Reclaiming Wildlife Habitat At The Buckskin Mine[1]

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Abstract. The Surface Mining Control and Reclamation Act and supporting regulations contain numerous requirements for the reclamation of wildlife habitat. However, these requirements are often contradicted by other requirements. Historically, regulatory agencies have tended to place more emphasis on those requirements that act to impede the reclamation of wildlife habitat then they have on those requirements that restore and/or enhance wildlife habitat. Wildlife habitat is a principal postmining land use over most of the coalmine lands in Wyoming. The Buckskin Mine has prepared a detailed reclamation plan to enhance wildlife habitat. This paper will present portions of that plan and examine the federal and state of Wyoming regulations that require reclamation of wildlife habitat and suggest permitting strategies to overcome many of these conflicting requirements.

Additional Key Words: reclamation

Introduction

Office of Surface Mining (OSM) regulations specify that fish and wildlife habitat enhancement measures cannot be limited to just revegetation efforts. OSM regulations also require that surface mining activities avoid, enhance where practicable, or restore habitats of unusually high value for fish and wildlife. The *Wyoming Environmental Quality Act* (WEQA) defines fish and wildlife habitat to be "land dedicated wholly or partially to the production, protection or management of species of fish or wildlife." Wyoming Department of Environmental Quality/Land Quality Division (WQDE/LQD) Coal Rules and Regulations mandate that a plan be prepared and implemented to protect and enhance important habitats for fish and wildlife.

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These regulations further require that wildlife habitat be restored commensurate with or superior to habitat conditions, which existed before the land became affected. "Important habitats" are defined by WDEQ/LQD regulations as habitat, which in limited availability, supports or encourages a maximum diversity of wildlife species or fulfills one or more living requirements of a wildlife species. Specific examples of important habitats listed by the WDEQ/LQD "include, but are not limited to, playas, wetlands, riparian areas, rimrocks, areas offering special shelter or protection, reproduction and nursery areas, and wintering areas." The WDEQ/LQD has also published Guideline No. 5 *Wildlife* which offers suggested practices to incorporate into reclamation plans. These practices include:

> "integrating vegetative components and those physical (land form) features required to perpetuate diverse plant communities. Varying gradients in slope, surface aspect, and soil moisture are required to promote structurally diverse vegetation. To accomplish this, operators should incorporate diverse slopes, surface undulations, minor depressions, swales, convoluted drainage ways, and rock piles. Topographic and plant species diversity are both essential to replace wildlife habitat. Specific suggested reclamation and enhancement practices include restoration of diverse land forms, direct topsoil replacement, shrub and tree transplants, nest structures, rock pile construction, snags and brush piles, water source development, stream rehabilitation, riparian zones, creation of lakes suitable for fisheries, and where variances can be obtained, development of highwalls to simulate natural rimrocks."

Much of the important habitat in Wyoming's Powder River Basin consists of erosional landforms including badlands, gullies, cut banks, head cuts, incised streambeds, rough breaks, cliffs, rimrocks, and steep slopes. The WEQA defines reclamation as "the process of reclaiming an area of land affected by mining to use for grazing, agricultural, recreational, wildlife purposes, or any other purpose of equal or greater value." Buckskin Mine's postmining land uses are wildlife habitat, grazingland, cropland, pastureland, industrial/commercial (agriculture) and developed water resources. A major goal of the Buckskin Mine's reclamation plan is to reestablish topography, vegetation, and landscape features that enhance wildlife habitat.

Important erosional landforms including badlands, gullies, cut banks, head cuts, incised streambeds, rough breaks, cliffs, rimrocks, and steep slopes will be reclaimed when possible. However, many of these important landforms are difficult, if not impossible, to restore or replace during reclamation as they were formed by a millennia of geologic and erosional processes. For example, the premine badlands and rough breaks are supported by consolidated underlying strata, which are subsequently replaced with unconsolidated material following mining. Coal mining regulations also tend to discourage many of these features with an often-misinterpreted requirement persuading gentle slopes and erosional stability.

