Chapter

3

BIGHORN NATIONAL FOREST

Land and Resource Management Plan

Draft Environmental Impact Statement

Affected Environment and Environmental Consequences

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Chapter
3

Purpose and Organization of this Chapter

Chapter 3 combines two chapters often published separately in environmental impact statements: *The Affected Environment* and *Environmental Consequences*. The primary purpose of this chapter is to describe the environment of the Forest and to disclose the effects of the alternatives.

This chapter contains a description of the physical, biological, and social environments on the Forest and the surrounding area. These descriptions include such topics as geology, topography, climate, plant and animal life, and current socio-economic conditions. The chapter is divided into five major categories:

Physical Elements.

Biological Elements.

Use and Designation of the Forest.

Production of Natural Resources.

Communities.

Each category is further subdivided. For example, Physical Elements is subdivided into four topics: air, aquatic resources, heritage resources, and soil. For each topic, the applicable statutory requirements, key indicators used for comparing alternatives, resource protection measures, and the affected environment and environmental consequences are discussed.

Many additional items were screened out of the analysis process. The reasons for eliminating them include the following:

- Analysis of the item was not considered important to the integrity of the Forest environment.
- Analysis of the item would not disclose direct or indirect effects to the environment.
- Analysis of the item was not acknowledged or required by law.

Resource Protection Measures

Mitigation measures as defined by 40 CFR 1508.20 include: avoiding the impact altogether by declining to take an action or part of an action; minimizing impacts by limiting the degree or magnitude of an action or its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; and/or compensating for the impact by replacing or providing substitute resources or environments.

Key laws, regulations, and policies are identified in the Revised Plan in Appendices A - C. Applicable standards and guidelines are also found in the Revised Plan. The DEIS will discuss key resource mitigation measures, unconstrained effects, and effects constrained by mitigation. Only those key mitigation measures such as laws, regulations, policies, and forest-wide standards will be discussed in each section of environmental effects.

Key resource mitigation measures should be viewed in a programmatic context. Specific mitigation measures will be developed during individual project analysis.

Monitoring and evaluation will determine the effectiveness of mitigation measures. Please refer to Chapter 4, Monitoring and Evaluation, in the Revised Plan.

Environmental Consequences

This section describes the direct, indirect, and cumulative effects on the environment resulting from activities. It also describes output levels for the alternatives. If a resource management activity has no direct or indirect effect on a particular environmental element (listed above), under any of the alternatives, there is no discussion.

Direct environmental effects are those that occur at the same time and place as the initial action. An example would be on-site soil compaction from rubber-tired skidders harvesting timber. Indirect environmental effects are caused by the action, but occur later in time or are spatially removed from the action. An example would be downwind effects of a power plant on air quality. Actions taken to achieve the goals of a particular alternative, along with past, present and foreseeable future activities undertaken by either the Forest Service or other parties, are called combined or cumulative effects to

the environment. The following table lists the past and reasonably foreseeable actions used in the analysis.

To ensure long-term productivity of the land, the environmental consequences of alternatives are limited by management requirements. Many are founded in law, federal regulations, and Forest Service policy. Other requirements to limit the environmental consequences are called forest-wide standards and guidelines. They apply to all desired conditions within each alternative developed. The alternatives considered in detail, with their attending forest-wide and management area standards and guidelines were designed to prevent extreme environmental consequences.

Table 3-1. Past and reasonably foreseeable actions for the cumulative effects analysis.

Project/Action	Location	Description
Past Activities		
Forest vegetation treatment	Forestwide	1. Acres and locations of past timber harvest and fires are shown in the Geographic Area and Forest wide analyses, and the fire and forest vegetation white papers. Approximately 20% of the forested acres on the Bighorn NF have had harvest activities in them, with only 4% totaling clearcuts (Meyer, et al, 2003) 2. The current condition of the forests resulting from the past natural events and planned activities is described in the current vegetation database. For example, recent fires are coded as Habitat Structural Stage 1T, clearcuts from the 1960s are typically 3A or 3B, which indicates current stand size and density.
Fire Suppression	Forestwide	Fire suppression activities have changed fire regimes and condition classes, particularly in sagebrush, ponderosa pine, and Douglas-fir vegetation types, though also aspen to some extent. This is fully documented in the fire/fuels section of Chapter 3.
Roads	Forestwide	The history, current status and management of the Bighorn NF Road System is described in: • The forestwide Roads Analysis. • The Geographic Area and forestwide assessments. • The Heritage and Engineering specialist's reports. • Road densities and stream crossings as assessed in the Terrestrial and Aquatic Ecosystem Assessments.
Livestock Grazing	Forestwide	Historically high numbers of livestock grazed on Forest that have decreased over the past century for a variety of carrying capacity, economic, and industry related issues. Improvements in upland and riparian vegetation communities have occurred since.

Project/Action	Location	Description
Non-native Species	4 county area	1. Accidental and/or purposeful introductions of noxious weeds and non-native vegetation leading to loss of native vegetation communities. 2. Accidental and/or purposeful introductions of non-native animals (insects, pathogens, fish, mammals) that have replaced some native species or caused decline of some (e.g. trout and amphibians/macroinvertebrates, white pine blister rust, biological control of noxious weeds, moose, honey bees, etc.).
Loss of Predators	North Central Wyoming	1. Extirpation of grizzly and wolves from the Forest following settlement of the area. 2. In conjunction with game protection laws, increase in big game herds.
All activities impacts upon water	Forestwide	1. onitoring by the Conservation Districts has found that water quality coming off of the National Forest is good. (Sheridan County CD report on Little Goose Creek Monitoring; Earl Jensen, personal conversation). 2. Granite Creek is presently the only stream listed on the Wyoming 303(d) list of impaired streams. 3. Tie hacking. The effects to streams were primarily from activity on Clear Creek in the 1920's and 1930's, since much of the Tongue River tie hack transport was done by tie flumes. Streams were straightened, debris removed, etc., as documented in the Clear/Crazy Landscape assessment. 4. Influences from past high numbers of livestock grazing in riparian areas and upland sites affecting water quality.
Present/Reasonably Forseeable Actions		
Commodity Uses	Forest-wide	Ongoing timber harvest, livestock grazing, prescribed burning, and recreation use. Recreation use likely to have biggest increase on Forest of these.
Coalbed Methane Drilling	Powder River Basin – Sheridan, Johnson, Campbell and Converse counties	The Bureau of Land Management's Record of Decision and Final Environmental Impact Statement are available at the Buffalo Field Office, Buffalo, WY, or at http://www.wy.blm.gov/nepa/prb-feis/. The decision is expected to result in, among other things, 39,400 new natural gas wells; about 17,754 miles of new road; and, long-term surface disturbance to about 102,650 acres. There is expected to be no impact upon the boreal toad; effects upon the bald eagle and Ute-ladies tresses are expected to adversely affect individuals, but are not likely to jeopardize the continued existence of these species. At the peak construction period (2007), approximately 5,761 workers would be required.

Project/Action	Location	Description
Urbanization	Sheridan and Johnson Counties	The Center of the American West at the University of Colorado projected areas of urban sprawl anticipated by 2050. (http://www.centerwest.org/futures/) A copy of that map is included in the social specialist report in the project record. It shows that the area south of Sheridan to Big Horn and Story is expected to become increasingly subdivided in the future. Some potential effects associated with the projected increase in population and the associated 'urban sprawl' are: a) a loss of 'open space', an amenity prized by area residents and a contributor to the quality of life enjoyed locally. b) An increase in land values making traditional land uses such as ranching increasingly marginal economically c) An increase in the number of conservation easements developed by groups such as The Nature Conservancy d) A reduction in the amount of habitat available for wildlife. This will favor species such as coyotes, skunks, and white-tail deer that have become acclimated to human environments. e) Increased amount of wildland/urban interface. This will affect fire suppression and increase the difficulty of pre-suppression, fuels, treatments. f) Heritage resource sites on private lands can be destroyed. This phenomenon is not likely to occur on the west side counties because of the large amount of public land.
Subdivisions near Forest boundary	Dayton, Hazelton, Onion Gulch	Existing and new subdivisions are resulting in homes near the Forest boundary. This has recreation, access, and wildland/urban interface effects to the National Forest System lands, including changing the distribution and patterns of use. The number of subdivisions near the forest boundary is expected to increase in the future.
Highway construction/ reconstruction	Bighorn NF	As of 6/2003, the Wyoming Department of Transportation has12 projects on their out year planning spreadsheet. Included are the currently ongoing US 16 reconstruction project west of Buffalo and the Steamboat Rock reconstruction project, which is scheduled for NEPA in 2004. A 2+ mile of US 16 is scheduled for reconstruction in 2005, starting near Deerhaven Lodge and running west to the Tensleep Creek crossing. The other projects include fence reconstruction, slide repairs, parking lot addition, snowfence south of Burgess Junction. The current WYDOT planned activity summary project listing is available in the project record.

Project/Action	Location	Description
Changing demographics (aging population)	Johnson, Bighorn, Sheridan and Washakie Counties (as well as national phenomenon)	Particularly relevant to recreation. Use by the elderly is likely to increase proportionately faster than other demographic groups given the national aging phenomenon. As tourism grows and the state and national population ages, there is also likely to be an associated added demand for increased recreation opportunities on the developed side of the ROS (easier access, more amenities, etc). Demand could increase markedly for such features as interpretive sites and campgrounds of a higher development scale. Acceptable amounts of roaded access for hunting another potential "demand factor."
Yellowstone snowmobile decision	Yellowstone National Park	On March 25th 2003, the National Park Service released its Record of Decision allowing continued, albeit modified, snowmobile use in Yellowstone and Grand Teton National Parks as well as the John D. Rockefeller Jr., Memorial Parkway. On December 16th, 2003, a U.S. District Judge struck down the rule proposal and replaced them with the rules promulgated during the Clinton Administration which will lead to a total ban on snowmobiles in the Park. In February, a federal district judge issued a temporary restraining order setting aside the Clinton rules and instructed the National Park Service to develop temporary rules for the rest of the 2004 season. Based on these developments, it is likely that further changes will occur before any final resolution is reached. Yellowstone National Park is a premier winter recreation destination. While any change in the Park's snowmobiling opportunities could potentially affect winter recreation on the Bighorn NF, it is not likely to be dramatic; there may be a slight increase due to displaced users.
State OHV program	Bighorn NF	As of January 1, 2002, all ORVs (ATVs, dirt bikes, and other unlicensed ORVs) are required to display a Wyoming ORV permit while operating on public lands and other designated trails and areas, mirroring the current snowmobile registration requirements. Just as snowmobile use increased dramatically in the 1990's, ORV use will likely continue to increase due to an increase in information and advertising by the State Division of Tourism. The negative effects from such unplanned-for increases in use include displacement of local users to other, less-known sites, and potentially unsatisfied tourists. Potentially positive effects include the generation of funds to benefit trails on the Bighorn National Forest in the form of signage, enhanced education and enforcement initiatives, additional trails opportunities (through construction or reconstruction) and the

Project/Action	Location	Description
		potential for additional tourist visitation to surrounding communities.
BLM activities – Buffalo Field Office	Powder River Basin BLM lands	The Buffalo Field Office Resource Management Plan (RMP) was updated in 2001, and is available on the web at: http://www.wy.blm.gov/bfo/bfoplan.htm. Excerpts are found in the Revision project record. Among the decisions that could result in cumulative effects for the Bighorn Revision are: • Up to 10 MMBF of timber could be harvested over the 10 year plan period. 9 MMBF could be sawtimber, and 1 MMBF could be Products Other Than Logs. However, they estimated that only .130 MMBF would be harvested annually over the plan period. • About 73,000 acres of land in northern Sheridan County is available for coal leasing. • They estimated an annual livestock grazing output of about 110,000 AUMs. • Out of 798,848 acres of BLM administered lands in Sheridan, Johnson, and Campbell counties, about 20,400 acres is open to vehicles off-roads if the vehicle is operated responsibly in a manner unlikely to cause significant undue damage. About 37,600 acres are closed to all motorized vehicles year round, and motorized travel is restricted to roads and routes on about 737,000 acres. • Middle Fork of Powder River will be managed as a Wild/Scenic River.
BLM activities – Worland Field Office – Washakie Resource Management Area	Primarily east half of BLM lands in the Bighorn River Basin	The Worland Field Office Washakie Resource Management Plan (RMP) was completed in September 1988, with minor updates in 1997 and 1999. It is available on the web at: http://www.wy.blm.gov/wfo/plan/washrmp.htm. Excerpts are found in the Revision project record. Among the decisions that could result in cumulative effects for the Bighorn Revision are: • Harvest levels were not set, but "…will be based on treatments needed to meet management objectives." • They estimated an annual livestock grazing output of about 142,000 AUMs. • Out of 1.23 million acres of BLM administered lands in Washakie, Big Horn and Hot Springs counties, about 6700 acres are closed to all motorized vehicles year round, and motorized travel is restricted to roads and routes on about 1.22 million acres.

Project/Action	Location	Description
		• Opportunities for recreational access would be emphasized in Laddie Creek, Paint Rock Creek and Upper Nowood River. • The Spanish Point Karst area is managed as an Area of Critical Environmental Concern (approximately like an RNA on National Forest System Lands). Since the original plan, the Big Cedar Ridge Fossil Plant ACEC and the Red Gulch Dinosaur Track ACEC have been designated.
BLM Activities – Cody Field Office Trail relocation and trailhead construction	Lands west of, and bordering western Bighorn National Forest border.	The BLM is planning to implement two trail relocation/trailhead construction projects on the west face of the Bighorns on BLM land abutting up to the National Forest. They will involve the Cottonwood Creek trail and the Hayes trail. The trails will remain nonmotorized use. Possible effects include improved ease of public access to the northwest portion of the Bighorn National Forest as well as the need for placement of gates or cattle guards at the National Forest boundary fence. It is likely that work will commence in 2004.
State of Wyoming – Timber harvest	State land in Johnson, Sheridan and Campbell counties	Average of 700,000 MBF annually. Likely to continue at that level for foreseeable future. Silvicultural systems used, primarily, are: • Even aged, clearcut: Lodgepole pine • Even aged, shelterwood: Ponderosa pine • Even aged, shelterwood OR uneven-aged, selection: Douglas-fir (manage per existing age structure) • Uneven aged, selection: spruce-fir *(from Bill Haagenson, State Forestry, 3/04)*
State of Wyoming – Timber harvest	State and private land in Bighorn, Washakie, Park and Freemont counties	A conservative estimate is about 500 MBF/year for the next few years. *(from Paul Morency, State Forestry, 3/04)*
Timber harvest	Crow Reservation	Estimate about 2.5 MMBF per year in the foreseeable future.
Timber harvest	Northern Cheyenne Reservation	Have had a number of larger fire salvage sales in the recent past. Estimate about 6 MMBF per year in the foreseeable future.
Timber harvest	Shoshone National Forest	Have had a number of larger bug killed salvage sales in the recent past. Estimate about 6 MMBF in various products per year in the foreseeable future. They have just started the plan revision process.

Project/Action	Location	Description
Timber harvest	Private lands	There are no records of all the private timber sales, so it is unknown how much timber harvest there will be in the foreseeable future.
Regional Haze Reduction Program	Wyoming, Utah, Arizona, New Mexico, Oregon	In January 2004, five states announced a plan to cap sulfur dioxide emissions from major industrial sources such as coal fired power plants, smelters, and refineries. Currently, sulfur dioxide emissions in the five states total about 360,000 tons per year. The cap would allow 309,000 tons to be emitted annually by 2018. The reduction effort stems from 1977 and 1990 amendments to the Clean Air Act that required cutting back on pollutants that impair visibility in Class I airsheds. Non-class I airsheds are expected to benefit. Montana and other states in the region are expected to produce their own plans by the end of 2007.
Fuel Treatment	Bighorn NF and adjacent land ownerships, including Bureau of Land Management, Bureau of Indian Affairs, National Park Service, Wyoming state lands, and private lands.	Large catastrophic fires occurring during recent drought years have stressed the need to treat wildland fuels to re-introduce fire into fire adapted ecosystems, to increase public and firefighter safety, and to reduce the potential for resource and property loss from wildland fires. The National Fire Plan and various legislations have encouraged treatment of wildland fuels. Recent legislation, such as the Healthy Forests Initiative and the Healthy Forests Restoration Act continue to increase this emphasis. Based on need and current emphasis, both mechanical fuel treatments and prescribed fire activities are expected to increase on all ownerships although to a higher degree on federal managed lands during this planning period.

Relationship Between Programmatic and Site-Specific Effects Analysis

This DEIS is a programmatic document. It discloses the environmental consequences on a large scale, at the planning level. This is in contrast to analyses for site-specific projects. The DEIS presents a programmatic action at a Forest level of analysis but does not predict what will happen each time the standards and guidelines are implemented. Environmental consequences for individual, site-specific projects on the Forest are not described. The environmental effects of individual projects will depend on the implementation of each project, the environmental conditions at each project location, and the application of the standards and guidelines in each case.

The affected environment and environmental consequences discussions in Chapter 3 allow a reasonable prediction of consequences for any individual location on the Forest. However, this document does not describe every environmental process or condition.

Budget Levels

All alternatives and associated outputs are achievable under current and anticipated budget levels. Implementation of the 1985 plan showed that plan outcomes and desires do not affect budget levels; national initiatives, such as the National Fire Plan, have a much greater impact on the Bighorn National Forest budget. Since we cannot predict future national initiatives, we are planning at current budget levels.

Incomplete and Unavailable Information

The Council on Environmental Quality (CEQ) established implementing regulations for the National Environmental Policy Act (NEPA, 1969). These provisions (40 CFR 1505.22) require us to identify relevant information that may be incomplete or unavailable for an evaluation of reasonable foreseeable significant adverse effects. If information is essential to a reasoned choice among alternatives, it must be included or addressed in an EIS.

Knowledge and information is and will always be incomplete, particularly with infinitely complex ecosystems considered at various scales. Jack Ward Thomas, former Chief of the Forest Service, aptly commented that ecosystem management is not only bigger than we think but "bigger than we **can** think." Many components of these ecosystems, such as terrestrial and aquatic species, forest lands, rangelands, local and regional economies, and human use and demands interact in ways that elude definition by even the most complex models. Issues of species viability, sustainable and resilient ecosystems and economies remain clouded with uncertainty and risk. The ecology, inventory, and management of such systems are still developing disciplines; however, fundamental ecological relationships and interactions have been well established in the science. The alternatives and their effects were evaluated using the best available scientific information.

While additional information, data collection, and interpretation can add greater precision or resolution to understanding the ecological, social, and economic relationships with Bighorn National Forest management strategies, new information is unlikely to significantly change the basic understanding of these relationships and concepts that form the basis of our evaluation for effects.

We will continue to use new information, consult with the scientific community, collect more data, and tap new technology as the analysis proceeds to a Final EIS and decision. The public review and comment period will provide new information and insights that will help us achieve an effective final Revised Plan.

Though new information is welcome and will be incorporated as it becomes available, no incomplete or unavailable information was deemed essential to a reasoned choice among the alternatives.

The cornerstone element of the Revised Plan to take into account ecosystem complexity and future unknowns is Chapter 4, monitoring and evaluation. The Bighorn NF has

conducted monitoring since the 1985 Plan was implemented, and has issued a Forest Plan monitoring report annually. Fifteen Forest Plan amendments and numerous undocumented management changes during that period were made to make 'mid-course' corrections to the original 1985 Plan 'trajectory'. The Draft Revised Plan monitoring and evaluation chapter incorporates what we have learned about monitoring and evaluation. No level of current effects analysis can *assure* ecosystem sustainability and species viability; it is only through continously monitoring and evaluating the implementation, effectiveness and validity of Plan direction and assumptions, and our proven willingness to adapt to those changes, that continued sustainability can be assured.

Physical Elements

Air

Introduction

Air pollution has the potential to impact a variety of resources on the Bighorn National Forest including visibility, water, soils, and sensitive species of flora and fauna. The Forest Service is involved in the protection of air quality through a number of laws and regulations. Air quality on the Forest is good and typically meets national and state air quality standards, except in the case of large wildfires, where national and state air quality standards may be temporarily and locally exceeded. The only wilderness in the Bighorn National Forest is Cloud Peak, a Class II air quality area. No portion of the Forest is currently in a non-attainment area; however, the Sheridan, Wyoming area has been designated as a federal non-attainment area (PM_{10} – moderate) where applicable standards have been violated in the past.

Management actions on the Forest have not caused clean air standards to be exceeded. Forest management and use have the greatest potential to directly affect particulate levels through dust from road use and construction, and through smoke and soot from wildland fires. Potential impacts from prescribed fire and wildland fire use are short-term and will be mitigated. These activities are coordinated with the Wyoming Department of Environmental Quality/Air Quality Division (WYDEQ/AQD) to ensure that standards are not exceeded. By applying state, federal, and local regulations, the Forest will be able to protect its ecosystems and resources from unacceptable air pollution impacts. No management activities resulting in violations of clean air standards or visibility goals are anticipated under any alternative.

Legal and Administrative Framework

The Federal Clean Air Act, amended 1977 and 1990 – this act designates wilderness over 5,000 acres and in existence as of August 7, 1977 (including later expansions) as Class I areas. Section 169(A) of the act requires "the prevention of any future and the remedying of any existing impairment of visibility in mandatory Class I areas …" Within Class I areas, the act protects air-quality-related values (AQRVs) from adverse impacts due to air pollution. AQRVs are features or properties than can be changed by human-caused air pollution: plants; animals; water; visibility; odor; and cultural, archaeological, and paleontological resources. Under the Clean Air Act, the Forest Service is required to comply with all federal, state, and local air quality regulations and to ensure that all management actions

conform to the State Implementation Plan (SIP). To comply with recently developed regulations under the Clean Air Act, the Forest Service must evaluate all management activities to ensure they will not:

- Cause or contribute to any violations of ambient air quality standards.
- Increase the frequency of existing violations.
- Impede a state's progress in meeting their air quality goals.

The Clean Air Act, Section 169 (A), required the federal Environmental Protection Agency (EPA) to produce regulations to ensure reasonable progress toward meeting the national visibility goal for Class I areas where EPA determined that visibility was an important value. Section 109 gave the EPA the authority to establish national ambient air quality standards. The Wyoming Department of Environmental Quality is the state regulatory agency responsible for air quality and is primarily responsible for enforcing EPA's air quality standards

The Wilderness Act of 1964 – this act, and the Code of Federal Regulations (CFR) developed to implement it, give the Forest Service the responsibility and direction to manage designated wilderness areas to preserve, protect, and restore, as necessary, natural wilderness condition.

The EPA's Interim Air Quality Policy on Wildland and Prescribed Fires provides guidance on mitigating air pollution impacts caused by wildland and prescribed fires while recognizing the current role of fire in wildland management.

The Wyoming Air Quality Standards and Regulations – these standards and regulations are revised in an ongoing effort by the Wyoming Department of Environmental Quality, Air Quality Division to implement mandated Federal environmental programs in a manner that best meets the needs of the State of Wyoming. Wyoming is currently considering adoption of new smoke management regulations.

Key Indicators

- Miles of classified road.
- Miles of motorized trail.
- Acres available for winter over-snow motorized recreation.
- Acres of potential prescribed and wild fires.

Resource Protection Measures

The Forest Service is responsible for protecting the Cloud Peak Class II area ARQVs from adverse effects due to air pollution. This responsibility is carried out through the Prevention of Significant Deterioration (PSD) permit process and includes:

- Identifying sensitive receptors, if any, for each AQRV.
- Determining the potential effects, if any, on sensitive receptors from a potential new air pollution source.
- Determining if a potential effect is adverse.

The Forest Service will review and comment on any PSD applications for sources that may have a potential impact on Forest Service lands following the Federal Land Managers Air Quality Related Values (FLAG) policy and other applicable agency policies. The Forest Service will conduct monitoring for AQRVs and to comply with federal Clean Air Act regulations, the Forest Service will evaluate activities on National Forest System land that might impact the Bighorn airshed and will mitigate emissions where necessary.

Smoke from prescribed fires will be managed by burning on days when air quality degradation can be minimized. How well the smoke will disperse is a key consideration in prescribed burning decisions. Coordination with the WYDEQ/AQD will help to ensure that prescribed fires do not violate the state standard for particulate matter.

On all Forest Service projects, road dust will be evaluated if it is an air quality issue. Mitigation measures could include type of road surface, season of use, daily time/use restrictions, road closures, use of dust abatement products or road watering, and management for lower speeds on gravel and native surfaced roads.

AFFECTED ENVIRONMENT

Regional

A review of the 1996 actual emissions from counties within 100 km of the Bighorn National Forest shows what the following contributors of air pollutants (sulphur dioxide, nitrous oxide, volatile organic compounds) near the forest. The largest contribution of SO_2 emissions is from oil and gas production/distribution, followed by electric services, then petroleum refining, then chemical production. The largest contribution of NO_x 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 National Forest. However, air quality near the Forest is being measured as part of an analysis of potential impacts from oil and gas development in the region.

Forestwide

Air quality conditions in rural areas surrounding the forest are generally very good, as indicated by limited air pollution emission sources (few industrial facilities and residential emissions in relatively small communities and isolated ranches) and good atmospheric dispersion conditions, resulting in relatively low air pollutant concentrations. Occasional high concentrations of CO and particulate matter may occur in more urbanized areas with automobiles and home fireplaces (for example Buffalo and Sheridan) and around industrial facilities, especially in the stable atmospheric conditions common during winter.

Emissions from fire, including prescribed fire, wildfire, and recreational campfires, are a contributor to air pollution on the Forest during the spring, summer, and fall. During periods of drought and/or wind events, fires have historically grown quite large and can affect local air quality for several weeks. Slash disposal from timber harvest activities has generally been done by pushing the logging residue into piles and burning them when the fire hazard on the Forest is low.

Approximately 2,500 acres on the Forest are burned annually, using prescribed fires. This is a relatively small prescribed fire program compared to other western Forests. Prescribed fires are an intermittent source of particulates that can cause short-term visibility problems and temporary changes in ambient air quality. Annual smoke permits are obtained from the Wyoming Department of Environmental Quality, Air Quality Division, based on estimated emissions from prescribed burn plans. The Division is notified prior to, and must give approval for, any prescribed burning activities that are conducted.

Road dust from vehicle traffic on the 1,445 miles of unpaved Forest roads (Maintenance levels 1-3) also adds particulates to the air. In general, these emissions have only caused air quality concerns in localized areas. During dry periods of the year, traffic on some roads can generate localized road dust, which is generally viewed as a traffic hazard and a social issue.

The only wilderness in the Bighorn National Forest is Cloud Peak, a Class II air quality area. The Forest developed an air quality monitoring plan for the Wilderness in 1992. The plan includes monitoring objectives, resource susceptibility and current status, monitoring protocols, and a section on how to use the monitoring data. The Forest is currently monitoring lake water chemistry and visibility. The WYDEQ/AQD operates a visibility monitoring station located about 14 miles west of Buffalo, Wyoming. These monitoring programs provide the necessary data used in local, regional, and state-wide air quality assessments and are crucial to understanding current conditions, trends, and potential impacts of proposed development on air quality and air quality related values.

Visibility and lake chemistry data have been collected on the Forest, and ozone and deposition data have been collected at nearby sites. The following table lists the air quality data that have been collected on the Bighorn.

Table 3-2. Air quality monitoring 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)	1995-2001
State of Wyoming	Visibility Monitoring	2001-Present

Photographic 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 as 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 National Forest, on the best days, is 327 km, making the visibility one of the best in the lower 48 states.

The Wyoming Game and Fish Department conducted periodic lake chemistry sampling in and near the Forest between 1984 and 1991. The Forest 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 Wilderness Areas 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,[1] except that a list of plant species with known sensitivity to air pollution has been developed for the Cloud Peak wilderness (USDA, 1992).

Particulate matter pollution consists of very small liquid and solid particles floating in the air. Particles small enough to be inhaled into the deepest parts of the lung pose the greatest public health hazard. These particles are less than 10 microns in diameter and are known as PM_{10}. The City of Sheridan is in non-attainment for the PM_{10} standard under the National Ambient Air Quality Standards (NAAQS). 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.

[1] Air quality related values (AQRVs) include flora, fauna, soil, water, cultural resources, odor, and visibility.

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 National Park 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, and probably at the Bighorn National Forest, are not currently high enough to affect human health or vegetation. It is not likely that ozone concentrations will increase significantly in the future (USDA, 1999).

ENVIRONMENTAL CONSEQUENCES

General Effects

None of the alternatives considered is expected to substantially change existing air quality on the Forest. Temporary reductions in visibility and increases of fine particulate matter may occur in population centers downwind from sizeable wildland fires. Long-term air quality impacts to the Forest will likely come from upwind regional sources such as fossil-fuel burning power plants, oil and gas extraction activities, and adjacent urban areas, such as Sheridan and Buffalo.

Direct and Indirect Effects

Forest management activities that can directly affect air resources include prescribed fires, use of travelways, developed recreation, mining, and oil and gas development. Indirect impacts to air quality can occur from management decisions: for example, issuance of a special use permit to expand a ski resort which results in increased vehicle emissions from additional people driving to the ski area to work or recreate.

Effects from Travel Management: Air quality impacts from forest travelways are associated with vehicle emissions and dust from traffic on unpaved roads. These effects typically are localized and temporary, and their extent depends on the amount of traffic. Dust from unpaved roads increases with dryness as well as vehicle weight and speed.

Travelways on the forest typically are unpaved. They are used both for recreational purposes (e.g., off-highway vehicle (OHV) and four-wheel-drive use) and for resource management purposes related to timber harvesting, and mining. All alternatives will decommission or close the same miles of system and non-system roads, approximately 4 miles annually. Alternatives E and A propose the most new road construction or reconstruction of existing roads and consequently have the highest potential to affect air quality. Alternative C has the lowest potential to affect ambient air quality when compared to other alternatives.

Effects from Recreation: Motorized recreation occurs year-round. Summer use includes off-highway, two-wheel, and four-wheel drive vehicles. Travel on unpaved surfaces by these vehicles can stir up dust. To date, these localized impacts have not adversely affected air quality in sensitive areas (e.g., those with important scenic vistas). As use of forest

transportation system roads increases with visitation, road dust impacts to sensitive areas may need to be addressed. The increased visitor use is expected to be the same for all alternatives, including No Action.

Winter motorized recreation use is mostly limited to snowmobiles. Emissions from these vehicles include carbon monoxide, oxides of nitrogen, and particulate matter. Most of the effects of motorized recreation are localized and temporary. Conflicts arise when this recreation use occurs alongside nonmotorized recreation pursuits, where clean-smelling air is desirable. While some alternatives have more areas that will be closed to snowmobiling due to higher allocations to Management Areas 1.2, 1.31, and 5.41, this is expected to displace that snowmobile use rather than decrease the amount of overall use. Over the planning period, the number of snowmobiles on the Forest is expected to increase equally among all alternatives, including the No Action.

Effects from Fire and Fuels Management: Both wildfires and prescribed fires generate smoke and particulates that can temporarily degrade visibility and ambient air quality conditions in downwind sensitive areas. The risk of adverse air quality impacts from fires increases with the acreage burned. Those alternatives with the most fuel treatment acres proposed are Alternatives B and D; Alternative C proposes the least. Alternatives with more management area allocations that emphasize natural processes have the highest potential for, and the most acreage potentially impacted by, wildfire. Alternative C has the highest percentage of management area prescriptions emphasizing natural processes, followed by B, D, A, and E.

The Wyoming Department of Environmental Quality/Air Quality Division (WYDEQ/AQD) requires the Forest to model the emissions from each prescribed burn or management-ignited fire and demonstrate that they will not violate ambient particulate standards. Computer modeling is used to evaluate particulate matter (PM) emissions less than 10 and 2.5 microns in size (PM10 and PM2.5) from fire and their effects on air quality. The Simple Approach Smoke Estimation Model (SASEM) is currently the required model; the results are submitted to the WYDEQ/AQD before a burn permit is issued. SASEM can estimate the number of acres that could be burned at one time without exceeding the NAAQS. The Forest Service must conduct its management-ignited fires according to the conditions outlined in burn plans submitted and approved by the WYDEQ Air Quality Division. In addition, the Forest Service must coordinate its planned burns with local health agencies. Prescribed burns that have the potential for significant smoke impacts must have a plan that addresses nighttime smoke impacts. Also required is coordination with the National Weather Service to mitigate these impacts. Although management-ignited fires may increase emissions in the short term, these burns could help to decrease the emissions from catastrophic wildfires by reducing the fuel loading over the long term.

Effects from Oil and Gas Development: Air quality is affected by oil and gas development activities that include road and drill pad construction, development-related vehicle traffic, well drilling, well testing, and gas compression. Air pollutants of concern include particulate matter from dust during well site construction and from vehicle traffic on unpaved roads, carbon monoxide and nitrogen oxides from gasoline and diesel engines (e.g., vehicles and

stationary engines such as generators), and hydrocarbons released during natural gas extraction. Emissions from pipeline compressor engines include nitrogen oxides, carbon monoxide, formaldehyde, and volatile organic compounds (VOCs). Emissions from glycol dehydrators include nitrogen oxides, carbon monoxide, VOCs, and hazardous air pollutants (HAPs). However, because most of the Forest has limited potential for oil and gas resources, with only one exploratory well drilled approximately thirty years ago, it is estimated that there will be no oil and gas development on the Forest during the planning period.

Cumulative Effects

Impacts to air quality come from both on-Forest and off-Forest activities. The cumulative effects table at the beginning of Chapter 3 includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to air quality. Generally, long-term air quality impacts to the Forest will likely come from regional oil and gas extraction activities and from the adjacent communities as populations increase. Emissions can come from both mobile and stationary sources. Mobile source contributors include vehicle exhaust, dust from construction activities, and dust from increasing road traffic. Stationary source contributors off-Forest include industrial and commercial operations and power plants upwind from the Forest.

Minor road construction would occur under any alternative. The cumulative disturbance from road construction, reconstruction, and maintenance varies little among alternatives. Recreation use of Forest roads under all alternatives is expected to increase in response to an increasing population. Overall, air quality impacts generated by recreational use of roads would vary little among alternatives. As growth continues, pollution generated by vehicles will increase. Forest road construction, reconstruction, maintenance, and use under all alternatives will contribute only a small amount of the road-related air pollution in the region. The cumulative road-related impacts vary little among the alternatives.

Very small mineral operations occur on the Forest. Where they do occur, the impacts on air quality are negligible. The cumulative impacts of these operations would not differ between alternatives. Mineral operations that could potentially affect air quality on the Forest are oil and gas development operations in the surrounding region.

Smoke from wildland and prescribed fires can adversely affect air quality. The Bureau of Land Management and the state of Wyoming manage lands in the counties surrounding the Forest. Smoke from prescribed burning operations on these lands could individually, or in combination with other fires, affect air quality on the Forest and in surrounding communities. The Forest would continue to work with the Department of Environmental Quality/Air Quality Division for coordination and approval of prescribed fires to help ensure that the cumulative impact of these burns do not unacceptably impact air quality. Under all alternatives, wildfires would likely continue to periodically cause temporary deviations from air quality standards.

For all alternatives, cumulative impacts on air quality from forest management would be small, and in general, temporary and localized. All areas of the Bighorn National Forest currently meet state and federal air quality standards and show no degradation to visibility or other air-quality-related values. Compliance with local, state, and federal air quality regulations will ensure that future forest management activities under any of the alternatives will continue to protect air resources on the Forest and not contribute to air quality degradation off the Forest. The state of Wyoming has the regulatory authority for controlling emissions including those emissions with potential to adversely impact Forest resources.

Aquatic, Riparian, and Fisheries Resources

Introduction

There are a variety of aquatic and riparian ecosystems on the Bighorn NF: streams, rivers, ponds, reservoirs, wetlands, and riparian areas. These ecosystems support complex communities of vertebrate and invertebrate aquatic animals and an assortment of riparian and aquatic plants. Complex, species-rich communities of phytoplankton, zooplankton, macroinvertebrates, and fish can be found in many of these habitats.

Historically, people have used aquatic ecosystems for many purposes. Common uses of aquatic ecosystems by people include water development facilities for agricultural and municipal uses and water-dependent recreational uses. Human demand for water resources is increasing, and meeting these demands is challenging for Forest resource managers.

Forest management activities can affect the physical, chemical, and biological characteristics and functions of aquatic ecosystems. The challenge to resource managers is to implement multiple-use activities while protecting, maintaining, and restoring aquatic biodiversity, watershed/stream health, and riparian/wetland condition.

Legal and Administrative Framework

The Federal Water Pollution Control Act (Clean Water Act) was enacted to restore and maintain the chemical, biological, and physical integrity of the nation's waters. The Endangered Species Act requires federal agencies to conserve threatened and endangered species. These acts, along with other land use laws, executive orders, and policies guide management of aquatic resources on NFS lands. Other laws pertinent to watershed management of NFS lands can be found in Forest Service Manual (FSM) 2501.1.

Laws

The Organic Administration Act of 1897 recognized watersheds as systems to be managed with care to sustain their hydrologic function and secure favorable conditions of water flow.

The Federal Water Pollution Control Act, as amended, intends to restore and maintain the chemical, physical, and biological integrity of the nation's waters. There are five required elements:

- Compliance with state and other federal pollution control rules.
- No degradation of instream water quality needed to support designated uses.
- Control of nonpoint source water pollution through conservation or "best management practices."
- Federal agency leadership in controlling nonpoint sources pollution from managed lands.
- Rigorous criteria for controlling discharge of pollutants into the Nation's waters.

The Sustained Yield Forest Management Act of 1944 and the **Multiple Use Sustained Yield Act of 1960** allow for the production of multiple quality goods and resources at sustained levels over time, including maintenance of water supplies.

The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974, as amended, requires an assessment of present and potential productivity of the land. This act contains many references to suitability and capability of specific land areas, to maintenance of land productivity, and the need to protect and, where appropriate, improve the quality of soil and water resources. The act specifies that substantial and permanent impairment of productivity must be avoided and has far-reaching implications for watershed management (including monitoring, inventories, condition, and trends, and support services) on National Forests.

The National Forest Management Act of 1976 prevents watershed condition from being irreversibly damaged and protects streams and wetlands from detrimental impacts. Land productivity must be preserved. Fish habitat must support a minimum number of reproductive individuals and be well distributed to allow interaction between populations.

The Endangered Species Act of 1973 requires federal agencies to conserve threatened and endangered species and their ecosystems.

The Safe Drinking Water Act Amendments of 1996 provides states with more resources and authority to enact the Safe Drinking Water Act of 1977. This amendment directs the State to identify source areas for public water supplies that serve at least 25 people or 15 connections at least 60 days a year. The Wyoming Department of Environmental Quality has implementation responsibility for this law.

Executive Orders

Executive Order 11988 directs federal agencies to provide leadership and take action on federal lands to avoid, to the extent possible, the long and short-term adverse impacts associated with the occupancy and modification of floodplains. Agencies are required to avoid the direct or indirect support of development on floodplains whenever there are

reasonable alternatives and evaluate the potential effects of any proposed action on floodplains.

Executive Order 11990, as amended, requires federal agencies exercising statutory authority and leadership over federal lands to avoid to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands. Where practicable, direct or indirect support of new construction in wetlands must be avoided. Federal agencies are required to preserve and enhance the natural and beneficial values of wetlands.

Regulations and Policies

Regulations and policies have been passed in support of these laws and require the following:

- Protection of surface resources and productivity from all natural resource management activities (36 CFR 219).
- Watershed analysis as part of all planning activities (36 CFR 219, FSM 2500).
- Limitations of resource use to protect watershed condition. FSM 2500 and Forest Service Handbooks (FSH) 2500 state policy and direction regarding watershed management.

Key Indicators

- Miles of new road construction.
- Acres of land allocated to timber emphasis management areas.
- Acres of land available for summer motorized travel.
- Management Indicator Species (MIS) habitat.

Resource Protection Measures

Region 2 of the Forest Service has developed a Watershed Conservation Practices (WCP) handbook (FSH 2509.25), which provides resource managers with guidance in the context of existing laws, regulations, and policies. The WCP handbook lists standards and design criteria that aim to protect, maintain, and enhance the chemical, physical, and biological integrity of aquatic ecosystems. Standards from the WCP have been incorporated into the Revised Plan as forest-wide standards. Design criteria, as amended, have been included in the Revised Plan as forest-wide guidelines. According to the handbook, streams and watersheds that exhibit the following three conditions are at "potential" and are in dynamic equilibrium:

- Integrity of streamflow – expressed as minimum flood runoff and maximum base flows. Healthy watersheds have high rates of infiltration and minimum surface runoff. Most precipitation soaks into the soil, which reduces flooding, recharges groundwater, maintains riparian and wetland areas, and regulates streamflow.

- Integrity of the fluvial system – expressed as stable stream networks and channels and a balance between runoff and sediment yield. In healthy watersheds, the stream network is not expanding through gully erosion; streams are not aggrading or degrading; channel capacity is maintained over time, and streambanks are well vegetated.
- Integrity of water quality and aquatic habitat –good stream health supports productive, diverse, and stable populations of aquatic life and displays a natural range of habitat features (pool depth, substrate composition, and sequences of pools and riffles) for aquatic organisms.

The Aquatic, Riparian, and Wetland Ecosystem Assessment produced by Winters and others (2003), also identified watersheds with unique qualities for protection of these resources. The Assessment includes an analysis, which classifies small watersheds into distinct groups that differ in aquatic resource productivity, abundance, and response to disturbance. This concept provides a sound stratification of these resources in the Forest landscape. In conjunction with watersheds, historic and current human influences were also analyzed. A synthesis of the watershed information and human influences assesses the sensitivity, importance, and management risks associated with aquatic and riparian resources. These analyses will be valuable to help identify priority areas for restoration and monitoring, as well as development of future management direction (Winters et al. 2003).

A Nonpoint Source Management Strategy is also included in the WCP handbook (FSH 2509.25 Chapter 20). The strategy addresses how the Forest Service will apply WCPs, monitor their implementation and effectiveness, and adjust land management activities, or recommend changes to state water quality standards, as needed, to meet state water quality standards. The WCP handbook was written to protect aquatic resources and to address the potential and actual effects of federal and nonfederal actions (range, timber, water development, engineering, recreation, etc.) on Forest aquatic resources. There was a concerted effort to make sure that State Best Management Practices were also included as forest-wide standards and guidelines in the Revised Plan. When these applicable measures are implemented and effective, adverse effects to aquatic resources from management activities will be minimized or eliminated.

Implementation and effectiveness monitoring of Best Management Practices are typically carried out as an administrative review and do not involve water quality measurements (MacDonald, Smart et al. 1991)). Implementation and effectiveness monitoring of watershed conservation practices and Forest Plan standards and guidelines can be carried out by a variety of personnel, including timber sale administrators, contract officer representatives, resource specialists, and line officers. Documentation of this monitoring might include field notes, memos, contract daily diaries, or the annual Forest monitoring report. Systematic monitoring and adjustment of land management activities, where necessary, will ensure the highest possible level of Best Management Practice implementation and effectiveness. The Forest has been monitoring BMP implementation and effectiveness.

AFFECTED ENVIRONMENT

This section gives a brief overview of Forest surface water, groundwater, riparian areas, and aquatic biota. The natural disturbance processes and human influences that affect aquatic resources are also discussed. The physical, chemical, and biological integrity of Forest aquatic systems are assessed and key risks to aquatic resources are identified. A more detailed discussion of this topic is found in the aquatic specialist report on file in the administrative record. Amphibian species were addressed in the Single Species Analysis portion of the Biodiversity section in Chapter 3.

Surface Water

Quantity and Distribution: There are approximately 1,400 miles of perennial streams in public lands within the Bighorn NF. Water originating on the Forest contributes to flow to the Upper Missouri River basin. The east side of the Forest is in the Powder and Tongue River drainages, whereas the west side of the Forest is in the Bighorn River drainage. There are also hundreds of lakes, reservoirs, and ponds distributed across the Forest.

Quality: Surface water quality on the Forest is considered to be very good overall. Within the Forest boundary, Granite Creek, a tributary to Shell Creek, is recorded on the 2002 Wyoming 303(d) list of impaired streams. Granite Creek is not meeting its contact recreation uses, from its confluence with Shell Creek, upstream approximately four miles, because of coliform bacteria in the system. Hunter Creek was listed as threatened on the 2002 303(d) list, for excessive sediment, but has since been removed as a result of road relocation in 2003.

Uses: Surface water from the Forest is used on and off-Forest, both consumptively and non-consumptively. Non-consumptive uses include recreation, wildlife, fisheries, channel maintenance, and the aesthetic and spiritual quality of the resource. Consumptive uses meet Forest Service administrative needs (campgrounds, firefighting, administrative sites), permitted activities on the Forest (stock watering facilities, summer home wells, snowmaking at ski areas), and off-Forest activities (irrigation, municipal water supplies) with permitted water diversion, transmission, and storage facilities on the Forest.

Groundwater

Quantity and Distribution: The majority of the Forest is underlain by Precambrian aquifers. Precambrian rocks are not a major aquifer; therefore, groundwater storage across most of the Forest is localized and limited. Development of groundwater resources on the Forest tends to only occur in shallow alluvial aquifers.

Quality: Groundwater quality information for the Forest is limited, although there is extensive off-Forest data available for the more extensive aquifers. Campground wells on the Forest have been tested for baseline water quality. Results of those tests indicate that primary drinking water standards (e.g., iron) are occasionally exceeded. Past management on the Forest has not had any significant adverse effects on groundwater.

Uses: Due to the limited supply and lack of development opportunities, beneficial use of Forest groundwater is low. Consumption is limited to stock-water facilities, spring developments, special- use permits, and Forest Service campgrounds and administrative sites with domestic wells. Off-Forest, groundwater is used extensively for pump irrigation and drinking water wells.

Water Developments and Municipal Watersheds

Development and use of Forest water resources can affect water quality and quantity. Reservoirs and other structures used to divert water are abundant off the Forest; however there are relatively few diversions within the Forest boundary (Winters et al. 2003). This is due to the lack of agricultural and municipal development within the Forest boundary, as well as the physical difficulty and expense of transporting water to private lands that are off of the Forest. A total of 27 diversions are located within the Bighorn NF boundary (Winters et al. 2003). There are at least 10 reservoirs on the Forest that are used for agricultural and municipal purposes, with flows being carried down existing streams with a few connecting diversions.

The majority of water development on the Forest is associated with agricultural and municipal uses beyond the Forest boundary. Agricultural uses include stock watering and irrigation. Stock watering facilities are common on the Forest and are usually small wells or spring developments. Irrigation water diversions tend to be simple headgate designs and open, earthen canals to transmit water for use off-Forest. Agricultural water uses tend to divert water only during the summer months. Municipal water diversions tend to be sophisticated, with multiple diversion structures feeding into larger and larger canals and pipelines. They also include use of reservoirs to store the water. Municipal water diversions take place all year long.

Five cities located at the base of the mountains rely on surface water that originates on National Forest lands. Wyoming's Department of Environmental Quality (DEQ) does not officially designate watersheds that produce water for domestic use. However, the state does designate Class 2AB as waters that have sufficient water quality and quantity to support drinking water supplies and protect those waters for that purpose. These watersheds would receive a higher level of protection, because of their inherent importance for consumptive uses. The following watersheds have been identified by the state as being suitable for drinking water and have been identified by the Environmental Protection Agency as serving community water systems.

Table 3-3. Bighorn NF watersheds serving as community water systems.

Watershed Name	State of Wyoming Surface Water Classification	Municipality Served by Forest Watershed
Goose Creek	Class 2AB	City of Sheridan, WY VA Medical Center
Tongue River	Class 1	City of Dayton, WY City of Ranchester, WY
Clear Creek	Class 2A	City of Buffalo, WY
Shell Creek	Class 2AB	City of Greybull, WY City of Shell, WY

Riparian/Wetlands

Riparian areas are places where water-dependent vegetation lives and grows on the banks of stream, lakes, and rivers and includes the watercourses themselves. Wetlands are areas that are frequently inundated by surface water or groundwater sufficient to support a variety of characteristic vegetation or aquatic life. Wetland plant and animal communities typically require saturated or seasonally saturated soils to survive. Wetland habitat types are swamps, bogs, marshes, sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds. Other definitions for these types of areas exist. For the purposes of this analysis, riparian ecosystems, wetlands, lakeside zones, springs, and floodplains will be referred to collectively as riparian ecosystems or riparian areas.

Riparian areas and wetlands cover a relatively small portion of the Forest; but their ecological significance far exceeds their limited physical area. Riparian areas and wetlands are an important component of the overall landscape and represent some of the most dynamic and ecologically rich areas on the landscape. Riparian areas exist in the rangeland and forested environments throughout the Forest. Riparian and wetland systems are responsive and dynamic to both natural and human caused disturbances, though they typically can be restored more quickly than other habitats due to the interaction between, water, vegetation, and soils.

Most riparian areas stand out because of their unique vegetation. In drier parts of the Forest, ribbons of dense vegetation flank streams and rivers, in distinct contrast to the surrounding uplands and valley bottoms. The following table displays the riparian acres in each geographic area, which total approximately 10% of the National Forest acres.

Table 3-4. Acres of riparian area, by geographic area on the Bighorn NF.

Geographic Area	Acres of Riparian Area
Devil's Canyon	5,594
Shell Creek	10,693
Paintrock Creek	10,883
Tensleep Creek	10,119
Clear/Crazy	14,257
Piney/Rock	10,704
Goose Creek	14,004
Tongue River	18,656
Little Bighorn River	9,686
Total	104,596

Although riparian zones occupy a small part of the Forest, they are a critical source of diversity within ecosystems. Healthy riparian areas, with an abundance of trees and other native vegetation, slow flood waters and reduce the likelihood of downstream flooding. Riparian areas improve water quality by filtering runoff, sediment, and nutrients from flood flows and adjacent upland slopes. Healthy riparian areas act like sponges; they absorb water readily during periods of excess. Water slowed by riparian areas enters the groundwater where some is released later. Riparian areas produce stream cover and shade, which keep the water temperatures cool for fish and water-dependent animals.

Benefits of riparian areas include food, cover, and nesting habitat for wildlife. Riparian areas often provide sheltered upstream and downstream transportation corridors to other habitats. Fish depend on healthy riparian areas for stable channels, sustained water supplies, clean, cool water, food, and shelter. Riparian areas are attractive and inviting to Forest visitors for aesthetic and recreational purposes.

Streamside riparian ecosystems are tied to the hydrologic, sediment, and disturbance regime of flowing waters. Many plant species reproduce only following flood disturbances. Maintaining the hydrologic regime is important for maintaining the integrity of riparian plant communities. Changes in sediment load in stream channels may lead to down cutting or lateral erosion, altering floodplains and their water table depth relationships. Sediment deposition form adjacent slopes can "fill" riparian areas and provide suitable sites for upland and exotic plant invasion.

Non-streamside riparian areas occur in sites with seasonally or permanently high water tables, as well as on the margins of ponds and lakes. Fens, bogs, springs, wet meadows, and wetlands are easily dewatered, which can convert them to uplands or facilitate exotic plant invasion.

Quantity and Distribution: There is great variability in the size and vegetative complexity of riparian zones on the Bighorn NF. Ecological drivers such as geology, climate, glaciation, and stream gradient all influence the type, complexity, quantity, and distribution of riparian and wetland ecosystems that occur. Glaciated landscapes on the Forest have a relatively higher proportion of wetland and riparian areas, due to an inherent landform of low gradient, wider valley bottoms (Winters et al. 2003).

