Forested Vegetation - Ecological Context

CLIMATE

The following climate synopsis was derived from previous climate summaries published in the following sources: 1) Hoffman and Alexander (1976), 2) Despain (1973), 3) Girard *et al.* (1997) and 4) Nesser (1986). The web was also used to extract current on-line data from selected weather stations within or near Section M331b. Climate influences on the Bighorn Mountains were emphasized in this summary.

The Bighorn Mountains are strongly influenced by the Absaroka Range of the Rocky Mountains, which lie 75 miles (121 km) to the west. Between the Absaroka Range and the west-flank of the Bighorn Mountains lies the Bighorn Basin – a temperate desert receiving about 7 inches (18 cm) of annual precipitation. Any westerly winds are downslope and, therefore, very dry. The Pryor Mountains to the northwest and the Owl Creek Mountains to the southwest keep moisture-laden winds from reaching the west flank of the Bighorn Mountains (Figure A-1). Consequently, the western side of the Bighorn Mountains generally receives less precipitation than the eastern side.

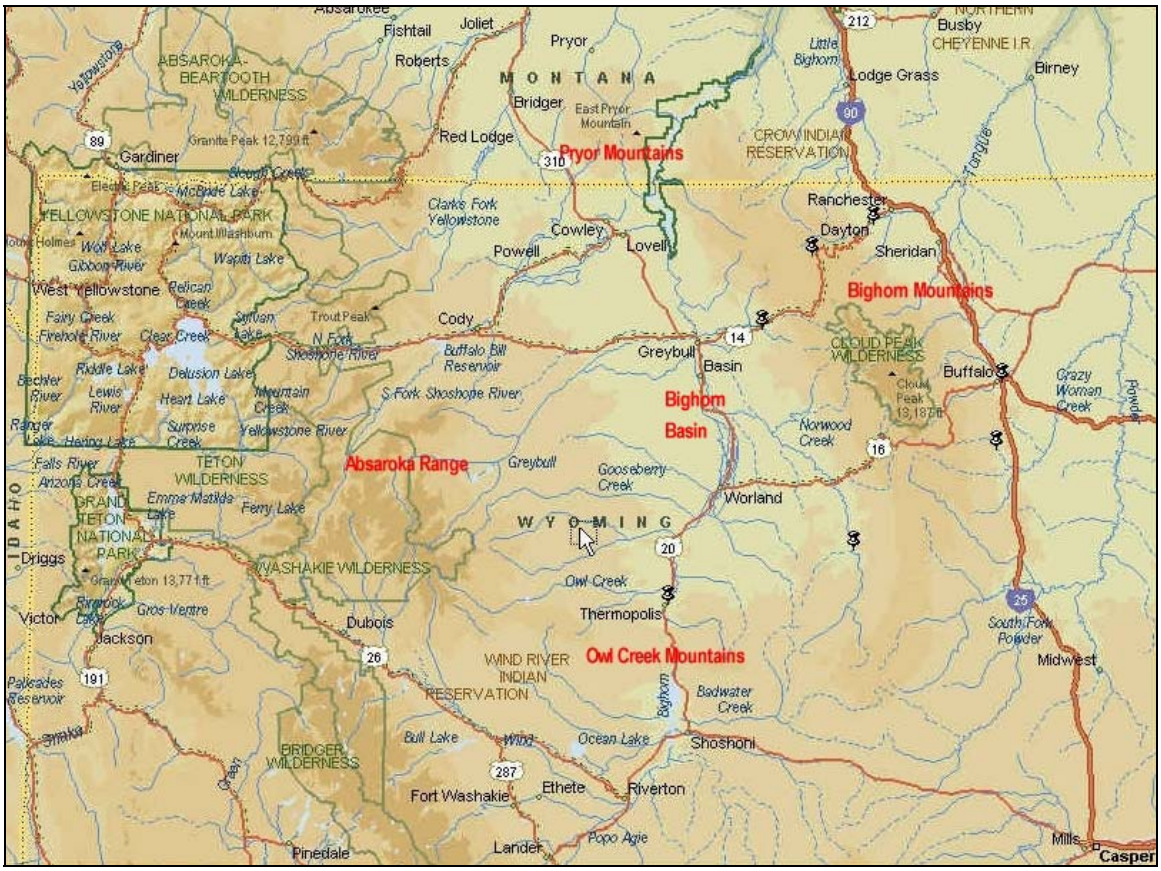


Figure A-1. Terrain view of the Bighorn Mountains vicinity.

Rainfall on the west slope comes primarily from regional weather patterns that produce airflow from the north or northwest. This allows moisture-laden air to enter the Bighorn Basin through the gap between the Pryor Mountains and the Beartooth portion of the Absaroka

Range. The air then releases its moisture as it rises over the Bighorn Mountains. As one would expect, annual precipitation generally increases in the Bighorn Mountains with increasing elevation. Figure A-2 shows generalized maps of mean annual precipitation and air temperature for Section M331B and the surrounding vicinity.

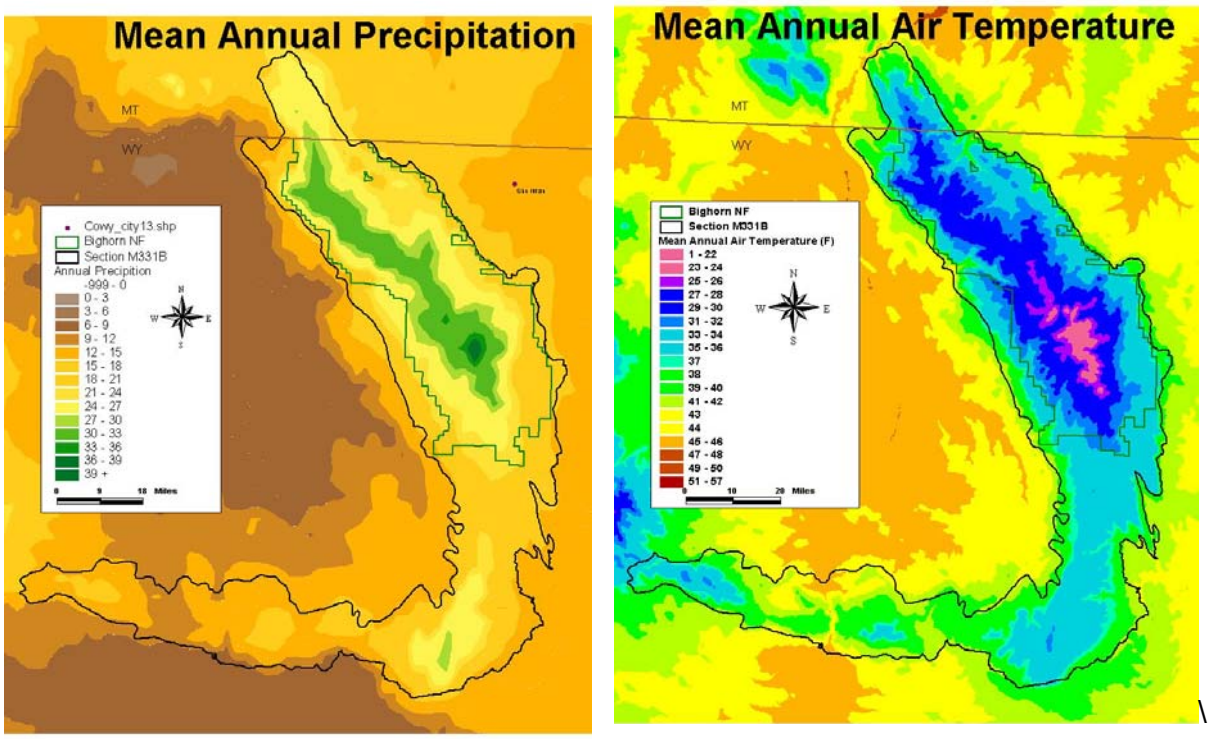


Figure A-2. Mean annual precipitation and air temperature for Section M331B and the surrounding vicinity (*source*: http://www.ocs.orst.edu/prism/prism_new.html).

The east slope of the Bighorn Mountains receives moisture from easterly winds coming from the prairies. The Powder River lies to the east of the Bighorn Mountains and receives approximately 11 to 15 inches (28 to 38 cm) of annual precipitation. The major storm tracks are to the north and produce winds mostly from the northeast, yielding higher precipitation on the northeast section of the Bighorn Mountains and intensifying the rain shadow effect southeast of Cloud Peak. The source of precipitation is from the prairies to the north and east, although the source of storm cells is originally from the Pacific Ocean.

In the winter, cold air masses from Canada bring strong northerly and northwesterly winds, low temperatures, and snow. Warm winds from the west and southwest often follow the passage of these fronts and moderate the weather. Upslope conditions that cause precipitation occur frequently in winter and spring on the eastern side of the Bighorn Mountains. In summer, local thunderstorms that move in a northeasterly direction occur in the mountains. Tornados have occurred in scattered locations according to Nesser (1986).

In the Bighorn Mountains, mean annual precipitation varies from about 15 inches (38 cm) in the ponderosa pine (*Pinus ponderosa*) forest zone to about 25 inches (64 cm) in the Engelmann spruce (*Picea engelmannii*) subalpine fir (*Abies lasiocarpa*) forest zone. The higher peaks receive as much as 40 inches (102 cm) of precipitation (Hoffman and Alexander 1976). At the higher elevations, precipitation is more equally distributed throughout the year,

but a higher proportion falls as snow. At lower elevations, most precipitation falls as rain during the months of April through September.

There are several weather stations within or surrounding the Bighorn Mountains. Stations at Shell, Burgess Junction, and Dayton bisect the northern end of the Bighorn Mountains. The Burgess Junction station is the only one actually on the Bighorn National Forest. Stations at Thermopolis, Ten Sleep, Billy Creek, and Buffalo form a southern line across the Section (Figure A-3).

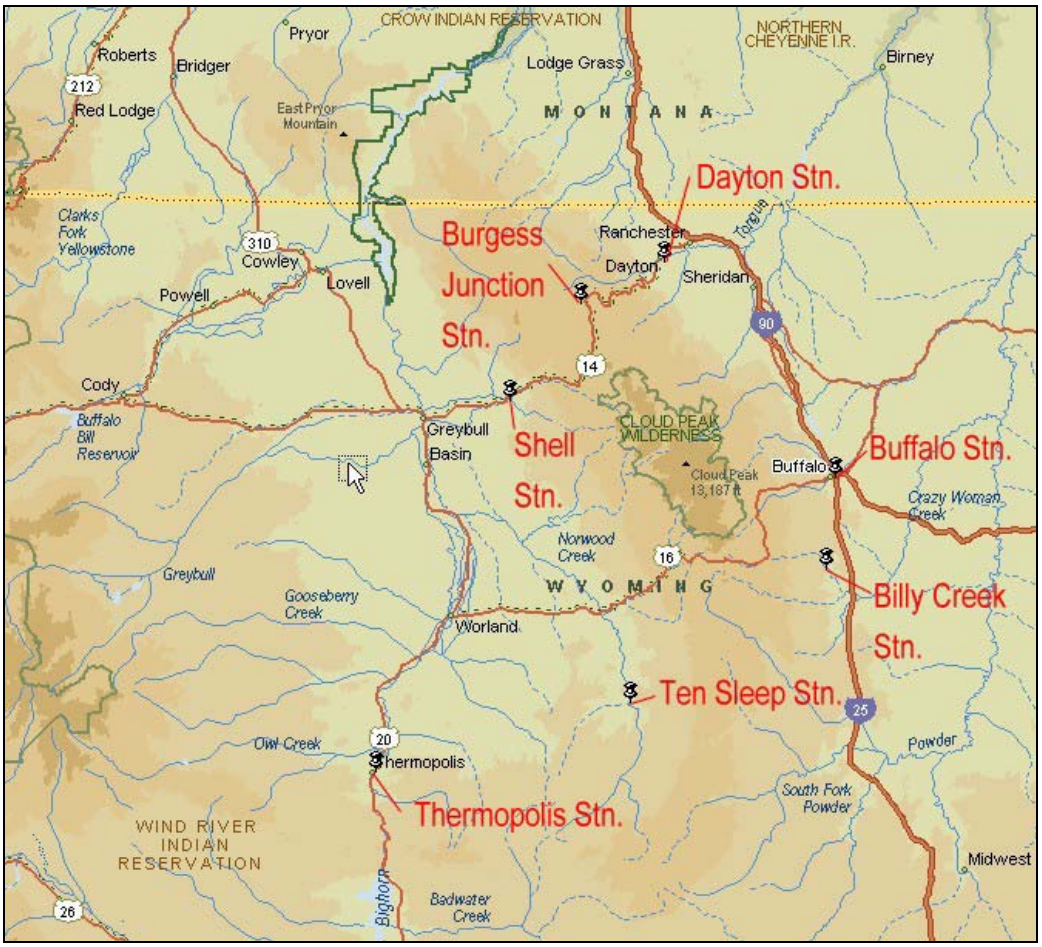
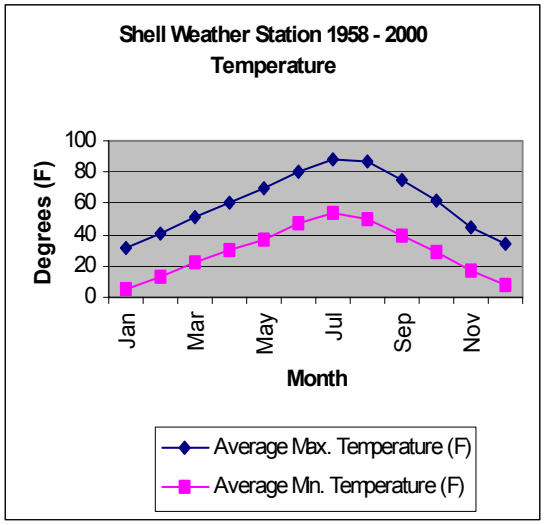
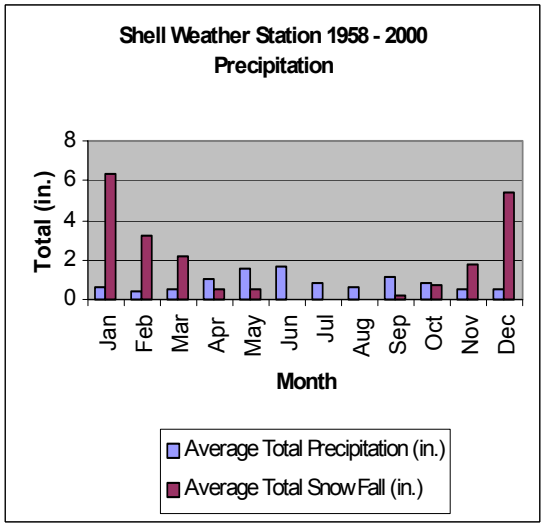
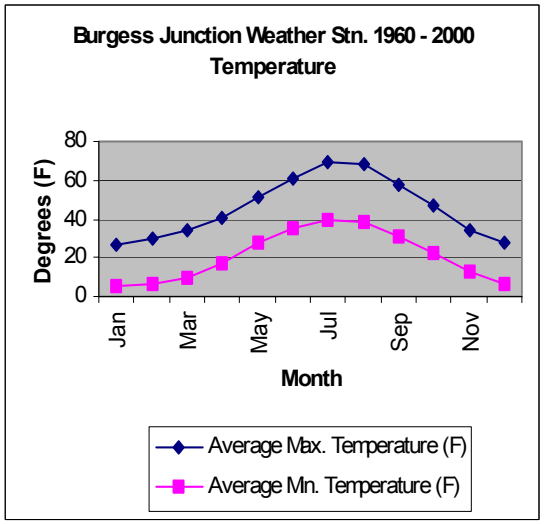