The Buckskin Mine

The Buckskin Mine is located in the Powder River Basin, 12 miles north of Gillette, Wyoming. The arid climate is characterized by long, cold winters and short warm summers with annual precipitation ranging from 8 to 14 inches. Seventy five percent of the precipitation occurs during spring and summer. Climate and fire were the dominant forces shaping the treeless character of the Powder River Basin. Drought is also an important influence and must be considered in all reclamation planning. The surface topography is generally comprised of gently rolling hills in a grassland plain at an elevation of approximately 4,200 ft. Highly eroded badland topography is intermingled among this grassland plain. Soils in the area are residual (developed in place) and have formed from weathered sandstones and siltstones. Due to the prevailing climate and vegetative conditions, organic matter accumulates slowly and the fertility of the soils is relatively low. Surface water features are primarily ephemeral streams, which are typically categorized as grassed swales. Dugout stock ponds are commonly located along these streams. The vegetation in the area is typical of a mixed grass prairie with the primary species being blue grama, needle and thread grass, prairies Junegrass, and western wheatgrass. Concentrations of silver sagebrush and big sagebrush are commonly intermixed in this grass prairie. The badlands areas support scattered stands of Rocky Mountain juniper in draws and on north-facing slopes. Numerous wildlife species common to the northwestern great plains inhabit the area. Big game include pronghorn antelope and mule deer. Other common mammals include cottontails, white-tailed jackrabbits, deer mice, harvest mice, Northern grasshopper mouse, least chipmunk, 13-lined ground squirrel, meadow vole, prairie vole, coyote, red fox,

striped skunk, and badger. Upland game birds in the area include sage grouse, sharp-tailed grouse and gray partridge. Several common species of waterfowl and shorebirds frequent the stockponds. Common passerine species include vesper sparrow, horned lark, grasshopper sparrow, lark bunting, and western meadowlark. Common raptors include harriers, American kestrel, red-tailed hawk, Swainson's hawk, rough-leg hawk, ferruginous hawk, great horned owl, golden eagle, and bald eagle. Land use in the area is predominantly livestock grazing and wildlife habitat.

Baseline inventories of the Buckskin Mine concluded that no critical habitat or crucial habitat existed within or adjacent to our permit boundary. While no specific inventory of "important habitats" was conducted during the wildlife baseline inventory, habitat currently defined as "important" did occur in various locations within the Buckskin Mine permit boundary. Much of this important habitat consisted of erosional landforms including badlands, gullies, cut banks, head cuts, incised streambeds, rough breaks, cliffs, rimrocks, and steep slopes.

Fish And Wildlife Habitat Restoration Plan

A major goal of Buckskin's reclamation plan is to reestablish topography, vegetation, and landscape features that enhance wildlife habitat. We have prepared a detailed reclamation plan map, which illustrates the location of all seeded vegetation/habitat types, postmine land contours, riparian areas, shrublands, and tree plantings. The following table provides a list of wildlife types and habitat features that will be restored during reclamation to promote postmining wildlife usage at the Buckskin Mine.

The following elements form the core of our wildlife habitat restoration plan.

Landform Diversity

Development of a diverse postmining topography will facilitate restoration of wildlife habitat during reclamation. Buckskin will strive to restore unique features and add vertical structure to our reclamation. These landforms will not only assist recolonization by wildlife but will enhance the aesthetics of the reclaimed mine land. A wide range of topographic features will be incorporated into our reclamation, including diverse slopes and slope aspects, swales, bottoms, playas, rimrocks, cutbanks, hills, ridges, saddles, exposed and sheltered sites, wetlands, surface

undulations, minor depressions, and convoluted drainages. This topography will provide cover, escape corridors, and visual barriers for wildlife. This diverse topography will also provide the foundation for development of a variety of native plant community types necessary for diverse wildlife habitat. Many of these features are microtopographic and these creations will occur opportunistically during final grading.

