Bighorn National Forest Plan Revision
Existing Condition Assessment

Clear Creek
Crazy Woman Creek
North Fork Powder River

Geographic Area Assessment

1999 Picture of Lost Fire
Loaf Mountain and Bighorn Peaks in the background.
Meadow in foreground is Buffalo Park.

Clear/Crazy/Powder Geographic Area Existing Condition Assessment for Forest Plan Revision

Appendix: Maps

Click on the map name for a full page view of map

I. Preface

This is one of nine geographic area existing condition assessments that will be used in the Bighorn Forest Plan Revision to describe resources at the geographic area scale and how they relate to the existing Forest Plan. A map of the Forest Plan revision geographic areas is in the appendix. A similar assessment will be done at the Forest-wide scale, and will include numerous resources/topics:

- that are not amenable to analysis at the geographic area scale. For example, most wildlife species are not bound by geographic boundaries, and to avoid needless repetition in the assessments, such topics will only be discussed at the Forest scale.
- where data bases are not complete or where analysis is still on going at the time the geographic area scale assessments are completed. Examples in this category are fire condition classes and timber suitability, which are expected to be completed by early 2002.

This existing condition geographic area assessment includes the portions of the North Fork of Powder River, Clear Creek, and Crazy Woman Creek watersheds that occur on the Bighorn National Forest, unless noted otherwise. A major exception to this is the scenery resource discussion, which covers only the Clear Creek and Crazy Woman Creek geographic areas.

There is very little information in this assessment concerning other than National Forest System land. This information will be gathered and analyzed, where appropriate, in the draft and final environmental impact statements' effects analyses.

These existing condition assessments focus on the physical and biological resources, and in some cases, human uses and resources, such as timber harvest, grazing and recreation. There will be a social and economic section in the Forest-wide existing condition assessment, and the draft and final environmental impact statements will also include the work of the social and economic analyses, which are currently being compiled by the University of Wyoming.

Despite the fact that these assessments primarily focus on the environmental effects of human uses, it must be remembered that National Forests are managed *to be used* by people. This is implicit in the laws governing National Forest management[1]. Human use of the National Forests has been directed administratively since the earliest days of the Forest Service, "This force has two chief duties: to protect the reserves against fire, and to assist the people in their use."[2] That tradition continues to this day in the "Caring for the land and serving people" mission. While these assessments focus on the environmental effects that people are having on the resource, the point is to make sure that the uses we enjoy today are sustainable so that our children and grandchildren can continue to use and enjoy the Bighorn National Forest.

Disclaimer for GIS generated data: The Forest Service uses the most current and complete data available. GIS data and product accuracy may vary. They may be: developed from sources of differing accuracy, accurate only at certain scales, based on modeling or interpretation, incomplete while being created or revised, etc. Using GIS products for purposes other than those for which they were created, may yield inaccurate or misleading results. The Forest Service reserves the right to correct, update, modify or replace GIS products without notification. The GIS data in these documents were generated using ArcInfo 7.2.1, operating on a Unix platform, with analysis occurring between August of 2001 and January of 2002. For more information, contact the Bighorn National Forest.

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[1] The Multiple Use Sustained Yield Act of 1960, the Renewable Resources Planning Act, and the National Forest Management Act, just to name a few.

[2] Forest Service "Use Book" of 1905.

II. Forest Plan

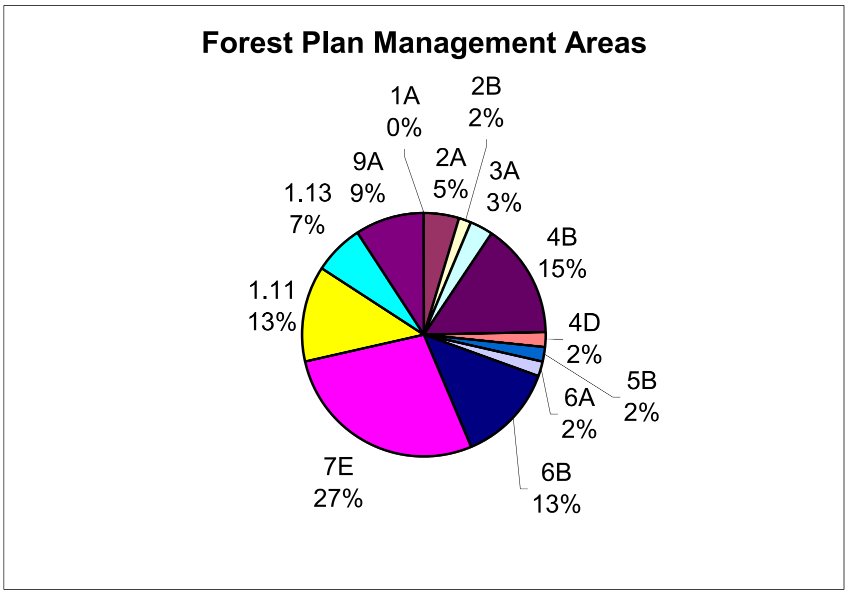
Table 1. Existing Forest Plan Management Area Allocations

Forest Plan Prescriptions	Prescription Description	GIS Acres with 9A Riparian Applied	
		Acres	%
1A	Existing and Proposed Developed Recreation Facilities	43	0%
2A	Semi-Primitive Motorized Recreation Opportunities	7176	5%
2B	Rural and Roaded Natural Recreation Opportunities	2599	2%
3A	Semi-Primitive Nonmotorized Recreation Opportunities	4715	3%
4B	Wildlife Habitat Management for Management Indicator Species	23,679	15%
4D	Aspen Stand Management	2835	2%
5B	Wildlife Winter Range in Forested Areas	3136	2%
6A	Livestock Grazing, Improve Forage Condition	3187	2%
6B	Livestock Grazing, Maintain Forage Condition	19,953	13%
7E	Wood Fiber Production	42,955	28%
1.11	Pristine Wilderness	19,859	13%
1.13	Semi-Primitive Wilderness	10,456	7%
9A	Riparian and Aquatic Ecosystem Management	14,272	9%
9E	Water Impoundment Sites	0[3]	
Total		154,865	
Non-FS		1071	

Some interpretations from Table 1 include:

- Commodity emphasis prescriptions of 6* and 7E account for 43% of the geographic area.
- Next high is 20% for Wilderness, and 4B at 15%.
- These four prescriptions account for 78% of this geographic area.

Figure 1. Existing Forest Plan Management Area Allocations

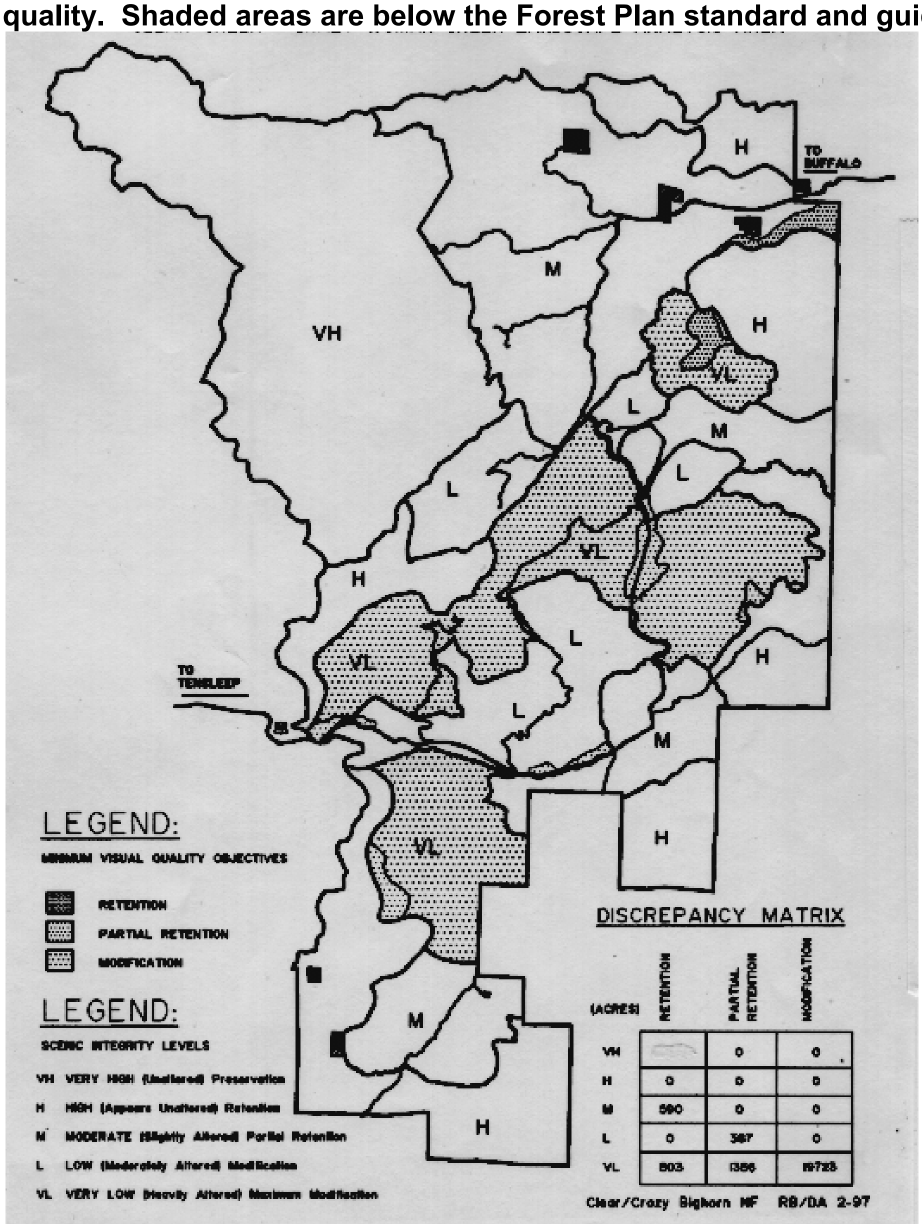


[3] The 64 acres of 9E associated with the Tie Hack Reservoir is included in the 9A area.

Comparison of existing condition to FP goals and objectives and standards and guidelines

- On a very gross scale, this geographic area is primarily allocated to timber production, and this is one of the most heavily logged geographic areas on the Forest. This is consistent with the high percentage of 7E allocation in this geographic area, and the long history of timber emphasis in this geographic area prior to the 1985 Forest Plan.
- The existing condition of scenery in the Clear Creek - Crazy Woman Creek portion of the Forest Plan analysis area is below the minimum standard for visual quality established in Forest Plan on 22,600 acres, or 15% of the area. (These figures do not include the North Fork of Powder River.) In Figure 2, the shaded areas on the map are those where the existing condition, as measured by the scenic integrity, is below the Forest Plan standard and guideline for visual quality. For a more complete description of the scenery resource, including a definition of scenic integrity, see pages 48-49 in this assessment.

Figure 2. Existing scenic condition compared to Forest Plan standard and guideline for visual quality. Shaded areas are below the Forest Plan standard and guideline.



- The current Forest Plan does not include visual quality standards to support high quality scenery along the scenic byway corridor.
  - The existing Forest Plan management area that most closely addresses the scenic byway concept is 2B, Rural and Roaded Natural Recreation Opportunities. However, it is not mapped continuously along the highways.
  - The Forest Plan management area direction was written in the early 1980's well before the concept of scenic byways was applied on the Bighorn NF.
- Currently the 3 highways across the forest are designated as scenic byways, which is recognized by Forest Plan Amendment 6. However, the amendment did not change the overall Forest Plan direction, and left the 1985 Forest Plan management area boundaries in place. While the areas in the foreground of the highways are designated as scenic byways, there are still 7E (timber harvest emphasis) management areas along the highways, which creates conflicting management goals and objectives.

What is broken and needs to be fixed in the Forest Plan?

- The diversity unit[4] scale for forested vegetation/habitats analysis and application of standards and guidelines is too small – the natural processes (fires) exceed this size.
- Update elk standards based on new data/studies – elk habitat effectiveness and elk security.
- Resource damage in areas open to cross country travel areas needs to be addressed.
- Management areas are often too small, and sometimes in hard to manage locations. An example is a 40 acre 4B management areas surrounded by large areas of 7E and bisected by Pole Creek road.
- The scenic byways management needs to be incorporated into the Plan, and integrated with other resource allocations.
- The current Forest Plan direction for scenery is described using the Visual Management System (USDA, 1974), which has been replaced by the Scenery Management System (SMS) (USDA, 1995). There is a need to update the scenery standards to be consistent with the SMS.
- Management Indicator Species (MIS) selection, standards and guidelines, and monitoring provisions need to be updated based on current uses, knowledge, and science.
- Riparian and aspen communities monitoring protocols need to be reevaluated in the Forest Plan.
- Revalidation of winter range areas, and reevaluate applicable standards and guidelines.
- Reevaluate the standards/guidelines regarding old growth.
- Fence construction standards for wildlife passage could be considered.
- Best Management Practices and Watershed Conservation Practice Handbook measures should be incorporated by reference into the Forest Plan.
- Reevaluate the standard and guideline for maintaining all riparian ecosystems in at least an upper mid-seral successional stage.
- Reevaluate the dispersed camping standards and guidelines, including the general direction prohibiting camping within a minimum of 100 feet from streams or lakes, with exceptions.
- During the roads analysis, compare road maintenance needs with the available budget. Currently, the road maintenance budget does not meet the need, see page 56.
- There are various standards and guidelines in the existing Forest Plan relating to soils, fisheries, and geographic area that are in need of evaluation. Some of the standards are

[4] Diversity unit is defined in the 1985 Forest Plan as: "A combination of contiguous analysis areas comprising a geographic area area of approximately 5000 acres. These units are the intermediate strata used in allocation of management practices." The natural scale of catastrophic fire exceeds 10,000 acres, with the Lost Fire in 1988 being a recent example.

either difficult to measure or are poorly defined. A list of the items to be reviewed is located in the forest-wide assessment.

What are the issues in this geographic area?

- User conflicts: The Forest Plan has strong objective for timber management, and the increasing use by recreationists and other forest users is creating conflicts between the people using this geographic area.
- Maintain adequate water quality to protect beneficial uses in all streams. Provide high quality water in Clear Creek for domestic use by the town of Buffalo, WY.
- Unique conifer old growth in Powder River area has important tie to marten and other species and needs managed/retained.
- Riparian and aspen impacts (past and present) may be affecting wildlife habitat quality.
- There are fewer beaver than previously thought to exist, consider this species as possible MIS/Focal species.
- High road density has lowered the amount of elk security habitat. This type of habitat can be an indicator for other species benefiting from less disturbance (e.g. marten).
- Neotropical avian monitoring (MAPS) has been conducted and these species could be considered for inclusion as part of the monitoring plan. Several species recommended as potential MIS/Focal/Species of Local Concern. This is the only site on the Forest with this type of monitoring has occurred.
- Harassment to wildlife perceived to be an issue due to “C” designation in area, and potential problems on big game winter range. Snowmobiles and moose may have localized conflicts.

III. Disturbance Factors

Riparian

For riparian landscapes, the dominant disturbance factors are streamflow regulation, fire suppression, agriculture, irrigation, livestock grazing, and human development. These factors are creating a riparian habitat that is quite different from that of presettlement times. To varying degrees, alterations of the riparian zone are occurring in both the lowlands and mountains, especially where roads and summer homes have been constructed in valley bottoms, where large herds of livestock or big game congregate, and where the land is cultivated. Such uses may be sustainable if management is done correctly, but the riparian zone has been altered more extensively than any other landscape (Knight 1994).

Fire

Over the long term, fire is the most dominant disturbance factor in this landscape, from the perspective of total number of acres affected. A very small percentage of fires affect a majority of the acre burned.

- Fires role is different among the major forest cover types of ponderosa pine, lodgepole pine and Engelmann spruce/subalpine fir. These are discussed in North Fork Powder River LA (pages 8, 33-36); North Fork Powder River fire history study (Bornong, 1996); and in the Clear/Crazy LA, pages 39-40).
- Natural factors make the Clear Crazy geographic area predisposed to more frequent and more intense fire than other geographic areas on the Bighorn NF. This is due to the large proportion of granitic soil substrate combined with the Cloud Peak rain shadow effect, that results in about 10-20% less annual precipitation than areas of the forest at similar elevations (Despain, 1973).
- Known major fire events in the Clear/Crazy geographic area:
    - Circa 1890: there was a large fire, or series of large fires around this time. This is evidenced in the year of origin information from Stage II data and the large contiguous areas of 110-year-old, pole sized, lodgepole pine stands in the geographic area. Notable areas include Doyle Creek and Elgin Park.
    - 1943: Duck Creek, about 10,000 acres (Murray, 1980)
    - 1988: Lost Fire, about 12,000 acres.
- Prescribed fire has been utilized in this area to attempt to recreate fire's natural ecological role and resulting stand conditions. Most of the acres burned to date have been in the ponderosa pine, "south slope burning", project. There are a few instances of aspen regeneration burning, and the Caribou timber sale prescriptions include about 600 acres of prescribed burning, primarily to maintain serotinous cones.

Insect and Disease

- Insect and disease are the second most dominant disturbance factor in this geographic area.
- Disturbance caused by insects and disease differs among the cover types present in the geographic area.
- For mountain pine beetle in lodgepole pine, roughly 19,709 acres (21% of the cover type in this geographic area) would be considered as being at high hazard. 72,916 acres (79% of the cover type) is at low to moderate hazard.
- For mountain pine beetle in ponderosa pine, 1441 acres (63% of the cover type in the geographic area) is considered to be high hazard to mountain pine beetle. 830 acres (37% of cover type) is estimated to be moderate to low hazard.

- About 7133 acres (40% of the cover type) of the spruce-fir cover type would be considered to be at high hazard for spruce beetle. 10,754 acres (60% of type) would be low hazard. Little is known about hazard rating for western balsam bark beetle in subalpine fir, but it will be assumed that the figures used for spruce would be roughly similar for fir.
- Dwarf mistletoes are common on the lodgepole pine throughout the geographic area. Stands are generally not hazard rated for mistletoe, as any and all hosts trees are susceptible to the disease. Recent investigations forest-wide in the Bighorns indicate that 27% of the sawtimber sized (greater than 9 inch DBH) lodgepole pine are infected with dwarf mistletoe, 15% of pole sized (5-9 inch) lodgepole are infected with dwarf mistletoe, and about 2% of saplings (less than 5 inches) are infected with dwarf mistletoe. It is assumed that these figures would be consistent across stands of lodgepole pine in this geographic area, with locally higher or lower infestations likely.
- Comandra blister rust is the other common disease in this area. Recent work in the Bighorns has indicated that about 28% of lodgepole pine is infected with this disease. It is assumed that the infection rate in the Clear/Crazy geographic area is similar to this number. Larger trees are the ones that are most obviously infected, since saplings and seedlings are frequently killed outright.