Quality: The conditions of riparian areas can be used to indicate riparian quality. Riparian conditions on the Bighorn NF are highly variable due to both natural and human disturbances. Overall, riparian areas on the Forest are functioning at or near their potential and are considered to be improving. However, there are many localized areas where they are functioning below their potential.

Factors leading to a decrease in riparian area function are: improper livestock grazing, timber harvest, road development, water diversions, and disturbances associated with recreational use. Improper livestock grazing has been the most important factor leading to degraded riparian areas on the Forest. Improper livestock grazing can lead to bank damage, riparian plant community conversion, and sedimentation. On forested landscapes, silviculture, road building, and fire suppression have altered riparian conditions by changing flow regimes and altering channel morphology. When disturbances to the riparian area are significant, they may modify the interaction between the floodplain, water table, and the stream channel. Impacts to the riparian area can lead to a decrease in the function and habitats provided by a healthy riparian area. Natural disturbances as described above may combine to degrade riparian conditions, but are also necessary for causing regenerative events in these areas.

Riparian areas can often be key sites for invasion of exotic plant species due to human uses and other transport mechanisms (wildlife) in these areas. Noxious weed invasion is less likely in high elevations (>9,000 feet), with the exception of Canada thistle. Likelihood of invasion and expansion of non-native vegetation increases as elevation drops due to climate differences (Winters et al. 2003). Refer to the Non-native and Invasive Species section of Chapter 3 for further information. Loss of native vegetation can disrupt the functioning of riparian areas.

In addition, there are 24 state and globally rare vascular plant species known to occur in wetlands on the Bighorn NF (Winters et al. 2003). Refer to the Biodiversity section of this chapter for further information on rare species. None of the plant species are known to be in decline from any current uses on the Forest in riparian areas, and some are deemed rare due to lack of information and surveys. Regardless, they are likely dependent on quality riparian habitat for persistence.

An indicator of riparian quality and condition can be tied to the amount of roads in riparian areas. Where greater densities of roads occur within riparian areas, there are increased potentials for degraded conditions as influenced by the factors mentioned above. The overall road density in a watershed can be another indicator for these potential effects, and road densitities are described in the Biodiversity section in Chapter 3 under fragmentation and in the Aquatic Assessment conducted for the Forest

(Winters et al. 2003). The following table displays the current amount of roads within riparian areas on the Forest. While there was no threshold identified for concern in Winters et al. (2003), the figures below indicate which watersheds have higher amounts of roads in riparian areas, and therefore greater risks for degraded conditions.

Table 3-5. Miles of road in riparian areas, by geographic area, on the Bighorn NF.

Geographic Area	Miles of Road within Riparian Areas
Devil's Canyon	6
Shell Creek	13
Paintrock Creek	8
Tensleep Creek	13
Clear/Crazy	32
Piney/Rock	2
Goose Creek	16
Tongue River	56
Little Bighorn River	11

More specifically, another indicator of riparian condition and quality is the number of road crossings within a drainage. The higher the road crossing densities, the more likely there will be detectable effects in water quality. The following table displays the range of road crossing densities within each of the planning watersheds. Exceeding 0.5 stream crossings per square mile of watershed appears to be a threshold after which higher risk of road related watershed impacts occur (Winters et al. 2003).

Table 3-6. Density of stream crossings, by geographic area, on the Bighorn NF.

Geographic Area	Number of Stream Crossings	Number of Stream Crossings per Square Mile
Clear/Crazy/Powder	276	1.4
Goose Creek	108	0.9
Tensleep Creek	174	1.5
Devil's Canyon	86	0.9
Little Bighorn	165	0.7
Paintrock Creek	118	1.1
Piney/Rock Creeks	17	0.1
Tongue River	337	1.2
Shell Creek	173	1.0

The Forest has been actively reducing the number of crossings, and improving the condition of stream crossings for the past several years through its aquatic management program. It is presumed that this emphasis would continue into the next planning period.

Aquatic Biota

The Bighorn NF supports a variety of aquatic biota in its lotic (flowing water) and lentic (still water) riparian ecosystems. The many reservoirs on the Forest also provide habitat for aquatic biota, however their fluctuation in water levels can create environmental extremes favoring few of the species groups considered below. Clearly, the most common aquatic biota in the Forest can be broadly categorized as fishes, aquatic plants, aquatic insects, and the embryonic and larval stages of amphibians. Less obvious and less well understood are the phytoplankton, zooplankton, and microbes associated with aquatic environments. These organisms play important roles in nutrient cycling, energy fluxes, and comprising food chains.

As a surrogate for addressing effects and plan direction for all of these species, the Forest has identified aquatic emphasis species including the Yellowstone cutthroat trout and mountain sucker as Forest Service sensitive species, the rainbow trout as a **Management Indicator Species** (MIS), and three sensitive amphibian species. Rainbow trout will be addressed below, but refer to the single species analysis portion of the biodiversity section, within this chapter, for discussion on the other sensitive species. The rainbow trout was selected as an MIS due to its Forest-wide occurrence, habitat associations with quality riparian habitat, and existing population monitoring in conjunction with the WGFD. Refer to the project record and specialist for further information on other species considered as MIS, including plankton, macroinvertebrates, and other fish species.

Fish: Historically, there were no fish in the high elevation lakes on the Forest (Gillette 1925), and the indigenous fishes were found in streams. Fish have been the focus of management emphasis by both the WGFD and Forest resource managers for the past several decades. There are eleven fish taxa that occur within the boundary of the Bighorn NF currently as displayed in the table below. The mountain sucker and the Yellowstone cutthroat trout are the only two native fish. Most of the remaining taxa were introduced for sport fishing, considered demand species, and have subsequently established self-reproducing populations. Both fish species native to the Bighorns are of conservation concern due to habitat concerns and competing populations of other fish. Both are considered to be sensitive species by Northern and the Rocky Mountain Regions of the Forest Service, and have associated rare status as declared by several States.

Brook trout were introduced into the Bighorn NF lakes beginning in the late 1800s. Later, non-native gamefish such as brown trout, rainbow trout, golden trout, splake, and Arctic grayling were stocked into Bighorn NF (see table below). Several of the stocked, non-native trout populations were able to successfully reproduce in the lakes because, at least in part, they were adapted to spawning in the streams. Most of the available spawning habitats in these subalpine lakes are found in the inlet and outlet channels. In subalpine lakes, non-

native trout may have adversely affected the abundance and distribution of native amphibians due to predation on larvae, juveniles, and adults.

Table 3-7. Fish species found on the Bighorn National Forest.

Species	Scientific Name	Status	Management Emphasis	Comments
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*	Native	Emphasis Species	Stocked and Naturalized
Rainbow trout	*Oncorhynchus mykiss*	Nonnative	Management Indicator Species	Stocked and Naturalized
Golden trout	*Oncorhynchus aguabonita*	Nonnative	Demand Species	Naturalized
Brook trout	*Salvelinus fontinalis*	Nonnative	Demand Species	Naturalized
Lake trout	*Salvelinus namaycush*	Nonnative	Demand Species	Naturalized
Brown trout	*Salmo trutta*	Nonnative	Demand Species	Naturalized
Grayling	*Thymallus arcticus*	Nonnative	Demand Species	Naturalized
Mountain sucker	*Catostomus platyrhynchus*	Native	Emphasis Species	Naturalized
Lake chub	*Couesius plumbeus*	Nonnative	none	Naturalized

Naturalized populations are either indigenous to the Forest or may be an introduced population of nonnative species, which are reproducing and have become self-sustaining in parts of the Forest.

Stocked populations have been introduced by human intervention, but may not naturally reproduce.

Often, native species become a focal element of wilderness areas. Of the 314 high mountain lakes in Management Areas 1.11 and 1.13 (Cloud Peak Wilderness) in the Big Horn Mountains, 10 lakes contain naturally reproducing populations of Yellowstone cutthroat trout. There are 65 lakes that support naturally reproducing populations of other game fish such as golden trout, lake trout, rainbow trout, and brook trout. Twenty lakes are stocked but do not have naturally reproducing populations because they are prone to winterkill and require periodic stocking to maintain a recreational fishery. The remaining 244 lakes are presumed to have no fish, demonstrating that approximately 78% of the wilderness area lakes are managed for a native condition.

Yellowstone cutthroat trout, an emphasis species, are considered unlikely to have historically occurred in the Powder River watershed. The historical distribution of this species on the remainder of the Forest has been substantially reduced, and many local populations have been extirpated. 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. Monitoring and inventory in association with the Wyoming Game and Fish Department (WGFD) has led to a near complete survey of the Forest to determine this species' extent.

All populations are at risk of hybridization with non-native species. Hybridization with introduced rainbow trout and competition with non-native species are believed to be the primary causes in the decline of this subspecies.

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. These activities have resulted in barriers to migration, reduced flows, sediment deposition, groundwater depletion, stream bank instability, erosion, and pollution. Recreational use can also be a significant source of disturbance to habitat.

Angling is another factor that may play an important role in the status of remaining Yellowstone cutthroat trout. Yellowstone cutthroat trout are particularly vulnerable to angling, and angler harvest has contributed to substantial declines in population abundance throughout the historical range of the species. This factor has been an element of management focus by the WGFD for the past several years.

Mountain Sucker, an emphasis species, are not common across the Forest, and currently the only known populations occur in the South Tongue River drainage and Kearny Reservoir. This species has wide distribution in the drainages at lower elevations and is common throughout its range. Historic distribution of Mountain Sucker in the Bighorn Mountains is not known. Self-sustaining populations have been identified downstream from the Bighorn National Forest boundary in the Paintrock, Shell and Tensleep drainages on the western slope and in the Tongue and Powder River drainages on the eastern slope.

Rainbow trout, a Management Indicator Species, as well as a demand species, are well distributed throughout most watersheds on the Forest. Though there are potential competition issues with the native Yellowstone cutthroats, rainbows are closely associated with high quality stream and riparian habitat. Population trends on the Forest are currently stable, as demonstrated through combined Forest and WGFD monitoring efforts. Populations are monitored by stream reach, with periodic sampling occurring on approximately 5 year intervals for selected streams. Habitat impacts such as those described for the cutthroat trout above would also be applicable for habitat of the rainbow trout.

Natural Disturbance Processes

Natural events, such as landslides and wildfire can influence the hydrology, water chemistry, vegetative succession, and geomorphology of watersheds and aquatic systems (Schullery and Varley 1994). For example, wildfire can cause landslides and alter vegetation

composition and structure, alterations that can cause watershed recovery to take hundreds of years (Swanston 1991). Human activities can directly or indirectly affect natural processes and the frequency, magnitude, and duration of catastrophic events.

The effects of these processes on habitat quality and productivity depend on the intensity and timing of disturbance events. Some disturbances occur regularly and are generally easy to anticipate such as seasonal and annual precipitation, bankfull flows, etc. Other events occur less frequently and are more difficult to predict. These unpredictable events are usually triggered by major storms, large-scale vegetation disturbances (fire, windthrow, insects and disease) or changes in the earth's crust (earthquakes, volcanic activity) (Swanston 1991). Another natural process is the ebb and flow of beaver occupancy in a watershed, where water tables are raised and ponded habitat increased, but stream incision may occur where beaver vacate an area and their dams fail. Due to the important role of beaver in riparian areas, they were selected as a MIS species as described in the Wildlife section in this chapter.

All of these natural events can alter watershed processes, local channel configuration, and aquatic biota. The magnitude of a disturbance will often determine the amount of change that occurs in a watershed. For example, during extreme (50 years +) flood events, organisms seek refuge in safe places behind logs, large rocks, under banks, and among roots and flooded vegetation. Extreme flood events, though relatively infrequent, can alter the habitats and behavior of aquatic organisms. Research has documented the impact of large-area wildfires (e.g., Yellowstone National Park, 1988) on stream channels (Gibbons and Salo 1973; Bozak and Young 1994). Sudden changes in channel morphology occurred because of increases in flow, sediment, and debris. Increases in sediment concentrations have lethal effects on fish populations. However, over time, these impacts may be beneficial if they increase the amount of nutrients in sterile streams and increase the available food supply for fish and macroinvertebrates.

Watershed response to disturbance is widely variable. Some watersheds are very sensitive to disturbance because they may have steep slopes and highly erodible soils. Other watersheds are more resilient and are capable of accommodating severe climate events or intense ground-disturbing activities.

ENVIRONMENTAL CONSEQUENCES

General Effects

Nearly all activities carried out on the Forest and described in this analysis have the potential to affect aquatic and riparian resources. Activities that alter the quantity, timing, and quality of water resources have the greatest potential for adverse effects, and the risk of adverse effects increases the closer the disturbance is to streams or wetlands. Environmental consequences of activities are expected to be proportional to the levels of activities that occur. This aquatic and riparian resource analysis focuses on effects from anticipated management activities.

Direct and Indirect Effects

Surface water, groundwater, floodplains, riparian areas, wetlands, and aquatic habitats for species are all closely related. Discussion of effects on these resources will be dealt with together since the pathways of effects that influence them are similar. When they are impacted differently, it will be specifically noted and described.

For each of the resource areas described below, the environmental consequences for aquatic resources are compared by alternative, based on key indicators of disturbance for each type of activity. In general, alternatives that propose greater levels of disturbance activities for various resource uses generally pose greater risk to aquatic and riparian resources.

Effects from Timber Harvesting: Timber harvest can affect aquatic resources in a variety of ways. Harvest in riparian zones reduces streamside vegetation, which can increase annual and daily stream temperature fluctuations, reduce overhead cover, and decrease the supply of large woody material available for recruitment to streams. Logging slash and debris can choke streams and reduce dissolved oxygen levels as debris decays, creating anoxic conditions toxic to fish and other aquatic organisms. However, the Forest in the past decade has avoided harvesting in riparian areas, so these effects are largely associated with more historic management activities. Major increases in erosion from harvested areas themselves are unusual, but the road and skid trail network associated with timber sales can increase the risk of erosion and sedimentation.

Water resources have been influenced by historic tie drives and timber removal for other commodity uses. Timber harvest started in earnest with the advent of railroad tie hacking in the late 1800s. The log drives along with those instituted for saw timber, damaged stream banks, and simplified channel structure. A complete description of effects can be found in Young et al. (1989). The culmination of the tie drives in the early 1900s allowed stream recovery to begin and it continues to this day.

Changes to natural flow regimes as a result of modifications to forest cover could alter stream channel morphology. Bankfull discharges have been found to mobilize and transport the majority of annual sediment loads over a period of years (Andrews 1980), and other research found that the duration of bankfull discharge increased after timber harvest (Troendle and Olsen 1994). Despite the logical link between altered flow and sediment transport characteristics, there are no known documented cases of stream channel alterations on the Forest resulting from increased water yield following timber harvest. Flows to streams may often increase following natural or man caused reductions in forested cover within watersheds.

A stream's susceptibility to channel morphology change is dependent on its characteristics (Rosgen 1996). The majority of streams on the Forest are not highly susceptible to changes in morphology as a result of vegetation management, since they are well armored and often enlarged due to historic tie drives. Harvest levels necessary to produce measurable increases in streamflow (i.e., greater than 20-25% of a watershed harvested) only occur in very small watersheds across the Forest. Revised Plan standards and guidelines (riparian section) provide measures to protect stream channels against increased flows as a result of vegetation

management. Channel instability as a result of increased water yield from vegetation management is possible, but is not expected to occur in most areas on the Forest due to the small harvest levels in individual watersheds and the channel conditions present on most of the Forest. In the few cases where there may be concerns, project-specific analysis and mitigation should address channel instability resulting from increased water yield following vegetation management.

Increases in stream flow, changes in riparian vegetation, and impacts to streambanks associated with both historic and current logging operations have the potential to alter channel morphology and fish habitat in streams on the Forest. Direct effects of vegetation removal are most likely to result in reductions in overhead cover that provides hiding and resting areas for fish, and reductions in the allochthonous input (e.g. leaves and debris) to a stream. Indirect effects of streamside timber harvest to aquatic ecosystems could be changes in community composition and relative abundance of aquatic biota and reductions in the abundance, distribution, and quality of spawning habitat and hiding cover due to sedimentation, embeddedness, and loss of streamside vegetation.

Forestwide standards and guidelines have been developed to minimize the impacts of timber harvest activities on aquatic resources (refer to the physical and biological elements). Careful project planning and project implementation are required to ensure that vegetation management does not preclude achieving desired conditions for aquatic and riparian ecosystems or adversely affect viability of aquatic emphasis species, management indicator species (MIS), or demand species. Implementation of effective watershed conservation practices will also minimize the changes to aquatic ecosystems that could occur as a result of timber harvest. These measures include State Best Management Practices for riparian areas, among other measures. Sediment and water yield modeling associated with timber harvest were not conducted due to the limited amount of impact anticipated from any of the alternatives, and due to the implementation of Forest-wide standards and guidelines, among other reasons.

The risk of adverse consequences to watersheds and fisheries may increase with higher harvest levels, as opportunities for conflict with standards or guidelines could occur, though this is primarily in relation to the associated road networks necessary for higher harvest levels rather than vegetative manipulation. The potential for impacts to water resources is estimated to be proportional to the acres of land allocated to timber management areas (suited timber) and is shown below. It should be noted that none of the alternatives have suited timber within 300’ of perennial streams, and none have suited timber within 100’ of both intermittent and perennial streams and other riparian areas.

Based on overall amounts of timber harvest, Alternative E has the highest risk of effects to aquatic resources, from timber harvesting, followed in order by Alternatives A, D, B, and C. This analysis assumes that the amount of harvest is proportional to the suited acres, and that there is equal risk and consequence of effects from timber harvest and related activities carried out in all locations. In reality, risk and consequence are dependant on a variety of factors, including the type of harvest and location relative to water resources. There is also

some benefit of increased water yield to streams by reduction in forested cover, assuming these areas are properly placed in the watershed.

Table 3-8. Relative impact of suited timber acres on aquatic resources, by alternative.

	Less Impact← Relative Impact →More Impact to Aquatic Resources				
Suited Timber by Alternative	Alt. C	Alt. B	Alt. D	Alt. A	Alt. E

Effective implementation of watershed conservation practices is key to avoiding or minimizing impacts to aquatic species and potentially affected streams under any alternative. Implementation and effectiveness of forestry watershed conservation practices was rated at 91 and 93 percent respectively, in a recent field audit which included two timber sales on the Forest (Wyoming Timber Industry Association 2002). Actual areas harvested in any given year vary depending on alternative and budget levels. Site-specific effects on aquatic and riparian resources would occur as a result of a variety of factors including harvest levels and type, location of harvest relative to aquatic resources and effective implementation of watershed conservation practices. Currently, harvest activities have occurred on approximately 20% of the forested acres on the Bighorn NF (Regan et al 2003).

Effects from Travel Management: Roads connected to the stream system are a source of increased sediment in streams on the Forest (Winters et al 2003). Many streams have roads or trails directly adjacent to them as described in the Affected Environment above, where nearly all erosion delivers sediment directly to the stream. Sediment fills pools, reducing habitat for fish, and fills the interstitial spaces of the streambed, reducing habitat for invertebrates and spawning fish. Unlike many other disturbances that increase erosion, sedimentation from travelways tends to be chronic and to last as long as the travelways exist, which can create long-term impacts on habitat for indicator species. Roads, trails, and associated human travel also cause reduction, disturbance, and interruption of riparian habitat. Accordingly, numerous wildlife species associated with riparian areas are adversely affected.

There are both economic and ecological consequences from increased sediment derived from roads and other sources. Sediment does not dissipate and is carried through the stream system where it may affect diversion structures, reservoirs, and water supplies. It can shorten the usable life of structures or result in higher maintenance costs. Since channels are interconnected, sediment delivered to ephemeral channels moves on to perennial channels during spring runoff. High sediment loads impact stream health by reducing pool depths, filling interstitial spaces in the streambed used by macroinvertebrate life, adhering to gills of aquatic life, changing channel morphology, and damaging habitat.

Alteration of aquatic habitats for emphasis species, MIS, and demand species, by sedimentation includes reductions in spawning gravels and hiding cover as substrates become more embedded. Pool volume can be reduced as sedimentation increases. During critical low-flow or overwintering periods, reduced pool depth can result in insufficient protection for fish, and increase the risk of summer or winter kills. Sediment deposition in

spawning gravels reduces both success in locating appropriate spawning areas and the survival of emerging juvenile fish.

The Forest is responsible for management of more than 1,544 miles of classified roads and 274 miles of unclassified (user-created) roads. Most of these roads were constructed in support of timber harvest activities. In addition, there are numerous other roads managed by other entities within the Forest boundary, including Highways 14, 14A, and 16, and county roads. There are also approximately 1,211 miles of trails on the Forest. These travelways provide a background level of disturbance that contributes to direct and indirect effects on aquatic and riparian resources. Trends in increased recreation on the Forest are expected to continue and to accelerate these effects.

Compliance with Revised Plan standards and guidelines (biological and physical sections) should minimize problems with new or reconstructed roads. However, bringing existing roads into compliance with new protection measures is a challenge. The Bighorn NF Roads Analysis Report (2002) analyzed 6th-level watersheds on the Forest and found 21 percent with high or extreme road densities, 20 percent with high surface erosion potential and 16 percent with high or extreme road densities within 200 feet of water courses. Roads managed under other jurisdictions that occur on private land or run across easements also contribute cumulatively with Forest roads to watershed conditions.

Future road management should consider relocation or obliteration of existing roads out of riparian areas to reduce associated impacts. Impacts can be greatly reduced by proper location and design. Travelways should be located away from stream channels, riparian areas, steep slopes, high-erosion-hazard areas and areas of high mass movement. Good design provides stable cut and fill slopes and adequate drainage that allows water to filter through vegetated buffers or sediment traps before entering the stream channel. Realignment of roads and other travelways so that they traverse riparian areas and streams at perpendicular rather than parallel angles would improve the quality of riparian and aquatic habitats in presently impacted stream reaches by reducing chronic sediment sources. If relocation is not possible, seasonal restrictions would limit road damage and subsequent sedimentation.

The amount of road construction varies directly with the amount of suited land. Alternative E would have the most road construction, followed by Alternatives A, D, B, and C.

Effects from Fire and Fuels Management: Wildfire and prescribed fires and their associated suppression activities have the potential to impact aquatic and riparian resources as described above in the natural disturbances section. By burning vegetation and organic matter on the soil surface, wildfire can greatly increase erosion rates and adversely affect water quality. Erosion and sedimentation following high severity wildfires tend to be very heavy, overwhelming other erosional sources, including timber harvest and roads, until the land revegetates. Fire suppression efforts considerably increase erosion potential from fire lines constructed by heavy equipment. The removal of vegetation also increases the speed with which overland flow reaches the channel network and the amount of water added to the streamflow. The combination of these effects can greatly increase peak flows in burned watersheds and result in major channel

cutting. When fires burn through riparian areas, buffering vegetation is lost and effects on aquatic ecosystems can be even more severe. Adverse impacts can persist for many years.

The effects of prescribed fire can be considerably less severe. Because the location and severity of the fire are controlled to a greater degree, more ground cover remains and erosion potential is reduced. For example, sediment-trapping buffers can be left around stream channels to reduce the amount of sediment delivered to the stream. Entire watersheds are rarely burned by prescribed fires, and this reduces the effects of changes in water yield and peak flow. Furthermore, the judicious use of prescribed fire can help to reduce the risk of uncontrolled wildfires that would otherwise burn through and severely damage watersheds and riparian areas. Alteration of aquatic habitats for emphasis species, MIS, and demand species, by sedimentation includes reductions in spawning gravels and hiding cover as substrates become more embedded.

Frequency, size, and severity of wildfire are difficult to predict for the short timeframes. Smaller wildfires occur relatively frequently, while larger wildfires occur infrequently. Severe wildfire can have devastating consequences to aquatic ecosystems. Management response to wildfire varies between alternatives and will likely affect the size and severity of wildfire expected under each alternative. There is a 75% probability that fires will cumulatively burn more than 5,000 acres during the analysis period. Refer to the Fire and Fuels section for additional information.

In addition, the area affected annually by fuels management (combination of prescribed fire and mechanical treatment) is expected to vary by alternative, as shown in the table below. Additional prescribed burning is intended primarily to improve wildlife habitat or reduce fuel loads. Fuels treatments may reduce the risk of severe wildfires and therefore have a positive long-term effect on aquatic conditions. In watersheds where the fuel conditions have been substantially altered, the long-term benefits of fuels treatments to aquatic resources are assumed to outweigh the short-term adverse impacts. Reductions in forested stands can also provide increased water flows that may be beneficial for aquatic resources. Alternative C may maximize the number of areas where natural processes such as wildfire would be allowed to shape fuels conditions more.

Table 3-9. Relative impact of anticipated fuels treatments on aquatic resources, by alternative, on the Bighorn NF.

	Less Impact← Relative Impact →More Impact to Aquatic Resources				
Forested	Alt. C	Alt. E	Alt. A	Alt. D	Alt. B
Non-Forested	Alt. C	Alt. A	Alt. E	Alt. D	Alt. B
Total	Alt. C	Alt. A	Alt. E	Alt. D	Alt. B

Effects of fire suppression activities are typically conducted to minimize impacts to riparian areas by restricting the use of dozer lines and retardant in riparian areas. When retardant is allowed to reach water sources, aquatic biota may be killed as a result from changed water chemistry and quality. Potentially undesirable aquatic biota may also be transferred from one water source to another, from the use of helicopter buckets during fire suppression. This type of activity is not currently restricted on the Bighorn NF, and has currently unknown impacts.

Effects from Livestock Grazing and Big-Game Use: Improper grazing can have detrimental effects on aquatic resources, particularly in those areas of the Forest where livestock tend to concentrate, such riparian areas. Alternatively, proper livestock, wildlife, and rangeland management can mitigate the grazing impacts to riparian areas and can be compatible with maintaining desired watershed conditions. Grazing in riparian areas directly affects vegetative condition and habitat quality in a number of ways.

Long-term use has changed the vegetation composition of some riparian sites. Loss of willows and deep-rooted grasses makes streambanks in these sites more susceptible to natural erosive forces. Improper grazing by livestock and wild ungulates can reduce bank stability through vegetation removal and bank trampling. It can compact soil, increase sedimentation, cause stream widening or downcutting, and often change riparian vegetation, resulting in insufficient overhead cover for fish, including emphasis species, MIS, and demand species. Stream widening and sedimentation can reduce instream cover and habitat quality for fish though mechanisms similar to those described for vegetation removal through timber harvest or fire, but grazing impacts can be compounded by repeated yearly livestock use of the same areas. Downcutting often leads to channel straightening and reduced stream sinuosity, which eliminates habitat for aquatic indicator species associated with stream bends, such as lateral scour pools and undercut banks.

Improperly managed livestock grazing can also lower water quality by introducing bacteria and pathogens into water bodies along with fecal material. Although this impact has occurred, it has not changed the support of designated uses of stream water, according to the state 2002 305(b) and 303(d) report (Wyoming Department of Environmental Quality 2002).

Alternatives do not vary in the number of active allotments, number, and type of animals permitted, or overall use by livestock. There are approximately 83 active allotments within the Forest. All alternatives maintain the current number of active allotments and aquatic resource impacts from grazing would be similar to the existing conditions. Livestock grazing under any of the alternatives is assumed to have high potential for direct impact on riparian and aquatic resources. Incorporating Revised Plan standards and guidelines into project level analysis will minimize the effects of grazing on aquatic resources. These measures are designed to protect water quality and riparian areas, and will be included in allotment-management plans as they are revised and updated. It is anticipated that all alternatives would result in the slow improvement of riparian resources over time from livestock and wildlife use through implementation of Revised Plan guidance. Incidences of competing use of riparian forage by livestock and wildlife were also addressed in the Revised Plan, and are estimated to be relatively minor, localized sources of impacts.

Effects from Mining: Existing mining operations in the Forest are typically small and limited in number. At present, much of the mining on the Forest is recreational (suction dredging) and is regulated by Revised Plan standards and guidelines. Increases in mining activity are not anticipated for the future, but cannot be ruled out. The 1872 mining law limits Forest Service authority over mining activities but allows the setting of terms and conditions to minimize impacts to National Forest System lands.

Most mining activity is concentrated outside the Forest in the sedimentary formations surrounding the Bighorn Mountains (Winters et al. 2003). The following table shows the number of mining sites inside and outside the Bighorn National Forest.

Table 3-10. Historic and recent mining sites inside and outside the Bighorn National Forest.

	Historic Mining		Recent Mining	
Watershed Name	**Inside Forest**	**Outside Forest**	**Inside Forest**	**Outside Forest**
Nowood River	7	51	1	15
Bighorn Reservoir	4	106	3	72
Little Bighorn River	7	35	0	31
Upper Tongue River	22	139	2	13
Middle Fork Powder River	1	100	0	30
Crazy Woman Creek	1	24	0	20
Clear Creek	5	56	0	17
Totals	**47**	**511**	**6**	**198**

Source: U.S. Geological Survey, 1997 Mineral Availability System Database

Mining effects include land disturbances and processing activities that may affect water quality, water quantity, and timing of release. For this analysis, aquatic resource effects from mining are assumed to be proportional to the amount of land available for locatable minerals. Potential impacts to aquatic habitats and populations are expected to be minor for all alternatives as there are no known proposals for development, and minimal if not non-existent potential. Alternative E would have the most area available for locatable minerals exploration and therefore has the greatest risk of adverse affects. Alternative C has the least area available for locatable minerals exploration and therefore, has the least risk of adverse effects.

Table 3-11. Comparison of land available for locatable minerals development by alternative.

	Less Impact← Relative Impact →More Impact to Aquatic Resources				
Land Available by Alternative	Alt. B	Alt. C	Alt. D	Alt. A	Alt. E

*Locatable minerals are minerals such as gold, silver, and molybdenum

Revised Plan standards and guidelines would provide direction on minimizing effects from any potential mining activities.

Effects from Oil and Gas Leasing: Because there has been no oil and gas activity on the Forest in the limited area that has development potential, oil and gas development on the Forest is not anticipated during this planning period. Therefore, there are no effects on aquatic resources from oil and gas leasing.

Effects from Utility Corridors: Three general types of utility corridors have varying potential to affect aquatic and riparian resources. Above-ground power and telecommunications corridors require vegetation clearing, but ground disturbance is limited to access routes and pole or tower locations. Streams and wetlands can often be spanned with no need for disturbance.

Below-ground power and telecommunications corridors require ground disturbance along the entire length of the corridor, including crossings of aquatic or riparian ecosystems. However, these corridors require relatively narrow trenches and minimal vegetation clearing. These utility corridors can often be located along other existing corridors such as roadways.

Below-ground oil, gas, or water transmission lines are most likely to significantly affect aquatic and riparian resources. These corridors often contain far larger pipelines that require large, deep trenches. To allow for gravity feed, these corridors are often located parallel to natural stream courses. Wide construction and access corridors are sometimes maintained to allow for repairs and cleaning. Within the oil/gas pipeline corridors, there is potential for leaks or spills that could cause environmental damage.

There are very few utility corridors on the Forest. Increasing urbanization makes it likely that there will be an upward trend in utility corridors. There is not likely to be any difference in utility corridor proposals between the alternatives because corridors are instigated and developed by private utilities rather than by Forest management direction.

Effect from Recreation Management: Recreation impacts to water resources on the Forest are related to streamside recreation use, water-based recreation, and indirect effects from upland recreation activities. Motorized off-road recreation travel can cause riparian area degradation and adverse water quality impacts. Horse, bike, and foot traffic generally have less impact but can cause localized effects. Water-based recreation is increasing and degradation can occur if proper facilities are not in place and use is not managed. Streamside areas are often chosen for dispersed campsites. Dispersed campsite use can damage riparian vegetation, cause soil compaction in riparian zones, erode streambanks, and cause increased nutrient loading and pathogen levels due to human waste contaminating streams and lakes (Helgath 1975; Clark and Gibbons 1991; Leung and Marion 1996; Cole 2000). Often, the impacts tend to be localized; however, in areas that experience substantial recreational use, the cumulative impacts to aquatic and riparian ecosystems can be both observable and measurable. Protection of water quality, quantity, and riparian habitat near recreationally significant water bodies is achieved through the implementation of the Revised Plan standards and guidelines.

Recreational use is expected to increase on the Forest and be similar between alternatives. The direct impacts to fish populations and fishing experiences are expected to be proportional to use rather than variable by alternative. Ski area effects by alternative are discussed below. Impacts on riparian and aquatic habitats from recreational travel were discussed previously under the Travel Management section above. The magnitude and extent of motorized recreation trends have a greater effect on aquatic resources than nonmotorized recreation, and has been potentially one of the largest increases in uses from the conditions in the 1985 Forest Plan. Recreation impacts on aquatic, riparian, and fish populations, including emphasis species, MIS, and demand species, are assumed to be proportional to the acres available to motorized recreation, as shown in the table below. Alternative C has the highest risk for potential adverse effects to aquatic resources from summer motorized recreation, followed in order by Alternatives B, D, A, and E based on anticipated opportunities for motorized recreation (Management Areas 1.33 and 3.31), as described in the Recreation section of Chapter 3.

Fishing is a primary reason to visit the Bighorn NF for many Forest users, and is often an important, though subordinate, activity associated with other recreational pursuits such as backpacking, camping, and horseback riding. Easy access to Forest streams, lakes, and reservoirs provides a variety of angling opportunities situated in locales that range from developed sites with amenities to subalpine wilderness areas.

Fishing pressure on the Forest is expected to increase in the coming decades under all of the forest plan alternatives. In the Bighorn NF – except for stocked lakes and reservoirs – fishing is a "supply-limited" activity because there is more fishing pressure on easily accessible fisheries than the fish populations can support. The WGFD manages the majority of streams on the Forest under the "Wild" management concept; i.e. stocking does not augment fish populations. The WGFD has also placed special regulations on some streams to offset the pressure of angling, such as in the North Tongue.

Recreational fishing may adversely affect existing populations of Yellowstone cutthroat trout, and emphasis species, rainbow trout, a MIS, and demand species on the Forest, because increased recreational fishing pressure is likely to result in increased illegal harvest and increased incidental fishing mortality, although periodic restocking by the Wyoming Game and Fish Department may be used to offset this or other fishing impacts. Refer to the Biological Evaluation in the project record for further information on Yellowstone cutthroat trout.

At the project scale, watershed improvement projects and fish habitat improvement projects can result in positive outcomes for both fisheries and for anglers.

Hiking trails are popular among Forest users in the Bighorn NF, and it is reasonable to expect increasing public demand for additional hiking trails over the coming decades. If those demands are met, the expanded trail networks and increased trail use could result in the alteration and degradation of aquatic, riparian, and wetland resources. Trail use can contribute to the propagation and distribution of pathogenic agents such as the Whirling disease protozoan, coliform bacteria, and Chitrid fungus in aquatic environments, all of

which may damage aquatic biota. Finally, trails can provide relatively easy access and opportunities for those who would introduce exotic species into aquatic environments. It is not anticipated that there would be a significant increase in trail construction in the next planning period, due to the deferred maintenance backlog of these routes. New trails may be developed along scenic byways, but probably 2 miles or less, and adjacent to the highway corridor. Most other trail construction on the Forest is reconstruction, as demonstrated by the past several years.

Dispersed motorized and nonmotorized winter recreation activities have some potential to adversely affect aquatic and riparian resources. Nonmotorized winter uses include cross-country skiing and snowshoeing. Motorized winter uses include snowmobiling and snow cat use for research and maintenance. Damage to vegetation and soil erosion can occur if there is inadequate snowpack to protect these resources. Winter motorized activities can also compact the snow, forming barriers that alter spring runoff patterns, which can result in soil erosion and gullies.

Contamination by human waste and by petroleum products such as motor oil and gasoline can degrade water quality in waters adjacent to areas of concentrated use such as parking lots and snowmobile staging areas (Hagan and Langeland 1973; Ingersoll, Turk et al. 1997)). The likelihood and magnitude of impacts due to these activities are dependent on site-specific factors such as average slope, aspect, elevation, vegetation, weather conditions, available facilities, and the amount of use. Because site conditions vary, and because these sites are relatively small in area and widely dispersed, it is reasonable to assume that cumulative impacts will not be measurable at the Forest scale. Appropriately, winter activities that appear to be problematic will be identified and rectified during project-level analysis.

Developed winter recreation sites may adversely affect aquatic and riparian resources. The Bighorn Ski Resort and Antelope Butte are ski areas that are permitted to operate on the Forest. Ski area development can lead to increased runoff and erosion through timber clearing for lifts, runs and other facilities. Ski areas and snow resorts typically remove forest vegetation from much of the area. Snowmelt runoff is increased, especially when cleared areas are compacted or snowmaking has artificially increased the snow depth. Substantial amounts of such disturbances can increase the size and duration of spring high flows, resulting in damage to the stream channel. Snowmaking that drains water from streams also reduces winter base flows that are limiting to populations of emphasis species, MIS, demand species, and other aquatic biota. Ski areas and snow resorts also typically disturb soils throughout cleared areas. Erosion and sediment can result, especially from soils that are near streams, unstable, or highly erodible. In addition, these uses can also degrade wetlands and riparian areas by draining or filling them or by altering their vegetation. Often, ski lift terminals are constructed in valley bottoms, which can cause long stretches of stream to be put in culverts, with a resultant increase in barriers to fish passage and loss of riparian and wetland habitat. These impacts often have adverse effects on aquatic and wildlife habitat.

All alternatives would continue to permit the existing ski areas. These are of small enough size that there are minimal current impacts to aquatic resources from their use. There is no anticipated expansion of the ski areas beyond that which is currently approved. However, the boundary of the Bighorn Ski Resort ski area is expanded in all alternatives except A. Any future expansions would be designed to mitigate effects to aquatic resources, though some potential would exist for adverse effects due to the proximity to Meadowlark Lake.

Effects due to Wilderness and RNA Allocation: Alternative C is the only alternative that includes additional wilderness over current allocations. With the proposed wilderness in this alternative, there are approximately 5 stream reaches that provide habitat for Yellowstone cutthroat that may benefit from this prescription. However, these same streams in almost all of the other alternatives are managed through roadless or equivalent non-motorized recreation emphasis prescriptions. None of the alternatives provide wild and scenic river prescriptions for streams that contain the emphasis species' Yellowstone cutthroat trout or mountain sucker. Alternatives B, C, and D provide for an increase of Research Natural Areas (Management Area 2.2), which would provide some aquatic habitat protection for Yellowstone cutthroat populations. These designations would have similar effects for the MIS, rainbow trout, in terms of minimizing potential disturbances from more aggressive land uses.

Effects from Land Use Authorizations: Various laws provide for rights-of-way over public lands. The Forest Service is responsible for all existing grants and permits located on National Forest lands, including their administration, amendment, and renewal when authorized and appropriate.

Water developments on the Forest include irrigation diversions and irrigation-storage reservoirs. Diversions reduce or eliminate downstream flows, which can affect channel size and limit habitat for aquatic and riparian management indicator species. Dams alter flow regimes by storing water during runoff to release later in the year. Both dams and diversions can impose significant barriers to migrations and can dewater streams during certain time periods, which fragments aquatic ecosystems. In some cases, altered flow regimes prolong periods of runoff and can enhance riparian vegetation communities.

Dams affect stream channels in different ways depending on their operation. Reservoirs store sediment and release sediment free water from the dam. As the water releases, it can downcut or widen the channel below the dam. On the other hand, if water storage reduces peak flows, the result can be the stabilization or reduction of channel capacity.

The 1985 Forest Plan contained provisions to protect aquatic habitats and stream channels from the potential adverse effects of water development. The Forest has reviewed some water use permits to ensure that aquatic habitats and stream channels are protected and to assess whether the uses were meeting forest plan standards. Some permits contain resource protection flow conditions and conditions to prevent gully erosion. The Revised Forest Plan includes standards to ensure flow in perennial streams and protect against gully erosion.

The Forest Supervisor has the authority to assure that permits are consistent with the Forest Plan and the Endangered Species Act. As permits are amended, renewed, or issued, the Forest will analyze environmental effects and ascertain if mitigation or additional terms and conditions are required to meet the proposed forest plan standards and guidelines and/or the Endangered Species Act. In some cases, analyses and terms will focus on single permits; in others, they will address all permits in the watershed. The degree of effects is currently unknown. While the effects of these projects can be significant, effects are not expected to vary between alternatives for two reasons. First, demand for water-use authorizations is driven by proponents of water development rather that by Forest programs or budgets. Second, many water facilities are operated under perpetual easements or other authorizations that are subject to limited environmental mitigation. There may be proposals to construct additional reservoirs or diversions on the Forest, as this has continued through the late 1990s, however there are currently none pending. Some proposals for a dam in Dry Fork in the Little Bighorn River drainage have been examined in recent years, though none have been finalized or permitted. This size of reservoir or diversion would have a negative impact on existing aquatic resources, though further project specific analysis would also accompany any such proposal. This stretch of river is proposed as a wild and scenic river in all alternatives, consistent with the nomination conducted in 1990.

Summary of Effects to Aquatics from Proposed Management Activities

Precipitation falls on all parts of a watershed and water flows over and through the soil mantle throughout the watershed on its path to stream channels. Consequently, aquatic resources are influenced by all the activities in the watershed.

The most significant improvement in the Revised Plan is the incorporation of forestwide standards and guidelines to protect aquatic resources. These elements were not in the 1985 Plan. If all applicable measures are implemented and if they are effective, adverse effects from any of the alternatives should be minimized. Accordingly, it is anticipated that there would be no difference in population trends or habitat available to the rainbow trout (MIS) or the Yellowstone cutthroat trout among alternatives. Catastrophic events such as flooding, landslides, disease, or competition with other species would likely dominate in terms of effects to these species, and their habitat and population trends.

Nearly all activities proposed in the Revised Forest Plan have the potential to affect water resources and indicator species (e.g. rainbow trout) that rely on aquatic and riparian habitats. Activities that disturb the soil surface have the greatest potential, and the risk of adverse effects increases, as the disturbance is located nearer stream channels. These effects are typically most expressed where additional roads are constructed with associated stream crossings, or other surface disturbances. Watersheds whose physical, chemical, or biotic function is at risk have been discussed previously (Affected Environment, Current Aquatic Conditions). These watersheds may be near their capacity to assimilate further impacts, or may need remedial action to reverse downward trends in watershed condition. However, as levels of activity increase, the risk that conservation practices will not be properly

implemented or will not be entirely effective increases. Therefore, alternatives that propose higher levels of activity for various intensive land uses pose greater inherent risks to aquatic and riparian resources.

The following table provides a summary of the relative impacts of alternatives on aquatic resources. The land use categories are ranked in order of existing and potential impact to aquatic resources on the Forest. The top line indicates highest degree of impact and bottom line indicates lowest degree of impact.

Table 3-12. Relative impact of forest plan alternatives on riparian and aquatic resources.

Land Use Category	Less Impact← Relative Impact →More Impact to aquatic resources				
Effects from land authorizations	No real difference between alternatives				
Effects from travelways (new road construction and stream crossings)	C	B	D	A	E
Effects from motorized recreation mgmt. (potential for user created roads)	C	B	D	A	E
Effects from livestock grazing	No real difference between alternatives				
Effects from timber harvesting (tied to road effects)	C	B	D	A	E
Effects from prescribed fire	No real difference between alternatives				
Effects from utility corridors	No real difference between alternatives				

Alternatively, it could also be expressed that additional acres managed for natural processes such as wildfires could allow widespread fires that may have negative effects to aquatic resources. However, based on the variability in severity of fires, and the fact that the majority of the Forest is within a condition class rating (refer to fire and fuels section) that is not outside of historic fire regimes, these effects should be minimal. Alternatives that maximize natural processes are Alternatives C and B, tapering off to D, A and E respectively.

Cumulative Effects

In some cases, events on the Forest can contribute to effects downstream off of the Forest. The cumulative effects table at the beginning of Chapter 3 includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to aquatic resources. An example is the effect of water depletions from water development on the Forest reducing streamflows available off of the Forest. As there are no anticipated water depletions proposed by the Forest, there should be no increases in this effect in the next planning period. Currently, these types of depletions off the Forest are affecting aquatic biota in many of the watersheds surrounding the Forest.

Another potential effect within the Forest, but not attributed to Forest management activities, is the urbanization or development of intermixed private lands within the Forest. Continued

development of these lands for residential purposes has the potential to affect aquatic and riparian resources. Increased runoff and sedimentation from roads, roofs, and driveways, increased use of surface and groundwater, increased use of herbicides, pesticides, and fertilizers; and increased recreation uses on adjacent National Forest system lands can all be attributed to urbanization. If activities on intermixed private lands approach tolerance limits for watershed disturbance, additional activities on the Forest may be limited to avoid adverse and cumulative watershed effects. With the limited amount of intermixed ownership on the Forest, this effect should be minimal.

Another effect would be the reconstruction or development of additional highways within the Forest boundary. There can be both short term and long-term effects from this type of activity. No additional highways are planned within the Forest. Currently, there would be reconstruction of Highway 14 planned in the near future, though State Best Management Practices would presumably limit the effects to aquatic resources. Existing culverts along Highways 14, 14A, and 16 are considered barriers to fish passage in some streams that would hopefully be corrected in the future through reconstruction or other opportunities.

As further development is anticipated along the Forest boundary, there is potential for noxious weeds or other invasive plants and aquatic biota to spread upstream onto the Forest due to livestock, recreation, or wildlife use. This may be one of the more significant cumulative impacts in the next planning period, altering riparian vegetation communities and biota with associated affects to water quality. Pollution of streams downstream of the Forest should be a minor problem to on-Forest resources as gravity would dictate most of the effects.

Future management of Forest resources is also dependent upon cooperation with other agencies. Most Forest management focuses on maintenance, protection, or enhancement of *habitats*, rather than the organisms that inhabit them, but the National Forest Management Act also requires maintenance of population viability. Management of *populations* is the role of state and other federal agencies that rely on Forest management of habitats to meet overall viability goals. The most specific example of this is the maintenance of viable native trout populations to include the emphasis species, Yellowstone cutthroat trout, the MIS, rainbow trout, and demand species, such as brook, brown, golden, lake trout, and grayling. Cooperative recovery efforts, including state control on nonnative stocking and careful management of fishing in streams to protect pure strains of native Yellowstone cutthroat trout are key to retaining this element of Forest ecosystems. Habitat protection and improvement projects should focus on the needs of emphasis species and management indicator species (MIS). Additionally, management decisions that affect the aforementioned species categories should be cooperatively made, where feasible, by the appropriate state and federal agencies. Moreover, threats to native and desired, non-native species viability, such as invasive species, habitat loss, and pathogens must be successfully managed through cooperative efforts by the appropriate resource management agencies. In conclusion, the Forest Service and cooperating agencies predicate the long-term maintenance and protection of Forest aquatic and riparian biodiversity from effective natural resource management.

Over all, it is anticipated that physical aquatic resource conditions will be maintained or improve into the future, due to increased management effort with these resources exhibited in the past decade. Biologically, this may not be the case as the effects from non-native species may have adverse effects on aquatic resources.

Heritage Resources

Introduction

In the early twentieth century, the public began to recognize that heritage resources (items modified by humans over 50 years old; i.e., stone artifacts, tepee rings, wagon roads, and turn of the century mining and homestead cabins) were an important aspect of our country's history and cultural values, that these resources are nonrenewable, and that they should be protected for future generations. A series of federal laws were enacted to protect heritage resources on federal lands from damage or loss due to federal programs and/or federally funded or permitted activities.

Legal and Administrative Framework

Antiquities Act of 1906 – This act protects historic or prehistoric remains or any object of antiquity on federal lands and applies to both cultural and paleontological resources. It imposes criminal penalties for unauthorized destruction or appropriation of antiquities without a permit.

National Historic Preservation Act (NHPA) of 1966 – This act protects historic and archaeological values during the planning and implementation of federal projects (CFR 36 800 and CFR 36 60). The law requires the following: (1) location and identification of cultural resources during the planning phase of a project, (2) a determination of "significance" (based on scientific archaeological values) for potentially affected resources, and (3) provisions for mitigation of any significant sites that may be affected.

Preservation of Historical and Archaeological Data Act of 1974—This act requires federal agencies to collect, protect, and preserve historic and archaeological data, as the results the agencies' undertakings/actions.

Federal Land Policy and Management Act of 1976 Section 102(8) – This act requires that "public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource and archeological values; that, where appropriate will preserve and protect certain public lands in their natural condition …" This law applies to cultural and paleontological resources.

American Indian Religious Freedom Act of 1978 (AIRFA) – This act protects American Indian rights to exercise traditional religions including access to sites and freedom to worship through ceremonial and traditional rites.

Archaeological Resources Protection Act (ARPA) of 1979 – This act imposes civil penalties for the unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources.

Native American Grave Protection and Repatriation Act 0f 1990 (NAGPRA) – American Indian burials and sacred items are protected by this act. If human remains or objects of cultural patrimony are discovered, this law requires consultation with the Indian tribe most closely related to the individual. The tribe then determines the appropriate treatment of the remains. This may include repatriation or scientific study and curation at a university.

Uniform Rules and Regulations (16 U.S.C.G 432-433) – These regulations coincide with the Antiquities Act of 1906. They give the Secretary of Agriculture "jurisdiction over ruins, archaeological sites, historic and prehistoric monuments and structures, objects of antiquity, historic landmarks, and other objects of historic or scientific interest" on the National Forest System lands. These regulations also apply to paleontological resources.

Code of Federal Regulations (CFR) 36 CFR 261.9 (g), (h) – This regulation prohibits excavating, digging or injuring/damaging in any way prehistoric and/or historic heritage resources, structure, site, artifact, or property and removing any prehistoric and/or historic heritage resource, structure, site, artifact, or property.

Executive Order 13007 (1997) – This order directs federal agencies to accommodate access to and ceremonial use of American Indian sacred sites by tribal religious practitioners, to avoid adversely affecting the physical integrity of such sacred sites, and, where appropriate, to maintain the confidentiality of sacred sites.

Key Indicators

- Number of Historic Preservation Plans constructed and implemented.
- Acres of heritage resource survey.
- Sites evaluated by National Register of Historic Places criteria.
- Number of sites nominated to the National Register of Historic Places.

Resource Protection Measures

The National Historic Preservation Act outlines protection measures for heritage resources. Prior to any undertaking, as defined in 36 CFR 800, all heritage resources are located, and, in consultation with the State Historic Preservation Office (SHPO), are evaluated for their potential to be placed on the National Register of Historic Places. Those sites determined to be eligible are identified as "historic properties." The SHPO and, in some cases, the Advisory Council on Historic Preservation must be informed of potential adverse effects to any historic property. If an adverse effect is determined though consultation with SHPO, an agreement on mitigating the adverse effects must occur through additional consultation with SHPO and the Advisory Council, before any project may take place.

AFFECTED ENVIRONMENT

Over 300 intensive Class III heritage resource inventories have been completed on the Bighorn National Forest. Approximately 97, 524 acres (9% of Forest) has been examined. The following table summarizes the type and number of sites inventoried and their eligibility for inclusion in the National Register of Historic Places (NRHP).

Table 3-13. Inventoried heritage resource sites on the Bighorn National Forest.

Type of Site	Number of Sites	Percent of Total Sites
Prehistoric	859	59
Historic	586	40
Other	19	1
Total	1,464	
Sites/portions of sites eligible for NRHP	531	36
Non-eligible sites	535	37
Sites lacking information to determine if eligible for NRHP	398	27

The Forest has a large variety of heritage resource types. The types are differentiated by the two time periods in which they occurred: prehistoric and historic. Prehistoric (approximately 11,500 to 250 years before present) resources include trails, plant processing, tool stone quarries, tepee ring and open camps, stone alignments, rock shelters, animal processing, and ceremonial sites. Historic resources include road/trails, mines, tie hack camps, tie flumes and ponds, burials, trash dumps, cow camps, dams, recreational cabins, and Forest Service administration sites.