Table 1. Restoration of Wildlife Habitat

Wildlife Type	Landscape Features to be Restored to Provide Wildlife Habitat
Mammals	
Big game	Hayfields, playas, riparian habitat, rimrocks, gullies, cut banks, head cuts, incised streambeds, cliffs, rimrocks, steep slopes, diverse native vegetation, shrublands, stockponds and reservoirs, trees.
Small mammals	Riparian habitat, gullies, cut banks, head cuts, cliffs, rimrocks, incised streambeds, diverse native vegetation, shrublands, rock outcrops, brush piles.
Birds	
Upland game birds	Hayfields, riparian habitat, playas, shrublands, steep slopes, diverse native vegetation, swales, stockponds and reservoirs.
Waterfowl and shorebirds	Playas, riparian habitat, wetlands, stockponds and reservoirs.
Passerines	Stockponds, riparian habitat, wetlands, diverse native vegetation, cliffs, rimrocks, trees and large shrubs, rock outcrops, brush piles.
Raptors	Diverse native vegetation, trees, rock outcrops, cliffs, rimrocks, riparian habitat, wetlands.
Migratory birds of high federal interest	Riparian habitat, wetlands, diverse native vegetation, cliffs, rimrocks, trees, rockpiles, stockponds and reservoirs.
Reptiles and amphibians	Riparian habitat, wetlands, playas, diverse native vegetation, stockponds and reservoirs, rock outcrops.
Fisheries	None on permit area prior to mining.
Threatened or Endangered Species	Reestablishment of prey base for bald eagles, diverse vegetation, cliffs, rimrocks, trees, rock outcrops, riparian habitat, topographic features.

Steep Slopes

LQD regulations specify that postmining slopes shall not exceed a slope necessary to achieve a minimum long-term static safety factor of 1.3, to prevent slides and restore stable drainages and hillslopes. However, the conflicting requirement to restore and enhance wildlife habitat suggests that exceptions are permittable on a case-by case basis. Buckskin's postmining topography does contain some short steep slope segments which approach this safety limit.

Swales, Hills, and Undulating Topography

Swales, hills, and undulating topography create different sun exposures, various wind flows, and concentrate surface moisture. These attributes combine to create variations in air temperature, soil temperature, humidity, and soil moisture which then encourages vegetation diversity and enhances wildlife use for viewing, hiding, and resting. Our postmining topography is illustrated at a 10 ft contour interval and depicts numerous undulations in topography. These surface undulations are impossible to exactly create as depicted however, we will final grade the rough backfill to create swales, hills, and undulating topography during reclamation. The key for incorporating these important features has been WDEQ/LQD's allowance of opportunistic construction during final grading as backfill allows. These micro-topography approximate original contour (AOC) features will be submitted as as-built features in our Annual Report, however, few of them will be evident on a 10 ft contour interval topographic map.

Rock Piles

Rock piles provide various habitat functions including perch sites, shelter, concealment, escape cover, nest sites, and den sites. Shrubs will be seeded in conjunction with rock piles. Rock piles will be diverse in construction. Some will consist of one large boulder (3-5 ft in diameter) placed at a prominent point or in open areas to serve as a raptor perch. Other outcrops will be considerably larger in area extent, but constructed of smaller rocks. Some outcrops may be "jumbles" where virtually all rocks are aboveground. Others may be more linear and may be dressed with topsoil on the uphill side to blend more aesthetically with the slope and create more burrow locations. Topsoil may also be thinner immediately down slope of the rock pile to provide and exposed rock face, burrow openings, etc. The typical rock pile will consist of 3-10 boulders, 3-5 ft in diameter, piled together at one location. Buckskin has previously committed to

an average rock pile density of 1 per 40 acres over the entire area to be disturbed and we will continue to meet, or exceed, this commitment.

Rimrocks/Cliffs/Bluffs

Rimrocks, cliffs, and bluffs are surface expressions of subterranean formations. These important wildlife habitat features were numerous and widespread in Buckskin's premine landscape. The Buckskin Mine will reclaim these AOC features as mandated by both OSM and WDEQ/LQD regulations. Numerous adjoining, unmined areas may be viewed to verify specific characteristics of these sandstone features. Early aerial photographs of the mine site clearly show similar habitats existed in the pre-2000 premine topography. Buckskin's typical technique to restore these rimrocks will involve aesthetically blending in selected segments of a highwall into the postmine topography. Development of highwalls to simulate natural rimrocks is specifically encouraged in WDEQ/LQD Guideline No. 5 *Wildlife*. WDEQ/LQD regulations state that "highwall retention may be considered on a case-by-case basis for enhanced wildlife habitat." WDEQ/LQD regulations also mandate the "elimination of all highwalls." However, highwalls are specifically defined in WDEQ/LQD regulations to be "the face of exposed overburden or coal in an open cut of surface mine or entry to an underground mine." Thus, upon reclamation as described in this plan, these reclaimed features will have essentially no characteristics of an exposed, unreclaimed overburden highwall. They will be reclaimed rimrock/cliff type wildlife habitat as mandated by both OSM and WDEQ/LQD regulations.

