

The Vegetation of Acid Shale Pine Forests,  
Petroleum and Fergus Counties, Montana

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The glaciated plains of North-central Montana are considered part of the Great Plains Floristic Province. Lower elevation areas are dominated by short and mid-grass prairie and shrublands. Coniferous forests and riparian forests form a minor component of the vegetation in this region. Parent materials and soils are complex resulting in a mosaic of different grassland and shrubland communities (Harvey 1982, Jorgensen 1979). Acid shales of the Bearpaw Formation outcrop in a low ridge which runs more-or-less continuously north of Highway 200 from the east edge of the Judith Mountains east to Winnett (ca. 48 km) in Petroleum and Fergus counties. Slopes are gentle to moderate, but soils are poorly developed. Although the surrounding vegetation at just slightly lower elevation is sagebrush grassland, the acid shale soils support forests dominated by ponderosa pine (Pinus ponderosa).

On June 19, 1987 I visited two areas on public land dominated by acid shale pine forest. Canopy coverage data obtained by ocular estimation in 100 m<sup>2</sup> plots for six stands in the War Horse Lake area and three stands in the Briggs Coulee area are presented in Table 1. Ponderosa pine is the only tree present. It attains a height of 10 to 15 m (30-50 ft.). Horizontal juniper (Juniperus horizontalis) is the only common shrub. The herbaceous layer is dominated by sun sedge (Carex pensylvanica) with lesser amounts of thick-spiked wheatgrass (Agropyron dasystachum), ticklegrass (Agrostis scabra), prairie sandreed (Calamovilfa longifolia), prairie reedgrass (Calamagrostis

Table 1. Percent canopy cover of vascular plant species in acid shale pine forests in Fergus and Petroleum counties. Stands 1-6 are from the War Horse Lake area. Stands 7-9 are from the Briggs Coulee area.

Species	Stands								
	North			Ridge			South		
	Slope			Crest			Slope		
	1	2	8	6	7	4	3	5	9
<i>Pinus ponderosa</i>	55	60	55	40	60	15	25	30	45
<i>Juniperus horizontalis</i>	40	10	15	5	5	20	20	10	20
<i>Carex pensylvanica</i>	35	30	60	--	10	5	--	--	35
<i>Agropyron dasystachum</i>	20	--	--	1	--	--	2	--	5
<i>Calamagrostis montanensis</i>	--	--	--	--	--	5	10	5	--
<i>Agrostis scabra</i>	--	--	--	--	--	--	5	5	--
<i>Calamovilfa longifolia</i>	--	--	--	--	--	2	--	5	--
<i>Agropyron spicatum</i>	--	5	5	--	--	--	--	--	--

montanensis) and bluebunch wheatgrass (Agropyron spicatum).

Canopy cover of forbs is sparse and relatively unimportant. Large areas of bare soil are common.

Both Jorgensen (1979) and Harvey (1982) conducted vegetation studies in the immediate area of the acid shale forests, and Pfister et al. (1977) studied and documented forest habitat types throughout Montana. All three studies recognize a Pinus ponderosa/Agropyron spicatum habitat type. This type often contains Rocky Mountain juniper in the canopy, has a sparse shrub layer composed of species such as chokecherry (Prunus virginiana), snowberry (Symphoricarpos albus) and serviceberry (Amelanchier alnifolia). Bluebunch wheatgrass dominates the undergrowth, and characteristic forbs include balsamroot (Balsamorhiza sagittata) and gromwell (Lithospermum reuderale). None of these species are present in the acid shale pine forests to any appreciable extent. Jorgensen (1979) also described a Pinus ponderosa/Artemisia tridentata habitat type which occurs on shales of the Colorado Formation south of Winnett. This type is somewhat similar to the pine forests on Bearpaw acid shale just to the north. Horizontal juniper and thick-spiked wheatgrass are common, but sagebrush (Artemisia tridentata) and rabbitbrush (Chrysothamnus nauseosus) which are dominant shrubs in Jorgensen's type are not found in the acid shale pines north of Winnett. Roberts (1980) described a Pinus ponderosa/Juniperus horizontalis habitat type from the Little Rocky Mountains north of Lewistown. Although horizontal juniper is characteristic of

this type, other common undergrowth species such as common juniper (Juniperus communis), skunkbush (Rhus trilobata), and bluebunch wheatgrass are uncommon or not present in pine forests on acid shale. It appears that acid shale pine forests may be an undescribed and unique climax plant community warranting designation of a new forest habitat type (Steve Arno, USDA Northern Forest Fire Laboratory, personal communication).

