Appendix 13a

Biological Crust Evaluation

Contents

Introduction

Biological crusts (also called microbiotic crusts) consist of lichens, bryophytes, algae, microfungi, cyanobacteria, and bacteria growing on or just below the soil surface (Eldridge and Greene 1994). Cover types in the project area that can be associated with substantial biological crust development include: salt desert shrub, low sagebrush, big sagebrush, and juniper woodland.

Biological crusts play a role in soil stability, nutrient cycling, and soil moisture, and in interactions with vascular plants. Lichens and algae provide forage for invertebrates, and some lichens provide forage for big game species during critical winter periods (Thomas and Rosentreter 1992). The ecological role of biological crusts is probably most substantial in arid ecosystems in which above-ground productivity is inherently low. More research needs to be conducted on biological crusts to ascertain their ecological roles, particularly with regard to hydrology, nutrient cycling, energy flow, and biodiversity.

Activities that disturb the soil surface—including grazing, off-road vehicle use, recreational hiking, and others—can reduce the maximum potential development of biological crusts. There has been a lack of research conducted within the basin to ascertain the response of biological crusts to land use disturbances such as livestock grazing. This part of the appendix describes the use of a matrix to analyze the effects of livestock grazing on biological crust in an environmental assessment or environmental impact statement.

Use of the Biological Crust Matrix

The matrix is split into two main parts:

1. Potential for biological crust development based on biological and physical factors.
2. Potential for management actions to negatively impact biological crusts.

1. Potential for biological crust development based on biological and physical factors.

The first step in use of the matrix is to determine whether or not the site has the potential to support a well-developed biological crust. Knowledge of local ecological sites (particularly soil characteristics and vegetation potential) is essential for use of the matrix. The factors listed are closely related and are components of the ecological site description, however variation in any one factor can influence biological crust cover and its relative importance to the ecological stability of the site.

In general, ecological sites dominated by shrubs listed in the first column will consistently have a well-developed biological crust. The main characteristic that will modify crust cover is soil surface texture. For example, low sagebrush communities often have a well-developed biological crust. Low sagebrush communities on calcareous, gravelly loams and silt loams (such as alluvial deposits from the Lemhi Range) have well developed lichen crusts that occupy fine-textured, mineral soil within the gravel matrix (and, in fact, are protected by the gravel). In constrast, low sagebrush communities occurring on rocky, well-drained, rhyolitic (volcanic) soils in the Owyhee Mountains have little potential for crust development due to high cover of rock fragments and coarser, rhyolite-derived soils.

A second important criterion is the potential herbaceous plant density. Note that mountain big sagebrush is listed in the "moderate", "low", and "very low" columns in part 1 of the sample matrix. Communities at the drier end of the mountain big sagebrush zone will have greater cover of biological crust due to lower density of herbaceous plants, limited by effective precipitation. More productive sites will have mosses and lichens beneath a dense herbaceous layer. However the vascular plant component has higher cover and is more important in these communities for soil protection relative to the biological crust.

Status of existing vegetation on the site is determined using the "Current ecological condition" or categories

under "Artificial seedings". Sites where vegetation structure has been modified due to introduction of invasive weeds or rhizomatous grasses seeded into areas that historically supported bunchgrass vegetation will have reduced potential for biological crust. Sites that have become dominated by annual species such as cheatgrass or medusahead wildrye have lowered potential for biological crust development due to high plant density, litter accumulation, and frequent fire. Biological crusts will recover on burned sites seeded with bunchgrasses, forbs and shrubs, if the resulting community structure is similar to that of the potential natural community and if it contains open interspaces.

2. Potential for management actions to negatively impact biological crusts.

After determining the potential for biological crust development, livestock impacts can be evaluated using two criteria: season of use and utilization levels (from monitoring data). Biological crusts require moisture for growth and reproduction; however moisture requirements are small compared to that required by vascular plants. Growth is promoted by cool season, as opposed to summer, moisture. Biological crusts are fragile when dry (dormant), but quite pliable when moist. The least impact occurs when the crust is moist or frozen. Regrowth potential is greatest during periods when cool season moisture is consistent for several weeks. For example, late fall use has low impacts because: 1) the biological crust is likely to be moist and pliable due to dew, frost, and periodic rain; 2) there is a considerable length of time between the period of use and the dry, hot season. Late spring use may also occur due to dew, frost, and rain; however, the dry, hot season is imminent and the crust may not have time to recover from trampling impacts via reattachment and regrowth. Once the crust is fragmented, the soil surface is vulnerable to erosion by wind and water. In addition, the crust fragments can be removed from the site along with surface soil, reducing the potential for future recovery.

Vegetation use is representative of animal stocking rates or length of grazing period. Hoof action affects the crust (the crust is not grazed). Severe to high use is indicative of localized concentration of animals and heavy trampling. Again, trampling impacts will be somewhat dependent on season of use and soil texture.