Various shapes, sizes, and configurations of rimrocks and cliffs will be created to promote variable diversity. Exact location of such features have not been identified or mapped because the location of competent postmining rock features is not known. However, as competent rock (normally sandstone) is encountered Buckskin will restore this important habitat feature. The key for incorporating these important features will be WDEQ/LQD's allowance of opportunistic construction during final grading. These micro-topography AOC features will be submitted as as-built features in the Annual Report, however, few of them will be evident on a 10 ft contour interval topographic map. The following configurations will constitute the general design criteria for rimrock/cliff habitat. Any rimrock feature which would exceed these general design criteria would be submitted as a separate non-significant revision prior to reclamation.

Length. Highwalls developed into several smaller sections of less than 1,300 ft, rather than one long wall, and a convoluted configuration have been shown to reduce direct lines of site (Green and Salter 1987). This technique may also reduce intra- and inter-specific conflicts among raptor species and allow multiple raptor nests in an area (Murphy et al 1969; Olendorff 1972; Smith and Murphy 1973; Lockhart et al. 1980). Broken bluff topography is simulated by series of short highwall sections. Mule deer prefer this type of broken topography (Hamlin 1978), and it does not constitute a movement barrier to other species.

Buckskin will create rimrock/cliff type wildlife habitat that does not exceed 1,000 ft in one continuous segment and we will generally have two or more shorter segments of 150 to 300 ft each in close proximity to each other.

Height. Most cliff nesting raptors will utilize vertical faces over 10 ft high as long as suitable nest sites (ledges) are available (Smith and Murphy 1973; Snow 1973; Maser et al. 1979). The minimum height preferred by golden eagles (Aquila chrysaetos) and prairie falcons (Falco mexicanus) is about 23 ft (Edwards 1968; Smith and Murphy 1973; Siebert et al. 1976; Lockhart et al. 1980). A varied height has been recommended by several researchers (Green and Salter 1987). Beyond 30 to 45 ft, safety might become a concern even though higher walls might attract more breeding raptors (Tessmann 1982a). One highwall segment approved for experimental variance was 40 ft high (Fala 1982). An optimum height for reclamation might be 30 ft, for both stability and to attract a wide range of wildlife species (Maser et al. 1979).

Buckskin's typical rimrocks will be of variable height ranging from 5 to 40 ft.

Aspect. An undulating profile can provide a wide range of exposures or aspects from which raptors can choose. Golden eagles, prairie falcons, and great horned owls (Bubo virginianus) exhibit some degree of selection for particular aspects (Enderson 1964; Murphy et al. 1969; Smith and Murphy 1973; Mosher and White 1976; Siebert et al. 1976). Generally, southern, southeastern, and southwestern exposures are preferred and highwall segments with these aspects should receive a higher priority for retention and development. In addition, big game and

nongame birds may be able to use southern aspects for feeding and resting during winter, because southern aspects retain less snow.

Golden eagles and prairie falcons prefer cliffs with a broad, unobstructed view (Edwards 1968; Boeker and Ray 1971). Highwall segments intended for raptors should therefore be developed with this in mind. Opposing slopes provide open areas next to the cliff face by partially recontouring adjacent and opposing slopes (Green and Salter 1987).

Ledges. Most cliff-nesting raptors nest on ledges (Call 1978). Golden eagles and prairie falcons prefer high ledges on the cliff face (Ogden and Hornocker 1977; Lockhart et al. 1980). Ledges should be excavated on the upper third of the modified highwall, preferably underneath overhangs for protection (Snow 1973; Ogden and Hornocker 1977; Evans 1982). A wide variety of ledges would maximize raptor nesting potential, small mammal travel lanes and vegetation development (Tessmann 1982a). Green and Salter (1987) recommended ledges 1-6 ft m in width, and up to 30 ft in length. The ledges should be at least 25 ft high, of relatively permanent or solid substrate, and free from excessive erosion (Fyfe and Armbruster 1977). Boyce et al. (1980) have described the design, placement, and construction of an artificial ledge for prairie falcons.

