United States Department of Agriculture | Forest Service | Kootenai N.F. | 506 U.S. Highway 2 W. Libby, MT 59923

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Subject: Kootenai Soil Monitoring Results for 1997; Monitoring Item F-4, Soil Productivity

To: Regional Forester
Attn: John Nesser

MONITORING ITEM F-4 is SOIL PRODUCTIVITY. For the Kootenai Forest Plan the action or effect to be measured is "determine the changes in site quality due to surface displacement and soil compaction". During 1997 I monitored logging activities within harvest units on timber sales, fuel abatement activities within timber sales, and segments of roads. Following is a summary of these activities.

A. Harvest activity:
   1. Thirteen sales
   2. Twenty-two harvest units
   3. Forty-two transects
   4. Total of 766 acres

B. Roads
   1. Three road segments

C. Fire
   1. Five sales
   2. Six harvest units that have been burned

The Kootenai National Forest harvested 12,093 acres in fiscal year 1997 in the following categories:

1. Clearcut - 2018 acres
2. Seed tree/shelterwood - 2661 acres
3. Final harvest - 663 acres
4. Salvage - 4445 acres
5. Special - 568 Acres
6. Intermediate - 1715 Acres
7. Select - 22 Acres

Of the 13 sales reviewed for harvest activities, three were "regular" sales involving 126 acres. The ten remaining sales were "salvage" involving 640 acres. Of these ten, six were fire salvage and four were dead and down and/or down lodgepole pine salvage. The "salvage" reviews represent 14 percent of the slavage acres harvested, while the "regular" represents approximately 1.5 percent of the regular acres harvested. The acres reviewed represent 6 percent of the total acres harvested in fiscal year 1997. A total of 15,418 monitoring points were described. As noted on the forms, operations occurred throughout much of the year, but avoided the months when the soils were at or near field capacity. This is reflected in the results, where only five units had five percent or more heavy disturbance.

A total of 88 harvest units within 44 sales have been reviewed since 1992. Of the 44 sales, 22 are regular, five are pest control, 10 are fire salvage, and seven are other (dead lodgepole pine, western white pine, and/or ponderosa pine over large areas; windthrow; etc.) salvage. Attached are four tables that indicate the types of sales, number of sales, number of units, the soil disturbance categories, and a summary of all from 1992-1997.

Overall, I am very pleased with the results of our more recent on-the-ground harvest activities. If you have any questions, please call.

/s/ Louis J. Kuennen

LOUIS KUENNEN
SOIL SCIENTIST, KOOTENAI N.F.

MONITORING SUMMARY: F-4 TOTALS

F-4-1 TYPES Of TIMBER SALES MONITORED

Sale Types	1992	1993	1994	1995	1996	1997	Totals
Regular	8	2	2	4	3	3	**22**
Pest Control	1	1	0	0	3	0	**5**
Fire Salvage	0	3	0	0	1	6	**10**
Other Salvage	1	0	0	0	2	4	**7**
Totals	**13**	**9**	**4**	**2**	**6**	**10**	**44**

F-4-2 NUMBER Of UNITS By HARVEST TYPE

Sale Types	1992	1993	1994	1995	1996	1997	Totals
Regular	15	7	4	9	6	5	**46**
Pest Control	4	2	0	0	5	0	**11**
Fire Salvage	0	6	0	0	1	10	**17**
Other Salvage	1	0	0	0	6	7	**14**
Totals	**20**	**15**	**4**	**9**	**18**	**22**	**88**

F-4-3a UNITS By DETRIMENTAL SOIL DISTURBANCE CATEGORY

Disturbance Categories: %	1992	1993	1994	1995	1996	1997	Totals
< 6	0	5	3	8	12	17	**45**
6 - 10	6	4	0	1	6	5	**22**
11-15	6	5	1 *	0	0	0	**12**
15 +	8	1	1 *	0	0	0	**9**
Total Units	**20**	**15**	**4**	**9**	**18**	**22**	**88**

* = represent transects within same unit

F-4-3b ACRES By DETRIMENTAL SOIL DISTURBANCE CATEGORY							
Disturbance Categories: %	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**Totals**
<6	0	170	32	160	377	637	**1376**
6 - 10	134	68	0	29	230	129	**550**
11 - 15	122	131	14 *	0	0	0	**267**
15 +	245	8	13 *	0	0	0	**266**
Total Acres	**501**	**377**	**59**	**189**	**607**	**766**	**2499**
* = represent acres within same unit							