Timber Harvest

Table 2 shows the amount of timber harvest and fire since the 1940s. This table does not include tie-hacking that occurred in the 1920s and 1930s. Acres are sums of the figures shown in the North Fork Powder River and Clear/Crazy Landscape Assessments, page 64 and 53, respectively. Caribou units 1,2,12,13 were added to 1990s, and all other Caribou units are reflected in 2000.

Table 2. Timber Harvest and Fires in the Clear/Crazy/N. Fork Powder River Analysis Area

Harvest Type	1940's	1950's	1960's	1970's	1980's	1990's	2000
Clearcut			3900	2959	885	568	7
Shelterwood: Prep Cut			18	6037	2151	67	
Shelterwood: Seed Cut				35	146	332	895
Shelterwood: Overstory Removal			142	1001	514		
Seed Tree			30	386			
Selection				769	4		
Commercial Thin			782	1434	366	2	
Sanitation/Salvage				159	757	12	
Pre-commercial Thin			2537	1252	4070	403	
Aspen Clearcut				64	117		
Fire	1901[5]				8807	250	
Blowdown					573	50	
Total Cut (system not specified)	2982	883					
Acres CC + SW + ST + S + S/S[6]			4090	11,346	4457	979	902

Some of the insights from table 2 are:

- The "Silviculture of the decade" is evident in the change from predominantly clearcutting in the 1960s to Shelterwood harvests in the 1970s. While not evident from the table, this continued into the latter half of the 1980s, when small, 5-35 acre clearcuts were the dominant prescription in lodgepole pine.

[5] This is the number of acres reflected in the RIS data base, but less than the 10,000 acres estimated by Murray, 1980.
[6] CC = Clearcut, SW = Shelterwood, ST = Seed Tree, S = Selection, S/S = Sanitation/Salvage. These were summed to portray the amount of sawlog harvest that has occurred.

- The rate of harvest has decline from the 1960s and 1970s to the current rate of harvest.

There has been additional timber harvest on the lands of other ownership south of the forest. The area in the Powder River and South Crazy Woman Creek watersheds has had a variety of silvicultural systems applied on State of Wyoming, Bureau of Land Management and private lands.

Tinker, et al, 1998 quantifies fragmentation caused by timber harvest and roads on the Bighorn National Forest. That analysis and conclusions are presented in the Forest wide portion of the Forest Plan Revision existing condition assessment, rather than in each geographic area discussion.

Figure 3 shows the relative amounts of suited timber by geographic area. Clear/Crazy/Powder has the highest percentage of forested area that is currently classified as suitable for timber harvest, at nearly 60%. This table could be considered an indicator of the relative amount of forested area that is *available* for timber production purposes.

Figure 3. Amount of Forested Area Available That is Suited Timber, by Geographic Area

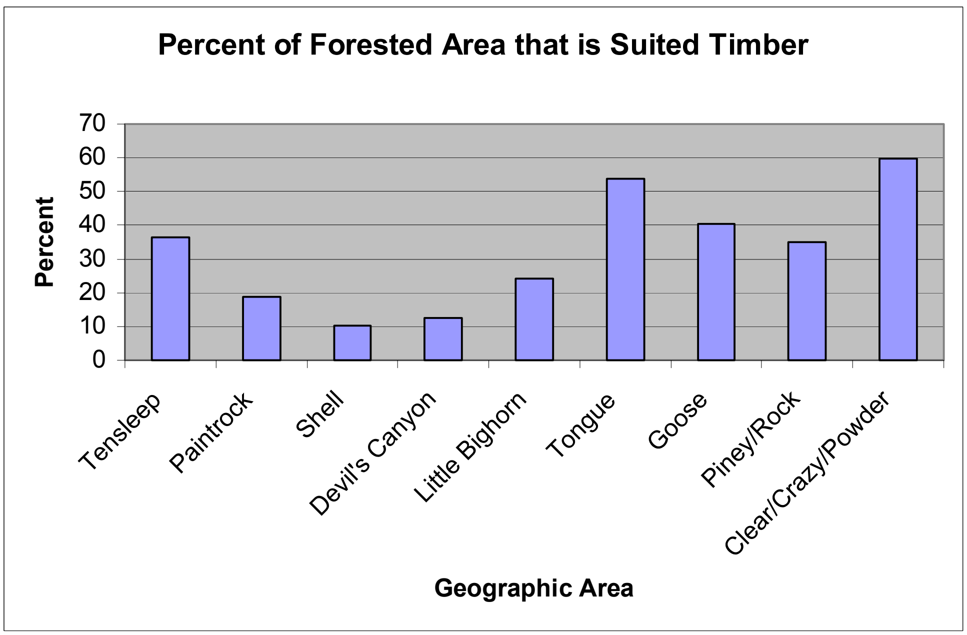


Figure 4 shows the percentage of the suited timber area that has received a final harvest (clearcut, shelterwood removal or seed cut, selection harvests) or stand-replacing fire or blowdown between 1960 and 2000. This is an indicator of the *intensity* of forest successional change, as it indicates how much of the suited land has actually had a stand replacing event between 1960 and 2000. This is from the RIS activity database and includes the time between January 1, 1960 and February 1, 2000. Each bar is divided into “fire and blowdown” and “timber harvest” to show the relative amounts of each type of disturbance.

Figure 5 shows the percentage of all forested lands that has received a final harvest (clearcut, shelterwood removal or seed cut, selection harvests) or stand-replacing fire or blowdown between 1960 and 2000. This is an indicator of the *intensity* of forest successional change, as it indicates how much of the forested area has actually had a stand replacing event between 1960 and 2000. This is from the RIS activity database and includes the time between January 1, 1960 and February 1, 2000. Each bar is divided into “fire and blowdown” and “timber harvest” to show the relative amounts of each type of disturbance.

Figure 4. Percent of Suited Timber that Received a Stand Replacing Event, 1960-2000

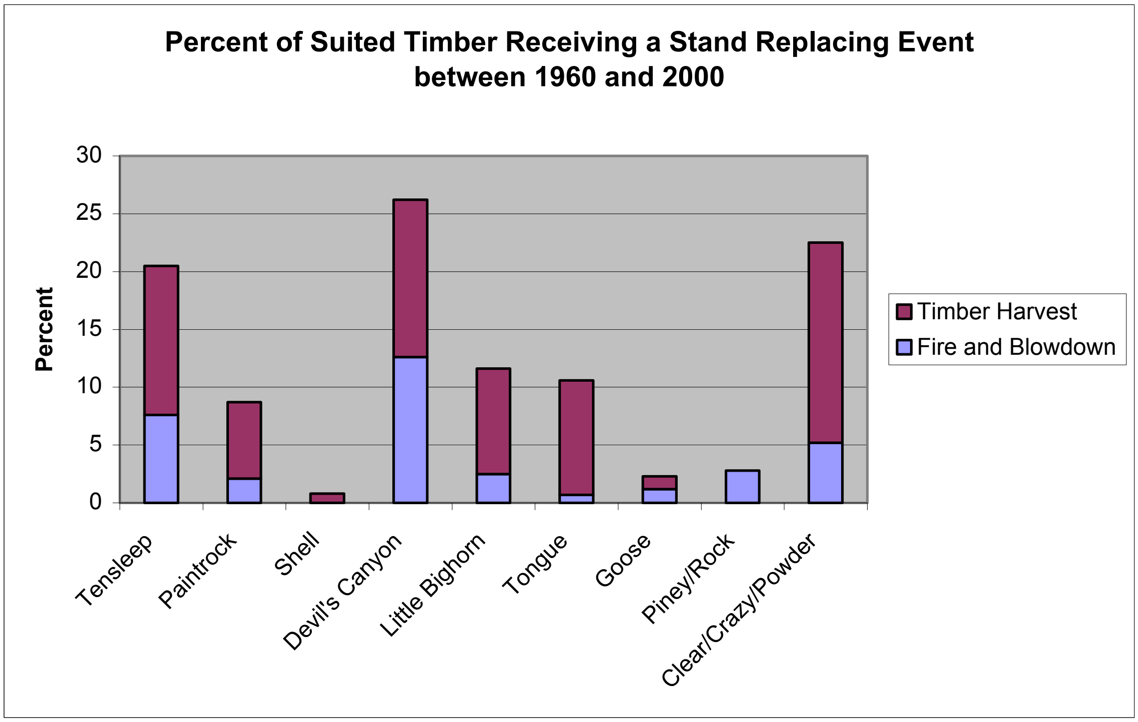
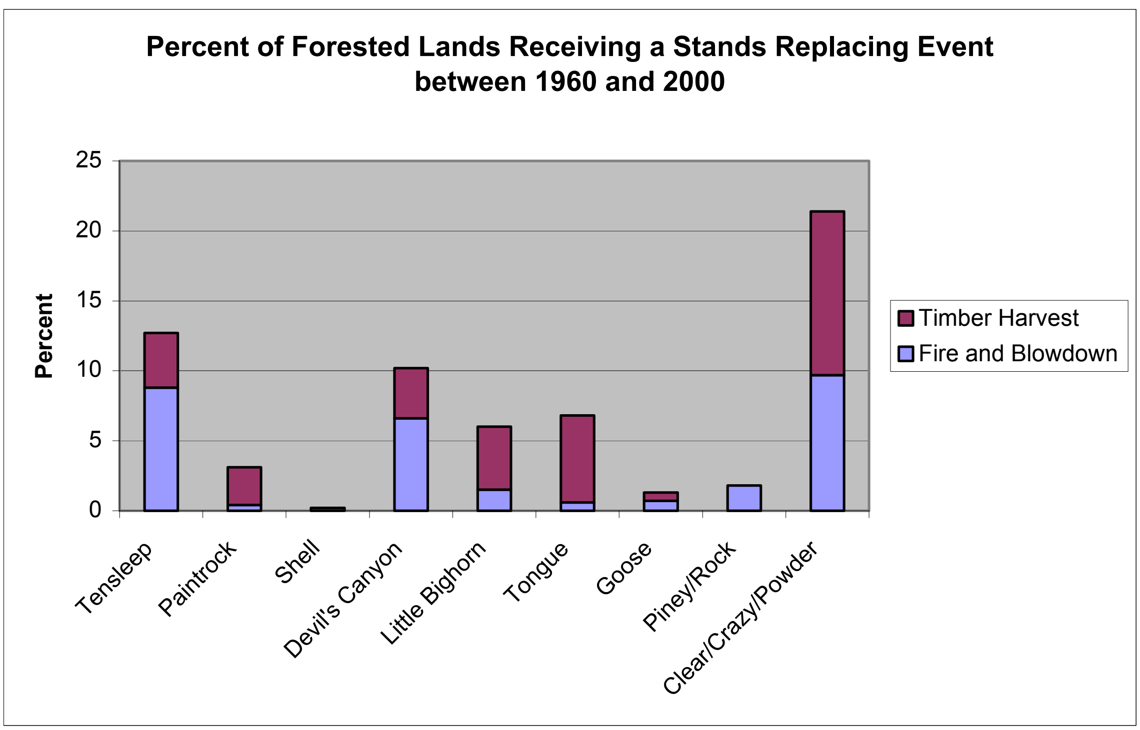


Figure 5. Percent of All Forested Lands that Received a Stand Replacing Event, 1960-2000



Exotic Species

- Forest-wide issue of non-native grass/forb seed mix for revegetation and erosion control.
- Fish: Eastern Brook trout, brown trout, golden trout, and rainbow trout are popular fishing species, but are not native to the Bighorn NF. Mountain sucker and longnose dace are the only fish species thought to be native to the Powder River geographic area.
- There are four identified areas in our GIS database of Canadian thistle in this geographic area. There are more sites, primarily along roads and timber harvest landings, throughout the geographic area.

IV. Geology and Geomorphology

Table 3 shows the Landtype Associations (LTAs) within the assessment area. Landtype associations are general descriptions of local geology and topography[7]. A map of the LTAs is in the appendix.

Table 3. Acres of Landtypes within Clear/Crazy/Powder Geographic Area

Landtype Description	Acres	% of total
Glacial cirquelands	14,266	9
Alpine mountain slopes and ridges	7,316	5
Glacial/tertiary terrace deposits	27,641	18
Granitic mountain slopes, gentle	86,869	56
Granitic mountain slopes, steep	9,013	6
Granitic breaklands	7,355	5
Sedimentary breaklands	1,545	1
Sedimentary mountain slopes, limestone/dolomite	967	1
Sedimentary mountain slopes, shale/sandstone	964	1

From Buffalo to the eastern mountain front, Highway 16 traverses Eocene rocks of the Wasatch, at the base of the Bighorn range, which is composed of cobbles of Paleozoic rocks that were deposited as gravels on alluvial fans along the front of the rising Bighorn Range around 55 million years ago. About 6 miles west of Buffalo, the road crosses the Piney Creek thrust fault, which shoved this portion of the central Bighorns over the western margin of the Powder River Basin. The road climbs through a narrow section of steeply inclined Paleozoic limestone and dolomite beds in the hanging wall of the Piney Creek thrust, and then cuts into much older Precambrian "basement" rocks. The Precambrian is composed of extremely ancient metamorphic gneisses that are over 3 billion years old. The earth is 4.7 billion years old, so these rocks are about 2/3 of the age of the planet. US 16 follows Precambrian rocks across the crest of the range to the west side where it again cuts through Paleozoic sedimentary layers along Tensleep Canyon.

Geologic Hazards

Table 4. Landslide Prone Acres

Geographic Area Name	Acres of Soils Prone to Landslides
Clear/Crazy/Powder Geographic Area	845

The landslide map used in this analysis was created from 1:24,000 scale maps obtained from the Wyoming State Geological Survey office in Laramie, WY. Within the Clear Crazy geographic area there are 845 acres of soils prone to landslides. The areas subject to slides are widely distributed in small units throughout the geographic area. The highest concentrations of slide prone soils are found in the North Fork of Clear Creek drainage, see the landslide map in the appendix.

[7] Landtype associations are groupings of landtypes or subdivisions of subsections based upon similarities in geomorphic process, geologic rock types, soil complexes, stream types, lakes, wetlands, and plant association vegetation communities. Names are often derived from geomorphic history and vegetation community. Avers, et al, 1993. See also Table 3, Chapter 1, for hierarchical location of landtype associations.

Erodibility

There are approximately 358 acres of soils within the Clear Crazy geographic area classified as having a severe risk for erosion, Table 5. Most of these areas are found near the forest boundary in the North Fork of Crazy Woman Creek Watershed. Ground disturbing activities on these soils would increase the risk of generating erosion.

Table 5. Acres of Erodible Geology

Geographic Area Name	Acres of Erodible Geology
Clear/Crazy/Powder Geographic Area	358

Mineral resources

The following information is taken from "Mineral Report-Tie Hack Campground Withdraw", Ronald L. Baer, Regional Geologist. The report is dated 3/5/2001 and can be found in the Tie Hack special uses file.

The area does not have a history of mining or mineral development. Potential diamondiferous kimberlite deposits may exist within some of the old intrusive bodies of the Bighorn Mountains, although none have been found to date. Presently, only kimberlitic indicator minerals have been identified in Precambrian and Paleozoic conglomerates along the Bighorn Mountains approximately 80 miles to the southwest of the Tie Hack reservoir.

<u>Locatable Minerals</u>
No known locatable mineral deposits (gold, silver, etc) are known to exist within the area. No information was found in the records or literature indicating past or present discoveries of locatable mineral deposits. From a record search, it does not appear there were any past mineral locations recorded in the area. There were no indications of dikes or other younger intrusive bodies, suggesting the presence of kimberlite deposits, found during the field mapping. In addition, no signs or indications of other mineralization were observed during the field work.

<u>Leasable Minerals</u>
No known leasable mineral deposits of coal, potassium, sodium, phosphate, oil, gas, oil shale, or tar sand are known to exist within the withdrawal tract. Commercial deposits of oil and gas are present in various formations east of the Bighorn Mountains in the Powder River Basin. No oil and gas drilling, exploration, or production has occurred within the area of tie hack reservoir.

<u>Salable Minerals</u>
There are no known salable mineral deposits within the withdrawal tract boundary. This includes aggregate and dimension stone deposits.

There are no known mineralized areas adjacent to the withdrawal tract. There has been a small amount of gold produced from the Cambrian Flathead Sandstone in the Kelly Creek area (T50N, R83W), a few miles southeast of the subject lands (Hausel 1989 p. 40). Some salable aggregate sources have been developed within a 10-mile radius of the withdrawal tract for road and reservoir construction use.

The potential for locatable, leasable, and saleable mineral resources within the tract area is considered low. No deposits of locatable minerals are found within the tract and the potential for economic resources, including diamonds, is considered low. There are no known leasable mineral resources within the area, thus giving the area a low potential for occurrence of leasable minerals. The salable mineral potential is rated low because of the small size of the deposit within the tract and the presence of other larger developed source deposits within a reasonable proximity of the withdrawal tract.

Hydrologic Disturbance factors

Disturbance is defined as a relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability or the physical environment (White and Pickett 1985). When quantifying the range of variation within an ecosystem, it is better to do so with an absolute measure that stresses the physical characteristics of disturbance and the mechanisms of ecosystem response, compared to an approach that focuses solely on the bounds of variation.

In general, disturbance varies along topographic gradients, as do other physical factors like insolation, temperature, and precipitation. Some disturbances are associated with particular geological settings and substrates; these include landslides and earthquakes. Others are biological in origin and include burrowing animals, grazers, and ants, beavers, and insects or pathogens. Most ecosystems experience not only several kinds of disturbance, but a range of disturbance impacts within each kind.

Not all disturbances are equivalent. Disturbances differ in six categories of descriptors: kind, spatial characteristics, temporal characteristics, specificity, magnitude, and synergisms. Taken together, the attributes of all the disturbances occurring in a system, the interactions between them, and their linkages with biotic and abiotic factors, define the disturbance regime.

Table 6. Dominant Natural Hydrologic Disturbance Factors

Disturbance Factors: Streams	Disturbance Factors: Riparian Areas	Disturbance Factors: Soils
Floods	Floods	Wind throw
Beavers	Ice Flows	Debris Flows
Drought	Fire	Fire
Erosion		Erosion

Infrequent floods do occur as the result of major convective thunderstorms with sufficient development and duration to impact this geographic area. When they occur, floods can have a serious and direct effect on water yield, quality, and timing.

V. Soils and Topography

Erosional processes

Erosion is a natural process in all watersheds. The by-product of erosion is sediment. Sediment either originates from surface erosion of exposed mineral soil or from mass movements such as landslides, debris torrents, slumps and earth flows. Sediment entering streams is delivered primarily by mass movements and surface erosion processes. Within the analysis area, the dominant sources of erosion are derived from roads and concentrated livestock grazing in riparian areas.

Failure of stream crossings, diversions of streams by roads, washout of road fills, and accelerated scour at culvert outlets are important sources of sedimentation in streams within roaded watersheds. The most common causes of road-related mass movements are improper placement and construction of road fills, inadequate road maintenance, insufficient culvert sizes, very steep hillslope gradients, placement or side cast of excess materials, poor road location, removal of slope support by undercutting, and alteration of slope drainage by interception and concentration of surface and subsurface water.

