture 2, and 3 from Pasture 4 to take into account any possible difference engendered in steer weight response due to differences in performance on these three spring pastures. The remaining 18 steers were grouped and moved into the rangeland summer pasture (Pasture 9) under System 2 (Figure 2). Due to the limited acreage available for spoils Pastures 7 and 8, it was impossible to assign an equal number of animals to these spoils pastures and the rangeland pasture under grazing Systems 1 and 2.

During late summer or early autumn, as dictated by vegetation condition, the cattle will be removed from both the spoils and rangeland summer pastures simultaneously and weighed. The cattle will then be divided and redistributed into the same spoils pastures grazed during the spring (i.e. Pastures 1, 2 and 4), with care taken to replace each individual tagged steer into the same pasture occupied during the spring. The cattle will remain on spoils Pastures 1, 2 and 4 until vegetation condition suggests termination of proper grazing. At that time, the cattle will be removed, weighed and returned to the lending rancher, and the 1976 field phase of the study will be concluded.

Quality of spoils (and native) vegetation for grazing livestock will be assessed during spring, summer and autumn by analyses for total digestable nutrients and trace elements. A major valid measure of forage quality during these grazing periods, however, will involve the animals themselves in terms of weight response and condition. Steer weight response patterns obtained with the two grazing systems of this study will be compared to determine the better of the two systems in terms of livestock performance in meeting Objective 2. These weight response patterns, especially those of

System 1--season-long grazing of spoils vegetation, will also be compared to established norms for this region (e.g. Houston and Urick, 1972) to address Objective 1 and to provide some insight on the relative performance of cattle on spoils vegetation.

Animal response to forage, however, addresses only one side of the question of the suitability of this type of spoils vegetation for grazing. Since it is a goal of reclamation to produce a stable plant community capable of maintaining itself under proper grazing pressure, it is also necessary in a study such as this to evaluate the response of forage and site to grazing livestock. Vegetation and site responses are treated under Objectives 3 through 5, and should most properly be determined over a longer grazing term than a single season. Hence, conclusive data on vegetation and site responses may only become available after 3 or preferably more years of grazing.

As noted previously, detailed baseline vegetative data for the six initial spoils pastures (Pastures 1 through 6) were collected during 1975. Plant production was sampled by clipping to ground level all vegetation within 20 one m^2 frames per pasture. Sample sites were randomly located along a predetermined course which crossed major slopes and features of a given pasture. Plant clippings were separated by species or major species classes, brought back to the lab, oven dried for at least 48 hours at $60^{\circ}C$, and weighed. Plant canopy cover was determined by the method of Daubenmire (1970). At the same time estimates were made of litter and bare ground. Two 100-meter-long transect lines were established in each pasture to represent the natural variation in vegetation, slope, and aspect. Each transect line was marked by metal stakes at the 0, 50, and 100 meter points.

These were driven into the ground so that only 25 to 30 cm remained above the ground. This was high enough to be easily located yet not at a sufficient height to affect the grazing livestock. Microplot frames of 2 x 5 (8 x 20 inches) were placed parallel to the transect line at 5 m intervals, starting at a distance of 5 m from the beginning post. The same microplots will be relocated for later measurements. This will enable a determination to be made of vegetational trends. The percentages of plant cover, ground litter, and bare ground are important indices of plant community development. In the case of plant species, canopy coverage provides an additional measure of dominance and is useful in detecting trends in plant community development, as might be expected with grazing pressure.

A plant species list was prepared by periodically traversing each pasture and taxonomically identifying all species present. Two permanent 1 x 1 meter quadrats were also established in each pasture, one each on the north and south aspects, for the purpose of qualitatively documenting the changes in plant cover that occur with time and grazing. The quadrats were photographed with twin 2¼" x 2¼" Hassleblad cameras for stereophotographic analysis (e.g. Pierce and Eddleman, 1970). Photographs will continue to be taken before and after each grazing period.

Percent livestock utilization of forage by species will also be assessed within the grazed spoils pastures by harvesting plants within and without wire mesh grazing microexclosures.

Similar vegetative data will be collected on the three new pastures (Pastures 7, 8 and 9) during 1976. Pasture 9, the rangeland summer pasture for the 1976 study, has the additional advantage of being situated adjacent to a permanent M.A.E.S. range exclosure from which vegetative data has been collected each year since 1973. This enclosed acreage has been designated as Pasture 10 for this study (Figure 2), and will be used as an ungrazed, control pastur

For purposes of the present study, most intensive vegetation measurements will be conducted (as described above) on the three spring and autumn grazed pastures (Pastures 1, 2 and 4). Vegetation data over the long term on these three pastures will hopefully meet Objectives 4 and 5 by suggesting any changes wrought by grazing pressure and should allow an evaluation of the stability of the plant community under such pressure. Concurrent data collected on the three adjacent, ungrazed control pastures (Pastures 3, 5 and 6) will provide an indication of that vegetative state which would occur without grazing.