F-4-4 KOOTENAI N.F. SOIL MONITORING SUMMARY							
Summary of Actions	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**TOTALS**
Number of Sales	10	6	2	4	9	13	**44**
Number of Units	20	15	4	9	18	22	**88**
Acres	501	377	59	189	607	766	**2499**
Number of Transects	70	31	8	17	48	42	**216**
Number of Monitoring Points	6800	7407	1963	4349	14,004	15,418	**49,986**
Walk Throughs	2	8	7	5	7	8	**37**

F-4-5 TYPE Of HARVEST SYSTEMS By SEASON							
Year	1992	1993	1994	1995	1996	1997	
Season	Win Sum	Win Sum	Win Sum	Win Sum	Win Sum	Win Sum	
Rubber-Tired Skidder	2* 5*	2 4	0 1	1 2*	2 6*	6 3	
Crawler Tractor	1 11*	1 5	3 0	1 4*	1 10*	3* 7*	
Forwarder	0 1	0 1	0 0	0 2	0 0	1 1	
Cable	0 2	0 1	0 0	0 0	0 0	0 3	
* = more than one operation occurred in a unit							

Munshower, Frank F. 1972. Cadmium Compartmentation and Cycling in a Grassland Ecosystem in the Deerlodge Valley, Montana. Ph. D. University of Montana, Missoula, MT.

Abstract

Airborne cadmium from a zinc smelter has accumulated in the Deer Lodge valley of western Montana for approximately fifty years. Permanent closure of the zinc smelter in 1969 created an ecosystem in which one could address the questions of distribution, compartmentation, and transfer of a little studied heavy metal contaminant without the introduction of new pollutant from outside the system. This study follows the pathway of introduced cadmium from its initial deposition as airborne particulate matter, movement into the soil system, transfer and accumulation by plants, and subsequent transfer to higher tropic levels. Soil samples were extracted with normal hydrochloric acid and plant and animal tissues digested in a mixture of hot perchloric and nitric acids. Cadmium contents of all samples were analyzed on an atomic absorption spectrophotometer.

The soil reservoir of intorduced cadmium is restricted to the top 2-5 cm, is geographically distributed in relation to the smelter and prevailing winds, and normally is not transferred to lower soil horizons. This indicates that the only probable routes of cadmium exit from this ecosystem will be by surface erosion or by cropping and not by leaching from the soil.

Analyses of plants grown in controlled cadmium concentrations in nutrient solutions and soil cultures, and of plants collected in the field, established that cadmium was absorbed and translocated by plants in a predictable manner. Plant cadmium concentrations are a function of the cadmium concentration of the root medium, time of collection during the growing season and species.

Grasshopper cadmium concentrations and the liver and kidney cadmium concentrations of cattle, swine, and columbian ground squirrels demonstrated cadmium accumulation increased above plant canmium levels as a function of the animal's age. The presence of cadmium in the kidney of the red fox, badger, and weasel documented cadmium transfer from herbivores to carnivores.

A mathematical model of the ecosystem was developed depicting the system as a closed, self-contained unit. Concentrations and quantities of cadmium in each ecological compartment were derived in terms of the cadmium concentration at the lower trophic level, life span of the organism, and its biomass on an areas basis. Interpretation of long term changes in cadmium concentrations in the ecosystem indicate a half-life for the introduced cadmium in this grassland is in excess of 1000 years. The cadmium half-life in cultivated lands is shorter.

Taskey, Ronald D. 1972. Soil Contamination at Anaconda, Montana: History and Influence on Plant Growth. Masters Thesis. University of Montana, Missoula MT.

Introduction

Serious environmental problems have existed at Anaconda, Montana, since the smelting of copper ores began there in 1884. Several million tons of wastes dumped from the smelting operations have destroyed thousands of acres of native vegetation. The problems became most serious starting in 1902 when copper production, and consequently poisonous emissions, increased with the construction of the present smelter.

The smelter's airborne effluent contains sulfur compounds and a number of heavy metals, including arsenic, copper, lead, and zinc, all of which are partially responsible for the debasement of the ecosystem of the mountains surrounding Anacaonda. The Anaconda Company, which owns and operates the smelter, has altered the recovery and waste disposalmethods so that in recent years the local ecosystem has been allow to begin at least partial recovery, as described later in this paper.

However, the local soils remain highly contaminated with heavy metals. This contamination combined with existing air pollution greatly hinders the rehabilitation process. Thus, plant cover and diversity are deficient over most of the area.