The Buckskin Mine will excavate ledges on and along rimrock habitat.

Holes. Prairie falcons, American kestrels (Falco sparverius), great horned owls, common barn owls (Tyto alba) and ravens (Corvus corax) all show an affinity for potholes and caves as nest sites (Dixon and Bond 1937; Enderson 1964; Edwards 1968; Murphy et al. 1969). A variety of holes blasted, drilled, or hand-dug into the highwall face would provide bird nesting and roosting sites, and mammal shelter and dens (Tessmann 1982a). Dimensions recommended by Green and Salter (1987) of 1-6 ft in diameter and 1-6 ft in depth should be suitable for these species. If holes of varied size and spacing are included, the birds are given several choices, which allows them to partition the resource (Steve Tessmann, Wyoming Game and Fish Department, pers. comm.). Boyce et al. (1982) describes design and effectiveness of an excavated cavity for peregrine falcon, and Fyfe and Armbruster (1977) describe design, placement and effectiveness

of an excavated cavity for prairie falcon. Call (1979) describes cavities, ledges, and burrows for several raptor species.

The Buckskin Mine will develop holes in rimrock habitat.

Cracks and Fissures. Developed highwalls that can be manipulated to hold a series of narrow, deep crevices may be more valuable to a wide range of mammal and bird species. Fissures less than 6 in. in width are preferred by bat species (Barbour and Davis 1969; Maser et al. 1979) and small rodents (Maser et al. 1979). Deep crevices with wider opening (12 in. or more) are preferred by various small mammalian predators (Maser et al. 1979).

The Buckskin Mine will excavate cracks and fissures as possible in rimrock habitat.

Talus Slopes. A wide variety of small mammals and reptiles utilize talus slopes for cover and denning (Rose 1976; Maser et al. 1979; Chapman and Feldhamer 1982). Size of the rock pieces should be at least 0.5-2 cu yards and the piles should be a minimum of 6-10 ft thick, but should include a variety of depths to provide diverse habitat (Green and Salter 1987). Tessmann (1982a) recommended depositing broken talus slopes of various sizes along the base of developed highwalls. This talus should not reach raptor nest ledges to minimize access by predators. Talus slopes enhance access by such species as woodrats, allowing them to utilize more of the habitat (Fala 1982). Talus should be either metamorphic or igneous rocks or competent sedimentary rocks because softer rock will erode easily and fill interstitial spaces (Green and Salter 1987).

The Buckskin Mine will place material suitable as talus along the toe slopes of some rimrock habitat.

Vegetation. Highwalls near undisturbed conifers or deciduous shrubs are good candidates for development as wildlife habitat. Otherwise, these species should be planted (Tessmann 1982a). Both red-tailed hawks (Buteo jamaicensis) and great horned owls prefer nest sites with numerous perch or hooting sites with a 1 to 2 mi. radius (Baumgartner 1939; Fitch et al. 1946; Call 1978).

Shrub availability near topographic relief increases the value of the site to big game and numerous nongame bird species (Maser et al. 1979; Fala 1982; Tessmann 1982a). Rimrocks often accumulate moisture from snow drifts. The increased moisture, along with variations in soil conditions, provide conditions for important shrubs used as winter forage (Proctor et al. 1983a, 1983b; Munshower 1994). These include currant, bitterbrush, and mountain mahogany. Steep slopes often support shrubs that are utilized by deer or pronghorns when climatic conditions are most severe, and other food is inaccessible under snow.

The Buckskin Mine will seed a wildlife browse mixture along and around rimrock habitat.

Riparian Areas

The riparian area along intermittent creeks will be reclaimed to restore alluvial aquifers and promote both channel flow and periodic flooding in adjacent floodplains. In addition to creation of a riverine environment, these functions will facilitate development of riparian vegetation, which will provide important wildlife habitat.