Field inventories in both the Clear-Crazy watersheds and the North Fork of Powder River show that there are stream reaches with abnormally high levels of sediment. The reaches of concern are generally located where there is concentrated livestock grazing and where roads are located within the riparian area. The sediment is being derived from bank erosion, surface erosion from roads, and overland flow across compacted soils. Currently, the extent of the impact is patchy and isolated. However, treatment of source areas would be relatively easy to accomplish. Once treated, the yearly contribution of sediment into streams within the analysis area would drop dramatically.

Range of variability in soil conditions

The range of soil conditions on managed forested lands in the analysis area has changed dramatically over the last 50-80 years. The changes are apparent in increases in soil bulk densities, lower productivity, and accelerated soil erosion. In general, where management has occurred on sensitive soils, or where mitigation measures have not been implemented, there is a wider range of conditions than is found on unmanaged soils. For example, the range of soil bulk densities in a timber harvest unit is shown to vary widely depending upon slope, soil moisture, and logging intensity. This can be compared to soils outside the unit where soil bulk densities are generally less and are less variable. The same pattern holds true for areas grazed by livestock and areas impacted by heavy recreation use. Therefore, management has the potential to increase the range of soil condition variability in the analysis area.

Table 7 shows the soil types that occur in the Clear/Crazy/Powder geographic area and the amount of the analysis area comprised of each soil type. A description of each soil type can be found in the Project File. Forage production is displayed in Table 7 as a way to display the natural range of soil productivity within the analysis area (Nesser, 1976).

Table 7. Acres of Soils within Geographic Area

Soil Identification Number	Acres	Productivity as Measured by Forage Production (#/acre)
10	21,756	500-700
11	9,433	500-700
13	6,856	Na
14	132	500-700
15	465	500-1,800
16	4,126	3,000-3,500
18	10,251	1,500-1,800
19 A and B	14,533	500-700
22	16	1,200-1,700
24	328	1,600-2,400
25	5,202	1,500-1,800
26	390	600-1700
27	129	1,600-2,400
29	780	1,600-2,400
31	8,847	500-700
32	1,182	500-700
33	5,771	600-800
36	2,486	500-800
37	7,642	Na
38	136	500-700
39	8	600-1,700
40	54,864	500-700
41 A and B	195	1,500-1,800
43	30	500-700
Water	366	Na

Risk to soil resources including soil loss or compaction

Natural and human-related disturbances have influenced the soils in the analysis area. Natural disturbances of the soil include floods, mass wasting, wind-throw, drought, insects, plant disease, and wildfire. These disturbances are directly or indirectly related to short and long-term local or global climatic conditions such as temperature differentials, freeze-thawing, precipitation (timing, amount, duration), and wind. Natural events such as these can alter long-term soil conditions within the analysis area.

Human disturbance of the soil in the analysis area began around the turn of the last century. The extent and degree of human disturbance, however, has been most pronounced in more recent times. These disturbances include such activities as road construction, grazing, mining, timber harvest, prescribed fire, fire suppression, and recreational activities. Human disturbances can have a long-term effect on soil quality by altering soil properties through road building (temporary or permanent), repeated recreation use, salt placement for cattle, pile burning following timber harvest to name a few.

The effects of past impacts to soils are expressed in terms of soil compaction. Effects of compaction may last decades or longer depending upon site conditions. Soil compaction decreases the macropore space, increases bulk density, and destroys soil structure. Decreased porosity reduces infiltration and percolation, increases surface runoff, and encourages erosion. The physical, chemical, and biological effects of compaction tend to restrict plant growth.

Dry soils are not as easily compacted as moist or wet soils. Frozen ground also tends to minimize the effects of compaction. Areas with high compaction hazard ratings may require restrictions on use during high moisture conditions. Areas currently compacted may be expected to remain impacted at least through the end of the next forest plan period.

VI. Hydrology and Water Quality

The analysis area encompasses three fifth level watersheds for a total of approximately 157,000 acres. The main fifth level watersheds are Middle Fork Crazy Woman, North Fork Crazy Woman, and Clear Creek. The watersheds range in elevation from just over 7,000 feet at the Forest boundary to over 12,000 feet at the upper portion of the Clear Creek drainage. Most of the lakes in the analysis area are high altitude lakes located in the Cloud Peak Wilderness.

Table 8. 6th Field Watershed Data within Planning Area

6th Field Watershed Name	6th Field Watershed Number	Perennial Stream Miles	Intermittent Stream Miles	FS WS Acres	Other WS Acres	Total WS Acres
North Fork Powder River near Powder River Pass	100902010101	6	32	10440	0	10440
North Fork Powder River near Dullknife Reservoir	100902010102	0	8	2087	0	2087
North Fork Crazy Woman above TA Ranch	100902050101	38	93	33862	0	33862
North Fork Crazy Woman below Munkries Pass	100902050102	8	18	6079	635	6714
Middle Fork Crazy Woman at Hazelton	100902050103	20	61	22588	126	22714
North Fork Crazy Woman: Kelly and Burnet Creek	100902050105	0	2	267	2	269
South Clear Creek	100902060301	34	40	25967	0	25967
Middle Fork Clear Creek	100902060302	19	16	13599	0	13599
North Clear Creek	100902060303	23	40	20928	151	21079
French Creek	100902060304	8	24	8299	153	8452
Clear Creek	100902060305	19	50	11818	167	11985
Totals:		**176**	**384**	**155,936**	**1,233**	**157,168**

Precipitation

The majority of the annual precipitation in this geographic area comes in the form of snowfall. In the summer, there is the risk of high intensity thunderstorms that result in flashy runoff. This high-intensity rainfall often exceeds the local infiltration rates and is directly related to the amount of runoff and the rapid response of the stream. Local surface erosion and channel erosion directly affect the water quality of the surface runoff.

The average annual precipitation ranges from 15 inches near the Forest boundary to 35 inches in the Cloud Peak Wilderness. Potential evapotranspiration ranges from 14 to 18 inches per year and the mean annual runoff ranges from 5 to 18 inches per year.

Human Impacts Upon Water Quality

The extent and intensity of land development and land-use activities within the area have increased during the past century. Environmental disturbances from non-mechanized, agriculturally based settlements have evolved into impacts associated with urban and suburban development. Non-point source pollution may be the most problematic cause of water quality deterioration because the origin of the impacts is often difficult to identify and control. Human activities and development around or near lakes, streams, reservoirs, and wetlands is directly associated with much of this non-point source pollution.

Analysis of lakes in the area shows that they have very low buffering capacities due to the granitic geology. The low buffering capacity of the lakes makes them susceptible to acidification due to atmospheric acid deposition.

Water quality criteria is established and monitored by the State of Wyoming. Surface water quality classes are a hierarchical categorization of waters according to existing and designated uses. There are four major classes of surface water in Wyoming with various subcategories within each class. Table 9 below gives a listing of water quality classes for streams within the analysis area.

Table 9. Wyoming Surface Water Quality Classifications (1998) and Domestic Water Users

Watershed	Wyoming Surface Water Quality Class	Tributaries	Wyoming Surface Water Quality Class	Community Water System being Served in each Watershed
Clear Creek	2A			City of Buffalo, WY
		French Creek	2A	Paradise Guest Ranch
		Grommond Creek	2A	
		N Fk Clear Creek	2A	
		M Fk Clear Creek	2A	
		Sourdough Creek	2A	
		S Fk Clear Creek	2A	
Crazy Woman Creek	2A			
		N Fk Crazy Woman	2A	
		Caribou Creek	2A	
		Pole Creek	2A	
		M Fk Crazy Woman	2A	
N Fork Powder River	3B			

All streams within the analysis area (except North Fork of Powder River which is 3B) are classified as 2A. Class 2 waters are waters that are known to support fish or drinking water supplies or where those uses are attainable. Class 2 waters may be perennial, intermittent or ephemeral and are protected for the uses indicated in each sub-category. There are four sub-categories of Class 2 waters, however only sub-category A applies to the streams in the analysis area.

Class 2A waters are those that are not known to have the potential to support game fish but are used for public or domestic drinking water supplies, including their perennial tributaries and adjacent wetlands. Uses designated on Class 2A waters include drinking water, aquatic life other than fish, primary contact recreation, wildlife, industry, agriculture, and scenic value.

Class 3B waters are tributary waters including adjacent wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable.

In 2000, the State conducted a review of all watersheds within the State to determine whether or not they are meeting the designated beneficial uses (i.e., fisheries, recreational use, etc.). The results of that review can be found in the document titled, "Wyoming 2000 305(b) State Water Quality Assessment Report". Table 10 summarizes the geographic areas within this analysis area listed in the State 305(b) report.

Table 10. Water Quality Impaired Watersheds (2000)

Watershed	Listed on 2000 State 305(b) Report?	Type of Listing (Impaired or Threatened)	Reason for Listing and Location of Impairment
Crazy Woman Watershed	Yes	Threatened	The North Fork of Crazy Woman watershed is listed as threatened due to water quality threats from physical degradation of the stream channel off of the Forest.
Clear Creek Watershed	Yes	Threatened	A water quality assessment in the Rock Creek and North/South Fork Shell Creek drainages indicated that these watersheds are threatened by physical degradation of the stream channel due to irrigation diversions off of the Forest. A short reach of Hunter Creek on the Forest was impacted from excessive sediment, which washed off an adjacent road and was listed on the 1998 303(d) list. Road modifications and changes to maintenance have been implemented to reduce the impact, and data indicates that conditions are improving. Because a TMDL has been developed and approved (2000), the Hunter Creek watershed will be removed from future 303(d) lists.

Over the years, there has been some water quality data collected in the geographic area. However, the data was collected without consistent methodologies or based on any monitoring objectives. Unorganized data collection limits our ability to make interpretations on condition and trend. This is an issue that will need to be addressed in Forest Plan revision.

<u>Influence of Grazing upon Water Quality</u>

Field inventories in the analysis area have shown that concentrated livestock grazing along with wildlife pressure has lead to non-point sources of sedimentation in some stream reaches. Improper grazing can lead to watersheds that have higher stream sediment levels than ungrazed watersheds. Increased sedimentation is the product of compaction, changes in vegetation composition and density, channel incision, overland flow, and bank sloughing. Sediment loads that exceed natural background levels can fill pools, silt spawning gravels, decrease channel stability, modify channel morphology, and reduce survival of emerging salmon fry. In addition, runoff contaminated by livestock wastes can cause an increase in potentially harmful bacterial. Compared to ungrazed sites, aquatic insect communities in stream reaches associated with over-grazing activities are often composed of organisms more tolerant of increased silt levels, increased levels of total alkalinity and mean conductivity, and elevated water temperatures. Monitoring is being conducted throughout the Forest to determine if negative grazing impacts can be avoided through implementation of grazing Best Management Practices (BMPs).

Influence of Timber Harvesting upon Water Quality

Timber harvest activities are one of the major land management activities within the analysis area. The mechanical processes involved in timber harvest and associated road construction, in conjunction with natural conditions, influence the level of disturbance within watersheds. Negative effects tend to increase when activities occur on environmentally sensitive terrain with steep slopes composed of highly erodible soils that are subject to high climatic stresses.

Soil and site disturbance that inevitably occur during timber harvest activities are often responsible for increased rates of erosion and sedimentation, modification and destruction of terrestrial and aquatic habitats, changes in water quality and quantity, and perturbation of nutrient cycles within aquatic ecosystems. Physical changes affect runoff events, bank stability, sediment supply, large woody debris retention, and energy relationships involving temperature. All of these changes can eventually culminate in the loss of biodiversity within a watershed.

Increased delivery of sediments, especially fine sediments, is usually associated with timber harvesting and road construction. As the deposition of fine sediments in salmonid spawning habitat increase, mortality of embryos, alevens, and fry rises. Erosion potential is greatly increased by reduction in vegetation, compaction of soils, and disruption of natural surface and subsurface drainage patterns. Generally, logged slopes contribute sediment to streams based on the amount of bare compacted soils that are exposed to rainfall and runoff. Slope steepness and proximity to channels determine the rate of sediment delivery.

Research by Troendle, et al (1998), shows that when approximately 24% or more of the basal area of a watershed is removed, peak flows (instantaneous maximum flow or maximum mean daily flow) were not significantly increased. However, the duration of the higher, near bankfull discharges were extended.

Historic fires, such as those that occurred in the 1880-1890 period, burned at least 24% of the Clear Creek and Crazy Woman watersheds. A more recent example, the 12,000-acre Lost Fire in 1988, was sufficiently large to induce streamflow changes in the affected watersheds. In this ecosystem fires of this magnitude and intensity are the norm, not the exception, so there was a natural range of variability in the total streamflow water output. If humans were able to effectively suppress fire in this ecosystem, which is not necessarily possible over the long term, suppression would narrow the range of variability that naturally occurs in water yield.

Table 12 gives the acres of treatment followed by the equivalent clearcut acres for that treatment. An equivalent clearcut acre is roughly equal to the basal area removal for a given harvest type. For example, a shelterwood prep-cut removes approximately 33% of the basal area in a treated stand. The ECA for that prescription is 0.33.

As shown in Table 11, approximately 17% of the geographic area is in an ECA condition. In reality, this number would be somewhat less than 17% due to vegetation recovery following fire or timber removal. However, given this worst-case scenario, timber management combined with natural wildfire has probably not exceeded the range of variability in vegetation removal in this geographic area.

Table 11. Equivalent Clearcut Acres for the Clear/Crazy/Powder Geographic Area

Harvest Type	Equivalent Clearcut Multiplier	1950's	1960's	1970's	1980's	1990's	2000	Totals
Clearcut								
(acres)	1.00		3900	2959	885	568	7	8319
(ECA)			3900	2959	885	568	7	**8319**
Shelterwood: Prep Cut	0.33							
(acres)			18	6037	2151	67		8273
(ECA)			6	1992	710	22		**2730**
Shelterwood: Seed Cut	0.33							
(acres)				35	146	332	895	1408
(ECA)				12	48	110	295	**465**
Shelterwood: Overstory Removal	1.00							
(acres)			142	1001	514			1657
(ECA)			142	1001	514			**1657**
Seed Tree								
(acres)	0.85		30	386				416
(ECA)			26	328				**354**
Selection								
(acres)	0.35			769	4			773
(ECA)				269	1			**270**
Commercial Thin								
(acres)	0.35		782	1434	366	2		2584
(ECA)			274	501	128	1		**904**
Sanitation/Salvage								
(acres)	0.35			159	757	12		928
(ECA)				56	265	4		**325**
Pre-commercial Thin								
(acres)	0.20		2537	1252	4070	403		8262
(ECA)			507	250	814	81		**1652**
Aspen Clearcut								
(acres)	1.00			64	117			181
(ECA)				64	117			**181**
Fire								
(acres)	1.00				8807	250		9057
(ECA)					8807	250		**9057**
Blowdown								
(acres)	1.00				573	50		623
(ECA)					573	50		**623**
TOTALS								**26,537**
% of Area[8]								**17%**

[8] This number does not account for vegetation recovery over time. Following fire or timber harvest, trees will reestablish themselves on a site and the ECA for that activity will approach zero. Therefore, the ECA's for this geographic area will probably be somewhat less than suggested by this table. Also, roads were not included in this table at this time. Roads add approximately 4 acres of ECA per mile.

Influence of Roads upon Water Quality

Table 12. Number of Stream Crossings in Planning Area

Geographic Area	No. of Stream Crossings	No. of Stream Crossings/Square Mile
Clear/Crazy/Powder	276	1.44

Roads contribute more sediment to streams than any other land management activity, but most land management activities such as mining, timber harvest, grazing, recreation, and water diversions are dependant on roads. The majority of sediment from timber harvest activities is related to roads and road construction and associated increased erosion rates. Serious degradation of fish habitat has been shown to result from poorly planned, designed, located, constructed, or maintained roads.

Roads in the analysis area directly affect natural sediment and hydrologic regimes by altering stream flow, sediment loading, sediment transport and deposition, channel morphology, channel stability, substrate composition, stream temperatures, water quality, and riparian conditions within a watershed. Road related mass movements can continue for decades after the roads have been constructed. Such habitat alterations can adversely affect all life-stages of fishes, including migration, spawning, incubation, emergence, and rearing.

Poor road location, concentration of surface and sub-surface water by cross slope roads, inadequate road maintenance, undersized culverts, and sidecast materials can all lead to road related mass movements. Sediment production from logging roads in granitics of Idaho was 770 times higher than in undisturbed areas; approximately 71 percent of the increased sediment production was due to mass erosion and 29 percent was due to surface erosion (Megahan and Kidd, 1972)

In granitic landtypes, such as those found in the analysis area, sedimentation is directly proportional to the amount of road mileage (Jensen and Finn, 1966). For instance, 91 percent of the annual sediment production by land use activities in the South Fork of Salmon River has been attributed to roads and skid trails (Arnold and Lundeen, 1968). Research has determined that roads in the Idaho batholith increased surface erosion by 220 times the natural rates per unit area (King, 1993). Roaded and logged watersheds in the South Fork of Salmon River drainage also have significantly higher channel bed substrate embeddedness ratios than undeveloped watersheds (Burns, 1984).

Road/stream crossings can also be a major source of sediment to streams resulting from channel fill around culverts and subsequent road crossing failures. Plugged culverts and fill slope failures are frequent and often lead to catastrophic increases in stream channel sediment, especially on old abandoned or unmaintained roads. Unnatural channel widths, slope, and streambed form occur upstream and downstream of stream crossings, and these alterations in channel morphology may persist for long periods of time. Channelized stream sections resulting from riprapping of roads adjacent to stream channels are directly affected by sediment from side casting, snow removal, and road grading; such activities can trigger fill slope erosions and failure. Because improper culverts can reduce or eliminate fish passage, road crossings are a common migration barrier to fishes.

Field inventories have shown that the amount of watershed risk presented by roads in the analysis area is directly related to maintenance level. The lower maintenance level roads tend to be more susceptible to yearly input of sediment into nearby streams. Table 13 displays the existing miles of road by maintenance level in the analysis area. This number will be used to compare watersheds at highest risk for road related watershed impacts.

Influence of General Recreational Activities upon Water Quality

Mountain lakes, especially those in wilderness areas may be the most susceptible aquatic systems to the negative effects of recreation. The inherent sensitivity of a lake to pollutants influences its susceptible to water quality degradation. Sensitivity varies among lake types. Large, deep lakes with a large inflow may be least susceptible to water quality degradation because pollutants are diluted by large volumes of water and settle along with particulate matter. Lakes that are small and shallow, or that have a low inflow, are more sensitive to pollutants. The likelihood of pollutant-loading increases if soil, geologic, or hydrologic characteristics of a watershed favor the transport of pollutants to the lake.