Site size can vary greatly. Sites can be less than a few feet in diameter and consist of a few stone chips or a few tin cans. Other sites can cover 300 acres or more and contain thousands of artifacts. Sites associated with roads may be several miles long.

The only area of the Forest that lacks heritage resource inventory is the Cloud Peak Wilderness. Due to its designation, the wilderness is literally unexplored at present. However, heritage resource inventories will be conducted in the Wilderness in conjunction with future term grazing permit renewals.

Ten Historic Districts were identified by the heritage resource specialist, and were considered during the development of alternatives and plan direction. The following table shows historic districts on the Bighorn National Forest.

Table 3-14. Historic Districts on the Bighorn National Forest.

Historic District	Size (Acres)	Property Types Found	Year Identified	Estimated Date of Management Plan
Medicine Wheel	20,802	Ceremonial, Open Camps, Trails, Quarry	1988	1996
Twin Buttes	5,512	Trail, Short term Camps, Geological	1989	No Date
Hunt Mountain	18,058	Ceremonial, Tepee Ring Villages, Trail, Lithic Scatters	1999	2006
Sheep Mountain	22,436	Trails, Tepee Ring Villages, Open Camps, Ceremonial	1991	2006
Riley Point	20,430	Ceremonial	1996	2010
Garden of the Gods	9,526	Open Camps, Trail, Ceremonial	1990	2012
Elephant Foot	7,587	Visuals, Audio, Archaeology	2001	2008
Buck Creek	26,221	Quarries, Open Camps, Lithic Workshops	1989	2009
Leigh Creek	2,496	Quarries, Lithic Worhshops, Trail	1990	No Date
Woodrock Tie Hack	24,427	Cabins, Flumes, Dams, Roads	1999	1999

Four of the Historic Districts (Battle Park, Elephant's Foot, Medicine Wheel, and Leigh Creek) were considered as management areas, and three (Battle Park, Elephant's Foot, and Medicine Wheel) were included in alternatives. Site setting (the surrounding landscape) is a contributing element for seven of the Historic Districts, since integrity of setting contributes to possible inclusion in the National Register of Historic Places. To properly manage the site setting for these seven Districts, as outlined by the Park Service Bulletin 15, the District's boundary and a specific Historic District management plan should be developed. Prior to completion of the management plan, the District should be managed to insure that the contributing elements for National Register eligibility are protected.

Additionally, a guideline in the Heritage Resource section identifies the need to consult map of Historic Districts during site-specific NEPA to ensure that the proper procedures are followed. The Historic Districts were initially identified during inventories for project specific NEPA, and further highlighted during forest plan revision by the analysis based on the following criteria:

- They are the highest quality Districts presently known on the Bighorn National Forest.
- They represent the most important heritage site types on the Bighorn NF.
- Their presence may influence the management of other Forest programs.
- The Heritage Districts represent multiple historic themes and time periods.

Seven of the Historic Districts include sites that can be classified as important to indigenous people's religious and traditional practices. Local tribes, through the consultation process, requested that these sites/landscapes not be specifically identified as management areas, if possible.

During the analysis process, several other historic districts were dropped from Forest Plan management direction because they consist of data sets that were better represented within other identified districts, and/or they could be adequately managed during site-specific NEPA.

Prehistoric/American Indian Resources

The earliest evidence of human activity on the Forest comes from the Paleoamerican period, which lasted from approximately 11,000 to 8,000/7,500 years before present (B.P.). Paleoamerican people are thought to have been largely dependent upon big game hunting, especially during the end of the Ice Age when the large mammals, such as mammoth, wild horse, giant ground sloth, and ancient bison were living. However, by 10,000 B.P. two concurrent but separate Paleoamerican lifeways were developing.

This period is well represented archaeologically in northern Wyoming and the Bighorn National Forest. Twenty-three sites with Paleoamerican material have been recorded on the Forest including Folsom and Foothills/Mountain type cultural complexes.

Trails are another indication of Paleoamerican activity on the Forest. There are at least seven trails, with fair to good integrity, considered to have their origins in the Paleoamerican period. This site type (trail) is rare in the region and throughout the United States.

Archaic Period

The Forest has at least 63 sites from the Archaic period (8,000 B.P. to 2,000 B.P.). Cultural remains from this period include base camps, open lithic scatters, stone quarries, animal processing sites, and the appearance of the use of conical living structures in the latter portion of the period. The structures are noted in the archaeological record by rings of stones used to hold down the edges of the conical structure, commonly referred to as a tepee ring.

Also during this time period, the dependence on plant foods increases, and is noted by the appearance of milling stones and large earthen baking ovens.

Late Prehistoric Period

The Late Prehistoric Period roughly dates from 2,000 B.P. to 500 B.P. Besant and Avonlea point types as well as other side-notched and corner-notched points are evidenced. Communal bison hunting was at its zenith in the Late Prehistoric, and ceramic artifacts begin to appear. At the beginning of the period, the major new adaptive shift is in weaponry, from the use of the atlatl (spear thrower) to the bow and arrow. Forty-five (45) well document sites from the time period have been recorded on the Forest. The Avonlea Complex materials appear on the Forest.

Protohistoric Period

The Protohistoric Period dates from 350 to 200 B.P. Zier (1984) defined it as "That time from the earliest contact of Indians with goods of European origin to actual contact with whites, accompanied by written records." The Protohistoric is a somewhat arbitrary assignment due to the slow and sporadic introduction of Euro-American products to the Plains Indian groups.

In the early portion of the Protohistoric Period, the major groups occupying the northwest plains, including the Big Horn Mountains area, included Apache, Shoshone, and the Absaroka/Crow (Craig and Gilbert 1982, Zier 1984).

Shoshone groups are believed to have entered Wyoming in the 1500s from the Great Basin. Throughout the next two hundred to two hundred fifty years, they traveled as far north as Canada and as far east as the Black Hills of South Dakota. Archaeological evidence, including bison kill sites, bundle burials, pictographs, steatite vessels, and Shoshone word lists, help trace their migration pattern and territory (Shimkin 1986:308).

Because of their relationship with the Comanches in the southwest, the Shoshone groups in Wyoming probably acquired the horse and gun before many of the other local groups (i.e. Crow). This advantage allowed them to expand rapidly during the Protohistoric period, and they became the dominant tribal group in the area until the end of the period.

At the time of historic contact, the Crow Indians occupied the area bounded by the Bighorn River on the west and Powder River on the east (Frison, et al. 1978:1-3). By the Protohistoric Period, the Big Horn Mountains became a stronghold for the Crow. The Big Goose site on the eastern flank of the Big Horns provides evidence of some of the earliest Crow occupation (530 and 450 B.P.). Ceramic and/or radiocarbon dates document Crow occupation on the Forest as early as 310 B.P.

Characteristics of the Protohistoric Period include small stone arrow points; the appearance of Euro-American trade goods such as metal arrow points, glass beads, and metal awls; and most important, the acquisition of the horse. Site types that date to the period include ceremonial sites (e.g., stone alignments, vision quest, medicine wheels), conical pole lodges,

and campsites with pottery and a low density of lithic artifacts (because the lithic tools were being replaced by metal tools). The exact number of sites on the Forest is unknown due to the overlapping dates with the historic period, but at least 20 sites are considered to of Protohistoric age. The site types considered important on the Forest from the period are stone alignments associated with religious practices of American Indians. This site type continues into the historic period.

Historic Period

The Historic Period dates from approximately 1800 to 1950 and is divided as follows:

- Early historic, 1800 to 1842
- Pre-territorial, 1842 to 1868
- Territorial, 1868 to 1890
- Expansion, 1890 to 1920
- Depression, 1920 to 1939
- Modern, 1939 to present

For this discussion, the last three subdivisions will be combined, discussed by theme, and not focus beyond 1945-50, as an item has to be 50 years old to be considered a heritage resource.

Early Historic, 1800 – 1842

This period is characterized by actual contact and interaction between tribes and Euro-Americans. Explorers and trappers were the first known to make contact with tribes around the Big Horn Mountains. By 200 B.P., the Crow, Cheyenne, Sioux, and Shoshone tribes inhabited areas around the Big Horn Mountains. The Arapaho, Blackfeet, Gros Ventre, Assiniboine, Plains Cree, and Pawnee were frequent visitors (Wardlow 1997).

The Crow and their allies tended to cooperate with the U.S. or Euro-American trappers, as well as the Eastern Shoshone. The Dakota/Siouan groups and the Cheyenne, being more closely associated with Canadian traders and enemies of the Crow, tended to be hostile towards Americans (Bearss 1970:92.).

At least 10 sites on the Forest are assigned to the Early Historic period. Any site from this time period is considered important. They are extremely difficult to identify because of the lack of stone lithic materials present, as the stone tools were being replaced by metal.

Pre-Territorial, 1842 – 1868

During this time period, there was an increase in Euro-Americans and U.S. military expeditions. Additionally, the eastern Siouan groups continued to be pushed westward by United States expansion, as well as pressure from the south by the Arapaho and Cheyenne.

By the end of the period, hostilities broke out between the U.S. Military and their Indian allies the Crow and Shoshone, and an alliance formed of the Cheyenne, Arapaho, and Siouan

groups. Many of these conflicts were played out on the eastern flanks of the Big Horn Mountains.

Beginning in the 1850s, the United States government attempted to settle the armed conflict with a number of treaties. The pertinent ones for the Big Horn National Forest include the 1851 and 1868 Fort Laramie treaties with the Crow, and the 1868 Treaty at Fort Bridger with the Shoshone

There are at least 8 sites on the Forest dating from the Pre-territorial period. These sites are significant due to their limited number.

Territorial, 1868 – 1890

Indian conflicts with Euro-Americans and the U.S. military continued during this period. Regionally, the conflict ended, for all practical purposes, within a year of Lt. Colonel Custer's defeat at the battle of the Little Bighorn in 1876. Just weeks after Custer's defeat, one skirmish occurred on the Forest— the (Lt.) Sibley Battle.

By 1900, the tribes in the region were delegated their present reservations, and they ceded their rights to the Big Horn Mountains. The United States still continues a trust relationship under the terms of past treaties and maintains a government-to-government affiliation with the tribes. In recent years, this relationship has moved the United States government to enact various laws and Executive Orders to protect and to enhance indigenous peoples' right to access and use traditional sites on federal lands.

The Big Horn Mountains were explored by two U.S. military expeditions in 1877 and 1881, lead by General Sheridan. Trails used by the expeditions have been recorded on the Forest; however, no evidence of military campsites has been noted.

Other uses of the Forest during the period include prospecting and limited extraction of lumber and fire wood. Generals Crook and Sheridan used the Big Horns for hunting and fishing trips, the precursor for the recreational use of the Forest.

At the end of the territorial period, we see the beginning of agriculture/ranching industry that helped support the formation of small towns adjacent to the Forest and the expansion of the railroad into the area. The first cattle were introduced to the Bighorn Basin in 1879 (Schermer and Gnabsik 1979:54; Markoff 1982:11; Murray 1980:64). Overgrazing, drought (1885 and 1886), and the severe winter losses of 1886-1887 caused some of the big outfits to fold while others consolidated.

Sheep were first brought into the area in 1871 when J.D. Woodruff settled on Owl Creek for ten years. The sheep industry grew slowly but did well in semi-arid areas. It escaped the big losses suffered by cattle ranchers in 1886-1887 and thereafter began to fill the vacuum (Schermere and Gnabsik 1979:55).

Passage of the Desert Land Act in 1877 allowed the acquisition of additional land if it was irrigated. The first irrigation ditch was opened in 1878 on Clear Fork, and many more followed (ibid.:68).

Settlements near the Big Horn Mountains began with suppliers to the forts. Freighters, contractors, farmers, and ranchers settled nearby and organized townships. Buffalo was the first in 1876. Big Horn began as the freighters' headquarters. Sheridan was plated in 1882. In the Bighorn River basin, scattered settlements appeared in 1879 (Schermer and Gnabsik 1979a:50). These settlements created a demand for lumber. Army sawmills were established on Clear Creek in 1877 and on Piney Creek the following year. In 1868, the first commercial sawmill opened at the head of Prairie Dog Creek. It supplied the lumber to the settlements; however, large-scale lumber operations were not instituted until the 1890s (ibid.:79).

There are several sites from this period on the Forest, but formal recording has not been accomplished.

Expansion (1890-1920), Depression (1920-1939), Modern (1939-ca.1945)

Mining: After 1877, miners entered the Mountains in large numbers, but no significant strikes occurred until 1890 (Markoff 1982:8). Actual mining, as distinguished from prospecting, first occurred in 1884 at Walker Prairie, but little development occurred until after the first big gold rush at Bald Mountain (Murray 1980:91).

The Bald Mountain strike took place in August 1890 on the western slope of the Big Horn Mountains due west of Sheridan. Hundreds of miners arrived by the end of the year-end, and Bald Mountain City, a typical mining boom-town of tents, log cabins and saloons, was established. The following spring brought large-scale investment and heavy equipment from Denver and New York, and the Fortunatus Mining Company, Inc. became the foremost operator in the area (Markoff 1982:8). Evidence of the company's activities is still visible at the Fortunatus Gold Mill Site. The Bald Mountain district's payoff began to decrease by the late 1890s and after the large mines closed there was only marginal activity from the 1900s on.

Other mining areas opened up soon after, but not on the scale of Bald Mountain. There were mining operations at Walker Prairie on the eastern slope between Big Goose and Wolf Creeks (Schermer and Gnabsiik 1979:76). There was a small rush at Kelley Creek on the southeastern slope of the Big Horn Mountains near Buffalo.

The mining industry experienced a momentary revival in the late 1920s. However, the limited operations did not survive the Depression. The economic hardships stimulated interest in reopening mines, but nothing resulted beyond plans and a few placers (Schermer and Gnabsik 1979a:78).

Numerous sites related to mining have been recorded on the Forest. Site types include prospect pits, adits, log cabins, and roadways. Though mining played an important role in early local development, the sites on the Forest are rather minor compared to others in the region.

Lumber: The first logging operations took place near the Bozeman Trail forts in the late 1860s. In 1886, the Ferguson and Farnham Sawmill was established at the head of Prairie

Dog Creek; several other mills including sites on Goose, Canyon, Babione, Piney, Trapper, and Mill Creeks (ibid.:79). Lumber was dry-chuted down to avoid dangerous wagon hauling over poor trails. The small mills were moved from site to site, and once a spot was logged out, numerous chutes and flumes were left scattered about the creeks (Murray 1980:114). It was not until the mining districts constructed switchback roads that mills went up "on top" and became big operations.

The first large mill was built in 1891 on Sheep Creek. Two years later it was purchased to supply ties for the Burlington Railroad. The mill was moved to the Tongue River in 1895 and a wooden flume system was constructed to transfer ties and lumber off the mountain to the Tongue River Canyon, and then by river to the sawmill at Ranchester. The lumber camp was named Rockwood and was established in 1895. This headquarter camp was relocated two more times, in 1900 to the Little Tongue, and in 1905 to the Woodrock camp at the fork of the South Tongue (Markoff 1982:15).

Timber use gradually dwindled after World War I. There was a short-lived tie cutting increase in the 1920s, with much of the activity occurring along the Sourdough Creek drainage west of Buffalo. The timber was used for Forest Service range improvements (drift fences, corrals), bridges, and ranger stations. During World War II, a gradual resurgence of timber harvest activities occurred in the Big Horn Mountains.

There are over fifty recorded sites associated with historical logging on the Forest. Site types include roads and trails, log cabins, flash dams, flumes, and holding ponds. Timber played an important part at the local level in early development; however, the timber harvest operations were rather common and represented small and short-term operations. The exception is the Tongue River tie-flume that is considered an engineering wonder.

Grazing and Irrigation: Following the cattle industry bust in the late 1880s, the increase of careful grazing practices resulted in a rebound in cattle numbers. However during the 1893-95 depression, cattle numbers dropped by 40% (from 100,000 to 60,000 head) in the plains surrounding the Big Horn Mountains (Murray 1980:78).

The unstable cattle industry left an opportunity for sheep-raising. Although the wool industry was also hit hard by the 1893-1895 depression, it recovered rapidly, reaching a peak by the late 1890s. Many cattlemen found it profitable to diversify by raising sheep.

The first grazing permits for the Bighorn Forest were issued in 1899, two years after the creation of the Forest Reserve. The following table shows the trends in permitted livestock numbers on the Forest from 1899 to 1926.

Table 3-15. Numbers of permitted cattle and sheep on the Bighorn National Forest, 1899 to 1926.

Year	Number of Cattle Permitted	Year	Number of Sheep Permitted
1899	3,000	1900	225,000
1906	30,000	1906	55,000
1919	45,000	1911	100,000
1926	23,000	1919	125,000

Source: Markoff 1982

The transfer of the Forest to the Department of Agriculture's jurisdiction in 1905 led to improved livestock grazing practices. Grazing permits gave priority to ranches bordering on the National Forest, transient livestock were forbidden during summers, and grazing fees were introduced. Permits were let annually until 1925 when the Forest Service changed to the current process of issuing permits for a ten years period (Markoff 1982:14).

The 1894 Carey Act initiated federal support for state-sponsored irrigation projects. An early result was the first successful large-scale irrigation work in the Basin, the Sidon Canal. After 1905, the Forest Service began building storage dams in the mountains to extend the irrigation season in the lower drainages. Private companies also built irrigation dams such as Kearney Lake (on Piney Creek) in 1906, and S.L. Wiley's German Bench Ditch on the Greybull River in 1902 (Murray 1980: 210, 248; Schermer and Gnabsik 1979:60).

In 1916, the Forest Service began a program of constructive range improvements by building drift fences and corrals. In the following years, this work expanded to bridges, water tanks, and trails (Markoff 1982:14). During the 1930s, Forest Service rangers, the Civilian Conservation Corps, and local ranchers worked on stock tanks and irrigation pipes to alleviate drought conditions. Many miles of drift fences were built or repaired to improve livestock distribution.

Numerous livestock- or irrigation-related sites have been recorded. Site types include dams, ditches, cow camps, stock trails, and fences. Many of the site types (e.g., dams and ditches) are rather common throughout the West. However, the Forest does contain a fair representation of historic cow camps. This site type is becoming rather uncommon throughout the region, as historic cow camps are being replaced with modern structures.

Recreation businesses began as an offshoot of cattle ranching. The earliest recreation spots were dude ranches, the first opening in 1891 at the D.H. Ranch on Little Goose Creek. Dude ranches, including the Eaton's, Hazelton Resort, and IXL developed in and near the Bighorn National Forest beginning in 1904. Dude ranching not only became a viable economic pursuit off Forest, but also resulted in the development of additional recreation/tourist activities on the federal land. The Forest Service produced promotional literature and built recreation facilities. Private business and Boy Scouts set up specific camping sites on the Forest under permits. On the national level, recreation was gaining momentum in the late teens and early 1920s, and the Forest Service produced its first recreational use plan in 1929.

The Depression, not surprisingly, seriously hurt the high-cost tourist business. Many dude ranches closed, but local and regional recreationists continued to use the Big Horn Mountains for camp and picnic grounds. The Civilian Conservation Corps (CCC) built over 100 such sites. Motels became popular for mid-level income tourists who could not afford resorts and dude ranches. Motels appeared along Highway 16 and 14 on special-use permits in the Forest (ibid.:361-362). Recreation, therefore, became an increasingly important income-producer for federal and private interests in the Big Horn, taking up some of the slack in grazing and lumber.

There are some sites associated with this theme on the Forest. However, the majority have either been destroyed/removed, are not a focus of heritage resource surveys, or they have been altered to the point that they are ineligible for inclusion to the NRHP.

Forest Management: The Bighorn Forest Reserve was proclaimed in February 1897 to be managed by the Department of Interior's General Land Office (Markoff 1982:15). In February 1905, President Roosevelt signed an act that consolidated the forest divisions of Interior and Agriculture into a new Forest Service under the latter department. Policies were developed to keep the forests productive for the long term.

The Forest Service determined that timber growth exceeded timber cuts and so encouraged more cutting. Dwindling game on the Forest led to efforts after 1910 to restrict hunting and to stock the areas as game and fish reserves (Murray 1980:229). Fires were another concern. Four large fires were reported in the pre-federal years: in 1880, 1889, and 1884 near Buffalo and in 1897 near Copeman's Tomb (Connor 1940:72). Forest Service records from 1909 to 1937 reported 280 fires, with outbreaks occurring in almost every year.

From 1916, road building, as well as the aforementioned range improvement efforts, became leading Forest Service activities. Roads afforded access for recreation, as well as fire fighting.

Wildlife became better managed in this period and wardens enforced game laws. Approximately one-third of the Forest was set-aside in wildlife preserves, mostly on elk migration routes. Winter ranges were also established (Murray 1980:328-329). Big game consisted primarily of deer, elk, and bear (black and grizzly). Populations of furbearers (e.g., beaver and martin) began to rebound after their severe depletion by earlier "market hunters." Predators (coyote, puma, and wolf) were hunted without regard for, or knowledge of, ecological balance (Connor 1940:92-93, 97). During this period, fish hatcheries were established to stock lakes and streams.

In the Depression years, increased federal money allowed for more projects in the National Forest. In addition to cooperative irrigation projects between the Forest Service and local agriculturist, a notable feature of the 1930s was the Civilian Conservation Corps (CCC). CCC camps were established near the headwaters of Muddy Creek in 1933, at Turkey Creek from 1934 to 1937, and at Tensleep Meadows from 1935 to 1937. A camp was also set up near present day Crazy Woman Campground. Dayton was the site of the winter camp until 1940. CCC workers built Sibley Dam on Prune Creek and Meadowlark Lake in the

Tensleep Meadows project (Murray 1980:351). Road building was another CCC activity (see section on roads).

Sites associated with forest management and the CCC era are fairly extensive on the Forest. The CCC built the vast majority of workstations on the mountain and these stations are still used today. CCC workmanship on workstations, roadways, and dams is considered to be of the highest quality; however, many such structures exist across National Forest system lands. On the Bighorn National Forest, three fire lookouts and two large dams are of primary importance.

ENVIRONMENTAL CONSEQUENCES

General

Direct and indirect effects upon heritage resources for each alternative are shown by the potential risk rating estimated for each management area. For example, because there are fewer activities that would adversely affect heritage resources in the Category 1 management areas, they are assigned a "low" potential risk for adversely affecting heritage resources. On the other hand, Category 5 management areas that overlap with the historic districts have a "high" potential risk for adversely affecting heritage resources. The rationale for making a low, moderate, or high potential risk rating for each management area is detailed below.

It is important to note that the potential risk ratings are 'theoretical' impacts, because if project level planning and implementation were done according to the heritage resource laws and regulations, the vast majority of potential adverse effects would be mitigated to no adverse effects. In other words, these ratings of low, moderate and high are a theoretical risk of potential effects at the forest plan level of analysis and do not account for standard mitigation measures, such as site avoidance, incorporated in project-specific NEPA.

Direct and Indirect Effects of the Alternatives

The following discussion of direct and indirect effects to heritage resources is divided into four parts:

1. **Assigning Potential Risk Ranking to Each Management Area** – this is a narrative description of how the potential risk ranking of low, moderate, or high was assigned to each management area. It is based upon the types of activities that are likely to occur within each management area.
2. **Table Summarizing the Number of Acres in Each Potential Risk Ranking Category.**

3. **Summary Ranking of Alternatives –** The alternatives are displayed in ordinal ranking calculated by using a weighted average of the total number of acres in each of the three categories.

   The No Action Alternative has the highest potential risk ranking, because it does not explicitly include changes to the National Historic Preservation Act, new laws such as Native American Grave Protection and Repatriation Act, and recent Executive Orders that went into effect since 1985.

4. **Summary of Heritage Resource Benefits by Alternative** – Description of how each alternative meets, or does not meet, various heritage resource concerns.

1. Assigning Potential Risk Ranking to Each Management Area

Each management area was assigned a potential risk ranking based on the following:

- The type of management activities likely to occur. Management Area Category 5 areas will have road construction, while Management Area Category 1 areas will not likely have this activity. Therefore, Category 5 areas have a higher potential for adverse impacts to heritage resources due to management activities than does Category 1 areas. Livestock grazing, recreation, and vegetation management are the management activities with the highest potential for adverse impacts to heritage resources.
- The amount of overlap between high-risk management areas and the historic districts. There is a higher potential risk for adverse effects where road construction and emphasis on vegetation management overlaps with the historic district boundaries.
- Management Areas 2.1 and 3.1 prioritize heritage resource management and are assigned low potential risk rankings; in fact, these areas are considered beneficial in the management of heritage resources.

Management Area Category 1

The management activities that could affect heritage resources within this category are, for the most part, completed. Infrastructure maintenance, such as road and trail maintenance, will be the primary Forest Service activity. Recreation impacts of repeated use of popular camp spots will continue. Livestock grazing occurs in these management areas, as well as in all other categories.

- Direct effects include ongoing impacts from established travel systems, repeatedly used disperse camping areas, new areas of repeated use, and areas of excessive human congregation (i.e. lake margins) that have not had heritage inventories completed, and are affecting an historic property. Minor amounts of road maintenance will occur on the roads in the 1.33 management area.
- Indirect affects, for example, would be site deterioration from erosion of an existing trail system that passes through an archaeological site.

Management Category 1, cont.

- This category is considered to have a low potential risk rating to adversely affect Heritage Resources based on past inventory work. The general objectives of these management areas are considered compatible with heritage resources.

Management Area Category 2

This category, which includes Heritage Special Interest Areas and Research Natural Areas (RNAs), is considered to have the lowest potential to impact heritage resource values. The Bull Elk Park RNA and the Shell Canyon RNA management areas totaled 1,618 acres in the 1985 plan.

- The direct effects, benefits in this case, of including 2.1 Management Areas is that the proactive, heritage-emphasis envisioned in Section 110 of the National Historic Preservation Act (NHPA) would be more likely to be achieved.
- Indirect affects would be conflicts between heritage resources and other programs. The following programs are most likely to be affected:
  - Dispersed recreation: if repeated use areas erode sufficiently to require protection.
  - Livestock grazing: high value heritage areas may require more intensive management in order to protect the heritage values in the 2.1 management areas.
- This category is considered to have a low potential risk rating to adversely affect heritage resources based on past inventory work. The general objectives of these management areas are considered compatible with heritage resources.

Management Area Category 3

Most Category 3 activities are considered to have a low potential risk ranking to adversely affect heritage resources. The exceptions are activities in MA 3.31 Backcountry Recreation, Year-round Motorized. Activities in this management area are considered to have a moderate compatibility with heritage resources where the management area occurs with or overlaps Historic Districts. The 3.31 management areas are moderately compatible, because motorized recreation activities may conflict with the audio and visual characteristics of the Historic Districts' site setting qualities.[2]

- Direct effects would primarily include noise from motor vehicles and visual affects from timber sales when such actions take place within a Historic District

[2]"Site Setting" in this context is define as the pre-settlement condition of the environment, including visual and audio elements.

- Indirect effects would be site deterioration from erosion of an existing trail system that passes through an archaeological site.
- The programs associated with Category 3 are considered to have a **low** potential risk rating to adversely impact heritage resources, as the number of actions predicted is small. The exception is MA 3.31 Backcountry Recreation Year-round Motorized that overlaps with a Historic District, which is considered to have a moderate potential risk rating to adversely impact heritage resources. The primary reason for the moderate rating is that portions of the transportation system are within Historic Districts that include a pre-settlement site setting as an important part of their character.

Management Area Category 4

The management activities that could affect heritage resources within this category are, for the most part, completed. Infrastructure maintenance (e.g., road and trail maintenance) will be the primary Forest Service activity. Recreation impacts of repeated use in popular camp spots will continue. Livestock grazing occurs in these management areas.

- Direct effects include ongoing impacts from established travel systems, repeated use of disperse camping areas, and areas of excessive human congregation (e.g., lake margins), that have not or will not have heritage inventories completed, and the actions are affecting an historic property. Additionally, there could be an impact to indigenous people conducting traditional cultural practices in Historic Districts where noise and visual impacts from dispersed recreationists can be seen and heard.
- Indirect effects include site deterioration from erosion of existing trail systems that pass through an archaeological site, and inadvertent camping on archaeological properties.
- The programs associated with Category 4, with one exception, are considered to have a low potential risk rating to adversely impact heritage resources, as the number of new actions predicted is small, and most sites have already been impacted from past actions. The exception is dispersed recreation, Management Area 4.3, that overlaps with an Historic District, which is considered to have a **moderate** potential risk rating to adversely impact heritage resources. The primary reason for the moderate ranking is that portions of the specific management area designations overlap with Historic Districts that have a pre-settlement site setting as an important part of their character.

Management Area Category 5

The programs generated under the category have been established, through the 1985 Plan, such as suited timber acres in relationship to commercial timber sales. Therefore, the changes to the number of suited acres, by alternative, influence the potential for impacts to heritage resources.

- The primary direct effects from MA 5.11 Forest Vegetation Emphasis and MA 5.13 Forest Products occur during timber sales. The primary impacts would be to the site setting of Historic Districts when visual integrity was an associated characteristic, as well as noise from trucks and machinery during tree harvest.
- Direct effect from MA 5.12 Rangeland Vegetation Emphasis is primarily domestic livestock grazing that causes trampling/bogging/trailing. This impacts the integrity of intact buried cultural deposits, as well as disturbing exposed cultural features and artifacts.
- Indirect effects associated with MA 5.11 Forest Vegetation Emphasis and MA 5.13 Forest Products are primarily limited to road reconstruction or new road construction, which in and of themselves seldom impact heritage resources. The real indirect impact is new road construction when the roads are left open for the public. The new roadways allow for easy access and heavier use in areas that were seldom visited, resulting in an increase potential for illegal artifact collecting and/or unintentional impacts to heritage resources.
- Indirect effects from MA 5.12 Rangeland Vegetation Emphasis stem from the lack and/or inability to enforcement utilization standards on what are typically small areas across an individual allotment/pasture. Even if the allotment as a whole meets or exceed standards, localized over utilization of vegetation can occur. When small localized over utilization occurs on an archaeological site, it results in erosion/deflation that effects site integrity, increases rodent activity do to destruction of rodent burrows, and produces a more desirable surface condition for illegal artifact collecting—lack of vegetation and/or exposing artifacts from erosion.
- MA 5.11 Forest Vegetation Emphasis, MA 5.13 Forest Products, MA 5.4 Plant and Wildlife Habitat, and MA 5.5 Dispersed Recreation and Forest Products, in general, are considered to have a low potential risk rating to adversely impact Heritage Resources. The exception would be when timber harvest creates a visual or auditory impact within a Historic District where those resources are contributing elements to the site setting. Therefore, suited acres within the Historic Districts will be assigned a **high** potential risk rating.

- Livestock grazing is considered to have a **high** potential for adversely affecting heritage resources, because grazing animals within a short period of time can congregate on an archaeological site, and cause irreversible impacts. The effect is considered to be about the same across alternatives, since the revised plan effects analysis is not predicting that the current permitted number of AUMs, approximately 118,000, will change due to the revision decision. For the analysis, the AUMs total is used as a constant, and the following table does not include acres for MA 5.12 Rangeland Vegetation Emphasis.
- MA 5.21 Water Yield (No Action Alternative and Alternative A only) is considered to have a **low** potential risk rating for adverse impacts to heritage resources.
- MA 5.41 Deer and Elk Winter Range is considered to have a **low** potential risk rating for adverse impacts to heritage resources. The management area encourages vegetation growth for wildlife winter range, and the primary management tool is prescribed fire that increase vigor for most grass and forbs species, though, timber harvest can occur.

Management Area Category 8

The majority of activity within this category is associated with built structures, such as dams, visitor centers, and ski runs. These structures have been previously constructed, and maintenance to the structures will be the primary activity in the future.

- Direct effects would be wave action/water level fluctuations at water impoundments that have not been previously inventoried, and a heritage resource is being affected.
- Indirect effects would be erosion from any road or trail that runs through a historic property.
- This category is considered to have a **low** potential risk rating to adversely impact heritage resources, as the majority of facilities were constructed/permitted several years ago (e.g., water storage/reservoirs). If heritage resources were affected, that impact has already occurred. There are no proposals for new ski areas or dam construction. Expansion of present facilities may occur, but the potential increase in a facilities size would be considered small at the forest plan level, and all new work would be inventoried.

2. Table Summarizing the Number of Acres in Each Potential Risk Ranking Category

Table 3-16. Acres of potential risk rating by category or program by alternative.

Risk Grouping[3]	Potential Risk Rating	Alternative (all figures are acres)					
		No Action[4]	A	B	C	D	E
Management Area Category 1	Low	284,108	284,110	321,929	447,893	269,898	252,715
Mgt. Area 2.1	Low	0	89	20,004	17,024	0	0
Mgt. Area 2.2	Low	1,618	1,618	21,190	21,188	21,190	1,618
Mgt. Area 3.1	Low	150	20,863	20,863	20,865	20,863	20,863
Mgt. Area 3.31 Overlap with Historic Districts	Moderate	2808	2808	16,874	13,207	294	1660
All Other Acres, Mgt. Area Category 3	Low	188,752	197,145	285,770	280,812	180,149	12,529
Mgt. Area 4.3 Overlap with Historic Districts	Moderate	0	0	0	0	672	3149
All Other Acres, Mgt. Area Category 4	Low	19,147	19,147	142,643	168,082	127,043	7,652
Mgt. Area Category 5, Suited Timber Overlap with Historic District,	High	24,010	31,715	10,805	3,520	22,184	29,445
AUMs (5.12)	High						
All Other Acres, Mgt. Area Category 5	Low	569,739	566,965	262,448	129,846	460,146	772,843
Mgt. Area Category 8	Low	1,358	1,358	2,580	2,580	2,575	2,540

[3] The risk grouping is based either upon the management area category or other factor (such as where suited timber overlaps with Historic Districts) as described in the narrative above this table.

[4] No Action Alternative will always be considered to have the highest potential to impact Heritage Resources, as the 1985 Forest Plan would need to be amended to include changes to the NHPA, new laws, and recent Executive Orders. In Alternative ranking, one equals lowest potential to impact Heritage Resources.

3. Summary Ranking of Alternatives

The percentages of low, moderate, and high potential risk rating for impacts are shown in the following table. In general, the No Action Alternative is considered to have the highest potential risk rating to impact heritage resources because the alternative does not take into consideration the Historic Districts nor does it explicitly include the laws and regulations developed since 1985. The next highest potential risk rating for impacts is Alternative E followed by Alternatives A, D, B, and C. However, it should be noted that the differences between the alternatives is very small, and the degree of heritage resource protection is largely influenced at the project level.

Table 3-17. Alternative potential risk rating by percentage of units measured.

Alternative	Low Potential	Moderate Potential	High Potential	Ranking (1 = lowest risk, 6 = highest risk)
No Action				6
A	88%	<1%	12%	4
B	88%	1%	10%	2
C	89%	1%	10%	1
D	88%	<1%	11%	3
E	88%	<1%	12%	5

4. Summary of Heritage Resource Benefits by Alternative

Potential significant circumstances/conditions that might influence an alternative's ranking include:

1. Does the alternative include changes to laws, new laws, new Excecutive Orders, etc.?
2. Are Historic Districts considered in the alternative, with direction for incorporation into long and short term planning and management?
3. Potential to impact Historic Districts.
4. The number of Special Interest Area (SIA) designations, with more being a larger benefit for heritage resources.
5. The number of compatable acres, as more acres is considered to benefit for heritage resources, as overall potential to impact a heritage resource is reduced.

4. Summary of Benefits, cont.

6. The funding level for heritage resource management (Section 110 of the NHPA) could change based upon the priorities and goals for each alternative. That is, given that the Forest's overall budget would not change, some alternatives (A and E) would potentially require shifting money from the Forest's recreation budget in order to fund higher outputs for timber harvest and fuels. Conversely, Alternative C would likely result in an increase in the recreation budget, resulting in likely increases to the heritage program. Heritage resources are funded from the 'recreation' portion of the Forest's budget.

Table 3-18. Summary of direct and indirect effects on heritage resources by alternative.

	Alternatives					
	No Action	**A**	**B**	**C**	**D**	**E**
Updated Laws, Orders, Regulations	No	Yes	Yes	Yes	Yes	Yes
Historic Districts	No	Yes	Yes	Yes	Yes	Yes
Potential Risk to Districts (1=Lowest Risk, 6=Highest Risk)	6	4	2	1	3	5
Number of Heritage Special Interest Areas	1	1	3	2	1	1
Compatable Acres (all category 1 and 2, and 3.1)	285,878	306,680	383,986	506,970	311,897	275,142
Budget for implementation of Section 110 projects (same = approximately current levels)	Same	Less	Same	More	Same	Less

The benefits analysis dose suggest a more clear seperation than the satistical analysis. Alternative C is considered to be the best alternative for the management of heritage resources. Though, Alternative C has one less special intrest area than Alternative B, the discrepancy is off-set by the large number of acres in the compatable category, and the potential increase in budget. The potential of additional funding would allow more dallors to be invest in oveall heritage resource management. The next benifical alternative is B followed by D, A, and E.

Cumulative Effects

General

In the past, the present, and future, heritage resources have and will continue to be affected by both natural and human caused disturbances. All of the impacts cited in the direct and indirect effects section would have long-term cumulative consequences. In

summation, they include land management projects that cause surface disturbance (e.g., timber sales; road construction), increased public visitation (e.g., increase potential to inadvertently impact a site by camping on it), management neglect, and livestock grazing. Other actions that are included in cumulative effects are natural impacts, such as weathering and deterioration, erosion, landslides, fires, and other physical/natural processes. Finally, long-term consequences of non-sanctioned activities are also incorporated; for example, creation of non-system ATV trails through an historic property and vandalism and/or illegal excavation and collection of heritage resource artifacts. The most likely activities sanctioned through forest planning that would affect heritage resources are vegetation management, management neglect resulting from budget short falls, and domestic livestock grazing. The primary non-sanctioned activities are the same as noted above.

Off-Forest activities (see the cumulative effects table in the Introduction to this chapter) also contribute to cumulative effects to heritage resources. The primary actions include the following:

- Coalbed methane (includes urbanization/development, road construction, etc.).
- Urbanization/development.
- Vegetation management.
- Road construction/travel management.
- Agricultural activities.
- Mining activities.

These activities have impacted and will continue to impact heritage resources. Past, present, and potential future cumulative effects are summarized in the following table.

It is assumed that actions off-Forest have comparatively greater effect on the region's heritage resource base as federal heritage resource laws do not apply on private ownership and very limited state provisions apply to state lands. Federal laws do apply to private and state lands when federal licensing, permitting, or funding occurs. However, in general, construction, farming/ranching, and development on private and state lands can destroy heritage resources without providing for avoidance, data recovery, or other mitigation measures. Because of this, heritage resources on federal lands assume greater importance in documenting past lifeways, archaeological and historical research, interpretation and education for the enjoyment of the public, and the protection and use of traditional properties by indigenous and ethnic groups.

Table 3-19. Summary of cumulative effects by time periods.

Time Period	On Forest	Off Forest	Comments
Past effects (1905 to 1985)	All actions noted but primarily: general development, road construction, urbanization (i.e., summer homes), timber/vegetation	All actions: same, with the addition of agricultural land uses such as farming, crop production.	The majority of historic sites on and off Forest have been destroyed or severely impacted, and few prehistoric sites have not incurred

Time Period	On Forest	Off Forest	Comments
	management, livestock grazing, recreation, artifact collecting, natural deterioration, and neglect		some type of impact.
Present effects (1985 to 2005)	All actions noted but primarily recreation in association with illegal artifact collecting, domestic livestock grazing, and neglect	All actions--primary: growth/urbanization, artifact collecting, grazing, neglect, and mineral development/coal bed methane (direct effect of construction impacts; indirectly, contributes to population increase)	The majority of historic structures on Forest are in a state of good to extremely poor condition. Estimated that 15% of known eligible prehistoric surface sites may be destroyed. Extensively impacted from artifact collecting and grazing. Overall lack of Section 110 compliance on all federal lands—neglect--for both historic and prehistoric sites.
Foreseeable future (2005 to 2020)	Main actions would be grazing, recreation, artifact collecting, and neglect	All actions noted but primarily development, urbanization, mineral development/coal bed methane (contributes to population increase), artifact collecting, grazing, and neglect	With the exception of a few managed sites, all historic structures would be remnants (neglect--non-compliance with Section 110 of the NHPA—low budget). Prehistoric sites would continue to dwindle in numbers. Most recorded surface sites in a range from fair to poor.

Past Effects

The time period of analysis for past effects is 1905 (establishment of the Forest Service) to 1985, as the present management philosophy and direction is based on the 1985 Forest Plan. The keystone of heritage resource management and protection began with the passage of the National Historic Preservation Act of 1966 (NHPA). Before this time, heritage resources (sites[5]) were not taken into account during project planning or implementation, unless the site was of unusual notoriety and/or importance to the local community or groups who where willing to take steps for the site's protection.

[5] Site(s) and property(ies), as used in the discussion of Cumulative Effects section, equates to being a site or property that would be considered eligible to the National Register of Historic Places (NRHP).

Undoubtedly, numerous sites on and off federal lands were destroyed, particularly historic structures, such as homesteads and tie-hack cabins from the turn of the century, as they were primarily viewed as eyesores and potential public safety hazards.

Even after the passage of the NHPA in 1966, it took several years before heritage resource management was fully implemented on the Bighorn National Forest. The first surveys began in the mid-1970s, and were primarily sample surveys for compliance with Section 106 of the Act on major projects, such as timber sales. However, the vast majority of the work accomplished did not meet standards for Section 106 as understood at that time, and no real management occurred with regard to compliance with Section 110 of the NHPA. It was not until mid-1980s that the Forest began a full-scale program in heritage resource management. In contrast, adjacent lands managed by the Bureau of Land Management began compliance with Section 106 by the late 1970s, and implemented a few statewide projects to fulfill Section 110 responsibilities by the early 1980s.

It is estimated that past cumulative effects have destroyed the majority of historic sites[6] on and off the Bighorn National Forest. Examples of historic sites are homesteads, tie-hack and mining structures/cabins/towns, wagon roads, and trash dumps.

In addition, all exposed prehistoric sites[7] (ca. pre-1810) on or off the Forest have been impacted to some extent. It is logical to assume the loss of prehistoric sites on private and state lands were higher due to agriculture production, road construction, and community development.

Discussion with other agencies and the State Historic Preservation Office (SHPO) indicate that past cumulative effects have destroyed and/or adversely impacted approximately 75% of historic sites and 25% of the prehistoric sites in the study area (the Bighorn National Forest and adjacent four counties); however, specific numbers are unknown. Properties would be classified from fair to good condition with the majority in the good category.[8] The percentages may seem large, but ranching/farming, road construction, mining, water projects, urbanization, etc., all occurred and/or were established long before the enactment of heritage resources laws.

Present Effects

Present cumulative effect analysis is based on the period from 1985 to 2005. Heritage resources, both on and off-Forest, are affected by artifact collecting, livestock grazing, and neglect. Additional effects, specific to private, state, and other non-Forest Service

[6] Ca. post 1810 to 1954; a site has to be 50 years or older to be historic.

[7] Examples of prehistoric sites include campsites, quarries for stone tools, buffalo and sheep traps, petroglyphs, and trails.

[8] Ranking on conditions are 100 to 90% of the structure is intact equals to extremely good, 90 to 75% good, 75% to 50% fair, poor 50% to 40%, and extremely poor below 40%.

lands (e.g., Bureau of Land Management) include growth/urbanization and mineral/coalbed methane development.

The condition of most historic structures on federal lands range from good to extremely poor condition. However, many are suffering from neglect due to insufficient funding. The same can be said for historic structures on private and state lands. By the end of the present period, it is estimated that 80% of the historic structures in the study area will be gone, and the remaining structures will be in a fair to extremely poor category.

Based on ongoing studies (Peterson and Laurent 2001), it is estimated that 15% of the known eligible prehistoric surface sites on the Forest will be destroyed from cumulative effects by the end of the present period. On adjacent federal and state lands, the rate is expected to be higher; the Forest Service is actively analyzing and reducing threats to heritage resources from livestock grazing, while other federal and states agencies are not. Private lands, again, in general, are not subject to federal heritage protection laws, and impacts are occurring. Grazing, artifact collecting, mineral development, and urbanization are considered to represent the majority of continuing impacts. An exact number is unknown, but for comparison, at least an additional 5% of surface prehistoric sites have been destroyed, and the remaining sites have deteriorated from good to fair.

Future Effects

The time period considered for future foreseeable cumulative effects is from 2005 to 2020. Pre-1940-45 historic structures, whether on federal, state, or private lands, by the end of the period are expected to be in extremely poor condition or little more than remnants from neglect, and/or modernization (replacement or significant modification of structure). On the Forest, it is predicted that aside from structures under administrative control, all historic structures will be remnants (e.g., tie-hack structures; mining cabins).

By the end of the period, some post 1940s structures may become eligible to the NRHP. Few, if any, would be found on Forest Service land, as our structures were built pre-1940-45, and those built after 1950 simply would not be expected to meet criteria for listing as an eligible property.

In the future, impacts to prehistoric sites from livestock grazing will be reduced significantly on Forest, through the re-issuance process of ten-year-term grazing permits, but some impacts would continue. Impacts from recreation will increase in line with use predictions resulting in an increased potential for inadvertent, and vandalism and illegal artifact collecting impacts. It is estimated that by the end of the period, 40% of the presently recorded eligible sites would be considered non-eligible, and the remainder being from good to poor condition with the majority being in the good condition.

Soils

Introduction

Soil is a fundamental component of the environment. It is the growing medium for most plants. Soil absorbs and stores water, releasing it slowly over time. It supplies nutrients for vegetation, which in turn supplies habitat for wildlife and other resources. All renewable resources of the Bighorn National Forest are dependent upon soil. Soil is considered a nonrenewable resource because of the time required for its formation.

Conceptually, the quality or health of a soil can be viewed as "its capacity to function." More explicitly, the Soil Science Society of America defines soil quality as, "The capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance soil quality, everyone must recognize that the soil resource affects the health, functioning, and total productivity of all ecosystems."

The Forest recognizes the importance of soils information as an integral part of land management planning and began soil resource inventory efforts in the 1980s. Since then, a soil resource inventory, also know as a soil survey, has been completed on the entire Forest. A goal is to utilize soils data as much as possible in the revision process so management activities may be blended with the ecological capabilities and potentials of the land.

The primary goal of soil management is to maintain or enhance long-term site productivity. There are five categories of physical soil disturbances that have been found to affect soil productivity. The categories include: compaction, displacement, erosion, puddling, and severely burned.

Soils information is used and analyzed at both the forest planning level. This Draft Environment Impact Statement (DEIS) presents an overview of alternatives and general effects on the soil resource. When projects are proposed, more site-specific soil analysis occurs, and mitigation is based on the potential, capability, and limitation of the soils at the site.

Legal and Administrative Framework

The Organic Administration Act of 1897 – "to improve and protect the forest within the boundaries …"

The Multiple-Use Sustained-Yield Act – this act sets forth the secondary purpose of the establishment "for outdoor recreation, range, timber, watershed, and wildlife and fish purposes."

The Forest and Rangeland Renewable Resources Planning Act (RPA) – this act requires an assessment of the present and potential productivity of the land. Regulations are to specify guidelines for land management plans developed to achieve the goals of the program that … ensure that timber will be harvested from NFS lands only where soil, slope, or other watershed conditions will not be irreversibly damaged.

The National Forest Management Act – this act was amended with the addition of a section that stressed the maintenance of productivity and need to protect and improve the soil and water resources and avoid permanent impairment of land productivity.

Key Indicators

- Miles of new road construction
- Acres of timber harvest

Resource Protection Measures

In order to maintain long-term soil productivity, soil disturbance should be kept to a minimum, and adequate measures need to be implemented to protect the soil resource. Mitigation measures have been developed to protect the soil resource and can be found in the forest-wide standards and guidelines, timber sale contract, and best management practices (BMPs). Resource protection measures apply to all alternatives.

Monitoring is a part of project planning and implementation. A key part of monitoring is to determine if the mitigations are working and protecting the intended resources.

AFFECTED ENVIRONMENT

Soils are an ecologically rich and active zone at the interface between the atmosphere and geologic materials. Soils form as a result of complex interactions between the geologic parent material, climate, relief, organisms, and time. The diverse geology and climate of the Forest, in conjunction with natural and human disturbances, have resulted in a spatially complex pattern of soils that differ in structure and function, and response to management activities.

For the purposes of this document, the Bighorn National Forest has been divided into six physiographic units, which are areas that contain similar soils, relief, and drainage (Nesser 1982). Each unit is a unique natural landscape. Typically, within each physiographic unit, there are one or more major soils and some minor soils or miscellaneous areas. Each physiographic unit is named for the major soils or miscellaneous areas that occur there. The descriptions for each unit can be used to compare the suitability of large areas for general land uses. Because of its scale, geographic units are not suitable for use as a site level analysis tool. The soils in any one unit may vary from place to place in respect so slope, depth, drainage, and other characteristics that can affect management.

Soil Productivity

Soil productivity varies widely due to varying characteristics such as soil depth, available water holding capacity, nutrient status, and site characteristics, including elevation, slope, and aspect. The most productive soils are found in valley bottoms and on toe slopes and benches.

The concept of productivity includes both the ability to grow vegetation as well as the maintenance of slope stability. In some areas, past practices have slightly reduced growth potential from compaction, nutrient loss from fires, and loss of large woody material. Soil productivity is the principle area of concern on the Forest, because it can be affected by management activities.

The effects of management practices will influence the future of soil productivity. The demand for many forest resources, which are dependent on soil productivity, is expected in the future. Soil erosion, soil compaction, and organic matter content all determine the productivity of Forest soils. The following section describes these processes/factors and their influence on productivity.

Soil Erosion is the origin of most of the sediment delivered to streams. This sediment can have adverse effects on water quality and fish habitat. The primary cause of soil erosion is overland flow from spring runoff or high intensity storms. Without overland flow, there is very little erosion. Wind erosion may occur on some exposed wind scour ridges, if the soil surface is exposed and unprotected.

Timber harvesting, site preparation, fuels treatment, and road construction remove or rearrange organic matter, which changes erosion rates. Surface erosion rates depend on such factors as soil erodibility, steepness of slope, slope length, and amount of bare ground. Erosion rates may be calculated at project levels, but not at the forest scale.

Mass movement of soil (geologic hazards) include slumping, slope failure, and earthflow. The geologic hazards with highest probability of mass movement potential have special management implications. Descriptions of the slope stability, or potential of mass movement have been, and will continue to be, used to indicate the types of management practices and mitigation measures which are appropriate for the site.

Most Forest soils are stable, thus no special measures are needed. The land with moderately stable soils requires more work in layout and design of roads and increased road construction cost. Areas with unstable soils should generally be avoided because the risk of resource damage is higher than the benefit. These acres are removed from the tentatively suited timber base.

Vegetation plays a major role in the complex interactions of slope stability, as well as erosion. It acts to intercept and store significant amounts of precipitation, thereby buffering the effects of storm events. The roots of vegetation physically bind soil particles together; the strength of roots adds strength to the soil; and the roots may grow to bedrock, forming an effective anchor system. Once precipitation enters the soil, it becomes available for the vegetation to remove it through evapotranspiration, which decrease the amount of destabilizing groundwater (Swanson, et al. 1989).

