

RECLAMATION AND GRAZING MANAGEMENT ON A SURFACE

COAL MINE IN NORTHWESTERN COLORADO¹

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ABSTRACT

Rangeland in northwestern Colorado destroyed by coal strip-mining can be reclaimed to high quality grazing land by following suitable revegetation practices, including: careful topsoil handling, proper seedbed preparation, and selection of adapted species. Grazing management of the stand is crucial. In one area seeded to introduced forage species, summerlong gain of yearling cattle has been 2.4 to 3.1 pounds per head per day and total cattle gains have been as high as 173 pounds per acre.

INTRODUCTION

The energy shortage and the concurrent concerns with air pollution have increased strip mining for the high-quality, low-sulfur coal in northwestern Colorado. Federal and state regulations require that any area disturbed by mining be reclaimed to beneficial uses. This paper briefly discusses how extensive disturbed areas, many of which were in fair or poor range condition, before disturbance, can be reclaimed to valuable, improved rangeland, and what we are learning about grazing management of these improved ranges.

The revegetation practices that are summarized below have been developed in research studies during the past ten years and have been found to consistently produce satisfactory reclamation results in northwestern Colorado.

THE RECLAMATION PROGRAM

The first step in a reclamation program is an effective reclamation plan as part of the overall mining plan because the reclamation procedures must be an integral part of the mining activities.

If there is a single most important practice to be followed in reclaiming mined lands, it is to remove and save both the A and B horizons of the topsoil before mining begins. This topsoil is then spread on reshaped mine spoils after mining. The most efficient and economical procedure is to avoid having to handle the topsoil more than once by spreading the topsoil on an adjacent area immediately after stripping. If this is not possible, the topsoil material can be stockpiled and stabilized by planting annual grains or an easily established mixture of perennial species.

The benefits from using topsoil include: (1) better physical conditions for water infiltration and storage, (2) a suitable substrate for seed germination and seedling establishment, (3) a reservoir of plant nutrients that will increase growth of the vegetation, and (4) a source of seed and vegetative propagules that can help to provide for the regeneration of vegetation.

As the thickness of the respread topsoil layer increases (at least up to 18 inches), seedling establishment, plant cover, and herbage yield increase. The increase in plant cover and herbage production appear to be a result of the greater amount of available nutrients in the topsoil. As little as 4 inches of topsoil will produce much better seeded stands than will planting directly on the spoil material. No benefits were derived from separately removing and then respreading the A over the B horizon material. The most common procedure is to lift the A and B horizons together and respread the mixture.

If the topsoil or the topsoil material in a stockpile is too wet when it is handled, serious problems with clods can be expected and the job of preparing the seedbed will be difficult.

¹Paper presented at the 1985 Annual Meeting of the American Society for Surface Mining and Reclamation. [Clarion Airport Hotel, Denver, Colo., October 8-10, 1985].

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Because scrapers make a number of trips over the topsoil in the process of spreading it, a tremendous amount of compaction occurs. Before the area can be seeded, the topsoil must be loosened using a chisel plow or similar equipment, and then a suitable seedbed prepared before planting. A smooth, firm (but not compacted), and well-prepared seedbed is essential to eliminate the rough, uneven surface common to respread topsoil and to ensure successful revegetation. A seedbed that is too loose will have poor seed-soil water relations, and controlling seeding depth will be difficult. For accurate seed placement, a drill equipped with depth bands should be used. Optimum planting depth for most species is about 3/4 inch; if the seed is planted too deep, emergence will be reduced, and if planted too shallow, the seed will dry rapidly. When a deep-furrow drill is used, planting must be very close to contour or there will be erosion down the furrows. Broadcast seeding, as opposed to drill seeding, should be used only for those situations where the slopes are too steep to permit safe operation of the drill.

Although early spring planting can be successful, the ground often is too wet to permit seeding operations. Fall planting usually is the most practical, and seed should be planted late enough so that there will be no germination until the following spring, but before snow cover. Most planting is done in September and October in our area.

Following the seeding operation, the entire area is contour furrowed to prevent the small rills that usually occur from developing into major gullies. Furrow spacing depends upon the degree of slope; furrow depth usually is 12 to 18 inches.

The species mixture planted is dictated by the post-mining land use and by the rules of regulatory agencies. Because regulatory agencies usually require a species diversity in the established stand equal to the diversity of the pre-mining vegetation, complex species mixtures are usually planted. However, planting a complex seed mixture does not ensure that the established stand will contain all, or even a significant percentage of the species seeded.