Table 13. Miles of Forest Service Roads in the Geographic Area

Maintenance Level	Miles of road within the Geographic Area	Overall Condition and Geographic Area Risk
Unclassified	58.2	In the Clear-Crazy geographic area, roads in this category are generally either user-created or abandoned system roads (50/50). The level of watershed risk depends upon the treatments used to reclaim them. They tend to be used seasonally to access recreation areas. No maintenance occurs on these roads. Watershed impacts can occur when these roads are near water bodies. However, limited use reduces the risk to water quality.
Level 1	110.5	These roads are generally not open to the public. They are closed except for administrative purposes. Watershed impacts tend to vary with the amount of use and the effectiveness of erosion control measures.
Level 2	159.1	These roads tend to be native surface roads with poor drainage design. During wet seasons, rutting frequently occurs. Stream crossings are generally a source of sediment. These roads pose the highest risk to water quality due to their frequent use, number of stream crossings, and low standard design. However, road maintenance is beginning to catch up on the tremendous backlog of improvement needs in this area.
Level 3	50.0	These roads are generally designed with good road drainage and maintained on a regular basis. These roads tend to be in-sloped with a ditch and have a gravel surface. They usually do not pose a serious threat to water quality.

Where visitor use is high, trampling associated with foot traffic can affect vegetation along lakes and streams through direct mechanical action and indirectly through changes in soil. Resistance to trampling depends on plant life form; large and broad-leaved plants are most susceptible, and grasses generally are most resistant. Loss of vegetation from shorelines, wetlands, or steep slopes can cause erosion and pollution problems.

In summary, the watershed conditions in the Clear Creek, Crazy Woman Creek, and North Fork of Powder River geographic area is in average to above-average condition. There are isolated areas that have been particularly impacted by land management activities. However, their overall impact to the water quality and channel stability of the streams in the area is negligible at the scale of this geographic area.

Reservoirs and Impoundments

The Tie Hack reservoir has a significant effect on the discharge of sediment and water from the Clear Creek watershed. Storage of water and sediment in the impoundment has a detectable effect on the stream conditions downstream.

The broad channels in the lower reaches are characterized by a net loss of surface runoff from the area (ground water recharge). The steeper G[9] channels tend to be unstable and produce sediment by bank erosion during flashy runoff periods. The steeper G and A[10] channels provide an efficient network to route water from the area during high-intensity precipitation periods.

The slopes and topography of the watershed, in combination with the geology and soils of the area regulate the type and extent of channel network development. Overall, the topography of the area does not influence the amount of water produced or the quality of the water. Topography does have a moderate effect on the timing of yield as a result of the drainage density of the watershed.

Wetlands/Riparian Areas

Table 14 shows the acres of riparian area within the Clear/Crazy/Powder geographic area, and a map of the riparian areas is in the appendix. Riparian areas are defined in management prescription area 9A of the 1985 Forest Plan, page III-198:

> "The aquatic ecosystem, the riparian ecosystem (characterized by distinct vegetation), and adjacent ecosystems that remain within approximately 100 ft. measure horizontally from both edges of all perennial streams and from the shores of lakes and other still waters bodies."

Table 14. Acres of Riparian within Clear/Crazy/Powder Geographic Area

6th Field Watershed Name	6th Field Watershed Number	Acres of Riparian
North Fork Powder River near Powder River Pass	100902010101	1,146
North Fork Powder River near Dullknife Reservoir	100902010102	121
North Fork Crazy Woman above TA Ranch	100902050101	3,251
North Fork Crazy Woman below Munkries Pass	100902050102	456
Middle Fork Crazy Woman at Hazelton	100902050103	1,872
North Fork Crazy Woman: Kelly and Burnet Creek	100902050105	7
South Clear Creek	100902060301	2,596
Middle Fork Clear Creek	100902060302	1,094
North Clear Creek	100902060303	1,849
French Creek	100902060304	880
Clear Creek	100902060305	986
Total:		**14,257**

At the time of the 1985 Forest Plan, only a few of the larger riparian areas were mapped. Since then, the riparian mapping project defined areas of riparian vegetation, and Geographic Information Systems (GIS) were developed, making the mapping of riparian areas feasible. The riparian mapping project on the Bighorn was completed in about 1995. The project consisted of using 1992

[9] G channels are deeply entrenched into bedrock and have moderate channel gradients, low width/depth ratios, and randomly spaced steps and plunge pools (Rosgen and Silvey, 1998).
[10] A channels are steep, entrenched, and confined in bedrock, and are associated with faults, scarps, folds, joints and other structurally controlled drainage ways (Rosgen and Silvey, 1998).

color infrared, 1:24,000 scale, aerial photography to map riparian areas based upon a combination of the riparian vegetation and the stream course geomorphology and topography. Broad vegetation types were identified from the photography, and are discussed on page 41 of this assessment.

Riparian vegetation has a moderate influence on water yield due to evapotranspiration rates associated with riparian species. Since evapotranspiration rates are highest during periods of highest runoff, the effect of riparian vegetation on the timing of water yield is only moderate. Riparian vegetation is extremely important for control of sediment from upslope sources during high runoff/surface erosion periods. Riparian vegetation is also critical for the stability of lower gradient stream reaches.

Natural and human causes of change between historical and current hydrologic conditions

Cattle and wildlife grazing in riparian areas is having are having a detectable effect on local water quality (bacteria/nutrients) in some areas. Cattle can trample stream banks and increase downstream sedimentation. This results in localized erosion and sedimentation as well as a direct change in channel form. Flow is moderately affected by localized soil compaction. Timing of flows is not affected by domestic stock.

Due to the relatively high road densities, there are detectable influences on water yield and timing. The effects of roads on water quality are highest during periods of high precipitation and runoff. Roads are a major source of sediment because of the geology, road densities, location, and proximity to streams.

Areas of high human concentration without proper functioning human waste disposal facilities can also contribute to bacteria and nutrient levels.

VII. Aquatic Species and Their Habitat

Aquatic Species Habitats

The effects of land use on aquatic systems are often manifested through substantive changes in hydrology and morphology of streams and rivers. Such changes can have serious ramifications for aquatic organisms. Streams and adjacent environments are generally the most biologically productive areas within watersheds, and are often the sites of greatest conflict in resource management.

Research has documented the detrimental effects of land management on aquatic habitats, and subsequent effects on aquatic species. This has spurred a closer look at the connections between land use, stream-channel characteristics, and habitat conditions.

The variables used to describe stream channel characteristics at the geographic area scale must be sensitive to land-use practices and be important indicators of habitat quality. Table 15 lists the twelve variables suited for analysis, four of which have biological implications. This information has been collected on approximately 40% of the Bighorn National Forest. However, this information is not currently available for the Clear/Crazy/Powder geographic area.

Table 15. Aquatic Habitat Measurement Indicators

Aquatic Habitat Indicators[11]	Measurement Criteria
Large Pool Frequency	Number of pools with maximum depth > 0.8 m and surface area > 20 m^2 per mean reach riffle width.
Total Pool Frequency	Number of pools per mean reach riffle width.
Fraction Slow Water	Fraction of total reach length consisting of pools and glides
Mean Pool Depth/Width	The mean of the ratio of maximum depth to width for all pool channel units in a reach.
Variance Pool Depth/Width	Variance of the ratio of max depth to width for all pools in a reach.
Mean Riffle Depth/Width	Mean of the depth to width for all riffles in a reach.
Variance Riffle Depth/Width	Variance of the ratio of depth to width for all habitat units in a reach.
Wood Frequency	The number of pieces of wood per average riffle width.
Wood Aggregate Frequency	The number of wood aggregates per average riffle width.
Embeddedness	Substrate is classified as being embedded if 35 percent of the interstices are filled with fine sediment.
Bank Stability	Fraction of the reach that is estimated being stable.
Surface Fines	Reach mean of the areal fraction of each pool tail and low-gradient riffle covered in sediment < 6mm in diameter.

[11] Reach-level aquatic data has not been collected for streams in the Clear-Crazy geographic area at this time. However, reach-level aquatic habitat data has been collected for the following geographic areas (1998-2001): Paintrock, Devil's Canyon, Little Bighorn, and Tongue. As this data is complied, summaries of habitat data for reference and non-reference reaches will be added to these geographic area assessments.

TES (species at risk) and their habitats

The Yellowstone cutthroat trout (Oncorhynchus clarki bouvieri) is the native trout of the Bighorn Mountains, although it is generally considered unlikely they were native to the Powder River watershed. Individual populations of the Yellowstone subspecies have evolved numerous life-history characteristics in response to the diverse environments in which they have been isolated since the last glacial retreat. Anthropogenic activities have resulted in a substantial reduction in the historical distribution of this subspecies, and many unique local populations have been extirpated. As a result, the Yellowstone cutthroat trout has been designated as a species of special concern – class A by the American Fisheries Society.

<u>Historical Distribution</u>
The Yellowstone cutthroat trout is more abundant and inhabits a larger geographical range in the western US than any other non-anadromous subspecies of cutthroat trout. Yellowstone cutthroat trout were historically found in the Yellowstone River drainage in Montana and Wyoming and in the Snake River drainage in Wyoming, Idaho, Utah, Nevada, and Washington.

<u>Current Status and Distribution</u>
Beginning in 1998, the Forest has worked with the Wyoming Game and Fish Department to inventory the distribution of Yellowstone cutthroat trout within the historical range in the Bighorn Mountains. The current distribution of Yellowstone cutthroat trout in the Bighorn Mountains can be found in the project file. There are known populations of genetically pure Yellowstone cutthroat trout on both the east and west sides of the Forest. Most populations are small and isolated in short reaches of remote streams. All populations are at risk of introgression from non-native species.

Natural populations of Yellowstone cutthroat trout are found in very small isolated pockets of remote streams on the Forest, none of which are in this analysis area.

Table 16. Miles and Quality of Occupied Yellowstone Cutthroat Trout Habitat in Clear/Crazy/Powder Geographic Area

Miles of Occupied YCT Habitat in Geographic Area	Quality of Occupied Habitat
0.0	There are no known populations of Yellowstone cutthroat trout in the analysis area.

<u>Life History Characteristics</u>
Low genetic diversity among populations of Yellowstone cutthroat trout may reflect a substantial compression of the geographic range of the subspecies during the Pleistocene. In contrast, life-history strategies across the range, and even within individual assemblages of Yellowstone cutthroat trout, are highly diversified. The variability in life-history strategies may represent a complex response to environmental variability operating at different temporal and spatial scales.

<u>Habitat Relationships</u>
Yellowstone cutthroat trout occupy diverse habitats. Lacustrine populations inhabit waters ranging in size from small beaver ponds to large lakes. Fluvial populations were historically present in streams ranging in size from large rivers to small first-order tributaries with mean widths of one meter and less.

The subspecies is well adapted to relatively cold, harsh environments. Although Yellowstone cutthroat trout are associated with cold water habitats, researchers report that water temperatures within portions of the historical range exceeded 26 degrees C. Most large river warm water populations have been extirpated; however, several populations have been documented in geothermically heated streams in Yellowstone National Park.

<u>Key Factors Influencing Yellowstone Cutthroat Trout</u>
Introgression with introduced salmonids is clearly a key factor in the decline of Yellowstone cutthroat trout. Hybridization resulting from introductions of rainbow trout and nonnative cutthroat trout is believed to be a primary cause in the decline of this subspecies. Hybrids are developmentally successful, and progeny may appear as morphological and meristic intermediates between parental types or virtually identical to a singe parental type. Consequently, verifying genetic integrity with morphological data alone is virtually impossible.

Habitat degradation is a second factor important in the decline of this trout. Activities such as dam construction, water diversions, grazing, mineral extraction, road construction, and timber harvest have substantially degraded environments throughout the range of Yellowstone cutthroat trout.

Recreational use can also be a significant source of disturbance. Anthropogenic activities such as road construction have resulted in barriers to migration, reduced flows, sediment deposition, groundwater depletion, stream bank instability, erosion, and pollution. Efforts to curtail human activities and restore degraded stream segments are increasing, but habitat degradation continues.

Effects of livestock grazing on riparian habitats are well documented. In the range of the Yellowstone cutthroat trout, researchers have reported that intensive livestock grazing has caused degradation of riparian areas and subsequent stream bank sloughing, channel instability, erosion, and siltation. Alterations are broadly distributed.

Angling is another factor that may play an important role in the status of remaining Yellowstone cutthroat trout. Yellowstone cutthroat trout are extremely vulnerable to angling, and angler harvest has contributed to substantial declines in population abundance throughout the historical range of the subspecies.

Natural and human causes of change affecting aquatic life

Wildfire has been a common agent of change in the assessment area since the Mesozoic. Present aquatic systems have evolved in response to, and in accordance with, fire. The effects of fire on aquatic systems may be direct and immediate (i.e., increased water temperature) or indirect occurring over an extended period. Ultimately fire results in a natural mosaic of habitats and populations. The persistence of species in freshwater aquatic systems is linked to adaptation to periodic perturbations such as those resulting from wildfire. In fact, the metapopulation concept is focused on the periodic loss of habitat patches (local extirpations) and subsequent re-invasion by individuals from neighboring patches (dispersal). In an ecologically functioning stream network that provides sufficient stream connectivity for species refuge, reestablishment of fishes is generally rapid.

The long-term effects of fire usually result from erosion. Erosional processes potentially change channel morphology, sediment composition and concentration, food availability, and recruitment and distribution of large woody debris. The intensity and scale of these effects are related to the size and intensity of the fire, geology, topography, and size of the stream system, and amount, intensity, and timing of subsequent precipitation events. Physical properties of soil that influence water retention are altered by heating, and in some cases, soils become water repellent after severe burns. The amount of vegetation remaining in a watershed after a fire directly influences runoff and erosion by physically mediating the force of precipitation on soil surfaces, altering the evapotranspiration cycle, and providing soil stability through root systems. Runoff rate and pattern and subsequent erosion potential are directly affected by the amount of organic debris left in the watershed. Revegetation of burned areas is influenced by the intensity and duration of a fire, and the amount and type of new vegetation are related to changes in water yield and nutrient retention in the watershed. Erosional effects of fire generally peak within 10 years following the event.

By the late 1860's, human activities had begun to alter the assessment area landscape, including the hydrologic function of rivers and streams and features that served as important habitat for aquatic life. By 1900, livestock grazing had reduced extensive willow coverage along many streams to scattered patches. Water withdrawals for irrigation were also developed early and rapidly. Constructing drains, ditches and dikes in valley bottoms and lowlands reduced terrestrial-aquatic interaction. Dams also altered the natural basin hydrology and sediment transport capacity.

In short, the ecological integrity of streams, lakes, and wetlands was significantly compromised by the mid 1900's. Increasing human populations, downstream water demands, and agriculture accelerated greatly following WWII. Individually, and in combination, these activities continue to fragment and compromise the remaining hydrologically connected and vegetated reaches of streams.

<u>Influence Of Non-Native Fish Species Introductions</u>

The introduction of non-native fishes and aquatic invertebrates has had an important influence on species assemblages and aquatic communities throughout the geographic area. Longnose dace (Rhinichthys cataractae) and mountain sucker (Catostomus platyrhynchus) are the species considered to be native to the Powder River watershed, although there is a possibility that Yellowstone cutthroat are also native. Currently at least seven species, subspecies, or stocks of fish have been introduced or have moved into habitats where they did not occur naturally. Most introductions have been made with the intent of creating or expanding fishing opportunities and were initiated in earnest as early as the late 1800's.

Stocking of mountain lakes with cultured stocks of cutthroat, brook, and rainbow trout has been extensive. Many lakes that were historically barren of fish were capable of sustaining them, but lack of spawning habitat or isolation from colonizing populations prevented natural invasion. A variety of species such as lake trout, rainbow trout, golden trout, brown trout, and splake were introduced to diversify angling opportunities, create trophy fisheries, and to provide forage for potential trophy species. Cultured strains of rainbow trout have been widely used to sustain put-and-take fisheries in lakes and rivers where angler harvest or habitat degradation is too excessive to rely on natural reproduction.

Such introductions have led to the elimination of some native populations, while further fragmentation and isolation of other populations have left them more vulnerable to future extirpation. Although introductions have provided increased fishing opportunities and socioeconomic benefits, they have also led to catastrophic failures in some fisheries and expanded costs to management of declining native stocks.

Consequences of introducing non-native species are not limited to a few interacting species. Effects frequently cascade through entire ecosystems and compromise structure and ecological function in ways that rarely can be anticipated. There is a growing recognition that biological integrity and not just species diversity is an important characteristic of aquatic ecosystem health. The loss or restriction of native species and the dramatic expansion of non-native species leave few systems uncompromised.

<u>Influence of Aquatic Habitat Fragmentation and Simplification</u>

The physical environment and the natural and human-caused disturbances to that environment profoundly influence the structure, composition, and processes defining aquatic ecosystems.

Aquatic habitat fragmentation (impassable obstructions, temperature increases, and water diversion) and simplification (channelization, removal of woody debris, channel bed sedimentation, removal of riparian vegetation, and water flow regulation) have resulted in a loss of diversity within and among native fish populations. The fragmentation of aquatic systems occurs though natural, dynamic processes as well. Over geologic time river basins become connected or isolated. Within the assessment area, river basins have been isolated by geologic processes that influence the distribution of species and subspecies. Natural populations of Yellowstone cutthroat trout, for example, are found in very small isolated pockets of remote streams on the Forest, none of which are in this analysis area.

VIII. Air Quality and Visibility

Sulfur Dioxide (SO^2), nitrogen dioxide (NO^2), and ozone (O_3) are gaseous pollutants that can harm vascular vegetation. Effects include injury of plant leaves or needles, reduced growth, and increased susceptibility to insects and disease. Generally, because SO^2 and NO^2 quickly convert to other compounds, they are only a threat to vascular vegetation in the immediate vicinity of the pollution source. Ozone, on the other hand, can affect vegetation far downwind of the source. Lichens may also be affected by SO^2 and ozone. Reported effects include changes in community composition and sulfur accumulation.

SO^2 and NO^2 convert to sulfate and nitrate, respectively. Sulfate and nitrate are acidic pollutants that can be deposited in dry or wet (snow or rain) form and can acidify soils and surface waters. Nitrate deposition can also affect soil nutrient cycling and plant community composition. Particulate mater, volatile organic compounds, SO^2 and nitrogen oxides (NO_X) all contribute to visibility impairment. The impairment can be in the form of a cohesive visible plume, or the pollutants can be dispersed, forming a diffuse regional haze.

Summary of air quality and visibility or other air resource concerns

The only wilderness in the Bighorn National Forest is Cloud Peak, a Class II air quality area. Bighorn National Forest personnel developed a proposed air quality monitoring plan for the Cloud Peak Wilderness (USDA, 1992). The plan includes monitoring objectives, resource susceptibility and current status, proposed monitoring protocols, and monitoring data uses. Portions of this plan have been implemented since 1992 (see Table 17).

Visibility and lake chemistry data have been collected on the forest, and ozone and deposition data have been collected at nearby sites. Table 17 lists the air quality data that have been collected on the Bighorn.