Objective 5 will also be addressed by taking periodic soil samples on the control and grazed spoils pastures and analyzing for organic matter and plant nutrients. To determine the degree of soil compaction, bulk density samples will be taken in all pastures. Samples will be collected in designated and marked areas. These include along fence lines, in wet depressions, along major slopes, and on ridge tops. This soil parameter will be periodically monitored closely, since soil compaction can be beneficial or detrimental depending on the degree.

Discussion

Several approaches of evaluating vegetation on spoils from a grazing standpoint seem logical, but the proposed plan comparing a complementary spoils-rangeland grazing system with an exclusive spoils grazing system is considered to offer most potential and practicality. This plan would provide the opportunity to evaluate response of grazing cattle on spoils vegetation continuously throughout the grazing season (System 1) and would compare this response to that obtained with a more logical grazing system, i.e. on spoils in spring and autumn and on rangeland during summer (System 2).

System 2 is considered the more logical grazing system for spoils vegetation of this nature because of the phenology of the dominant plant species. Proper grazing in spring and autumn should promote long-term plant community vigor because grazing is excluded at the time when seed heads are maturing and tillering is at its maximum rate (e.g. summer). Seed scatter is thus encouraged, and sufficient root energy reserves should be present for growth the following spring. Frischknecht and Harris (1968) concluded that spring grazing of crested wheatgrass, a dominant grass in the study area, will contribute toward stand success. However, it is also important to note that smooth brome, another dominant spoils pasture grass, matures earlier than crested wheatgrass, and the removal of grazing livestock during the period in which smooth brome develops seed stocks (i.e. early summer) may allow this grass to be more competitive to created wheatgrass, a favorable response since pure stands of crested wheatgrass are not usually desired. By late summer, smooth brome may be more palatable than crested wheatgrass. According to observations from late summer and autumn grazing on spoils in 1975, this species will then be grazed to a heavier degree than crested wheatgrass. By that time, however, the seed shatter of smooth brome should be complete and moderate utilization is expected to do little damage.

Although spring-autumn grazing may prove to be the best system for utilizing spoils vegetation of this nature, this still must be confirmed by research. Thus, it is necessary to evaluate as well livestock performance on and forage quality of spoils vegetation season long (i.e. System 1), including during the cured-out vegetative stage of the late summer months. It is recognized that future landowners of revegetated spoils areas may not always find it feasible to remove cattle from spoils pastures during the summer, and there is a need to know whether or not vegetation of the type established on the spoils of this study (i.e. mainly introduced species) can acceptably support (and withstand) livestock pressure during this period.

Steer weight responses obtained via grazing Systems 1 and 2 will not only be compared with each other for relative practicability but also with established norms for native rangeland of the region to gain an idea of how this particular spoils vegetation compares with vegetation of unmined areas. Data obtained from the native range summer pasture of this study will be checked for variability against these norms so that irregularities of the season caused by weather, insect infestation or other causes may be recognized. It is hoped that in the future direct single season comparisons of cattle weight response on spoils and native range vegetation may be possible, thus eliminating the necessity of reliance on established, long-term native range averages; during 1976 there simply was not a sufficient acreage of good-excellent condition, deferred native rangeland available for season-long use in this study.

The evaluation of forage quality by cattle weight response on mainly introduced spoils vegetation with respect to native range vegetation may perhaps be questioned as being a comparison of cattle response on two distinctly different types of plant communities. In a research sense there is nothing unacceptable about this. Researchers have long evaluated livestock response on different specific types, conditions and sites of native rangeland. The fact that the spoils pastures have been fertilized as a necessary part of the revegetation process may accentuate the immediate differences between spoils pastures and native range, but fertilizer effects will be taken into account in interpretation of the initial year's data and, in any event, will become progressively less pronounced in successive years following the last fertilizer application in 1974. Even so, the evaluation of cattle response on fertilized spoils pastures is a valid research goal in itself.

It should again be emphasized that forage quality evaluation by cattle response on spoils pastures constitutes only the first part of the overall scope of this study. The second portion of the study consists of an evaluation of the capability of spoils vegetation of this nature to sustain itself under proper grazing pressure. It may be that such vegetation cannot withstand even moderate grazing without undergoing some form of retrogression. It is recognized that the spoils pastures of this study may indeed not have stabilized themselves so soon after initial seeding; concurrent, long-term data collection on the ungrazed control pastures should confirm or disprove this possibility. If the grazed spoils pastures are indeed still changing vegetatively, effects of plant community successional development will be superimposed upon those of grazing. This study will then demonstrate the magnitude of successional impact and desirability of grazing on this type of spoils pastures at such an early stage of plant community development.

The current 1973 Montana Stripmining and Reclamation Law regulations presently require reclaimed areas to be seeded to predominantly native plant species. This regulation may ultimately prove to be ecologically correct, assuming first of all that it proves possible to establish native plant species on spoils, since native species are best adapted to regional climate and resulting development of soils. The spoils pastures of this study, although seeded primarily to native but with lesser amounts of introduced species, are presently supporting a forage cover consisting predominantly of introduced species. Thus, there is doubt as to whether this seeding satisfies the intent of the current legal regulation. However, it should be objectively determined by research whether or not the current legal reliance on seeding primarily native species is indeed correct to achieve the stable, productive conditions so necessary for effective reclamation. This study, if conducted over a sufficient term and under a representative variety of meteorologic conditions, should describe the grazing response and quality of vegetation within a spoils plant community composed mainly of introduced species. It is hoped that a similar future study may be possible on spoils successfully revegetated primarily with native species, thus enabling a comparative evaluation of these two types of revegetation.