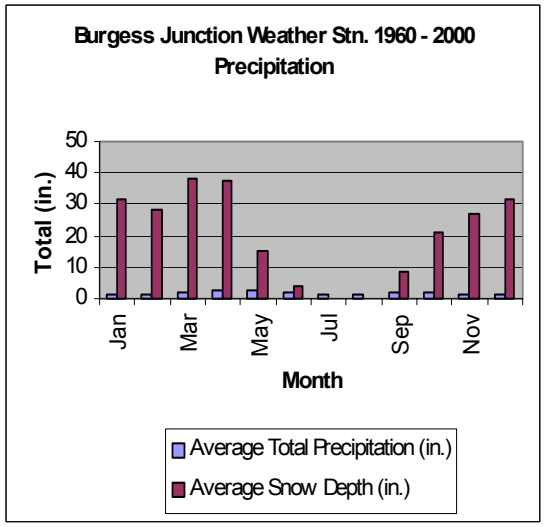
Figure A-3. Selected Wyoming weather stations within or near Section M331B.

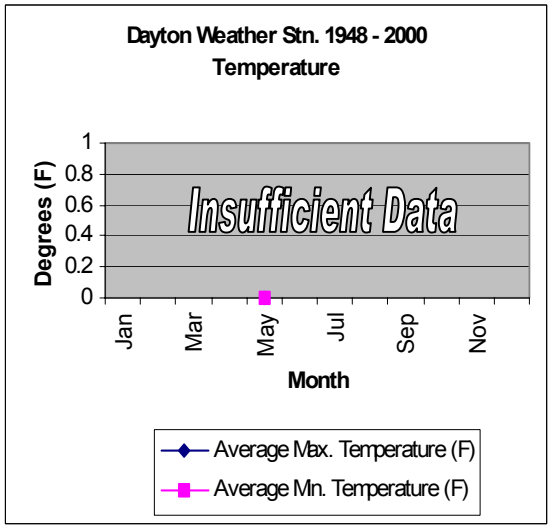
Wyoming weather station data are available on-line from the web at: http://www.wrcc.dri.edu/summary/climsmwy.html and they were used to provide the monthly average precipitation and temperature summaries shown in Figure A-4.











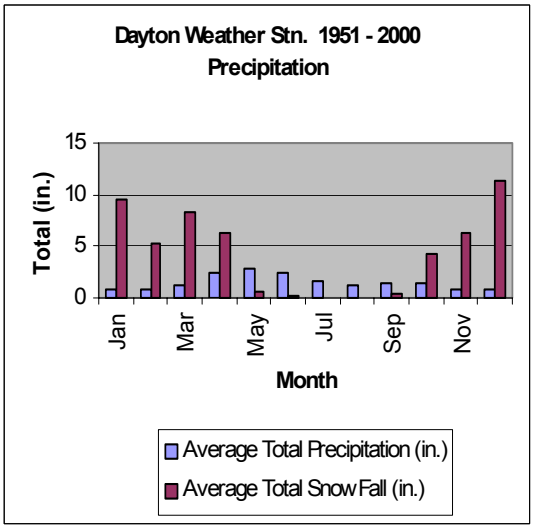
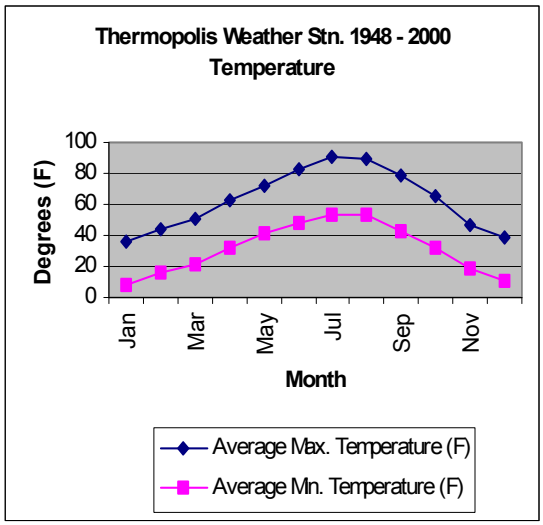
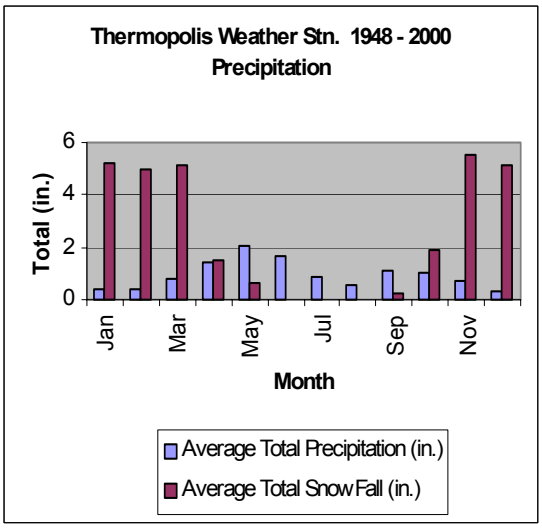
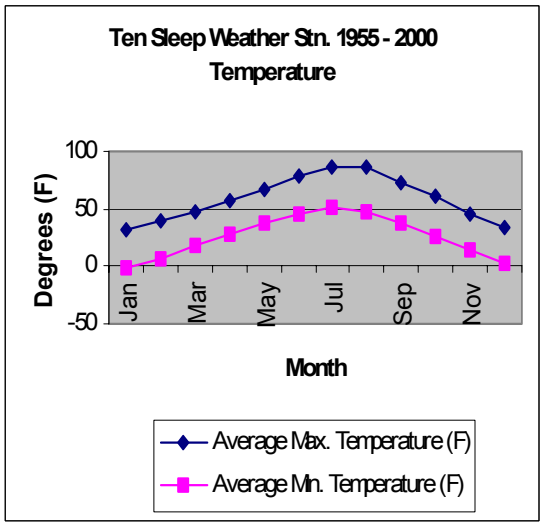
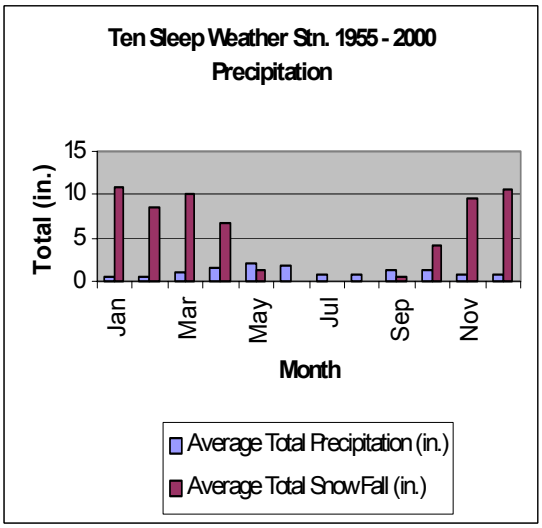


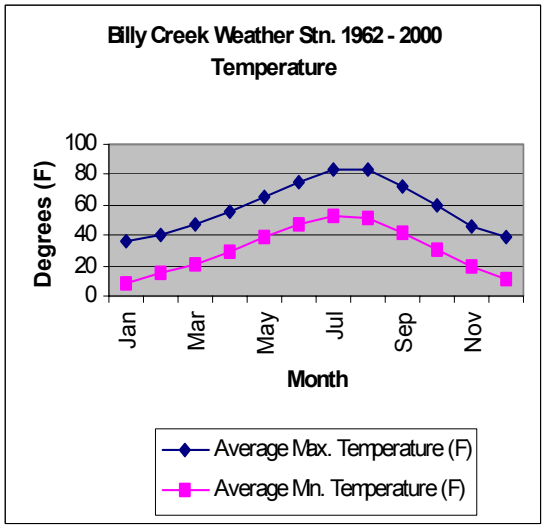
Figure A-4. Mean monthly temperature and precipitation summaries from selected Wyoming weather stations within or near Section M331B (*source*: http://www.wrcc.dri.edu/summary/climsmwy.html).

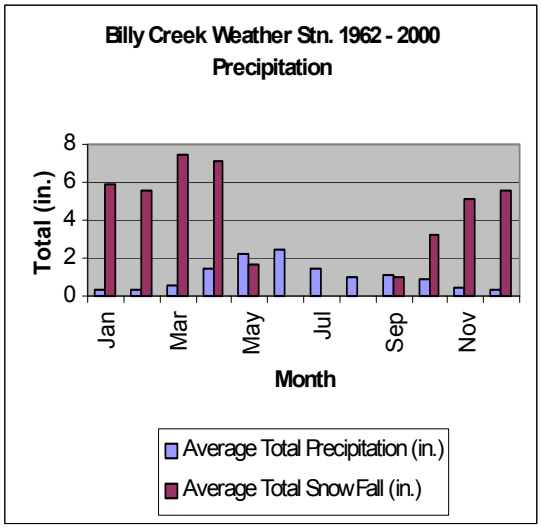












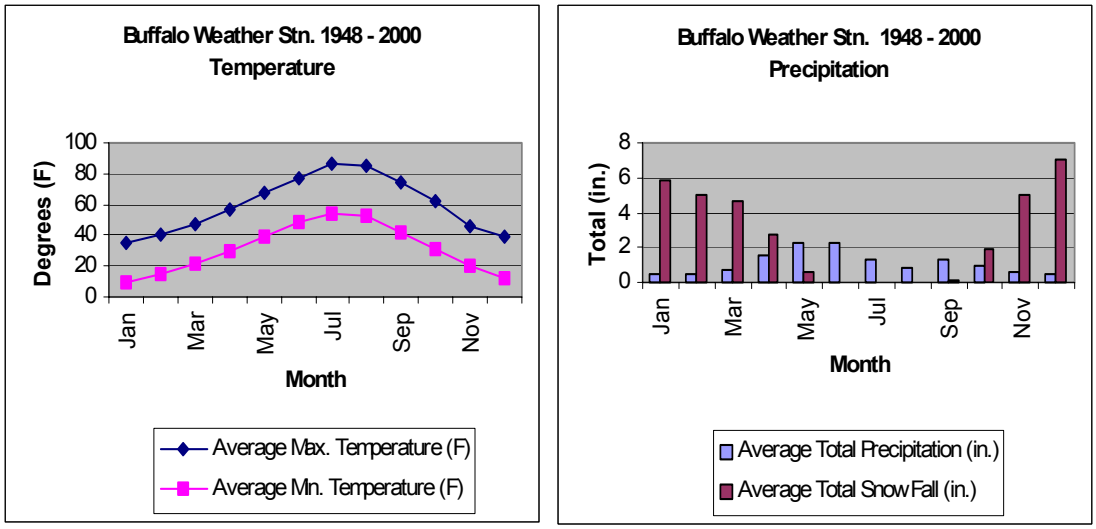


Figure A-4 (continued). Mean monthly temperature and precipitation summaries from selected Wyoming weather stations within or near Section M331B (*source*: http://www.wrcc.dri.edu/summary/climsmwy.html**).**

The mean maximum temperature at Burgess Junction is 69.5º F (21º C) in July and 5º F (-15º C) in January (Figure A-4). Nesser (1986) mentioned extremes of –42º F (-41º C) and 99º F (37º C) recorded at the Hunter Ranger Station -- 12 miles (19 km) west of Buffalo, Wyoming at 7,300 feet (2,225 meters).

The weather station data shown in Figure A-4 appear to reveal two peaks of precipitation; one in the spring, and then a smaller peak in the fall. Mean total monthly snowfall appears to show a pattern depending on whether one is west or east of the Bighorn Mountains as follows: the Dayton and Buffalo stations have the highest average total monthly snowfall in December; the Burgess Junction and Billy Creek stations peak in April; and the Shell and Ten Sleep stations peak in January. The distribution of precipitation appears to become more uniform at higher elevations (see Burgess Junction station in Figure A-4).

An annual climate summary was constructed from the monthly weather data, including mean annual temperature, mean annual precipitation, and mean annual snowfall (Figures A-5 and A-6). The Thermopolis and Burgess Junction stations, on average, are the warmest and coldest locations, respectively (Figure A-5).