Table 17. Air Quality Data on the Bighorn National Forest

Data Source	Parameter	Dates
Forest Service	Lake Chemistry (long-term)	1994-Present
Forest Service	Lake Chemistry	1992-1993
Forest Service	Visibility (Camera only)	1995-Present

Camera data have been collected on the forest since 1995. Summer season slides were evaluated to provide a rough estimate of the standard visual range (SVR). SVR is inversely related to light extinction and can be interpreted at the farthest distance a large, black feature can be seen under prevalent atmospheric conditions. The theoretical maximum SVR is 391 km. The slides suggest that visibility in the Bighorn NF on the best days is 327 km. This makes the visibility on the Bighorn National Forest one of the best in the lower 48 states.

The Wyoming Department of Game and Fish conducted sporadic lake chemistry sampling in and near the Bighorn NF between 1984 and 1991. The USDA Forest Service conducted synoptic sampling of 35 lakes in the Cloud Peak Wilderness in 1992 and 1993. The surveys identified a number of lakes in the wilderness with acid neutralizing capacity (ANC) below 100 micro equivalents per liter (µeq/l), indicating the lakes are sensitive to acid deposition. In fact, many of the lakes are extremely sensitive, with ANC below 25 µeq/l. The Cloud Peak Wilderness had a higher percentage of sampled lakes with acid sensitivity than the Collegiate Peaks, Eagles Nest, Mount Evans, Weminuche, or San Juan wildernesses in Colorado.

Two lakes in the Cloud Peak wilderness, Emerald and Florence, were selected for long-term monitoring. While monitoring has not been conducted long enough to detect trends, data collected from 1994 through 1997 have consistently shown that the lakes are acid-sensitive (low buffering capacity). Data have not been collected for other air quality related values[12], except that a list of plant species with known sensitivity to air pollution has been developed for the Cloud Peak wilderness (USDA, 1992).

The Wyoming Department of Environmental Quality (WDEQ) District 4 engineer compiled a 1997 summary of permitted emissions for all major and minor sources in Big Horn, Hot Springs, and Washakie counties. Permitted emissions are the pollution limits contained in the source permit. Often sources emit less than their permitted limits because pollution controls work better than anticipated or lack of demand for their product curtails the number of operating hours. Permitted emissions are shown in Table 18.

Table 18. Permitted emissions (tons/year) in selected counties

County	Sulfur Dioxide (SO^2)	Nitrogen Oxides (NO_X)	Volatile organic compounds (VOC)	Particulate Matter (PM)
Big Horn	2568	546	69	510
Hot Springs	1709	33	588	0
Washakie	1591	1330	288	170

The city of Sheridan is in non-attainment for the PM10[13] standard under the North American Air Quality Standards. Under the ‘conformity’ section of the Clean Air Act, federal agencies such as the USDA Forest Service are prohibited from conducting or approving activities that could impede the clean up of these areas. Consequently, Forest Service activities, such as prescribed fire, that produce pollutants in or near Sheridan may be subject to special restrictions, documentation requirements, and or mitigation.

Ozone data have not been collected on the Bighorn NF. However, Yellowstone National Park data are likely to be representative of conditions on the Forest. The Yellowstone NP values for these statistics are far below those believed to result in foliar injury or growth effects in vegetation. In conclusion, ozone concentrations at Yellowstone NP, and probably at the Bighorn NF, are not currently high enough to affect human hearth or vegetation. It is not likely that ozone concentrations will increase significantly in the future (USDA, 1999).

Air Quality Trends

A review of the 1996 actual emissions from counties within 100 km of the Bighorn NF shows the major stationary source categories that are the largest contributors of air pollutants near the forest. The largest contribution of SO2 emissions is from oil and gas production/distribution, followed by electric services, then petroleum refining, then chemical production. The largest contribution of Nox emissions is from oil and gas production/distribution, followed by electric services. The largest contribution of VOC emissions is from oil and gas production/distribution, followed by petroleum refining, then electrical services. The greatest contribution of particulate matter is from coal and lignite mining.

Other than statewide information, there are no data on emission or source category trends near the Bighorn NF.

[12] Air quality related values (AQRVs) include flora, fauna, soil, water, cultural resources, odor and visibility.
[13] Particles with a diameter less than or equal to 10 micrometers.

A number of activities and industries emit air pollutants that can affect the air quality and resources on National Forests. Examples include power plants, pulp and paper mills, motor vehicles, wildfire, prescribed burning, oil and gas, and mining. Actual emissions information for major stationary sources (those that emit more than a threshold amount of at least one pollutant) is entered into the US Environmental Protection Agency AIRS database by the Wyoming DEQ on an annual basis. Actual 1996 emissions, by country, from the stationary source categories in Wyoming responsible for the greatest amount of pollution were compiled from an AIRS database retrieval of February 1998, and are shown in table 19. Note that emissions from most minor stationary sources and all non-stationary sources are not included and may comprise a significant portion of total statewide emissions.

Table 19. Actual 1996 emissions (tons/yr) by source type for counties near the Bighorn National Forest

County	Source Type	Sulfur Dioxide (SO^2)	Nitrogen Oxides (NO_X)	Volatile organic compounds (VOC)	Particulate Matter (PM)
Bighorn	Oil and Gas	1327	103	37	0
	Bentonite	0	13	0	7
	Clay and related minerals	0	46	0	0
	Beet sugar	0	38	0	0
	Gypsum products	0	40	0	0
	Nonmetallic mineral products	0	54	0	0
Sheridan	Oil and gas	0	0	22	0
	Hospitals	47	46	0	0
Washakie	Bentonite	0	10	0	0
	Beet sugar	11	79	0	0
	Metal cans	0	0	105	0
	Oil and gas	460	1150	146	0

IX. Climate

To the east of the Bighorn Mountains is the Northern Great Plains, and the main spine of the Rocky Mountains is situated immediately to the west. This surrounding area is an interior, midlatitude desert and steppe region where mountains protect from invasions of maritime air masses. It is dominated by continental tropical air masses in summer and by continental polar air masses in winter.

The climate in north-central Wyoming is that of a highland area surrounded by a midlatitude steppe. The annual temperature range is wide; summers are hot, with temperatures ranging from 90 to 105 degrees Fahrenheit (F) and winters are cold, with temperature ranges of -20 to –30 degrees F. The Bighorn Mountains make up the highland areas. The range in temperature is less in this area; summers are generally cool, with daytime highs generally reaching no more than 75-85 degrees F. Also, precipitation is higher and is more uniform throughout the year.

In winter, cold airmasses 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. Airmasses from the Pacific Ocean and the Gulf of Mexico rarely reach the survey area. 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. Tornadoes have occurred in scattered locations. The average annual temperature varies from 47 degrees F at Hyattville to 34 degrees F at Burgess Junction and Dome Lake. Generally, the mean annual air temperature decreases about 3 degrees F per 1,000 feet increase in elevation. Recorded extreme temperatures are –42 and 99 degrees F at Hunter Ranger Station and –42 and 90 degrees F at Dome Lake. The growing season at these elevations is about 50 to 55 days. July is the warmest month and is marked by an average daily high temperature of about 70 degrees F; January is the coldest month and is marked by an average daily minimum temperature of about 0 degrees F. Freezing temperatures can occur in any month of the year.

Annual precipitation ranges from about 10 inches to more than 40 inches. Commonly, one-half to two-thirds of the annual precipitation is snow. The wettest months, in order, are June, May, April, and September. The driest are December, January, and February. Generally, the distribution of precipitation from month to month is more uniform at the higher elevations. The western side of the Bighorn Mountains receives less precipitation than the eastern side because it lies in the rain shadow of the Absaroka Mountains, 75 miles to the west, and because precipitation caused by upslope conditions is less frequent. Average snow depth on May 1, based on snow course measurements, ranges from 14 to 81 inches, with an overall average of 47 inches. There are perennial snowfields on the flanks of Cloud Peak, Blacktooth Peak, and other peaks in the central part of the mountains.

The Clear/Crazy portions of the analysis area receive slightly less precipitation that like elevation areas further to the north in the Bighorn Mountains. This is due to a rain shadow effect created by Cloud Peak and the typical summer moisture flow originating in the plains of eastern Montana (Despain, 1973).

X. <u>Vegetation</u>

Composition, distribution, and abundance of the major vegetation types and successional stages of forest and grassland systems

Figure 6 shows the major vegetation cover types that occur in the Clear/Crazy/Powder geographic area. Non-vegetation includes rock and bare areas.

Figure 6. Vegetation Cover Types in the Clear/Crazy/Powder area.

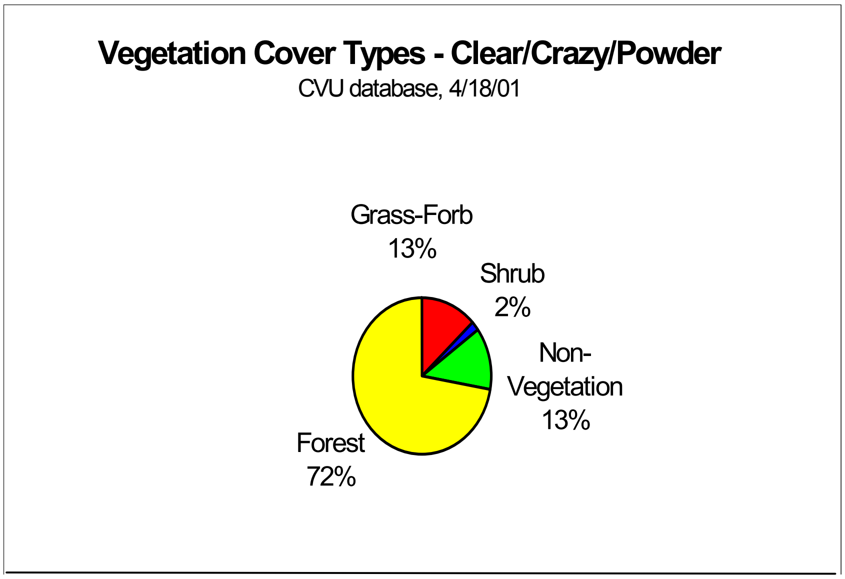
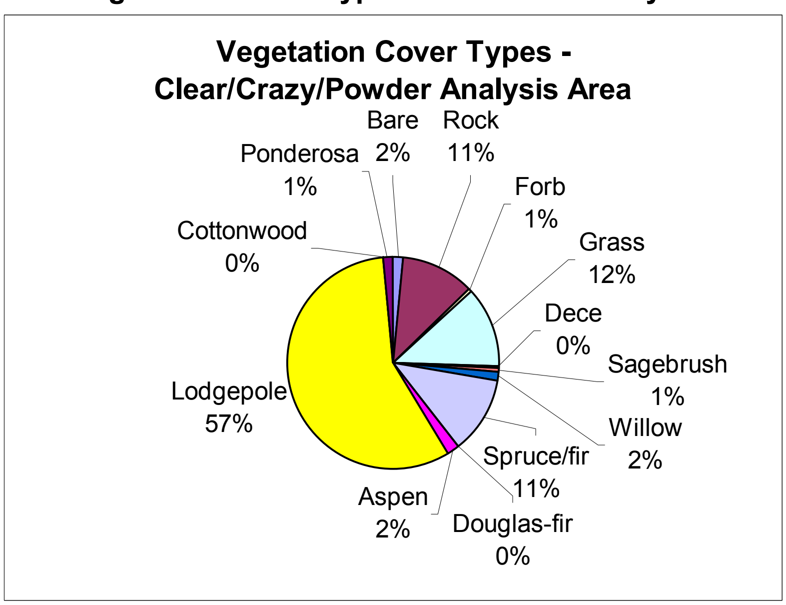


Figure 7 shows the relative amounts of the dominant cover types. Other species exist in the geographic area, but were not of sufficient size and scale to be the dominant cover type in a common vegetation unit polygon. Clear/Crazy/Powder is very homogeneous as far as vegetative diversity is concerned, with a high proportion of lodgepole pine.

Figure 7. Vegetation Cover Types in the Clear/Crazy/Powder area.



The origin dates chart, figure 8, shows the stand origin dates for the forested stands in the assessment area. This data is either from the Stage II point information, or origin years were assigned to stands that regenerated after harvests or fires. Some of the major disturbance events can be seen in this chart:

- The highest spike represents the Lost Fire (1988) and, to a lesser degree, timber harvest.
- The next, smaller, spike to the left is the Duck Creek fire.
- The 2nd highest spike, centered around 1895, represents large fire events.

Figure 8. Forested Stand Origin Dates in the Clear/Crazy/Powder area

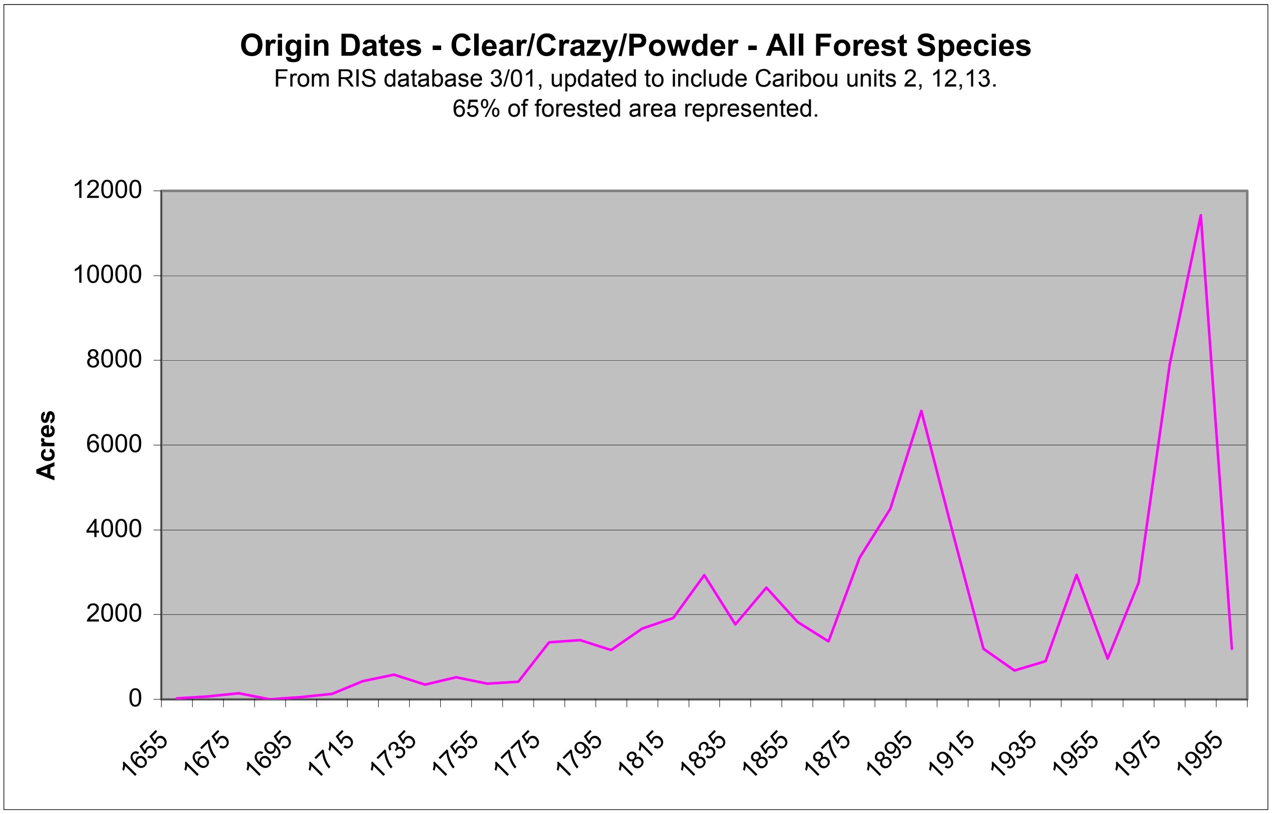


Figure 9 shows the habitat structural stages for the forests in the geographic area. Habitat structural stage provides a "coarse filter" look at habitats provided by forests in the geographic area. It gives an indication of forest size and density, which can be interpreted for wildlife habitat suitability. Forested stands provide an infinite variety of tree sizes and canopy densities, and to consider the amount, type, and spatial distribution of wildlife habitats, people need a simplified system to comprehend this variety. Many habitat considerations, such as amount and type of understory vegetation; size and amount of snags and coarse woody debris; and, the amount of hiding cover provided, can be approximately inferred from the broad habitat groupings described in the habitat structural stage model.

Habitat structural stages are defined in Hoover and Wills (1987). Structural stages describe the developmental stages of tree stands in terms of tree size and the extent of canopy closure. Structural stages can be considered a descriptor of the succession of a forested stand from regeneration, or bare ground, to maturity. For the purposes of a describing wildlife habitat, forest structural stages are divided into four categories, consisting of Stage 1, grass/forb; Stage 2, shrub/seedling; Stage 3, sapling/pole; and Stage 4, mature, Table 20. It is important to recognize that structural stages represent succession in *forested stands* only; the grass/forb, structural stage 1, refers only to forested stands that have undergone a stand-replacing event, and are temporarily in a "non-forested" condition. Structural Stage 1 does not include naturally occurring meadows.

The Structural Stage 1 areas are shown on the transitory forest cover type map in the appendix. These areas do not have a forested cover type in the CVU database, but they are areas that were either recently burned or harvested and have a current cover type of grass, forb, bare, wood, etc. The letter in the structural stage naming convention (a, b, or c) refers to the crown density, Table 20.