Literature Cited

Cook, W.W., Biswell, H.H., Clark, R.T., Reid, E.H., Stoddart, L.A., and M.L. Upchurch. 1962. Basic problems and techniques in range research. Pub. No. 890, National Academy of Sciences - - National Research Council, 341 p.

Daubenmire, R. 1970. Steppe Vegetation of Washington. Washington Agricultural Experiment Station, Technical Bulletin 62.

Frischknecht, N.C., and L.E. Harris. 1968. Grazing intensities and systems on crested wheatgrass in central Utah: Response of vegetation and cattle. Tech. Bull. No. 1388, U.S. Forest Service, 47 p.

Houston, W.R. and J.J. Urick. 1972. Improved spring pastures, cow-calf production and stocking rate carryover in the Northern Great Plains. Tech. Bull. No. 1451,ARS, USDA

Lauenroth, W.K., Dodd, J.L., Heitschmidt, R.K. and R.G. Woodmansee. 1975. Biomass dynamics and primary production in mixed prairie grasslands in southeastern Montana: Baseline data for air pollution studies. In: Proceedings, Fort Union Coal Field Symposium, Billings, Montana, 559-578.

Munshower, F.,E. DePuit, and D. Neuman. 1976. The effect of stack emissions on the range resources in the vicinity of Colstrip, Montana: progress report 1975. Mt. Agr. ExO. Sta. Res. Rep. (in prep). Mt. State Univ., Bozeman

Meyn, R.L., Sundberg, E.S., and R.P. Young. 1975. Research on reclamation of surface mined lands at Colstrip, Montana. Mt. Agr. Exp. Sta. Res. Rep. (in press), Mt. State University, Bozeman

Pierce, W.R. and L.E. Eddleman, 1970. A field stereo photographic technique for range vegetation analysis. J.Range Manage. 23: 218-220

Sindelar, B.W., Atkinson, R., Majerus, M. and K. Proctor. 1974. Surface mined land reclamation research at Colstrip, Montana. Mt. Agr. Exp. Sta. Res. Rep. 69, Mt. State Univ., Bozeman, 98 p.

Westinghouse Electric Corporation. (Environmental Systems). 1973 Colstrip Generation and Transmission Project. Applicants Environmental Analysis prepared for the Montana Power Company and their cooperating affiliates.

Reseeding Mine Spoil to Sustain Itself and Support Livestock

R. L. Meyn and R. P. Young[1]

Introduction

Can reseeded mine spoil sustain itself and support livestock? This is a question scientists of the Reclamation Research Group at the Montana Agricultural Experiment Station are attempting to answer with research at Colstrip, Mont.

Our country's demand for energy may require accelerated mining of coal, our most abundant fossil fuel. Vast deposits of coal in eastern Montana may be stripmined to meet this need if reclamation methods can be found which are environmentally acceptable. Lands proposed for mining are insignificant in area compared to the total land base, but they cannot simply lie idle following mining. Reclamation techniques must be developed and tested to ensure that the mined lands are restored to useful productivity.

Stripmining at Colstrip is expanding to meet increased demands for energy in Montana and other regions of the country. Increasing acreages of native rangeland are being mined, reshaped and seeded to a mixture of plant species. The local livestock industry is affected since beef production is curtailed until grasslands capable of supporting cattle grazing are re-established. Because reseeded mine spoils presently contain a preponderance of introduced grasses, there is still some question regarding the longevity of these species.

Objectives

With support of the Western Energy Company at Colstrip, Mont., an experimental grazing study was implemented on some formerly mined lands which were successfully reseeded to predominantly grassland vegetation. This study is intended to be a cooperative effort supported by local ranchers, industry and other interested parties. Its objectives are (1) to evaluate a management plan utilizing mine spoil pasturage in a manner which accounts for proper stocking rates and seasons of use, (2) to establish the value of summer grazing on native range in conjunction with the use of reseeded spoil, (3) to determine the degree and importance of spoil compaction caused by livestock grazing, (4) to determine the impact of grazing on reseeded mine spoil pasturage and (5) to document weight gains obtained with controlled grazing.

The Research Site

The research site is located at the extreme northern portion of Pit No. 6 at the Rosebud Mine near Colstrip. Mining operations were completed in 1971. The area was later topped with a sandy loam material. In the spring of 1972, the Western Energy Company, assisted by the Montana Agricultural Experiment Station (MAES), prepared the site for seeding. This consisted of construction of large basins (dozer basins) for precipitation and entrapment on the steep slopes small basins (gouges) on the moderate slopes and contour chiselling of all slopes which were thought not to have a severe erosion potential.

