

(see Smith et al 1985 for a more complete description of treatments and plot arrangement):

- 1) rate of wood residue application: 0, 45, 90 and 135 Mg/ha, and
- 2) rate of nitrogen fertilization: 0, 2.5, 5.0 and 7.5 kg of N/Mg of wood residue in residue-amended treatments; the non-residue amended treatment received 0, 112, 224 and 336 kg N/ha, which was equivalent to the rates of N applied on the 45 Mg/ha wood rate treatment.

Initial results indicated that while vegetation was significantly stimulated by the lowest rates of N fertilization, little subsequent difference in plant response existed among the 3 rates of N application (Smith et al 1985). For the purposes of the present analysis, therefore, plant responses to non-N fertilization will be compared to the average of responses among the 3 N fertilization rate treatments (i.e., a non-N vs. N-fertilized treatment comparison).

Two mixtures of seeded species (native and introduced perennial grasses) were sown on the site in 1981 to comprise a seed mix treatment (Smith et al 1985). This report will present only responses of the native mixture, since this mix was

Table 1. Pre-treatment characteristics of bentonite spoils at Upton, Wyoming study site, 1981 (from Smith et al. 1985).

Spoil Attribute		Mean and Standard Error	
Particle Size Distribution (%):	Sand	10.8	± 0.8
	Silt	29.6	± 0.8
	Clay	56.6	± 1.1
NO ₃ -N (mg/kg):		7.7	± 0.4
NH ₄ -N (mg/kg):		2.6	± 0.1
Total Kjeldahl N (mg/kg):		751.1	± 5.8
P (mg/kg):		8.1	± 0.3
C (mg/kg):		10.0	± 1.0
pH		6.8	± 0.1
Electrical Conductivity [EC](dS/m)		13.4	± 1.1
Sodium Adsorption Ratio [SAR]:		63.1	± 1.2
Soluble Cations (mg/kg):	Ca	187.9	± 9.2
	Mg	73.6	± 4.2
	Na	3613.7	± 101.3
	K	32.0	± 0.8

later selected to receive the gypsum treatments because of better overall response to the initial spoil amendments. The native mixture included 5 cool-season perennial grasses ('Rosana' western wheatgrass, *Agropyron smithii*; 'Critana' thickspike wheatgrass, *A. dasystachyum*; 'Revenue' slender wheatgrass, *A. trachycaulum*; 'Sodar' streambank wheatgrass, *A. riparium*; and 'Lodorm' green needlegrass, *Stipa viridula*) and one shrub (Nuttall saltbush, *Atriplex nuttallii*). This mixture was seeded at rates to yield 130 live seeds/m² for each grass species and 32 live seeds/m² for Nuttall saltbush.

Site preparation after grading consisted of chisel plowing; application of varied wood residue and N-fertilization rate treatments (plus a uniform application of phosphorus at 90 kg/ha); and disk plowing to uniformly incorporate all residue and fertilizer amendments within the surface 30 cm. The seed mixture was subsequently sown with a grain drill in October 1981.

In April of 1987, the study was expanded by adding gypsum as a third soil amendment treatment (see Schuman et al 1989 for full detail). Two gypsum regimes were superimposed by dividing each native species plot, and randomly designating each portion to receive gypsum at either 0 or 56 Mg/ha. The 56 Mg/ha gypsum rate supplied sufficient Ca ions to reduce the exchangeable sodium percentage (ESP) of the spoil to 15. The gypsum was surface-applied with no subsequent soil incorporation, to avoid physically disrupting previously established vegetation.

Sampling (1988 - 1990)

Techniques of vegetation sampling and analysis for the pre-gypsum amendment years of 1981 through 1986 were described in preceeding reports (Smith et al 1985, 1986; Schuman et al 1989; Belden et al 1990). Methods and results of post-gypsum amendment soil sampling were described by Meining (1991), and will not be included in this paper.

Vegetation was sampled from 1988 through 1990 for density, canopy cover, and aboveground biomass. Within each replicate block, 2 permanent 0.25 m² rectangular quadrat locations were established within each wood residue-fertilization-gypsum treatment combination subplot for density and canopy cover estimation. Stem density was