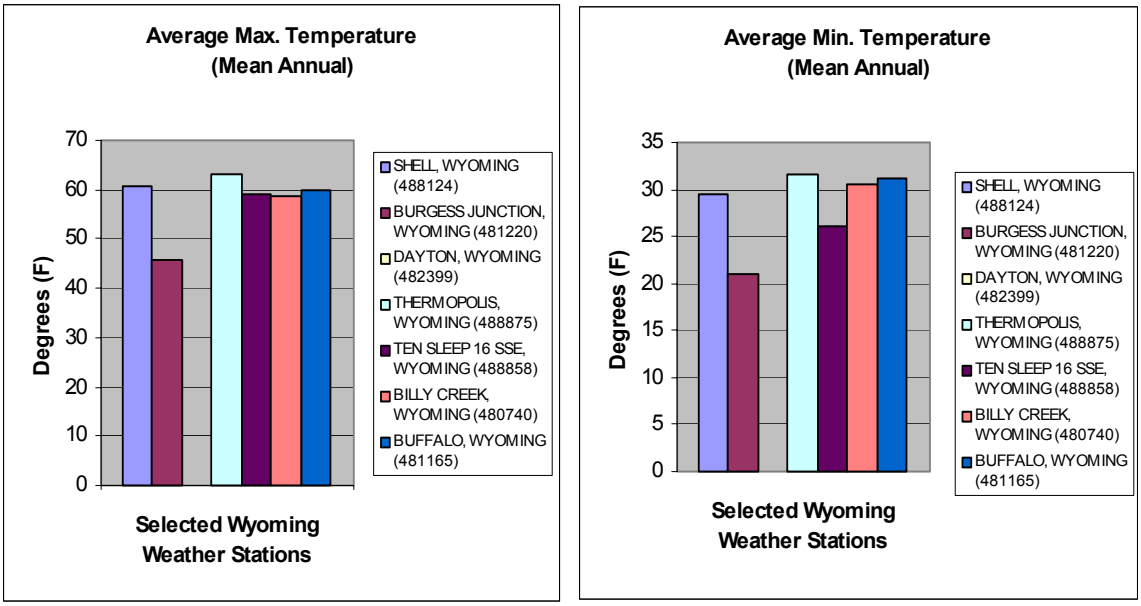
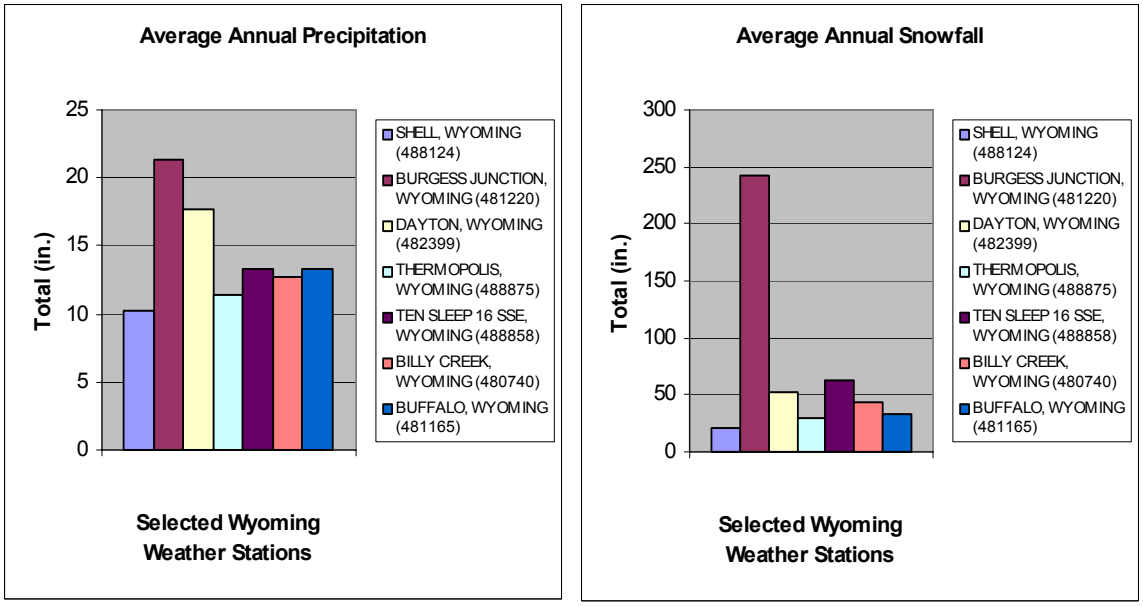


Figure A-5. Average annual maximum and minimum temperatures at selected Wyoming weather stations (*source*: http://www.wrcc.dri.edu/summary/climsmwy.html).

The Shell and Burgess Junction stations, on average, are the driest and wettest locations, respectively. Mean annual precipitation ranges from 10.2 inches (26 cm) at the Shell Station to 21.3 inches (54 cm) at the Burgess Junction station. Mean annual snowfall is the highest at the Burgess Junction station (Figure A-6). Nesser (1986) reported that there are perennial snowfields on the flanks of Cloud Peak, Blacktooth Peak, and other peaks in the central part of the Bighorn Mountains.

Figure A-6. Average annual precipitation and snowfall at selected Wyoming weather stations (*source*: http://www.wrcc.dri.edu/summary/climsmwy.html).



The Western Regional Climate Center provides summarized wind data for the weather stations shown in Figure A-7.

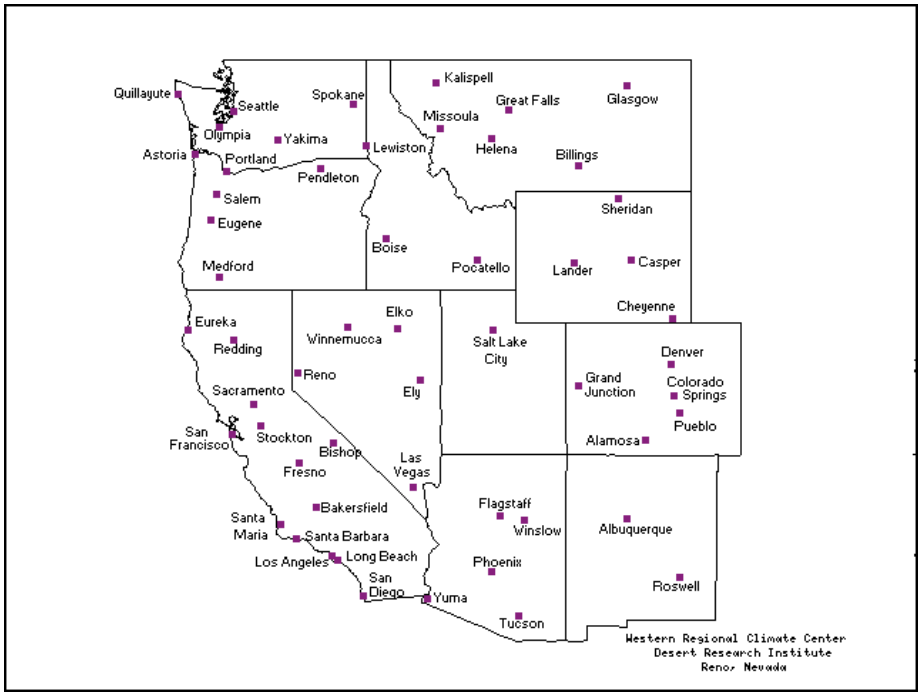


Figure A-7. Western Regional Climate stations with summarized wind data (*source:* http://www.wrcc.dri.edu/summary/lcd.html).

The weather stations closest to Section M331B with summarized wind data are Billings, MT; Sheridan, WY; Casper, WY; and Lander, WY. Mean wind speed, by month, is presented for these weather stations in Figure A-8. These data span at least 45 years of continuous, monthly record collection.

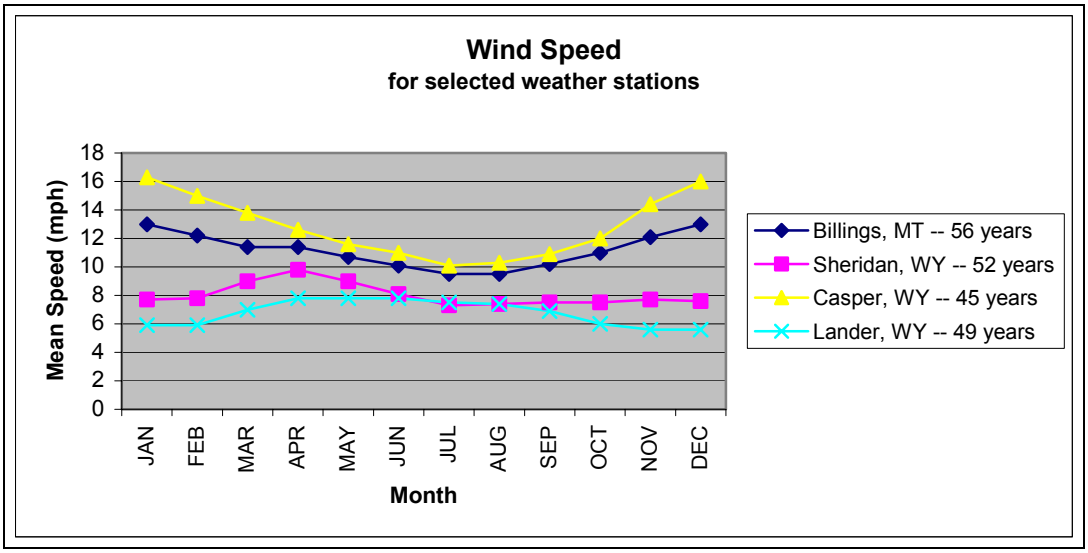


Figure A-8. Mean wind speed for selected weather stations (*source:* http://www.wrcc.dri.edu/summary/lcd.html).

Table A-1 shows the yearly mean wind speed and the prevailing direction for the same four weather stations as presented in Figure A-8. An interesting side note is that each of these stations has a recorded historical peak wind gust approaching or exceeding 70 mph (31 m/s).

Table A-1. Wind Speed and Direction for four selected weather stations.

Weather Station	Yearly Mean Wind Speed (mph)	Prevailing Direction
Billings, MT	11.2	SW
Sheridan, WY	8	NW
Casper, WY	12.8	SW
Lander, WY	6.8	SW
(*Data source:* http://www.wrcc.dri.edu/summary/lcd.html)		

Meyer and Knight (2001) briefly summarized historic climatic change in Wyoming and Colorado and it is presented in Table A-2.

Table A-2. Chronology of major climatic, geologic, and vegetation history in Wyoming and Colorado (adapted from Meyer and Knight 2001).

Time	Climate/Geology	Vegetation
2 mybp – 10,000 ybp (Pleistocene epoch)	Six glacial advances and retreats; flooding, creation of outwash plains, loess, and soil development	Coniferous forests, shrublands, and grasslands (many broad-leaved trees now regionally extinct)
127,000 ybp	Interglacial period	Douglas-fir and limber pine common in Yellowstone
15,000 ybp	Glacial advance; temperatures 18-23º F (10-13º C) colder than today; permafrost	Trees in Yellowstone confined to a narrow elevational band; lowlands tundra-like
11,500 ybp	Temperatures 9-11º F (5-6º C) cooler than today; retreat of glacial ice	Upper treeline about 1,970 ft (600 m) lower than today in Yellowstone; gradually colonized by Engelmann spruce, and later by subalpine fir and whitebark pine in some areas (11,000 – 9,500 ybp)
9,500 ybp	Continued warming	Establishment of lodgepole pine at higher elevations and Douglas-fir in foothills in Yellowstone
9,000 – 7,000 ybp		Upper treeline at its lowest in Colorado Front Range
7,000 – 4,000 ybp	Antithermal period, comparatively warm and dry conditions	Expansion of sagebrush, greasewood, juniper, and grasses; spruce and fir retreated to higher elevations; elevational range of spruce and fir reduced
4,000 ybp – present	Neoglacial period of gradual cooling	Expansion of forests to previous elevational ranges
ca. 1350 – 1500 AD and 1700 – 1900 AD	Characterized by cooler temperatures (during "Little Ice Age")	Potential glacial advances in the mountains
1850 AD – present	Generally warmer and wetter than "Little Ice Age;" 20th century warmer than previous 1,000 years	Increased tree recruitment near upper treeline (Hessl and Baker 1997), in subalpine meadows (Jakubos nd Romme 1993) and in montane forests (Savage *et al.* 1996)
mybp = million years before present ybp = years before present		

Historically, there have been important climatic fluctuations over very long time spans. At about the end of the Pleistocene (approximately 10,000 years before present), there was a significant warming trend that, in turn, influenced the spatial and elevational distribution of vegetation. Since that time, the Rocky Mountains have experienced several cooling and warming trends. Presently, this area is experiencing a period of overall warmer climate relative to the last 1,000 years (Meyer and Knight 2001).

HIERARCHY OF ECOLOGICAL UNITS

Central to biodiversity and ecosystem management is the study of landscape spatial and temporal patterns. The hierarchical structure of ecological systems allows characterization of ecosystems and the identification of patterns and processes of interest at different scales. Ecosystem composition, structure, and function determine diversity patterns across a range of spatio-temporal scales. The ecological hierarchy level of interest is determined by the assessment question. To determine sustainability of an ecosystem, patterns of natural or historically sustained variability must be defined at all relevant scales (Bourgeron and Jensen 1993).

Complex landscape patterns, along with the many processes that form them, exist within a hierarchical framework. This framework consists of multi-scaled systems that can be viewed as constraints in which a higher level of organization provides, to some extent, the environment that the lower levels evolve from. Every level is a discrete functional entity and is also part of the larger whole. Using the hierarchy concept allows us to define the components of an ecosystem or set of ecosystems, and the linkages between different scales of ecological organization.

The spatial context is described below, using the National Hierarchical Framework of Ecological Units (ECOMAP 1993) as a uniform method of describing and delineating similar ecological potentials. Since biodiversity does not follow political boundaries, it is essential to evaluate the Forest's biodiversity at a variety of spatial ecological scales.

The levels of hierarchical scale used to define the management situation for the Bighorn National Forest are identified below. The scales of ecosystems are described in terms of vegetation patterns, biotic processes, environmental constraints, and disturbances. Table C-1 presents the National Hierarchy of Ecological Units (ECOMAP 1993).

Table C-1. National Hierarchy of Ecological Units (ECOMAP 1993).			
Planning and Analysis Scale	Ecological Units	Purpose, Objectives, and General Use	General Size Range
Ecoregions Global Continental Regional	Domain Division Province	Broad applicability for modeling and sampling RPA assessment. International planning	1,000,000's to 10,000's of square miles
Subregions	Sections Subsections	RPA planning multi-forest, Statewide, and multi-agency analysis and assessment	1,000's to 10's of square miles
Landscape	Landtype Association	Forest or area-wide planning, and watershed analysis	1,000's to 100's of acres
Land Unit	Landtype Landtype Phase	Project and management area planning and analysis	100's to less than 10 acres

Table C-2 summarizes the criteria used to differentiate each ecological unit in the national hierarchy (ECOMAP 1993).

Table C-2. Principal Map Unit Design Criteria of Ecological Units (ECOMAP 1993).