The presence of pine forests at low elevations surrounded by sagebrush grassland is undoubtedly due to unusual edaphic conditions. Throughout Montana soils derived from shales are generally heavy in texture and of a near-neutral or alkaline pH. Although acid shales are found in other parts of the state, they usually support grassland or shrubland vegetation (Veseth and Montagne 1980). Soils derived from acid shale in the War Horse Lake area behave like clays when wetted and compacted, but they have a pH of 3-4 (Clarence Clark, BLM soil scientist; personal communication). Soils associated with forests of the Pinus ponderosa/Agropyron spicatum habitat type have a mean pH of 7.1 (Pfister et al. 1977). The high concentration of hydrogen ions in acid shales is probably caused by the weathering of sulphur compounds to form sulfuric acid (Veseth and Montagne 1980). The result is a soil which appears to be very friable and, in many ways, possesses the properties of a sandy soil. Many of the species common in the acid shale forests, such as sun sedge prairie sandreed, are more typical of sandy soils.

The largest, best developed and most diverse example of acid shale pines on public land occurs just south of War Horse Lake and approximately eight miles northwest of Winnett at an elevation of 3,200-3,300 feet (Figure 1; T16N R25E Sec 27,28,29,30,31,32,33 and T16N R24E Sec 25,36). Part of this area has recently been transferred from management by BLM to the War Horse National Wildlife Refuge managed by the U.S. Fish and Wildlife Service. Although plant species diversity in this area is not high (Table 2), forests occur on all aspects, and pine canopy coverage varies from 15-60%. Soils on this site are fragile and easily eroded (Clarence Clark, personal communication). Overgrazing by livestock would probably result in increased rates of erosion, degradation of existing plant communities, and introduction of exotic species. Fortunately, at this time, the parts of this area that I visited appeared to be grazed only lightly. Additional potential threats to the area are non-commercial timber harvesting and off-road vehicle use. Another large area of acid shale pine forests occurs on land administered by the Bureau of Land Management in the Briggs Coulee area (T16N R24E Sec30,31,32,33). Forests in this area appear to be less diverse, and soil development appears to be greater. Evidence of disturbance due to livestock grazing and recreational use is more apparrent.

In summary, ponderosa pine forests occur on outcrops of acid shale in Petroleum and Fergus counties. These forests appear to constitute a unique plant community in Montana. Soils are