Figure 9. Habitat Structural Stages in the Clear/Crazy/Powder Geographic area

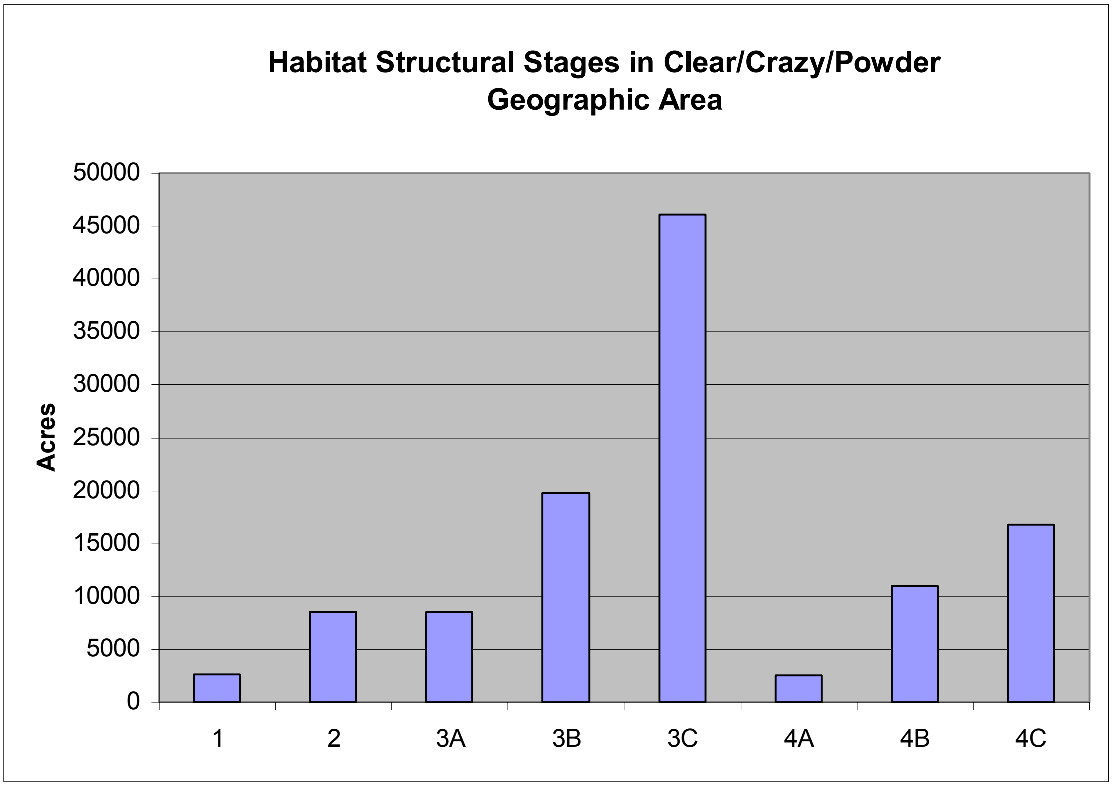


Table 20. Habitat Structural Stage Definitions, Hoover and Wills 1987

Habitat Structural Stage	Diameter	Crown Cover %	Habitat Structural Stage	Diameter	Crown Cover %
1	Not applicable	0-10%	3C	1 – 9 inches	70-100%
2	< 1 inch	10-100%	4A	9+ inches	10-40%
3A	1 – 9 inches	10-40%	4B	9+ inches	40-70%
3B	1 – 9 inches	40-70%	4C	9+ inches	70-100%

Interpretations from this table are:

- Compared to other Bighorn geographic areas, there is a relatively high amount of 3* classes. This is due to timber harvest in the 1960's, which have regenerated in sapling size (1-5" diameter) stands; and, due to fires in the latter part of the 1800s, which have grown into pole size (5-9" diameter) stands.
- There is a relatively small amount of over 9" diameter stands, compared to other Bighorn geographic areas, for the reasons cited above.

Concerning old-growth, approximately 5642 acres of old-growth are needed to represent 5% of the forested area in the Clear/Crazy/Powder geographic area, which is the current Forest Plan minimum standard and guideline. At least 6702 acres of old-growth currently exist in this geographic area, based upon the inventories conducted for the Landscape Analyses of the North

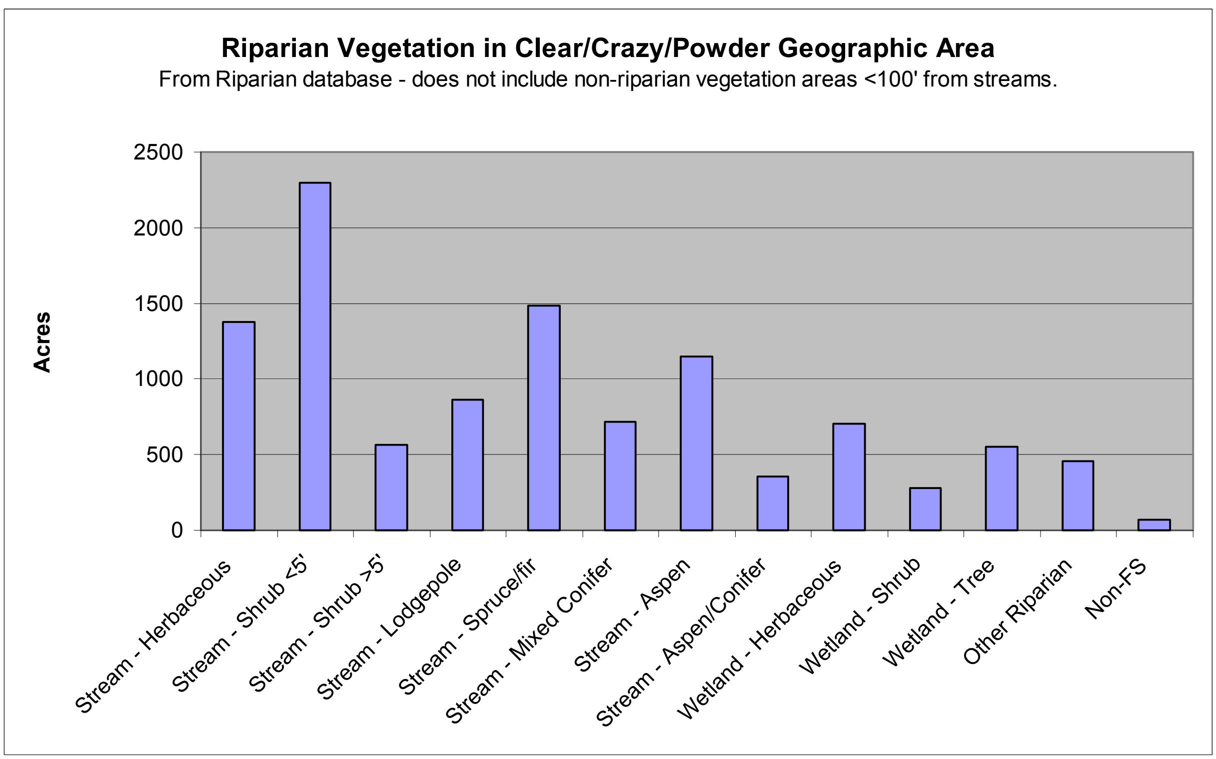
Fork Powder River (USDA, 1996) and Clear Creek and Crazy Woman Creeks (USDA, 1997). Because of these inventories and analyses, more is known about old-growth in the Clear/Crazy/Powder analysis area than any other area on the Bighorn NF. The Bighorn has informally adopted the old-growth definition in Mehl, 1992. There is no cited definition in the 1985 Forest Plan.

Powder River contains very high quality old-growth. 500 year old lodgepole pine and 550 year old Engelmann spruce were recorded, and University of Wyoming ecologist Dennis Knight stated during a 2001 field tour that the lodgepole in Powder River were the largest he has seen. At least 33% of the forested areas within Powder River qualified as old-growth when surveys were stopped. All stands that were not harvested or burned in the 1890 fire event qualified as old-growth.

Clear Creek and Crazy Woman Creek, on the other hand, have smaller, younger trees, as a general rule. Although inventories found the minimum 5% old-growth currently existing, there is probably only a few percent additional old-growth areas, because of the large amount of timber harvesting since the 1920's and the large areas burned around 1890. The inventories revealed that because of lower site indices (which will result in smaller trees) and a higher frequency of stand-replacement fire, the Clear/Crazy area has less inherent potential for old-growth habitat.

Figure 10 shows the number of acres of riparian vegetation in the assessment area. This data was interpreted from 1993 aerial photography. All of the areas portrayed in this table are included in the 9A, Riparian, Management Area.

Figure 10. Riparian Vegetation Cover Types in Clear/Crazy/Powder Geographic Area



Estimate the Range of Variability in vegetative conditions

- The overall change in the relative amounts of forests to meadows in the subalpine habitat types[14] changes very little, due to soil conditions (Despain, 1973). Thus, the current mix, of 68% forest to about 14% meadow, fluctuates by no more than 1-2%.
- Because of suppression of fires in the ponderosa pine forests along the east face of the Bighorns, it is probable that the amount of forested area has increased since 1890. Assuming a fire frequency interval of 25-50 years in those forests, at least two fire occurrences have been missed, causing an increase in the amount of forest vs. meadow in this habitat type.
- Riparian areas may fluctuate as large, catastrophically burned areas return to a forested condition, and more water is lost to transpiration and sublimation off of the forested canopy in the winter. This would only occur in watersheds and subwatersheds that have a large percentage of the watershed burned in the same event.
- Aspen is declining for three factors:
    - Long term climatic warming since the little ice age about 10,000 years ago. There was also a relative drying of the climate since that time until the last 100 years, at which point, the climate became relatively wetter. (Knight, 1994)
    - Effects on seedling survival due to wildlife and domestic livestock grazing.
    - While the subalpine fire cycle has only marginally been affected (since this type has a fire frequency interval of 100-300 years and European man has only been suppressing fires for about 100 years), continued fire suppression will decrease the amount of aspen in the geographic area, since stand replacing fire events are regeneration events for aspen.

Effects from air quality

There have been no studies to date on the Bighorn concerning air quality effects on plants. An applicable study from Yellowstone National Park concluded that ozone levels are suspected to be well below the level that would affect human health or vegetation.

Risks to ecological sustainability

- Vegetation in high use areas of the Cloud Peak Wilderness is threatened by overuse by people. This affects both trees (used for firewood) and long term soil productivity (soil compaction and removal of plant/litter layer in heavily used campsites.) This has been recently addressed by additional use restrictions, but monitoring will be needed to see if the restrictions are sufficient in light of increased rates of human visitation.
- The cumulative effects of human intervention in the ecosystem. This includes:
    - People as vectors of exotic species. This includes plant and animal species.
    - Roads
    - Livestock and wildlife grazing and browsing
    - Timber harvest
    - Fire suppression
    - Recreation use

[14] Subalpine habitats include lodgepole pine and Engelmann spruce forested areas. Douglas-fir and ponderosa pine forests are not included in this generalization.

Describe reference conditions (landscapes)

Two areas in this geographic area were considered as potential Research Natural Areas (pRNAs):

- Crazy Woman Canyon: The valley bottom is considered too heavily impacted by human use to meet the RNA criteria for unimpacted, natural, ecosystem health and function. The canyon walls are considered to be little impacted by human use, other than fire suppression.
- Poison Creek: Of the eleven pRNAs, this is the most impacted by human use, is not considered to be a reference landscape, and will not be considered for further RNA consideration.

In the Fine Filter Analysis (Welp, et al., 2000), three areas within the geographic area were considered areas "…that contain a high concentration of important taxa or representative vegetation communities." (For a complete discussion of ranking criteria, codes and descriptions, see pages 1192 to 1230 of Welp, et al., 2000):

- Cloud Peak, B2 rank (very high significance): Contains nine species tracked by Wyoming Natural Diversity Database (WYNDD); alpine, granite, habitats are unique in the Bighorn Mountains, and are relatively undisturbed.
- Powder River Pass – Hazelton Peak, B3 rank (high significance): Contains six species tracked by WYNDD; very old forests, with lodgepole pine and Engelmann spruce dated to about 500 and 550 years old, respectively; possibly some of oldest forests on Bighorn NF. On a visit to the Powder River watershed in June, 2001, University of Wyoming ecologist Dennis Knight stated that the lodgepole pine were the largest he has seen in his career.
- Sourdough Creek, B3 rank: contains three species tracked by WYNDD, including only known Bighorn occurrences of two species (*R. acaulis* and *B. lanceolatum*); habitat is montane riparian zone, with mixed coniferous, willow, and carex habitats.

XI. Terrestrial Species and their Habitat

Most of the wildlife existing condition information will be presented at the Forest wide scale, since geographic areas rarely bound terrestrial species. Topics included in the forest wide scale assessment include population viability, species categories (species of local concern, species at risk, etc.), and species habitats.

Species and habitats within the geographic area

High quality conifer old growth exists in the Powder River area, which provides important habitat for late successional dependant species, such as marten. 550 year old spruce and 500 year old lodgepole pine are present. During a 2001 field tour, Dennis Knight characterized one lodgepole stand along the Powder River Road as the "largest lodgepole" he had encountered.

The Clear/Crazy and Powder River landscape analyses noted that old growth conifer stands and the riparian communities were particularly important habitats.

Historically, *beaver* were likely more abundant in the geographic area than presently occur. The species is important for shaping and maintaining riparian communities. The link to deteriorated quality and reduced presence of aspen was also noted as an important consideration for this area. Aspen habitats are frequently used by beaver for dam construction when they occur in riparian areas.

Neotropical bird monitoring was completed within the Powder River and Clear Creek geographic areas in 1995 and 1996 through the national protocol of Mapping Avian Productivity and Survivability (MAPS). These are the only two sites on the Forest where this type of monitoring was conducted, and the validity of repeating this effort needs assessed. Trends for the Baird's sparrow, vesper sparrow, savannah sparrow, Brewer's sparrow, white-crowned sparrow, and MacGillivray's warbler were noted to be on the decline during this period and recommended to become "species of concern" or of similar notation. Correlation to suspected impacts from livestock grazing were not validated

Elk as a Management Indicator Species (MIS) were utilized to evaluate road densities and security cover, concepts that likely apply to other species. Road densities (#miles per square mile) are shown on page 56. Elk security areas were noted to be lacking in the Clear Creek and Crazy Woman Creek areas due to the number of roads constructed associated with past harvesting activities and recreation development. Methods to assess elk security cover need to be updated in the plan revision, and displays of potential security areas need to be identified at the Forest scale. Off road vehicle use in the area is creating wildlife harassment issues, and habitat potential may be reduced through soil disturbance and impacts to vegetation communities. The winter range management area mapping may not accurately reflect actual winter range. The winter range review needs to be compiled at the forest-wide level. Human disturbance on winter range may be an issue.

Moose as an MIS are suspected to be impacted by snowmobile use within riparian areas, particularly in the South Fork of Clear Creek, Pole Creek, Little Sourdough Creek, Sourdough Creek, Circle Park, and Crazy Woman Canyon. Rerouting snowmobile traffic away from Hondo Creek drainage and Willow Marsh area was specifically recommended in the Clear/Crazy Landscape Assessment (USDA, 1997).

Bighorn sheep are not currently present in the area, but were in the pre-European settlement era. Elements of extirpation included loss of open corridors for migration habitat use, disease from domestic livestock, and over hunting. Future opportunities for the species to occur in the geographic area are likely minimal.

XII. Cultural, Human Uses, Land Use Patterns

Recreation and Travel Management

Summary
- Clear Crazy is one of the most heavily used geographic areas for recreation on the forest
- Easy access from Buffalo and developed recreation facilities account for high use numbers
- The "C" travel area open to cross country is an area with increasing resource damage
- The recreation opportunity spectrum classes for the northern portion of the geographic area is predominantly motorized emphasis, southern portion nonmotorized
- Conflicts exist between motorized and nonmotorized uses in summer and winter

Participation in outdoor recreation has grown in most activities on the Bighorn National Forest including camping, hiking, horseback riding, atvs, motorcycles, fishing, snowmobiling and cross country skiing. Access is associated with almost every activity that takes place on the forest.

There are several campgrounds, lodges/resorts and recreation residences within the analysis area. Trails primarily serve the Cloud Peak Wilderness, and the trailhead at Elgin Park provides horseback riding opportunities. Several interpretative stops exist along US Highway 16. The Tie Hack Campground and Reservoir provides water based recreation opportunities. Fishing is popular in streams and lakes.

Summer travel: This area is easily accessed and is one of the most heavily used recreation areas on the forest. The recreation opportunity spectrum (ROS) classes in the north half of the analysis area are predominantly for motorized travel with the highly developed road system, including US Highway 16 and Forest System Roads 20, 22, 23, 28, 31 and 33. A large portion of the analysis area is a "C" classification, meaning the area is open to cross-country travel. There have been many miles of user created routes in the area. The southern portion of the analysis area has predominantly nonmotorized ROS classes, with most of the area unroaded.

Winter travel: There are several miles of State groomed snowmachine trails in the Clear Crazy area. The Forest Service maintains thirteen miles of cross-country ski trails in the vicinity of Pole Creek.

Relationship between supply and demand of opportunities: Campgrounds located on US Highway 16 are typically full on weekends and busy during the week between June 15 and August 15. Based on capacity, campgrounds, picnic areas and lodges in the area accommodate over 1,000 people at one time. It is difficult to quantify whether supply meets demand due to the dispersed recreation activities that occur away from developed sites. Opportunities for nonmotorized activities are limited due to the extensive road system. It is assumed that recreation participation will continue to grow because of the popularity and marketing of the Bighorns and growth in population and participation rates in outdoor recreation.

Recreation Opportunities: There are many recreation opportunities within the Clear Crazy analysis area. The Forest Service describes different recreation experiences using the setting, activities and the experience. These experiences are separated in recreation opportunity spectrum ROS classes. Table 21 shows ROS classes and acres within the analysis area.

Table 21. Recreation Opportunity Spectrum (ROS) Classes within the Clear Creek/Crazy Woman Creek Analysis Area

ROS class	Acres in analysis area	Percent
Primitive	22,499	14%
Semi-primitive nonmotorized	34,961	5%
Semi-primitive motorized	33,592	19%
Roaded natural	27,122	17%
Roaded modified	30,467	22%
Rural	7,236	22%

As displayed in table 21, the area has more opportunities towards the more developed classes of the spectrum.

Primitive – 22,499 acres
These areas are characterized by an unmodified environment and have a very high probability of experiencing solitude, freedom, closeness to nature, tranquility, self-reliance, challenge and risk. There is very low interaction between recreation users. Access and travel is nonmotorized on trails or cross-country.

Semi-primitive nonmotorized – 34,961 acres
Areas in a semi-primitive nonmotorized class are in a natural appearing environment with a high probability of experiencing solitude, closeness to nature, tranquility, self-reliance, challenge and risk. There is low interaction between users. Access and travel is nonmotorized on trails, some primitive roads or cross-country.

Semi-primitive motorized – 33,592 acres
There is a moderate probability of experiencing solitude, closeness to nature and tranquility. The setting is in a predominantly natural appearing environment. There is a low concentration of users, but often evidence of others on trails. Motorized vehicles are allowed for travel.

Roaded natural – 27,122 acres
Self-reliance on outdoor skill is of only moderate importance to the recreation user with little challenge and risk. The environment is mostly natural appearing. Access and travel is motorized including sedan and trailers.

Roaded modified – 30,467 acres
In a roaded modified setting, there is opportunity to get away from others, but with easy access. There is moderate evidence of other users on roads and little evidence of others or interaction at camp sites. Conventional motorized access includes sedan, trailer, atv and motorcycle travel.

Rural – 7,236 acres
The opportunity to observe and affiliate with other users is important, as is convenience of facilities and recreation opportunities. There is little challenge and risk. Interaction between users may be high as is evidence of other users.

Areas of conflict: Increasing participation rates in outdoor recreation bring increased complaints of user conflict. Some areas of conflict identified from field surveys in 1996 in the Clear Crazy area are:

- conflicts between motorized and nonmotorized users
- horseback riders and encounters of mountain bikes near Hunter Corrals

- hikers and horseback riders – resource damage and horse manure left on trails
- wildlife watchers interrupted by motorized users
- cross-country skiers and snowmobilers on the same trails or area
- cattle in campgrounds
- damage to trails from moving cattle
- dispersed camping and recreation residence conflicts

In 1996, a comprehensive recreation study was completed for the Clear Crazy area. Many of these same trends are occurring forestwide. Some of the results were:

- From 1990 to 1996, dispersed campsites increased 93 percent – from 344 to 664
- Increased damage to trees surrounding dispersed sites is more prevalent
- The "core" of dispersed campsites has grown in size
- Many campsites have multiple access routes
- Almost 40 percent of the total campsites are within 100 feet of a stream, causing riparian damage and not in compliance with Forest Plan.