Ecological Unit	Principal Map Unit Design Criteria [1]
Domain	Broad climatic zones or groups (e.g., dry, humid, tropical).
Division	Regional climatic types (Koppen 1931, Trewartha 1968) Vegetational affinities (e.g., prairie or forest). Soil order.
Province	Dominant potential natural vegetation (Kuchler 1964) Highland or mountains with complex vertical climate-vegetation-soil zonation.
Section	Geomorphic province, geologic age, stratigraphy, lithology. Regional climatic data. Phases of soil orders, suborders, or great groups. Potential natural vegetation. Potential natural communities (PNC) [2].
Subsection	Geomorphic process, surficial geology, lithology. Phases of soil orders, suborders, or great groups. Subregional climatic data. PNC-formation or series.
Landtype Association	Geomorphic process, geologic formation, surficial geology, and elevation. Phases of soil subgroups, families, or series. Local climate. PNC-series, subseries, plant associations.
Landtype	Landform and topography (elevation, aspect, slope gradient, and position). Rock type, geomorphic process. Phases of soil subgroups, families, or series. PNC-plant associations.
Landtype Phase	Phases of soil families or series. Landform and slope position. PNC-plant associations or phases.

Figures C-1 through C-3 show Ecological Domains, Divisions, and Provinces, respectively for the United States. These Ecological Units define a very broad ecological spatial context for the Bighorn National Forest. Information pertaining to the Domain and Division spatial scales of the National Hierarchy of Ecological Units is described in very general terms. This document provides increasing detail in discussing Province, Section, Subsection, Land Type Association, and Land Types relative to the Bighorn National Forest.

[1] The criteria listed are broad categories of environmental and landscape components. The actual classes of components chosen for designing map units depend on the objectives for the map.

[2] Potential Natural Community Vegetation that would develop if all successional sequences were completed under present site conditions.

DOMAINS

Domains are sub continental areas of broad climate similarity. The Bighorn National Forest is within the Dry Domain (Figure C-1). This Domain is characterized by a relatively dry climate in which annual losses of water through evaporation at the earth's surface exceed annual water gains from precipitation (Bailey 1995).

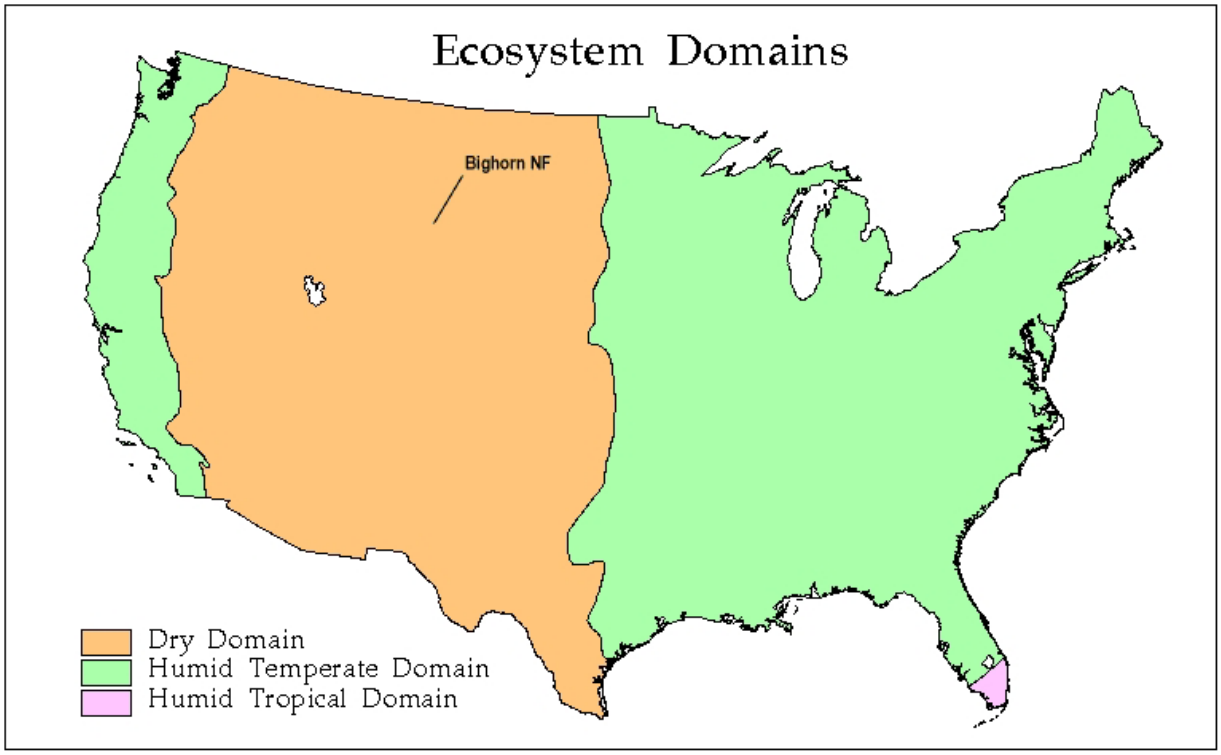


Figure C-1. The Bighorn NF relative to the Dry Domain (*map source:* http://www.fs.fed.us/colorimagemap/ecoreg1_domains.html)

DIVISIONS

Domains are further partitioned into Divisions. Divisions are determined by isolating areas of differing vegetation, broad soil categories, and regional climates. The Bighorn National Forest resides within the Mountain Segment (M330) of the Temperate Steppe Division (Figure C-2). This Division is characterized by a semi-arid continental climatic regime with the mountains displaying altitudinal zonation (Bailey 1995).

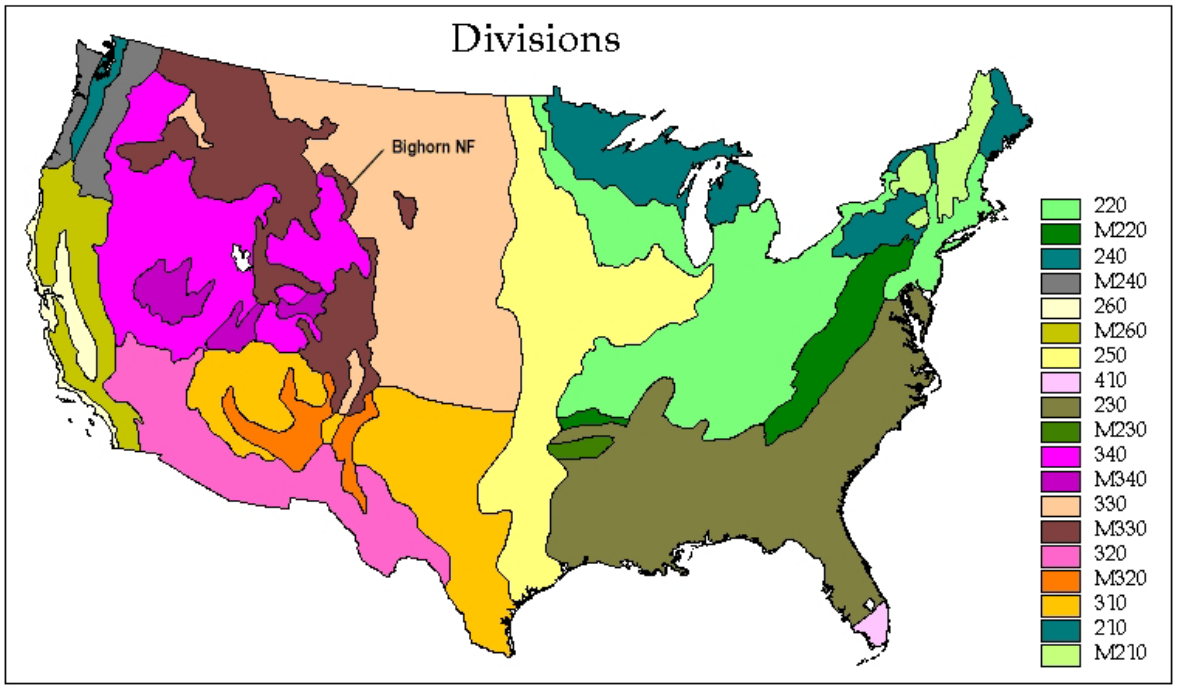


Figure C-2. The Bighorn NF relative to the M330 Division (*map source:* http://www.fs.fed.us/colorimagemap/ecoreg1_divisions.html)

PROVINCES

Divisions are further subdivided into Provinces. Provinces are determined by broad vegetation regions that are primarily controlled by length and timing of dry seasons and the duration of cold temperatures. Provinces are also characterized by similar soil orders and by similar potential natural communities as mapped by Kuchler (1964). The Bighorn National Forest is within the Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province (M331). The Forest is surrounded by the Great Plains - Palouse Dry Steppe Province (331) to the east and the Intermountain Semi-Desert Province (342) to the west. Figure C-3 shows the spatial relationship of the Bighorn National Forest and the Provinces mentioned above. Detailed descriptions of these Provinces are found in (Bailey 1995).

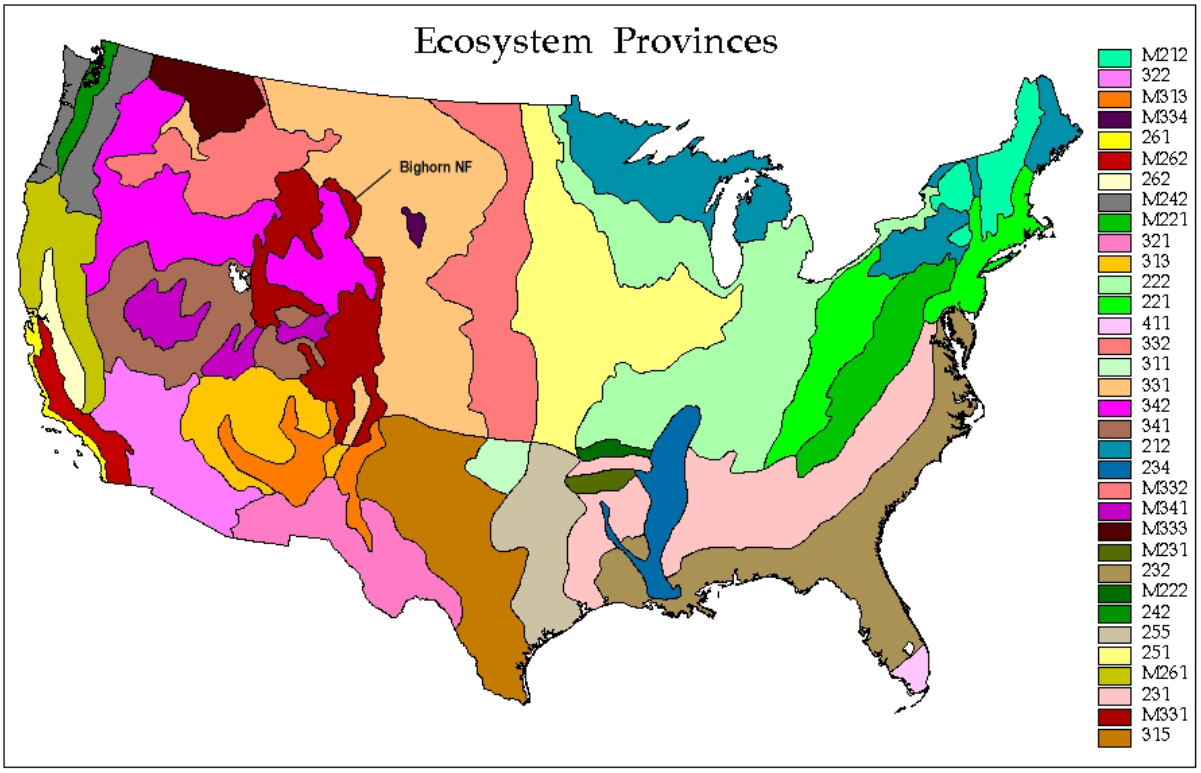


Figure C-3. The Bighorn NF relative to the M331 Province and surrounding Provinces (*map source:* http://www.fs.fed.us/colorimagemap/ecoreg1_provinces.html)

SECTIONS

Provinces are further subdivided into Sections. Sections are broad areas of similar geologic origin, geomorphic process, stratigraphy, drainage networks, topography, and regional climate. Sections are typically inferred by relating geologic maps to potential natural vegetation "series" groupings as mapped by Kuchler (1964). The Bighorn National Forest resides within one Section, the Bighorn Mountains (M331B) (McNab and Avers 1994). Figure C-4 shows the spatial relationship of the Bighorn National Forest and Section M331B. The detailed description of this Section can be found in Appendix 1.

SUBSECTIONS

Sections are further subdivided into Subsections. They are based upon geology, geomorphic process, soils, regional climatic data, and vegetation. The Bighorn Section is divided into three subsections as follows: 1) Bighorn Mountains, Sedimentary Subsection (M331Ba), 2) Bighorn Mountains, Granitic/gneiss Subsection (M331Bb), and 3) Owl Creek Mountains Subsection (M331Bc). Figure C-4 shows the spatial relationship between the Bighorn National Forest and these Subsections. The detailed description of these Subsections can be found in Appendix 2.