In May of 1972, a mixture of native and introduced grasses, shrubs and legumes was seeded by air at the rate of about 34 lbs/A. A total of 95 lbs/A each of nitrogen and P_2O_5 phosphorus were applied by air, 50 lbs/A in 1972 and 45 lbs/A in 1974. This corresponds to about 250 lbs of bulk 16-20-0 per acre in 1972 and about 117 lbs of bulk 34-0-0 and 111 lbs of 0-45-0 per acre in 1974. These early reclamation operations were designed to quickly establish a dense and productive vegetative cover and to limit soil erosion.

The Experimental Design

Reclamation operations as described produced roughly 80 acres of reseeded grassland in the ensuing growing seasons from 1972 to 1974. About 60 acres of this planting were designed as suitable for a grazing study design. As a whole, the

[1] *Research Associate and Research Assistant, respectively, Montana Agricultural Experiment Station, Montana State University, Bozeman.*

chosen area was the most uniform in terms of plant development of reseeded areas in Pit No. 6 large enough to be divided into pastures.

The chosen pasture area was subdivided into six pastures ranging from 4.7 to 12.2 acres to accommodate two grazing treatments with three replications of each. The treatments are moderate grazing (50% utilization) and no grazing. The long-term objective of the study (objective 2) is to graze native range in conjunction with the reseeded spoil in a complementary pasture grazing system. A native range pasture will be selected and baseline plant data will be collected in the coming field season.

Two periods of grazing in the designated pastures will be carried out during the first phase of the study. The first will be from April to mid-June. The second will begin in August and last until proper utilization of the forage has been reached. During the coming field season the livestock will be held on reserve pasturage during midsummer. In following years livestock will be taken to native range during the dry part of the summer. These grazing periods will utilize reseeded spoil early in the spring when native range is not ready, native range in the summer when reseeded spoil is less palatable and reseeded spoil again in the fall when "greenup" occurs on the spoils seedings.

Pastures 1, 2 and 4 were randomly chosen for grazing during the first few years of study. Pastures 3, 5 and 6 will serve as controls (no grazing) until enough data are collected to determine the initial effects of grazing on vegetation, to determine the proper stocking rate, and to determine the probable cattle weight gains.

This project will require long-term support, possibly five or more years. When sufficient information has been collected on both the reseeded pastures and native range, the study may be expanded in scope to evaluate a year-long management system integrating both native range and reseeded mine spoil. Establishment of plant communities on newly mined areas which differ greatly from those presently being studied may require a different research approach. The experimental approach to the present study, as well as to future studies, will be geared toward proper range management, the key to successful and sustained reclamation.

Late Summer 1975 Grazing

Facilities for the grazing of pastures on reseeded mine spoil were completed by mid-August, 1975, and all baseline data (vegetation and soil) were collected by Aug. 21, 1975. Water tanks of 700 gallon capacity were installed and filled from a trailer-drawn tank since there was no permanent water in any of the pastures.

Twenty-three head of Hereford cattle (cows, calves and yearlings) were selected and put on the three designated pastures on Aug. 3, 1975, in proportion to the amount of forage available. Grazing of the study site continued until Nov. 15, 1975, when the cattle were removed and taken to winter pasture.

The purpose of this first grazing period was to utilize the abundant forage produced during the 1975 growing season. Cattle weights were not monitored because facilities were not available. Weight measurements, however, will be taken in each of succeeding grazing periods.

Some Preliminary Results

Forage production and carrying capacity

The grazing area on reseeded spoil supports a varied flora (Tables 1 and 2) although many species constitute only minor or trace percentages of the total plant production.

Table 1. Standing vegetative biomass[1] (lbs/A) at the experimental grazing pastures of Colstrip on July 24, 1975.

Species plant groupings	*Pasture number*						
	1	*2*	*3*	*4*	*5*	*6*	*Avg.*
Smooth bromegrass	242	387	166	242	277	286	267
Crested wheatgrass	784	1401	950	1214	901	744	999
Tall wheatgrass	240	248	132	241	205	177	207
Other perennial grasses	176	41	53	55	43	26	66
Annual grasses	36	18	0	0	70	9	22
Legumes and forbs[2]	589	424	269	325	284	763	442
Shrubs	0	0	4	2	12	2	3
Total standing biomass	2066	2518	1574	2079	1792	2008	2006

[1] *This includes only the current year's live growth on the date of measurement.*

[2] *Principally yellow sweetclover.*

Table 2. Plant species which constitute minor percentages of total biomass at the experimental pastures at Colstrip, July 24, 1975.

Perennial Grasses	
Needle-and-thread grass	Blue grama
Thickspike wheatgrass	Slender wheatgrass**
Orchard grass*	Foxtail barley
Annual Grasses	
Japanese brome	Cheatgrass
Legumes and Forbs	
Cicer milkvetch*	Sainfoin*
Silverleaf scurfpea	Wild lettuce
Western ragweed	Wavyleaf thistle
Cudweed sagewort	Wild licorice
Alfalfa*	Goldenrod
Scarlet globemallow	
Shrubs and Half-shrubs	
Fourwing saltbush*	Broom snakeweed
Yucca (soapweed)	Fringed sagewort
False-tarragon sagewort	

**Were in the seeded mixture; all others are invaders.*
***May have been with Western wheatgrass seed.*

The total forage production was about 2,000 lbs/A, which was far greater than the annual forage production of most native range in the Colstrip area. This resulted in part from large energy inputs through application of chemical fertilizer. Soil tests in the spring of 1975, however, showed neither more available nitrogen nor phosphorus than on local native range. From this we may assume that the residual nutrients from the application of chemical fertilizers have either been utilized by plants or are tied up in a form not readily available for plant use. Much of the fertilizer applied may have been leached deep into the soil. A key question that remains to be answered, of course, is whether an acceptable production level can be maintained for sustained forage production.