The use of native species normally is mandated, but we have found no evidence that native species are superior to introduced species for surface mine reclamation. Our experience is that native species are difficult to establish and seed of native plants is expensive and difficult to obtain. Our preference is for a simple mixture of species that are easy to establish, will persist in the seeded stand, will provide for the desired post-mining land use, and will protect the site from erosion. Where precipitation is adequate we believe that a mixture containing some combination of intermediate wheatgrass (Agropyron intermedium), pubescent wheatgrass (A. tricophorum), crested wheatgrass (A.

desertorum), western wheatgrass (A. smithii), smooth brome (Bromus inermis), and 'Regar' brome (B. biebersteinii), alfalfa (Medicago sativa), and cicer milkvetch (Astragalus cicer) will meet these requirements. However, such a mixture will not meet the diversity or native species requirements of the current regulations in many states. In drier areas the brome grasses and legumes may not be adapted but the wheatgrasses, especially crested wheatgrass, should do quite well. With "live-handled" topsoil, many additional species will also become established from seed or plant parts in the topsoil.

We have found no benefit in stand establishment from use of mulch or the addition of fertilizer at the time of seeding and this is consistent with most range seeding literature. On older established stands that do not contain a legume, as little as 50 lb of nitrogen/acre has doubled both production and aerial plant cover, but annual fertilizer applications are necessary to maintain these benefits.

GRAZING SYSTEMS

The type or system of grazing treatment applied to reclaimed surface coal mines will depend upon a number of factors including: the climate of the area, the forage species planted, the total and seasonal production pattern, and the forage needs of the livestock manager. A common requirement for all reclaimed areas is that of livestock management. Once an area is seeded, even if it is seeded to native species, it must be managed as a separate unit or misuse (overuse or underuse) will occur. Furthermore, no single grazing system is suited to all mined areas.

The preliminary results of a grazing study on reclaimed mined land in northwestern Colorado are given below as an example of how such an area can be managed for both high forage and livestock production when seeded to high-producing introduced species.

Methods

The study is being conducted on the Colorado Yampa Coal Company near Steamboat Springs, Colorado. Cooperators are the Agricultural Research Service, the Bureau of Land Management, University of Wyoming, Utah State University, and Colorado State University. The reclaimed mined areas used were seeded to introduced plant species in 1975 and 1976. The present herbage production on the areas consists of approximately 60% alfalfa with intermediate wheatgrass, smooth brome, and other grasses also present. Elevation is approximately 7200 ft. Average annual precipitation at the nearest weather station (Hayden, 25 mi NW) is about 16 inches but, based on the vegetation, we believe the study areas receive slightly more precipitation. Most of the precipitation occurs as snow in the winter and spring and summer rain. Original

vegetation before mining was a mountain shrub-sagebrush type with a grass-forb understory. Pockets of quaking aspen (Populus tremuloides) occurred on north slopes and moist areas.

The objectives of the study are to determine the effects of different grazing systems on animal response, forage production, and species composition.

Grazing was started in 1982. The systems being studied are short duration grazing (SDG) and summerlong grazing at two different rates. The SDG system is divided into eight pastures with electric fencing and grazing consists of three complete rotations each summer grazing season. The heaviest of the summerlong systems is stocked at the same rate as the SDG system. This rate is intended to be "Heavy", utilizing at least 65% of the available forage, but, in reality, has only been "Moderate". The other summerlong treatment has had half the stocking rate of the other two treatments and has been designated "Light". All grazing systems are replicated on two different mined areas; one consisting of 168 seeded acres (Mine 2) in the pastures and the other 106 acres (Mine 3).

Because of delays in finishing the pasture fences, grazing did not start until mid July in 1982. Problems with water supply delayed grazing until early July in 1983. The start of grazing was at least 30 days too late in both years because the vegetation had attained considerable growth. Because of this, the livestock rotation in the SDG pastures consisted of 3 days of grazing in each pasture through all three rotations both in 1982 and 1983 although the number of days in the third rotation was extended in some pastures to get uniform utilization.

Grazing started in early June in 1984 when the alfalfa and other vegetation was 6 to 8 inches tall. Because of the early stage of growth, the first rotation consisted of 2 days per pasture, the second rotation consisted of 3 days per pasture, and the third rotation consisted of 4 days per pasture. We imposed some variation in the number of days per pasture in the last rotation to try to achieve approximately even utilization between pastures. The total grazing period was approximately 75 to 80 days in all 3 years.

Yearling cattle have been used for all grazing treatments. They are weighed before grazing and all cattle are weighed at the end of each rotation in the SDG system. A supplement to prevent bloat was fed to all cattle on a free choice basis throughout the grazing trial all three years.

Results

Stocking, Production and Utilization

Table 1 summarizes stocking rates, production of vegetation, and utilization only for

Mine 2, the larger and more productive of the two study areas. Cattle stocking rates in the first year of the study (1982) were based on preliminary 1980 and 1981 forage production data. Production values were significantly lower than that actually achieved in 1982. Therefore, utilization of the forage was rather low (Table 1). Numbers of yearlings were increased substantially in 1983 but, because of favorable summer precipitation, production of vegetation also increased. As a result, utilization levels were still lower than expected although they did increase on the two heaviest treatments. Cattle numbers were increased again in 1984 but, increased precipitation resulted in production generally higher than in 1983. Average production in 1984 was approximately 5580 lbs/acre on Mine 2 (Table 1) and 4030 lbs/acre on Mine 3. Utilization levels changed little from those achieved in 1983 on all treatments both on Mine 2 (Table 1) and on Mine 3.