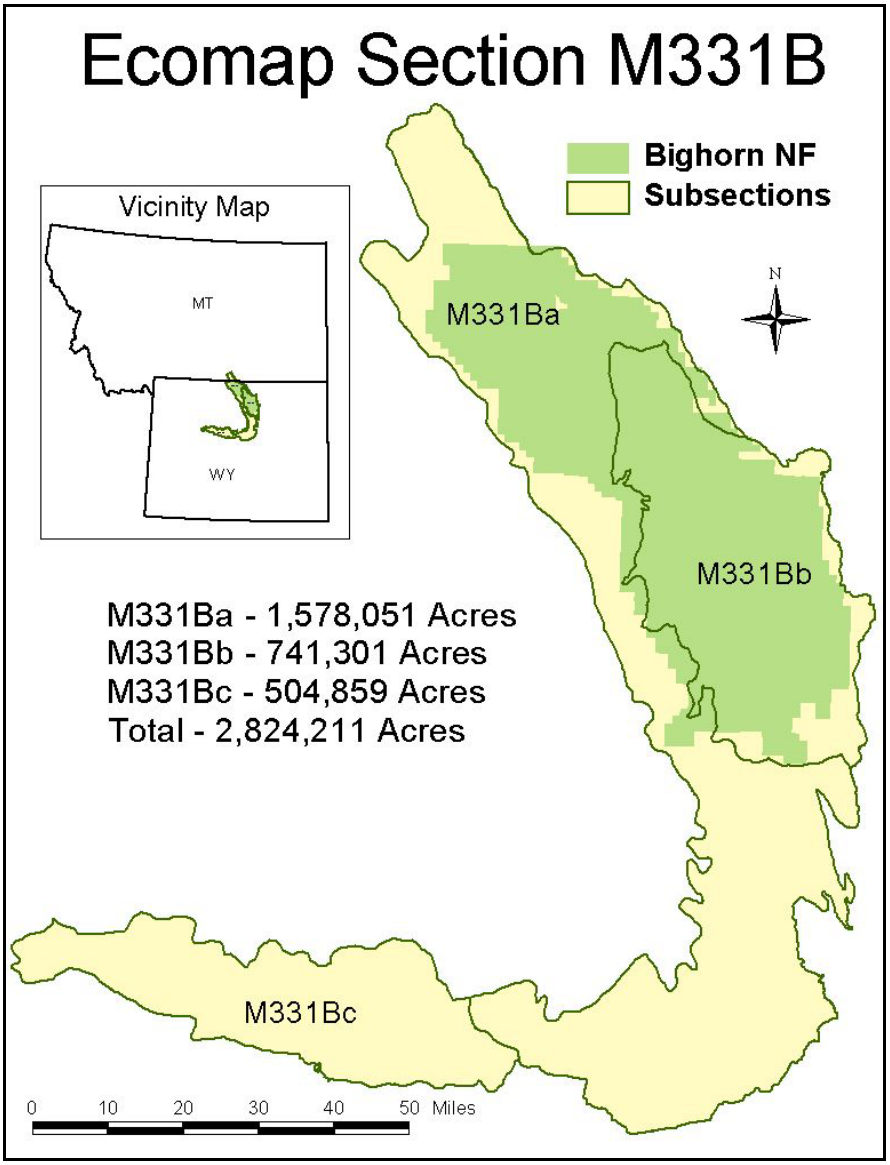


Figure C-4. The Bighorn NF relative to the Bighorn Mountains Section (M331B) and its three associated Subsections.

LANDTYPE ASSOCIATIONS

Each Subsection is further divided into Landtype Associations (LTAs) based on similarities in geology, soils, and plant associations. Repeatable patterns of soil complexes and plant communities are useful in delineating map units at this level. The LTAs within each Subsection are listed below:

Bighorn Mountains, Sedimentary Subsection (M331Ba)
M331Ba-01 Sedimentary Breaklands
M331Ba-02 Landslide/colluvial deposits
M331Ba-03 Sedimentary Mountain Slopes, Limestone/dolomite
M331Ba-04 Sedimentary Mountain Slopes, Shale/sandstone (calcareous)
M331Ba-05 Sedimentary Mountain Slopes, Shale/sandstone (non-calcareous)

Bighorn Mountains, Granitic/Gneiss Subsection (M331Bb)
M331Bb-02 Glacial Cirquelands
M331Bb-03 Glacial/Tertiary Terrace Deposits
M331Bb-04 Granitic Mountain Slopes, Steep
M331Bb-05 Granitic Mountain Slopes, Gentle
M331Bb-06 Alpine Mountain Slopes and Ridges

Owl Creek Mountain Subsection (M331Bc).
Landtype Association descriptions are unavailable -- see Reiners *et al.* 1999.

Detailed descriptions of each Landtype Association are provided in Appendix 3. Figure C-5 shows the spatial relationship between the Bighorn National Forest and these LTAs. The largest LTA is M331Bb-05 (Granitic Mountain Slopes, Gentle).

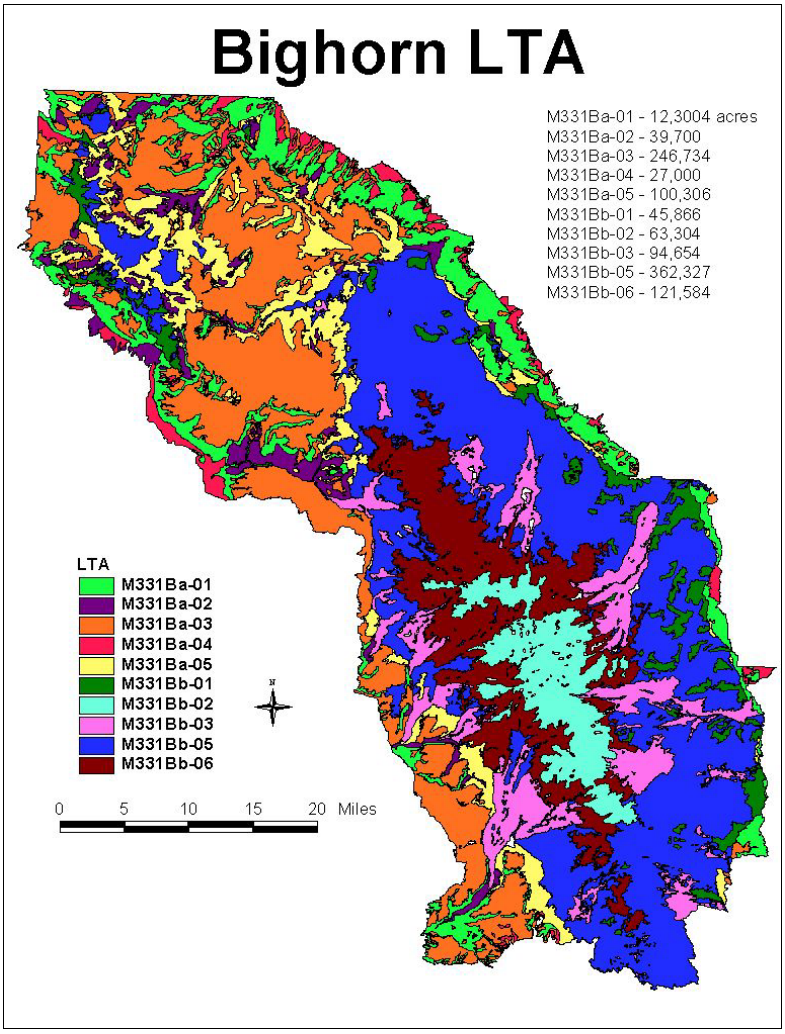


Figure C-5. Landtype Associations (LTAs) for the Bighorn NF.

LANDTYPES

Landtypes are unique combinations of soil and potential natural vegetation at a relatively fine mapping scale. Almost 70 Landtypes are found on the Bighorn National Forest and they were identified as part of the Common Land Unit mapping on the Forest. Appendix 4 contains a list of the Landtypes found on the Bighorn NF. Detailed descriptions, interpretations, and maps of Landtypes are available from the Supervisor's Office for the Bighorn NF, Sheridan, Wyoming. No spatial representation is provided here due to the large number of map units and the difficulty in clearly displaying them.

DEFINITION AND TYPES OF CLIMAX COMMUNITIES

Terminology in ecology is not uniformly used, but ecologists in the West have typically followed the terms and usage by Daubenmire (1968) and Daubenmire and Daubenmire (1968). The following discussion, unless stated otherwise, adheres to this convention.

Every part of the land surface, over geologic time, has been denuded of vegetation due to vulcanism, mass soil movement, fire, submergence, glaciation, etc. Plants generally appear

on all but the extremely dry or cold land surfaces at successive intervals over time. Typically, one assemblage of plants must await the special conditions created by an earlier assemblage of plants that have modified site conditions (i.e., changes in soil fertility, soil shading and moisture, etc. over time modify the microclimate). This sequence of plant communities changing over time is termed *succession*.

The dominant plants that are capable of occupying a site over time are termed the *climax* community, and it perpetuates itself unless disturbed by outside forces. The climax community can usually redevelop following destruction as long as the total biota and climate remain constant (Daubenmire 1968).

Daubenmire (1968), relying on the concepts of Tansley (1935), outlined five categories of climax according to the key forces essential in molding their character. Daubenmire also distinguished between *primary climaxes* and *disclimaxes*; the former including climatic, edaphic, and topographic climaxes, while the latter included fire and zootic climaxes. Daubenmire's *habitat type* concept was built upon the concept of primary climaxes, not on disclimaxes. Each of these climaxes is described below:

Primary Climaxes

Climatic climax: Any climax that characterizes normal topography and soils, and shows no dependency for its character upon the maintenance of recurrent disturbance, such as by animals or fire, is called the climatic climax. Normal topography means gentle, undulating landscape. Normal soils would be relatively deep and loamy having neither excess nor deficiency of solutes with respect to the average plant.

Edaphic climax: Soils deviate from the normal characters indicated in the climatic climax to the extent that the vegetation expressed is distinctly different and self-perpetuating. Examples are bogs, salt marshes along seacoasts, serpentine outcrops, and sand plains.

Topographic climax: North-facing slopes and south-facing slopes usually have microclimates that significantly contrast one another. The former receives much less radiant energy than normal topography; whereas the latter receives much more radiant energy. Where slopes are steep enough, their microclimates promote distinctive successional paths and climaxes. Wherever local topography, usually operating through microclimate, produces a distinctive vegetation, the climax of these places has been classed as a topographic climax.

Disclimaxes

Fire climax: Vegetation that maintains its composition and structure only as a consequence of periodic, frequent burning may be referred to as a fire climax. The recurrent burning of vegetation eliminates fire-sensitive species, whose places are then taken by fire-tolerant members of the flora. The repeated burning that is required to produce fire climaxes is always the consequence of human activity, according to Daubenmire (1968).

Zootic climax: Places where the composition and structure of a plant community are in large measure controlled by the constant and vigorous destructive activity of one kind of animal. Examples are the communities that arise in response to heavy, frequent livestock grazing, or by the nesting, trampling, and manuring influences of colonial birds.

GEOGRAPHIC SCALES OF POTENTIAL NATURAL VEGETATION (PNV) DESCRIPTION.

Küchler (1964) produced a map (along with an accompanying manual) of potential natural vegetation (PNV) for the United States. Küchler defined potential natural vegetation as, "…the vegetation that would exist today if man were removed from the scene and if the resulting plant succession were telescoped into a single moment. The latter point eliminates the effects of future climatic fluctuations while the effects of man's earlier activities are permitted to stand." Küchler's map provides a relatively coarse view of potential natural vegetation at a very broad level of spatial mapping for the country. The Küchler map units for the Bighorn Mountains Section (M331B) are shown in Figure D-1.

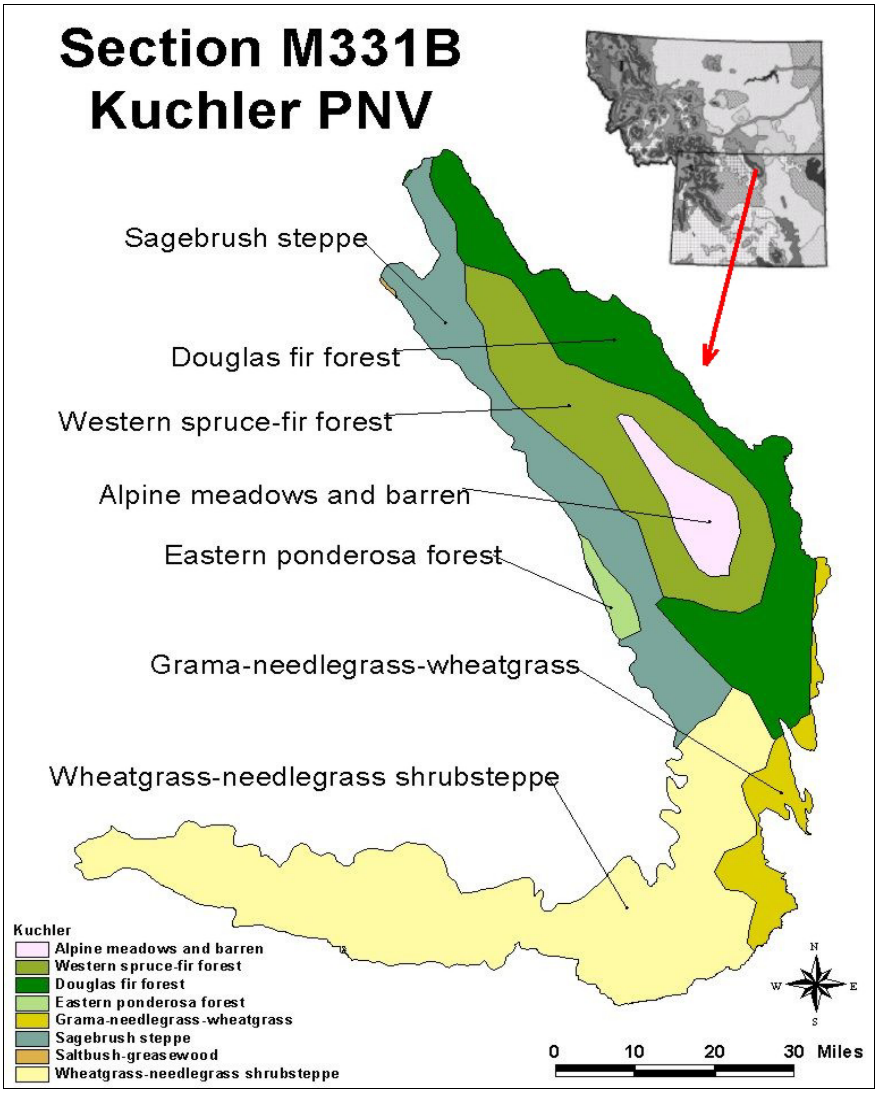


Figure D-1. Küchler's (1964) Potential Natural Vegetation for Section M331B.

Küchler's (1964) map unit descriptions for Section M331B are shown in Table D-1.

Table D-1. Küchler (1964) map unit descriptions for Section M331B.				
Map Unit Name	Physiognomy	Dominants	Other Components	Occurrence
Alpine Meadows and Barren (#52)	Usually short grasses and sedges, dense to very open with extensive barren areas; many forbs	Bentgrass (*Agrostis* spp.), Sedges (*Carex* spp.), Hairgrass (*Deschampsia caespitosa*), Fescue (*Festuca viridula*), Woodrush (*Luzula spicata*), Mountain timothy (*Phleum alpinum*), Bluegrass (*Poa* spp.), Spike trisetum (*Trisetum spicatum*)	Achillea spp., Antennaria spp., Aquilegia spp., Arenaria spp., Castilleja spp., Draba spp., Erigeron compositus, lichen spp., Oxyria digyna, Pentstemon fruticosus, Phacelia spp.. Phlox caespitosa, Polemonium spp., Polygonum spp., Potentilla diversifolia, Potentilla spp., Salix nivalis, Salix spp., Saxifraga spp., Selaginella spp., Sibbaldia procumbens, Sieversia turbinata, Solidago spp.	Rocky Mountains, Cascade Range, Sierra Nevada
Western Spruce-Fir Forest (#15)	Dense to open forests of low to medium tall needleleaf evergreen trees; open forests with a synusia of shrubs and herbaceous plants	Subalpine fir (*Abies lasiocarpa*) Engelmann spruce (*Picea engelmannii*)	*Arctostaphylos uva ursi. Arnica cordifolia, Calamagros-tis canadensis, Carex* spp., *Larix lyallii, Menziesia fer-ruginea, Pinus albicaulis* (northern part), *P. contorta, Populus tremuloides,*	High altitudes of northern Rocky Mountains and Washington

Table D-1. Küchler (1964) map unit descriptions for Section M331B.