Soil compaction can significantly reduce long-term soil productivity; therefore it is important to prevent unnecessary compaction. Compaction often occurs as a result of management activities, thus it is important to stay within acceptable standards in order to minimize the overall effect. The Soil Management Handbook (FSH 2509.18 R2) defines detrimental compaction as a greater than 15% increase in the average undisturbed soil bulk density. It is believed that an increase of 15% or more would represent a significant loss in soil productivity.

Some soils are more easily compacted than others, and most soils are more easily compacted by the use of ground skidding equipment or equipment used to pile the residue after timber harvest. Each trip across the same location with a piece of machinery or a log or logs will cause some compaction. The effects are cumulative, with each succeeding trip increasing the compaction. Because it reduces soil productivity in terms of the amount of timber and forage that land can produce, compaction is not desirable for the Forest in general.

Organic matter content and related nitrogen availability is an important component of soil productivity. Soil organic matter affects both water- and nutrient-holding capacity and reduces the erosion hazard. Organic matter holds many times its weight in water and has a high cation exchange capacity that increases the soil's ability to retain nutrients for plants. As soil organic matter (leaves, needles, and twigs) decomposes, it releases nutrients, in soils. Nutrient losses are of concern because if nutrient levels are allowed to decline, the productivity of the site is reduced. These losses most often occur as a result of erosion of the surface horizon, volatilization by fire, or whole-tree harvesting.

Large woody material (3 inches) supports the life cycle of symbiotic soil fungi (ecto-mycorrhizae), which attach to conifer roots, and greatly increase the tree's ability to take up nutrients and water. Duff and litter on the soil's surface also act as mulch and reduce soil erosion due to rainfall impact. Fine root mats in the surface soil bind the soil together, reducing down slope soil creep and washing. Some forest soils have accumulated very little organic matter and are considered sensitive to any organic matter removal by management. These soils generally occur in the upper elevations

where the colder climate and short growing season do not generate large amount of annual vegetative growth.

ENVIRONMENTAL CONSEQUENCES

General Effects

Litter, humus, soil wood, and certain key properties of the surface mineral layers of forest soils are usually most critical when developing silvicultural systems. These are the soil layers most easily and commonly disturbed by silvicultural activities, yet they are the most crucial to forest productivity (Graham, et al. 1991).

Coarse woody debris physically protects the soil from erosion, displacement, and compaction. In addition, it can protect a regenerating forest from both abiotic and biotic elements. Coarse woody debris provides shade and protection from wind and snow and can be a critical factor in protecting newly established seedlings from livestock and other large animals.

The silvicultural methods available to manage the forest need to be assembled into complete silvicultural systems—planned programs of treatments to be applied throughout the life of a forest stand. This is important in ecosystem management. Soils are critical to the regeneration, productivity, nutrient values, and moisture-retention abilities of all forest sites.

The choice of regeneration methods is, in many ways, the most critical decision regarding the entire system. It should be selected by considering all abiotic and biotic elements that might influence forest regeneration and development, but soil properties are especially important. Physical properties of the mineral soil, especially water-holding capacity, can be used to help determine which regeneration methods would be appropriate. For example, stands located on soils with high amounts of available water would be most suited to the clear-cut methods, and stands on droughty soils with little available water would be more appropriate for selection or shelterwood methods. This is not to say that soil is the only fact that should be considered when selecting a harvest method, but soils should be used as input in the decisions. Silvicultural prescription in some cases may depend more on the shade tolerance of the tree species.

Many public forestry agencies have shifted from even-aged to uneven-aged management, primarily because of the public perception that uneven-aged management is less damaging to the environment, better for wildlife, and will result in a more aesthetically pleasing landscape.

Harvey, et al. (1994) stated that with uneven-aged management, the potential for soil damage increases because, with fewer trees removed over larger areas, ground-based extraction is mandatory to avoid excessive cost. With this forest management approach, potential soil damage threatens long-term wood production. Short- and long-term growth reductions from traffic-induced soil compaction and soil displacement can be

expected. The use of mitigation such as designated skid trails will keep the disturbance to an acceptable level.

Tractor piling of logging debris and machine site preparation is used throughout the West. Similar to tractor yarding, tractor piling can detrimentally impact the soil. The greater the disturbance, the greater the potential loss of the surface organic layers. A balance is needed to achieve the level of disturbance required for site regeneration while minimizing adverse impacts from that disturbance.

After the site preparation and hazard reduction treatments are completed, it is imperative to leave sufficient large woody material on the site. As mentioned earlier, residue has several properties important for maintaining forest productivity. Graham, et al. (1991) recommend leaving a minimum of 5 to 15 tons per acre of large woody material after timber harvesting and other site treatments. These recommendations are general and will be refined as more research makes them more site-specific (Graham, et al. 1994).

Direct and Indirect Effects

Effects from Fire and Fuels Management: Wildfire is a natural process, which can cause many impacts to the soil resource, including erosion and severely burned soil (DeBano 1991).

Wildfire can have serious short-term implications for watershed protection. Severe wildfires not only destroy vegetation but also can detrimentally burn soils. Soils are considered detrimentally burned when most woody debris, litter, duff, and humus are consumed down to bare mineral soil (USDA Forest Service 1992). Detrimental burning reduces soil productivity. Gully formation, shallow slumping, and decreased microbial activity may result.

DeBano et al (1998) in their book *Fire's Effects on Ecosystem* discussed that fire-related changes in soils produce a wide array of changes in the surrounding ecosystem because of the interdependency between the soil and other ecosystem components. Immediate short-term and long-term response to fire occurs. Immediate effects of fire arise as a result of the heat released during a fire and directly impact the soil and surrounding ecosystem. The response of biological components (soil microorganisms and vegetation) of the fire is rapid. Another immediate effect is the release of gases and other air pollutants by the combustion of soil organic matter during a fire. The long-term fire effects are usually subtler, but they can persist for years following a fire or be permanent. When the effects become long-term, they are considered an impact to the soil resource. An example of long-term fire effects is the disruption of the relationship between nutrient cycling and long-term productivity.

In the aftermath of wildfires, streamflow may increase in response to soil and vegetation changes. A severe wildfire may create hydrophobic soil condition, which decreases the infiltration capacity. This decrease in the soil's ability to absorb water, combined with reduced transpiration resulting from vegetation removal, can result in significant

streamflow increases. If the resulting streamflow causes streambank instability and undermines the integrity of downstream structures in the floodplain, soil erosion will occur. This is particularly important in forested areas where intense thunderstorms can create considerable overland flow if infiltration capacity is reduced.

Severely burned areas would need emergency treatments to prevent watershed and soil degradation. The Forest has a burned area emergency rehabilitation program and plan that would respond to watershed concerns after a major wildfire (USDA Forest Service). This would be true for all alternatives.

For prescribed burning, similar hazards exist as described for wildfires, but under managed conditions are expected to occur over a smaller area and have lesser impacts. The areas selected for burning are usually small enough and burn cool enough so that widespread adverse effects area minimized, and effects are not as severe as those resulting from a major stand replacement fire.

Prescribed burning can affect the physical and chemical nature of the soil. The amount of soil erosion after a prescribed burn depends on the inherent erodibility of the soil. Project analysis and monitoring would be completed for all prescribed burn proposals so that long-term soil productivity would not be impaired. Prescribed fire programs in all alternatives can be implemented in a way that prevents excessive soil impacts.

The effects of wildfire could potentially be greater in those alternatives where natural processes dominate. This will depend on fuels loads, moisture, insect and disease activity, but the more natural processes are allow, the greater the potential change of wildfire impact to the soil resource. See writeup on ecological function (Biodiversity section) for more information on natural processes. The potential for impacts fuel treatment would be similar for most of the alternatives.

Effects from Rangeland Management and Big Game Use: In the Eastside Forest Health Assessment (Johnson et al. 1994), the discussion on vegetation stated that perhaps livestock grazing during the late 1800 has caused the greatest degree and extent of disturbance in the western United States. The mobility and extensive used of the various ungulates across western rangeland affected virtually all segments of the landscape to some extent. The effect was greatest along watercourses, in basin meadows, and on ridgetops, where stock driveways and bedding grounds were used season after season for many years. The degrading of native vegetation in some areas has been so complete that thresholds were passed, leaving disclimactic vegetation. This "new" vegetation is usually either simpler biologically than the native flora or contains invasive, less desirable, or noxious plants.

Under a properly managed grazing system, livestock are well distributed, grasses are grazed to a preferred use, and trailing is minimized. There is plenty of vegetation left for soil protection. The use of ground cover for soil protection is a basic premise. When the vegetation is utilized to its allowable limits it is time to move the livestock. Proper utilization levels need to account for both livestock and big game needs.

If grazing systems are not properly managed, riparian areas may be heavily grazed and streambanks become raw and erosive. If too much forage utilization occurs, upland soils may become compacted and the loss of vegetation can result in increased erosion. Excess trailing can result in rilling, which would not maintain the integrity of the ecosystems.

An analysis of desired vegetation condition and soil standards on the Forest showed that some of the rangelands are not meeting forest plan direction. This indicates that soils may be exceeding allowable soil loss limits in some locations. Soils information is vital to conducting range analysis and would provide site-specific information at the project level. Changes in amount and timing of use, pasture rotation, deferment, resting, and vacating allotments may all be appropriate means to reduce grazing-related erosion problems. Vegetation utilization monitoring indicates that levels of use are being meet across the vast majority of rangelands on the forest. See section on rangeland grazing and big game use for more information.

Soil surface characteristics are currently the best available indicators of soil stability and watershed function. Soil surface characteristics, such as presence of rills and gullies or pedestaling of plants, have been widely used as indicators of the degree of soil movement and condition of the soil surface. An evaluation of soil stability and watershed function, using soil surface characteristics as indicators of soil erosion and runoff, should become a fundamental component of all inventory and monitoring programs for rangelands (National Research Council 1994).

With grazing occurring over large areas of the Forest in all alternatives, the possibility for erosion exists. Erosion takes place on livestock trails to watering sites or favored crossings, such as over roads, ridges, and streams. In some areas, overgrazing has resulted in soil compaction. These effects would be similar under all alternatives.

Effects from Recreation Management: Overuse of campsites can cause soil compaction and deterioration of the vegetation. Both the compaction and vegetation deterioration can lead to increased surface-water runoff and gully formation. This situation presently occurs in some developed recreation sites or at frequently used, dispersed recreation sites, such as campsites near streams. These effects are expected to be similar under all alternatives. Effects can be mitigated by surface treatments (the application of gravel or paving) for heavily used footpaths or by closing areas to dispersed camping. Mitigation would be applied under all alternatives.

Since vegetation is removed from trails and compaction occurs, either during construction or by use, trails increase the potential for erosion. Where trails descend/ascend steep slopes, gullying may occur. Proper trail reconstruction, proper cross-drainage, barriers, and interpretive signing can mitigate effects. Some indirect adverse impacts can result from trail construction. For example, as access increases, so does off-trail hiking and biking on previously undisturbed areas. This can increase soil erosion, gullying, and compaction. Interpretive signing and barriers area examples of mitigation that can help reduce the amounts of off-trail use.

Off-highway motorized recreation has the potential for heavy impacts to the soil resource. When use is heavy or concentrated along corridors, ground cover tends to be damaged without the opportunity to recover. Soils are compacted and, in some instances, the topsoil layer is lost. Heavy use on unstable soils or steep slopes has caused soil erosion, permanent loss of ground cover, and gully formation.

Dispersed motorized recreation can damage soil and water resources; however, because the areas affected are so small and scattered, the effects on soil and water are negligible at the forestwide scale. In general, the impacts occur when users do not comply with existing regulations: for example, OHV use occurring off designated travel ways. Incorporating the watershed conservation practices identified in the forestwide standards (see Draft Revised Plan, Chapter 1) will further mitigate effects.

Effects from Timber Harvesting and Road Construction: Timber harvesting affects the soil in many ways. Activities such as skidding, decking, site preparation, and machine piling of slash results in various degrees of soil displacement, soil compaction, and disturbance to vegetative ground cover. Within a cutting unit, regardless of silvicultural prescription, skid trails can lead to erosion and gullying if not properly located and water-barred or if insufficient slash is left on the skid trail surface.

The effects of equipment operation will result in varying degrees of disturbance or removal of the existing vegetation, litter, and humus from the surface of the soil.

When individual projects are planned, site-specific soil characteristics are taken into consideration. Some soil characteristics will restrict where timber harvesting can be done. Soil characteristics may also require specialized harvesting methods. Where soils area highly erosive or unstable, care must be taken to keep soils in place. Slash should be lopped and scattered on some soil types to maintain nutrients and organic material.

Timber harvest can affect the soil productivity through heavy equipment compaction to the soil and through the removal of nutrients in the form of tree boles, limbs, and branches. Heavy equipment on the forested site can result in detrimental puddling, compaction, erosion, and displacement. In addition to these direct effects, damaged soil can lead to increase runoff from the lower infiltration rates, sedimentation, lower permeability, and reduced site productivity.

The amount of soil erosion occurring within a timber sale depends on the amount of bare soil, slope steepness, slope length, inherent erodibility, and rainfall intensity. Slash and logging debris that remains after a timber sale reduces erosion because it protects the soil from raindrop impact and presents physical barriers to soil movement. If logging activities expose too much soil, then erosion becomes excessive and site productivity is reduced or impaired.

The road building activities associated with timber management can impact the soil resource. Road construction and reconstruction require that the soil be excavated, cut through, and reshaped by heavy equipment. When the vegetation is removed and bared soil is exposed, there is an increased chance that erosion will take place.

In some cases, road reconstruction may be beneficial, particularly if it corrects drainage problems. In many cases, road reconstruction removes vegetation and reshapes the road surface. For these reasons, reconstruction is counted as an impact rather than a benefit.

Effects from Travel Management: Motorized vehicle use on designated travelways and off-road uses have the potential to adversely impact soils through loss of vegetative cover, erosion, and compaction. Motorized off-road uses do not cause damage if the use is minimal and infrequent. However, once the vegetation has been imprinted by tires, the potential for additional use and resource impacts (including erosion and compaction) increases. For this reason, motorized use is restricted to roads and trails in all alternatives unless specifically allowed by Forest order.

Decommissioning of a road can have a positive effect on the soil resource. Road decommissioning should re-establish proper drainage, remove structures requiring long-term maintenance, and restore vegetative cover that would stabilize soils and reduce sedimentation. Road decommissioning techniques may vary, but it is essential that soil and water objectives be met in the selected closure method. All alternatives propose to decommission the same amount of roads per year. Therefore, there would be no difference between alternatives regarding road decommissioning.

Uninventoried two-track roads exist on the Forest, but are generally limited to concentrated areas of high use. These roads are not part of the Forest road system and are not designated for motorized use. These roads are the results of hunters, wood gathers, firefighters, and others driving off designated travel ways. As management activities occur, these roads will be identified and decomissioned or placed on the Forest road system. Decomissioning unclassified roads will have a beneficial effect on long-term soil productivity and will reduce overall open-road density on the Forest.

Cumulative Effects

The effects on soils from all major ground-disturbing activities expected to occur under the alternatives for the next decade are shown in the following table. The cumulative effects table at the beginning of Chapter 3 includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to the soil resource on the Forest. The soils cumulative effects analysis did not extend beyond the National Forest boundary, since the National Forest is at the top of the watershed.

Alternatives can be evaluated on a cumulative effects basis in terms of the amount of activity in the same area. For timber harvesting, those alternatives with greatest multiple entries to the same area would potentially have the greatest cumulative effects. Each alternative differs in the relative amount of activities schedules.

The effects above show estimated future disturbance differences between alternatives. Yet, watershed have been impacted to some extent by past management efforts. A discussion of cumulative effects to watershed is contained in the Water Resources section.

Table 3-20. Primary activities affecting soils.

Management Activity	Unit of Measure	Alt A	Alt B	Alt C	Alt D	Alt E
Timber Harvest						
Suitable Timber	Acres	271,896	124,519	62,093	184,606	305,535
Total Sale Quantity	MCF	3,809	2,209	1,068	2,557	4,339
Even-aged	Acres/Year	2,845	901	607	1,056	1,880
Uneven-aged	Acres/Year	0	230	6	0	1,464
Total Acres Harvested	Acres/Year	2,845	1,131	613	1,056	3,344
Livestock Grazing						
Domestic Livestock Grazing	% NFS Lands with Active Allotments	83	83	83	83	83
Oil and Gas						
Available Land for Development	Acres	571,141	245,040	112,041	453,478	638,646
Land with Stipulations	Acres	533,875	859,976	992,977	651,537	466,469
Roads						
New Construction	Miles/Year	2.9	2.0	0.9	2.7	3.2
Decommissioned	Miles/Year	4	4	4	4	4
Fuel Treatments						
Prescribed Fire	Acres/year	3,210	4,779	2,013	4,350	4,041

Biological Elements

Biological and Habitat Diversity

Introduction

Biological diversity refers to "the full variety of life in an area, including the ecosystem, plant and animal communities, species and genes, and the processes through which individual organisms interact with one another and with the environment" (USDA Forest Service 1992). The Forest Service is charged with providing for diversity of plant and animal species (36 CFR §219.26), and providing habitat to ensure viable populations of species (36 CFR §219.19 and USDA Regulation 9500-04).

The Bighorn National Forest adopted a two-pronged approach to assessing and managing ecosystem and species diversity for this plan revision effort. This approach is consistent with direction from the Acting Deputy Under-Secretary for Natural Resources and Environment, USDA (Tenny 2001) and with other national direction (Holthausen 2002).

This approach works by first obtaining an understanding of ecological processes, described in the Ecosystem Analysis. Ecological processes functioning within a Historic Range of Variability provides for the most opportunity of beneficial habitats for species associated with those habitats. The second aspect, described in the Single Species Analysis, examines the provision for individual species viability, where species viewed as at-risk or as focal elements within the ecosystem are analyzed in terms of habitat and population conditions and trends.

The Ecosystem Analysis provides the decision-maker with information about the trends in ecosystem conditions that will be either reinforced or changed by taking or not taking various management actions. The ecological processes are placed in a management context through the examination of the historical range of variability (HRV) and the relationship between natural factors and management activities. Ecosystem function and diversity is the focus of the Ecosystem Analysis. It addresses the continued functioning of ecosystems and ecological communities within the planning area and its objectives are listed below:

- Identify ecosystem elements whose current condition differs from most common conditions based on HRV.

- Provide an ecosystem context for the Single Species Analysis.
- Quantify and describe the occurrence and distribution of ecosystem elements such as covertypes and habitat structure stages for the existing condition and the conditions that would result from the implementation of the alternatives, and compares them to historical conditions.
- Determine how each management area contributes to the maintenance of biological diversity and how combinations of management area allocations contribute to biological diversity.
- Provide findings regarding conditions that will provide habitat for all species and maintain ecological functions.

The Single-Species Analysis is an analysis of particular species and their habitats. These species have been identified as having a need for a more rigorous examination of viability due to their perceived rarity as a function of habitat or population conditions or due to their representation of needs of other species and habitats (e.g., Management Indicator Species/Focal Species). The following are part of the Single-species Analysis:

- Emphasis species identified including federally Threatened, Endangered, Proposed, and Candidate species; Forest Service sensitive species; Species of Local Concern to the planning area; Management Indicator/Focal Species; and Demand species. These were selected from out of hundreds of species that rely on the Forest for habitat.
- Limiting habitat or population components and management risks for those species identified.
- Environmental consequences of the alternatives to the species and their habitats described, and the likelihood of persistence in a viability context of the at-risk and MIS/focal species described.

This two-pronged approach evolved from policy and direction contained in many federal laws and regulations, particularly the National Forest Management Act and the Endangered Species Act. The goals of the Endangered Species Act demand a species-specific focus to prevent extinction of endangered taxa. In contrast, NFMA calls for the maintenance of viable populations of all native and desirable non-native vertebrate species, which is broadened by USDA Regulation 9500-04 to include viable populations of all wildlife, fish, and plants. The Ecosystem Analysis responds to limitations of the species-by-species approach and deficits in the knowledge of species requirements. It is assumed that by providing functioning ecosystems that the majority of species would remain viable. As a “safety-net” approach, species for which a concern in viability exists are analyzed to ensure adequate measures have been taken to address viability requirements of known species at risk.

The biodiversity analysis used a variety of reference materials. The Regional Office commissioned a report on the Historic Range of Variability (HRV) of the upland vegetation (Knight 2003) as part of a Terrestrial Ecosystem Assessment (Regan et al. 2003). Eco-regional assessments as developed by The Nature Conservancy and others

were examined to help frame the Ecosystem Analysis and other aspects of the planning process. Species level information was reviewed by the Wyoming Game and Fish Department. The overall process used to assess viability, incorporating both ecosystem level and individual species level components is described in the Viability Process document in the project record.

The following laws, executive orders, regulations, and policies guide management of biological diversity on NFS lands.

Legal and Administrative Framework

Laws

The Multiple-Use Sustained Yield Act of 1960 – "It is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed and wildlife and fish purposes…The Secretary of Agriculture is authorized and directed to develop and administer the renewable surface resources of the national forests for multiple-use and sustained yield of several products and services obtained therefrom…the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land."

The Endangered Species Act of 1973 – "The purposes of this act are to provide a means whereby the ecosystems upon which the endangered species and threatened species may be conserved, to provide a program for the conservation of such endangered species and threatened species…"

The National Forest Management Act of 1976 – "It is the policy of the Congress that all forested lands in the National Forest System shall be maintained in appropriate forest cover with species of trees, degree of stocking, rate of growth and conditions of stand designed to secure the maximum benefits of multiple use sustained yield…Plans developed …shall…provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet the overall multiple-use objectives, and within the multiple-use objective."

Executive Orders

EO 11990 Protection of Wetlands – "Each agency shall…provide leadership and take action to preserve and enhance the natural and beneficial values of wetlands in …conducting Federal activities and programs affecting land use."

EO 13186 Protection of Migratory Birds– "Each agency shall…promote the conservation of migratory bird populations" as referenced by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Regulations and Policies

36 CFR §219.19 (a)(5) Evaluate the effects of pest and fire management.

36 CFR §219.19 Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area.

36 CFR §219.26 Forest planning shall provide for diversity of plant and animal communities and tree species consistent with the overall multiple-use objectives of the planning area. For each planning alternative, the interdisciplinary team shall consider how diversity will be affected by various mixes of resource outputs and uses, including proposed management practices.

FSM 2670 Region 2 Supplement 2003-01 Forest Service direction on wildlife, fish and sensitive plant habitat management.

USDA Regulation 9500-04 States policies of the USDA with respect to management of fish and wildlife and their habitats and prescribes specific actions to implement this policy.

Key Indicators

Key indicators were selected to identify ecosystem elements manipulated most by management activities that could affect the range or structure of biodiversity. Other indicators used in the Aquatics, Riparian, and Fisheries section would also apply here (e.g. stream crossings, etc.). While not all elements can be tracked, these selected indicators are the focal elements of most concern for the Forest, historically and based on public input. Rare and declining habitats or specific threats and risks are also considered by individual species through the single species analysis. The following key indicators apply for the biodiversity section:

- Changes in habitat composition, including rare or declining habitats. Changes in habitat structural stage for forested cover types.
- Amounts of snags and coarse woody debris.
- Connectivity/fragmentation of vegetation (patch size and isolation, road densities).
- Viability outcomes for species at risk.

Resource Protection Measures

In order to maintain biological diversity and viability, desired conditions, management areas, and standards and guidelines have been delineated and have been developed. These management tools will help guide implementation of the Revised Plan. The standards and guidelines, in particular, provide conservation measures for ecosystem and species habitat components. Monitoring is a part of project planning and implementation and is designed to validate the application and assumptions made in developing the plan and its components. The configuration and use of management

prescriptions was also varied by alternative to provide areas where biological diversity were managed through either more active management of vegetation resources, or through more natural processes.

Abstract

Proactive improvements for biodiversity in all alternatives (except A) included the focus on larger management areas and the acknowledgement and planning for larger disturbance processes that typically shape high elevation vegetation types. This is varied by alternative by focusing on mechanical methods versus more natural processes. In addition, proactive measures were added for landscape processes in terms of goals, objectives, standards and guidelines in the Plan, as well as species-specific requirements largely focused in standards and guidelines. Proactive measures to be taken by management in this next planning period include: watershed restoration (e.g. road and stream/riparian interactions), travel management (road density concerns), livestock administration for non-forested vegetation improvement, aspen enhancement, vegetation treatments for habitat diversity primarily in pole sized lodgepole pine stands and other cover types with missed fire cycles, and prevention and reduction of undesirable non-native species (vegetative and non-vegetative). There is also the opportunity to begin use of wildland fire use. Sources for these measures included more recent scientific findings and reports. One of the most important resources for biodiversity is riparian areas, which are discussed in the Aquatics, Riparian, and Fisheries section of Chapter 3.

From the Ecosystem Analysis, elements of ecosystem composition will be most likely compromised by effects from non-native species such as noxious weeds. Similarly, species composition is affected with loss of habitat, which would occur when road construction results in the likely permanent modification of habitat. These threats would be greatest under Alternatives A and E where increased road construction occurs; current levels of threats would likely remain constant in other alternatives. Natural disturbances (fire, insects, and disease) would continue as the largest influence on structural diversity in forested and non-forested cover types, with Alternative C, followed by B, and D likely having the highest potentials for this. Alternatives A and E would likely have more timber harvest which would increase structural diversity in forested types; in these alternatives, natural disturbances would be a lesser influence than active management. In Alternatives A and E, existing patterns of smaller openings as compared to historical disturbances would generally persist where mechanical treatments are prescribed, with this effect tapering off through Alternatives D, B, and C. RNAs that provide areas where ecological processes are emphasized would be increased in Alternatives B, C, and D.

In terms of single species viability, several species would continue to be at risk. Aquatic species such as Yellowstone cutthroat trout and amphibians may be at risk due to non-native fish. Bighorn sheep may be at risk of contracting diseases from domestic sheep. Several plant species have limited information for their distribution, but are typically at less risk due to locations of potential habitat. Roads are the most common development

threat from management activities to individual species' habitat, with effects summarized above.

Ecosystem Analysis

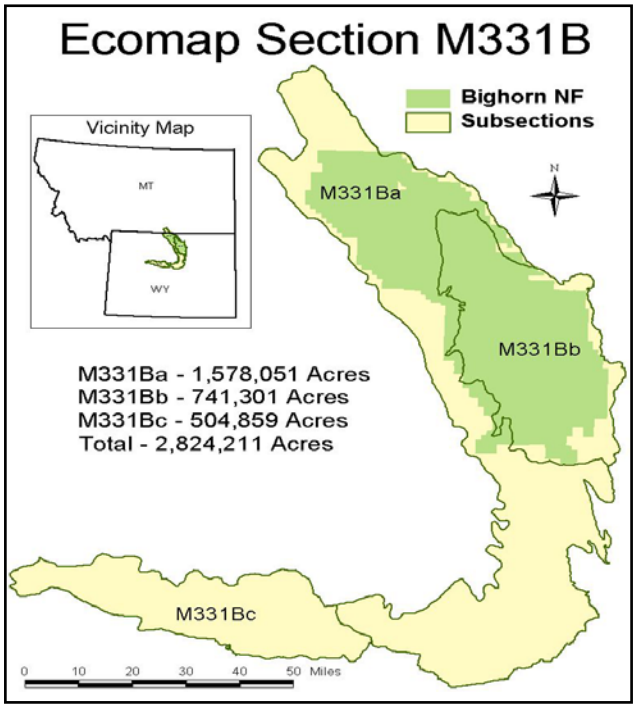
The Ecosystem Analysis examines the consequences of the alternatives and their effects on the **composition** (covertypes) and **structure** (habitat structural stages, fragmentation and connectivity, snags and coarse woody debris). Elements of disturbance processes are incorporated into these ecosystems of the Bighorn NF. The Single Species Analysis follows this section.

Many aspects of the existing condition of the ecosystems of the Bighorn NF were described in the forest-wide assessment conducted as part of the Analysis of the Management Situation (see Project Record). While the affected environment and the environmental consequences presented in this section deal primarily with resources on the Bighorn NF, a larger spatial scale was considered in the ecological assessments reviewed (Regan et al. 2003; Winters et al. 2003) as described in the viability assessment process documents in the project record. In addition, interagency review and input has occurred and will continue through this process. The assessments reviewed incorporate the best knowledge and science currently available.

The Bighorn NF is situated within the Big Horn Mountains section in terms of ecological hierarchical classification (McNab and Avers 1994). The Big Horn Mountains section is largely an island mountain range, surrounded by basin/plains type formations. This section is further divided into subsections of three different geological/soils associations (see following figure):

- Big Horn Mountains, Sedimentary Subsection (M331Ba)
- Bighorn Mountains, Granitic/gneiss Subsection (M331Bb)
- Owl Creek Mountains Subsection (M331Bc).

Figure 3-1. Ecological section and subsections on the Bighorn National Forest.



Additional descriptions in the forestwide assessment (project record) include discussions of climate and soils and their relationship to the geological formations, which further refine the ecological classification into landtypes. Landtypes and soil associations define the covertypes that occur in the Section and the Forest. The following table displays the covertypes in the Section and the proportion of those elements on the Forest.

Table 3-21. Comparison of major covertypes at the section and forest scale.

Major Covertype	Percentage in Bighorn Mountains Section	Percentage in Bighorn NF*
Grass-forb	25%	18%
Shrub	16%	9%
Non-Vegetated	4%	10%
Forest	55%	63%

Source: Forest CVU vegetation GIS database, including all of the Forest and approximately 1 mile out from the boundary.

From this table, it is evident that the Forest has the bulk of the acreage for the forested covertypes in the Section. Further analysis showed that the Forest has the majority of the lodgepole pine and spruce-fir covertypes in the Section, modest amounts of the Douglas-fir type, and marginal amounts of limber pine, juniper, and ponderosa pine with regards to the overall amount in the Section by land ownership. Aspen and cottonwood covertypes occur at low amounts across the Section, and the Forest has a small fraction of the acreage for these types based on land ownership. Where the Forest has responsibility for the majority of the covertype in the Section, the management of these resources becomes the dominant force for how these elements are maintained in the Section.

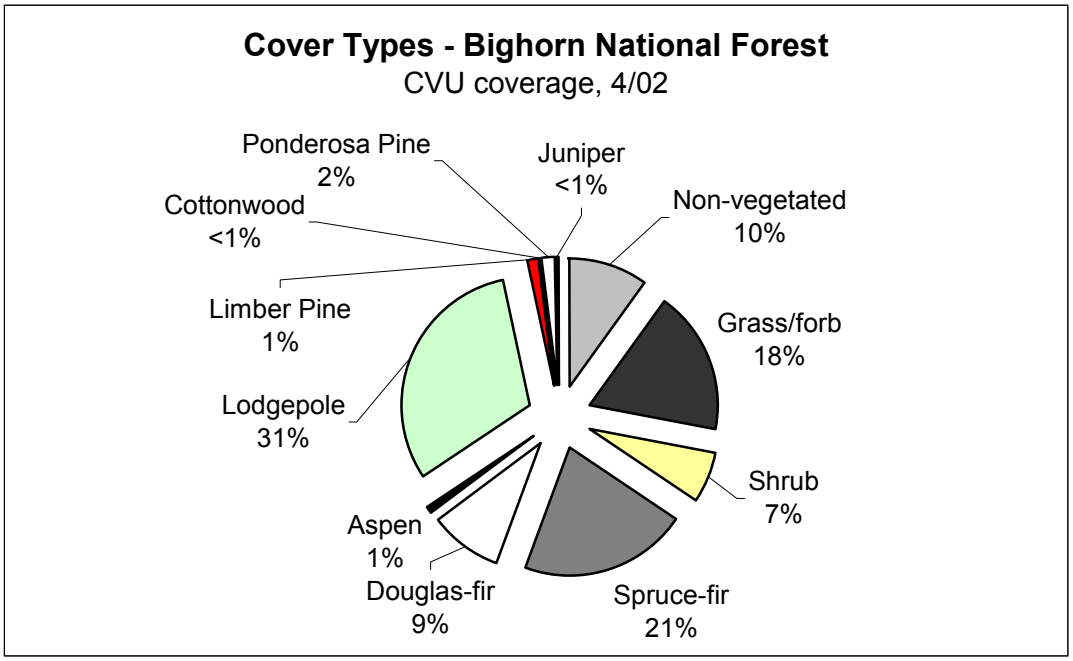
Despain (1973) described the relationship of soil types to vegetation occurrence, showing that soils largely determine the potential vegetation type. Accordingly, there are few areas on the Bighorn where forested covertypes are continually expanding into meadows in a successional pattern. There is a natural edge between meadows, forests, and other vegetation types. As shown in the previous table, the Forest has a high degree of naturally fragmented landscape, with meadows and shrub covertypes frequently interspersing forested covertypes. Strong association also exists where lodgepole pine occurs primarily on the granitic soils, while Douglas-fir, limber pine, and ponderosa pine occur on sedimentary soils. In general, the east side of the Forest is comprised of more forested areas compared to the west, and further variations of forested to un-forested are evident at the geographic area scale. Spruce-fir and aspen can occur on both types of substrates. While it is necessary for the Forest to consider the activities occurring on the resources and lands surrounding the Forest for cumulative effects, often information is difficult to gather for these areas. The Historical Range of Variability assessment conducted by Knight and Meyer (2003) provided the context to assess what currently occurs versus what was thought to occur historically and is used in several of the ecosystem analysis descriptions below.

The appropriate scale for analysis was determined by the spatial extent of ecosystem elements being evaluated, or in the case of species analyses, by the movement patterns, population distribution, and other biological characteristics of specific taxa. The major elements of the ecosystem components that affect functioning of those systems and that are manipulated through management activities were selected for the analysis detailed in the following affected environment and environmental consequences sections. **Cumulative effects** are largely described by either the Forest or the Big Horn Mountain section and the surrounding, immediately adjacent private land. There is additional discussion in the Vegetation, Fire and Fuels, Insects and Disease, Wildlife, and Aquatics sections that provides details that are not included in the Biological Diversity section.

Affected Environment
Composition

The ecosystems of the Bighorn NF have a combination of forest, shrub, grass and other vegetation and non-vegetated features. The composition of the Bighorn NF can be described by the occurrence of dominant covertypes, including forested and non-forested types. The major vegetation covertypes occur in elevation zones on the Bighorn NF. The zones are strongly influenced by climatic and geologic effects including soils. Riparian areas cross through the various vegetation zones. The following figure displays the abundance of covertypes found on the Bighorn NF.

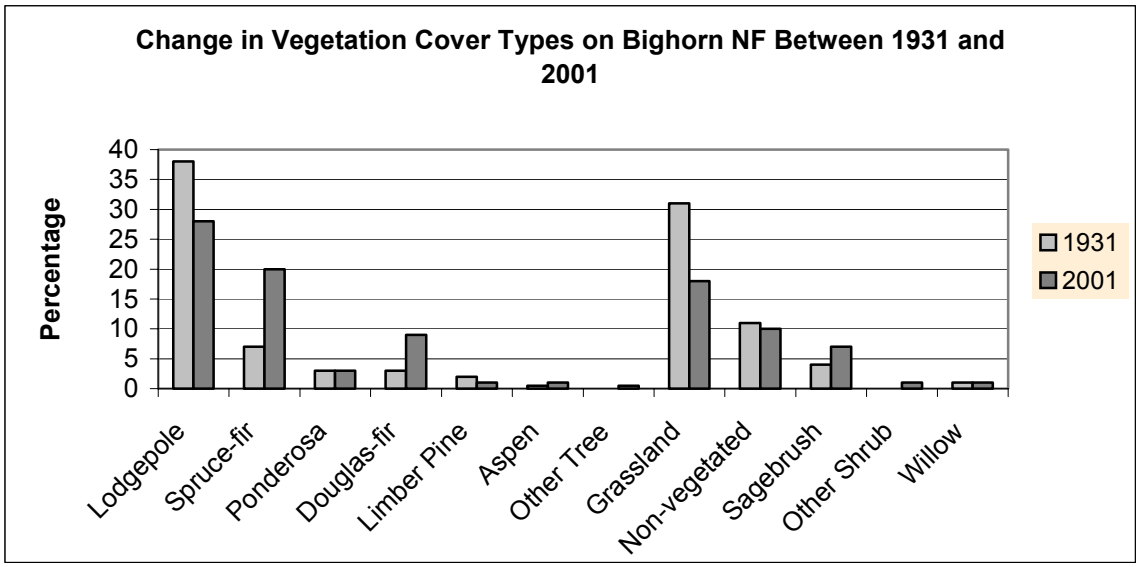
Figure 3-2. Covertypes and percent of Bighorn NF.



The amount and distribution of covertypes and the moisture regimes associated with them affect the occurrence of species that are dependent on the ecosystems. As the Big Horn Mountains are a geologic uplift, a strong elevation gradient shapes the arrangement of the covertypes according to the precipitation levels and soils. Refer to the map in the project record to view the current distribution of covertypes on the Forest that are indicative of these elevation ranges.

There has likely been little change in the overall composition of the covertypes on the Forest from a historical perspective. The following figure shows how the major vegetation covertypes have changed on the Bighorn NF between 1931 and 2001. The 1931 data is from silvicultural notes by V.J. Dayharsh, while the 2001 data is from the Common Vegetation Unit GIS database. There is a slight discrepancy between these data since the CVU database includes some areas of other than National Forest System lands. In addition, there may be some discrepancy in the definition of "grassland." In some older surveys of the forest, notably F.E. Town (1898), recently burned forests were classified as grassland. Town estimated that 50% of the reserve (Forest) was grassland.

Figure 3-3. Vegetation covertypes on the Bighorn NF in 1931 and 2001.



The amount of lodgepole (-10%) and grassland (-13%) covertypes decreased, while spruce-fir (+13%), Douglas-fir (+6%) and sagebrush (+3%) covertypes increased over the past 70 years. The increase in spruce-fir covertype and differences in other cover types may be due to a difference in inventory methods and classification, as well as the potential succession of spruce-fir from understory to overstory in some lodgepole pine stands. Aspen has likely decreased over time. Knight and Meyer (2003) concluded that the current composition of covertypes is likely within the historic range, as climate is the primary driving factor of large scale changes, and it has remained relatively constant in the last century.

The covertypes on the Bighorn NF that have been traditionally viewed as the most important from an ecosystem and species viability perspective are the riparian, aspen, and spruce-fir forest communities. This is due to their associated structure and moisture regimes that contribute to watershed function and provide unique habitats for the most species.

The importance of riparian areas to overall biodiversity and use by species has been well substantiated in the literature (Thomas 1979; Hawkins 1994). Riparian ecosystems cross through and occur within a number of covertypes on the Forest and include wetlands, fens, and surface waters. There is great variability in the size and complexity of riparian zones because of the many possible combinations of stream gradient, elevation, soil, aspect, topography, water quantity and quality, type of stream bottom, and plant communities. Girard (1997) characterized 12 main vegetation groups and 53 vegetation types that can occur in riparian habitats on the Bighorn NF. From this aerial photo interpretation effort, approximately 101,000 acres were identified as riparian covertypes, which is approximately 10% of the total acres on the Bighorn. Riparian

acres are not displayed in the previous tables. Shrublands and forests make up more than 60% of the riparian areas on the Forest. In contrast, less than 20% of the riparian areas are grass/forb dominated. The following table displays riparian covertypes on the Forest.

Table 3-22. Riparian acres for the Bighorn NF.

Vegetation Type	Acres and % of Total Riparian
Forested	42,288 (42%)
Shrub dominated	18,445 (18%)
Grass and Forb	19,317 (19%)
Other	20,027 (20%)
Total Acres	**100,077**

Source: Bighorn NF Riparian GIS coverage and Girard (1997).

Historically, variations in riparian covertypes have occurred in response to different land uses (e.g., timber harvest and livestock grazing) and disturbance processes (e.g., flooding, fires). Historic tie hacking used streams to move products, causing an alteration in composition and geomorphology. While there have been no loss of streams on the Forest, there may have been a reduction in the amount of riparian vegetation due to lowered water tables from changes in geomorphology of stream systems (e.g., incised streambanks). Willows, the primary riparian shrub, may have been reduced through historic livestock grazing. A reduction in beaver colonies from historic levels has also affected the ecosystem functioning of riparian areas. Refer to the aquatics section for more information on variances that have occurred. There are approximately 1,400 miles of perennial stream on NFS lands within the Bighorn NF. Water originating on the Forest contributes to flow in the Big Horn, Powder River, and Tongue River basins. There are also hundreds of lakes, reservoirs, and ponds distributed across the Forest, totaling approximately 6,000 acres or 0.5% of the Forest.

From a biodiversity perspective, particularly wildlife, the next most important covertypes on the Forest are spruce-fir forests and the aspen forests. Spruce-fir forests typically have a diverse stand structure due to the multiple canopies, size of trees, and amounts of coarse woody debris and snags. This is a function of the long fire return intervals, which is largely due to the moister climate and short growing season in which the forests are located. There has probably been little change historically in the amount and distribution of this covertype (Knight 2003), though management and disturbance processes have altered the structural stages. Exceptions to this were noted above. The late-successional structure stage of this covertype is typically viewed as the most valuable for species dependent on a high number of large snags and large amounts of coarse woody debris. Well-developed soil horizons in this type support a diversity of organisms. Lodgepole pine is the most dominant covertype on the Forest, though some lodgepole pine is seral to spruce-fir (Hoffman and Alexander 1976; Jones and Ogle

2000). Approximately half of the 385,000 acres of lodgepole pine on the Forest may be seral, indicating some fluctuation over time in the amount of spruce-fir in response to disturbance processes, succession, or vegetation management practices.

There are approximately 9,400 acres (less than 1% of the Forest acres) of aspen on the Forest. Aspen provides an abundance of forage for many species due to the moister sites it typically occupies, its quick growth, and its higher-than-average number of snags and cavities for some species due to the amount of diseases and pathogens associated with the covertype. A greater diversity of understory vegetation also contributes to the biodiversity value of aspen. Aspen have been noted to be in decline in many areas of the West from the following factors:

- Conifer succession from a lack of fires resulting from more active fire suppression and a lack of fine fuels available from livestock grazing.
- Possible climate changes.
- High levels of ungulate browsing suppressing regeneration (Bartos 1998).

Aspen on the Forest may occur as a climax or as a successional part of the landscape, depending on soils and surrounding vegetation. It is not clear if any aspen has been "lost" on the Bighorn NF, however there are many areas where conifer succession is taking place and areas where ungulate browsing is retarding regeneration and productivity of sites (Knight 2003). Aspen have been a focus of management effort for the past few decades, though the amount of treatments has not been enough to cause widespread changes in the current condition of the covertype on the landscape; there is still a lack of young aspen stands on the Forest.

Other habitat types of interest in the Big Horn Mountains include alpine meadows, cliffs, and caves. Alpine meadows support a diversity of plants and associated pollinators despite a short growing season. This covertype may be undergoing some loss due to the amount of recreation use in the wilderness, among other factors. Cliffs and caves are a function of the geological formations and provide for unique habitats for associated plant or animal species. Cliffs and caves are largely unchanged from historical conditions, though recreation use has altered some, such as a reduction of use by bats in highly visited caves, or potential rock climbing disturbance at some popular cliff sites. Under the definitions in the 1988 Cave Management Act, four "significant" caves have been designated on the Forest, all on the Tongue Ranger District. Several other caves on the Forest may provide habitat for bats and may be considered significant but have not been evaluated. No gating or other restrictive management actions are in place for these caves. Cliffs are important for nesting raptors and some rare plant species that can be sensitive to recreation disturbance including rock climbing, which is currently a minor use.

Current threats to covertypes include introduction of non-native species (e.g., white-pine blister rust and noxious weeds) and development. Non-native agents changes the native composition of the covertypes beyond what has taken place historically. Refer to the insects and disease, and noxious weeds sections for more information on these

subject. Most of the limber pine covertype will have been killed from the white pine blister rust in the next two decades, which may impact some wildlife species dependent on them. In the Terrestrial Assessment (Regan et al. 2003), road and urban development patterns were evaluated against covertypes. Aspen and willow (riparian) covertypes also contain a high percentage of travel routes.

Ecosystem processes and composition may also be influenced by changes in plant and animal species that shape the systems and disturbance processes. The introduction of non-native fish species affects the ecological functions and composition of aquatic ecosystems. The current lack of beaver also affects runoff and disturbance processes in aquatic ecosystems. The lack of certain extirpated large predators such as wolves and grizzly bears may be influencing upland ecological functions.

Thousands of species are tied to the habitat features described above, including plants and animals, both terrestrial and aquatic. Due to the interspersion of many different habitat features, the Forest provides a unique setting for many species found within the Rocky Mountains, Great Plains, and Great Basin ecotypes. No single species unique only to the Big Horn Mountains has been identified, though unique subspecies occur due to the isolated geography of the Big Horns.

Environmental Consequences
Composition

Direct and Indirect Effects

In considering direct and indirect effects to resources resulting from Forest Service management activities, only those activities with the potential to cause a measurable or substantial change are described. For example, minerals and special use activities are not anticipated to have a substantial affect on Forest resources because these activities are a minor component of overall management activities on the Forest and they are not expected to increase during the planning period.

Under all alternatives, climatic and biological processes will continue to influence the composition of the Bighorn NF. The occurrences of the major covertypes are relatively constant over historic time frames. The current abundance and distribution of major covertypes and vegetation composition are generally within HRV (Knight 2003), with noted exceptions where noxious weeds or other non-native species (e.g. blister rust) have altered it. Composition changes following disturbances can last for varying amounts of time depending upon the severity of the disturbance. For example, severe wildfire disturbances, insect and disease, or blowdown in spruce-fir ecosystems can change composition for hundreds of years following the disturbance, though eventually a spruce-fir stand will be reestablished. Other types of disturbances create composition changes that last only for a few years. Refer to the wildfire and insect and disease sections in this chapter (3) for more information. The following management activities

have the potential to introduce or increase spread of noxious weeds, which are the most likely element to cause a change in composition of vegetation types currently on the Forest.

Effects from Livestock Grazing: Grazing by both livestock and wildlife is a disturbance agent to the herbaceous cover. Its exact effect on composition depends on a number of factors, including the amount of grazing, timing, seral stage of the area, and other environmental parameters. Most changes to composition on the Forest, including the expansion of Kentucky bluegrass in riparian areas, noxious weeds, and other effects associated with livestock grazing have occurred from higher use levels of livestock in the past. Grazing retards the growth of herbaceous and woody cover if done in excess, and thereby slows progression of seral stages following disturbances. Trampling can also disturb soil or ipact plant growth. Most effects from livestock grazing are evident in riparian areas and, to a lesser extent, in meadows and aspen sites. from

There will be few changes in the composition or the amount of riparian areas. The composition of vegetation within riparian areas will trend towards species and life forms (trees and large shrubs) associated with later successional stages. Standards and guidelines limit activities adjacent to riparian areas and wetlands, including amount of livestock use. Changes have been made in forestwide direction to address cumulative effects of livestock and wildlife grazing to plant species composition; desired vegetation conditions are addressed at the site-specific or project level. The effects of livestock grazing on vegetative composition does not vary by alternative because livestock grazing does not vary by alternative. Grazing conducted according to forest plan direction should result in a positive change in vegetative composition from past conditions. For a description of past, current, and future livestock grazing levels, refer to the Livestock Grazing section in this chapter; for additional vegetative effects, refer to the Rangeland Vegetation section.

Effects from Timber Harvest and Fire Management: Timber harvesting and/or prescribed fire can emulate natural disturbances in that they change or remove the dominant vegetation and provide for the growth or establishment of other vegetation. Overall, there are no long-term changes to composition as regeneration occurs and matches pre-existing composition. The amount of vegetation manipulated through timber harvest varies by alternative, as described in the following discussion of habitat structural stages. from timber harvest and fire management

The largest effect to composition would be from natural disturbances including fire, insects, disease, and blowdown. These disturbances would affect all vegetation types by restarting seral progression. For forested vegetation types, refer to the habitat structural stage discussion below. Prescribed fire would continue to be conducted primarily in shrub covertypes. In non-forested vegetation types, many plant species are adapted to fire occurrence and would thrive from the effects of fire. Other species would need time to reestablish. Under Alternatives B and C, more land would be managed with wildland and prescribed fire as the primary disturbance agents.

Alternative D would be similar to existing levels of this type of management, and Alternatives A and E would have the least amount of this type of management and more commercial timber harvest to manipulate forested vegetation. In the past, harvested areas were sometimes revegetated with species not present originally. This practice is no longer used. Timber harvest areas are now planted with the tree species that occur on the site naturally.

Aspen management would be emphasized in all alternatives. However, due to past funding history and priorities, and expense involved in protecting aspen from browsing, it is unlikely enough aspen would be treated with regeneration treatments to counteract maturing forest conditions. A total of 20 acres per year may be treated with regeneration harvests (e.g., canopy thinning, conifer removal, and clone fencing) over the next planning period in Alternatives B, D, and E versus 10 acres likely in Alternatives A and C. This is considerably less than the 150 acres per year needed to maintain aspen on the Forest in a more balanced age class distribution. Limited road networks may limit treatment of this resource as costs rise considerably when access is considered. Livestock and wildlife browsing impacts would continue to be addressed through small site-specific projects. Wildfires and prescribed fires may help regenerate stands and control succession in some instances, though there may be insufficient fine fuels in aspen stands to carry fires. For the next planning period, management emphasis (other than regeneration treatments) will likely focus on removing conifer encroachment. Up to several hundred acres per year could be treated with this practice. Herbivory impacts would likely continue to retard aspen regeneration. In addition, both harvesting activities and fire management activities can provide conditions for the establishment or expansion of undesirable or non-native vegetation

Effects from Recreation and Travel Management: Roads and trails have change vegetation composition by removing existing vegetation and altering soil structure. For a description of existing and future road and trail networks and densities, refer to the travel management section of Chapter 3, and to the connectivity/fragmentation discussion below. Roads have been constructed primarily to harvest timber on the Forest. They are generally constructed in the less steep terrain and in open covertypes (sage, grass) when possible due to ease and cost of construction. Hiking trails largely follow riparian areas, are narrow (2' wide), and are typically constructed for recreation purposes. Less than 3 miles of new hiking trail are anticipated in the next planning period, while most trail maintenance will involve reconstruction or other activities. There would be anticipated reductions in overall road densities in Alternatives B and C and increased levels of road densities in Alternatives A and E. If Piney and Rock Creek areas are roaded in Alternative A and E, this would significantly increase road densities. Road densities in Alternative D would remain similar to current levels, with small increases. Approximately four miles of road per year would be decommissioned under all alternatives, allowing some areas to regenerate to pre-existing covertypes. Where new roads cross streams, there will be some disruption or loss of aquatic vegetation and function. The required use of best management practices limits the effects of stream crossings. from recreation and travel management

Alternatives E and A would likely have some impacts to spruce-fir due to timber harvest activity. These alternatives would have with minimal impacts on riparian (road crossings) and likely minimal, if any, impacts to aspen. However, none of the impacts would likely cause a loss or decline of the cover types. The total miles of road and acre equivalents of anticipated road development by alternative are displayed in the table below. Approximately 90% of these roads would be closed following construction and use. However, some loss of vegetation communities would occur associated with the acreage impacts. The acre figure estimated was from an assumed 16-foot road prism. Under Alternatives A and E, primary access roads into the Piney/Rock Cr. areas would remain open for motorized vehicle travel for the purposes of this analysis. This would represent a substantial change over current conditions. The roads considered in this analysis are forestwide estimates derived from timber modeling.

Table 3-23. Anticipated road construction for the Bighorn National Forest by alternative for the first decade.