Cattle Gains

Daily gains of the yearling cattle in 1984 were almost identical to gains in 1983. On Mine 3, the daily gains per head were almost equal for all three grazing treatments (Table 2) for the approximately 80-day grazing season (early June through mid August). On Mine 2, daily gains were lowest in the SDG, intermediate in the "Moderate summerlong" and highest in the "Light summerlong" treatment (Table 2). Utilization was only about 40 percent in the two heaviest treatments on Mine 2 so forage availability should not have been the cause for the lower gain in the SDG system. We have not yet studied forage quality or animal behavior, either of which could result in different levels of average daily gain in any specific treatment. The daily gains obtained for all three years from both mines are approximately twice what has been obtained from yearlings grazing on native range during the same period or similar vegetation types at this elevation.

The highest gain of beef per acre was obtained in the "Moderate summerlong" treatment on Mine 2. The 173 pounds of beef produced per acre in 1983 is 7 to 8 times what can be produced on native rangeland in the same area. This high beef production is a result of the high productivity of the alfalfa and other introduced plant species being grazed, the high stocking rate of animals per acre (Table 1) and the highest daily gains of all the treatments (Table 2). In years of below average precipitation, daily and per acre gains may be lower than reported here but, gains from the seeded, reclaimed areas would be expected to be considerably greater than the corresponding gains on native range.

CONCLUSIONS

Mined areas in northwestern Colorado can be successfully reclaimed by careful topsoil handling, proper seedbed preparation, and

Table 1. Size of pastures, number of animals, production of vegetation, and utilization in study pastures on Mine 2, Colorado Yampa Coal Co., Colorado.

	No. of Acres	No. of Animals			Production (lbs/A)			Utilization (%)		
		1982	1983	1984	1982	1983	1984	1982	1983	1984
Short Duration										
Grazing	69	18	51	61	3710	5430	4050	20	56	40
Summerlong										
"Moderate"	40	19	28	34	3310	5770	6720	35	46	42
"Light"	59	18	16	26	2240	4640	5980	25	15	22

Table 2. Gain of animals (yearlings) on study pastures, Colorado Yampa Coal Co., Colorado.

Grazing System	Ave. Daily Gain (lbs/hd/day)						Total Gain (lbs/acre)					
	Mine 2		Mine 3				Mine 2		Mine 3			
	1982	1983	1984	1982	1983	1984	1982	1983	1984	1982	1983	1984
Short Duration												
Grazing	2.6	2.4	2.4	2.7	2.7	2.9	34	123	158	11	36	126
Summerlong												
"Moderate"	2.6	2.9	2.7	2.6	2.8	2.8	63	137	173	24	90	116
"Light"	2.4	3.1	3.1	2.8	3.1	2.7	34	55	101	14	20	52

selection of adapted species. Where precipitation is adequate, introduced forage species such as alfalfa, intermediate wheatgrass and smooth brome, generally are easier to establish and produce more forage than native species. This high production may be quite important in the development of a true "soil" on the reclaimed areas. High production of above-ground biomass usually is accompanied by a similar high production of roots. The organic matter added to the soil and the penetration of these roots into the underlying spoil material should hasten soil development.

Based on this, one of the goals of any reclamation effort should be maximum forage production. Of course, site stability also is important but production and amount of foliage cover usually are highly correlated. State regulations often prohibit planting the introduced species which give the highest production and, instead, emphasize use of native species and high species diversity.

In our opinion, regulatory agencies should give more emphasis to the contribution of high-producing stands of introduced species to overall habitat diversity (juxtaposition of different vegetation types) and an increase in "edge" instead of striving for native stands with high species diversity. For wildlife habitat, a small mined area (200-300 acres) surrounded by native sagebrush rangeland, is far more valuable if seeded to alfalfa and grass because of the increase in habitat diversity than if planted back to sagebrush. The seeded stands in the grazing study area reported here are used by elk, deer, sage grouse and many

small mammals. The animals are drawn to the seeded areas in spring and early summer because the introduced species start growth and provide nutritious forage long before the native range has made much growth. The seeded areas are also used in the fall because the alfalfa stays green and highly nutritious long after most native species have become dormant.

Preliminary results from a grazing study on a reclaimed mined site seeded with alfalfa and grass indicate that daily gains of yearling cattle can be double and total red meat production per acre 7 to 8 times greater than gains than those obtained from native ranges. The study was conducted during a period of above-average precipitation. In dry years, both gains per head and gains per acre might be lower than reported here, but both gains per acre would be expected to be substantially higher than those from native ranges.

Thus, planting of high producing, introduced forage species, including alfalfa, where there is enough moisture, can produce a high yielding stand of vegetation that not only speeds soil formation and adds to overall landscape diversity but also produces red meat at a rate thought possible only from irrigated pastures. Where grazing is the post-mining land use, these factors should be taken into account by regulatory agencies to a greater extent than they have been in the past to help both improve reclaimed sites and to help maximize production from those sites.