Map Unit Name	Physiognomy	Dominants	Other Components	Occurrence
			Pseudotsuga menziesii (lower ele-vations), *Shepherdia canadensis, Symphoricarpos albus, Tsuga mertensiana* (western part), *Vaccinium* spp., *Xero-phyllum tenax*	
Douglas Fir Forest (#12)	Medium dense forest of medium tall needleleaf evergreen trees	Douglas-fir (Pseudotsuga menziesii)	*Abies concolor, Larix occidentalis, Physocarpus malvaceus, Picea pungens* (northern part), *P. glauca, Pinus contorta, P. ponderosa* (lower elevations), *Populus tremuloides*	Northern Rocky Mountains and Washington
Eastern Ponderosa Forest (#16)	Medium dense to open forest of low to medium tall needleleaf evergreen trees with a fairly open ground cover of grasses	Ponderosa pine (*Pinus ponderosa*)	Agropyron smithii, Bouteloua gracilis, Stipa comata	Eastern Montana, northeastern Wyoming, western North and South Dakota, northwestern Nebraska
Sagebrush Steppe (#55)	Dense to open grassland with dense to open shrub	Bluebunch wheatgrass (*Agropyron spicatum*) Big	Artemisia arbuscula (western part), A. nova (eastern part),	Pacific Northwest and eastward to Rocky

Table D-1. Küchler (1964) map unit descriptions for Section M331B.

Map Unit Name	Physiognomy	Dominants	Other Components	Occurrence
	synusia	sagebrush (Artemisia tridentata)	Balsamorrhiza sagittata, Festuca idahoensis, Lithospermum ruderale, Lupinus sericeus, Oryzopsis hymenoides. Phlox spp., Poa nevadensis, P. secunda, Purshia tridentata, Sitanion spp.	Mountains
Grama-Needlegrass-Wheatgrass (#64)	Rather short, open to fairly dense grass	Western wheatgrass (*Agropyron smithii*) Blue grama (Bouteloua gracilis) Needle-and-thread grass (*Stipa comata*)	*Agropyron spicatum, Andropogon scoparius, Artemisia frigida, Carex filifolia, Chrysopsis villosa, Gutierrezia sarothrae, Koeleria cristata, Liatris punctata, Muhlenbergia cuspidata, Poa secunda, Sporobolus cryptandrus,* Stipa viridula	Montana, Wyoming
Wheatgrass-Needlegrass Shrubsteppe (#56)	Open grasslands, sometimes fairly dense, with scattered dwarf shrubs	Western wheatgrass (*Agropyron smithii*) Big sagebrush (Artemisia tridentata) Plains bluegrass (*Poa arida*) Needle-and-thread grass (*Stipa comata*)	Agropyron spicatum, Artemisia cana, A. frigida, Atriplex canescens, A. confertifolia, Carex filifolia, Eurotia lanata, Koeleria cristata, Sarcobatus vermiculatus	Montana, Wyoming

APPENDIX 1. BIGHORN MOUNTAINS SECTION DESCRIPTION (M331B).

Geomorphology. There are high mountains with sharp crests, rolling uplands, and dissected hills, with alpine glaciation dominating the upper third of the area. The rugged hills and mountains are cut by many narrow valleys with steep gradients. Elevation ranges from 4,000 to 13,000 ft (1,220 to 3,962 m). This Section is within the Middle Rocky Mountains physiographic province.

Lithology and Stratigraphy. The central part of the Section is Precambrian quartz monzonite to quartz diorite in the north and Precambrian gneiss in the south. The periphery of the Section is Paleozoic carbonates and shales. A small area in the extreme northeast of the Section is Cretaceous sandstones, siltstones, and shales.

Soil Taxa. Soils include cryic Borolls, Ochrepts, and Boralfs. These soils are generally shallow to moderately deep, but some deep soils occur in alluvial and colluvial basins. Textures are generally loamy or sandy, with large amounts of rock fragments.

Potential Natural Vegetation. Kuchler mapped potential vegetation as Douglas-fir forest and western spruce--fir forest (50 percent) and wheatgrass--needlegrass--shrubsteppe (50 percent). Common tree species include lodgepole pine, Douglas-fir, subalpine fir, and Engelmann spruce. Idaho fescue, bluebunch wheatgrass, and mountain big sagebrush are common grass and shrub species.

Fauna. Birds are typical of the Rocky Mountains. Species include ferruginous and Swainson's hawks, golden eagle, blue grouse, sage grouse, mountain plover, Steller's and gray jay, Clark's nutcracker, Townsend's solitaire, green-tailed towhee, and western tanager. Species nearing the edge of their ranges are calliope hummingbird, indigo bunting, and clay-colored sparrow. Typical herbivores and carnivores include white-tailed deer, mule deer, elk, moose, pronghorn, black bear, bobcat, and cougar. Smaller common herbivores include the snowshoe hare, yellow-bellied marmot, and the northern flying squirrel. Bison are historically associated with this Section. Herpetofauna typical of this Section are the spotted frog, rubber boa, boreal toad, bloched tiger salamander, and, at lower elevations, the prairie rattlesnake.

Climate. Precipitation ranges from 15 to 40 in (380 to 1,020 mm), with much occurring as spring and fall rains. Climate is cold continental with dry, cold winters. Temperature averages 36 to 43º F (2 to 6º C). The growing season lasts 45 to 90 days.

Surface Water Characteristics. This area has medium to fine density dendritic patterns with moderate gradients. Streams are deeply entrenched as they leave the mountains. Lakes occur in glaciated terrain, as well as in high elevation cirques and basins. Major streams include the Tongue, Shell, and Tensleep.

Disturbance Regimes. Fire, insects, and disease are the dominant natural sources of disturbance. Fire has historically been fairly frequent, low intensity, and patchy; however, fire suppression has caused this pattern to change to less frequent, more intense, larger fires.

Land Use. The land is used for timber harvest, livestock grazing, wildlife habitat, watershed, and recreation.
Cultural Ecology. Reserved.

Compiled by Northern Region and Rocky Mountain Region.

Appendix 2. Subsection Descriptions. [1]

Bighorn Mountains, Sedimentary Subsection (M331Ba)

Both the eastern and western margins of this subsection were digitized along a slope contour of roughly 10°. This subsection consists mainly of Mesozoic and Paleozoic limestone, dolomite and sandstone, although it includes some plutonic rocks in the North, and gneissic rocks in the south (Figure 6 and Figure 7). Deep, steeply walled canyons cut through the dipping sedimentary rocks, particularly along the eastern flank. Mixed grass prairie is mapped for much of this area although it has a distinct mountain meadow character associated with the higher elevations. Juniper woodland is found at lower elevations on rocky outcrops and Douglas-fir in the canyons (Figure 24 and Figure 25).

The majority of this subsection is included in the Bighorn National Forest LTA coverage (Figure 35). We have mapped 9 polygons in the northwest coverage within this subsection, seven of which are designated as "low mountains," one is "high hills," and one is "irregular plains."

Bighorn Mountains, Granitic/gneiss Subsection (M331Bb)

This subsection is embedded within the Bighorn Mountains Sedimentary Subsection. Although it roughly follows the delineation of Freeouf (1996), our subsection boundary was digitized using both relief and geologic coverages and follows more closely the contact between gneissic and plutonic rocks with the surrounding sedimentary rocks. This area is generally higher and more rugged than the sedimentary subsection and soils consist primarily of Rock Outcrop and Lithic Cryorthents (Figure 10 and Figure 11). Vegetation includes bare rock, alpine tundra, lodgepole pine forest, spruce-fir forest, mountain big sagebrush, mountain meadow grassland and, along the lower margins, ponderosa pine woodland (Figure 24 and Figure 25).

The majority of this subsection is included in the Bighorn National Forest LTA coverage (Figure 35). We have mapped only 4 polygons in the Buffalo Resource area within this subsection. Landtype Associations include "Footslope," "Low Hills," "High Hills," and "Low Mountains."

Owl Creek Mountains Subsection (M331Bc)

Our delineation of the boundary between the Owl Creek Mountains and Bighorn Mountains, Sedimentary subsections roughly follows that of Freeouf (1996), however it is slightly to the east (Figure 28). Our line follows along Bridger Creek to the south, and Kirby Creek to the north. This line is roughly the topographic low dividing these two mountain ranges. This subsection bounds on the west with the Absaroka Range and Southern Absaroka Range Subsections, on the north with the Bighorn Basin and on the south with the Eastern and the Western Wind River Basin subsections. The low range comprising this subsection is cored with Precambrian rocks in places but for the most part consists of Paleozoic sedimentary rocks dipping gently to the north (Figure 6). This is not a very high range and therefore is

[1] *source:* Reiners *et al.* 1999

relatively dry throughout its elevational extent. Common soils are Typic Hapludolls and typic Hapludalfs on the sedimentary rocks with Rock Outcrop and Lithic Cryorothents on the Precambrian plutonic and metamorphic rocks (Figure 10). Vegetation is similar to that of the Bighorn sedimentary Subsection.

This subsection is contained entirely within our northwest Wyoming map area. The majority of the subsection is mapped as “High Hills,” although other Landtype Associations include “Low Hills,” “Open Low Hills,” “Hills,” “Single Cuesta,” “Alluvial Valley,” and “River Valley.”

Appendix 3. Bighorn NF Landtype Associations Descriptions.

A01 M331Ba-01 SEDIMENTARY BREAKLANDS

Map Units Included: 1/3 14, 15, 1/2 22, 32, 34, 35, 61, 62, 71, 75, 77, 90, 91

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Sedimentary Subsection.

Concept: This LTA is typically composed of steep mountainsides, escarpments and canyon walls, and steep colluvial slopes. The vegetation is a mosaic of Douglas-fir forest, shrubland, and mountain grasslands.

General Characteristics:

Topography: Steep mountainsides, escarpments, talus; relief 1500 - 2500'.

Elevation: 5000 - 9000'

Slope: 40 to 70%

Extent: 188,525 acres for IRI; 134,068 acres within Forest; 12.0% of Forest.
22,301 acres of grass, 2.0%; 111,767 acres of trees, 10.0%

Climatic Zone: Lower Montane, Lower Montane and Montane, and Montane

Average Annual Precipitation: 15 to 35 inches

Average Annual Temperature: 31 to 38 degrees F.

Formations: Bighorn Dolomite, Madison Limestone, Amsden Formation, Tensleep Sandstone

Lithology: Sandstone, Limestone, Dolomite, Interbedded sandstone and shale

Parent Material: Sedimentary residuum and colluvium

Potential Natural Vegetation: Douglas-fir, mountain ninebark, Utah juniper, mountainmahogany, big sagebrush, Idaho fescue, bluebunch wheatgrass

Soil Classification: Typic Cryoboralfs - 60%
Ustic Torriorthents - 25%
Rock Outcrop - 15%

Use and Management:
Windthrow Hazard: Severe - rock fragments, depth to bedrock
Moderate - loose material

Prescribed Burning Limitations: Severe - slope, depth to bedrock, on grassland - thin organic layer, rock outcrop

Reforestation Potential: Low - droughtiness
Moderate - depth to bedrock, rock fragments

Revegetation Potential: Poor - slope, droughtiness, depth to bedrock
Fair - too alkaline, shrink-swell, rock fragments

Surfaced Roads Limitations: Severe - slope, depth to bedrock, large stones
Moderate - shrink-swell, low strength, frost action

Unsurfaced Roads Limitations: Severe - slope, too stony
Moderate - dusty

Slope Stability Hazard: Low

Debris Flow Hazard: Moderate - slopes <55%
High - slopes >55%

A02 M331Ba-02 LANDSLIDE/COLLUVIAL DEPOSITS

Map Units Included: 17, 20, 30

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Sedimentary Subsection.

Concept: This LTA is typically composed of moderately stable to stable landslide deposits. The vegetation is mostly mountain shrubland and grassland.

General Characteristics:

Topography: Complex slopes, relief from 200 to 600'

Elevation: 5000 - 9000'

Slope: 10 to 40%

Extent: 38,838 acres for IRI; 35,295 arcres within Forest; 3.2% of Forest; all grass/shrub.

Climatic Zone: Lower Montane and Montane, Montane, Montane and Subalpine

Average Annual Precipitation: 15 to 35 inches

Average Annual Temperature: 33 to 38 degrees F.

Formations: Flathead Sandstone, Gros Ventre Formation, Gallatin Limestone, Bighorn Dolomite, Madison Limestone, Amsden Formation, Tensleep Sandstone, Chugwater Formation

Lithology: Colluvial/landslide deposits.

Parent Material: Colluvium from limestone, shale, and sandstone

Potential Natural Vegetation: Big sagebrush, Idaho fescue, black sagebrush, bluebunch wheatgrass

Soil Classification: Typic Cryorthents - 60%
Argic Cryoborolls - 40%

Use and Management:

Windthrow Hazard: Moderate - loose material

Prescribed Burning Limitations: Severe - slope, on grassland - thin organic layer

Revegetation Potential: Poor - slope, shrink-swell
Fair - too alkaline, depth to bedrock

Surfaced Roads Limitations: Severe - slope, shrink-swell

Moderate - low strength, frost action

Unsurfaced Roads Limitations: Moderate – slope

Slope Stability Hazard: High

Debris Flow Hazard: Low

Map Units Included: 2/3 14, 21, 1/2 22, 24, 27, 39, 63, 66, 67, 68, 69, 70, 74, 78, 79, 80, 81, 82, 83, 92, 93, 96

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Sedimentary Subsection.

Concept: This LTA is typically composed of mountainsides, ridges, toeslopes, and fans. The vegetation is a mosaic of mountain grassland and Douglas-fir/Engelmann spruce forest.

General Characteristics:

Topography: Moderate complex slopes, strongly dissected.