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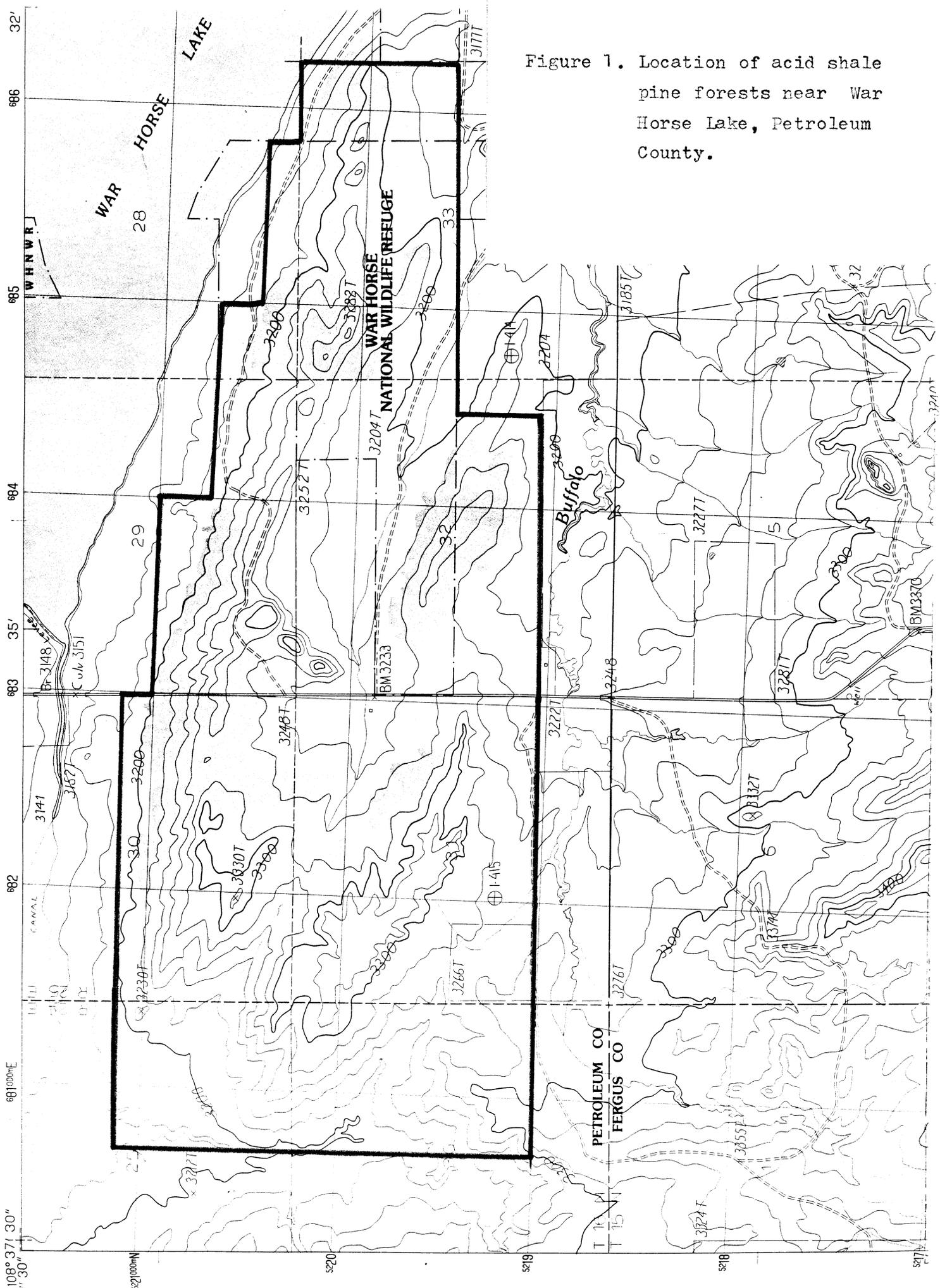


Figure 1. Location of acid shale pine forests near War Horse Lake, Petroleum County.

Table 2. Vascular plant species observed in pine forests near  
War Horse Lake, Petroleum County, 19 June 1987.

Nomenclature follows Hitchcock and Cronquist (1973).

<i>Pinus ponderosa</i>	<i>Machaeranthera grindelioides</i>
<i>Juniperus horizontalis</i>	<i>Koelaria cristata</i>
<i>Carex pensylvanica</i>	<i>Gayophytum</i> sp.
<i>Calamagrostis montanensis</i>	<i>Antennaria microphylla</i>
<i>Calamovilfa longifolia</i>	<i>Erigeron compositus</i>
<i>Rosa woodsii</i>	<i>Lygodesmia juncea</i>
<i>Thermopsis rhombifolia</i>	<i>Danthonia unispicata</i>
<i>Artemisia longifolia</i>	<i>Erigeron caespitosus</i>
<i>Eriogonum pauciflorum</i>	<i>Phacelia linearis</i>
<i>Penstemon nitidus</i>	<i>Collomia linearis</i>
<i>Gutierrezia sarothrae</i>	<i>Vicia americana</i>
<i>Opuntia<sup>a</sup> fragilis</i>	<i>Juncus tenuis</i>
<i>Arenaria hookeri</i>	<i>Collinsia parviflora</i>
<i>Solidago missouriensis</i>	<i>Cerastium arvense</i>
<i>Agropyron dasystachum</i>	
<i>Artemisia tridentata</i>	
<i>Agropyron spicatum</i>	
<i>Opuntia polyacantha</i>	
<i>Agrostis scabra</i>	
<i>Achillea millefolium</i>	
<i>Poa sandbergii</i>	

fragile, and acid shale forests may be threatened by livestock grazing, off-road vehicle use, and timber harvesting. Public lands administered by the Bureau of Land Management and the U. S. Fish and Wildlife Service south of War Horse Lake in Petroleum County contain a large and excellent example of acid shale forest. Proper management of this area will ensure the continued existence of this unusual endemic plant community.