From the clipping data of July, 1975, an estimate of stocking rate was determined. The weight of dry forage per acre was first obtained from the field measurements. This was adjusted to account for the proper utilization of each major plant species. The pounds of dry useable forage per acre thus obtained were divided by the dry weight consumption per day of one animal unit. The dry weight consumption per day is dependent on the type of animal, age of the animal and weight gain objectives. A conservative figure of 30 pounds per day per animal unit was used. The result of this calculation was stocking rate in animal unit days per acre. This was divided by 30 to give animal unit months per acre, a common expression for stocking capacity. The values presented in Table 3 should be considered as maximum stocking rates. They will need to be adjusted according to production levels in coming years. The current stocking capacity of the reseeded spoil is about one and one-half times as much as most local native range.

Table 3. Approximate stocking capacity of the experimental grazing pastures at Colstrip on July 24, 1975.

Pasture Number	*Stocking capacity (AUM's/Acre[1])*
1	1.3
2	1.7
3	1.1
4	1.4
5	1.2
6	1.3
Mean	1.3

[1] *One AUM/Acre equals one animal unit grazed for one month on one acre, where one animal unit is equivalent to one 1,000 lb. cow with calf.*

Grazing habits and cattle health

Although quantitative data will be available in the future, there were a number of visual observations concerning livestock behavior and the degree of forage utilization in the late summer of 1975 grazing period.

Smooth bromegrass and tall wheatgrass were the most preferred grass species. Severe defoliation of sweetclover by grasshoppers in mid-summer prevented utilization of this species. Crested wheatgrass, even in advanced stages of drying, was utilized to some extent. Overall, we estimated that about 40 percent of the vegetation was consumed during the first grazing period.

Placement of salt on the drier slopes distant from the water tanks of each pasture helped to achieve, on an aerial basis, more uniform grazing than would have occurred without it.

No "pullup" of individual plants was observed as we walked the pastures during this grazing period. Some plants were grazed to ground level but crowns were left intact.

There appeared to be no adverse affects on cattle health due to a diet of mature reseeded vegetation. Uneasiness was noted the day that cattle were introduced to the pastures, but normal grazing behavior appeared shortly thereafter.

Appendix C.

Rosebud Protective Association

Forsyth, Montana 59327

CRITIQUE OF THE GRAZING STUDY *

The Rosebud Protective Association is concerned about the Grazing Study currently underway at Colstrip through the Reclamation Research Group of the Montana Agricultural Experiment Station. The Grazing Study is already predisposed to show that reclamation is a success and produces more forage than native range. These things are not true, yet the researchers have slanted their study to make erroneous conclusions look true.

The study area is not yet reclaimed according to the current Montana Strip Mining requirements since it still shows residual effects of fertilizer applied previously and grows primarily one kind of grass, crested wheatgrass. It is in an unusual category where there is nothing to compare it with other than reseeded spoils. Yet, the Grazing Study has already made misleading comparisons of this area with native range. The study claims that the area produces one and a half to two times the forage as native range without mentioning the limited usefulness of the grass species or the fertilizer effects on the spoils. Even with fertilizer, the spoils vegetation is suitable for grazing only in limited periods of the year.

Instead of reclaiming the land to its former usefulness, the researchers are pursuing an intensive grazing management plan to justify leaving land unreclaimed. They plan to show that their special management system works by comparing weight gains of cattle grazing on spoils vegetation with cattle on native range. These weight gains are misleading since they depend upon special spoils management.

The study fails to mention that the intensive management required to get results from fertilized, introduced species is uneconomical. The study ignores the logistics of a ranching operation where moving cattle to different pastures every two months creates significant capital and labor problems. It is a foregone conclusion that a rest-rotation system of grazing benefits both forage production and cattle weight gains, but the intensive, limited use of spoils in the Grazing Study is impractical, and uneconomical, for most ranching operations.

The study also assumes that a strip mined area will always be a small, manageable part of a ranching operation. Since strip mines often destroy entire ranches, this assumption is not realistic. Strip mining follows the boundaries of coal deposits, therefore indiscriminately cutting across summer and winter pastures as well as hay meadows. Thus, the study's specialized spoils management system is worthless if an entire ranch is strip mined since the system uses spoils vegetation for only a few months out of the year.

Taking weight gains of cattle at this time misleads the public into thinking that reclamation works when it is not yet a success. A weight gain analysis would be valid if done under different circumstances:

(1) The land should be growing primarily native grasses;
(2) There should be no residual effects of fertilizer;
(3) The vegetation should be suitable for grazing at anytime during the year, not merely Spring and Fall.