Elevation: 5500 to 10,500'

Slope: 5 to 30%

Extent: 215,481 acres for IRI; 166,282 within Forest; 14.9% of Forest.
103,357 acres of grass, 9.0%; 62,925 acres of trees, 5.9%

Climatic Zone: Montane, Montane and Subalpine

Average Annual Precipitation: 15 to 35 inches

Average Annual Temperature: 31 to 38 degrees F.

Formations: Gallatin Limestone, Bighorn Dolomite, Madison Limestone

Lithology: Limestone and dolomite

Parent Material: Residuum, colluvium, and alluvium (calcareous)

Potential Natural Vegetation: Douglas-fir, Engelmann spruce, mountain ninebark, grouse whortleberry, Idaho fescue, silky lupine.

Soil Classification: Typic Cryoboralfs - 50%
Argic Cryoborolls - 40%
Calcic Cryoborolls - 10%

Use and Management:

Windthrow Hazard: Moderate - loose material
Severe - rock fragments and depth to bedrock

Prescribed Burning Limitations: Severe - on grassland - thin organic layer
Moderate - slope, depth to bedrock, some stoniness and slope

Reforestation Potential: Low - droughtiness

Moderate - depth to bedrock, rock fragments

Revegetation Potential: Poor - slope, depth to bedrock
Fair - shrink-swell, droughtiness, too alkaline

Surfaced Road Limitations: Severe - slope
Moderate - shrink-swell, frost action, low strength, depth to bedrock, large stones

Unsurfaced Road Limitations: Moderate - slope, dust
Severe - too stony

Slope Stability Hazard: Low

Debris Flow Hazard: Low

Map Units Included: 12, 28, 1/2 29, 42, 64, 65, 72, 73, 95, 97, 98, 99

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Sedimentary Subsection.

Concept: This LTA is typically composed of mountainsides, toeslopes, and fans. The vegetation is a mosaic of mountain shrubland and grassland.

General Characteristics:

Topography: Moderately dissected mountain slopes

Elevation: 6000 to 9500'

Slope: 2 to 35%

Extent: 57,136 acres for IRI; 27,058 within Forest; 2.5% of Forest; all grass/shrub

Climatic Zone: Lower Montane, Lower Montane and Montane, Montane, Montane and Subalpine

Average Annual Precipitation: 15 to 35 inches

Average Annual Temperature: 31 to 38 degrees F.

Formations: Gallatin Limestone, Amsden Formation, Tensleep Sandstone, Chugwater Formation

Lithology: Interbedded sandstone, limestone, and shale.

Parent Material: Residuum, colluvium, and alluvium

Potential Natural Vegetation: Idaho fescue, big sagebrush, bluebunch wheatgrass, silky lupine

Soil Classification: Argic Cryoborolls - 70%
Lithic Argiborolls - 30%

Use and Management:

Windthrow Hazard: Moderate - loose material
Severe - rock fragments and depth to bedrock

Prescribed Burning Limitations: Severe - on grassland - thin organic layer
Moderate - slope, depth to bedrock

Revegetation Potential: Poor - slope, rock fragments, depth to bedrock
Fair - shrink-swell, too alkaline, too clayey

Surfaced Roads Limitations: Severe - slope, depth to bedrock
Moderate - shrink-swell, frost action, low strength

Unsurfaced Roads Limitations: Severe - slope, too stony
Moderate – dusty

Slope Stability Hazard: High - on shale and slopes > 27%

Debris Flow Hazard: Low

A05 M331Ba-05 SEDIMENTARY MOUNTAIN SLOPES, SHALE/SANDSTONE (NONCALCAREOUS)

Map Units Included: 23, 1/2 29, 38, 43

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Sedimentary Subsection.

Concept: This LTA is typically composed of mountainsides, toeslopes, and fans. The vegetation is a mosaic of lodgepole pine/Engelmann spruce forest and grasslands.

General Characteristics:

Topography: Moderately dissected mountainsides.

Elevation: 6000 to 10,000'

Slope: 2 to 35%

Extent: 85,855 acres for IRI; 81,617 acres within Forest; 7.3% of Forest
26,762 acres of grass, 2.4%; 54,855 acres of trees, 4.9%

Climatic Zone: Montane, Montane and Subalpine

Average Annual Precipitation: 15 to 35 inches

Average Annual Temperature: 31 to 35 degrees F.

Formations: Flathead Sandstone, Gros Ventre Formation

Lithology: Interbedded sandstone and shale, sandstone, shale

Parent Material: Residuum, colluvium, and alluvium

Potential Natural Vegetation: Lodgepole pine, Engelmann spruce, grouse whortleberry, Idaho fescue

Soil Classification: Typic Cryoboralfs - 55%
Argic Cryoborolls - 45%

Use and Management:

Windthrow Hazard: Moderate - loose material
Severe - depth to bedrock

Prescribed Burning Limitations: Severe - on grassland - thin organic layer
Moderate - depth to bedrock

Reforestation Potential: Moderate - depth to bedrock, too acid
Low – droughtiness

Revegetation Potential: Poor - slope, shrink-swell
Fair - depth to bedrock, too acid

Surfaced Roads Limitations: Severe – slope

Unsurfaced Roads Limitations: Moderate – slope

Slope Stability Hazard: High

Debris Flow Hazard: Low

B01 M331Bb-01 GRANITIC BREAKLANDS

Map Units Included: 31, 1/3 37

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Granitic/Gneiss Subsection.

Concept: This LTA is typically composed of steep mountainsides, escarpments, and canyon walls. Rock outcrop and Rubble land are common. The sparse vegetation is mainly grassland, lodgepole pine, grouse whortleberry.

General Characteristics:

Topography: Complex slopes, strong dissection, relief 1500 - 2500'.

Elevation: 6500 - 10,500'

Slope: Dominately 40 to 70%

Extent: 44,406 acres for IRI; 39,278 acres within Forest; 3.5% of Forest
14,495 acres of Rock outcrop/grass, 1.3%; 24,783 acres of trees/Rock outcrop; 2.2%

Climatic Zone: Montane and Subalpine, Subalpine, and Alpine

Average Annual Precipitation: 25 to 35 inches

Average Annual Temperature: 28 to 35 degrees F.

Formations: Precambrian granite and gneiss

Lithology: Granite and/or gneiss

Parent Material: Residuum and colluvium

Potential Natural Vegetation: Alpine vegetation, lodgepole pine, grouse whortleberry

Soil Classification: Rock outcrop - 60%
Typic Cryoboralfs - 40%

Use and Management:

Windthrow Hazard: Severe - depth to bedrock, rock fragments

Prescribed Burning Limitations: Severe - depth to bedrock, too stony

Reforestation Potential: Low - droughtiness, too acid
Moderate - depth to bedrock, rock fragments

Revegetation Potential: Poor - slope, rock fragments, depth to bedrock

Surfaced Roads Limitations: Severe - slope, large stones, depth to bedrock
Moderate - shrink-swell

Unsurfaced Roads Limitations: Severe - slope, too stony

Slope Stability Hazard: Low

Debris Flow Hazard: High

B02 M331Bb-02 GLACIAL CIRQUELANDS

Map Units Included: 13, 2/3 37

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Granitic/Gneiss Subsection.

Concept: This LTA is typically composed of glacial cirque headwalls, cirque basins, and periglacial rubble and talus. The vegetation is a sparse alpine community.

General Characteristics:

Topography: Very steep mountainsides, cirques.

Elevation: 9500 - 13,000'

Slope: 10 to 130%

Extent: 64,418 acres all within Forest; 5.8% of Forest; all Rock outcrop with inclusions of alpine vegetation

Climatic Zone: Alpine

Average Annual Precipitation: 30 to 40 inches

Average Annual Temperature: 28 to 32 degrees F.

Formations: Precambrian granite and gneiss

Lithology: Granite and/or gneiss

Parent Material: Residuum and talus

Potential Natural Vegetation: Sparse alpine plant community

Soil Classification: Rock outcrop, hard

Use and Management:

Windthrow Hazard: Severe - depth to bedrock, rock fragments

Prescribed Burning Limitations: Severe - depth to bedrock, too stony

Revegetation Potential: Poor - slope, rock fragments, depth to bedrock

Surfaced Roads Limitations: Severe - slope, depth to bedrock, large stones

Unsurfaced Roads Limitations: Severe - slope, too stony

Slope Stability Hazard: Low

Debris Flow Hazard: High

B03 M331Bb-03 GLACIAL/TERTIARY TERRACE DEPOSITS

Map Units Included: 18, 19A, 19B, 41A, 41B

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Granitic/Gneiss Subsection.

Concept: This LTA is typically composed of glacial moraines and Tertiary terraces. The vegetation is a mosaic of lodgepole pine forest, shrubland, and mountain grasslands.

General Characteristics:

Topography: Bull Lake Stade: highly weathered moraine, Pinedale Stade: potholes and lakes moraine, old terraces.

Elevation: 6500 - 9000'

Slope: 2 to 40%

Extent: 105,715 acres for IRI; 99,140 acres within Forest; 9.0% of Forest
24,532 acres of grass, 2.2%; 74,608 acres of trees, 6.8%

Climatic Zone: Montane, Montane and Subalpine

Average Annual Precipitation: 25 to 35 inches

Average Annual Temperature: 31 to 35 degrees F.

Formations: Precambrian granite and gneiss

Lithology: Granite and/or gneiss

Parent Material: Till and outwash

Potential Natural Vegetation: Lodgepole pine, grouse whortleberry, Idaho fescue, big sagebrush

Soil Classification: Typic Cryoboralfs - 70%
Argic Cryoborolls - 30%

Use and Management:

Windthrow Hazard: Severe - rock fragments, wetness in glacial moraines
Moderate - loose material

Prescribed Burning Limitations: Severe - on grassland - thin organic layer, too sandy
Moderate – slope

Reforestation Potential: Low - rock fragments, too acid
Moderate – droughtiness

Revegetation Potential: Poor - slope, rock fragments
Fair - shrink-swell, too acid

Surfaced Roads Limitations: Severe - slope, large stones
Moderate - shrink-swell, frost action, low strength

Unsurfaced Roads Limitations: Severe - too stony, ponding
Moderate – slope

Slope Stability Hazard: Moderate - on slopes <27%; High - on slopes >27%

Debris Flow Hazard: Low

B04 M331Bb-04 GRANITIC MOUNTAIN SLOPES, STEEP

Map Units Included: 1/3 10

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Granitic/Gneiss Subsection.

Concept: This LTA is typically composed of steep mountainsides. The vegetation is dominately lodgepole pine forest.

General Characteristics:

Topography: Moderately dissected mountainsides.

Elevation: 7000 - 9500'

Slope: 25 to 50%

Extent: 42,826 acres for IRI; 41,767 acres within Forest ; 3.8% of Forest; all trees/Rock outcrop

Climatic Zone: Montane and Subalpine

Average Annual Precipitation: 25 to 35 inches

Average Annual Temperature: 31 to 35 degrees F.

Formations: Precambrian granite and gneiss

Lithology: Granite and/or gneiss

Parent Material: Residuum

Potential Natural Vegetation: Lodgepole pine, grouse whortleberry

Soil Classification: Typic Cryoboralfs - 80%
Rock outcrop - 20%

Use and Management:

Windthrow Hazard: Severe - loose material, rock fragments
Moderate - depth to bedrock

Prescribed Burning Limitations: Moderate - slope, thin organic layer
Severe - rock outcrop

Reforestation Potential: Low - droughtiness, too acid
Moderate - depth to bedrock, rock fragments

Revegetation Potential: Poor - slope, depth to bedrock, too acid
Fair - shrink-swell, droughtiness

Surfaced Roads Limitations: Severe - slope, depth to bedrock
Moderate - shrink-swell, frost action

Unsurfaced Roads Limitations: Severe - slope, too stony

Slope Stability Hazard: Low

Debris Flow Hazard: Moderate

B05 M331Bb-05 GRANITIC MOUNTAIN SLOPES, GENTLE

Map Units Included: 2/3 10, 11, 16, 25, 40

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Granitic/Gneiss Subsection.

Concept: This LTA is typically composed of mountainsides, fans, and outwash plains. Floodplains and wetlands are common. The vegetation is a mosaic of lodgepole pine/Engelmann spruce forest and mountain grasslands.

General Characteristics:

Topography: Moderately dissected mountain slopes, floodplains, wetlands.

Elevation: 7000 - 9500'

Slope: 5 to 25%

Extent: 318,046 acres for IRI; 303,242 acres within Forest; 27.2% of Forest
45,718 acres of grass, 4.1%; 257,524 acres of trees, 23.1%

Climatic Zone: Montane and Subalpine

Average Annual Precipitation: 25 to 35 inches

Average Annual Temperature: 31 to 35 degrees F.

Formations: Precambrian granite and gneiss

Lithology: Granite and/or gneiss

Parent Material: Residuum and colluvium

Potential Natural Vegetation: Lodgepole pine, Engelmann spruce, grouse whortleberry, Idaho fescue

Soil Classification: Typic Cryoboralfs - 75%
Argic Cryoborolls - 25%

Use and Management:

Windthrow Hazard: Severe - loose material
Moderate - rock fragments, depth to bedrock

Prescribed Burning Limitations: Severe - depth to bedrock
Moderate - slope, thin organic layer

Reforestation Potential: Low - droughtiness, too acid
Moderate - depth to bedrock, rock fragments

Revegetation Potential: Poor - slope
Fair - too acid, too sandy, shrink-swell

Surfaced Roads Limitations: Severe - slope
Moderate - depth to bedrock, shrink-swell, frost action, large stones

Unsurface Roads Limitations: Moderate – slope

Slope Stability Hazard: Low

Debris Flow Hazard: Moderate

B06 M331Bb-06 ALPINE MOUNTAIN SLOPES AND RIDGES

Map Units Included: 26, 33, 36

Location: Bighorn Mountain range in northern Wyoming in Bighorn Mountain Section, Granitic/Gneiss Subsection.

Concept: This LTA is typically composed of mountainsides, alpine ridges, and glacial trough valleys. The vegetation is dominately an alpine community and some Engelmann spruce forest.

General Characteristics:

Topography: Strongly dissected mountainsides, ridges, valleys.

Elevation: 9000 - 11,000'

Slope: 5 to 35%

Extent: 120,314 acres for IRI; 119,976 acres within Forest; 10.8% of Forest
108,162 acres of grass/Rock outcrop, 9.7%; 11,814 acres of trees, 1.1%

Climatic Zone: Subalpine, Alpine

Average Annual Precipitation: 30 to 40 inches

Average Annual Temperature: 29 to 33 degrees F.