In addition, cross-country travel has caused resource damage including vegetation damage and increased stream sedimentation.

Additional information needed: User information on roads and trails should be collected to determine if any Level 1 or 2 roads in the analysis area should be recommended for opening, closure or decommissioning. This information will be determined after public involvement is completed during the revision process on travel management.

Scenery Management

Forest Plan and Scenery[15]

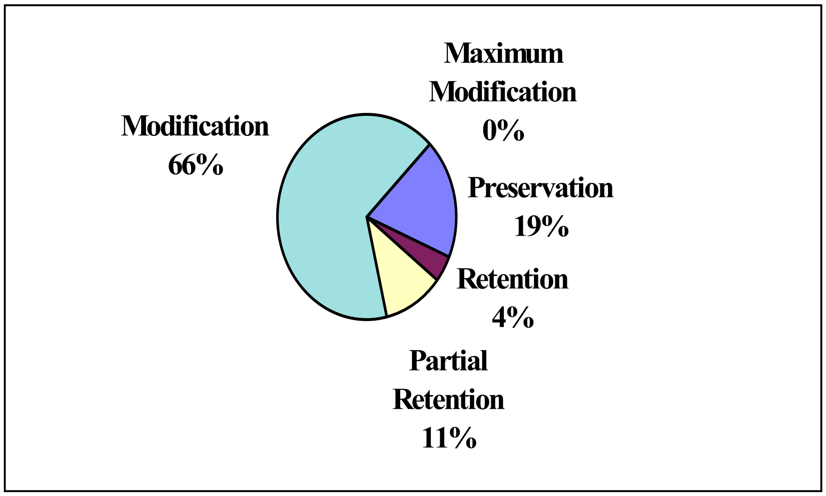
A map in the appendix shows the minimum standard and guideline for Visual Quality from the Forest Plan, except for the 9A management area, which is not mapped, but has a minimum standard and guideline of partial retention.

The 1985 Forest Plan includes prescriptions for each management area. Part of each prescription is a standard and guideline for visual quality. The four standards/guidelines applied are preservation, retention, partial retention, and modification. They differ in the degree of change from a natural appearing landscape management activities may introduce. The modification standard/guideline allows for management activities that dominate the natural appearance of the landscape. This is the standard/guideline applied to 66% of the Clear Creek – Crazy Woman Creek area. The preservation standard/guideline is applied to portions of the Cloud Peak Wilderness. It allows for only minute deviations from the naturally occurring landscape.

Figure 11 shows the Forest Plan allocation to the various Visual Quality standards/guidelines in the Clear Creek and Crazy Woman Creek portions of the analysis area.

[15] The scenery analysis applies specifically to the Clear Creek and Crazy Woman Creek portions of this analysis area. The conclusions in this section that apply broadly to the Bighorn National Forest cover this entire analysis area, but any acreage figures and percentages apply only to the Clear Creek and Crazy Woman Creek portions of the larger Forest Plan geographic area.

Figure 11. Forest Plan allocation to the various Visual Quality standards/guidelines in the Clear Creek and Crazy Woman Creek area



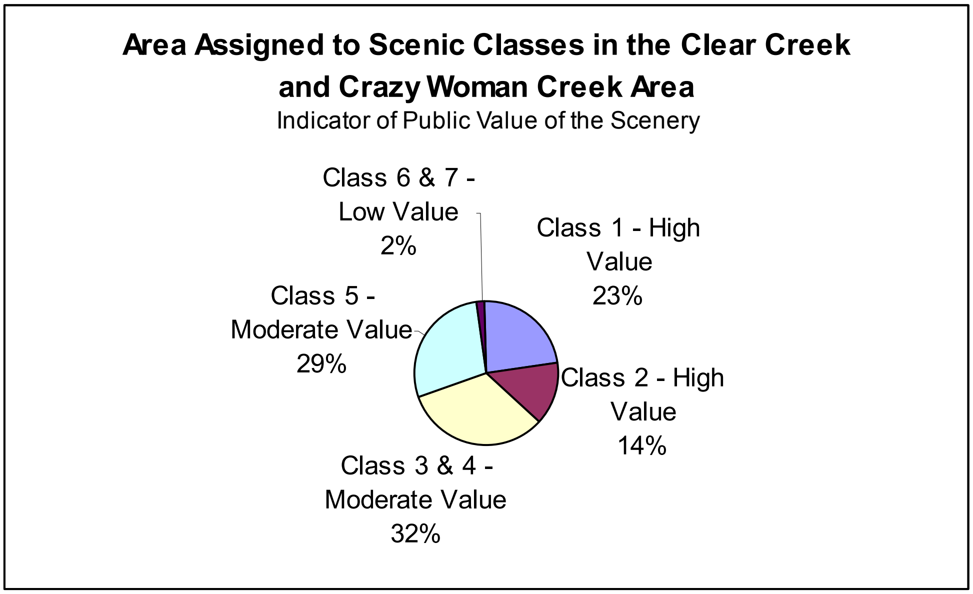
The visual management system (VMS) (USDA, 1974) has been replaced by the scenery management system (SMS) (USDA, 1995). SMS uses scenic classes, numbered 1-7, to rate the relative public value of scenery in the analysis area. Scenic classes are based on three considerations: an estimate of the Forest user numbers and interest in natural beauty on various travel ways; the visibility of the landscape from those travel ways; and the intrinsic beauty of the landscapes. These three considerations, known as the concern level, distance zone, and scenic attractiveness are mapped and combined to map scenic classes. The scenic classes provide the manager with a range of desired conditions for scenery based on visibility and natural beauty. They are for use in developing and analyzing Forest Plan alternatives. Figure 12 shows the distribution of the scenic class in the Clear Creek and Crazy Woman portions of the analysis area.

Existing scenic integrity

Figure 6 shows the existing scenic integrity in the Clear Creek and Crazy Woman Creek portions of the analysis area. The scale ranges from very high scenic integrity where scenery is unaltered to very low scenic integrity where scenery is heavily altered by management activities. Scenic integrity is defined as:

> "Scenic integrity is a measure of the degree to which a landscape is visually perceived to be 'complete'. The highest scenic integrity ratings are given to those landscapes that have little or no deviation from the character valued by constituents for its aesthetic appeal. Scenic integrity [can] describe an existing situation, standard for management, or desired future conditions. Scenic integrity indicates the degree of intactness and wholeness of the landscape character." (USDA, 1995)

Figure 12. Scenic Classes in the Clear Creek and Crazy Woman Creek area



Low and very low scenic integrity occurs in areas accessed by Pole Creek Road, Caribou Mesa Road, Hesse Creek Road and Poison Creek (Hazelton Peak) Road. Facilities with high ratings for scenic integrity include the South Fork Lodge and the fisherman parking at North Fork of Crazy Woman Creek (EDAW, 1998).

Figure 13. Existing scenic integrity in the Clear Creek and Crazy Woman Creek area

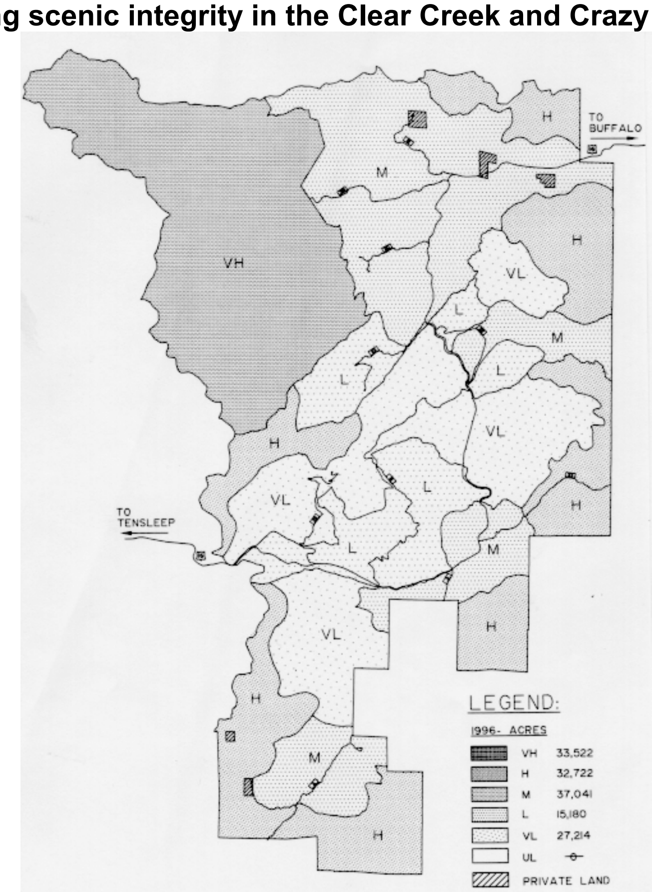
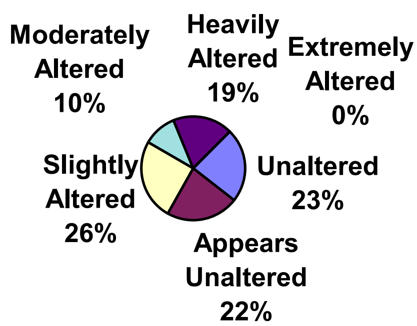


Figure 14 shows the 2001 existing scenic integrity categories, by percentage, in the Clear Creek and Crazy Woman Creek portions of the analysis area. The moderately and heavily altered area total of 29% is considerably less than the 66% of the area that the plan standards would allow.

Figure 14. 2001 Existing Scenic Integrity Categories, by Percentage, in the Clear Creek and Crazy Woman Creek Portions of the Analysis Area.



Comparing the existing scenic integrity to the Forest Plan standards and guidelines

Areas shaded in Figure 2, page 6, are those where the existing condition, as measured by the scenic integrity, is below the standard and guideline for visual quality in the Forest Plan. A few of these areas have a Forest Plan standard and guideline of partial retention, but have a current scenic integrity of moderately altered, primarily due to developed sites, roads, trails and/or fences. Most of the areas shaded in Figure 2 are areas with a Forest Plan standard and guideline of modification, but have a current scenic integrity of heavily altered. Most of these alterations were caused by timber harvest planned and implemented prior to the 1985 Forest Plan.

Scenic Integrity Trends

Table 22 compares scenic integrity levels in 1976 and 1996 for the Clear Creek and Crazy Woman Creek portions of the analysis area.

Table 22. Scenic Integrity Levels in 1976 and 1996 for the Clear Creek and Crazy Woman Creek area

Scenic Integrity Levels		1976 acres	1976 % of total	1996 acres	1996 % of total	Change over 20 years
Very High Integrity	Unaltered	33,301	23	33,301	23	0
High Integrity	Appears Unaltered	45,207	31	32,506	22	- 12,701
Moderate Integrity	Slightly Altered	31,837	22	36,797	26	+ 4,960
Low Integrity	Moderately Altered	3,344	2	15,080	10	+11,736
Very Low Integrity	Heavily Altered	8,447	6	27,034	19	+ 8,587
Unacceptably Low Integrity	Extremely Altered	22,763	16	0	0	- 22,763

Among the conclusions that can be drawn from this table:

- Areas of high scenic integrity which appear unaltered have decreased in the twenty years from 1976-1996. In most cases of large scale change this is caused by road construction and timber harvest activities. Increases in fencing and increasing impacts of roads and trails have also factors in reducing areas of high integrity.
- Scenic integrity in clear-cut areas classified as extremely altered in 1976 has improved. Over the twenty year period young trees have reached sufficient size to support classification of the scenic integrity as heavily altered. These landscapes are no longer unacceptable modifications and now meet the definition of maximum modification.
- A pattern of leave strips and patches associated with clear cut areas contributes to a continuing fragmentation of the characteristic landscape. In some cases, leave strips were intended to screen timber management activities thus maintaining scenic quality along roadsides. In some cases, leave strips were also used to protect steep slopes, riparian vegetation, water quality and other resource values.
- Scenic integrity is reduced in some areas by the accumulation of woody debris from harvest and thinning activities.
- The area rated low scenic integrity (i.e. moderately altered - modification VQO) increased most during the 20 years from 1976-1996. This is consistent with the minimum standards for visual quality established in the Forest Plan. It is somewhat inconsistent with the inventoried visual quality objectives.
- The quality of scenery in the Clear Creek – Crazy Woman Creek area, between 1976 and 1996, has moved toward the center of the scenic integrity scale. Acres of moderately altered, heavily altered and slightly altered scenery increased. Acres that appeared unaltered and acres that were extremely altered declined.

Grazing

In 1995 the Bighorn National Forest in conjunction with the University of Wyoming Department of Renewable Resources, University of Wyoming Extension Service, and Bighorn National Forest Grazing Permittees Association developed the ***Bighorn National Forest Vegetation Grazing Guidelines.*** These guidelines were revised in 1996 and finalized on April 9, 1997.

The Guidelines outline vegetation-monitoring requirements for riparian areas on the Forest. This monitoring is mandatory for all allotments on the Forest with penalties established if the monitoring is not completed. The Forest rangeland management personnel spot check permittee monitoring and if discrepancies are found they are resolved on the ground or Forest Service data is used as the baseline for that season. Upland vegetative standards are outlined in the 1985 Bighorn National Forest Plan and still apply to all upland use.

Bighorn National Forest staff are in the process of completing geographic area level Allotment Management Plans (AMPs). The Shell and Clear/Crazy/Powder geographic areas' AMPs were completed recently. The Tongue and Devil's Canyon AMPs are in the process of being completed, and data collection began on the Paintrock AMP during the summer of 2001. Until the geographic area level AMPs are complete, existing AMPs will remain in affect and Annual Operating Instructions will be used to adjust the Plans to fit current resource objectives and assure management meets existing on the ground needs.

To assure objectives are being met annually the Forest Service, permittees or both complete riparian and upland monitoring. If problems occur adjustments in grazing use (changes in season of use, livestock numbers, rest periods, or deferment of on-dates) are made to allow the herbaceous vegetation to recover.

Table 23 shows selected information for the six grazing allotments in the Clear/Crazy/Powder analysis area.

Table 23. Select Information for Grazing Allotments in the Clear/Crazy/Powder Analysis Area

Allotment	Livestock Permitted	Number Permitees	Total Acres	Capable Acres	Current AMP	Scheduled AMP Update	Permitted Season
Clear Creek C&H	875 C/C 144 Y	3	15,910	6073	9/30/98	Current	7/1-9/30
Doyle/Upper Doyle C&H	120 C/C	1	14,336	2264	9/30/98	Current	7/6 - 9/15
Grommund/Sour dough Creek C&H	232 C/C	2	11,475	3409	9/30/98	Current	7/7-9/30
Muddy Creek/Crazy Woman C&H	1060 C/C	10	46,373	8302	9/30/98	Current	6/25-9/25
Poison Creek C&H	330 C/C	1	2,848	1299	9/30/98	Current	7/7 - 9/21
Powder River C&H	303 C/C 650 Y	2	9245	3468	9/30/98	Current	7/16-9/30
Rock Cr. C&H	300 C/C	1	30720	6073		2004	7/1-9/26

The Allotment Management Plan (AMP) analysis was conducted in 1998 and a decision notice signed on September 30, 1998. This decision notice outlined strategies for managing eight allotments and the Crazy Woman Stock Driveway. The selected alternative from the analysis made combinations of the eight allotments into six. Lower elevation portions of two sheep allotments that are suitable for cattle use were combined with adjacent cattle allotments. If the cattle use on the lower elevation areas of the allotments proves workable, the changes will be made permanent. The upper portions may be reallocated to sheep, or may be removed from the grazing base if the conversion is made.

Between 1999 and 2000 the alternative selected was implemented through development of Allotment Management Plans covering the implementation of the standards and guides from the selected alternative on the ground.

Overall the herbaceous vegetation in the geographic area is in good condition with static to upward trends on most allotments. Isolated areas occur where vegetation use exceeds standards and guides but corrective action is taken the following year to allow these areas to recover. For example, following documented instances of overuse by permitted cattle, the Powder River Allotment was rested to allow vegetative resources to recover.

Recreation/livestock conflicts have occurred in the geographic area over the years with gates being left open and livestock being moved out of areas the permittees had placed them and into areas outside the permitted areas or into areas not ready to be grazed. To address this problem, gates have been replaced with cattleguards. Highway right-of-way fences are also being planned and built in coordination with the Wyoming Department of Transportation to reduce the livestock hazard on Highway 16.

Historic and cultural sites

Since Forest Plans are programmatic documents, this topic will only be briefly discussed in this geographic area assessment. Analysis of cultural resource will be by unified entities segregated by site types, time periods, and spatial relationships within a specific historic context/theme (e.g., pre-1890s sheep grazing, southern Big Horn Mountains). This document will not discuss individual cultural resources, as such discussions are more appropriate to site specific analysis.

Management area allocation, specifically special area designation, would be the most likely Forest Plan decision that could affect heritage resources, and the affect would be at the landscape level versus site specific. Based on monitoring and the analysis to date, it appears that the heritage resources in the Clear/Crazy/Powder area, for the most part, are not interrelated, and those that are can be adequately managed under the project-level protections currently in place without Forest Plan special area designation.

A summary of cultural resources found in the analysis area follows:

<u>Pre-European</u>

Based on cultural resource inventories, people used the Clear/Crazy/Powder area sparingly. The number and types of pre-historic sites that exist in the area are few in number and small in size. Those sites recorded are generally classified as small short-term lithic scatters/camps that contain very little specific information, such as chronological time indicators, or cultural affiliation. The lower density and diversity of site types is common in areas that lack resources needed in the pursuit of daily life. The analysis area contains little or no lithic resources, and was covered by large stands of lodgepole pine that contributed little in both animal and plant foods, and made travel difficult through the area. Therefore, the sites reflect small groups moving through the area rapidly, probably traveling to areas that contained important/readily available resources, such as tool stone, concentration and variety of food plants, or areas with more natural openings for hunting. Consequently, prehistoric site quantity and quality is relatively low compared to other areas on the Bighorn National Forest.

<u>European:</u>

The first European uses of the Clear/Crazy/Powder area were for timber and livestock grazing. Wood was first harvested on the face of the mountain beginning with the earliest settlements (1880s). Tie hacking began in Clear Creek in the mid-1920s, when Ranger Hettinger showed the Burlington Northern railroad people one of the last large unharvested tracts in the country. The tie hack industry left the most sensitive cultural landscape in the analysis area.

Livestock grazing began in what was to become the Bighorn National Forest in the 1880s, and was intensive until the 1920s when the Forest Service began asserting its authority to bring grazing under control. Sheep were the prevalent livestock in the early days (ca. 1917) with approximately 10,000 compared to 5,000 head of cattle (USDA n.d., Forest Historic Files, Drawer 1, Folder 38b). Many of the sheepherders were of Basque origin, which is still reflected in Buffalo in the annual Basque festival. Approximately 3,500 head of cattle are found in the project area today. Historic stock driveways are the best define resource associated with the grazing cultural landscape.