AN AFFILIATE OF THE NORTHERN PLAINS RESOURCE COUNCIL

Until these conditions exist, weight gain comparisons will not further the goal of reclamation. If anything, these misleading comparisons will serve to weaken the Montana Strip Mining law. They could allow land that is an economic liability to pass for reclamation.

Because these conditions do not yet exist, we ask the Experiment Station to drop the study from their approved projects. Since it deceives, rather than serves, the public, it has no place in a taxpayer-supported agency. The Experiment Station is merely lending its credibility and services to slanted research. If the study is done at all, it should be done through a private contract with the researchers and the coal companies funding it without the Experiment Station lending false credibility to it.

August 1976

* The Grazing Study refers to PLANT RESPONSE AND LIVESTOCK PERFORMANCE ON COAL MINE SPOILS PASTURES: A Statement of Proposed Research (June 1976). Author: Edward J. DePuit. Program Leader: Richard L. Hodder. Animal and Range Sciences Department: Montana Agricultural Experiment Station; Montana State University, Bozeman.

Rosebud Protective Association
Forsyth, Montana 59327

DETAILED COMMENTS ON THE GRAZING STUDY

The following comments on the Grazing Study point out the biases throughout the study. Its slanted statements indicate that the nature of the research is inappropriate for a project under the taxpayer-supported Montana Agricultural Experiment Station.

INTRODUCTION (pp. 1-2)

The Introduction points out the researchers' slant toward the Montana Strip Mining Act. While attempting to return land to a "productive, stable and useful" grazing condition (p. 1), they ignore the logistics of a ranching operation. The "projected local post-mining land use" is indeed livestock grazing, as stated on p. 2. However, local livestock grazing is done under different conditions than the researchers have established.

RPA Recommendation: The researchers should change the study from seasonal grazing to year-round grazing on spoils moving the cattle once for summer grazing and again for winter grazing. The pastures should grow grasses suitable for grazing at anytime during the year.

The study should also use cows and calves, not steers, since Colstrip-area ranchers generally run a cow/calf, not a steer, operation.

The study should also defer drawing any comparisons with native range until data exists from Colstrip. Using the data from Miles City as proposed (p. 2), is not applicable to Colstrip since the soils and grasses are different in the two areas.

OBJECTIVES (pp. 2-3)

None of the objectives which further reclamation require weight gains at this time.

(1) Objective (1) measures the quality and palatability of vegetation. As stated further on in the study, both the quality and palatability of the vegetation can be evaluated by means other than weight gains (p. 10). Palatability can be measured by analysing the grasses and quality through trace elements and TDN analyses. Weight gains would complement these analyses if the research had a scientific method for isolating the fertilizer effects on the grasses. However, although the study states it will consider the fertilizer effects, there is no explanation of how this will be done.

RPA Recommendation: If possible to draw one up, a formula should be included on fertilizer effects. If not, the weight gains should be dropped as part of Objective (1).

(2) Objective (2) presents the most difficult problems. It spells out the intensive management system which the study is promoting, without regard to the local economic and logistic constraints of the area.

This objective can be the most damaging since misleading results may be used to weaken the Montana Strip Mine Law (pp. 24-5). What the researchers are working on is not an economic range management system for year-long grazing but a specialized spoils management system that is economically and logistically useless. As the goal of reclamation is to make the land as useful and productive as before (p. 1), Objective (2) clearly does not have that goal in mind.

RPA Recommendation: This objective should be dropped entirely unless the researchers change their grazing plan to conform with local land use. The researchers should use a system of year-long grazing on spoils moving the cattle only twice a year, once for summer grazing (approximately May-October) and again for winter (approximately November-April).

METHODS AND PROCEDURES (pp.3-13)

(1) The grasses seeded, although predominantly native, are not ones people depend on in the Colstrip area (p. 4), with the exception of two: western wheatgrass and green needlegrass. Big sage, instead of being useful, is a problem which people burn and spray to get rid of. Silver sage on the other hand would perhaps be of value.

RPA Recommendation: Native grasses, shrubs and forbs should be planted that livestock in the area use.

(2) This criticism, however, is superfluous since none of the native grasses seeded came up in any great quantities.

RPA Recommendation: The establishment of native species should be the highest priority for the researchers, not intensive management systems to use seasonal, introduced species.

(3) Researchers assume that areas devoid of vegetation result from not broadcasting seed there (p. 5). There is no substantiation for this statement. The lack of vegetation may be due to other factors such as soil conditions or toxic materials.

RPA Recommendation: A fuller explanation without slanted statements asserting reclamation success is needed.

(4) The list of species that came up shows two species that were never planted: tall wheatgrass and slender wheatgrass (p. 6). There is no explanation of how they got there, leaving us to wonder if the seeds were not pure or if these plants invaded.

RPA Recommendation: A fuller explanation again is needed to show if plant succession is occuring naturally or if the seeding mixture was contaminated.

(5) Comparisons of spoils productivity with native range use estimates of production "typically found" near Colstrip (p. 7). "Typically found" may in this case refer to range in an overgrazed condition, not range in an optimal condition. 3 of the 4 species typically found in their native range comparisons are increasers which indicate an overgrazed condition.