Wetlands

The Buckskin Mine has prepared a detailed final wetland mitigation plan in conjunction with our Army Corps of Engineers Section 404 permit. The final wetland mitigation plan includes a detailed discussion of wildlife use of wetland reclamation.

Playas

Playas (internally drained depressions) are common features in the Powder River Basin which provide important habitat for numerous wildlife species. Buckskin Mine will specifically design and restore several wetland playas through reestablishment of the hydrologic system and soils, the two principal requirements for wetland vegetation.

Numerous small shallow playas, dispersed throughout the reclaimed landscape, will also be created without design. These playas will typically be less than 0.2 acres in size and less than 2 ft deep. Since they are so small, specific locations are not mapped; Buckskin's Environmental Engineer will conduct a field reconnaissance during topsoiling to determine if site-specific

conditions and timing (e.g., soils, terrain) are suitable for playa construction. Differential settling of spoils will also naturally create numerous small playas.

Trees

Native trees will be established at a density at least equal to the premining density throughout the reclaimed area. Typically, trees will be located within or adjacent to other important wildlife habitat features (e.g., around ponds, in riparian areas, on north-facing slopes). Shelterbelts will also be planted adjacent to reclaimed hay fields.

Brush Piles and Snags

Brush piles are important wildlife habitat features to many species. These important micro-site habitats will be created both within and outside the affected area. These micro-site features are too small to depict on existing maps, but they will be distributed throughout the reclaimed landscape. Brush piles will be constructed with any and all available brush. This will include trees excavated while stripping topsoil and brush and trees obtained off-site (e.g., discarded Christmas trees) moved onto reclamation. Snags (e.g., telephone poles or relocated downed timber) may be moved into reclaimed areas to serve as raptor perches.

Summary

Wildlife habitat is a principal postmining land use over most of the coalmine lands in Wyoming and the arid west. Where wildlife habitat will be part of the postmine land use, coal mine regulations require development of a plan to restore this use. OSM and state regulations specify that fish and wildlife habitat enhancement measures cannot be limited to just revegetation efforts. Detailed habitat reclamation procedures should be described in the operators Reclamation Plan. Baseline data on wildlife use of the permit area will provide a valuable reference for development of the Reclamation Plan and for evaluating the effectiveness of current reclamation practices. For wildlife reclamation, emphasis should be placed upon habitat features that promote maximum species diversity following mining. The Reclamation Plan should integrate vegetative components and those physical (landform) features required to perpetuate diverse plant communities. Reclamation designed to produce shrubland or a mixture of grasses,

shrubs, and forbs will benefit wildlife more than straight grassland and/or agricultural crops. Varying gradients in slope, surface aspect, and soil moisture are required to promote structurally diverse vegetation. To accomplish this, operators should incorporate diverse slopes, surface undulations, minor depressions, swales, convoluted drainageways and rock piles. Generally, the more diverse the plant and animal composition on the reclaimed area, the more stable the system is and the more chance that something will survive climatic extremes like drought, freezing temperatures or prolonged heavy snowfall.

The Reclamation Plan should present a statement of the reclamation goal and a timetable for achieving that goal. Revegetation should include native plant species, preferably a mixture of some of those species on site prior to mining. Seed mixtures will have to be tailored to soil and topography. Topographic and plant species diversity are both essential to replace wildlife habitat. Aquatic habitat within streams supporting fish and stock ponds used by wildlife should be restored.

Wildlife reclamation and enhancement measures planned by the operator should be explained, not just identified, though the operator must have the option to alter plans as material availability and technology change. Reclamation Plan changes should be actively proposed in permit renewal applications or by permit revision.

Suggested reclamation and enhancement practices include restoration of diverse land forms, direct topsoil replacement, shrub and tree transplants, nest structures, rock pile construction, snags and brush piles, water source development, stream rehabilitation (fish habitat structures, pools, riffles, etc.), riparian zones, creation of lakes suitable for fisheries, and where variances can be obtained, development of highwalls to simulate natural rimrocks.

Proposed locations of habitat components, including seed mixtures, should be plotted on a topographic map. This will allow comparison with premining habitat interspersion.