Alternative	Miles of Road/Acres
A	46 miles/ 89 acres
B	28 miles/ 54 acres
C	11 miles/ 21 acres
D	24 miles/ 47 acres
E	36 miles/ 70 acres

In addition to management-created roads, roads created by recreationists continue to be of concern. These user-created roads do not typically affect composition as much as system roads, as they tend to be limited to tire tracks, though watershed effects (e.g., erosion and sedimentation) also accompany these roads. An effect that is directly proportional in relative magnitude to the amount of road construction anticipated in the table is that people and vehicles on open motorized routes are a vector for spreading invasive species (e.g. noxious weeds).

In addition to roads, dispersed recreation campsites affect composition by removing vegetation on the site; sites are typically in riparian areas or in meadows on the edge of timber stands. This type of use would probably increase, though new emphasis on managing these types of sites applies to all alternatives. This problem occurs in both wilderness areas and in motorized recreation areas, so there would be no likely differences among alternatives. Developed sites (campgrounds, lodges, summer cabins, etc.) have also caused a loss of habitat or a change in original composition, though there is no increase in this type of activity anticipated in the next planning period. In addition, there can be effects to vegetation resources from winter motorized recreation activities. A summary of this information occurs in the wildlife section of Chapter 3, but also applies to vegetation resources.

With regard to caves, recreational activity would continue, possibly impacting some caves, though there would be no "loss" of caves. However, development and implementation of management plans for these resources has also been identified as a strategy in the Revised Plan. Where significant damage or safety considerations exist, some caves may have restricted access applied. Caves serve an important role in providing habitat for rare bats and other species. Of typical concern for caves are the effects of above-ground activities, including road construction and vegetation management (grazing, fire, timber harvest, etc.). As most of the cave resources are located on the steep faces near the Forest boundary, there are few, if any, above ground activities anticipated for these areas that would have the potential to affect these resources, though plan direction was included to address this potential in projects. It is assumed that vegetation management largely mimics what would occur naturally, but road construction would not. As discussed above, there would be more potential for additional roads in Alternatives A and E as compared to other alternatives.

Cumulative Effects

In general, the analysis area for cumulative effects to biodiversity composition would include the Bighorn NF and the land immediately adjacent to it within approximately 3 miles. Trends applied to the larger Big Horn Mountains ecosection are noted below. Cumulative effects include past, present, and reasonably foreseeable (planning period) projects, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for biodiversity composition, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions, highway widening, and increased recreation use (OHV, demographics) are most significant.

Alternatives E and A have the highest potential for additional road construction and would be more likely to introduce additional noxious weeds than the other alternatives. All the alternatives contain management direction to limit this affect, however, the risk increases with the amount of ground disturbance. Forestwide direction requires the use of native vegetation during revegetation efforts for projects. This would help minimize expansion of non-native species and/or weeds to prevent a loss of native composition of vegetation. Under all alternatives, noxious weeds are likely to keep expanding their range. This expansion would be most significant in riparian areas or grassland sites.

Noxious weeds and non-native vegetation (e.g. cheatgrass) would also likely continue to expand on lands adjacent to the Forest, possibly creating larger seed sources and opportunities for expansion onto the Forest. Dispersal vectors of most significance include roads, recreation use, livestock, and wildlife. Losses of vegetation composition could also result in losses of species such as pollinators and other wildlife tied to the affected vegetation. Efforts at coordinating prescribed burning with adjacent landowners or managers have increased in recent years to prevent excessive changes of habitat types or structure.

Increases in road or trail development would also be a significant impact to any vegetation or other covertype on the Forest in the next planning period. User-created roads from dispersed recreation would likely continue to increase regardless of alternative, though likelihood is higher in alternatives with additional road construction. New roads that are constructed and are not planned for decommissioning or closure would represent a loss of composition elements. Other than planned expansion of the Highway 14 corridor above Dayton, there are no additional highway losses anticipated. It is likely that road densities adjacent to the Forest would continue to increase through urban development or other resource uses, making the integrity of the vegetation composition on the Forest more valuable.

The loss of extensive acres of limber pine is expected to continue because of the non-native white pine blister rust. While the Forest is collecting seed from resistant trees, it is expected that 90% of the limber pine will be killed from the rust within the next 2 decades. Trends of this effect would be similar for the lands adjacent to the Forest, and for the entire Big Horn Mountains ecosection.

Aside from noxious weed impacts, riparian areas would likely continue to improve in quality in terms of vegetative composition and structure over time. This is primarily related to the application of livestock grazing standards and guidelines, and other forest-wide direction listed in the riparian section of the Revised Plan. Improvements in riparian areas have been demonstrated for at least the past decade on the Forest at the project scale in terms of both improved livestock administration and in terms of watershed improvement projects. Riparian areas off the Forest may degrade in comparison to the Forest through urban development or other land uses, placing a higher value on this type on the Forest. The Forest also has the bulk of the montane riparian component of the Big Horn Mountain ecosection, indicating trends on the Forest would affect or represent the larger area.

Impacts to other community types or composition elements, including aspen, spruce-fir, cliffs, and rock would not be measurably impacted by the alternatives, nor cumulatively. Planned management will change vegetation covertypes similar to historic processes.

Effects of water depletion on riparian system function and vegetative composition may increase if municipalities request additional reservoirs or diversions. However, many municipalities are also utilizing wells drilled off the Forest for their water needs. There would not likely be any additional depletion from the Forest attributable to agricultural diversions or facilities needs on the Forest. Refer to the Aquatics section of Chapter 3 for further discussions on aquatics and riparian impacts.

Together, these uses indicate an increased value in the less developed condition of the Forest in terms of retaining composition elements. In considering the above cumulative effects, there is some risk to biodiversity from a reduction in composition (weeds, limber pine, etc.), however the impacts in the next planning period are estimated to be localized from weeds rather than widespread, and it is anticipated that rust resistant limber pine will also emerge as dominant over time. It is estimated that existing natural

processes will allow the composition elements to continue to function across all alternatives.

AFFECTED ENVIRONMENT
HABITAT STRUCTURE STAGES

Forested ecosystem elements are created in the interplay of succession and disturbance. Succession is a process of biotic community development that involves changes in species, structure, and community processes with time. It is reasonably directional and, therefore, predictable (Schwarz et al. 1976). Forested stands develop recognizable stand structures over time. This structure can be described in terms of the horizontal and vertical distribution of components including height, diameter, crown layers and stems of trees, shrubs, herbaceous understory, snags, and down woody pieces (Thomas 1979).

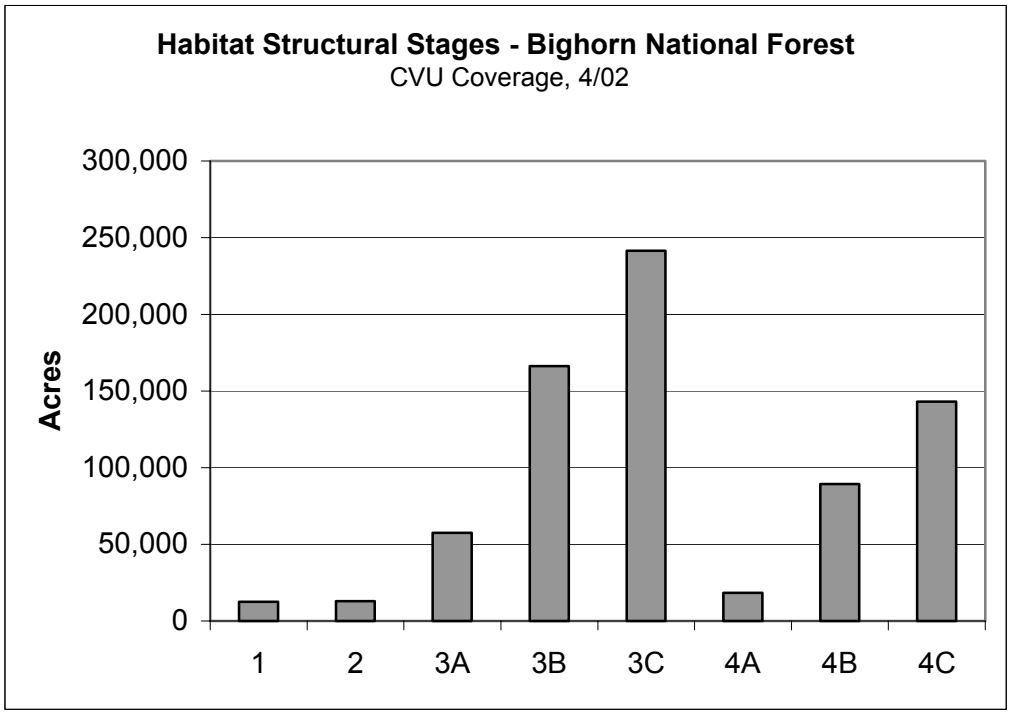
Different arrangements of these components provide different habitat for wildlife (Edgerton and Thomas 1978, De Vos and Mosby 1971). Combinations of these components were identified as habitat structural stages (HSS) for forest covertypes by Hoover and Willis (1987), and range from HSS 1 (grass/forb) to HSS 5 (old growth). The following table describes the characteristics of HSS; HSS 5 is discussed separately below.

Table 3-24. Habitat structural stage definitions, Hoover and Wills (1987).

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

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, nor does structural stage 2 include naturally occurring shrublands. Though the Forest’s CVU database assigns structural stages to grass and shrub vegetation types, the areas where this is a successional stage to future timber types carry a “T” (timber) designator. The following figure shows the distribution of structure stages for all forested covertypes on the Forest.

Figure 3-4. Habitat structural stages on the Bighorn National Forest.



As is shown in the figure, the Bighorn NF is dominated by the SS 3 size classes. This is primarily due to fires in the latter part of the 1800s and to timber harvest in the 1960s. The burned areas have grown into pole-size (5-9" diameter) stands; the harvested areas have regenerated in sapling size (1-5" diameter) stands. Structural stages also vary geographically. In Piney/Rock Creek area, past fires have resulted in almost entirely pole sized stands (SS 3); in Shell Canyon approximately 60% of the stands are in a mature (SS 4) condition. There are also differences among covertypes; for example, lodgepole pine and Douglas-fir stands have a high proportion of SS 3 compared to spruce-fir. Lodgepole pine is a fire-adapted species which regenerates in densely stocked stands following disturbance. Many of these stands become stagnated at the pole size and are regenerated by another disturbance prior to reaching more mature stages. For additional discussion of structural stage distributions by covertype and by geographic area, please refer to the forestwide and geographic area assessments completed for the plan revision and the administrative record. The following table describes the distribution of structural stages by covertype at the forestwide scale. Early, intermediate, and mature stages represent the totals of those stages above them as a percent of the total acres.

Table 3-25. Acres in each Habitat Structural Stage by covertype for Bighorn NF (2002).

HSS	Spruce-fir	Lodgepole pine	Douglas-fir	Ponderosa pine	Aspen
1	0	4,260	0	0	0
2	2,015	9,023	188	0	119
Early	1%	4%	0%	0%	1%
3a	27,091	13,173	7,149	1,060	1,892
3b	49,840	78,178	22,674	5,636	3,406
3c	4,7848	157,432	30,377	4,053	529
Intermediate	53%	71%	60%	57%	62%
4a	8,601	4,292	2,388	1,118	1,163
4b	37,352	30,954	12,270	4,768	1,817
4c	62,007	53,008	25,249	2,074	474
Mature	46%	25%	40%	43%	37%
Total Acres	234,754	350,320	100,295	18,709	9,400

The 1985 Forest Plan had direction to maintain 5% of Diversity Units (approximately 5,000-acre areas) in the grass/forb structure stage (SS1) and 5% in the old growth stage. While the Forest is likely meeting this past old-growth direction, it is not meeting the early seral condition direction. Both percentages were estimated to be of benefit for ecosystem processes and wildlife needs.

There are no acres currently defined as HSS 5 (late-successional/old growth) in the Forest's CVU database as that type of rating could not be obtained through aerial photo interpretation. With regard to late-successional forested stands (HSS 5), documents prepared as part of the forestwide assessment describe the current knowledge of the amount and distribution of this resource, as well as future management recommendations (see the administrative record for a more complete discussion). There has been a limited amount of inventory to determine the amount and distribution of old growth on the Forest. Inventory has largely been completed in the Clear/Crazy geographic area, resulting in approximately 7% of the area identified as old growth, though this area has experienced significant changes from timber harvest and wildfire. On a forestwide perspective, available data comes from stand exam (inventory) data on approximately 40% of the forested acres. Old growth inventories (scorecards) have only been conducted in small project areas in response to desired vegetative treatments, the exception being the Clear/Crazy effort. From stand origin dates (when the stand

was regenerated) and current knowledge of 4C structural stages in roadless areas where timber harvest has not occurred, it is estimated that approximately 10-15% of all the forested acres on the Bighorn NF would qualify as old-growth. The following table displays the description of old growth by covertype. Some covertypes (limber pine, juniper, and cottonwood) were not described due to their low occurrence on the Bighorn NF, historically and presently, and lack of management in these types.

Table 3-26. Old growth descriptions by covertypes.

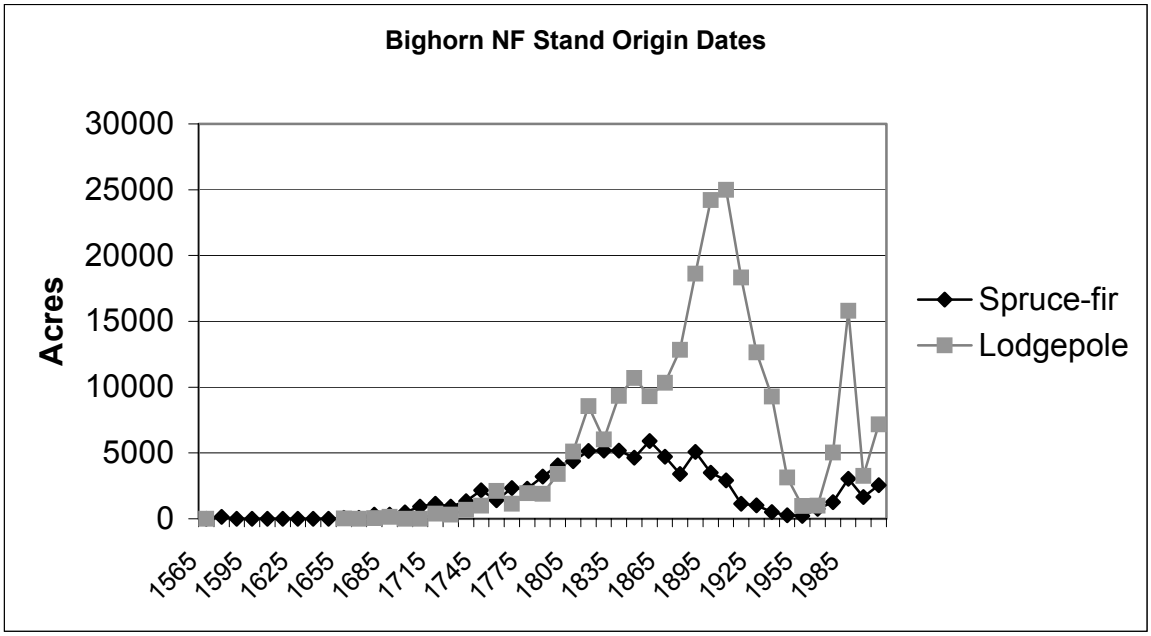
Covertype	Age of Largest Trees	DBH of largest trees	Crown Cover %
Lodgepole	150	10 tpa > 10 inches	≥ 1 canopy layer
Spruce/Fir	200	10 tpa > 16 inches	>1 canopy layer
Ponderosa Pine	200	10 tpa > 16 inches	≥ 1 canopy layer
Douglas-fir	200	10 tpa > 18 inches	≥ 1 canopy layer >50% cover
Aspen	100	20 tpa > 14 inches	≥ 1 canopy layer >50% cover

tpa- trees per acre, from (Mehl 1992)

Characteristics of late-successional stands vary according to the covertype as described in Mehl (1992). For example, late-successional conditions in ponderosa pine stands involve large trees in an open, park-like setting, while the same stage in spruce-fir involves large and small trees in a multi-canopied overstory and a diverse understory. One challenge in using habitat structural stages to describe forests is that there are no provisions for multiple canopy layers or numerous age classes within the same stand of trees (Hoover and Willis 1987).

Spruce-fir forests typically occupy higher elevations and wetter zones, causing a longer disturbance interval and allowing stands to reach a mature and old growth condition more readily than some lodgepole pine stands. However, most of the spruce-fir and higher elevation lodgepole pine types are in a mature condition. This indicates a lack of balance in presence of younger structural stages, though the covertypes are still within natural ranges due to the long fire return intervals. The current amount and distribution of structural stages has been the result of disturbance processes, namely the combination of wind, insects and disease, and wildfire. From the late 1800s to the early 1900s, widespread fires changed the forested landscape. The following figure illustrates the stand origination dates (date of disturbance that led to regeneration of a new stand) for the spruce-fir and lodgepole types on approximately 50% of the Forest. The dates can also be correlated to the above descriptions of minimum ages to attain old growth. The spikes in the data show the results of the widespread fires.

Figure 3-5. Forested stand origin dates for lodgepole pine and spruce-fir on the Bighorn NF.



Ponderosa pine occurs primarily at lower elevations around the edge of the Forest boundary. Most of the ponderosa pine is in mature structure stages with dense understories as a result of fire suppression for the past century. Douglas-fir occurs at higher elevations than above ponderosa pine and is similarly characterized by an abundance of mature conditions with dense understories. While also a result of fire suppression, the Douglas-fir is generally not out of HRV due to a more mixed fire return interval. Aspen is not abundant on the Forest and typically occurs on more mesic soils at mid-elevations. It is also represented by an abundance of SS 4. Limber pine, juniper, and cottonwood were not displayed due to their lack of abundance on the Forest. Refer to the project record to view the current distributions of structural stages by covertype on the Forest.

Disturbance Processes Affecting Structural Stages

Ecosystem processes are most influenced by the availability of water, in terms of both soil moisture and what is available in the atmosphere and in surface water. Disturbance processes such as fire, insects, and disease often fluctuate in response to water availability. Water is not evenly distributed on the Forest. High elevations are generally wetter than lower elevations. The “rain shadow” effect from high peaks also influences available moisture. This distribution of water influences the spatial pattern of aquatic and riparian ecosystems and influences soil types and associated vegetation covertypes.

Succession is slow in Rocky Mountain coniferous forests because of the short, cool growing season (Knight 1994). Decomposition is also limited by the cool and sometimes dry climate (Knight 1994). As much decomposition can occur under the snow as during the summer (Fahey 1983). Forest level growth, nutrient cycling, and decomposition processes have also been modified by land uses or disturbances.

The main disturbance processes of fire, insects, and disease affect all vegetation covertypes on the Forest creating changes in composition and structure stages, but these changes are most noted or most focused upon in the forested covertypes. Blowdown typically only affects forested vegetation and affects much fewer acres than fire, insects, and disease.

Fire is the most significant natural disturbance agent in high-elevation forests of the Rocky Mountains. Wildfire has been an important influence on the patch size and landscape structure, density, species composition and age of non-forested and forested vegetation throughout the Bighorn NF. Meyer and Knight (2003) report that "At higher elevation, fires were less frequent and the stands had a mixed fire regime, with both ground fire and stand-replacing fire occurring in the past; the structure and fire pattern of this forest is probably consistent with historic forests." The role that fire plays in an ecosystem is summarized by fire regime descriptions as described in the Fire and Fuels section in Chapter 3. Stand-replacing fires may be small or widespread in extent on the Bighorn NF. With the exception of ponderosa pine forests, fire suppression in has not currently altered fire return intervals, as long intervals are typical for higher elevation forests that comprise the majority of the Bighorn NF. As more low-elevation forested types occur in the remainder of the Big Horn Mountains ecosection, fire suppression has likely had a larger effect on altering historic patterns of structural stages and covertype composition than compared to the Forest.

Insects and disease are widespread over the Forest. Refer to the insects and disease section in Chapter 3 for further information. Bark beetles can act as a stand replacement process similar to fire, but at times may occur at low levels that affect small groups of trees and influence within-stand structure more than landscape structure. Changes in stand composition and structure can be changed relatively rapidly by insect attacks.

Native diseases mostly operate at the stand level and influence growth and structure of individual trees. Dwarf mistletoe is noted for reducing tree growth and ultimately the supply of forest products but also provides wildlife habitat structure not found in areas without mistletoe. Native disease works more slowly than insects and may take decades to change forest stand composition or structure. Non-native diseases such as white pine blister rust works much faster and has much more impact on the native species.

Engelmann spruce is affected primarily by spruce beetle (*Dendroctonus rufipennis*). Lodgepole pine is affected primarily by the mountain pine beetle (*Dendroctonus ponderosae*) and dwarf mistletoe (parasitic plants). Armillaria root disease has been observed on lodgepole pine, ponderosa pine, and subalpine fir, but is of minor concern on the Forest. Comandra blister rust has also been observed on lodgepole pine and

ponderosa pine but is also of minor concern. Western balsam bark beetle primarily affects sub-alpine fir. Aspen decline is due to a complex of lack of disturbance, fire suppression and replacement by other later successional species.

Blowdown extent and patterns are influenced more by topography and duration of wind events. Blowdowns have occurred in the recent past, including 1991, 1993, and 1997 where a combined total of approximately 4,000 acres of mature timber were blown over. This scale of wind incident is historically rare on the Forest. Smaller events are more common. Some of the blowdown in forested stands are associated with the edges of timber harvest units or fires, where wind patterns have been changed by the removal of trees. Blowdown may also result in increased levels of insect and disease elements.

Timber harvest activities have occurred in approximately 18% of the forested acres on the Forest, though only approximately 3% of the forested acres have been treated with clearcuts (Regan et al 2003). Harvest systems other than clearcut do not affect structural stage distributions nearly as readily.

Alterations in stand structure affect habitat for plant and wildlife species. Some species are adapted to an open structure for at least part of their life cycle. Some animal species need a long line of sight for successful hunting; some rely on plants that need a sunny or open understory. Other species need large trees and snags in dense canopies for nest sites and winter roosts, or shaded growth conditions for certain plants. Some animals may use a combination of open forest for foraging and dense patches for nesting in close proximity.

ENVIRONMENTAL CONSEQUENCES
HABITAT STRUCTURE STAGES

Direct and Indirect Effects

Vegetation patterns across large spatial scales result from complex interactions between biotic and abiotic disturbances, processes, and constraints. It can be difficult to project the combined effects of these complex interactions over long periods of time due to the assumptions involved. For planning purposes, vegetation modeling did not include these more random and highly variable factors that will inevitably occur. Only management induced changes resulting from mechanical harvest were modeled. For the DEIS, there was no spatial modeling available on where anticipated effects would be located.

For each alternative, modeling was conducted to describe the likely projection of habitat structural stages over time. Projecting changes in vegetation structure and composition over time is an important part of predicting the environmental consequences of changes in the occurrence and distribution of ecosystem aggregates and in the maintenance of biological diversity from management area allocations. The contractor providing the information used the *Woodstock*© model (Remstock, Inc. Version 3.25), which allows

for growth and yield components of forested stands to be tracked spatially as one possible solution. Actual site-specific project implementation will likely be more detailed and may be different than the solution the model predicted. The existing CVU GIS database was used as a baseline for this modeling effort. Constraints were applied to the model to reflect forest-wide standards and guidelines, as well as management area prescriptions and their corresponding emphasis. For determining availability of commercial timber products, only those acres suited for timber production (see glossary) within management prescriptions 5.11, 5.12, 5.13, 5.4, and 5.5 were included. Refer to the project record for additional details on this modeling.

There are no anticipated effects from minerals management or special uses or other programs on the Forest other than those listed.

Effects from Timber Harvest: Timber harvest directly alters the structural stage of forested covertypes, either in density, size class, or canopy cover. Several harvest methods are available to achieve silvicultural objectives, producing different effects. Shelterwood harvest maintains a mature canopy longer, as do selection harvest methods. Clearcut harvests create an immediate change to structural stage 1. Refer to the Vegetation and Timber sections in Chapter 3 for further information. Final harvests conducted for timber production objectives on suited timber lands are designed with an assurance of regeneration of within 5 years. This successful regeneration maintains covertypes and initiates the flow of successional stages over time. Different management scenarios emphasize or allow retaining forest structural elements within regenerated stands.

The following table illustrates the anticipated habitat structural stage distribution by alternative that is anticipated in conjunction with timber harvest at the 10 year and 50 year horizons. Modeling was conducted up to 150 years to ensure sustained yield of the timber component, which all alternatives met, but were not reported here due to the level of uncertainty given other disturbances such as fire and insects and disease that would likely affect structural stage distribution by this point in the future. Model results are only from predicted timber harvest, and do not include changes in structural stages that are possible from natural disturbances. Spatially, these changes would only occur where suited lands are designated. As forests mature, levels of insects and disease and fire would likely become the major agents of change resulting in changes in structural stages. Refer to the Fire and Fuels and Insects and Disease section for estimates of this type of activity. Model results are compiled for all forested acres. For more details on acres of structural stages by covertype (e.g. lodgepole, spruce/fir, ponderosa) or geographic area, refer to the administrative record. In the table, the early stage includes HSS 1 and 2, the intermediate stage includes HSS 3A-C, and the late stage includes HSS 4A-C and 5. Total forested acres used in the model were approximately 724,500. Variances in outputs are due largely to harvest method and acres of suitable timber as described in the timber products and forested vegetation sections within Chapter 3. Refer to the Timber section in Chapter 3 for anticipated HSS on suited lands.

Table 3-27. Acres of Habitat Structural Stage by alternative at 10- and 50-year periods.

HSS	Alt A	Alt B	Alt C	Alt D	Alt E
Early (1 and 2) 10 years	12,032 1.7% of total forested acres	10,521 1.5%	9,763 1.3%	10,389 1.4%	13,712 1.9%
50 Years	12,093 1.7%	12,339 1.7%	2,896 0.4%	14,962 2.1%	23,975 3.3%
Intermediate (3A-C) 10 yrs.	446,063 61.6%	449,469 62.0%	448,923 62.0%	449,062 62.0%	448,765 62.0%
50 Years	279,406 38.6%	275,716 38%	273,223 37.7%	277,517 38.3%	289,502 40%
Late (4A-C) 10 Years	182,180 25%	181,443 25%	181,651 25%	182,013 25%	179,287 24.7%
50 years	348,776 48%	353,378 48.8%	364,218 50.3%	348,985 48.2%	328,288 45.3%
Old Growth (5) 10 Years	84,164 11.6%	83,108 11.5%	84,173 11.6%	83,073 11.5%	82,630 11.4%
50 Years	84,164 11.6%	83,108 11.5%	84,173 11.6%	83,073 11.5%	82,630 11.4%

Under all alternatives, model results indicate that without fire or other natural disturbances, there will be very little change from current conditions as a result of timber harvest activities at the forestwide scale.

In Alternatives A and E, there is some risk of not retaining enough old growth due to increased levels of harvest. Under Alternatives A and E, less than 30% of the total forested acres is suited for timber production. Modeling of potential harvest levels included the old growth parameters. Under all alternatives, the model indicated that the lack of timber harvest activity would result in an increase in the amount of habitat structure stages 4a-5. The increase is less pronounced under Alternatives A and E; however, it may be difficult to meet or maintain younger seral stages under all alternatives, as no alternatives meet the desired condition of 5% young seral stages by geographic area.

In some areas, timber harvest and the resulting changes in habitat structural stage may improve resiliency to natural disturbances. For example, where timber harvest is employed, wildfire severity may be reduced due to less fuel loading. However, experience on the Forest has shown that roads constructed for timber harvest may provide additional fire starts from recreation use and do not provide barriers to fire spread during intense stand-replacing fires due to spotting potentials of forested covertypes, and the high wind usually associated with larger fires. Roads improve

firefighter access; however the improved access may increase the risk of human-caused fires as well.

Effects from Disturbance Processes (Fire, Insects and Disease, Blowdown): For all alternatives, the combination of wildfire, insects and disease, and blowdown would continue to be the most significant disturbance events influencing regeneration of forested covertypes and causing differences in habitat structure stages. These largely random events were not included in the effects analysis modeling conducted as part of the plan revision. However, fire probability modeling indicates a 75% chance of fires consuming more than 5,000 acres on the Forest in the next 10 years. This could be in addition to insect and disease outbreaks and blowdown, though they are often interrelated.

Wildfire would likely be more extensive in alternatives emphasizing natural processes, such as C and B. Wildfires and insects are both influenced by stand structure and drought. Since many of the existing forest stands originated between 100-150 years ago, there is potential for large-scale events over large areas of the forest during extreme climatic conditions (Brown et al. 1999, Romme and Knight 1981, Veblen et al. 2000).

Alternatives A and E have the greatest number of acres where direct fire suppression would be used and where insect and diseases would be managed. Conversely, Alternatives C and B would have more acres where fires are allowed to burn to accomplish resource objectives. Similar suppression efforts for insects and disease would accompany the fire suppression efforts, as stands managed for commercial timber products would have active management against these agents. There would be a difference in resilience or treatment of blowdown with Alternatives C and B having more acres where natural processes are the dominant force, and salvage would not occur at the same level as Alternatives A, E, and D.

Prescribed fire is largely conducted in non-forested covertypes, though an increasing amount of forested covertypes are being treated in the past few years. This is evidenced by projects such as Pete's Hole and the Little Bighorn prescribed burns. These burns did not target forested stands that are considered suitable for commercial timber products.

Blowdown is a random event, though typically mature stands are more affected than young stands of trees. Blowdown has the potential to occur within the next several decades, though would likely be at a scale of hundreds to a few thousand acres.

With regard to old growth seral stages, plan direction was updated to include double to triple the amounts of old growth managed for compared to the 1985 plan, largely in response to species viability concerns, and from information in the Terrestrial Assessment (Regan et al. 2003; Romme 2002). Ten percent would be sought for most forested covertypes and 15% for spruce-fir. Because old growth typically has higher fuel loads and stands with little resistance to the disturbances, natural disturbance processes would be the dominant influences. Plan direction for early seral conditions was retained, though modified to include both grass/forb and seedling/sapling stages

(SS1 and 2) rather than just the grass/forb stage (SS1), as the timeframe of transition from stage 1 to 2 is relatively short (10 years). Young seral stages provide a balance of structural stages on the landscape for species and ecosystem process functioning. Plan emphasis for the next planning period will be to obtain an inventory of old growth structure stage for use in planning and evaluating projects.

Effects from Livestock Grazing: Livestock and wildlife use of forage may affect the regeneration of forested covertypes by impeding or delaying progression to more mature conditions if seedlings or saplings are consumed or damaged. This impact is addressed through forestwide standards and guidelines for livestock grazing, and current effects are anticipated to be reduced over time through application of these measures. Wildlife effects to this resource are not directly manageable, though WGFD population objectives do consider carrying capacity. Ungulate grazing may also impact stand composition and structure by reducing the availability of fine fuels for fires. This is most noted in aspen stands, though it can also affect the edges of meadows and conifers where fire spread between stands may be reduced. This effect has not been quantified on the Bighorn NF, though is thought to be of significance.

Effects from Recreation and Travel Management: The effects of recreation (primarily dispersed) activities are negligible at the forestwide scale, and was not considered in the growth and yield modeling. At the site-specific/stand scale, recreation activities may impact regeneration of forested stands by suppressing young trees and even damaging mature trees.

Roads result in the direct removal or loss of forested vegetation. The loss of vegetation attributable to roads was not considered in the growth and yield modeling, as the loss is typically minor and along narrow, linear corridors that can be all but overshadowed by tree canopies.

Cumulative Effects

In general, the analysis area for cumulative effects to biodiversity composition would include the Bighorn NF and the land immediately adjacent to it within approximately 3 miles. Trends applied to the larger Big Horn Mountains ecosection are noted below. Cumulative effects include past, present, and reasonably foreseeable (planning period) projects, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for habitat structure stages, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions, highway widening, and private land vegetation management are most significant.

Historic forest management activities and land uses that have changed structure stages include timber harvest, road construction, recreation site development, reforestation, and fire suppression. Historic timber harvest has primarily replaced older mature forest stands with younger stands creating early seral structure stages similar to natural succession.

All alternatives would result in a range of structural stages within the HRV, as this range is so broad in terms of number of acres by structural stage. As the Forest represents the bulk of the forested acres for the Big Horn Mountains ecosection, this would indicate that structural stages in ecosection would also remain within the HRV. Timber harvest on lands adjacent to the Forest would continue and affect structural stages and potential for natural disturbance agents. This is primarily focused on a scale of hundreds to a few thousands of acres on the southeast corner adjacent to the Forest, small areas along the west end of the Forest, and off the north end of the Forest on adjoining tribal lands.

Human-caused wildfire on adjacent land would have the potential to spread on to the Forest and change habitat structural stage. The spread of insects and disease from adjoining lands on to the Forest is not likely to be factor influencing habitat structural stages of forested vegetation.

AFFECTED ENVIRONMENT
FRAGMENTATION AND CONNECTIVITY

Fragmentation: The alteration or reduction of patch sizes of covertypes from the HRV, or fragmentation, has become a management issue on many national forests in the Rocky Mountains. It can be described as "human caused discontinuities" in natural landscapes (Knight et al. 2000). Fragmentation also occurs in aquatic systems in the form of dams and diversions, as addressed in the aquatics section. This section will refer to terrestrial vegetation elements only. Fragmentation can be caused by roads, vegetation treatments, land ownership patterns and associated uses, and development. The existing patch size, connectivity of patches, and the amount of edge within the patches are the result of historical natural process and disturbances as modified by land uses in the more recent past and foreseeable future.

Most research on this topic has occurred where human uses have caused a permanent change in the land use or covertype. Examples include subdivision/urbanization, conversions of timber or grass/shrub to agricultural land, or wide interstate highways. The land management practices on the Bighorn NF are typically considered "perforation," which temporarily changes forest successional stage but keeps the area in a forested covertype. Roads on the Forest are typically narrow, generally native surface and are thought to affect a narrow range of species and processes for all vegetation types. Although fragmentation will be the term used throughout this section, it is important to note the difference in terms or impacts normally described in the literature.

The Bighorn NF is a naturally fragmented compilation of covertypes. There is a high degree of natural interspersion of forested vs. non-forested covertypes, though the type, amount, and extent of each differs by soil types, moisture regimes, and disturbance processes throughout the Forest. The following table displays the ranges of forested to non-forested covertypes that are possible at the geographic area and forestwide scale.

Where fires or harvests have occurred in forested areas, these areas are still classified as forested, as the soil types would lead them to regenerate similarly.

Table 3-28. Forested and non-forested acres at the geographic area and forestwide scale on the Bighorn NF.

Scale of Analysis	Acres	Percent Forested	Percent Non-Forested
Bighorn NF	1,107,670	66%	34%
Shell Geographic Area	140,130	49%	51%
Piney-Rock Geographic Area	110,255	79%	21%

Historic livestock grazing and fire suppression altered disturbance processes—fire—which generally resulted in larger patch sizes, particularly in the low elevation forested and all non-forested covertypes. In contrast, areas with roads and corresponding development (e.g., campgrounds, lodges) can break up the natural patch size in a permanent context. Timber harvest and prescribed burning alters successional stages of covertypes but is a non-permanent land use change. Current information on fragmentation and patch size was summarized in the forestwide assessment (see project record). Regionally and on the Forest, several research efforts have attempted to quantify fragmentation on forested covertypes.

Tinker et al. (1998) examined the effects of road building and clearcuts relative to core patch size at the watershed scale on the Forest. While documenting these landscape changes to forested systems, no correlation to effects on biodiversity were estimated. While core patch size was shown to be decreasing in response to treatments, there was no interpretation as to how this compared to natural fragmentation from disturbances.

Beauvais (1997) conducted research on mammal distributions relative to clearcuts, resulting in species associations to certain covertypes and structural stages. Changes in mammal community composition were described relative to the habitat changes, and recommendations were made to conduct additional clearcutting cautiously. Beauvais noted that thresholds of effects may not have been reached, but that older boreal forests should be maintained in such a state.

Merrill (1997) conducted research on avian diversity and species richness at various landscape scales on the Forest. This effort concluded "landscape heterogeneity [variation in covertypes] was generally a more important indicator of bird diversity than indices related to patch size or isolation or edge characteristics."

Knight et al. (2000) in their review of fragmentation on the forests in the southern Rocky Mountains, concluded that given a "lack of knowledge about the long-term effects of anthropogenic fragmentation ...., managers [should] be conservative and cautious when they contemplate new, intensive land uses for the 21st century." The terrestrial assessment (Regan et al. 2003) and the Historical Range of Variation (Knight 2003) similarly identified that patch size may be smaller than what historically may

have occurred, as clearcuts and other treatments have been more numerous and of smaller pattern than typical wildfires.

For the Bighorn NF, anthropogenic changes to covertypes are most concentrated in areas where more extensive road building has occurred. Ingelfinger (2001), in a study near Pinedale, WY, indicated that roads have an affect on the suitability of the habitat adjacent to them for certain avian species, demonstrating the potential for roads to create edge or fragment habitat. The acres in management prescriptions where road building might occur is the most useful indicator of possible fragmentation for the most species. Fragmentation modeling such as FRAGSTATS (McGarigal 1995) was not conducted due to the high amount of natural fragmentation on the Forest as described above, and from the existing research that has examined this subject on the Forest as described above.

It should also be noted that, since the 1970s, forested cover from timber harvest changed from larger clearcuts that more closely represented natural fire disturbances to smaller patch cuts that increased the amount of edge, all due primarily to changes in what seemed most beneficial for elk as the Management Indicator Species. Natural fragmentation within forested stands routinely occurs; for example, small fires from lightning strikes or insect attacks create small openings (0.1 – 5 acres) versus widespread fire or insect and disease epidemics that affect thousands of acres.

While reduction in patch sizes from roads has occurred in all vegetation types, the impact to forested covertypes is typically of the greatest research focus. The table below depicts the road density by geographic area for the Forest, an indicator of the amount of fragmentation that has occurred. Open roads include operational maintenance levels 2 – 5. Total road density includes the open roads plus closed roads (maintenance level 1) and user-created or unclassified roads. Road density figures *do not include wilderness or private lands* within the acreages figured. Trails were not included in these figures, and highways (14, 14A, 16 – 120 miles total) are only included in the forestwide figure at the bottom. Most roads have been constructed on flatter terrain and in non-forested community types on average due to reduce construction costs.

Table 3-29. Road densities in geographic areas on the Bighorn National Forest.

Geographic Area	Open Road Density (miles/sq. mile)	Total Road Density (miles/sq. mile)
Clear/Crazy Creek	1.3	2.2
Devil's Canyon	0.8	1.4
Goose Creek	0.9	1.2
Little Bighorn	0.5	1.2
Paintrock	0.8	1.5
Piney/Rock Creek	0.2	0.2
Shell Canyon	0.9	1.3

Geographic Area	Open Road Density (miles/sq. mile)	Total Road Density (miles/sq. mile)
Tensleep Canyon	1.3	1.7
Tongue Canyon	0.7	1.4
Forestwide	0.8	1.36

For some terrestrial wildlife species associated with these habitats, road densities of greater than one mile per square mile may be a threshold for suitability of use, depending on other factors (location of roads, topography, etc.).

With regard to timber harvest activities, less than 8% of the spruce-fir covertype and 33% of the lodgepole covertype have had timber harvest activities in them, indicating large acreages where landscape pattern has remained largely unchanged as compared to historic conditions. Areas harvested have also mostly included past tie hacking sites. Overall, approximately 20% of the forested acres on the Bighorn NF have had harvest activities in them (Regan et al. 2003).

Connectivity: Another aspect of fragmentation is the connectivity of patches—the degree to which patches have been isolated or cut off from other similar type patches. An example would be whether patches of old growth conifer are still connected by forested covertypes to allow dispersion of some wildlife species associated with this structure. On the Bighorn NF, connectivity of vegetation has been influenced, to varying degrees, by road construction, ski area development, utility corridors, livestock grazing, and land ownership. Timber harvest and wildfires have been sporadic in distribution, rather than continuous, allowing forested covertypes to persist within range of what likely historically occurred with minimal interruptions in continuity of covertypes.

Construction of primary roads, mainly objective maintenance level 3 through 5 roads (well developed graveled roads to highways) has reduced connectivity of patches, though there are no currently known significant effects to any species associated with those types of habitat. Highways through the Forest (14, 14A and 16) are currently of two-lane configuration with relatively low traffic volumes. The low traffic volumes and more narrow condition of these highways, they are not known or presumed to fragment patches and create barriers in migration patterns for species. Other National Forests have larger interstates and high traffic volumes that more readily contribute to formation of barriers and fragmentation effects to species distribution. Roads may also serve as dispersal routes for some wildlife and plant species, though there may not be habitat contained on the road itself.

Ski areas create a more permanent change in forested canopies and a potential reduction in connectivity as a result. The Bighorn NF has two small ski areas, with no likely addition of other ski areas. These two ski areas have had minimal impacts on connectivity or patch size due to their small size.

Utility corridors can impact connectivity and increase the amount of edge created. The existing utility corridors are comprised of low-voltage (less than 24 kv) electric lines and likely provide minimal amounts of disruption to connectivity as compared to more developed areas with larger utility corridors.

Land ownership and the associated management of it can also have an affect on connectivity and fragmentation. Land managed to differing intents can create more edge or affect patch size as well. The Bighorn NF has perhaps the least amount of private or state in-holdings of any National Forest in the Rocky Mountain Region, indicating a low level of potential for this type of effect.

The changes to connectivity and potential fragmentation have largely been associated with roads. As stated in Knight et al. (2000), additional research is needed to understand this effect, but managers should proceed cautiously with additional roading. They further summarized that it appears that no vertebrate or vascular plant species has been extirpated in the Rockies because of fragmentation, however long-term effects are unknown. Much greater impacts in terms of urban development and associated roads are occurring around the Bighorn NF, though given the rural nature of the four-county area, these impacts are considerably less than in other more urbanized area such as the Colorado Front Range. This is also supported in the Terrestrial Assessment (Regan et al. 2003), where over 90% of the Bighorn NF was found to have high or moderately high ecological integrity. High integrity was defined as having low road density, limited timber harvest activity, limited livestock use, limited occurrences of invasive species, low departure from historical disturbance regimes, limited high-impact recreation, and no utility corridors.

Environmental Consequences Fragmentation and Connectivity

Direct and Indirect Effects

Fragmentation and connectivity have been of increasing concern in recent years. Fragmentation is primarily addressed through patch sizes; both fragmentation and connectivity are characterized by permanent or temporary losses or changes in habitat from uses such as roads. Both components are difficult to measure, particularly in naturally fragmented, heterogeneous landscapes.

Effects from Timber Harvest and Travel Management: In all alternatives, timber harvest and associated road construction would create patches and fragmentation. This effect would be greatest in Alternatives E and A, followed by Alternatives D, B, and C respectively. Forestwide direction emphasizes creating patches similar to those created by natural processes. However, public acceptance of larger patch sizes generated from clearcuts may not allow for this.

Timber harvest type affects connectivity or fragmentation differently, clearcutting has the most dramatic effect on patch size and fragmentation. Current Forest direction limits the size of clearcut units to 40 acres or less, which perpetuates the smaller patch sizes. For some covertypes (e.g., lodgepole pine), this creates a pattern which is likely outside the HRV. Shelterwood and uneven-aged harvest types affect fragmentation and connectivity less; however, they also involve more entries into stands creating more disturbance over time as compared to clearcut methods.

An indicator of likely effects to patch sizes would be the anticipated levels of timber harvest and road building anticipated in each alternative. Refer to the previous section to view a table describing anticipated road increases, and refer to the forested vegetation section for tables showing anticipated timber harvest levels by alternative.

The acres affected overall by timber production in the most aggressive harvest alternative, E, would be less than 30% of the total forested acres (as indicated by suited acres). Actual timber harvest acres in the next planning period would be significantly less than this 30% due to economics and other factors. It is unlikely that timber harvest under any alternative would result in large enough changes in actual connectivity of habitat to be measurable, as vegetation changes, other than roads, are not permanent.

Though any additional road building would increase fragmentation over current levels, roads constructed for timber harvest are not typically large enough or have high enough traffic volume to measurable impact connectivity for most species. In addition, reductions in road density associated with projects may help offset some effects over time. It is estimated that approximately 4 miles of road per year would be decommissioned or reconstructed by alternative, largely in response to road maintenance backlogs and resource needs, and largely associated with user-created roads (not FS system roads).

The following table shows the anticipated total road densities (Level 1 – 5) by alternative at the forestwide scale, not including existing wilderness or private land. Also included are the current estimate of approximately 274 miles of user-created roads, though these would likely decline over time through rehabilitation and enforcement. As shown, there is little difference in road density between alternatives. Anticipated miles of road construction under each alternative are listed in Table 3-23.

Table 3-30. Forestwide anticipated road densities and road construction by alternative after the first decade projected on the Bighorn NF.

Alternative	Total Road Density (miles/sq. mile)
A	1.39
B	1.38
C	1.36
D	1.38
E	1.38
Current Condition	1.36

Effects from Disturbance Processes (Fire, Insects and Disease): Patch sizes created with prescribed fire are likely to be between those created by timber harvest and those created by natural processes. Patches created by prescribed fire would often be designed to emulate natural patch size shape and connectivity, however patch size would still be constrained by standards and guidelines for other resources such as riparian areas, recreation, and scenic resources. Anticipated levels of prescribed burning by alternative, including both forested and non-forested communities, are described in the following table.

Table 3-31 Acres of prescribed burning anticipated on the Bighorn NF.

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Forested	500	1,100	250	1,050	250
Non-Forested	2,500	3,000	1,500	2,500	2,500

Over time, natural processes (endemic levels of insects and diseases and small fires) would create numerous very small patches (<5 acres) and (epidemic levels of insects and stand replacement fires) would create a smaller number of very large patches (>1,000 acres). Since insect risk is medium high or high on more than 50% of the forested acres, and since insect damage is associated with population levels and drought cycles, it is possible that many of these high-risk acres would be attacked within the next 50 years.

Large stand replacement fires are associated with fuel loading and drought cycles. See the Fire and Fuels section for details. It is possible that many of these acres would burn in single year or in a series of drought years. The effects of wind can be greater where trees are already affected by root diseases. After wind events, spruce beetle epidemics can spread out from the blowdown. Wind events can also be followed by large-scale fire events that can create extensive areas of severely burned soil and vegetation from the loading of large fuels.

Natural processes that operate without control or suppression have the potential to create large patch sizes. In areas without roaded access, control and suppression actions are less often attempted and less often successful at limiting the size of patches created. Those alternatives (C and B) with the greatest emphasis on natural processes will, over time, have the largest patch sizes. Although the other alternatives with the greatest allocation to management category 5 would provide some management emphasis against these processes, it is also likely that natural processes will continue to dominate on the landscape, being the largest driver of patch size over time.

Effects from Special Area Designations: The addition of Research Natural Areas (RNAs) under Alternatives B, C, and D would provide opportunities to track natural patch size and impacts to connectivity and fragmentation. This opportunity would not occur in Alternatives A and E. In addition, RNAs help maintain high ecological integrity of composition (covertypes). However, RNAs have not been managed according to their intent, research, based on previous experience on the Bighorn NF.

Cumulative Effects

In general, the analysis area for cumulative effects to biodiversity composition would include the Bighorn NF and the land immediately adjacent to it within approximately 3 miles. Trends applied to the larger Big Horn Mountains ecosection are noted below. Cumulative effects include past, present, and reasonably foreseeable (planning period) projects, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for fragmentation and connectivity, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions, highway widening, vegetation management on adjoining lands, and increased recreation use (OHV, demographics) are most significant.

Fragmentation and connectivity impacts would likely continue to escalate on lands adjacent to the Forest through urban development or other land uses. This would place a higher value on retaining more historic patch sizes on the Forest to offset this effect. With the dominance of natural disturbance processes, there would likely be a strong element of this occurring, regardless of alternative. Departures from a more historic norm of patch sizes may occur through timber harvest activities on the Forest, which would be greatest in Alternatives E and A and less in Alternatives D, B, and C, respectively.

Highways can represent the largest possible potential for impacts to connectivity and fragmentation for the most species. There are no anticipated increases in major highways in the next planning period either adjacent to or within the Forest. Similarly, any development (e.g., through campgrounds, lodges, utility corridors, etc.) would remove habitat and increase fragmentation. There would likely be minimal to no additional permanent disturbances of these types on the Forest other than a possible rest area along Highway 16, and possibly a few additional hiking trails. These activities would occur regardless of alternative implemented.

In viewing the lands adjacent to the Forest and in the rest of the Bighorn Mountains subsection, it is also evident that the Forest has much lower road density than the surrounding areas. This may place an inherently higher value of lands on the Forest, both socially and from a resource standpoint, to take a cautious approach in increasing road densities on the Forest.

AFFECTED ENVIRONMENT
SNAGS AND COARSE WOODY DEBRIS

Snags and coarse woody debris are important forested ecosystem components; they provide habitat necessary for many species and help maintain soil productivity by adding organic matter to the soil horizon and maintaining the mycorrhizae crucial to the decay processes.

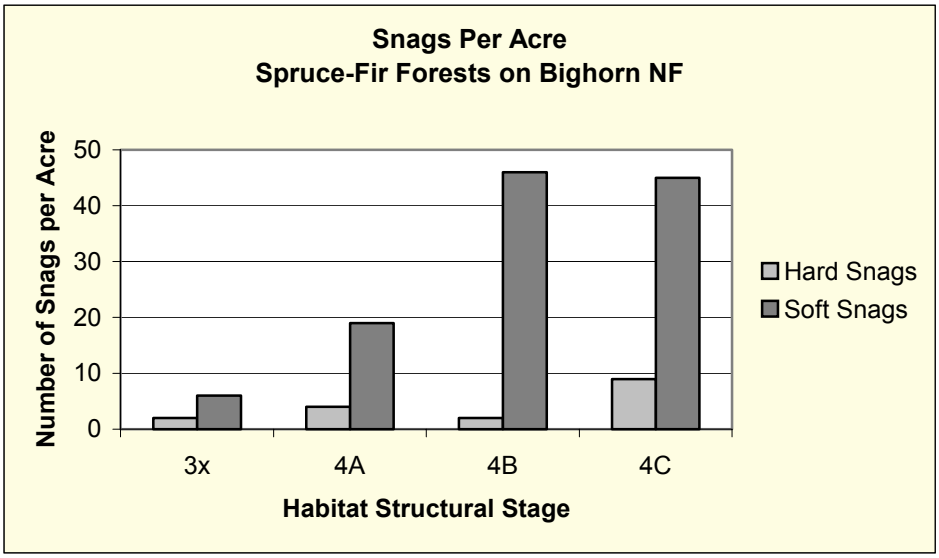
The existing levels of snags and coarse woody debris are the result of historical natural process and disturbances and human activities/uses. Snag residence time varies by climate and cause of mortality. For Englemann spruce in Utah killed by spruce beetle, 84% of the killed trees were still standing after 25 years (Lowery 1982; Mielke 1950). In a Colorado study for Engelmann spruce killed by spruce beetles, 8% of the snags had fallen after 10 years and 28% after 20 years (Lowery 1982; Hinds et al. 1965). For fire-killed lodgepole pine in Montana, very few snags fell the first 2 years after the fire; then for snags smaller than 3 inches dbh,[9] 28% fell each year. For snags 3 to 8 inches dbh, 8% fell yearly, and snags larger than 8 inches dbh had a sporadic rate with some predicted to stand indefinitely (Lyon 1977). Snags with a variety of "soundness" are desirable on the landscape, as some species require soft and others hard snags. Soundness is typically a function of the decay time. Typically the larger, taller snag are utilized by more species.