This deficiency leaves the watershed poorly protected, and serious water and wind erosion have resulted. In addition, the wildlife habitat is of poor quality, at least in the uplands. Other values of the land resource, such as grazing and recreation, are also degraded. These facts, combined with the ghostly tree stumps and a knowledge of what could be, provoke a vitiated aesthetic experience for the concerned observer.

The purpose of this study is to present the history of damage to vegetation by smelter wastes in the Anaconda region; to ascertain the extent of soil contamination by arsenic, copper, lead, and zinc; and to test the response of lodgepole pine and Douglas-fir grown in soils from within the zone of the smelter's influence.

Ottersberg, Robert J. 1977. Amorphous Character in Twenty Western Montana Forest Soils with Apparent Eolian Influence. Masters Thesis. Montana State University, Bozeman, MT.

Abstract

Volcanic ash is a significant component of eolian deposits of Recent age in Western Montana. A survey of soil scientists in this region indicated brown color, low bulk density and high silt content are used by many respondents to recognize volcanic ash influence. Twenty forest soils were sampled and characterized. The soils represent Andept suborders, Andic and Andeptic subgroups and soils with apparent eolian influence indicated by their morphology. Strong amorphous character was associated with a combination of the following morphological properties: 1) high silt content, usually 60% or more; 2) high chroma, usually four or more for Andept suborders, and three or more for Andic and Andeptic subgroups; 3) weak consistence, usually soft, friable, nonsticky, nonplastic; 4) weak structural grade. Nutrient content, cation exchange capacity and water holding capacity appear to be much larger in andic soil with strong amorphous character than non-andic soil material when expressed on a weight basis. On a volume basis, analysis of andic layers was not very different from other soil material with similar textures.

Conclusion

Soils with strong amorphous character are generally found northwest of Missoula, where the climate is wet and the loess apparently rich in volcanic ash. East and south of Missoula misclassification of soils with eolian surface layers could be prevented if the morphological indices of amorphous character presented in this paper are used. Very few andic layers in Montana appear to have enough volcanic glass to make petrographic examination necessary for classification.

Andic layers have characteristics which make them relatively fertile compared with layers that are coarse textured, fine textured or compacted. The andic layer is expected to be the major source of nutrients and water when it occurs over coarse textured granitic materials. Poor root penetration in clayey or compacted subsoils could make andic layers the main source of air, nutrients and water. On a volume basis, nutrient and water holding capacity may be no greater in andic layers than comparably textured soils. The pH dependent cation exchange capacity is potentially valuable. Liming to raise the pH could significantly increase cation exchange capacity.

McDaniel, Paul A. 1983. Nature and Origin of an Argillic Horizon in a Soil of the Boulder Batholith, Montana. Masters Thesis. Montana State University, Bozeman, MT.

Abstract

Some forested soils of the granitic Boulder batholith in Montana have clay-rich horizons ard are poorly drained. The purpose of this project was to study a representative soil of the area and determine the processes responsible for genesis of a clay-rich argillic horizon in coarse-grained granitic parent material. X-ray diffraction, thin section, and scanning electron microscopy techniques were used to do this.

Clay fractions from the B horizons of this soil differed markedly from surface horizons in both type and amount of clay minerals present. Smectite dominated the clay fraction and accounted for up to one-fourth of the fine-earth. Soil fabric analyses indicated pedogenic processes were not responsible for the high smectite content of the B horiaon. The smectite is an in situ weathering product occurring in zones of weathering similar to those characteristic of hydrothermal alteration.

Hydrothermal alteration of quartz monzonite, a geological process, is apparently responsible for most of the chemical, physical, and mineralogical properties of the B horizon. Although effects of pedogenic processes of clay formation and clay movement (lessivage) can be seen, their influence on soil properties is mininal in these soils.

Conclusions

A geochemical process, hydrothermal alteration of quartz monzonite, is primarily responsible for the chemical, physical, mineralogical, and morphological characteristics of the argillic horizon investigated here. Although pedogenic processes of clay formation and lessivage have been sufficiently active to form an argillic horizon, their influences on these properties has been minimal.

Black, Janette L. 1984. Soil Mineralogy Used to Distinguish Solifluction Deposits Formed Under a Periglacial Environment on the Boulder Batholith, Jefferson County, Montana. Masters Thesis. Montana State University, Bozeman, MT.