Important habitat components such as rock outcrops, pools along streams, trees, and erosionally formed gullies should be interspersed within the major vegetation communities as these features may substantially affect local carrying capacity.

Epilogue

The State of New Mexico has taken a major step forward in innovating creative ways to permit reclamation of wildlife habitat. Douglas Romig and David Clark of NM Mining and

Minerals Division presented a paper in the 2000 Billings Land Reclamation Symposium titled *Enhancing Diversity Through Substrate Variability*. This paper and the expressed philosophy should be required reading of all reclamation specialists and coal mine regulators. I quote select portions of their paper:

"We [regulators] *fully understand to enhance post-mine diversity we must allow flexibility in reclamation plans."*

"As reclamationists, we need to overcome the homogenization of mining/reclamation process if we desire more post-mine diversity."

"The key to incorporating these features [ledges, bluffs, rimrocks] *during reclamation is to permit opportunistic construction where competent rock is available."*

"Make reclamation plans flexible be describing methods to be applied to and take advantage of certain regarded landforms rather than using maps. Minimize the need for permit modifications."

"Encourage the use of soil substitute materials at any time rather than [only] *when there is a deficit of topsoil."*

"Promote variable rather than uniform topdressing replacement in order to resemble premine soil landscapes."

"Be patient whenever non-uniform reclamation is attempted. Establishment of the desired species takes three to five years on harsher sites."

And finally.

"Regulators, however, cannot go it alone; operators need to propose alternative plans that enhance diversity that work within their specific mine operations."

Literature Cited

Barbour, R.W., and W.H. Davis. 1969. Bats of America. Univ. Press Ky., Lexington, 287 pp.

Baumgartner, F.M. 1939. Territory and population in the great horned owl. Auk 56(3):274-282. http://dx.doi.org/10.2307/4079048.

Boeker, E.L., and T.D. Ray. 1971. Golden eagle population studies in the Southwest. Condor 73(4):463-467. http://dx.doi.org/10.2307/1366668.

Boyce, D.A., Jr., L. Fisher, W.E. Lehman, and B. Hipp. 1980. Prairie falcons nest on an artificial ledge. Raptor Res. 14:45-50.

Boyce, D.A., Jr., C.M. White, R.E.F. Escano, and W.E. Lehman. 1982. Enhancement of cliffs for nesting peregrine falcons. Wildl. Soc. Bull. 10:380-381.

Call, M.W. 1978. Nesting habitats and surveying techniques for common western raptors. U.S. Dept. Inter., Bur. Land Manage. Tech. Note 316. 115 pp.

Call, M.W., 1979. Habitat management guides for birds of prey. U.S. Dep. Inter., Bur. Land Manage. Tech. Note 339. 70 pp.

Chapman, J.A., and G. A. Feldhamer (eds.). 1982. Wild mammals of North America: Biology, management, and economics. John Hopkins Univ. Press, Baltimore. 1145 pp.

Dixon, J.B., and R.M. Bond. 1937. Raptorial birds in the cliff areas of Lava Beds National Monument, California. Condor 39:97-102. http://dx.doi.org/10.2307/1363738.

Edwards, B.F. 1968. A study of the prairie falcon in southern Alberta. Blue Jay 26:32-36.

Enderson, J.H. 1964. A study of the prairie falcon in the central Rocky Mountain Region. Auk 81(3):332-352. http://dx.doi.org/10.2307/4082689.

Evans, D.L. 1982. Status report on twelve raptors. USFWS Special Sci. Rep. Wildl. No. 238. Washington, D.C. 68 pp.

Fala, R.A. 1982. Development of a mine highwall as wildlife habitat (highwall variance proposal) for Bed 51 West of Arch Mineral Corporation Environmental Group, Western Division, Hanna, WY. 50 pp.

Fitch, H.S., F. Swenson, and D.F. Tillotson. 1946. Behavior and food habits of the red-tailed hawk. Condor 48:205-237. http://dx.doi.org/10.2307/1363939.

Fyfe, R.W., and H.I. Armbruster. 1977. Raptor research and management in Canada. pp. 282-293. In: R.D. Chancellor (ed.) World Conference on Birds of Prey: Report of Proceedings. 1975. Int. Counc. Bird Preservation, Vienna, Austria. 442 pp.