Activities that may reduce snag abundance include mechanical harvest, firewood gathering, fire, and wind. Though fires may consume snags, typically many more are generated if the fire is severe enough to kill portions of the mature canopy. In terms of snag size and abundance, the spruce-fir covertype produces the largest snags and the most per acre of any other covertype. Trees in lodgepole stands typically do not grow as large and burn more frequently than spruce-fir; Douglas-fir stands may be more similar to spruce-fir in abundance and size. The majority of the mechanical timber harvest activity has taken place in spruce-fir and lodgepole pine covertypes. However, these activities have impacted less than 20% of the forested acres. Mechanical harvest activities have occurred in less than 8% of the spruce-fir acres on the Forest, and approximately 33% of the lodgepole pine covertype.

[9] Dbh – diameter breast height; the diameter of a standing tree at a point 4 feet, 6 inches from ground level.

To evaluate the current amount of snags, an analysis of Stage II timber inventory data, was conducted. The following table illustrates the amount of snags by covertype and structural stage from these inventories, which are typically conducted in areas scheduled for harvest activities. The highest number of snags and largest diameter are typically attributable to spruce-fir stands, as they naturally produce larger trees and a greater abundance of snags, particularly where elements of insects and disease may be working. While this table indicates a range of 10-40 snags per acre in spruce-fir, levels of 5-30 snags per acre are more typical in lodgepole pine, due both to previous harvest emphasis and the natural potential for snags in the lodgepole type. Douglas-fir has a similar abundance of snags as the spruce-fir type.

Figure 3-6. Snags per acre in spruce-fir covertypes on the Bighorn National Forest.



Some snag-dependent species, such as three-toed woodpeckers, are more directly associated with spruce-fir, due primarily to prey association (spruce beetle). No species are known to be limited to only lodgepole pine snags. General direction in the 1985 plan was for 20 to 30 snags per 10 acres, and 90 to 110 snags per 100 acres, with sizes varying by covertype. The Forest has easily met this requirement as shown in the figure above. Typically, snag inventories have been conducted at the project level where reductions in snag abundance are anticipated. Projects are designed to ensure retention of an adequate number and size and recruitment trees typically in excess of the minimum forest plan requirements.

Many sites in roadless or wilderness areas have not been inventoried. These areas generally have an abundance of snags due to a lack of disturbances associated with roads (firewood, timber harvest). Approximately 354,600 forested acres occur in roadless areas (updated 2003 inventory), which is approximately half of the total forested acres. Roadless areas (2003 inventory) represent approximately 53% of the

Forest, including the Cloud Peak Wilderness. These sites, in conjunction with the inventoried sites, demonstrate the abundance of snags on the Forest, and this is likely within HRV.

Coarse woody debris (CWD) refers to the amount, size, and length of material found on the forest floor. CWD is important both for species needs and for soil nutrient processes affecting regeneration of forested sites. Snags contribute to the amount of CWD over time. Natural fluctuations in CWD occur through disturbance processes. A high amount may occur after a blowdown or following an insect and disease outbreak, and fire may consume CWD during more severe events. However, snags created during a fire provide the next layer of CWD. Existing levels of CWD may be manipulated during timber harvest due to skidding operations (repositioning CWD) or slash treatment (e.g., burning). However, timber harvest also typically creates additional CWD as cull trees are left on site, as well as tree tops. CWD has not been inventoried on the Forest, but would likely have similar abundance and distribution as described previously with the snags.

Graham et al. (1994) examined amounts of coarse woody material needed to maintain ecosystem functions by habitat type. They found that between 3 and 25 tons per acre of coarse woody debris are needed to maintain ecosystem functions. Similarly, Bull et al (1997) describe amounts needed for terrestrial wildlife. This amount is typically readily obtained on timber harvest units, both pre and post treatment, on the Bighorn NF.

With regard to the Big Horn Mountains ecosection, the Bighorn NF has the most forested acres, and the least amount of road building, indicating it probably has the highest abundance of snags and CWD in relation to the rest of the section.

ENVIRONMENTAL CONSEQUENCES
SNAGS AND COARSE WOODY DEBRIS

Direct and Indirect Effects

The level of snags and coarse woody debris under each alternative will vary based on the management area allocations. In management areas where natural processes predominate, the level of snags and coarse woody debris will approach ecosystem maximums, particularly as the bulk of the forested acres continue to mature. These management prescriptions are maximized in Alternatives C and B, tapering off to the least in Alternatives A and E (for additional discussion of management area allocations by alternative, see DEIS Chapter 2). Aspen covertypes provide some of the most valuable snags due to the softer nature of the wood and other attractions of the habitat type to species. Snags are typically left on site when aspen regeneration treatments are conducted.

Snag and coarse woody debris guidelines were updated in the Draft Revised Plan to reflect new knowledge. The desired amounts of both elements were increased compared to levels in the 1985 Plan.

Effects from Disturbance Processes (Fire, Insects, and Disease Management): Stand replacement fires and insect and disease incidents will create high density snag patches in some areas that will eventually become high density patches of coarse woody debris. Subsequent wildfiresin these high density snag/coarse woody debris patches would likely consume most of the snags and woody debris. Species such as the three-toed woodpecker are adapted to take advantage of high densities of insects and the associated snags. This natural ebb and flow of snags and coarse woody debris typically moves across the landscape, with associated fluctuations in abundance and distribution of these components. Alternatives with greater emphasis on natural processes (C and B) would likely retain higher amounts of snags but also exhibit more fluctuations in levels as compared to alternatives with more timber harvest (A and E).

Effects from Timber Harvest, Recreation and Travel Management: Timber harvest can result in a loss of snags and future coarse woody debris in harvest units and along roads where subsequent fuelwood gathering takes place (Tinker et al 1998; Tinker 1999; Tinker and Knight 2000 and 2001; Tinker and Baker 2000; Brown and See 1981; Brown et al 2001). The loss of snags and coarse woody debris would potentially be greater in alternatives with higher levels of timber harvest (A and E) and less in those alternatives with greater emphasis on natural processes (D, B, and C, respectively). However, levels that are needed for both species habitat and ecosystem functioning processes can be maintained following these activities. In areas where timber harvest and fuelwood gathering take place, there may be differences in long-term amounts of both of these resources as compared to what may have historically occurred, though at the forestwide scale the levels and distribution are well within HRV. Modeling results (see project record) for snag numbers from the FVS portion of the harvest model also demonstrate snag abundance above forest plan minimums for each alternative.

Firewood gathering that removes snags is permitted except in areas closed to fuelwood collection. Standing dead trees with bird cavities (holes), nests, or wildlife tree signs and marked trees or trees with signs or paint are not allowed to be cut. Most fuelwood collection occurs approximately 150 feet from open roads.

Removal of dead standing trees that pose a safety hazard occurs in campgrounds, administrative sites and along roads. Felling of these snags contributes to a reduction in snag abundance. If these snags are felled and not removed from the site, they would contribute to coarse woody debris.

Roads constructed in support of harvest activities can remove snags and coarse woody debris. The potential for road construction is greater in Alternatives E and A, decreasing with D and B and least in C. Given the narrow, linear nature of this disturbance, it is not likely to be a significantly impact snag and coarse woody debris abundance on the Forest.

Cumulative Effects

In general, the analysis area for cumulative effects to biodiversity composition would include the Bighorn NF and the land immediately adjacent to it within approximately 3 miles. Trends applied to the larger Big Horn Mountains ecosection are noted below. Cumulative effects include past, present, and reasonably foreseeable (planning period) projects, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for habitat snags and coarse woody debris, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions, highway widening, and private land vegetation management are most significant.

Under any alternative, it is likely that snag abundance and distribution would continue to be within HRV with application of revised standards and guidelines. It has also been hypothesized that any removal of wood fiber from the Forest is outside of HRV as this did not typically occur significantly prior to European settlement. There would be more risk associated with implementation of Alternatives A and E, as higher levels of timber harvest and fuelwood gathering would likely occur, reducing snags and possibly coarse woody debris available. However, natural disturbance processes would continue to dominate in terms of effects to amounts and distribution, as by alternative, only between 7 and 30% of the forested acres would be managed for timber production. It is noted that long-term declines in coarse woody debris and snags are likely over the long-term with timber harvesting (Tinker and Knight 2000 and 2001), and this has potential to occur on areas managed for timber harvest in the long term.

As the Forest comprises the majority of the forested acres within the Big Horn Mountains ecosection, the effects on the Forest would represent the trend and condition for the rest of the ecosection. As timber harvest is conducted on lands adjacent to the Forest, there are further depletions of these resources, however the scale and extent of those effects are small, and primarily occur on the southeast corner of the Forest, though with some activity on the north and west flanks.

Summary of Environmental Consequences – Ecosystem Analysis

In general, forest succession and natural disturbance processes would be the primary agents of change for biodiversity components, with stands growing older and denser until stand-replacing events occur. Given the progression toward more mature structure stages and the likelihood of natural disturbances, the limited extent of timber harvest and other management activities described above would not be major influences on Forest structural stages in any alternatives. Fire suppression in areas dominated by management category 5 prescriptions may reduce opportunities for more large scale disturbances, however drought and wind events factored in with fires largely determine where disturbances occur regardless of management prescription boundaries. Since the majority of the Forest is represented by long fire return intervals, historic fire suppression has had little effect on all but the shrub, Douglas-fir, and ponderosa pine ecosystem components.

Forest Service management activities would remain close to current levels and outputs under Alternative D. Alternatives C and B would have less commercial timber harvest activity than presently occurs; Alternatives A and E would have more. Timber harvest and road construction carries some risks to resources such as vegetative community composition (noxious weed introduction), riparian functioning (stream crossings), old growth, snags, and coarse woody debris, and fragmentation as discussed above.

Livestock grazing would continue similarly across all alternatives, with effects greatest in riparian areas and meadow communities, and improvements in those community types occurring slowly over time.

Recreation use is another potential source of impacts. Recreation use can affect riparian areas, wilderness meadows, and other sites, though mitigation measures may correct some deficiencies. In general, recreation activities are a minor influence on biodiversity elements at the forestwide scale; however, there may be localized impacts. At the site-specific/stand scale, recreation activities may impact regeneration of forested stands by suppressing young trees and even damaging mature trees. Dispersed and developed recreation campsites affect composition by removing vegetation on the site or changing the vegetative composition at the site. An increase in recreation use is predicted under all alternatives.

With natural processes as the major influence, ecosystem components and functioning would largely remain within HRV across all alternatives. However, there may be exceptions where noxious weeds or non-native insects and disease expand and change vegetative composition.

All alternatives have updated standards and guidelines with positive benefits for both habitats and ecosystem processes. These updates would not occur under a No Action Alternative as described in Chapter 2.

Historic land uses such as timber harvesting and roads have created various patch sizes and arrangements on the landscape of the Bighorn NF. Historic and existing timber management direction and policy have limited the creation of large patches. The arrangement of harvest units in the past was influenced by acceptable road locations, types of harvesting equipment, and economics of harvest. Other land uses such as developed recreation sites and special use sites have often been based upon historical uses and feasible locations to provide desired outcomes (e.g., electronic sites on mountain tops). Large-scale disturbance events such as fire and insects and disease would continue to shape the most vegetation patterns in forested areas, with patterns persisting for 100-300 years into the future.

Single Species Analysis

This Single Species Analysis discloses information about species that have been selected and determined to require special attention due to unique habitat requirements or suspected threats to their continued viability. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure its continued existence is well distributed in the planning area. The Single Species Analysis corresponds to national direction in addressing species viability requirements (Hoffman 1976; Holthausen 2002) and is a part of the overall Viability Analysis Process as described in the project record documents. The approach used incorporates the most recent knowledge and scientific findings available for individual species and their habitats.

For analysis purposes, species were divided into five categories including: 1) federally threatened, endangered, proposed, or candidate species; 2) Forest Service sensitive species; 3) species of local concern; 4) management indicator/focal species (MIS); and 5) demand species. The first three categories represent species at risk from a viability perspective. Only one of the selected MIS is also a species-at-risk. For details on how each species was selected or not selected for a given category, refer to the Species Emphasis Categories document in the project record. Existing conditions and environmental consequences for federally listed (T&E) species are addressed in the Biological Assessment (Appendix F), and Forest Service sensitive species are addressed in the Biological Evaluation (see project record). For details on the process used to select MIS, refer to Selection Process for Management Indicator Species document in the project record. Species assessments, also in the project record, were conducted for each MIS and at-risk species, with details on the species' habitats, known distributions, threats, and conservation measures. A management strategy for rare plants was also developed for the Forest in conjunction with plan revision efforts, as described in the project record.

For each of the species at risk from a viability perspective, the potential impact of implementing each alternative was evaluated. Elements of species' habitat trends (distribution and amount) and population trends (abundance, distribution, dispersal ability) likely resulting from Forest Service management activities were summarized in viability outcomes for each alternative. These outcomes were assessed by evaluating the main risks associated with the species or its habitat, and how different alternatives would affect those. The process used to arrive at these determinations and outcomes is described in detail in the Viability Analysis Process document in the project record. In addition, viability outcomes for species are listed given known cumulative effects, such as impacts that occur off Forest or from activities other than Forest Service responsibilities. Viability for any species cannot be ensured due in part to effects in other areas of a species range, and non-management induced disturbances or catastrophic events affecting their habitat. In addition, little information is known about the current distribution or habitat for many of the species, contributing to ambiguity

when applying viability outcomes. The following outcomes are displayed for each species by alternative:

- **Outcome A:** Suitable ecological conditions are broadly distributed and of high abundance across the historical range of the species within the planning area. The combination of distribution and abundance of ecological conditions provides opportunity for continuous or nearly continuous intraspecific interactions for the species.
- **Outcome B:** Suitable ecological conditions are either broadly distributed or of high abundance across the historical range of the species within the planning area, but there are gaps where suitable ecological conditions are absent or only present in low abundance. However, the disjunct areas of suitable ecological conditions are typically large enough and close enough to permit dispersal among subpopulations and potentially to allow the species to interact as a metapopulation across its historical range within the planning area.
- **Outcome C:** Suitable ecological conditions are distributed frequently as patches and/or exist at low abundance. Gaps where suitable ecological conditions are either absent, or present in low abundance, are large enough that some subpopulations are isolated, limiting opportunity for species interactions. There is opportunity for subpopulations in most of the species range to interact as a metapopulation, but some subpopulations are so disjunct or of such low density that they are essentially isolated from other populations. For species for which this is not the historical condition, reduction in overall species range from historical within the planning area may have resulted from this isolation.
- **Outcome D:** Suitable ecological conditions are frequently isolated and/or exist at very low abundance. While some of the subpopulations associated with these ecological conditions may be self-sustaining, there is limited opportunity for population interactions among many of the suitable environmental patches. For species for which this is not the historical condition within the planning area, reduction in overall species range from historical condition within the planning area may have resulted from this isolation.
- **Outcome E:** Suitable ecological conditions are highly isolated and exist at very low abundance, with little or no possibility of population interactions among suitable environmental patches, resulting in strong potential for extirpations within many of the patches, and little likelihood of re-colonization of such patches. There has likely been a reduction in overall species range from historical within the planning area, except for some rare, local endemics that may have persisted in this condition since the historical period.

The following outcomes are used to describe effects to species from overall cumulative effects, including those activities not associated with Forest Service management or from time spent in habitat off of the Forest. These would include activities listed in the table in the introductory pages to Chapter 3, as well as those far removed from the local area due to the migratory behavior of some species.

- **Outcome I:** The combination of environmental and population conditions provides opportunity for the species to be broadly distributed and of high abundance across its historical range within the cumulative effects analysis area. There is potential for continuous or nearly continuous intraspecific interactions at high population size.
- **Outcome II:** The combination of environmental and population conditions provide opportunity for the species to be broadly distributed and/or of high abundance across its historical range within the cumulative effects analysis area, but there are gaps where populations are potentially absent or present only in low density as a result of environmental or population conditions. However, the disjunct areas of higher potential population density are typically large enough and close enough to other subpopulations to permit dispersal among subpopulations and potentially to allow the species to interact as a metapopulation across its historical range within the cumulative effects analysis area.
- **Outcome III:** The combination of environmental and population conditions restrict the potential distribution of the species, which is characterized by patchiness and/or areas of low abundance. Gaps where the likelihood of population occurrence is low or zero are large enough that some subpopulations are isolated, limiting opportunity for species interactions. There is opportunity for subpopulations in most of the species range to interact as a metapopulation, but some subpopulations are so disjunct or of such low density that they are essentially isolated from other populations. For species for which this is not the historical condition within the planning area, reduction in overall species range from historical condition may have resulted from this isolation.
- **Outcome IV.** The combination of environmental and population conditions restrict the potential distribution of the species, which is characterized by areas with high potential for population isolation and/or very low potential abundance. While some of these subpopulations may be self-sustaining, gaps where the likelihood of population occurrence is low or zero are large enough that there is limited opportunity for interactions among them. For species for which this is not the historical condition within the planning area, reduction in overall species range from historical has likely resulted from this isolation.
- **Outcome V.** The combination of environmental and population conditions restricts the potential distribution of the species, which is characterized by high levels of isolation and very low potential abundance. Gaps where the likelihood of population occurrence is low or zero are large enough there is little or no possibility of interactions, strong potential for extirpations, and little likelihood of recolonization. There has likely been a reduction in overall species range from historical within the planning area, except for some rare, local endemics that may have persisted in this condition since the historical period.

A summary of the determinations and viability outcomes for each species is included in this section. The Draft Revised Plan contains many positive conservation measures for species viability in the form of goals, objectives, standards, guidelines, and monitoring.

These measures apply to all of the alternatives considered in detail. A list of these conservation measures occurs within the individual Species Assessments and in the Viability Process document in the project record.

Existing conditions and evaluations of effects to MIS and Demand species are summarized in the Aquatics (fisheries) and Terrestrial Wildlife sections of Chapter 3, as they were selected to represent these resources and the associated habitats.

AFFECTED ENVIRONMENT
THREATENED AND ENDANGERED SPECIES

The list of species evaluated is based on a letter to the Forest from the U.S. Fish and Wildlife Service (USFWS) dated March 24, 2004. Two federally listed species were included for the Bighorn National Forest Land and Resource Management Plan revision process. No candidate species were included.

Federally listed threatened and endangered species are those plant and animal species formally listed by the U.S. Fish and Wildlife Service under authority of the Endangered Species Act of 1973, as amended. An endangered species (E) is defined as one which is "in danger of extinction throughout all or a significant portion of its range." A threatened (T) species is defined as one "that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (FSM 2670.5 (81) and FSM 2670.5 (211), respectively). A proposed species (P) is defined as one in which "information now in possession of the FWS (that) indicates that proposing to list the species as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability and threats are not currently available to support proposed rules." (FSM 2670.5). Candidate species are those for which information exists to support a listing, however further study is required or other priorities are affecting listing decisions.

In 2002 and 2003, the Forest conducted surveys for potential habitat and occurrences of the mountain plover (P) and the Ute's ladies'-tresses (T). No potential habitat was found, no observations of the species occurred, and no historical observations were known to have occurred, so these species have been dropped from consideration. Gray wolves (T) and grizzly bears (T) have the potential to occur on the Bighorn NF. Grizzly bears would not likely be retained on the Bighorn NF, should they occur, as detailed in the Wyoming Game and Fish Department's (WGFD) Bear Management Plan (2002). None are known to currently occur.

Wolves have been sighted on or near the Forest in recent years, with some control activities due to predation on sheep and cattle, indicating potential for a pack to develop in the area in conjunction with expanding populations from the Yellowstone area. The WGFD's Wolf Management Plan (2003) dictates necessary processes in dealing with wolves, and the plan may be amended due to recent disputes. Should depredation of livestock using the Forest occur from wolves, they would most likely be removed by the

USDA Wildlife Services or WGFD. This activity would not be of jeopardy to the continued existence of wolves in Wyoming, as the Big Horns are outside of the recovery area and the wolves are a non-essential experimental population. Changes that may occur in the state's Wolf Management Plan would not likely cause a change in management in wolves for the Bighorn NF. As the Forest has lower road densities than surrounding lands, wolves may be attracted to the Forest, and may also utilize big game winter range habitats as foraging areas. Management direction (standards or guidelines) in the Forest Plan is not necessary due to the experimental status of the wolf and the Bighorns not being a prime recovery area. Refer to the Biological Assessment (Appendix F) for further information.

Bald eagles use the Forest during migratory periods for foraging purposes. No nesting or winter roosting has been observed or is known to have historically occurred on the Forest. Bald eagle populations have improved greatly over the past few decades, largely due to the ban of use of DDT. There has been some discussion of de-listing the species, which may occur in the next planning period.

Canada lynx historically occurred on the Forest, and there have been some recent reports of sightings, though unconfirmed. It is not known if a self-sustaining population of lynx ever occurred on the Forest, but it is estimated that current observations may be a result of influx from other source populations. The Forest conducted hair snare sampling for three seasons from 2000 – 2002, with no lynx detected on the routes. Lynx denning habitat includes high levels of coarse woody debris and overhead canopy; foraging habitat involves areas where primary prey such as snowshoe hare or red squirrel may occur.

Environmental Consequences
Threatened and Endangered Species

Effects determinations correspond to determinations required by Section 7 of the ESA, and indicate the estimated viability of the species. The USFWS is responsible for concurring with effects determinations and determining if a proposed action is likely to jeopardize the continued existence of a species, indicating its viability at a scale larger than a National Forest. Effects determinations include "no effect" to the species, or "may affect, not likely to adversely affect", "may affect, likely to adversely affect", or "may affect, beneficial affect." The following table displays information about the effects determination for each of these species as described in the Biological Assessment (Appendix F). The Forest will be receiving comments from the USFWS regarding effects and determinations for the bald eagle and Canada lynx between the Draft and Final EIS, and preparing a Final Biological Assessment for their concurrence based on the preferred alternative of the Final EIS.

Table 3-32. Effects determinations for threatened (T) species occurring on the Bighorn NF by alternative.

	Canada lynx (threatened)	Bald eagle (threatened)
Alternative A	Likely to adversely affect Viability outcome B Cumulative viability outcome IV	Not likely to adversely affect Viability outcome A Cumulative viability outcome II
Alternative B	Likely to adversely affect Viability outcome B Cumulative viability outcome IV	Not likely to adversely affect Viability outcome A Cumulative viability outcome II
Alternative C	Likely to adversely affect Viability outcome B Cumulative viability outcome IV	Not likely to adversely affect Viability outcome A Cumulative viability outcome II
Alternative D	Likely to adversely affect Viability outcome B Cumulative viability outcome IV	Not likely to adversely affect Viability outcome A Cumulative viability outcome II
Alternative E	Likely to adversely affect Viability outcome B Cumulative viability outcome IV	Not likely to adversely affect Viability outcome A Cumulative viability outcome II

Bald Eagle

As bald eagles occur only intermittently on the Forest, population factors were not well represented in viability determinations. Regionally the population trend of these species has improved, due largely to changes in protection for the species from pesticides and disturbance or takings. It is likely that a continued improved trend would occur regardless of the selected alternative. To guide project implementation, nest site and winter roost protection measures for habitat are included in the plan direction (standards and guidelines). Under all alternatives, there are no anticipated changes that would affect foraging habitat for this species. However, existing uses (e.g., powerlines) and other potential disturbances on the Forest prevent a “no effect” determination, though these impacts are thought to be non-significant and allowed for an “A” viability outcome. With regards to a cumulative viability outcome, habitat conditions and potential disturbances on lands adjoining the Forest where most habitat use occurs could result in degraded conditions in the future, resulting in a “B” viability outcome. The Biological Assessment discusses direct, indirect, and cumulative effects of each alternative in detail supporting the determinations made above.

Canada Lynx

As it is unknown whether Canada lynx occur on the Forest, the Forest would continue to manage habitat for this species as described in the plan amendment recently started for lynx as part of the Northern Rockies Forest Plan amendments (Bighorn NF Plan Amendment #16). Viability outcomes are speculative as population factors are difficult to consider due to a lack of distribution information. The current conservation measures

for the species from the Northern Rockies amendment preferred alternative (E) are being carried forward into the revised plan direction in the form of goals, objectives, standards, guidelines, and monitoring. Most of the plan direction applies to Lynx Analysis Units (LAUs) developed in conjunction with the USFWS to show potential and suitable habitat.

As all alternatives would comply with this direction, there is little difference in determinations by alternative based on habitat effects. Baseline suitable habitat (>70% suitable, >10% denning habitat) was retained when potential timber harvest was modeled for each alternative. With the continuation of existing practices such as winter recreation, livestock grazing, and vegetation treatments that can affect potential habitat, a "no effect" determination was not warranted, and a "B" was used for viability outcomes. However, a cumulative viability outcome of IV was used, as there are likely few if any lynx on the Forest currently, and stochastic or other events could remove them, though they are also highly mobile and may immigrate from other areas, though source populations elsewhere may also be reduced. As activities conducted on the Forest from prescribed burning, timber harvest, recreation use, etc. could potentially disrupt habitat or an individual, the Forest determined it was prudent to assume the worst-case scenario of a potential harm situation to an individual or habitat and arrived at a "may affect, likely to adversely affect" determination. This is a non-quantifiable assumption however due to an unknown amount or occurrence of lynx on the Forest. It is generally considered a very low level of risk for harm to occur to lynx or its potential habitat.

In 2000, the Forest prepared a forest-wide BA that addressed all known ongoing and proposed actions with regard to lynx management. There were no determinations of "likely to adversely affect" for any of the activities analyzed in 2000, and no outstanding mitigation measures were identified other than consideration of the measures in the Lynx Conservation Assessment and Strategy (Ruediger et al. 2000), which was the basis for Plan Amendment 16. There has been little change from the conditions analyzed in this effort, nor would the habitat trajectory of alternatives produce a significant change from the type or extent of activities analyzed in this effort. This rationale could support a "not likely to adversely to affect determination", however the determination currently being used for the Northern Rockies Plan Amendment is also a "likely to adversely affect" determination, due in part to the preferred alternative not implementing all of the conservation measures from the LCAS as written. The BA discusses direct, indirect, and cumulative effects of each alternative in more detail, supporting the determinations made above. The BA also contains current habitat values and a map of the LAUs on the Forest.

While lynx may benefit from roadless areas due to less winter habitat disturbance and potential competition with other predators, this relationship has not been proven. Prey populations are likely of greatest importance for the lynx, and the Forest may lack enough early seral stage (HSS 1 and 2) forested areas that provide higher densities of snowshoe hare, a primary prey species. Disturbances to create more of these conditions can arise from both natural (e.g., wildfire, insects) and management-related regeneration

events (e.g., prescribed fire and timber harvest). While the emphasis on both these factors varies by alternative, vegetation modeling also shows that the forested covertypes will largely continue to become older with fewer young forests, barring any large wildfire events. The difference between alternatives is not significant enough to warrant different determinations in effects and viability outcomes based on these uncertainties. Large wildfire events will become increasingly likely as time progresses due to maturing stand conditions. This could possibly change the lack of young seral conditions, though this is not certain in the next planning period. It is estimated that a total of 10,000 acres of wildfire events could occur in the next planning period, changing habitat conditions. This estimate was not included in timber harvest modeling due to the uncertainties involved, however even with this much disturbance in addition to the anticipated harvest under any alternative, the % suitable habitat would still not likely be reached due to the size of LAUs and the extent of mature stand conditions.

The Forest is not likely to receive additional funding to implement the Healthy Forest Restoration Act, as other Regional priorities exist. Therefore, potential effects from this type of activity are deemed consistent with past programs in view of the determinations made above.

The Forest has not proposed limiting snowmobiling or other winter activities that could affect lynx habitat in any alternative. There are no additional proposed groomed snowmobile trails or identified play areas, in compliance with the proposed Plan Amendment 16. The effect of restricted thinning in young forests (a current requirement) is uncertain. Thinning may reduce habitat for hares in some instances but can also prolong a higher density of lower branches and crowns that benefit hares and can more readily produce habitat for red squirrels. This management aspect is being researched, with possible resolution in the next planning period.

The Forest would continue to investigate sighting reports. In addition, winter snow track surveys for all carnivores as described in the Monitoring Plan may provide detections of this species should they occur. Annual monitoring of vegetation databases would also provide the indicators necessary to track the % suitable habitat and other habitat features on an annual basis.

Cumulatively, there are no anticipated increases in highways or other barriers that could affect linkage routes adjacent to or within the Forest. Though timber harvest would occur on lands adjacent to the Forest, the level is not anticipated to affect linkage habitat or overall lynx habitat availability. The Forest likely provides the bulk of the lynx habitat in the Big Horn Mountains ecosection, and these factors resulted in a continuation of the current viability outcome (B) as the conservation measures for lynx would be adhered to. Mortality elements such as vehicle deaths and prey availability would continue to be factors determining population levels for this species. Predator control activities conducted in support of livestock grazing would continue to occur. There have been no mortalities of lynx on the Forest recorded with this type of activity, and due to changes made by USDA Wildlife Services in trapping methods, there is little likelihood that this activity would result in any mortality in the future.

Other Species

There are no anticipated effects from Forest activities on threatened, endangered, proposed and candidate species occurring in the plains and in downstream portions of the watersheds originating on the Forest. This is due to the difference in habitat types in the case of terrestrial species, and due to the known water quality (high) coming off the Forest for aquatic species. Prairie species occurring or potentially occurring adjacent to the Forest include the black-footed ferret (E), Ute's ladies'-tresses (T), and the black-tailed prairie dog (C). Forest activities do not affect habitat for these species due to the distance from the Forest and no known cumulative effects from Forest management activities. The downstream aquatic species is the pallid sturgeon (E) in the Yellowstone River, with reintroduction proposals being considered in the lower Tongue River. Coordination with the USFWS for this species indicates no concern with regards to plan revision or Forest activities as no additional consumptive uses of water are being proposed on the Forest (Jordan pers. comm.). This would also apply to any potential downstream populations of the Ute's ladies tresses. The main issues for the sturgeon are the diversions and dams that occur a considerable distance from the Forest boundary. The greater sage grouse has been petitioned for listing as threatened and is assessed below as a Forest Service sensitive species.

AFFECTED ENVIRONMENT
SENSITIVE SPECIES

Sensitive species are those plant and animal species whose population viability is a concern on National Forests within the Region. They may also be those species whose current populations and/or associated habitats are reduced or restricted, or their habitats and/or populations are considered vulnerable to various management activities, and special emphasis is needed to ensure they do not move towards listing as threatened or endangered. Sensitive species were selected by the Regional Forester according to criteria developed and information evaluated by a panel of Forest Service specialists (USDA Forest Service 2003). It is known that many impacts to species may occur off of the National Forests, depending on a species' life history. Only those species known to occur or with the potential to occur on the Bighorn NF are included in this analysis, as indicated on the Regional Forester's list. Direction for sensitive species management comes from the FS Manual (2670).

A description of each species and what is known of the current and historical distribution of that species and its habitat on the Forest in included in the Species Assessments (see project record) and the Biological Evaluation (See Project Record). Known locations on the Forest were mapped on the Forest's GIS with assistance from the Wyoming Natural Diversity Database, Wyoming Game and Fish Department, and others. The sighting records are included in the project record.

Two fish, three amphibians, six mammals, 15 birds, and 10 plant species are known to occur or are documented in the vicinity of the Bighorn NF and similar habitat occurs on the Bighorn NF. The following table lists the species, their known distribution or abundance on the Forest, and their associated habitats on the Forest.

Table 3-33. Bighorn National Forest sensitive species.

Common Name	Scientific Name	Habitat	Species Occurrence on Forest
Fish			
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*	Riverine	Known to limited streams.
Mountain Sucker	*Catostomus platyrhynchus*	Riverine	Known to Tongue River drainage.
Amphibians			
Northern leopard frog	*Rana pipiens*	Ponds/Wetland/ Riparian	Known to limited areas.
Columbia spotted frog	*Rana luteiventris*	Ponds/Wetland/ Riparian	Known to limited areas.
Wood frog	*Rana sylvatica*	Ponds/Wetland Riparian	Known to limited areas.
Mammals			
Fringed myotis	*Myotis thysanodes*	Caves/Mines & Forested areas	Known to limited sites.
Spotted bat	*Euderma maculatum*	Caves/Mines & Forested Areas	None known, but locations near Forest and potential habitat.
Townsend's big-eared bat	*Corynorhinus townsendii*	Caves/Mines	Known to limited sites.
Water vole	*Microtus richardsoni*	Riparian	Known, but very limited in known distribution.
American marten	*Martes americana*	Late-successional conifer	Known to several areas.
Wolverine	*Gulo gulo*	Spruce-fir/ Alpine tundra	Historic/Potential with occasional sightings.
Birds			
Harlequin duck	*Histrionicus histrionicus*	Wetland/Lake	Historic/Potential as sighted nearby.
Northern harrier	*Circus cyaneus*	Grasslands/ Shrub-steppe	Known with many observations.
Northern goshawk	*Accipiter gentilis*	Mature conifer/aspen	Known with several observations.

Common Name	Scientific Name	Habitat	Species Occurrence on Forest
Peregrine falcon	*Falco peregrinus anatum*	Canyons/Cliffs/ Riparian	Known, though sporadic but historic nesting on Forest.
Greater sage grouse	*Centrocercus urophasianus*	Sagebrush	No leks (breeding) on Forest. Late summer brood rearing primarily on west side of Forest.
Flammulated owl	*Otus flammeolus*	Mature ponderosa/ aspen	None currently known on Forest, though north of it. Limited potential habitat.
Short-eared owl	*Asio flammeus*	Grassland/Sage Steppe	Known, though somewhat limited potential.
Boreal owl	*Aegolius funereus*	Mature Conifer	Known, but from limited sightings.
Lewis' woodpecker	*Melanerpes lewis*	Conifer/Riparian	Known, but from limited sightings.
Three-toed woodpecker	*Picoides tridactylus*	Mature Conifer	Known to several areas of Forest.
Olive-sided flycatcher	*Contupus cooperi*	Mature Conifer	Known to several areas of Forest.
Loggerhead shrike	*Lanius ludovicianus*	Grassland	Known on fringes of Forest where meadows occur.
Brewer's sparrow	*Spizella breweri*	Sage steppe	Known to several areas of Forest.
Sage sparrow	*Amphispiza bellii*	Sage steppe	None known on Forest, but potential.
Grasshopper sparrow	*Ammodramus savannarum*	Grasslands	Known from limited sightings.
Plants			
Mountain lady's slipper	*Cypripedium montanum*	Shady forests and riparian shrublands at mid-elevations.	Known from 3 occurrences on Forest.
Yellow lady's slipper	*Cypripedium parviflorum*	Damp mossy forests, and streamsides at mid-elevations.	Known from 2 occurrences on Forest.
Russet cotton-grass	*Eriophorum chamissonis*	Montane swamps and bogs.	Known from 1 occurrence on Forest.

Common Name	Scientific Name	Habitat	Species Occurrence on Forest
Hall's fescue	*Festuca hallii*	Montane meadows	Known from 1 vague historical (1898) record.
Grass-of-parnassus	*Parnassia kotzebuei*	Moist seeps.	Known from 1 occurrence on Forest.
Cary beardtongue	*Penstemon caryi*	Disturbed areas on sedimentary soils.	Known from 14 occurrences on Forest.
Wooly twinpod	*Physaria lanata*	Rocky outcrops and rocky soil, without dense grass or shrub cover. Forested areas.	Known from 3 occurrences on Forest.
Tranquil golden-weed	*Pyrrocoma clementis var. villosa*	Sagebrush grasslands and montane meadows.	Known from 3 occurrences on Forest.
Northern blackberry	*Rubus acaulis*	Riparian area along Sourdough Creek	Known from 1 occurrence on Forest.
Lesser bladderpod	*Utricularia minor*	Submerged in ponds, slow moving streams	Known from 1 occurrence on Forest.

Environmental Consequences
Sensitive Species

Effects determinations are made for sensitive species similar to the determinations required for threatened and endangered species, and are documented in the Biological Evaluation (BE) (See Project Record). Effects determinations include "no impact" to the species, "may impact individuals or habitat, but not likely to lead to a trend toward federal listing", "May impact individuals or habitat, likely to lead to a trend toward federal listing", and "beneficial effect". Requirements for BEs and sensitive species in general are stated in FSM 2670. In addition to the standard determinations, viability outcomes for these species were made, as described previously. The following table summarizes the determinations made in the BE and the estimated viability outcomes. A summary of effects for the species follows the table.

Table 3-34. Effects determinations for sensitive species occurring on the Bighorn NF by alternative.

Sensitive Species	A	B	C	D	E
Yellowstone cutthroat trout	MIIH[10] V-C[11] CV-V[12]	MIIH V-C CV-V	MIIH V-C CV-V	MIIH V-C CV-V	MIIH V-C CV-V
Mountain sucker	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II
Northern leopard frog, Columbia spotted frog, Wood frog	MIIH V-C CV-IV	MIIH V-C CV-IV	MIIH V-C CV-IV	MIIH V-C CV-IV	MIIH V-C CV-IV
Fringed myotis, Spotted bat, Townsend's big-eared bat	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II
Water vole	MIIH V-C CV-III	MIIH V-C CV-III	MIIH V-C CV-III	MIIH V-C CV-III	MIIH V-C CV-III
American marten, Wolverine	MIIH V-B CV-II	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-B CV-II
Harlequin duck	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I
Northern harrier	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III
Northern goshawk	MIIH V-B CV-II	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-B CV-II

[10] Effects Determinations from Biological Evaluation: NI = No Impact; MIIH = May impact individuals or habitat but not likely to cause a trend toward federal listing or loss of viability; LFL =May impact individuals or habitat, likely to result in a trend toward federal listing or loss of viability; BE = Beneficial effect.

[11] Viability (V) Outcomes: Described in introduction to this Single Species assessment section. Range from A (stable), to E (high risk), thus the A – E ratings for those ecological conditions directly resulting form FS management of habitat.

[12] Cumulative Viability (CV) Outcomes: Described in the introduction to this section. Range from I (stable) to V (high risk). These ratings include cumulative effects from adjoining lands or other influencing factors beyond the scope and control of the Forest Service.

Sensitive Species	A	B	C	D	E
Peregrine falcon	NI V-A CV-I	NI V-A CV-I	NI V-A CV-I	NI V-A CV-I	NI V-A CV-I
Greater sage grouse, Short-eared owl	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III
Flammulated owl, Boreal owl, Lewis' woodpecker, Three-toed woodpecker, Olive-sided flycatcher	MIIH V-B CV-II	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-B CV-II
Loggerhead shrike, Brewer's sparrow, Sage sparrow, Grasshopper sparrow	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III
Mountain lady's slipper, Yellow lady's slipper, Cary beardtongue, Lesser bladderpod	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II	MIIH V-B CV-II
Wooly twinpod	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I	MIIH V-A CV-I
Hall's fescue, Tranquil golden-weed, Russet cotton-grass, Northern blackberry	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III	MIIH V-B CV-III
Grass-of-parnassus	MIIH V-C CV-III	MIIH V-C CV-III	MIIH V-C CV-III	MIIH V-C CV-III	MIIH V-C CV-III

Under all the alternatives, the determination for the sensitive species is predicted to be "may impact individuals or habitat but not lead to a trend toward federal listing." This is due to the variety of factors that can influence a species, regardless of protective measures or other beneficial actions that are proposed. The main difference in viability outcomes between alternatives is tied to the risk of additional roading (including spread of noxious weeds and habitat fragmentation) that would be likely with implementation of Alternatives E and A. The risks for Alternatives A and E applies mainly to the species tied to mature conifer habitat. Snags and coarse woody debris may occur at reduced levels in Alternatives A and E compared to the other alternatives. Cumulatively, the short-term impact of diseases such as the West Nile Virus on avian species is unknown.

The Yellowstone cutthroat trout (YCT) are of viability concern due largely to the limited distributions caused by past actions. These actions include the introduction of non-native species that either out-compete or dilute genetic integrity of YCT, habitat isolation from diversions and dams (largely of the Forest), and habitat degradation from past management of riparian areas (e.g., historic levels of livestock grazing, tie hacking). Due to their suppressed or small isolated populations, YCT on the Forest are at an increasing risk from catastrophic disturbances or diseases such as whirling disease. Genetic exchange among sub-populations is limited. With management towards improved watershed conditions and improved riparian habitat conditions across all alternatives, some of these past trends can be reversed. Coordination with WGFD would occur regarding non-native species interactions and attempts to improve current distribution of YCT (reintroduction, etc.). There are no management prescriptions that would necessarily benefit or detract from habitat for this species, as the standards and guidelines that ensure habitat are forestwide. Therefore, there are few, if any, differences among alternatives considered, as the current impacts of dispersed recreation and livestock grazing would not likely vary by alternative significantly. There could be increased risk in additional roading (stream crossings, sediment potential), which would be greatest in Alternative E, and least in Alternative C, but design measures would provide for fish passage and minimize sediment. This is one of the species that is of greatest risk for continued viability due to these cumulative factors above, and populations have a good chance of being reduced despite any improvement measures taken.

Mountain sucker were listed as a sensitive species largely due to impacts in other parts of its range. It is known to only the Tongue River drainage. It is considered a stable and common species in Wyoming and is not thought to have changed in its distribution on the Forest as a result of any habitat impacts, past or current. Habitat would remain similar across all alternatives.

All three sensitive amphibians (wood frog, northern leopard frog, and spotted frog) are considered of viability concern on the Forest. This outcome arises largely from the global declines in amphibians for uncertain reasons (climate, disease, etc.) and predation by the non-native fish. With the limited number of current populations, the amphibian species are at increased risk from any catastrophic events that could impact habitat or populations. It is not clear whether Forest Service actions are contributing to the decline of these species, though impacts to riparian habitats from livestock grazing and dispersed recreation may be a factor. Reductions from historic livestock numbers and improved management by applying standards and guidelines should minimize this risk. Management of livestock grazing does not vary by alternative. There are no predicted losses of any wetland habitat from planned activities, and forestwide standards and guidelines for the YCT would also apply for this species. Coordination with the WGFD would continue with regard to non-native species effects and any improvement efforts in amphibian distribution (reintroduction, etc.). With coordinated efforts to improve the presence of beaver (MIS) on the Forest, habitat for these species should continue to improve over time. Continued inventory and monitoring would

occur for these species, as only approximately 50% of the Forest has been surveyed for them. Cumulatively, it is not thought that populations on the Forest have the opportunity to interact with other populations in the state based on the island nature of the Forest. Continued viability of these species is at risk due to these cumulative factors, which resulted in its low viability rating in the table above. Cumulative effects are limited to the Forest as there are few or no known occurrences of these species off the Forest in lands adjacent to it.

Water voles are at risk based on limited distribution. There may be more risk for this species than others with regard to riparian habitat conditions affected by livestock and wild ungulate grazing and recreational use. There would be little difference among alternatives with regard to this, and riparian conditions are likely to improve over time through application of livestock and recreation standards and guidelines for riparian areas. Continued inventory and monitoring would occur for this species. Cumulative effects are limited to the Forest, as there is thought to be no suitable habitat connecting populations on the Forest with those in other areas of the state. Sub-populations on the Forest may disperse to interact with others during wet years.

For bat species, the viability concern arises from the condition of cave habitats. The Forest has taken action to designate significant caves and will be preparing and implementing cave management plans for these species, possibly involving gating some caves. Recreational cave use is not predicted to vary between alternatives; however, recreation use and impacts from that use may continue to increase on the Forest. Forestwide direction would provide improvements for managing these habitats. Snags also provide roosting habitat for some of the bat species, and corresponding forestwide direction should ensure the availability of this type of habitat. Potential snag habitat may be the greatest in Alternative C due to the amount of area dominated by natural processes and lowest in Alternative E due to increased management for timber production. Continued inventory and monitoring would occur for these species, and many areas have not been surveyed for determining presence or absence. As these species are migratory to some extent, it is not clear how habitat conditions in the rest of the state will influence populations on the Forest.

For **species associated with old growth, coarse woody debris, and/or snags** for at least part of their habitat requirements (marten, wolverine, flammulated owl, boreal owl, goshawk, woodpeckers, and flycatcher), refer to the previous discussion of these habitat types under ecosystem analysis. Plan direction protecting these species would be applied regardless of alternative chosen, indicating a base level of viability protection. The management activities likely to reduce these types of habitat would be greatest in Alternative E and least in Alternative C. However, modeling indicated that mature conditions on the Forest would continue to dominate, and all alternatives would likely still provide habitat structure within the HRV. The effects of wildfire are somewhat unknown, other than a larger event (10,000 acres or greater) is likely to occur in the next planning period. The Forest currently estimates that it may have at least the minimum level of old growth as prescribed by the Revised Plan (10% and 15%), however the spatial location has not been surveyed. With implementation of the

Revised Plan (strategies and guidelines), this resource should be maintained to meet the requirements, as indicated by timber model results. Spatially, it was not estimated where harvest activities would occur in the next planning period for the DEIS.

Marten are impacted by trapping, which is regulated by the WGFD. Trapping pressure could increase where roads are created into areas with marten habitat. Marten habitat modeling shows many areas of potential habitat, but there is limited information on their current distribution. They likely do not interact with populations off the Forest, but there is good potential for populations on the Forest to interact due largely to their dispersal ability.

Wolverines have most often been associated with areas managed for low occurrence of people, which could be greatest in Alternative C and least in Alternative E. A viability outcome determination for wolverines is difficult as they are not known to occur as residents, and therefore the determination is speculative. Due to their known ability to disperse across long distances, a population, should it occur on the Forest, would likely continue to have interaction with other populations in the state. Lynx conservation measures applied in Amendment 16 and in this revision may also benefit habitat requirements for martens and wolverines.

Information about nest locations for the **flammulated or boreal owl** is lacking; effects to these species are speculative based on habitat in other known areas, and viability outcomes are also speculative. Lack of aspen or deteriorated condition of aspen as a source of cavities for nesting for both of these species is a concern. **Goshawks** are often more associated with an open understory under a mature canopy, and no effect from past management disturbances has been observed in known nest locations. In areas where mature conditions are not replaced through widespread disturbance events, active management for structural stage diversity may play a role in providing habitat through time. Active management for structural stage diversity would likely be greatest in Alternative E and lowest in C, though anticipated changes from wildfire are not considered in these predictions. Risk of altered habitat from increased harvest activity may also take place, however. This would be greatest in Alternatives E and A, least in C and B.

Three-toed and Lewis' woodpeckers would likely thrive where insects and disease occurred. This potential may be greatest in Alternative C which has the greatest emphasis on natural processes, less in Alternatives B and D, and least in Alternatives A and E respectively. Similarly, **olive-sided flycatchers** may do best where snags have the most potential to occur, following similar trends as the woodpeckers. Flycatchers are migratory, and would be more susceptible to cumulative effects on winter ranges.

Inventory and monitoring would continue for all old growth associated species. Cumulative effects for these species are largely limited to the Forest in terms of habitat, as the Forest provides most of the conifer habitat in the ecosection. All of these species may migrate off or to the Forest, with potential genetic interaction with other populations in the state.

With regard to the **Brewer's sparrow, sage sparrow, and sage grouse**, the Forest would continue actively managing the sagebrush habitats, primarily through prescribed fire, in an effort to restore more historic conditions: diverse canopy covers and densities and diverse understory vegetation. While this may cause a temporary displacement of some species' use of the older patches, this action should have long-term benefits due to the creation of diversity in shrub age classes. There may be some reduced risk of widespread wildfires which are more likely to create primarily young conditions and opportunities for noxious weed expansion over larger acreages. Active management of these habitats would likely occur most in Alternatives A, B, D, and E, but least in C. Under all alternatives, protection measures such as application of grouse management guidelines (Connelley 2000) and monitoring practices would occur. As it is not known if the sage sparrow occurs on the Forest, viability outcomes for this species are largely speculative. All three species spend a considerable portion of their life off Forest and would be affected by cumulative effects in those areas, including habitat conversions to cheatgrass or habitat loss from wildfire and noxious weeds.

The harlequin duck is a riparian-associated avian species. There are no anticipated impacts to these habitats, and the protection measures for these habitats and this species are forestwide, regardless of alternative. As there are no known occurrences of this species currently on the Forest, viability outcomes were speculative. Recreation disturbances would likely be the main potential impact. Reservoirs construction, over time, may have reduced potential habitat for this species. Impacts from off Forest may currently be limiting the expansion of this species onto the Forest. There have only been sporadic observations in the Forest in past times, indicating a lack of use of the Forest for primary habitat, as Wyoming is at the southern end of its range.

Effects to **species associated with grasslands** (harrier, short-eared owl, loggerhead shrike, grasshopper sparrow) are tied largely to livestock grazing management and recreation. Neither activity varies by alternative therefore the effects to these species would be similar between alternatives. Application of standards and guidelines for rangeland vegetation should continue to provide habitat for these species, with potential improvements over time. Continued inventory and monitoring would occur for these species. The Forest provides less of this type of habitat than the surrounding plains, and it is largely a stable type of habitat on the Forest due to soil conditions. Cumulative effects off Forest on adjacent lands are likely more important than any effects on the Forest. Shooting or poor rangeland conditions are likely the main threats in their range.

The peregrine falcon would not likely be affected differently by any of the alternatives, as its habitat is largely secure in cliffs. Some recreation disturbance may occur, though this would likely be similar among all alternatives. Nest protection measures would apply regardless of alternative selected. Improved trends in this species are largely from halting use of DDT throughout its range, and reintroduction efforts by private and state agencies. Continued inventory and monitoring would occur for this species in coordination with the WGFD.

All of the **plant species** are known to few locations, and are thus at some risk from a viability aspect with regard to catastrophic events (fire, flood, etc.). Their ability to persist through seed or other dispersal mechanisms is largely unknown, though their presence indicates their adaptability to the ecosystems of the Forest given these types of events. Risks are relatively low from any management-related activity. Protection measures in the Revised Plan (spatial buffers, etc.) would apply across all alternatives, and a difference in effects among alternatives is not anticipated. Project planning includes site-specific surveys and documentation in a BE, which would include needed mitigation. Some of the plants have known locations in potential RNAs, which would not be as protected in Alternative E. The opportunity for impacts from noxious weeds may similarly be greatest in Alternatives A and E due to the increased amount of roading; Alternative C would have the least potential for noxious weed impacts. Throughout the Forest, the potential for recreational activities to introduce weeds would likely remain high in all alternatives. Treatment for noxious weeds would continue similarly from all alternatives, and the current threat to sensitive plant populations from noxious weeds is unknown. Most plant populations are in remote locations due to unique habitat associations and, as such, are largely protected from potential management activities. Livestock grazing has the potential to impact some aquatic, grassland, or shrub-associated species, and these same habitat types are the most likely areas for noxious weed expansion, though primarily at lower elevations. Many species are sensitive based on limited information about their distribution. Continued inventory and monitoring would occur for these species as outlined in the Monitoring Plan.

Affected Environment
Species of Local Concern

In addition to Region 2 sensitive species, each Forest may assess species of "local concern." These species may be doing well on other administrative units or states but are less successful locally and in need of management attention. Local endemics, even if not known to be at risk, may be worth additional analysis if the population size is small and/or isolation makes the populations vulnerable. Most of the species were selected because of a lack of information about distribution or presence/absence on the Forest. This is true of the plants selected. Rationale for selection of local concern species occurs within the Emphasis Species Categories document (see project record). Individual species assessments were prepared with information on habitat and populations on the Forest. In total, three mammals, nine birds, and 24 plants were identified (see following table).