Formations: Precambrian Granite and Gneiss

Lithology: Granite and/or gneiss

Parent Material: Residuum and till

Potential Natural Vegetation: Sparse alpine community, Engelmann spruce

Soil Classification: Pergelic Cryumbrepts - 50%
Rock outcrop - 40%
Typic Cryoboralfs - 10%

Use and Management:

Windthrow Hazard: Severe - depth to bedrock, rock fragments
Moderate - loose material

Prescribed Burning Limitations: Severe - depth to bedrock, thin organic layer

Reforestation Potential: Low - droughtiness, too acid
Moderate - depth to bedrock, rock fragments

Revegetation Potential: Poor - slope, depth to bedrock, rock fragments, too acid

Fair - shrink-swell, too sandy

Surfaced Roads Limitations: Severe - slope, depth to bedrock, large stones
Moderate - shrink-swell, frost action, low strength

Unsurfaced Roads Limitations: Severe - too stony
Moderate – slope

Slope Stability Hazard: Low
Debris Flow Hazard: Low

Appendix 4. Bighorn NF Landtype Descriptions.

Table 1 is a summary of the Landtypes on the Bighorn NF. Landtypes are equivolent to Common Land Units (CLU) on the Bighorn NF. Common Land Unit Soil Identification number and Map Unit Identification code preceed the Map Unit Name in the table. Detailed descriptions are available from the Supervisor's Office for the Bighorn NF, Sheridan, Wyoming.

Table 1. Bighorn NF Landtype Legend (May/1999)

CLU_SOIL	CLU_MUID	Common Land Unit (CLU) Map Unit Name (CLU_MU_NAME)
10	60GR010	PICO/VASC [1] Agneston-Granile-Rock outcrop association on montane and subalpine mountain slopes, 5 to 50 percent slopes
11	60GR011	PIEN/VASC Agneston-Leighcan association on montane and subalpine mountain slopes, 5 to 30 percent slopes
12	40SX012	JUOS/ARTR2 Chilton Variant - Sunup - Spearfish Variant association on lower montane and montane mountain slopes, 5 to 60 percent slopes
13	80GR013	ALPINE Cirque Land, 10 to 130 percent slopes
14	60LS014	PSME/PHMO4 - PIEN/VASC Cloud Peak gravelly silt loam on montane and subalpine mountain slopes, 5 to 45 percent slopes
15	50SX015	PSME/PHMO4 - ELSP3/KOMA Cloud Peak-Eutroboralfs-Argiborolls association on montane mountain slopes, 10 to 65 percent slopes
16	60AL016	SALIX/JUCO Cryaquolls on montane and subalpine mountain slopes, 0 to 5 percent slopes.
17	50LS017	ARTR2/FEID Farlow - Pishkun association on montane mountain slopes, 5 to 40 percent slopes
18	60GO018	FEID/LUSE4 Fourmile loam on montane and subalpine mountain slopes, 2 to 30 percent slopes
19A	60GT19A	PICO/VASC Frisco - Troutville association on montane and subalpine glacial till, 2 to 40 percent slopes
19B	60GM19B	PICO/PIEN/VASC Frisco - Troutville association on montane and subalpine glacial moraines, 2 to 40 percent slopes
20	50SX020	JUOS/ARNO4/ELSP3 Grobutte very gravelly loam on montane mountain slopes, 8 to 60 percent slopes
21	60LS021	FEID/LUSE4 Hanson-Raynesford association on montane and subalpine mountain slopes, 0 to 30 percent slopes
22	50LS022	FEID/ELSP3/CAREX Hanson Variant - Starley association on montane mountain slopes, 10 to 60 percent slopes
23	60SS023	FEID/CAREX Inchau-Carbol association on montane and subalpine mountain slopes, 2 to 20 percent slopes
24	60LS024	FEID/LUSE4 Leavitt-Passcreek association on montane and

[1] Botanical scientific codes are listed at the end of this table along with the corresponding common name and scientific name.

		subalpine mountain slopes, 2 to 30 percent slopes
25	60GR025	FEID/CAREX Lucky-Burgess-Hazton association on montane and subalpine mountain slopes, 2 to 30 percent slopes
26	80GR026	ALPINE Mirror-Teewinot-Bross association on subalpine and alpine mountain slopes, 2 to 40 percent slopes
27	60LS027	FEID/LUSE4/CAREX Nathrop-Passcreek-Starley association on montane and subalpine mountain slopes, 2 to 30 percent slopes
28	60SX028	FEID/LUSE4 Nathrop Variant-Nielsen-Passcreek association on montane and subalpine mountain slopes, 2 to 35 percent slopes
29	60SX029	ARTR2/FEID Owen Creek-Echemoor-Bynum association on montane and subalpine mountain slopes, 2 to 30 percent slopes
30	60SX030	ARTR2/FEID Owen Creek-Waybe association on montane and supbalpine mountain slopes, 5 to 35 percent slopes
31	60GR031	PICO/VASC Rock outcrop-Agneston-Rubble land association on montane and subalpine mountain slopes, 5 to 60 percent slopes
32	60LS032	PSME/PHMO4 Rock outcrop-Cloud Peak association on montane and subalpine mountain slopes, 10 to 70 percent slopes
33	80GR033	ALPINE Rock outcrop-Mirror-Teewinot association on subalpine and alpine mountain slopes, 5 to 35 percent slopes
34	60LS034	FEID/CAREX Rock outcrop-Starman association on montane and subalpine mountain slopes, 5 to 70 percent slopes
35	40LS035	CELE3/ELSP3 Rock outcrop-Starman Variant association on lower montane and montane mountain slopes, 10 to 70 percent slopes
36	70GR036	ALPINE/PIEN/VASC Rock outcrop-Teewinot-Agneston association on subalpine mountain slopes, 5 to 35 percent slopes
37	80GR037	ALPINE Rubble land on subalpine and alpine mountain slopes, 5 to 50 percent slopes
38	60SX038	PICO/VASC Sapphire-Bottle-Foxton association on montane mountain and subalpine slopes, 2 to 35 percent slopes
39	60LS039	FEID/CAREX Starman-Starley association on montane and subalpine mountain slopes, 2 to 30 percent slopes
40	60GR040	PICO/VASC Tellman-Granile-Agneston association on montane and subalpine mountain slopes, 2 to 20 percent slopes
41A	60GM41A	ARTR2/FEID/LUSE4 Tine-Fourmile association on montane and subalpine glacial moraines, 2 to 30 percent slopes
41B	60GT41B	ARTR2/FEID/LUSE4 Tine-Fourmile association on montane

		and subalpine glacial till, 2 to 30 percent slopes
42	50SX042	ELSP3/KOMA Tolman-Beenom Variant-Carbol Variant association on montane mountain slopes, 5 to 35 percent slopes
43	60SX043	PICO/VASC/PIEN Tongue River-Gateway association on montane and subalpine mountain slopes, 2 to 35 percent slopes
61	20AL061	ELCI2/ELTR7/SALIX Barnum loam on semiarid alluvium, 1 to 3 percent slopes
62	40SS062	PICO/PIPO Billycreek-Wetterhorn complex on lower montane and montane mountain slopes, 6 to 60 percent slopes
63	50SS063	STCO2/FEID/CELE3 Chittum-Rock outcrop association on montane mountain slopes, 2 to 25 percent slopes
64	40SX064	STCO2/FEID/ARTR2 Clayburn-Bachus-Inchau association on lower montane and montane mountain slopes, 2 to 25 percent slopes
65	40SS065	STCO2/FEID-CAREX/DECE Clayburn-Wallrock association on lower montane and montane mountain slopes, 2 to 25 percent slopes
66	30SX066	ELSP3/ARTR2-ATGA/ORHY Clifterson-Persayo association on lower montane mountain slopes, 1 to 45 percent slopes
67	40SS067	STCO2/ARTR2 Coutis-Greenman association on lower montane and montane mountain slopes, 2 to 45 percent slopes
68	30SX068	ELSP3/ARTR2-SPAI/SARC Forkwood-Haverdad association on lower montane mountain slopes and fans, 1 to 10 percent slopes
69	30SX069	ELSP3/STCO1/ARTR2 Forkwood-Kishona association on lower montane mountain slopes and fans, 1 to 15 percent slopes
70	40SS070	STCO2/BRMA/ARTR2 Greenman-Splitro association on lower montane and montane mountain slopes, 2 to 25 percent slopes
71	50LS071	PSME/PICO Limber-Hyattville-Rock outcrop association on montane mountain slopes, 3 to 40 percent slopes
72	50SH072	STCO2/FEID/ARTR2/CELE3 Lymanson-Turk-Jenkinson association on montane mountain slopes, 1 to 30 percent slopes
73	50SS073	PICO-FEID/STCO2/ARTR2 Meadowlake-Castino Variant-Rock outcrop association on montane mountain slopes, 5 to 30 percent slopes
74	50LS074	FEID/LUSE4/CAREX Nathrop-Starley-Rock outcrop association on montane mountain slopes, 2 to 40 percent slopes
75	30SX075	ELSP3/STCO1/ARTR2 Neville-Spearfish-Rock outcrop association on lower montane mountain slopes, 1 to 45

		percent slopes
77	40SX077	ELSP3/STCO1/ARTR2 Spearfish-Travessilla-Rock outcrop complex on lower montane and montane mountain slopes, 10 to 60 percent slopes
78	50SX078	STCO2/FEID/ARTR2 Stubbs-Turk association on montane mountain slopes, 1 to 30 percent slopes
79	30SX079	ELSP3/STCO1/ARTR2 Vale-Tensleep association on lower montane mountain slopes, 1 to 40 percent slopes
80	40SS080	STCO2/FEID/ARTR2 Whaley-Rock outcrop complex on lower montane and montane mountain slopes, 3 to 60 percent slopes
81	50LS081	STCO2/FEID/ARTR2 Woosley-Decross association on montane mountain slopes, 1 to 25 percent slopes
82	50LS082	STCO2/FEID/ARTR2 Woosley-Morset association on montane mountain slopes, 2 to 25 percent slopes
83	50LS083	STCO2/FEID/ARTR2/CAREX Woosley-Starley-Rock outcrop association on montane mountain slopes, 2 to 35 percent slopes
90	50SX090	FEID/SCSC/STVI4 Abac-Rock outcrop association on montane mountain slopes, 35 to 50 percent slopes
91	50SX091	PIEN/PIPO/PIFL2-STCO2/FEID/ELSM3 Cloud Peak-Tolman complex on montane mountain slopes, 10 to 75 percent slopes
92	50SX092	FEID/STVI4-PIPO/PRVI Farnuf Variant-Cloud Peak Variant complex on montane mountain slopes, 0 to 6 percent slopes
93	50LS093	STCO2/FEID/CAREX Hardhart-Starley association on montane mountain slopes, 10 to 60 percent slopes
95	50AL095	CANE2/ELTR7/DECE Nesda stony silt loam on montane mountain slopes, 0 to 3 percent slopes
96	50SX096	PIPO/PRVI Nesda-Rubble land complex on montane mountain slopes, 0 to 3 percent slopes
97	50SH097	ELSM3/ANSC10/FEID Norbert-Doney-Rock outcrop complex on montane mountain slopes, 8 to 45 percent slopes
98	50SH098	ELSM3/ANSC10 Norbert-Rock outcrop complex on montane mountain slopes, 15 to 35 percent slopes
99	50SX099	FEID/STCO2/ELSM3 Tolman-Beeno-Beenom complex on montane mountain slopes, 5 to 45 percent slopes

Botanical scientific codes used in the table above for the Bighorn NF.

SCIENTIFIC CODE	COMMON NAME	SCIENTIFIC NAME
ABLA	subalpine fir	*Abies lasiocarpa*
ACNE2	boxelder	*Acer negundo* L.
ANSC10	little bluestem	*Andropogon scoparius*
ARNO4	black sagebrush	*Artemisia nova*
ARTR2	big sagebrush	*Artemisia tridentata*

ATGA	Gardner saltbush	*Atriplex gardneri*
BRMA	mountain brome	*Bromus marginatus*
CANE2	Nebraska sedge	*Carex nebraskensis*
Carex	sedge	*Carex*
CELE3	curlleaf mountainmahogany	*Cercocarpus ledifolius*
DECE	tufted hairgrass	*Deschampsia cespitosa*
ELCA4	Canada wildrye	*Elymus canadensis*
ELCI2	Basin wildrye	*Elymus cinereus*
ELLA3	thickspike wheatgrass	*Elymus lanceolatus*
ELSM3	western wheatgrass	*Elymus smithii*
ELSP3	bluebunch wheatgrass	*Elymus spicatum*
ELTR7	slender wheatgrass	*Elymus trachycaulum*
ELYM	wildrye	*Elymus*
FEID	Idaho fescue	*Festuca idahoensis*
HESP	Spike fescue	*Hesperochloa*
JUCO	rushes (roundfruit)	*Juncus compressus* Jacq.
JUCO6	common juniper	*Juniperus communis*
JUOS	Utah juniper	*Juniperus osteosperma*
KOMA	prairie Junegrass	*Koeleria macrantha*
LUSE4	silky lupine	*Lupinus sericeus* Pursh
Mosses	mosses/lichens	
ORHY	Indian ricegrass	*Oryzopsis hymenoides*
PHAL2	alpine timothy	*Phleum alpinum* L.
PHMO4	mountain ninebark	*Physocarpus monogynus*
PICO	lodgepole pine	*Pinus contorta*
PIEN	Engelmann spruce	*Picea engelmannii*
PIFL2	limber pine	*Pinus flexilis*
PIPO	ponderosa pine	*Pinus ponderosa*
POPU	cottonwood	*Populus*
PRVI	common chokecherry	*Prunus virginiana* L.
PSME	Douglas fir	*Pseudotsuga menziesii*
Salix	willow	*Salix*
SARC	greasewood	*Sacrobatus*
SCSC	little bluestem	*Schizachyrium scoparium*
SHAR	silver buffaloberry	*Shepherdia argentea*
SIHY	bottlebrush squirreltail	*Sita hystrix*
SPAI	alkali sacaton	*Sporobolus airoides*
STCO1	needleandthread	*Stipa comata*
STCO2	Columbia needlegrass	*Stipa columbiana*
STVI4	green needlegrass	*Stipa viridula* Trin.
VASC	grouse whortleberry	*Vaccinium scoparium*