Abstract

Using soil mineralogy and relative mineral stabilities, soils formed on stable sites were compared to soils formed on features believed to have undergone mass movement. The mass movement features studied are termed solifluction terraces. The terraces are gently sloping and extend into an arcuate, convex-downslope, steep, rocky front. The presence of Early to Late Wisconsinan glacial deposits in close proximity and at similar elevations to the study area terraces, coupled with the lack of glacial features within the study area, provides evidence that a periglacial environment existed in the area. This study indicates that the terraces were formed by periglacial processes during the Pleistocene. Specifically, the terraces are thought to be formed by solifluction, used here to indicate the slow movement of water-saturated material from higher to lower ground over a frozen substrate in a periglacial environment.

A study of the mineralogical changes in the soils within the study area was made in order to substantiate the solifluction hypothesis. An analysis of the degree of weathering and the distribution of the minerals within the soils found striking differences between the soils of the solifluction terraces and those found on the stable sites. Clay mineralogy analysis demonstrates sharp and erratic changes in the distribution of minerals within the solifluction terrace profile, which contrast sharply with the gradual changes in clay mineral distribution exhibited by the stable profiles. In addition, coarse-size minerals in the stable sites show a gradual decrease in weathering with depth whereas the solifluction soils contain a mixture of fresh and highly weathered minerals throughout the profile. These differences are likely the result of frost heaving and downslope motion in the solifluction terrace soils and support the concept that the origin of the terraces are attributable to the mass movement process of solifluction.

The study demonstrates the utility of inegrating soil mineral analysis with geomorphology and that an analysis of mineral texture and distribution within a soil can provide valuable information to distinguish stable landforms from those formed by mass movement processes.

Rassman, James. 1993. Prescribed Fire Effects in Southwestern Montana, Aspen Dominated Riparian Areas. Masters Thesis. Colorado State University, Fort Collins, CO.

Abstract

Fire effects on vegetation, soils, and stream structure were measured on two prescribed burn units in southwestern Montana. The U.S. Forest Service burned two riparian units in May of 1992. Both of the units contained a riparian component dominated by quaking aspen (Populus tremuloides Michx.) and an upland component with a Douglas-fir (Pseudotsuga menziesii) and Rocky Mountain Juniper (Juniperus scopulorum) overstory. Data on woody plant cover and density, and litter and humus depth were collected before the burns, and once a month throughout the first summer following the burns. Fire behavior measurements were used to place the 39 permanent plots in five different fire intensity categories.

Aspen sprout density was highest ($P < 0.05$) on the plots subjected to moderate intensity fires. Riparian shrub species response was difficult to analyze, due to the low number of shrubs and high cover and density variability on the permanent plots. Low intensity fires caused little change in cover, density or species composition.

Litter and humus depths were reduced significantly ($P<0.05$) by all fire intensities, except the unburned and lowest intensity fire plots. Litter cover was reduced significantly on all the burned plots. There was no change ($P>0.05$) in organic matter in the uppermost mineral soil horizon on either burn unit. There were no visible changes in channel cross-section three months after the prescribed fires. Permanent plots installed in this study area are intended to be read annually to document long-term response to fire.

Opportunities and implications of the use of prescribed fires in riparian areas are discussed. Recommendations for future riparian fire research are also presented.

Hodge, Robert J. 1997. Where Have All the Suckers Gone? A Comparison of Aspen Treatments on the Deerlodge National Forest. Masters Thesis. University of Montana, Missoula, MT.

Abstract

Quaking aspen (Populus tremuloides) clones in the Deerlodge National Forest in Southwestern Montana have been declining in both density and patch size. Regeneration efforts have achieved varying degrees of success. The purpose of this study was to examine the effects of existing silvicultural treatments on aspen regeneration success in the Deerlodge National Forest. Over the past ten years, quaking aspen clones were treated in four areas in the Deerlodge National Forest using fire and mechanical scarification on upland sites and cutting on riparian sites. This study compared treatments as an attempt to identify factors which affect the success of aspen regeneration on these sites. Representative control sites were selected for each of the four areas and treatments were compared to the controls using paired t-tests. Aspen treatments were not consistently successful. Regeneration failure was caused by poor response to treatment and by large scale aspen sucker mortality due to Cytospora canker infections encountered in the years following treatment. Fencing proved to be effective when applied to a treated site. Leaving high slash concentrations on treated sites did not reduce browse intensities when compared to treated sites. Mechanical scarification was probably the most successful treatment observed in upland sites.