Table 3-35. Species of local concern on Bighorn National Forest.

Common Name	Scientific Name	Habitat	Species Occurrence on Forest
Mammals			
Long-eared myotis	*Myotis evotis*	Caves/Mines	Known, but to limited sites.
Hoary bat	*Lasiurus cinereus*	Aspen/Conifer Snags	None known, but potential habitat. Due to lack of aspen on Forest, may be less potential than other areas of state where known to occur.
Rocky Mountain bighorn sheep	*Ovis canadensis*	Rock/ Alpine meadow	Historic forest-wide. Currently in Shell Cr. watershed with <30 animals.
Birds			
Common loon	*Gavia immer*	Wetland/Lake	Known observations, but no known breeding.
Merlin	*Falco columba-rius*	Ponderosa Pine/Riparian	Known, but to few areas due to limited potential habitat. Nests in trees.
Swainson's hawk	*Buteo swainsoni*	Grassland/Riparian	Known to few areas. Nests in trees.
Great gray owl	*Strix nebulosa*	Mature Conifer	Suspected occurrence, and potential habitat.
Pygmy nuthatch	*Sitta pygmaea*	Mature Conifer	Known, but from limited sightings.
Calliope hummingbird	*Stellula calliope*	Conifer/Riparian	One known occurrence.
Golden-crowned kinglet	*Regulus satrapa*	Spruce-fir	Known, but through limited occurrences.
Plants			
Musk root	*Adoxa moschatellina*	Shady, moist, moss-rich limestone cliffs	Known – two locations, one in Leigh Cr. pRNA
Aromatic pussytoes	*Antennaria aromatica*	Open slopes/ridges, limestone talus at or above timberline	Known – one location.
Pygmy pussytoes	*Antennaria monocephala*	Wind swept, open slopes, ridges in alpine or subalpine tundra	Known – one location in Cloud Peak Wilderness.
Upward lobed moonwort	*Botrychium ascendens*	Hummocky marshes and bogs	Known from one occurrence on Forest.

Common Name	Scientific Name	Habitat	Species Occurrence on Forest
Lance-leaved grapefern	*Botrychium lanceolatum*	Riparian areas, organic rich hummocks	Known –one occurrence.
Mingan moonwort	*Botrychium minganense*	Wide variety: riparian, moist meadows, sand dunes, prairies, woods.	Known – two occurrences, one in Mann Cr. pRNA
Rattlesnake fern	*Botrychium virginianum*	Calcium rich, moist shady areas	Known - one occurrence in Mann Cr. pRNA
Mud sedge	*Carex limosa*	Wetlands, often limey	Known from one occurrence on Forest.
Short-leaved sedge	*Carex misandra*	Alpine wet meadows, willows, streambanks	Known – one occurrence in McClain pRNA
Leafy thistle	*Cirsium foliosum*	Moist areas along roads, meadows, slopes	Known –one occurrence.
Fragile rockbrake	*Cryptogrammast elleri*	Moist wooded slopes and limestone cliffs	Known – one occurrence in Cloud Peak Wilderness
White arctic whitlow-grass	*Draba fladnizensis var. pattersonii*	Fellfields and talus slopes above 1000 feet	Known – two occurrences in Cloud Peak Wilderness
Howard forget-me-not	*Eritrichium howardii*	Limestone outcrops and dry rocky areas	Known from one occurrence on Forest.
Woodland horsetail	*Equisetum sylvaticum*	Preacher Rock Bog - riparian	Known – one occurrence on Forest.
Low fleabane	*Erigeron humilis*	Granite and limestone cliff faces on moist mossy microsites	Known – one occurrence in Cloud Peak Wilderness.
Three-flower rush	*Juncus triglumis var. triglumis*	Wet gravel slopes below melting snows	Known – one occurrence in Cloud Peak Wilderness.
Watson's prickly-phlox	*Linanthus watsonii*	Dry ledges on sedimentary cliffs.	Known from one occurrence on Forest.
Northern twayblade	*Listera borealis*	Moist, shady spruce forests.	Known from two locations on Forest.
Broad-leaved twayblade	*Listera convallarioides*	Moist, shady spruce forests.	Known from one occurrence on Forest.
Sheathed musineon	*Musineon vaginatum*	Limestone outcrops, chugwater redbeds	Known – six occurrences on Forest.

Common Name	Scientific Name	Habitat	Species Occurrence on Forest
Alpine poppy	*Papaver kluanense*	Alpine meadows, talus slopes and fellfields	Known – one occurrence in Cloud Peak Wilderness plus additional unconfirmed reports.
Mountain lousewort	*Pedicularis pulchella*	Alpine meadows and alpine scree slopes	Known – two occurrences in Cloud Peak Wilderness.
Large-leaved pondweed	*Potamogeton amplifolius*	Lakes and slow moving streams	Known – one occurrence in Cloud Peak Wilderness.
Hairy prince's plume	*Stanleya tomentosa var. tomentosa*	Limber pine woodlands, juniper shrublands on limey-sandstone ridges, dry dolomite cliffs/talus	Known -one occurrence near Shell Canyon RNA.

Bat species selected are indicative of state heritage rankings showing rarity or concern, coupled with possible management activities in their habitats. Bighorn sheep were selected due to past historic occurrence and struggling populations currently. Disease interactions with domestic livestock (sheep) are likely the issue, though the issue is complicated by similar interaction potentials on adjoining private land where bighorn sheep winter.

Bird species selected were largely due to lack of information on occurrence, and yet state heritage rankings were of sufficient concern to justify inclusion since management activities can occur in their potential habitat.

Plant species were selected to help prioritize inventory efforts over the next planning period, though most selected were not due to management related threats.

Environmental Consequences
Species of Local Concern

As a Biological Evaluation was not required for local concern species, effects to these species were addressed through the viability process document contained in the project record, according to the habitat type with which they are associated. There were no determinations made as required for the sensitive species. However, viability outcomes were assessed for each species, though this is largely speculative based on the lack of population information for most of the species. Viability outcomes were previously described in the introduction of the single species assessment. The following table summarizes the viability outcomes and includes those attributable to Forest Service management activities tied to alternatives and cumulative effects (CV). A summary of effects for the species follows the table.

Table 3-36. Viability outcomes for species of local concern on the Bighorn National Forest by alternative.

Species of Local Concern	Alt A	Alt B	Alt C	Alt D	Alt E
Long-eared myotis	V-B[13] CV-II[14]	V-B CV-II	V-B CV-II	V-B CV-II	V-B CV-II
Hoary bat	V-B CV-II	V-A CV-I	V-A CV-I	V-A CV-I	V-B CV-II
Bighorn sheep	V-C CV-V	V-C CV-V	V-C CV-V	V-C CV-V	V-C CV-V
Common loon	V-A CV-I	V-A CV-I	V-A CV-I	V-A CV-I	V-A CV-I
Swainson's hawk	V-B CV-III	V-B CV-III	V-B CV-III	V-B CV-III	V-B CV-III
Merlin, Great gray owl, Pygmy nuthatch, Calliope hummingbird, Golden-crowned kinglet	V-B CV-II	V-A CV-I	V-A CV-I	V-A CV-I	V-B CV-II
Musk root, Pygmy pussytoes, Mud sedge, Short-leaved sedge, Leafy thistle, Howard forget-me-not, Fragile rockbrake, Sheathed musineon, Upward lobed moonwort, Lance-leaved grapefern, Mingan moonwort, Rattlesnake fern, Woodland horsetail, Alpine poppy, Mountain lousewort, Large-leaved pondweed	V-B CV-II	V-B CV-II	V-B CV-II	V-B CV-II	V-B CV-II
White arctic whitlow-grass, Low fleabane,	V-A CV-I	V-A CV-I	V-A CV-I	V-A CV-I	V-A CV-I

[13] Viability (V) Outcomes: Described in introduction to this Single Species assessment section. Range from A (stable), to E (high risk), thus the A – E ratings for those ecological conditions resulting form FS management of habitat.

[14] Cumulative Viability (CV) Outcomes: Described in the introduction to this section. Range from I (stable) to V (high risk). These ratings include cumulative effects from adjoining lands or other influencing factors beyond the scope and control of the Forest Service.

Species of Local Concern	Alt A	Alt B	Alt C	Alt D	Alt E
Aromatic pussytoes, Watson's prickly-phlox, Three-flower rush	V-C CV-III	V-C CV-III	V-C CV-III	V-C CV-III	V-C CV-III
Northern twayblade, Broad-leaved twayblade, Hairy prince's plume	V-B CV-III	V-B CV-III	V-B CV-III	V-B CV-III	V –B CV-III

Effects to species of local concern were addressed by habitat group association in the viability process document in the project record. The rationale for the above outcomes are summarized below.

The effects to the bat species would be similar to those described for sensitive bat species previously, with the exception that hoary bats are known to occur more in forested areas and use snags. Therefore, there may be a higher risk in alternatives where the greatest management of forested treatments occurs (E and A). They may preferentially use aspen, due to the larger number of cavities or prey associations. Due to their migratory status, cumulative effects are more speculative.

Bighorn sheep would not likely continue as a viable population on the Forest due to potential disease transmissions from domestic sheep. Even if domestic sheep were removed from the Forest (refer to the Alternatives Considered but Not Analyzed In Detail section in DEIS Chapter 2), the bighorn sheep could still interact with domestic sheep on their winter range as this involves cumulative effects from private lands off the Forest where domestic sheep occur. The Revised Plan contains conservation measures to benefit bighorn sheep, particularly within the Shell Cr. watershed where bighorn sheep are currently known to persist. Due to the presence of domestic sheep, the WGFD has not made the Forest a priority for reintroduction, as the past reintroduction effort of 1994 was unsuccessful. The Forest Service and the WGFD have identified priority recovery sites in Wyoming and have implemented actions toward those recovery goals, in which the Bighorn NF has taken an active role. The Bighorn NF is currently considered a "non-emphasis" management area for bighorn sheep and is not a priority recovery site. There would be no difference among alternatives with regard to management for bighorn sheep, as conservation measures apply forestwide. Habitat remains in good condition on the Forest, but the potential for disease likely limits its value.

The effects to the common loon would be similar to those previously described for the harlequin duck (see the sensitive species section). The effects to the avian species associated with mature conifer, old growth, snags, or coarse woody debris (great gray owl, pygmy nuthatch, golden-crowned kinglet, merlin, calliope hummingbird) would also be similar to the effects described for the sensitive species linked to this type of habitat.

The effects to grassland avian species (Swainson's hawk) would be similar to those described for the sensitive grassland avian species (harrier, short-eared owl). This species is highly migratory and has been suffering cumulative effects on its winter range.

Effects to the plant species of concern would be similar to those described for the sensitive plant species previously. In addition to the species of local concern, plant demand species were listed in the Revised Plan and include sweetgrass and purple coneflower. Sweetgrass is known to occur on the Forest and is collected by Americans Indians for ceremonial purposes. This plant may be in decline due to this factor and other habitat related factors, though details are unknown. Purple coneflower is not currently known to occur on the Forest, but is known adjacent to it. It is collected for its medicinal values. Designation as demand species will provide emphasis for inventory and monitoring and assessing habitat and collection related effects. The Forest can regulate collection of plant materials through a permit process should the effects deem this necessary.

Summary of Environmental Consequences

In summarizing the effects of the alternatives, the following table provides the number of species viability outcomes by each alternative taken from the non-cumulative effects tables, for all species at risk.

Table 3-37. Summary of species viability outcomes by alternative, from anticipated Forest management activities.

Alternative	# Species with Outcome A	# Species with Outcome B	# Species with Outcome C	# Species with Outcome D	# Species with Outcome E
Alt A	7	55	10	0	0
Alt B	21	41	10	0	0
Alt C	21	41	10	0	0
Alt D	21	41	10	0	0
Alt E	7	55	10	0	0

From this table, the inherent risks involved with additional roading are the most prevalent influence on the viability outcomes. In general, due to the risks associated with roads, alternatives with an increased level of roading over current levels carry more risk for most species, either due to habitat lost, additional disturbance from people, dispersal of noxious weeds, and to a lesser extent, fragmentation issues. However, it is recognized that under Alternative E, the maximum timber harvest alternative, activities over time would be scheduled on less than 30% of the forested acres on the Forest, tempering these potential effects. Alternative C would be at the other range of the spectrum, scheduling harvest activities on approximately 7% of the forested acres within the Forest. None of these risks would be likely to lead toward a trend in federal listing or loss of viability for any of the sensitive species, and updated

forest plan direction in standards and guidelines would provide a level of protection for these species across all alternatives. The direction to survey for species, design projects to promote habitat, and mitigate potential concerns from management activities such as through spatial or temporal buffers would provide baseline levels of protection for these species. With the baseline of goals, objectives, standards, and guidelines in the Revised Plan, all alternatives provide for the viability of species, some with more risk associated, but also with differing approaches in terms of the level of natural disturbance processes used vs. management induced processes, primarily in terms of vegetative manipulation.

Fire and Fuels Management

Introduction

The Bighorn National Forest fire management program has two broad purposes:

1. To protect and enhance resources through wildfire prevention, fuel treatment, prescribed fire, and implementation of the appropriate management response to all wildland ignitions.
2. To meet Forest management goals and objectives through the use of prescribed fire and the management of natural fires.

Although a variety of natural disturbances occur in the Rocky Mountains, fire is the predominant one. Fire has shaped the vegetation mosaic for thousands of years by causing a variety of scales of disturbances (Knight 2001). Fire is also thought to have been a major disturbance agent for the Big Horn Mountains. Fire has a significant role in the various ecosystems on the Bighorn National Forest and has a major influence on structure, density, species composition, and age of shrub and forest vegetation. An accurate and detailed description of "natural" fire regimes is difficult because detailed fire histories are lacking for the Big Horn Mountains. Searches of historical literature have resulted in known fires prior to 1910, however, exact locations and sizes have not been ascertained. In addition, there are historical references indicating that large portions of the Big Horn Mountains were burned in the 1870s, although locations and acreages are not known.

The use of prescribed fire has been practiced on the Forest since the 1970s. These fires have primarily been used for fuels reduction and to improve or enhance habitat for wildlife and range for domestic livestock. Acres burned annually have varied significantly, but most recently have averaged about 2,600 acres. Most of the burns have been conducted in sagebrush/grass areas with a minor amount of burning within conifer stands. Prescribed fire has also been commonly used to reduce activity fuels following timber harvest.

The current Bighorn National Forest Land and Resource Management Plan (1985) does not allow for implementation of wildland fire use (managing natural ignitions to meet resource objectives). After the signing of the Record of Decision (ROD) for this forest plan revision, the Bighorn Fire Management Plan will be updated to address opportunities for wildland fire use/appropriate management response across the Forest. The ROD is the decision document for the appropriate management response identified for each management area and the Fire Management Plan is the implementation document.

Currently, all wildland fires receive an immediate initial attack response. Cody Interagency Dispatch Center (CDC) located in Cody, Wyoming, serves the Forest through dispatch for initial attack, resources for extended attack, and large fire support.

Legal and Administrative Framework

The Organic Administration Act – June 4, 1897 (U.S.C.551): Authorizes the Secretary of Agriculture to make provisions for the protection of national forests against destruction by fire.

The Economy Act of 1932 – June 30, 1932 (41 U.S.C. 686): Provides for the procurement of materials, supplies, equipment, work, or services from other federal agencies.

The Reciprocal Fire Protection Act – May 27, 1955 (42 U.S.C. 1856): Authorizes reciprocal agreements with federal, state, and other wildland fire protection organizations.

The Wilderness Act – September 3, 1964 (16 U.S.C. 1131, 1132): Authorizes the Secretary of Agriculture to take such measures as may be necessary in the control of fire within designated wilderness.

The National Forest Management Act of 1976 – October 22, 1976 (16 U.S.C. 1600): Directs the Secretary of Agriculture to specify guidelines for land management plans to ensure protection of forest resources.

The Clean Air Act of 1977 (42 U.S.C. 1857): Provides for the protection and enhancement of the nation's air resources.

The National Forest Directives System (Manuals, Handbooks and their current amendments) outlines the administrative framework for fire management activities, which includes protecting resources and other values from wildfire and using prescribed fire to meet land and resource management goals and objectives. The framework in these manuals and handbooks provides for cost-efficient wildfire protection and embraces the positive roles that fire plays on National Forest lands. Specifically, fire management guidance can be found in Forest Service Manual 5100, chapters 10 through 90, and Forest Service Handbooks 5109.14, 5109.17, 5109.18, and their subsequent amendments.

Other publications include *The Wildland and Prescribed Fire Management Policy: Implementation Procedures Reference Guide* (and its January 2001 update) and the National Fire Plan. The first publication represents an effort by federal wildland fire management agencies to establish standardized procedures to guide immediate implementation of the policy described by the 1995 Federal Wildland Fire Management Policy and Program Review; it is used by the Forest Service as a guidance document. The National Fire Plan places an emphasis on protecting people and sustaining resources in fire-adapted ecosystems.

Key Indicators

- Appropriate management response.
- Condition class.
- Acres of timber harvest and fuels treatment.

AFFECTED ENVIRONMENT

Fire Regimes and Condition Class

A fire regime is a generalized description of the role fire plays in an ecosystem. Systems for describing fire regimes may be based on the characteristics of the disturbance, the dominant or potential vegetation of the ecosystem in which ecological effects are being summarized, or fire severity based on the effects of the fire on dominant vegetation (Agee 1993).

Vegetation on the Bighorn National Forest has been categorized into five fire regimes. These fire regimes have been quantified and described by the method used in the National Fire Plan (USFS 2000) and are consistent with Fire and Land Management Planning Across Multiple Scales (Hann 2001). This method groups cover types by a combination of fire frequency (expressed in terms of fire return intervals) and fire severity (intensity). Fire frequency is determined by ignition sources and burning conditions (primarily fuel moisture and wind). *Intensity* and *severity* are commonly used interchangeably; however, intensity is more an indicator of resistance to control and severity is a measure of ecological impact (i.e. tree mortality, impact to organisms, etc.). The following table displays the fire regime groups with associated cover types, fire return interval, and fire severity for the Bighorn National Forest. The fire return intervals and burn severity displayed for the various fire regimes/cover types are what would "historically" be expected; for example, a ponderosa pine stand historically would be expected to burn at relatively frequent intervals (less than 35 years) with a low surface fire intensity or understory burn (i.e. high frequency, low severity fire regime).

Table 3-38. Fire regime groups with associated primary cover type, frequency, and severity.

Fire Regime Group	Primary Cover Type	Fire Return Interval (Frequency)	Burn Severity
1	Ponderosa pine (Cottonwood)	0-35 years	Low/Understory Burn
2	Sagebrush Grass/forb (Willow)	10-70 years	High/Stand Replacement
3	Limber pine Douglas fir Rocky Mountain juniper	35-100+ years	Mixed Severity/Understory and Stand Replacement
4	Lodgepole pine	70-100+ years	High/Stand Replacement
5	Engleman spruce Subalpine fir Aspen	Over 150 years	High/Stand Replacement
No Fire	Bare soil, rock & water	N/A	N/A

Fire Regime 1 is a fire-maintained ecosystem as characterized by high frequency of low intensity (severity) fire. In a fire-maintained ecosystem, frequent low intensity fires reduce the incidence of destructive wildfires through thinning, pruning, and removal of dead and down fuels. Fire Regimes 2, 4, and 5 are fire-initiated ecosystems in which severe or high intensity fires will terminate the resident vegetation and initiate a vegetation response (i.e., stand replacement). Fire Regime 3 will burn with mixed severity (both low intensity and high intensity) depending on site-specific conditions.

Within the fire regimes described for the Bighorn National Forest, the following dominant cover species respond to fire occurrence and severity in a variety of ways (adapted from Fire Effects Information System, 2002). Note that in the information presented below, severity describes the product of fire intensity and fire residence time.

Ponderosa pine (*Pinus ponderosa var. scopulorum*): Interior ponderosa pine is rated "very resistant" to fire. Mature trees are well adapted to survive surface fires due to thick bark which protects the cambium layer[15], self pruning branches, open crowns which are usually elevated well above the flame zone avoiding excessive scorch, and deep rooting. Mature ponderosa pine cannot survive crown fires, but can survive considerable crown scorching. Surface fires often kill seedlings and saplings (trees less than 3 to 5 years of age or less than 6 inches diameter breast height), however, the effect is dependent on stand structure and fire intensity. Young trees in open stands develop fire-resistant traits rapidly, while those in dense stands tend to develop thinner bark and denser foliage, which makes them less resistant to surface fires and more prone to crown fires. Mature trees in open stands with light fuels and sparse understory are less vulnerable to mortality from fire than those in dense stands. Heavy accumulations of litter increase the intensity and duration of fires, making the trees more susceptible to mortality and scarring. Fire prepares favorable seedbeds for regeneration.

Wyoming big sagebrush (*Artemisia tridentata ssp. Wyomingensis*): Although Wyoming big sagebrush ignites readily and burns intensely, this fuel type is dependent on moderate wind speeds to move the fire through the shrub layer. At lower wind speeds, the fire will drop to the ground. Fires in Wyoming big sagebrush on the Bighorn National Forest typically are not continuous, creating a mosaic burn pattern in which seeds from surviving plants are the principal means of post fire reproduction. Wyoming big sagebrush is slow to re-establish after a burn and frequent fire may inhibit re-establishment. Some sites in southern Idaho that have burned 2 to 3 times within 10 years are not regenerating Wyoming big sagebrush and are converting to annual grasslands.

Mountain big sagebrush (*Artemisia tridentate ssp. Vaseyana)*: Mountain big sagebrush is readily killed by fire and will not resprout. Regeneration is from seed produced by on-site or off-site surviving plants, requiring at least 15 years to recover after fire.

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[15] The cambium is a layer of living, meristematic cells between the wood and inner most bark of a tree. The cambium allows for fluid and nutrient movement between the roots and leaves of the tree. The cambium layer of thin-barked tree species is easily damaged by heat from fire.

Limber pine (*Pinus flexilis*): The bark at the base of older limber pine trees is up to 2 inches thick, which protects these trees from low severity surface fires. However, the bark of young trees is very thin making them very susceptible to mortality from low severity fires. Terminal buds are protected from crown scorch because the needles form tight clusters around the buds. As with ponderosa pine, mature trees in open grown stands are less susceptible to mortality from fire. Wildfires are less frequent in limber pine communities than in other conifer habitats because of limited productivity and fuel accumulation associated with poor soil development, short growing seasons, and late snowmelt. Where limber pine grows in association with other trees, the fire regimes of the other species are relevant.

Rocky Mountain Douglas-fir (*Pseudotsuga menziesii var. glauca*): Sapling and pole stages of Rocky Mountain Douglas-fir are susceptible to fire damage due to thin and resin-filled bark. Young trees also generally characterized by low branching, which allows surface fires to transition into the crowns. Mature trees can survive moderately severe surface fires because the bark on the lower bole is thick and corky, providing good insulation of the cambium from heat damage. Fire resistance provided by thick bark in mature trees is off-set by the fact that the trees tend to retain low branching even after the lower branches have shaded out and died. This lower branching serves as a ladder for surface fire to transition into the crowns.

Rocky Mountain juniper (*Juniperus scopulorum*): Due to thin bark and compact crown, Rocky Mountain juniper up to 4 feet tall are easily killed by fire and because this species is slow-growing, they are susceptible to fire for their first 20 years or more. Mature trees develop thicker bark and more open crowns allowing them to survive surface fires if low branches do not carry fire into the crown. Highly volatile oil content in lower branches increases the flammability of the trees. Horizontal fuel continuity tends to be low in these fuel types, so crown fires are usually confined to small areas unless influenced by a strong wind event or extreme drought. Fire is the major factor controlling Rocky Mountain juniper. In general, this tree grows on sites that do not burn frequently, such as rocky areas. Post fire re-establishment is by seed with animal transport of seed being an important factor.

Lodgepole pine (*Pinus contorta var. latifolia*): The thin bark of the lodgepole pine provides little insulation to the cambium layer making the tree susceptible to mortality from surface fires. Low severity surface fires tend to provide natural thinning of lodgepole pine stands since some trees will survive the fires. Closed-cones and open-cones occur in most stands of lodgepole pine in the Rocky Mountain area. The closed or serotinous cones will open after intense fires to reseed the area. Low severity surface fires do not generate enough heat to open serotinous cones, so regeneration is dependent on open cones. Thus, lodgepole pine is adapted to regenerate after both high severity and low severity fires.

Engelmann Spruce (*Picea engelmannii*): Engelmann spruce is very fire sensitive and is often killed even by low severity surface fires. This susceptibility to fire is due to thin bark which provides little insulation for the tree's cambium layer, resin in the bark which

readily ignites, shallow roots which are subject to soil heating, low growing branches with moderately flammable foliage that can readily transition surface fire into the crown, tendency to grow in dense stands, and presence of heavy lichen growth. While some of the larger Engelmann spruce may survive surface fires, they often will die later as a result of infection from wood-rotting fungi that enter the tree through fire scars. Post fire regeneration occurs via wind-dispersed seeds from surviving or adjacent trees.

Subalpine fir (*Abies lasiocarpa*): Subalpine fir is very fire sensitive and is often killed by low severity surface fires. Its susceptibility to fire is due to the same factors described above for Engelmann spruce. The discontinuous, broken fuels and moist, cool, environment of subalpine fir habitat often allows scattered trees to escape fires. Dense stands are susceptible to infrequent high severity crown fires, which will kill all trees within the fire area. Post fire regeneration occurs via wind-dispersed seeds from surviving or adjacent trees.

Quaking aspen (*Populus tremuloides*): In general, aspen is thin barked with little heat resistance. Small diameter aspen is usually top killed by low severity surface fires. While large aspen may survive low severity fire, they usually show damage. Moderate severity fire usually top kills most aspen although some of the largest trees may survive. Moderate to high severity fire does not damage aspen roots, but high severity fire may kill roots near the surface while leaving the deeper roots undamaged. Following a fire, aspen sprouts or suckers from the roots and also establishes from off-site wind blown seed.

In addition to the five fire regimes outlined in the National Fire Plan, three condition classes have been developed to categorize the current condition with respect to each of the historic fire regime groups. Current condition is defined in terms of departure from the historic fire regime determined by the number of missed fire return intervals (with respect to historic fire return interval) and the current structure and composition of the system resulting from alterations to the disturbance regime. Note that the relative risk of fire-caused losses of key system components increases for each respectively higher numbered condition class, with little or no risk at Condition Class 1.

Table 3-39. Condition class[16] descriptions.

Condition Class	Fire Regime
1	Fire regimes are within a historic range and the risk of losing key ecosystem components is low. Vegetation attributes (species composition and structure) are intact and functioning within a historic range.
2	Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical frequencies by one or more return intervals (either increased or decreased). This results in moderate changes to one or more of the following: fire size, intensity and severity, and landscape patterns. Vegetation attributes have been moderately altered from their historical range.
3	Fire regimes have been significantly altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been significantly altered from their historical range.

The following table summarizes the condition classes for the fire regimes currently identified on the Bighorn National Forest. These figures were derived through the use of GIS, using species and structural stage as the determining variables. As the table indicates, the majority of the acres in Fire Regimes 4 and 5 (long fire return interval) are in Condition Class 2. This implies they have missed at least one fire return interval. Due to the long fire return interval of the species involved, these stands likely are at the upper end of Condition Class 1 or early into Condition Class 2, so it was somewhat of a judgment call to place them into Condition Class 2. It should be noted that approximately 10% of the total area on the Bighorn National Forest is naturally not vegetated (rock, bare soil, and water).

Table 3-40. Fire regime and condition class.

Fire Regime	Condition Class	Cover/Vegetation Type	% of Vegetated Acres on Forest
1	1	Ponderosa pine	<1%
1	2	Ponderosa pine	<1%

[16] Current conditions are a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire suppression, timber harvesting, grazing, introduction and establishment of exotic plant species, insects or disease (introduced or native), or other past management activities. Source: *Protecting People and Sustaining Resources in Fire-adapted Ecosystems: A Cohesive Strategy*.

Fire Regime	Condition Class	Cover/Vegetation Type	% of Vegetated Acres on Forest
1	3	Ponderosa pine	3%
2	1	Sagebrush/Grass/Forb	<1%
2	2	Sagebrush/Grass/Forb	<1%
2	3	Sagebrush/Grass/Forb	29%
3	1	Limber pine/Douglas-fir/Rocky Mtn. juniper	<1%
3	2	Limber pine/Douglas-fir/Rocky Mtn. juniper	8%
3	3	Limber pine/Douglas-fir/Rocky Mtn. juniper	4%
4	1	Lodgepole pine	2%
4	2	Lodgepole pine	27%
4	3	Lodgepole pine	3%
5	1	Engelman spruce/Subalpine fir/ Aspen	1%
5	2	Engelman spruce/Subalpine fir/Aspen	21%

Source: Protecting People and Sustaining Resources in Fire-Adapted Ecosystems: A Cohesive Strategy.

Fire Hazard Analysis

The potential for wildland fire is measured in terms of fire hazard and resistance to control. Wildland fire hazard can be directly related to stand age, stand structure, live and dead fuel loads, and their resulting effects on fire behavior. In an effort to model fire behavior, fire managers have developed fire behavior modeling systems. Two of the most commonly used are the NFDRS (National Fire Danger Rating System) and the FBPS (Fire Behavior Predication System) models.

NFDRS is used as an indicator of fire potential and fire behavior across broad areas. These areas may include many thousands of acres. FBPS is useful for more site-specific applications. The FBPS model illustrates the differences in fuels and how they react to factors such as wind, humidity, and topography after an ignition occurs.

Output from the FBPS can be rated based on relative resistance to fire suppression activities. The classifications usually used are low, moderate, high, and extreme which are a function of flame length and rate of spread. Low resistance to control typifies fires that are relatively easy to suppress in short time frames. Although fires in the low hazard category generally correspond to the shortest flame length and lowest intensity levels, they can exhibit rapid rates of spread and other elements of extreme fire behavior when subjected to very low humidity and/or high wind speeds. High-resistance fuels typically consist of the older age conifer fuel types with heavy fuel loading or shrub lands with extreme fuel loading (e.g.,

older stands of sagebrush). These fuels can often produce extreme flame lengths and fire intensities, which exceed the capability of direct fire suppression action.

In an effort to model fire hazard on the Bighorn NF, a forest-wide analysis was completed using GIS (Geographic Information System), FlamMap (Finney 2000), RMRIS (Rocky Mountain Resource Information System), and CVU (Common Vegetative Units). FlamMap is a computer program that produces fire behavior values (e.g., rates of spread, flame lengths) based on weather and physical characteristics of the ground and allows the user to produce fire behavior maps.

The objective of this hazard analysis is to quantify flame length, using 90th percentile weather[17], across the landscape. Flame length is a function of fireline intensity. It is used to estimate the difficulty of controlling a fire, as well as to estimate whether the fire will torch (ignite the crown of an individual tree or crowns of groups of trees), spot (embers from the fire land on unburned fuels and ignite new fires), or crown (transition from the surface into the tree tops and continue to advance in the crowns).

Flame lengths are routinely grouped into four categories: (1) low – flame lengths four feet or less, (2) moderate – flame lengths greater than four feet and less than or equal to eight feet, (3) high – flame lengths greater than eight feet and less than or equal to eleven feet, and (4) extreme – flame lengths greater than eleven feet. These groupings are commonly used fire behavior thresholds and are further described in the table titled "Hazard and flame length summary."

Methods for Determining Fire Hazard

Fire hazard can be directly related to stand age, stand structure, live and dead fuel loads, and their resulting effects on fire behavior. Differences in fuels and how they react to such factors as wind, humidity, and topography are also considerations.

Crown base height (CBH), crown bulk density (CBD), and stand height were determined for the average site for each cover type and subsequently for each forested fuel model identified on the Bighorn National Forest. Live and dead fuel moisture levels and wind speed and direction were determined using historical Remote Automated Weather Station (RAWS) weather station data processed through Fire Family Plus. GIS was used to create a fuel model layer and the above information was used for FlamMap, which is a program to display fire hazard.

Fuel models are mathematical descriptions of fuel properties that allow the user to realistically estimate fire behavior. A fuel model layer was created in GIS based on the 13 standard Fire Behavior Prediction System (FBPS) fuel models (Anderson, GTR INT-122, April 1982). The following table lists the FBPS fuel models identified for the

[17] 90th percentile weather represents days when the fire danger is very high to extreme—a combination of low humidity, high temperature, and high winds. It should be noted that percentiles can be approximated to seasonal fire behavior nomenclature where 90th percentile equates to "drought conditions."

Forest. It should be noted that approximately 10% of the total area on the Bighorn National Forest is naturally not vegetated (rock, bare soil, and water).

Table 3-41. Fire Behavior Prediction System (FBPS) fuel models.

Fuel Model	Description	% of Vegetated Acres on Forest
1	Short grass	20%
2	Timber with grass understory	4%
5	Brush (short brush/seedlings/sapling)	5%
6	Sagebrush	6%
8	Closed timber litter	48%
9	Hardwood litter	1%
10	Timber (litter and understory)	16%

Because crown base height (CBH), crown bulk density (CBD), and stand height were determined for each timbered fuel model identified on the forest, the model was able to calculate surface to crown fire transition, as well as, crown fire behavior.

Fuel moisture is a critical component for evaluating fire hazard. Fuel moisture is the amount of water in a fuel, expressed as percent of its oven-dry weight. Moisture content influences how quickly a fuel will ignite and how well it will burn. When the moisture content of fuels is high, fires do not readily ignite and will burn poorly if at all. When the moisture content is low, fires start easily and influences such as wind can cause rapid spread with high intensity (NFES 2378, National Interagency Fire Center 1994).

Wildland fuels are any organic material, living or dead, that can ignite and burn. Living vegetation, such as grasses, forbs, shrubs, and trees, may actively contribute to a fire's energy or may retard the spread and intensity, depending on the moisture level of those fuels. In live fuels, moisture content changes seasonally, exhibiting the highest moisture content during spring green-up with moisture content decreasing throughout the growing season and culminating in the lowest moisture content as fuels cure or enter dormancy. Dead fuel moisture is a function of weather conditions (specifically, precipitation and relative humidity) and the fuel's reaction to changes in weather is a function of composition (e.g., duff, needles, leaves, sound wood, rotten wood), size (depth of the duff, diameter of the wood), and shape (surface to volume ratio, etc.).

Timelag is defined as the time it takes a dead fuel to reach 63% of the difference between its initial moisture content and equilibrium moisture content[18] due to changes in its environment. Dead fuels are classified into timelag groups according to the time it takes them to gain or lose moisture in response to wetting or drying cycles. Each timelag group

[18] Equilibrium moisture content is the level at which dad fuels neither gain or lose moisture with time, under specific constant temperature and humidity. At equilibrium moisture content, a fuel will have no net exchange of moisture with its environment.

includes dead fuels of specific diameter ranges. In general, the smaller the fuel diameter, the shorter the timelag, which is primarily a function of surface to volume ratio. Fine fuels (those with very small diameter) have a high surface to volume ratio, which is conducive to moisture exchange. The standard dead fuel timelag classes with associated diameter ranges are displayed in the following table.

Table 3-42. Dead fuel timelag classes.

Timelag Class	Fuel Diameter
1-hour	Less than ¼ inch
10-hour	¼ to 1 inches
100-hour	1 to 3 inches
1,000-hour	Greater than 3 inches

The 1-hr fuels (grasses, small twigs, pine needles) gain or lose moisture faster than 10-hr, 100-hr, or 1,000-hr fuels. They dry out faster and reach their equilibrium moisture content more rapidly. When dried to a point below their respective moisture of extinction, they can ignite and burn readily. The moisture of extinction is the fuel moisture content at which a fire will not spread or spreads only sporadically in a non-predictable manner. Conversely, an increase in atmospheric moisture (precipitation, fog, high humidity) can keep them from igniting or burning if their percent fuel moisture is near or above their moisture of extinction. These fuels are the greatest contributor to fire intensity at the flaming front. In contrast, under normal conditions 1,000-hour fuels are considered a heat sink and not a heat source primarily due to their low surface to volume ratio. Although they may not contribute directly to fire intensity at the flaming front,[19] they increase intensity following passage of the flaming front and as such are important in resistance to control of fires.

Surface wind speed is often the most critical weather element affecting fire behavior and fire danger. It is also the most variable and, consequently, the hardest to evaluate. Winds that persist for one minute and momentary gusts both affect fire behavior. For this analysis, both the probable maximum one-minute wind speed and probable momentary wind gust were used because both play important roles in fire behavior. Probable maximum 1-minute wind speed was used because winds that persist for one minute can affect gross fire behavior, including rate of spread and fireline intensity, thereby affecting surface to crown fire initiation and transition. Probable momentary wind gust was used because gusts can produce large, temporary fluctuations in flame height and can easily trigger crowning or shower embers across the fireline.

Fuel moisture, wind speed, and wind direction values were obtained using historic weather data from the Burgess, Hunter, Schoolhouse Park, and Mill Creek weather stations and RAWS which are representative of the Forest. A comparison of weather data from these

19 Flaming front is the zone of a moving fire within which the combustion is primarily flaming. The flaming front in light fuels is typically shallow, whereas, a deeper front occurs with a component of heavier fuels.

stations indicated a close correlation among the various areas of the Forest. As a result, it was decided to use an average range of values from these stations. The following table summarizes 90th percentile weather from weather stations.

Table 3-43. Range of fuel moisture levels and wind speeds based on historic weather data for the Bighorn National Forest.

10-hr fuel moisture level % by wt.	100-hr fuel moisture level % by wt.	1-hr fuel moisture level % by wt.	20 foot Wind Speed MPH	Probable max. 1-min wind speed MPH	Probable momentary gust MPH
4-6	7-9	4-5	14-17	19-22	28-32

This percent range of fuel moisture levels indicates extreme fire conditions on the Forest. Although the wind speeds by themselves are not problematic, when combined with very low fuel moisture levels, fires are more likely to display extreme behavior—characteristics beyond those exhibited by most fires. Although relatively few fires exhibit extreme behavior, those that do, present many challenges in suppression, and in providing for firefighters and public safety.

Fuel models, crown base height (CBH), crown bulk density (CBD), stand height, fuel moisture levels, and wind speeds were input into FlamMap and used to obtain flame length. As previously mentioned, flame length is used to estimate how difficult it is to control a fire and whether the fire will torch, spot, or crown. The following table displays hazard ratings with associated flame lengths, and implications for fire suppression.

Table 3-44. Hazard and flame length summary.

Hazard Rating	Flame Length (feet)	Fire Suppression Interpretation
Low	Less Than 4	Fires can generally be attacked at the head or flanks by persons using hand tools. Handline should hold the fire.
Moderate	4.1 to 8.0	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
High	8.1 to 11	Fires may present serious control problems, i.e., torching, crowning, and spotting. Control efforts at the head of the fire will probably be ineffective.
Extreme	Greater Than 11	Crowning, spotting, and major fire runs are common. Control efforts at the head of the fire are ineffective.

The following table displays acres in the fire hazard rating class calculated for the probable maximum 1-minute wind speed, 22 miles per hour (mph), and the probable momentary gust, 32 mph. The effect of these two different wind speeds is particularly noticeable in the extreme hazard classes. Acreage in this class is significant because it indicates resistance to fire suppression efforts. 20-foot winds refer to the standard height for wind measurements

used by land management agencies in the U.S. Wind speeds are measured 20 feet above the surface, adjusted for vegetation depth (Rothermel 1983). The fire hazard rating class was run for the Bighorn National Forest, as a whole, because there is not a distinct difference between the various geographic areas of the Forest in regard to fire hazard, with the exception of the Cloud Peak Wilderness. In the Cloud Peak Wilderness, the majority of the land area is rock, bare soil, or water, none of which will carry fire. The fuel and wind elements were obtained using RAWS (Remote Automated Weather Station) and older manual weather data, downloaded to Fire Family Plus and filtered to obtain 90th percentile conditions.

Table 3-45. Percent of area (excluding non-vegetated areas) in each fire hazard rating class for 22 mph winds and 32 mph wind gusts for the Bighorn National Forest.

22 mph, 20-foot winds			
Low	**Moderate**	**High**	**Extreme**
91.9%	4.1%	3.9%	<.1%
32 mph, 20-foot winds			
Low	**Moderate**	**High**	**Extreme**
81.4%	12.6%	1.8%	4.2%

The hazard rating analysis has some limitations. Since CBD, CBH, and tree height were calculated on the "average" site for each cover type and subsequent fuel model, the analysis underestimates fire behavior at the upper end for each fuel model, especially is it relates to surface to crown fire initiation, transition and canopy fire behavior. For this analysis, we used worst-case weather and fuel conditions, which may compensate somewhat for use of "average" site data.

Fire Risk Analysis

To further evaluate the relationship of fire to overall forest management and protection, fire hazard must be related to risk. Risk relates to the source and number of ignitions, which can result from either human-caused or natural (i.e. lightning) ignitions. Although fire risk is simple to calculate, it is often difficult to predict, especially with human-caused fire starts.

Fire risk is the simple measure of fire starts on a 1,000-acre basis per ten-year period (per decade). The fire risk value corresponds to a likelihood of fire starts per 1,000 acres per decade. The following are risk ratings with the ranges of values used to categorize risk.

- Low Risk: 0 to 0.49 – This projects a fire every 20 or more years per thousand acres.
- Moderate Risk: 0.5 to 0.99 – This projects one fire every 11 to 20 years per thousand acres.
- High Risk: ≥ 1.0 – This level projects at least one fire every 0 to 10 years per thousand acres.

The risk analysis used historical fire data from 1970 to 1996. Fire locations were plotted and overlaid on a Forest map. This revealed no definitive, homogeneous geographic areas in which to group fire occurrence; therefore, fire risk was analyzed on the Fire Management Zones (FMZs) established in NFMAS for the Bighorn NF. The Fire Management Zones and associated fire risk are displayed in the following table.

Table 3-46. Fire risk analysis (1970 – 1996) for the Bighorn National Forest.

Analysis Area	% of Bighorn NF	Number of Ignitions	Natural (Lightning) Ignitions	Human-caused Ignitions	Fire Risk
FMZ 1, Bighorn Mountain Face Below 7000 Feet	27%	215	151	64	.27 Low
FMZ 2, Montane Above 7000 Feet	56%	354	113	241	.21 Low
FMZ 3, Cloud Peak Wilderness	17%	12	4	8	.02 Low
Bighorn NF Average		581	268	313	.19 Low

Source: Fire Management Zones (FMZs), acres, and ignition data are from Bighorn National Forest NFMAS.

ENVIRONMENTAL CONSEQUENCES

General Effects

The structure and condition of the vegetative ecosystems on the Bighorn National Forest are dynamic. Climate, natural processes (such as insect and disease activity, fire, and wind events), and human activity all play a role in vegetative condition, structure, live and dead fuel loading, and subsequent fire behavior.

In **Fire Regime 1** which is primarily ponderosa pine, absence of frequent fire and/or management activities trend toward allowing surface fuel loading in the form of dead and down fuels, seedling/sapling trees, shrub vegetation, and overall stand density to increase. This increase in understory fuel load would produce higher surface fire intensity would create conditions in which transition from surface fire to crown fire could occur more readily and more frequently. The stand density would facilitate extreme fire behavior with stand replacement conditions which are uncharacteristic for ponderosa pine. Where this type of fire behavior occurs over large areas, sites are usually slow to regenerate, primarily because tree species associated with this fire regime group are adapted to surface fire, not stand-replacing fire.

Fire Regime 2 includes the drier shrubland communities, specifically sagebrush/grass. These vegetation communities are important food sources for many wildlife species and for

domestic livestock. Following a fire, this vegetation type usually responds by producing a heavy grass and forb component. Where sprouting vegetation (e.g., bitterbrush and serviceberry) is present, young shoots usually revegetate the site. Absence of fire in these communities is usually indicated by the presence of older, decadent vegetation with reduced forage production. Fire behavior in the younger communities with a high grass component typically exhibits rapid rates of spread with relatively short flame lengths. In the older decadent stands that have experienced an absence of fire, flame lengths and fire line intensity are much higher.

Burns within sagebrush communities on the Bighorn National Forest typically are not continuous and generally create a mosaic pattern. Re-colonization of the burned area is through seed dissemination and is dependent on the number and location of residual plants, climatic conditions, and/or the size of the burned area.

Fire Regime 3 includes species with fire return intervals of ranging from 35 to over 100 years. Specifically, on the Bighorn National Forest, Fire Regime 3 includes species such as limber pine, Douglas-fir, and Rocky Mountain juniper. Fires in these stands will burn with a mixed severity varying from a low intensity understory burn to a high intensity stand replacement burn. Fuels buildup through exclusion of fire and/or management activities is a primary factor in increasing severity of burns in this group. The absence of management activities and/or frequent fire occurrence would trend toward allowing dead and down fuels and understory vegetation to build up to the point of creating a higher intensity fire situation than historically would be expected to occur.

Fire Regime 4 includes older dense stands of lodgepole pine. Lodgepole pine is typically an early-seral tree species that establishes as a result of fire. Lodgepole pine can be the persistent seral stage vegetation on sites with relatively frequent disturbances or the climax vegetation on sites with regular disturbances. Subsequently, fire return intervals could be as low as 35 years, but are more frequently well over 100 years. On the Bighorn National Forest, fires in lodgepole pine have historically been both surface and stand replacement crown or canopy fires. Dense stands containing accumulated downfall and ladder fuels have high potential to support a stand-replacement fire. Conversely, after a burn that removes most large fuels, young pole-size stands of pure lodgepole pine have a low potential to initiate crown fire due to lack of ground fuels. When a lodgepole pine stand becomes mature or over-mature, tree growth and vigor declines markedly and the likelihood of a mountain pine beetle epidemic increases. Insect epidemics kill many trees that begin falling after a few years, and within 10 to 15 years, large amounts of dead woody fuels accumulate which greatly adds to the potential of stand-replacement fire (Langowski 2002).

Fire Regime 5 on the Bighorn National Forest is the long-interval (infrequent) fire return, stand replacement fire regime, which is composed primarily of Engelmann spruce and Subalpine fir, with some aspen. Mean fire return intervals in spruce-fir forests range from 100 to well over 150 years. In the event of an extended absence of fire, these species tend to maintain themselves in stable communities until changed by an external force, such as fire, wind, insects, and/or disease activity. After fire, spruce and fir are replaced by lodgepole

pine, aspen, or grassy parks, which slowly trend towards climax spruce-fir if left undisturbed.

Appropriate Management Response

Fire has historically played and will continue to play, a role in the structure, occurrence, and condition of vegetative communities of the forest. Under the 1985 Bighorn Land and Resource Management Plan, the only management response to an unplanned ignition is a suppression strategy. One of the objectives of this revision is to establish a range of acceptable Appropriate Management Response (AMR) actions. AMR actions are incorporated into the standards and guidelines for each management area prescription (Plan Chapter 2). The three AMR strategies allowed for the Bighorn NF are defined below:

Direct Control is to immediately and completely extinguish a wildfire. It is associated with high value areas, such as housing and other urban development, campgrounds, administrative sites, ski areas, and areas with high natural resource values. Immediate suppression action needs to be taken in these locations throughout the fire season. Usually this control is restricted to new fire starts, steady-state fires that have not reached large sizes and specific portions of large fires.

Fuels treatment for hazard reduction and pre-suppression planning is a high priority where this strategy is utilized.

Perimeter Control is a strategy that seeks to confine the active zone responsible for fire spread. Perimeter control considers site-specific values at risk. Firelines, whether natural or constructed, are used to confine the active zone of spreading fire. Direct or indirect fireline locations are selected to minimize the cost of suppression while recognizing the values that could be lost to the fire. The potential fire effects (beneficial or negative) will be evaluated and recognized when determining fireline location. The time of season and forecasted weather are important considerations affecting fireline location.

Although there are many fuel management opportunities in perimeter control areas, the fire regime dictates the effectiveness and suitability of fuels treatments. Strategies for ecosystem restoration and maintenance may blend well with strategies for hazardous fuel reduction. Near private property, fuels projects are likely to be directed at defensible space to protect structures while in the more remote areas, ecological values would be emphasized.

Because **prescription control** emphasizes the natural role of fire in the environment, human caused fires cannot be managed for resource benefit under current policy. Under prescription control, a fire is considered controlled as long as it burns within specified geographic boundaries and predetermined burning parameters. Parameters for this strategy are contained within a written prescription documented in the Fire Management Plan. Fires that are within prescription and advancing management goals in the prescription are allowed to burn. Should a fire jeopardize investments or other critical resource values, a suppression response will be implemented. Prescribed fire is appropriate in most prescription control areas. In Management Area 1.11, Pristine Wilderness and 1.13, Semi-Primitive Wilderness,

policy only allows prescribed fire if needed to reduce to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness.

An AMR will be assigned to every area on the Forest with burnable vegetation. AMR parameters will be outlined in the FMP (Fire Management Plan). When the FMP has been completed and approved, management of all ignitions will consider the full range of management options available, depending upon resource management objectives presented in the FMP. These options range from monitoring with minimal on-the-ground actions to intense suppression actions on all or portions of the fire perimeter. The appropriate management response is developed from analysis of the local situation, values to be protected, management objectives, external concerns, and land use. The Forest Plan is a decision document and the Fire Management Plan is the implementation document. The AMR options for each management area are displayed in the table below. The AMR for each alternative, expressed in acres and percent, is displayed in the second table below.

Table 3-47. Appropriate management response by management area.

Direct	Direct or Perimeter	Direct, Perimeter or Prescription
MA 8.1	MA 5.11	MA 1.11
MA 8.22		
	MA 5.12	MA 1.13
	MA 5.13	MA 1.2
	MA 5.21	
	MA 5.4	
	MA 5.41	MA 1.31
	MA 5.5	
		MA 1.32
		MA 1.33
		MA 1.5
		MA 2.1
		MA 2.2
		MA 3.1
		MA 3.24
		MA 3.31
		MA 3.4
		MA 3.5
		MA 4.2
		MA 4.3
		MA 4.4

Table 3-48. Appropriate management response (acres/percent) by alternative.

Alt.	Direct		Direct or Perimeter		Direct, Perimeter or Prescription	
	Acres	Percent	Acres	Percent	Acres	Percent
A	1,358	.1%	598,678	54.2%	504,977	45.7%
B	2,580	.2%	273,251	24.7%	829,180	75.1%
C	2,580	.2%	133,366	12.1%	969,068	87.7%
D	2,575	.2%	482,328	43.7%	620,110	56.1%
E	2,540	.2%	802,288	72.6%	300,186	27.2%

Note that current direction allows for a change in strategy from prescription (wildland fire use) to a more restrictive strategy, such as confinement. For example, assume the Forest Plan assigns an AMR of prescription control to a specific area. However, during subsequent development of the FMP, it may be determined that direct control is a more suitable AMR because of the small size of the area and/or the presence of values at risk. It is permissible to move from a prescription (wildland fire use) strategy to a suppression strategy (direct or perimeter), but not from a containment strategy, such as direct control to a less restrictive fire use strategy.

Acres of Fuels Treatment (mechanical and prescribed burning) by Alternative

An estimate was made for the number of acres of fuels treatment attainable annually under each alternative. This was based on values at risk, historic funding level experienced by the Forest, objectives of the current Bighorn Land and Resource Management Plan, and management objectives for each alternative. The highest priority for mechanical treatments will be adjacent to high-value areas and/or communities at risk. Because fires in long return interval fire regimes are typically high intensity, stand replacing fires, fuel treatments adjacent to high-values in those areas would likely concentrate on defensible space. Among the high value areas on the Bighorn National Forest are lodges, resorts, primary residences, summer homes/summer home groups, campgrounds, administrative sites, and ski areas. All fuel breaks created will require maintenance. The type and interval of the maintenance will be determined through project level planning.