RPA Recommendation: Again a more complete explanation is needed that does not mislead people into thinking reclamation is already a success in comparison with either grazed or overgrazed native rangeland.

(6) Throughout the study the researchers refer to the area as seeded to native grasses. The test plots, however, are almost a monoculture of crested wheatgrass (p. 9). Crested wheatgrass covers 32% of the land. Bare ground is extremely high, 45%, presenting erosion and expiration problems particularly in a series of dry years.

A characteristic of crested wheatgrass is that it bunches together with bare ground around it. A hot wind will dry out this ground, making difficult establishment of other species. An assumption of reclamation is that eventually there will be plant succession back to native grasses. With crested wheatgrass, natural plant succession is extremely difficult.

RPA Recommendation: A fuller explanation of the problems of plant succession on spoils with crested wheatgrass is needed.

(7) The differences in the protein content of the grasses, as stated on p.10, could be attributed to maturity rates, but not necessarily.

RPA Recommendation: An explanation, if included at all, should be expanded to present an accurate analysis of protein content of spoils vegetation.

(8) The chemical analysis contains no pH tests nor statement of what happened to the soils between November 1974 and April 1975 to cause the changes.(Table 7, p. 12).

RPA Recommendation: Fuller tests should be conducted along with an analysis of possible alkaline problems resulting in the area.

EXPERIMENTAL DESIGN (pp. 13-21)

(1) From the explanation it is hard to figure out how the spoils test plots #7 and #8 were divised. It appears that the researchers, rather than fencing the area into efficient rectangular areas, as in plots #1-6, (p. 15), chose to fence only the best available spoils vegetation. No further explanation is given.

RPA Recommendation: The study should describe fully how the shape of the grazing areas was limited by "ground conditions", so that people realize whether or not these spoils are typical or atypical of surrounding spoils areas.

(2) The researchers chose a "suitable area" of native range, called plot #9, (p. 15). There followes no specific description of the area other than that it has been deferred from grazing for "many years."

RPA Recommendation: The study should include a full explanation of the area, location, acreage, years deferred from grazing, forage production and types of species for pasture #9 to substantiate assertions that it is in good condition.

(3) So-called "randomly chosen plots" 1,2, and 4 (p. 15) bear a remarkable resemblance to the plots with the highest forage production (p. 8). It may be an extraordinary coincidence but the probability of randomly choosing these three highest producing plots from the six available is one in twenty.

(4) The use of steers (p. 16) limits the amount of information gathered on the cattle. Yearling heifers would give a better indication of the effects of forage on breeding, in addition to merely showing weight gains. Although steers generally gain better than heifers, groups of heifers, if compared to each other, will show how they react to spoils vegetation.

RPA Recommendation: The study should use yearling heifers rather than steers and use the estrous cycle to provide further information on spoils vegetation quality. Other tests could be taken, such as bone samples to show effects of trace elements on livestock. Also shrink factors, whether using heifers or steers, have to figure into weight gain assessments, but no mention of weighing conditions was made.

(5) The grazing management system set up in the study is determined by the suitability of the forage (p. 16). The steers appear from nowhere to graze for limited periods in the Spring, then some move off the spoils entirely for the Summer and then reappear on the same spoils in the Fall, only to disappear again in the Winter. Unfortunately, most ranchers have to worry about where their cattle will spend the Summer and Winter.

RPA Recommendation: Again, we think the study should incorporate year-long grazing in a system used locally, not an intensive management system for strip mined spoils.

(6) Again, on p. 18, the underlying assumption is that people can afford to let vegetation dictate proper grazing pressure. Economics are such that a person can not graze cattle solely for optimum plant production.

RPA Recommentation: The study, if conducted at all, should investigate the logistics of the grazing system with input from local ranchers since there is no use recommending a grazing system for optimum plant production on spoils if it is uneconomical.

(7) Comparison of steer weight gains is a foregone conclusion built into the researchers' management plan (p. 18). If steers gain more under the spoils-native range system, the result will still say nothing about reclamation, but merely test a grazing management technique which ignores the logistics of a ranching operation.

The researchers' comparisons with native range will also not tell much, particularly since the data comes from Miles City, which is not applicable to the Colstrip area because of different soils and grasses.

RPA Recommentation: No weight gains should be taken or comparisons made until a fair and scientific comparison can be made of two comparable areas.

(8) We agree that "conclusive data" will not be available for many years (p. 19) and certainly not within three years. Since the area has not even been reclaimed yet, the possibility of any conclusive information in three is highly unlikely.

RPA Recommentation: A more honest assessment of future success for reclamation should be included.

(9) The grass clippings came from sites "randomly located along a predetermined course" (p. 19). This statement is contradictory.

RPA Recommendation: The study should make clear whether choices were made randomly or on a predetermined basis.

DISCUSSION (pp. 21-25)

(1) The researchers have already determined that System 2 is the most logical even before they get the results from the study (p. 21). This approach seems exactly backwards especially when their "most logical approach" is not the most economical for the area.

RPA Recommentation: The Grazing Study should be turned around. The researchers should work on reclaiming the land first and then see how well it holds up to grazing over time. Instead, they planted grasses, watched what came up, and now are trying to figure out a scheme which could use these grasses, which may be palatible and nutritious only during limited periods of the year.