Other cultural resources noted include mining and Forest Service management. Prospecting began as early as the 1860s in the Big Horn Mountains. Some prospecting did occur around the turn of the century, and continues today. However, it has been primarily hype versus substance, has never been a manger factor to the region, and is represented by little more than prospect pits in the analysis area.

The last historic theme/landscape is the management of the area by the Forest Service, beginning in 1907. The most sensitive and best representative examples of this theme are Forest Service historic structures. Examples are the Hunter Ranger Station and the Sheep Mountain Fire Lookout.

XIII. Transportation System (Roads and Trails)

A Forest-wide roads analysis will be conducted during the effects analysis part of Forest Plan revision. It will be done under the 1985 Forest Plan direction. When the revised Forest Plan is implemented, the roads analysis will be reviewed and applicable revisions made.

Roads

There are currently approximately 422 miles of roads in the Clear/Crazy/Powder analysis area. This system of roads accesses an area of approximately 243 square miles, including wilderness and private lands. The road system in this analysis area varies from high standard US Highways to primitive, abandoned wheel tracks. Table 24 gives a breakdown of roads within the analysis area.

Table 24. Miles of Road by Jurisdiction

Jurisdiction	Length (miles)
Forest Service	319.6
County	10.5
BLM	3.2
State	26.9
Private/Other	3.2
Unclassified	58.2
Total:	**421.6**

The roads within the analysis area under Forest Service jurisdiction are divided into categories called maintenance levels. Maintenance levels range from 1-5, with 5 being the highest standard, and 1 being the lowest standard. There may also be additional roads no longer required for management purposes, or which have been created by off road vehicle use, but there still exists a road 'footprint'. These roads are called unclassified, and the mileage of these unclassified roads is an approximation. A description of maintenance levels is shown in Table 25.

Table 25. Description of Road Maintenance Levels

Maintenance Level	Description
1	Closed to public travel – can be used intermittently for management purposes.
2	Maintained for use by high clearance vehicles.
3	Maintained for use by a prudent driver in a passenger car.
4	Maintained for use by passenger cars with a moderate degree of user comfort. Usually double lane, gravel roads.
5	Maintained for a high degree of user comfort, double lane, often paved.

Figure 15 shows a breakdown of Forest Service roads within the analysis area by maintenance level, as well as other roads within the analysis area by jurisdiction.

Figure 15. Roads by Forest Service Maintenance Level and Roads by Other Jurisdiction

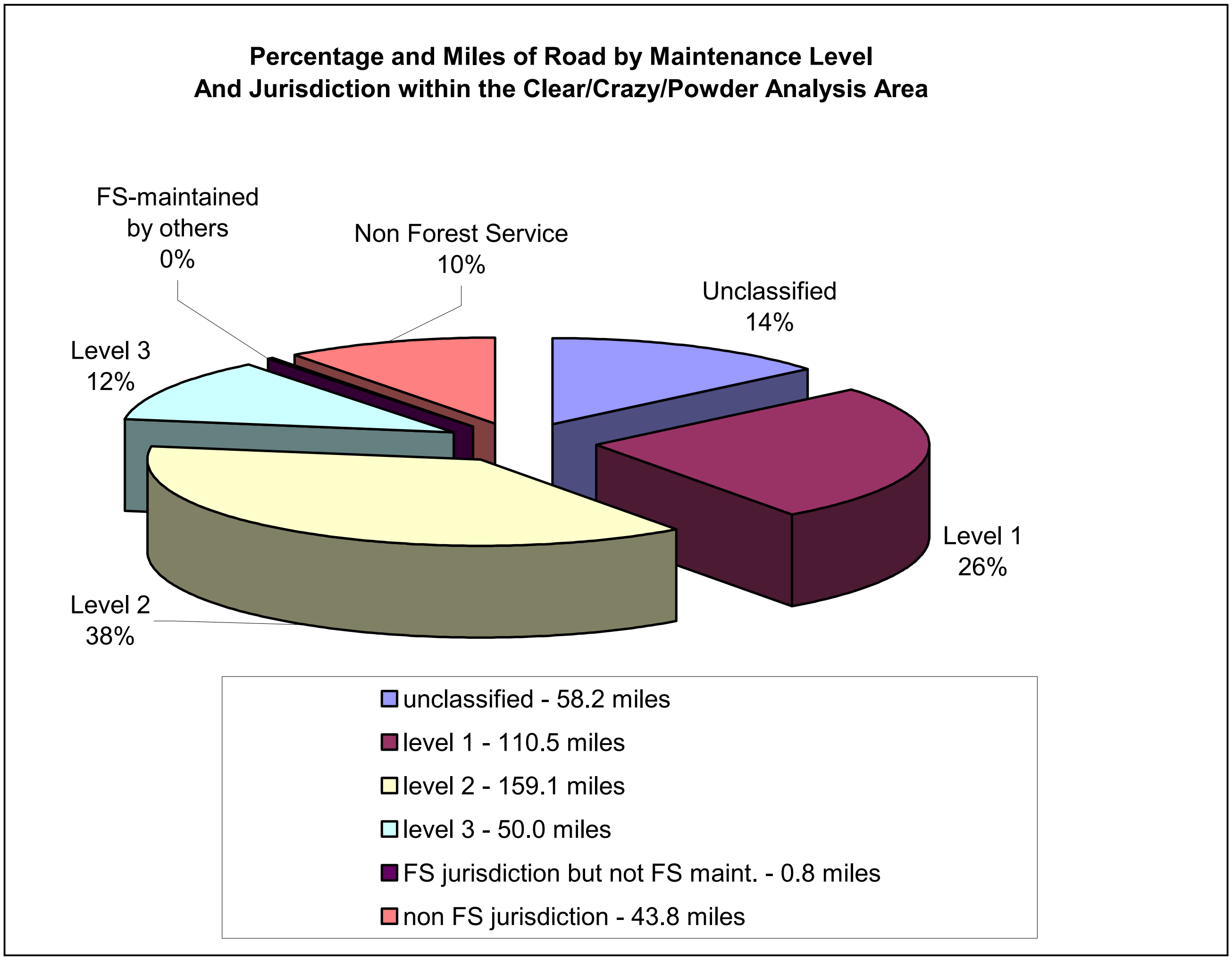


Table 26 lists the road density in the Clear/Crazy/Powder analysis area. These figures do not include wilderness and private land. The open road density does not include unclassified roads.

Table 26. Road Density in Clear/Crazy/Powder Analysis Area (National Forest System, Non-wilderness land only)

Total Road Density	2.22 miles per square mile
Open Road Density	1.33 miles per square mile

Various structures and components are needed to manage and operate those roads under Forest Service jurisdiction. For those roads in the Clear/Crazy/Powder analysis area, there are 14 bridges, which range in age from 1945 to 1994. There are also two major culverts (end openings greater than 35 square feet), approximately 450 minor culverts, 30 cattleguards, 1,050 waterbars, 215 gates, and 565 signs. These structures along with the roads themselves represent a great investment in the transportation system, as well as a great cost for annual maintenance and, over the years, a resulting backlog of maintenance needs. Table 27 shows the breakdown of annual and deferred maintenance needs by maintenance level[16].

Table 27. Annual and Deferred Maintenance Needs by Maintenance Level

Maintenance Level	Miles	Annual Cost/Mile	Deferred Cost/Mile
1	110.5	$683	$886
2	159.1	$920	$2,316
3	50.0	$6,561	$8,109
4	0	$5,991	$14,730
Total needs for annual maintenance in Clear/Crazy/Powder = $ 549,893			
Total needs for deferred maintenance in Clear/Crazy/Powder = $ 871,829			

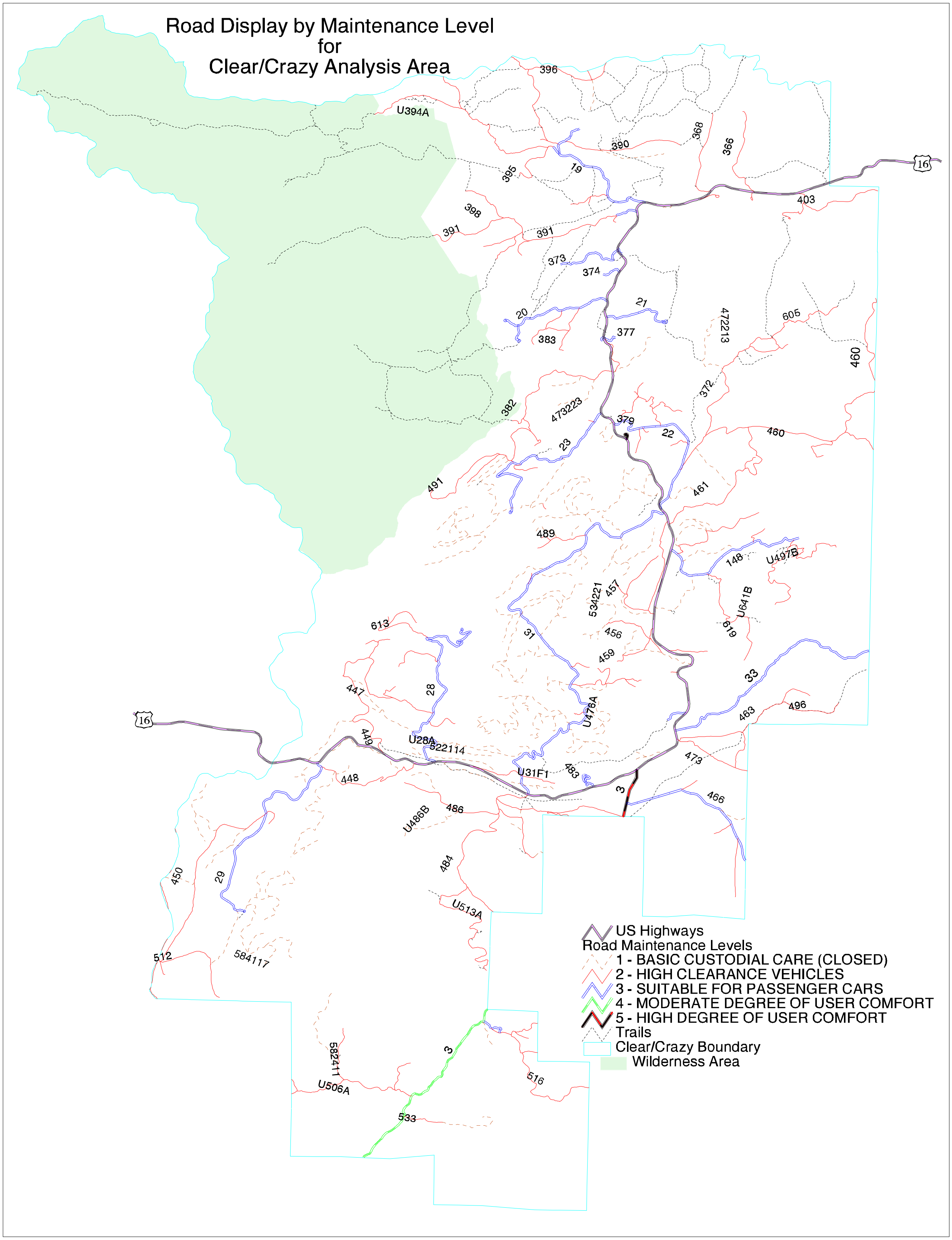
Current funding levels for road maintenance over the past 3 years have remained fairly constant, with an approximate allocation of $460,000. This amount is far below the level needed for full implementation of the current transportation system forest wide. Current forest plan standard for full maintenance is also not being met under current allocations. Currently, general plan direction states to keep roads open to public use unless financing is not available to maintain the facility, or use is causing unacceptable damage to soil and water resources. Based on current deferred maintenance and annual maintenance needs, plan direction is not being met.

Forest Plan Goals/Desired Conditions

Forest Plan direction for road management and operations are primarily based on resource needs rather than the road systems as a separate entity. In other words, the driving force behind road management decisions are primarily based on the management directions resource needs for an area. The Forest Plan does, however, give direction that roads may be closed if financing is not available to maintain the facility, if use is causing unacceptable resource damage, if they are unsafe, or if their use conflicts with the management objectives for an area. The Forest Plan also states that arterial and collector roads shall be maintained to a minimum maintenance level of 3, and all open local roads shall be maintained to a minimum maintenance level of 2. In contrast, forest plan goals to provide additional road and trail access to the National Forest boundary are being met.

The map on page 59 shows the current Forest Service Road system by maintenance level in the Clear/Crazy/Powder analysis area.

[16] Costs arrived from performing condition surveys on each level 3, 4, and 5 road on the Bighorn National Forest in 1999, and from a random sample of level 1 and 2 roads in 2000. Costs per mile were interpolated from these surveys. Also, these costs do not reflect annual and deferred costs for bridges. Those costs are not yet readily available.


Road Display by Maintenance Level
for
Clear/Crazy Analysis Area
US Highways
Road Maintenance Levels
1 - BASIC CUSTODIAL CARE (CLOSED)
2 - HIGH CLEARANCE VEHICLES
3 - SUITABLE FOR PASSENGER CARS
4 - MODERATE DEGREE OF USER COMFORT
5 - HIGH DEGREE OF USER COMFORT
Trails
Clear/Crazy Boundary
Wilderness Area

Trails

There are currently approximately 106 miles of trail in the Clear/Crazy/Powder analysis area. This trail system accesses an area of approximately 243 square miles. The trail system in the analysis area varies from high standard all terrain vehicle trails to primitive single track trails. The majority of the trails within the analysis area are constructed and maintained by the Forest Service. However, there is also a small length of trails in the analysis area that are user created, or are abandoned trails that still retain an existing footprint. These trails are referred to as unclassified. Table 28 shows the breakdown of classified and unclassified trails within the analysis area.

Table 28. Miles of Trail by Status in Clear/Crazy/Powder

Trail Status	Length (Miles)
Forest Service	94.6
Unclassified	11.9
Total	106.5

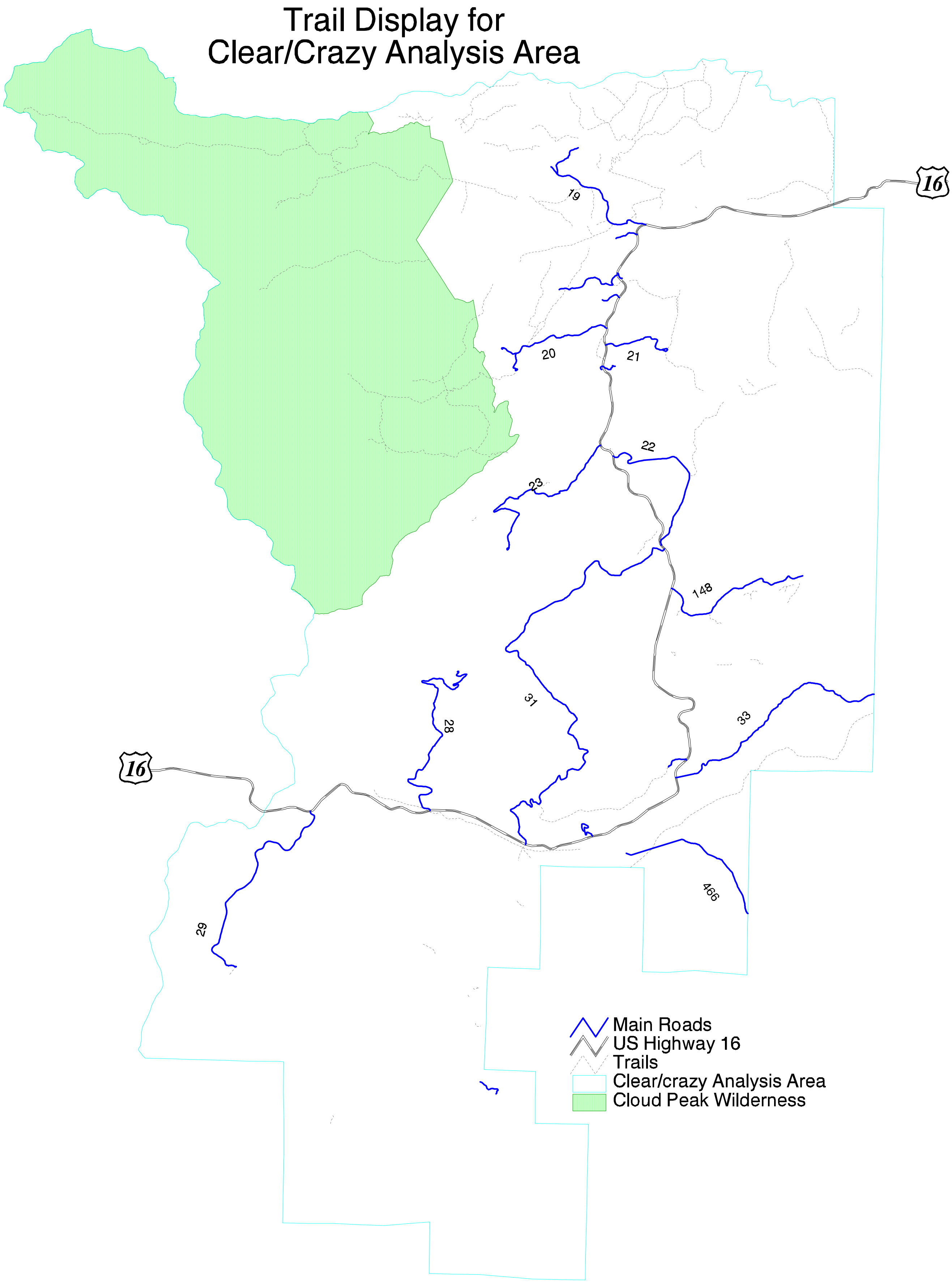
Forest Plan Goals/Desired Conditions

Forest Plan direction for transportation facilities are primarily based on resource needs rather than the road systems as a separate entity. In other words, the driving force behind road management decisions are primarily based on the management directions resource needs for an area. Currently, general plan direction states to maintain all trails to certain minimum requirements, including maintaining drainage structures to prevent unacceptable resource damage, and to remove all hazards from trails to allow safe passage for specified classes of users. For the most part, this direction of the plan is being met, however, deferred maintenance surveys have revealed that a lack of a steady budget in trail maintenance has caused some degradation of the trail system that is not consistent with current plan direction. In contrast, plan direction for providing a full range of trail opportunities in coordination with other state, federal and county municipal jurisdictions and private industries is generally being met.

The current annual trail maintenance need is estimated to be $1,217 per mile and deferred maintenance costs are estimated to be $13,125 per mile[17]. Total trail maintenance needs in the Clear/Crazy/Powder analysis area are estimated to be $ 129,610 annually maintenance, with a $1,397,812 deferred maintenance backlog.

The map on page 61 shows the current trail system within the Clear/Crazy/Powder analysis area.

[17] These costs are interpolated from the forest wide condition survey assessments done in 2000 and 2001.


Trail Display for
Clear/Crazy Analysis Area
16
19
20
21
22
23
148
31
28
33
16
29
466
Main Roads
US Highway 16
Trails
Clear/crazy Analysis Area
Cloud Peak Wilderness

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