Green, J.E., and R.E. Salter. 1987 Methods for reclamation of widlife habitat in the Canadian prairie provinces. Prepared for Environment Canada and Alberta Recreation, Parks and Wildlife Foundation by the Delta Environmental Management Group Ltd. 114 pp.

Hamlin, K.L. 1978. Population ecology and habitat relationships of mule deer and white-tailed deer in the prairie-agricultural habitats of eastern Montana. pp. 185-197. In: Montana Deer Studies, Prog. Rep., Fed. Aid in Wildl. Restor., Proj. W-120-R-9, Montana Dept. Fish and Game, Helena. 217 pp.

Lockhart, J.M., D.W. Heath, and C.L. Belitsky. 1980. The status of nesting peregrine falcons and other selected raptor species of the Black Butte Mine Lease and adjacent lands. Denver Wildl. Res. Ctr. Final Rep. 59 pp.

Maser, C., J.M. Geist, D.M. Concannon, R. Anderson, and B. Lowell. 1979. Wildlife habitats in managed rangelands—The Great Basin of southeastern Oregon, geomorphic and edaphic habitats. Pacific Northwest Forest and Range Experiment Station, Forest Service, USDA, Gen. Tech. Rep. PNW-99.

Moser, J.A., and C.M. White. 1976. Directional exposure of golden eagle nests. Can. Field-Nat. 90(3):356-359.

Munshower, F.F. 1994. Practical handbook of disturbed land revegetation. Lewis Publishers, CRC Press, Inc. Boca Raton, Florida 265 pp.

Murphy, J.R., F.J. Camenzind, D.G. Smith, J.B. Weston. 1969. Nesting ecology of raptorial birds in central Utah. Brigham Young Univ. Biol. Ser. 10 (4):1-36.

Ogden, V.T., and M.G. Hornocker. 1977. Nesting density and success of prairie falcons in southwestern Idaho. J. Wildl. Manage. 41(1):1-11. http://dx.doi.org/10.2307/3800084.

Olendorff, R.R. 1972. The large birds of prey of the Pawnee National Grassland: Nesting habits and productivity 1969-1971. Int. Biol. Programme Grassland Biome Tech. Rep. 151. 59 pp.

Parrish, T. and Anderson, S. 1994. Handbook of Methods to Reclaim Wildlife Habitat on Surface Mines in Wyoming. Wyoming Cooperative Fish and Wildlife Research Unit. University of Wyoming, Laramie, WY 82017.

Proctor, B.R., R. W. Thompson, J.E. Bunin, K.W. Fucik, G.R. Tamm, E.G. Wolf. 1983a. Practices for protecting and enhancing fish and wildlife on coal surface-mined land in the Green River-Hams Fork region. P.L. Dittberner, Project Officer. FWS 14-16-0009-80-075. FWS/OBS-83/09. March 1983. Performed for Western Energy and Land Use Team, Division of Biological Services, Research and Development, Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C. 20240.

Romig D. and Clark D. 2000. Enhancing Diversity Through Substrate Variability. In 2000 Billings Land Reclamation Symposium. Reclamation Research Unit, Montana State University, Bozeman, MT 59717.

Rose, B.R. 1976. Habitat and prey selection of Sceloporus occidentalis and Sceloporus graciosus). Ecology 57(3):531-541. http://dx.doi.org/10.2307/1936437.

Siebert, D.J., R.J. Oakleaf, J.M. Laughlin, and J.L. Page. 1976. Nesting ecology of golden eagles in Elko County, Nevada. U.S. Dept. Inter., BLM Tech. Note 281. Denver, CO. 17 pp.

Smith, D.G. and J.R. Murphy. 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. Brigham Young Univ. Sci. Bull. Biol. Serv. 18(3):1-76.

Snow, C. 1973. Habitat management series for unique or endangered species: golden eagle, Aquila chrysaetos. BLM Tech. Note Rep. 7. Denver, CO 52 pp.

Tessman, S.A. 1982a. Procedures for developing strip mine highwalls into wildlife habitat in Wyoming. Wyo. Game and Fish Dep., Cheyenne. Unpub. Rep. 20 pp.