References

Eldridge, D. J.; and Greene, R. S. B. 1994. Microbiotic soil crusts: A review of their roles in soil and ecological processes in the rangelands of Australia. Australian Journal of Soil Research. 32: 389-415.

Thomas, A.; and Rosentreter, R. 1992. Antelope utilization of lichens in the Birch Creek Valley of Idaho. In Proceedings: Symposium of the 15th biennial pronghorn antelope workshop, June 9-11, 1992, Rock Springs, Wyoming., pp. 6-12. [Place of publication unknown]: Wyoming Fish and Game Department.

Biological Crust Matrix.

1. Potential for biological crust development based on physical and biological factors (based on site potential):

	High——————>Moderate——————>Low——————>Very Low			
Dominant tree or shrub	salt desert shrub Wyoming big sagebrush basin big sagebrush low sagebrush black sagebrush stiff sagebrush	Wyoming big sagebrush basin big sagebrush mountain big sagebrush low sagebrush black sagebrush stiff sagebrush	mountain big sagebrush xeric big sagebrush subalpine big sagebrush threetip sagebrush silver sagebrush alkali sagebrush fuzzy sagebrush juniper pinyon pine	mountain big sagebrush mountain shrub
Herbaceous plant density	low	low-moderate	moderate-high	high
Dominant herbaceous life form	bunchgrass	bunchgrass	rhizomatous	rhizomatous
Annual precipitation	<12"	12-14"	>14-16"	>16"
Soil surface texture	silts silt loams clays (excluding shrink/swell clays)	loamy	sandy	coarse sand gravel or broken rock (>80% rock fragment)
Historical fire return interval	>50 years	25-50 years	10-25 years	<10 years
Current ecological condition	mid- to late-seral or potential natural community	early- to mid-seral	disturbed to early-seral	disturbed with/without high weed cover
Artificial seedings				
Date since seeding	>20 years	10-20 years	5-10 years	<5 years
Primary seeded life-forms	bunchgrasses	bunchgrasses	rhizomatous grasses	rhizomatous grasses

2. Potential for management actions to negatively impact biological crusts:

	High——————>Moderate——————>Low——————>Very Low			
Livestock season of use	summer	late spring	early spring late fall	winter
Vegetation utilization	severe to high	moderate	light	slight

Example: Completed Biological Crust Matrix

The following is an example of a completed biological crust matrix. The top part of the matrix indicates that the potential for biological crust cover is high and season of use by livestock should result in low impact to the crust. However, level of use when livestock are present is high (for example, more than 80 percent utilization). This indicates that impacts of livestock on biological crust are probably significant due to vegetation use levels and the associated trampling impacts. Field observations support this analysis as biological crust is present but highly fragmented (clumps less than one inch in diameter) and is primarily restricted to protected areas under shrubs. Reducing livestock numbers would probably result in improved cover and distribution of biological crust.

Example - Biological Crust Matrix.

1. Potential for biological crust development based on physical and biological factors (based on site potential):

	High——————>Moderate——————>Low——————>Very Low			
Dominant tree or shrub	salt desert shrub ✓ Wyoming big sagebrush basin big sagebrush low sagebrush black sagebrush stiff sagebrush	Wyoming big sagebrush basin big sagebrush mountain big sagebrush low sagebrush black sagebrush stiff sagebrush	mountain big sagebrush xeric big sagebrush subalpine big sagebrush threetip sagebrush silver sagebrush alkali sagebrush fuzzy sagebrush juniper pinyon pine	mountain big sagebrush mountain shrub
Herbaceous plant density	low ✓	low-moderate	moderate-high	high
Dominant herbaceous life form	bunchgrass ✓	bunchgrass	rhizomatous	rhizomatous
Annual precipitation	<12" ✓	12-14"	>14-16"	>16"
Soil surface texture	silts ✓ silt loams clays (excluding shrink/swell clays)	loamy	sandy	coarse sand gravel or broken rock (>80% rock fragment)
Historical fire return interval	>50 years ✓	25-50 years	10-25 years	<10 years
Current ecological condition	mid- to late-seral or potential natural community	early- to mid-seral	disturbed to early-seral ✓	disturbed with/without high weed cover
Artificial seedings				
Date since seeding	>20 years	10-20 years	5-10 years	<5 years
Primary seeded life-forms	bunchgrasses	bunchgrasses	rhizomatous grasses	rhizomatous grasses

2. Potential for management actions to negatively impact biological crusts:

	High————— ————>Moderate——————>Low——————>Very Low			
Livestock season of use	summer	late spring	early spring ✓ late fall	winter
Vegetation utilization	severe to high ✓	moderate	light	slight

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