(2) The other objectives of the study, #3 -#5, seem to serve a useful purpose. Because of the biases of the weight gain comparisons and the grazing management system, these valid objectives of the study get lost.

RPA Recommendation: The study should focus on vegetational response to grazing pressure, until the area is reclaimed. The long-term goals of the research as currently proposed seem to work toward achieving reclamation if separated from the short-term goals on intensive spoils management and cattle weight gain response.

Appendix D. Pertinent Language in the Montana Strip and Underground Mine Reclamation Act (Sec. 50-1034)

Definition--

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

Grounds for denial--

(a) biological productivity, the loss of which would jeopardize certain species of wildlife or domestic stock, or

(b) ecological fragility, in the sense that the land, once adversely affected, could not return to its former ecological role in the reasonable foreseeable future.

Planting of vegetation following grading of disturbed area--

(1) After the operation has been backfilled,...,the operator shall prepare the soil and plant such legumes, grasses, shrubs and trees upon the area of land affected as are necessary to provide a suitable permanent diverse vegetative cover capable of:

(a) feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation;

(b) regenerating under the natural conditions prevailing at the site, including occasional drought, heavy snowfalls, and strong winds; and

(c) preventing soil erosion to the extent achieved prior to the operation.

The seed or plant mixtures, quantities, method of planting, type and amount of lime or fertilizer, mulching, irrigation, fencing, and any other measures necessary to provide a suitable permanent diverse vegetative cover shall be defined by rules of the board.

Appendix E. Pertinent Language in the Rule Adopted Pursuant to the Montana Strip and Underground Mine Reclamation Act

26-2.10(10)-S10300 Site Inventory

(2) Adequate mine site resource inventories shall be sumbitted and shall include:

(b) vegetative surveys as described in Sec. 6 (3) (k) of the Act, which shall include:

(i) a vegetative map acceptable to the Department which delineates community types based on two (2) or more dominant species. Dominant species are those which by their structure, number or coverage have the greatest functional influence on the type.

(ii) a narrative describing the community types by listing associated species and discussing environmental factors controlling or limiting the distribution of species. Current condition and trend shall be discussed for each community type or portion thereof if significant differences exist within a type.

26-2.10(10)-S10350 Planting and Revegetation

(1) A suitable permanent diverse vegetative cover capable of meeting the criteria set forth in Section 12 of Chapter 325, Session Laws of Montana, 1973, shall be established on all areas of land affected except traveled portions of railroad loops and roadways or areas of authorized water confinement. Areas shall be planted or seeded during the first appropriate season following completion of grading, topsoil redistribution and remedial soil treatments.

(2) An operator shall establish a permanent diverse vegetative cover of predominently native species by drill seeding or planting, by seedling transplants, by establishing sod plugs, and/or by other methods. All methods must have prior approval by the Department.

(3) The operator shall utilize locally grown genotypical seed and seedlings when available in sufficient quality and quantity.

(4) An operator shall plant seed of a pure and viable nature. Unless otherwise approved by the Department, seed shall be at least 90% pure. Seeding rates shall reflect germination percentages.

(5) The operator shall consider soil, climate, and other relevant factors when planting and/or seeding to provide for the best seed germination and plant survival.

(6) All drill seeding shall be done on the contour. When grasses, shrubs and/or forbs are seeded as a mixture they may be drill seeded in separate rows at intervals specified in the standards Soil Conservation Service (SCS) planting guidelines. Such mixed seedings shall be done in this manner wherever necessary to avoid deleterious competition of different vegetal types or to avoid seed distribution problems due to different seed sizes.

(7) Soil amendments shall be used as necessary to supplement the soil and to aid in the establishment of a permanent vegetative cover as specified in the approved reclamation plan or as later deemed necessary by the Department.

(8) An operator shall use any other means necessary to insure the establishment of a diverse and permanent vegetative cover, including but not limited to irrigation, and fencing or other protective measures.

(9) The Department may require the seeding of annual grasses and/or legumes on such areas as it deems necessary.

(10) Mulch shall be immediately applied to all areas that do not have permanent or temporary cover established when, in the opinion of the Department, the grade or length of any slope presents a likelihood of substantial erosion or substantial deposition of sediment into any waters of the state.

(11) The Department will annually inspect seeded areas at the end of the growing season to determine species diversity, germination, and seeding take. If the Department determines that seedlings are unsuccessful in terms of good germination and/or seedling take, immediate investigative action shall be taken by the operator at the request of the Department to determine the cause so that alternatives can be employed to establish the desired permanent vegetative cover at the very next seasonal opportunity. The investigative report shall be submitted along with prescribed course of corrective action prior to the next growing season.

(12) If the area affected is to be primarily utilized by domestic stock, the Department may require incorporation of a grazing system after vegetative establishment to gauge stand tolerance to grazing pressure. (History: Sec. 50-1023, R.C.M. 1947; NEW, Order MAC No. 26-2-5; Adp. 8/15/73; Eff. 9/5/73; MAC Not. No. 26-3-2.)