The table below displays the percentage of acres of Condition Classes 2 and 3 and acres of high and extreme hazard classes (see Existing Condition section) being treated over a ten-year planning period, for each alternative. It is important to note that, while prescribed burning results in benefits to the fuels profile and/or condition class, often a goal of the burn will be to improve wildlife habitat or range condition for domestic livestock.

Table 3-49. Acres of fuel treatment annually by alternative.

	Alternative				
	A	B	C	D	E
Annual Acres of Treatment	2,610	4,520	1,860	3,970	3,370
Potential Maximum Percent of Condition Class 2 & 3 Treated per Decade	2%	4%	2%	4%	3%
Potential Maximum Percent of High and Extreme Hazard Ratings Treated per Decade	39%	68%	28%	59%	50%

Acres identified for treatment under Alternative A display an average level of treatment under the 1985 Bighorn Land and Resource Management Plan. Alternative B shows a 1,900 acre increase over the historic average. This is primarily due to the increased emphasis placed on fuel treatments by the National Fire Plan, both in urban interface zones and across the landscape and prescribed fire to improve wildlife habitat. Alternative D shows a 1300 acre increase over historic average due to increased emphasis on prescribed fire for vegetative management. Alternative E shows a 700 acre increase from historic average which reflects a higher emphasis of this alternative on timber harvest as a means of treating forested vegetation. Acres proposed for fuels treatment under Alternative C are reduced significantly from the other alternatives. This is primarily due to the increase in special designations (i.e. proposed wilderness) and the emphasis on natural processes.

The actual level of fuels treatment, in any given year, is dependent on funding levels and by weather conditions conducive to implementation of prescribed fire.

Acres Burned by Wildfire

It is very difficult to predict the number of acres that will be burned by wildfire in future years. Conditions that dictate the severity of fire seasons tend to vary significantly year to year. Weather, which is the primary influence on availability of fuels for ignition, is very difficult to predict with any degree of reliability more than a few days into the future. Research suggests that large stand-replacing fires are more likely to occur because of weather conditions than fuel accumulations. Most large fires occur in years with elevated weather variable values and fires in those years account for >99% of the area burned (Bessie 1995). Prediction of major influences, such as the occurrence of drought, is improving, but is still not very reliable. For these reasons, the best method for predicting the number of acres that will burn in the future is to base the prediction on historical fire occurrence.

In an effort to predict the number of acres that will be burned in the future, in a decade, the fire probability analysis program PROBACRE (Wiitala 1999) was utilized. This program assesses the risk of catastrophic consequences from a single wildfire or series of wildfire events. PROBACRE calculates the probability of a major single event, or multiple fire

events, and the long-term probability that a combination of fire events, both large and small, would result in a total burned area in excess of a particular number (user-specified). The probabilities are calculated from historic fire information for annual frequency of fires by size class.

The PROBACRE analysis period was 10 years. The probability analysis was completed for the Big Horn Mountain face, Big Horn montane area above 7,000 Feet, Cloud Peak Wilderness, and for the Bighorn National Forest, as a whole. Output from PROBACRE is summarized in following four tables:

As indicated in the following table, within the Bighorn Mountain Face, there is a 97% probability that wildfires will cumulatively burn more than 1,000 acres over the planning period. There is a 64% probability wildfires will burn more than 2,500 acres during the planning period. It is much less likely that wildfires will cumulatively burn over 5,000 acres during the planning period.

Table 3-50. Probability analysis for the Big Horn Mountains face.

Probability of exceeding the	10	acre threshold in	10	years is	1.00000
Probability of exceeding the	100	acre threshold in	10	years is	1.00000
Probability of exceeding the	500	acre threshold in	10	years is	0.9852
Probability of exceeding the	1,000	acre threshold in	10	years is	0.96854
Probability of exceeding the	2,500	acre threshold in	10	years is	0.63539
Probability of exceeding the	5,000	acre threshold in	10	years is	0.09367
Probability of exceeding the	10,000	acre threshold in	10	years is	0.00000

As indicated in the following table, within the montane area, there is a 94% probability that wildfires will cumulatively burn more than 1,000 acres during the planning period. There is a 68% probability wildfires will burn more than 2,500 acres during the planning period. The probability that wildfires will cumulatively burn more than 5,000 acres is 16% and the probability that wildfires will cumulatively burn more than 10,000 acres during the planning period is slight.

Table 3-51. Probability analysis for the montane area above 7,000 feet elevation.

Probability of exceeding the	10	acre threshold in	10	years is	1.00000
Probability of exceeding the	100	acre threshold in	10	years is	1.00000
Probability of exceeding the	500	acre threshold in	10	years is	0.97975
Probability of exceeding the	1,000	acre threshold in	10	years is	0.94305
Probability of exceeding the	2,500	acre threshold in	10	years is	0.67937
Probability of exceeding the	5,000	acre threshold in	10	years is	0.15942
Probability of exceeding the	10,000	acre threshold in	10	years is	0.00054
Probability of exceeding the	15,000	acre threshold in	10	years is	0.00000

In the Cloud Peak Wilderness Area there is a 54% probability that wildfires will cumulatively burn over 10 acres during the planning period.

Table 3-52. Probability analysis for the Cloud Peak Wilderness.

Probability of exceeding the	10	acre threshold in	10	years is	0.54350
Probability of exceeding the	100	acre threshold in	10	years is	0.00000
Probability of exceeding the	500	acre threshold in	10	years is	0.00000

For the entire Bighorn National Forest there is a 98% probability wildfires will cumulatively burn more than 2,500 acres during the planning period. The probability wildfires will cumulatively burn more than 5,000 acres during the planning period is 75%. The probability wildfires will cumulatively burn more than 10,000 acres during the planning period is 6%.

Table 3-53. Probability analysis for the total Bighorn National Forest.

Probability of exceeding the	10	acre threshold in	10	years is	1.00000
Probability of exceeding the	100	acre threshold in	10	years is	1.00000
Probability of exceeding the	500	acre threshold in	10	years is	1.00000
Probability of exceeding the	1,000	acre threshold in	10	years is	0.99991
Probability of exceeding the	2,500	acre threshold in	10	years is	0.98452
Probability of exceeding the	5,000	acre threshold in	10	years is	0.74570
Probability of exceeding the	10,000	acre threshold in	10	years is	0.06230
Probability of exceeding the	15,000	acre threshold in	10	years is	0.00000

Direct and Indirect Effects

Effects from Timber Management: The fuel profile and subsequently, fire behavior will be affected in sites where timber harvest occurs. Effects to the fuel profile and fire behavior can be both positive and negative.

Surface fuel loading, crown base height and canopy bulk density are the primary stand attributes influencing crown fire initiation and spread. Depending on the silvicultural system being implemented, timber harvest may affect each or all of these attributes. At a minimum, with a silvicultural system that thins the timber stand, canopy bulk density is reduced which in turn affects potential for spread of fire through the canopy within the treated stands. After such a timber harvest, a fire may transition into the crowns of individual trees (known as passive crown fire or torching), but movement of fire through the canopy (known as active or independent crown fire) will be inhibited through reduced crown bulk density. A crown bulk density of 0.10 kg m^{-3} appears to be the critical threshold for sustained crown fire spread (Langowski 2002).

When the intensity of a surface fire exceeds a critical level, fire can spread vertically into the canopy. Ground fuels in the form of slash will be temporarily increased as a result of timber

harvest, but the manner in which slash is treated after harvest plays a significant role in potential surface fire intensity. Treatment of the slash by various methods, such as, piling, lopping and scattering, and burning can mitigate much of this effect.

Timber harvest units may affect the spread of fire across the landscape, however, the extent of this effect is dependent on the size of the harvest units, location of units in proximity to fire spread and the intensity of the fire. High intensity, stand replacing fires which are typical within the fuel types prevalent on the Bighorn National Forest would most often involve spotting well ahead of the fire front in which case timber harvest units would have little to no effect in slowing or stopping fire progress. In the case of a smaller, less intense fire, treatment units could serve to slow the fire's advance. Harvest units may also provide anchor points for fireline construction and safety zones for fire suppression resources for a period of time after slash is treated.

Timber harvest operations may present a slightly increased potential for fire occurrence caused by mechanized equipment and other increased activity in the short-term while operations are in progress. Thus, the more timber harvest implemented, the greater the potential for these types of person caused fires. Timber sale contracts include clauses that address fire prevention and suppression, which would mitigate most of this potential. Among the timber sale contract provisions are requirements for mufflers and approved spark arrestors, requirement for fire extinguishers with saws and equipment, restrictions on smoking, blasting, and welding, and requirement that timber sale purchaser take suppression action on any fire occurring on the sale area.

Since timber harvest can have some long term beneficial effects in regard to fuels reduction, alternatives with the highest projected allowable sale quantity (ASQ) would have the most benefit in terms of fuels reduction. These alternatives would also have a slightly higher short-term fire risk due to equipment operation and slash generated. Alternative E has the highest projected ASQ, followed by Alternatives A, D, and B. Alternative C has the lowest ASQ, emphasizing natural processes to sustain ecological systems.

Effects from Travel Management and Recreation: Historical fire records dating back to 1970 indicate that approximately 30% of the fires on the Forest have been accessible by roads. Although roads can aid in fighting fires by providing ground access to the fires and access for fuel treatments, they also provide access for recreation use, which increases the potential for human-caused ignitions. Increased human use of the forest may also result in increased reporting of fires which could result in fewer acres burned. Roads can serve as anchor points for fireline construction by suppression forces and can serve as barriers to the spread of low intensity fires. High intensity fires typical of the fuel types predominating much of the Bighorn National Forest would likely exhibit extreme radiant heat and spotting well ahead of the fire front which may make roads relatively ineffective as barriers to high intensity fire spread. For less intense fires, roads can be a very effective barrier to fire spread. When a fire is accessible by road, response times for initial attack are reduced and road access during extended attack improves logistics (thus reducing costs) of managing fires. Any alternative that would increase the miles of roads on the Forest would realize both the positive effects of better access to manage fires and the negative effect of a higher risk of

human-caused fires. Alternatives that decrease road miles would likewise have both positive effects by decreasing human use and thus the chance for human caused ignitions and negative effects by reducing accessibility for firefighting equipment.

A significant change in the miles of road on the Forest could, to some degree, change the make-up of the Forest's firefighting force. For example, because much of the Forest currently has limited road access, engines are often not useable on Bighorn fires, so ground crews and helicopters are relied upon for suppression efforts. If considerable miles of roads were to be added, engines could become more important in fighting fires on the Forest. Conversely, if the miles of roads were to be significantly reduced, the current number of engines on the Forest could possibly be reduced in favor of hand crews and/or air resources (helicopters). The National Fire Management Analysis System (NFMAS), which is the current planning and funding mechanism for the fire program would respond to these types of changes.

Under all alternatives, the number of miles of existing roads to be decommissioned would be the same, so there is no difference between alternatives in regard to effects resulting from decreased road access. Because increases in road miles would be directly related to the timber harvest levels of the alternatives, the effects (both positive and negative) from increased road miles would be the greatest in Alternative E, followed by A, D, B, and C.

Effects from Wilderness and Research Natural Areas: There are two objectives of fire management in wilderness: (1) to permit lightning caused fires to play, as nearly as possible, their natural ecological role within wilderness, and (2) to reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness (Forest Service Manual 2324.21).

Implementation of Forest Plan fire management strategy occurs through the Fire Management Plan, Operational Wildland Fire Use Plans and individual Wildland Fire Implementation Plans. Although Wildland Fire Use may be desirable in wilderness areas and Research Natural Areas, it is possible that it may not be applicable in some of these areas due to the size of the area or proximity to high value areas. These high value areas could range from private property with a high monetary value to areas that are of high resource value for watershed to areas with high historic values. All areas will be evaluated based on the local situation, values to be protected, management objectives, and external concerns. Small areas are often not as feasible for application of wildland fire use as larger areas, due to the potential for the fire to move into areas where wildland fire use is not desired. In general, the larger the area, the more feasible it will be to implement wildland fire use. Therefore, from a wildland fire use standpoint, the alternatives with the most wilderness, proposed wilderness, and research natural areas, especially where they are contiguous to one another, would be the best candidates for implementation of a wildland fire use program. For any fires within designated wilderness or research natural areas requiring suppression, the logistics may be more difficult and cost of suppression may be somewhat higher than other areas due to restrictions on use of mechanized equipment and access limitations. This effect may be off-set by reduced costs associated with wildland fire use instead of expending funds for suppression and by the resource benefits derived from the fire on the landscape.

Alternative C is the only alternative proposing additional wilderness (approximately an additional 151,955 acres of the Forest). Alternatives B, C, and D each propose an additional 21,190 acres in RNAs. Alternatives A and E recommend no additional wilderness or RNAs.

Effects from Livestock Grazing and Big Game Use: Since grass and forbs are the primary carriers of surface fire in open forested areas, shrublands, and grasslands, grazing (by domestic livestock and to a lesser degree by wildlife) has the effect of reducing fire intensities through the reduction of available fuels. The degree to which fire intensities may be reduced is dependent on how much of the grass and forb production is removed through grazing. Grazing also can have an effect on the ability to successfully implement prescribed fire, for example, it is sometimes necessary to rest an area from livestock grazing for a season prior to burn implementation in order to have sufficient grass to carry the fire.

Grazing would continue to have the most effect on reducing fire behavior in fire regimes I and II, which includes ponderosa pine, grass communities, and shrublands (primarily sagebrush). Fire regime III, which includes Douglas fir, juniper, and limber pine, does not generally produce heavy grass/forb fuel loads due to predominantly dry sites along with often poor soil conditions. Fire regimes IV and V (long-interval fire regimes with lodgepole pine, spruce, and subalpine fire) have a minimal grass/shrub component and notice little effect from grazing. In aspen stands, grazing affects the understory and can limit regeneration.

The level of livestock grazing would be very similar between alternatives, so the effects of grazing on fire and fuels would be nearly identical under all alternatives.

Effects from Insects and Disease: Insect and disease outbreaks in forested communities affect the fuels profile and have a subsequent effect on fire behavior and fire suppression activities. The extent of the effects from dead and dying trees is dependent on the scope of the infestation. Small endemic occurrences of insect infestations or disease may have little or no effect on fire behavior or suppression activities, while epidemic or large scale outbreaks can have significant effects. Both types of outbreaks have naturally occurred on the forest throughout time.

When tree mortality occurs as a result of insects or disease, the needles die, but may persist on the branches for several years. The length of time the needles will persist depends on the tree species. This creates a situation conducive for transition from surface fire to the canopy and possibly fire spread through the canopy. Among the variables determining whether a fire remains on the surface or transitions to a crown fire are surface fire intensity, vertical fuel arrangement (availability of ladder fuels), and crown flammability (live foliar moisture or fine dead fuel moisture) (NFES 2378). In a healthy stand, during normal climate conditions, foliar moisture content is relatively constant, averaging about 100%. However, when a tree dies, the dead needles respond to climate as a one-hour fuel. It is common for one-hour fuel moistures to drop to 4% and occasionally lower during periods of hot temperatures with low relative humidity. As a result, a dead tree with needles still attached to the branches is much more susceptible to torching than a live green tree. Whether the fire after transitioning into the crowns will become an active crown fire in which the fire moves independently through the crowns is dependent on the crown spacing. Stands in which

crowns are closely spaced are more likely to sustain active crown fire than in open stand conditions.

As time passes, the needles gradually fall from the trees, onto the surface and eventually become part of the duff layer. In the short-term, this adds to the surface fuel loading, but since it occurs over a relatively long period of time the effect is gradual and is mollified as the needles become compacted and thus, less available to burn.

Although the smaller fuels as described above are the most important in regard to fire intensity at the flaming front, large fuels are also affected. Dead trees eventually fall to the ground, often as a result of wind. While this greatly increases the fuel loading, it does not increase the fire intensity at the flaming front to a significant degree. The primary importance of this increase in large down fuels is an increase of intensity following the passage of the flaming front, which equates into a longer residence time which influences fire effects. Probably the greatest effect from increased loading of large down fuels is in resistance to control during suppression operations. These heavy, down fuels can generate considerable intensity making direct fire line construction infeasible and they inhibit the line building process. Standing dead trees or snags are a recognized safety hazard in suppression activities due to the possibility of the snags falling on firefighters and for their propensity for showering embers across fire lines increasing the potential for spot fires.

Alternatives emphasizing timber management would have the most potential to limit the spread of insect or disease outbreaks by harvest of diseased or insect infested trees and stands at high risk for disease or insect problems where stands are accessible. These alternatives would also have the most potential to harvest dead and dying trees before they accumulate into a hazardous fuels problem. Alternatives emphasizing timber management would have more potential to salvage dead trees, which would limit fuels build-up due to insect and disease mortality which would reduce resistance to control of fires. Alternative E has the highest ASQ, followed by Alternatives A, D, and B. Alternative C has the lowest ASQ, emphasizing natural processes, such as fire and insect and disease activity, to occur. Thus, Alternative A would have the most potential to reduce insect and disease related hazardous fuels buildup, and Alternative C would have the least effect. However, slash would increase as a result of additional harvest which represents a tradeoff.

Effects from Noxious and Invasive Species: Increases in fire activity (wildfire and/or prescribed fire) could have the effect of increasing noxious weed spread due to disturbances from the fires and from fire suppression operations. Additionally, the stand replacement fires which are most typical on the Bighorn create conditions conducive to invasion of noxious weeds where seed sources are present. Since it is not possible to predict differences in wildfire occurrences or sizes of fires between alternatives, the only way to quantify potential noxious weed spread due to fire and fuels activities would be based on the level of fuels treatments. Alternative B would have the most fuel treatment and thus the most potential for noxious weed spread, followed by Alternatives D, E, A, and C.

Cumulative Effects

Past, current, and reasonably foreseeable cumulative effects for fire and fuels were considered and analyzed. The activities listed in Cumulative Effects table in the Introduction to Chapter 3 were considered in the cumulative effects analysis for fire and fuels.

Condition Class

The trend for all alternatives will be for current condition classes in Fire Regimes I - III (short to moderate fire return interval fire regimes) to experience a net increase, while Fire Regimes IV and V (long fire return interval fire regimes) will not experience a noticeable change during this planning period. As a result Fire Regimes I –III will continue to increase in the potential for uncharacteristically severe fires during this planning period. This is based on the proposed levels of timber harvest, fuels treatment, and wildfire occurrence probability analysis. The increase in condition class will be slightly less for those alternatives with higher timber harvest and fuel treatment levels. Thus, the increase would be smallest in Alternative E, followed by Alternatives A, D, B, and C, respectively. Due to the treated acres in comparison to total forest acres, this will be negligible on a Forest wide basis.

Most of the ponderosa pine and other forested Fire Regimes I-III on the Big Horn mountains are on lands of adjacent ownerships. The adjacent ownerships are primarily BLM on the west side of the Bighorn NF, where timber harvest and fuel reduction activities occur, but at low levels that will continue the trend of increasing the condition class in these fire regimes. On the east side, land ownership is predominantly private , with some state and a very small amount of BLM land. With the exception of the Story fuels project, and some fuels treatments on state lands such as the Amsden and Kerns winter ranges, most of the Fire Regime I-III forest types are not being treated, which will result in increased condition class. The Wyoming Game and Fish is anticipating less prescribed fire use on the elk winter ranges than has occurred in the past.

The cumulative effect of increased acres in higher condition classes will result in more fires of unnatural intensity, with increased risk to ecosystem function.

Fire Risk

The risk of ignition from lightning would be the same for all alternatives. The risk of human-caused ignitions could increase as public use of the Forest increases. Regardless of alternative, development within the wildland urban interface (private lands within and adjacent to the Forest) is anticipated to continue and most likely to increase. The Cumulative Effects table in the Introduction to Chapter 3 shows that subdivisions adjacent to the forest, such as Hazelton, Onion Gulch, and the area near Dayton are likely to continue to grow and others may develop. The anticipated trend toward continued growth in the wildland urban interface would increase the values at risk from wildfire and potentially increase the incidence of human-caused ignitions. Growth of wildland urban interface also creates greater importance for fire prevention and mitigation activities and increases the complexity and cost of wildland fires that occur in those areas due to safety considerations for firefighters and residents and the values at risk.

Air Quality

The smoke created by wildfires or prescribed fires on the Forest generally do not have a notable effect on air quality, however, there is a potential for cumulative effects to negatively impact air quality. The emphasis to treat fuels (as shown in Cumulative Effects table in the Introduction to Chapter 3) on all land ownerships indicates that fuel treatment (including prescribed fire) will increase in the future. While none of the alternatives have any effect on the amount of fuel treatments on adjacent land ownerships, any prescribed fires implemented or wildfires occurring on adjacent lands have the potential to cumulatively affect air quality should agencies conduct prescribed fires during the same time frames. The potential for this would be the greatest in those alternatives with the highest projected levels of fuels treatments which are Alternatives B, D, E, A, and C respectively.

Although the alternatives can be ranked for cumulative effects as described above, the differences between the alternatives in regard to overall cumulative effects are very slight indicating that potential cumulative effects are very near the same under all alternatives.

Insects and Disease

Introduction

Forest Health

A vegetation management goal of the Bighorn National Forest Plan (1985) is to "Attain the overall goal of a healthy, vigorous forest." Researchers have been attempting to develop a definition of "forest health" that encompasses the variety of philosophies and viewpoints. In his 1949 “Sand County Almanac, Aldo Leopold stated that "health" is the capacity of the land for self renewal." Expanding on this early thought, one of today's definitions has developed with the evolution of ecosystem management in the National Forests. For the forest plan revision, we are using the following definition: "a desired state of forest health is a condition where biotic and abiotic influences on the Forest (for example: pests, atmospheric deposition, silvicultural treatments, and harvesting practices) do not threaten resource management objectives now or in the future" (USDA, MP-1513, 1993). This definition recognizes:

1. Land management planning goals.
2. Resource management objectives for all resources.
3. The inevitability of human influences.
4. Insects and disease as part of the forest ecosystem.

Diversity is one of the key elements to maintaining forest health. A forest with a variety of ages, size classes, species mix, and densities has more resistance to catastrophic events than a monoculture of one size, age, species, and density. Forest insects and diseases each have a niche where they prosper. By creating a diverse forest, we can reduce the extent of their niche. Diversity reduces the potential areas where insects and diseases can reach epidemic levels that could produce adverse effects to Forest resource objectives. Variety in the forest vegetation also acts as natural firebreaks, limiting all but the most severe fires.

Forest Insects and Diseases

Insects and diseases are disturbance processes in the forested ecosystem. They are widespread over the Forest and the effects from their actions can last for long periods of time. Endemic populations of forest pests are a natural part of an ecosystem. They provide an important role in the nutrient cycle and successional changes of a forest. When populations increase to epidemic levels, however, the potential for negative resource consequences increases. Losses may include: Timber volume and value;

potential growth of forest vegetation; native plant species and forage condition; quantity and quality of wildlife habitat; recreation opportunities; visual aesthetics; and fuel build up which increases wildfire risk.

In general, a healthy forest contains endemic populations of forest pests. They usually kill isolated, overmature, and stressed trees on an annual basis. A healthy forest is able to keep insect and disease populations from reaching epidemic levels. The main goal of integrated forest pest management is to keep the forest in a healthy condition.

Generally, stands of lodgepole over 80 to 100 years in age are susceptible to epidemic mountain pine pest outbreaks. Engelmann spruce over 100 to 150 years are susceptible to Engelmann spruce bark beetle outbreaks. When trees are healthy, they can repel beetle attacks by flows of resin that "pitch" the beetles out. Overmature trees and trees growing in dense stands are less resistant to attack. This is particularly true during times of stress, such as drought or after a fire. If beetle populations reach epidemic levels, they successfully attack even the most vigorous trees.

Sound forest management is regarded as a way to develop stands that are more resistant to insect and disease epidemics. Integrated pest management (IPM) strategies involve the collection of available knowledge on pest/host relationships and identifying thresholds for unacceptable damage. Integrated pest management requires consideration of a full range of management strategies and techniques before prescribing treatment designed to reduce damage from any forest pest. Strategies include indirect control (which focuses on increasing forest resistance to epidemics) and direct control (which focuses on reducing the actual insect or disease population). Management strategies can include biological, chemical, mechanical, or manual control and prescribed fire to manage populations.

Those alternatives with the greatest allocation to management areas that allow for a wide range of forest management treatments will be most successful at reducing the impacts of insects and diseases.

It is extremely difficult to determine the probability of insect and disease activity. There can be a large combination of factors or sequence of events (weather or climate, succession in vegetation ages and species, epidemic levels of insects and disease) that affect these disturbances.

Legal and Administrative Framework

National Forest Management Act: Requires assessment of alternative management actions to facilitate balanced, integrated approaches to resource protections and development and implementation of sound management practices to prevent excessive losses due to pests.

Cooperative Forestry Assistance Act of 1978: Sets forth the basic Federal authority for forest insect and disease management and provides for cooperation with states and private individuals.

Code of Federal Regulations 36 CFR 219.16 (a)(2)(iii) – this regulation allows for the harvesting of stands of timber that have not reached CMAI (Culmination of Mean Annual Increment) "which are in imminent danger from insect or disease attack."

Code of Federal Regulations 26 CFR 219.27 – This section of the regulations sets the minimum specific management requirements to be met in accomplishing goals and objectives for the National forest System. 36 CFR 219.27(a)(3) requires that all management prescriptions utilize principles of integrated pest management to prevent or reduce serious, long lasting hazards and damage from pest organisms, consistent with the relative resource values involved. 36 CFR 219.27(c)(2) discusses the ASQ (allowable sale quantity) and states: "Nothing in this paragraph prohibits, salvage or sanitation harvesting of timber stands which are substantially damaged by fire, windthrow, or other catastrophe, or which are in imminent danger of insect or disease attack and where such harvests are consistent with silvicultural and environmental standards." 36 CFR 219.27(c)(7) states: "Timber harvest and other silvicultural treatments shall be used to prevent potentially damaging populations increases of forest pest organisms. Silvicultural treatments shall not be applied where such treatments would make stands susceptible to pest-caused damage levels inconsistent with management objectives."

Key Indicator

- Acres of active insect and disease management by management area categories.

Resource Protection Measures

Resource protection is accomplished through forest-wide and management area prescription standards and guidelines. Forest management is the first step in preventing insect and disease outbreaks. Sanitation and salvage sales may be used to suppress insect and disease activity where necessary and allowed.

AFFECTED ENVIRONMENT

Insects and diseases can affect the production of timber resources, wildlife habitat, old growth, recreation opportunities and can increase fire risk. Insects and disease are also a key component of ecosystem processes, creating habitat and serving as prey for many wildlife species.

The most serious insect pest of pine throughout the West is the **mountain pine beetle** (*Dendroctonus ponderosae*). This is a native beetle that can attack and kill all of the pine species (lodgepole, ponderosa, and limber pine) in the Bighorn National Forest. Mountain pine beetle activity in lodgepole pine has historically been relatively light and scattered; however, outbreaks have been recorded in the late 1960s and mid-1970s in the Little Bighorn River area. The ponderosa pine along the eastern slopes of the Bighorn Mountains has gone through a number of outbreaks over the years. In recent

years a fluctuating population of mountain pine beetles has killed areas of ponderosa pine along the east face of the Big Horn Mountains. This has occurred mainly in the Sand Turn, Story, Red Grade, and Hospital Hill areas. Many of the infested trees are not on the Forest; however, they are of considerable concern to local residents. Efforts to minimize the mountain pine beetle population have taken place throughout the post settlement history. The Civilian Conservation Corps (CCC) did a number of projects in its day, and records indicate concern over beetle populations date back to the early days of the Bighorn National Forest.

The mountain pine beetle can reach epidemic proportions and kill significant amounts of their hosts. Although beetle behavior is well understood in relation to lodgepole pine stands, the same cannot be said of ponderosa and limber pines. In lodgepole pine, the beetle generally attacks large diameter, overstory trees, but once an epidemic starts, smaller trees can also be killed (Amman and Cole 1983). The death of overstory trees influences stand structure and composition, and can lead to stand conversion to other species.

The mountain pine beetle generally completes its life cycle in one year in lodgepole pine, although at higher elevations, it can take two years (McGregor and Cole 1985). Adults typically emerge sometime in July or August and attack standing green trees. On successfully attacked trees, adults lay eggs and larvae develop under the bark. Immature larvae overwinter under the bark, then finish feeding in the spring and early summer. The developing larvae feed on the phloem, killing the tree.

Mountain pine beetle populations in lodgepole pine are in a large part dependent on the conditions present in the forest. In lodgepole pine, susceptibility to mountain pine beetle is based on three factors (Amman et al. 1977):

1. Average tree diameter.
2. Average tree age.
3. Location by latitude and elevation.

Beetle behavior in ponderosa pine is not as well understood. Forest conditions have been related to beetle susceptibility in the Black Hills of South Dakota and Wyoming. In these areas, beetle susceptibility is based on tree diameter and stand density (Schmid and Mata 1992). Average stand diameters of over 7.0 inches makes for susceptible stands. In stands that are above the minimum diameter, stands that have a basal area of over 120 square feet per acre are considered to be high risk. Stands with a basal area between 80 and 120 are moderate risk and those below 80 basal area are low risk (Schmid et al. 1994). It will be assumed that these same criteria are applicable to ponderosa pine on the Bighorn National Forest as well.

Little work has been done on mountain pine beetle behavior in limber pine. What is known is that brood production is fairly high in limber pine, indicating that beetles do very well in this species (Cerezke 1995). It will be assumed that the beetle behaves in much the same way in limber pine as in lodgepole, preferring larger diameter trees.

In both lodgepole and ponderosa pine, the factors that can be managed to reduce a stand's susceptibility to beetles include reducing average diameter and age and/or reducing stand density. Treating the stands to reduce susceptibility will provide the most long-term defense against a mountain pine beetle epidemic. In lodgepole pine, thinning is effective at reducing future losses to the mountain pine beetle (Amman et al. 1988, Cole 1989, Gibson 1989, McGregor et al. 1987). Since beetles are attracted to the largest trees initially, removal of large diameter material is also effective at reducing loss during epidemics (Cahill 1978, Cole et al. 1983, McGregor et al. 1987). Obviously, clearcutting lodgepole pine stands removes any risk of beetle infestation.

Treatments to reduce mortality in ponderosa pine include thinning stands to lower basal area or smaller diameter sizes prior to beetle outbreaks. These types of silvicultural treatments should be effective at reducing loss to the beetle in ponderosa pine. In areas where beetle populations have already become established and started increasing, sanitation harvesting can be considered. Sanitation efforts prior to the beetle flight period (July - August) may serve to reduce localized beetle spot expansion. However, sanitation harvesting on a small scale does not prevent future bark beetle migration from adjoining areas.

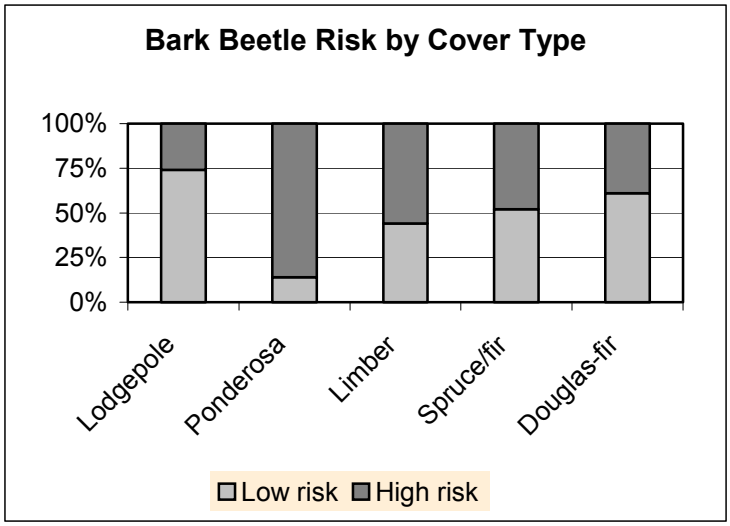
No work has been conducted on silvicultural treatments for reducing beetle damage in limber pine. Based on what is known from lodgepole and ponderosa pine, limber pine stands should be treated to remove the largest diameter trees and reduce stocking levels. Without any real information, these seem to be the safest options for minimizing beetle damage.

Fifty-six percent of the identified limber pine stands are in a condition that would be considered high hazard to a mountain pine beetle outbreak. There are 44% of the limber pine stands that are in a low hazard condition due to tree size or density. There are areas of limber pine that are currently being attacked by mountain pine beetle, with Tensleep Canyon being the most visible. In areas where beetles have already built up, the risk to the surrounding high hazard stands is significant.

Twenty-six percent of the lodgepole pine on the forest is in a state of high hazard to a mountain pine beetle outbreak. The remaining 74% is low hazard. Currently, there are no large outbreaks of mountain pine beetle in lodgepole pine.

Eighty-six percent of the ponderosa pine cover type on the Bighorns is in a state of high hazard for a mountain pine beetle outbreak. 14% is at low hazard based on average tree size or tree density. Much of the ponderosa pine cover type is on the east face of the mountain, which is currently undergoing a mountain pine beetle outbreak. Any stands in the high hazard are at risk for significant mortality and many of the low risk stands may suffer some mortality considering the current MPB situation.

Figure 3-7. Bark beetle risk by covertype on the Bighorn National Forest.



The most important threat to spruce is the **spruce beetle** (*Dendroctonus rufipennis*). The spruce beetle is a native bark beetle that occurs throughout the range of spruce in North America. The beetle is typically found at endemic levels in downed trees and large pieces of slash. Epidemic populations most often occur after large disturbances, such as windthrows, create a large volume of suitable host material for the beetle to build up in. Once populations reach an epidemic stage, all sizes of standing green spruce can be attacked except for reproduction. While all sizes can be attacked, it is most often focused on the larger trees within a stand. Epidemics develop as small spruce beetle outbreaks, which increase and coalesce into large areas of infested trees as the beetle continues to attack and kill vast acreages of the cover type (Massey and Wygant 1954, Holsten et al. 1999). Recovery and regeneration of affected stands may be very slow; often spruce is replaced by subalpine fir which, over time, is replaced by spruce again as the fir dies (Schmid and Hinds 1974).

Spruce beetle, unlike mountain pine beetle, is attracted, and often builds up in damaged trees. Frequently this is in windthrown/blowdown trees, however, fire-scorched trees also are susceptible. For example, Rasmussen et al. (1996) found an increased number of spruce beetles in trees that were scorched up to a certain level of damage. Once scorching exceeded 60 percent of the basal circumference girdled, trees were no longer as suitable for spruce beetle infestation. This is something to be considered when using prescribed fire. Many of the larger spruce may have bark thick enough to survive lighter prescribed burns, however, if they are scorched to a certain degree, they can be more susceptible to spruce beetle attack. Stands that contain a large number of larger, partially scorched spruce, could be centers for spruce beetle buildup and epidemics.

The spruce beetle usually requires two years to complete a generation; in high elevations it can take three years. Adults fly, attack host trees, and lay their eggs in June and July. Larvae develop under the bark and remain there to overwinter. Larval development continues the following spring and summer, with new adults emerging in August. These adults then hibernate beneath the bark until the following June and July.

Spruce stands that are most susceptible to spruce beetle outbreaks generally have the following characteristics (Schmid and Frye 1976):

- Located in creek bottoms.
- Have large diameter host trees.
- Have high basal areas.
- Have a large proportion of spruce in the canopy.

Spruce beetle is a concern that should be noted in stands that have large mature and overmature trees. Windthrow events in or near these stands can lead to mortality of standing green trees (Schmid and Hinds 1974).

Forty-eight percent of the spruce/fir cover type is in a state of high hazard for a bark beetle outbreak across the forest. 52% is in a low hazard condition. These numbers are probably the least accurate of any of the hazard ratings, because so little is known about the fir component. It is safe to say that the amount of the cover type in high hazard condition is underestimated by possibly up to 10-15%. It appears that almost anywhere on the forest where spruce/fir occurs, there is bark beetle caused mortality occurring at this point. For spruce beetle, in many cases it is killing all spruce trees down to about 8-10 inches in diameter. Dayton Gulch and Shell Reservoir are two examples of current rising spruce beetle population centers.

The **western balsam bark beetle** (*Dryocoetes confuses*) infests a number of western conifers but is most significant in subalpine fir. It contributes to subalpine fir decline, which is a poorly understood problem in this species. It is a significant problem on the Bighorn NF; it kills both large diameter and small diameter trees. The decline appears to be associated with the western balsam bark beetle and root disease. The beetle appears to have a 2 year life cycle. Attacking beetles introduce a virulent fungus (*Ceratocystis dryocoetidis* Kend. and Moln), that contributes to the decline of the attacked tree. This insect/root disease association appears to be important in converting fir/spruce stands to predominantly spruce stands over long periods of time.

As there is no accepted method for risk rating stands for western balsam bark beetle, a conservative estimate for the number of stands at risk would be to use numbers similar to what the spruce beetle show. It is likely that far more fir is at risk, since the beetles will attack and kill much smaller trees than is typically seen with spruce beetle.

The **Douglas-fir beetle** (*Dendroctonus pseudotsugae*) is a native insect that attacks Douglas-fir throughout its range in North America. It has a single generation per year, generally overwintering as callow adults. Its life cycle is similar to other bark beetles, with new adults infesting host trees in the summer. Douglas-fir beetle"

The Douglas-fir beetle is usually found at low densities in the forest. It is often found building to epidemic populations following other disturbance events such as windthrow or fire (Furniss 1962, Furniss et al. 1981). After these disturbance events, beetles can reach levels where surrounding green trees are attacked and killed.

Stands of Douglas-fir can be rated as to their susceptibility to Douglas-fir beetle based on stands density, average stand age and the amount of Douglas-fir in the stand (Weatherby and Thier 1993, Negron 1998, Negron et. al 1999).

Currently, 39% of the Douglas-fir stands are in a condition that leaves them susceptible to large scale Douglas-fir beetle mortality. The other 61% are in a lower hazard state, based on tree size and density. There are a number of areas, Shell Canyon and Tensleep Canyon being the two most obvious, that are also at high risk to Douglas-fir beetle attack considering that there are already high numbers of beetles and beetle killed trees occurring in these areas. Any stands that are in the high hazard category and even many that are borderline between high and low hazard in these areas could be significantly affected.

Western spruce budworm (*Choristoneura occidentalis*) also exists on the Forest. High population levels have been noted in Douglas-fir stands on the northwest side of the Forest, as witnessed by the large area of red topped trees near Mexican Hill. These stands usually are able to survive attacks for a year or two, however, four to five years of continuous defoliation may result in top-killing and tree mortality. This defoliation will make the trees vulnerable to attack by other insects and diseases. Western spruce budworm"

The **gypsy moth** (*Lymantria dispar*), has been accidentally introduced into areas in and around the Bighorns on a few occasions over the last 20-30 years. As of now, it is not known to have an established breeding population in the Bighorns. The chances of further introductions and the possibility of this insect becoming established in this area are increasing. As more people from infested areas visit and bring campers and recreational vehicles that could harbor gypsy moth into the Bighorns, the chances of this insect being brought in increase.

The gypsy moth is a serious threat to all forest resources. It will feed on the leaves of over 300 trees and shrubs, predominately hardwoods (Liebhold et al. 1995). If established in the Bighorns, the biggest threat would be to riparian and aspen communities.

There are a number of other exotic forest pests that could, in theory, become established in the Bighorns. As with the gypsy moth, any exotic insects that are found should be handled using an eradication plan as soon as possible.

Aspen decline is associated with a variety of canker and stem and root decay pathogens that cause stands to decline, die, and fall apart over time. The usual suspects are stem decays (*Ganoderma applanatum* and *Phellinus tremulae*), root decay (*Armillaria ostoyae*), canker diseases (*Cytospora sp*., *Ceratocystis fimbriata*, and *Hypoxylon mammatum*).

The largest disease problems on the Forest are **dwarf mistletoe** (*Arceuthobium spp.*) and comandra rust (*Cronartium comandrae*) in lodgepole pine. A past Forest survey conservatively estimated 44 percent of the lodgepole pine had dwarf mistletoe, and 55% was infected with comandra rust. This is an increase in the mistletoe level from similar

surveys done in the 1970s on the Bighorns (Harris 2003). The distribution of both diseases is fairly uniform. They extend from the northeast portion of the Forest, along the east side of the Cloud Peak Wilderness, and continuing southwest onto the Tensleep District. Dwarf mistletoe increases mortality and decreases growth and seed production. Young trees can be killed while mature trees may take years to show noticeable damage. The mistletoe infection lowers the resistance of trees to attacks by other diseases and insects.

Dwarf mistletoe spreads at a relatively slow rate through a forest stand. Over long periods of time, especially in the absence of fire, lightly infested dwarf mistletoe stands become severely infested as the pathogen intensifies and spreads. Fire is an important regulator of dwarf mistletoe occurrence, particularly where large-scale stand replacing fires have occurred. These fires eliminate the dwarf mistletoe-infested overstory and understory pines and allow new seedlings to grow free of the plant parasite.

Comandra blister rust (*Comandra umbellata*) is a native rust fungus that requires two different hosts to complete its life cycle, bastard toadflax and hard pines such as lodgepole and ponderosa pines. The spores are spread by wind from the Comandra plants to infect pine needles and new shoots. The fungus then grows into the branch, creates a canker that kills the branch. These cankers often produce spores that appear as rust-colored blisters; these spores travel from the pine to infect the Comandra plant. As the fungus grows in the tree branch, it will advance towards the tree stem. If the fungus forms a girdling canker on the stem then the distal portion of the tree dies causing top-kill (Mielke 1957).

Timber harvest provides one tool for controlling diseases on the Forest. Areas of high mistletoe risk or infestation are a prime consideration when locating and designing timber sales. Current strategies to control comandra blister rust are generally aimed at reducing the disease rather than preventing infections. One option is to harvest the heavily infected stand while trees are still usable.

White pine blister rust (*Cronartium ribicola*), an exotic disease, infects limber pine trees on the Bighorn National Forest. The rust fungus also infects alternate hosts of currant or gooseberry plants (*Ribes* spp.) to complete its life cycles. The fungal spores spread by wind from the *Ribes* plants to infect pine needles. After a short infection time, the fungus will develop cankers that girdle and kill branches and eventually stems. Around the edges of these cankers, the fungus produces blisters of spores that travel by wind to infect the *Ribes* plants. While spores from *Ribes* can travel a great distance and still be viable, most pine infections in Wyoming occur in areas where *Ribes* plants grow in close proximity to the trees (Mielke 1943).

Limber pine is being infested severely in many parts of the forest by white pine blister rust. In places where this disease has moved through in the past, such as Idaho (in western white pine), as much as 90-95% of the cover type can be killed. It is unknown what the final impact to limber pine will be on the Bighorns, however, there are places where the disease has already started killing high percentages of the host trees.

Little work has been done on **root diseases** in the Bighorns. It is likely that at least *Armillaria* and *Annosus* root diseases exist and perhaps others. Root diseases can be major factors in causing growth loss and even outright mortality in forest stands. Root diseases can be stress factors that increase the likelihood of bark beetle attacks on trees when beetles are at endemic levels. Root diseases can also be major factors in causing tree failures, and so are important organisms in and around developed recreations areas.

ENVIRONMENTAL CONSEQUENCES

Direct and Indirect Effects

Management area prescription designation will greatly influence the occurrence of insect and disease activity and what, if any, actions are taken to minimize impacts.

Natural disturbance events will continue to operate regardless of the alternative, however the scale upon which natural processes operate as the primary agents of change will vary by alternative. Where natural processes are the predominant process, the management of insect and disease populations is less likely. Since insect risk is medium or high on much of the forest, it is possible that many of these acres at risk of insect damage will be attacked within the next 50 years. The same could be said of the disease situation on the Forest. With the current high levels of infection, it is likely there will be continued high levels of tree mortality and stand structural changes over the coming 50 years. The potential exists for large areas of the forest to be subject to large-scale events when high risk conditions occur.

The emphasis on management activities to prevent or reduce pest populations varies from one alternative to another, and may correspond to levels of timber harvest or other activities that promote greater habitat diversity. Management alternatives that change the mix of age classes, density, and species makeup of forest stands will have the greatest effect on insects and diseases. Those alternatives that put most of their emphasis on natural processes being the major change agent will have greater risk to loss from insect and diseases.

The following table lists the different management area allocations and management area number. Management areas are defined in Chapter 2 of this document. These management areas can then be grouped into categories, using their first number, these categories (1, 2, 3) have similar levels of forest management activities.

The following two tables show a comparison of land allocation by alternative. Based on the allocation, the amount of insect and disease prevention and suppression possible will change. In the first table, Categories 1, 2, 3, and 4 are listed as where natural processes will predominate, while categories 5 and 8 are where forest management will predominate. In the second table, it is assumed that suppression strategies will be rarely used in categories 1, 2, and 3. Suppression strategies will be occasionally used in lands allocated to category 4 and will be frequently used in categories 5 and 8. The amount of active management

available for each category will play a major role in how much of the landscape will be affected by insects and diseases.

Based on this, Alternative E should be least susceptible to large insect and disease outbreaks, followed by Alternatives A, D, B, and C in succession. The converse of this is that Alternative C would be most likely to experience large insect and disease outbreaks. These rankings would be the same for which alternatives would use the most aggressive prevention and suppression techniques.

Table 3-54. Allocation to management areas where natural processes or forest management will predominate in acres and percent of forest area, by alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
Natural process predominate, Category 1,2,3,4	504,978 ac 47%	816,232 ac 74%	948,594 ac 86%	617,689 ac 56%	287,054 ac 26%
Vegetation Mgmt Activities, Category 5 & 8	584,598 ac 53%	286,784 ac 26%	154,422 ac 14%	485,327 ac 44%	815,962 ac 74%

Table 3-55. Response to insects and diseases, by alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
Insect and Disease Suppression and/or Control					
Rarely Used, Category 1,2,3	496,357 ac 45%	672,840 ac 61%	783,141 ac 71%	474,567 ac 43%	264,994 ac 24%
Occasionally Used, Category 4	22,060 ac 2%	143,392 ac 13%	165,452 ac 15%	121,061 ac 11%	22,060 ac 2%
Routinely Used, Category 5 &8	584,598 ac 53%	286,784 ac 26%	154,422 ac 14%	485,327 ac 44%	815,962 ac 74%

Effects from Fire and Fuels Management: The effects of large, destructive wildfires on forest pests would likely be to reduce those that exist in areas where extremely hot fires burn over. Fires can also reduce stand density and make stands more resistant to attack. However, lower burning intensities associated with parts of most wildfires and most prescribed fires can severely weaken the resistance of trees to pest attacks by damaging root systems and cambial tissues. This can in turn lead to increasing populations and subsequent outbreaks of some pest species.

The extent and frequency of large fires may increase following major bark beetle outbreaks. However, the occurrence of this type of behavior has not been noted in the past. There have not been, for unknown reasons, large scale outbreaks of mountain pine

beetle in lodgepole pine on the Bighorns. Large scale insect and disease disturbances can create an increase in dead and down fuels.

Effects from Administrative Site Management: Costs may be higher than for general forest areas to ensure that vegetation surrounding administrative sites is not degraded due to the activity of insects and diseases; however, this will not vary from one alternative to another.

Effects from Timber Management: Timber harvesting and timber stand improvement provides an opportunity to prevent or reduce pest outbreaks. Harvesting trees provides an opportunity to remove diseased and high-risk trees. Clearcuts and other final harvest methods provide opportunities for long-term protection and prevention of insect and disease outbreaks. Stands most susceptible to insect damage and most infected with mistletoe can be harvested and replaced with mistletoe-free young stands. In stands scheduled for overstory removal, shelterwood, or uneven-aged management, individual suppressed or dying tees can be removed, increasing the overall growth and vigor of remaining trees. In commercial and precommercial thinning operations, susceptibility to insects and disease will be decreased by increasing the growth and vigor of the remaining trees.

Alternatives that increase the amount, extent, or density of mature and over mature stands will generally increase the risk of attack by bark beetles. Large scale disturbances caused by bark beetles can change stand structure, effect species changes, or change successional trends. Large disturbances can also have the effect of regenerating expansive areas to basically a single age class, reducing diversity.

Under all alternatives, there exists potential for salvage and/or sanitation cuts to harvest dead or damaged timber and to attempt to slow or impede infestations from spreading. The degree to which these harvests are undertaken will largely depend upon the risks associated with the potential infestation spread into healthy stands, public safety, the presence of high value resources, and the resource emphasis of the infected or adjoining area.

Timber management can go a long way in creating forests that have increased age and species diversity. The more diversity that is present in an area, the less likely that large scale epidemics will occur.

Alternatives with the greatest allocation to management areas that allow active forest management will have the least amount of area left at high risk to insect and disease outbreaks.

Effects from Wilderness Management: As land is allocated to proposed wilderness, the amount of suppression and control and silvicultural activities to reduce risk will decrease and the occurrence of insects and diseases will increase.

Effects from Riparian Area and Wetland Management: Restrictions on use of pesticides near water may limit some pest management options. As areas are added to National River System, management options available may become constrained causing

an increase in pest activity. Costs of pest management activities may be higher in riparian and wetlands due to more restrictive guidelines.

Effects from Recreation and Travel Management: In developed and dispersed sites, where trees are often impacted by camping activities and overall health and vigor are reduced by soil compaction from recreational uses, insects and diseases can occur at higher levels. Pest management activities would be intensified under all alternatives to protect developed recreation sites. Costs may be higher than for general forest to ensure that vegetation in and around developed recreation areas is not degraded, causing safety hazards due to insects or disease. This should not vary substantially from one alternative to another.

Alternatives emphasizing the creation of more natural settings and older stands for recreation opportunities would result in forest conditions susceptible to some forest pests. Management areas that emphasize wilderness, backcountry, and non-motorized recreation would have little or no management activity for prevention or reduction of insects and diseases.

The extent of road systems in each alternative determines the ability to access areas and carry out suppression and silvicultural treatments to reduce pest impacts. Recreation activities and travel can contribute to the spread of exotic or nonnative insects or diseases.

Effects from Scenic Resource Management: Generally, the more restrictive the Scenic Integrity Objective, the greater the potential for some pests to be present at potentially damaging levels. Alternatives that limit forest management practices will lead to denser stands and increased likelihood of bark beetle infestations and continued increases in mistletoe. These alternatives may have an opposite effect on diseases such as root diseases.

Effects from Wildlife Habitat Management and Old Growth: In general, alternatives favoring older age classes of vegetation tend to favor buildup of forest pests. Those that favor a wide range of age classes, greater vertical diversity, and greater species diversity tend to reduce the effects of insects and diseases. Thermal cover for big game is generally very susceptible to insect outbreaks. Alternatives that seek to increase the level of thermal cover would create a higher risk to insect outbreaks.

Trees that are left behind after treatment as replacement snags will generally continue to increase in susceptibility due to size and age. Clumps of trees left after harvest will have the same response only stronger due to being more closely spaced.

Areas that are treated with prescribed fire can have a resulting positive or negative effect from insects and diseases, depending on how the residual live trees are stressed from the burn.

Areas left as old growth will generally be highly susceptible to insect and disease outbreaks. Typically these are stands with larger trees and closed canopies that are

highly favored by bark beetles. Maintenance of these stands may call for intensive management.

Effects from Threatened, Endangered, and Sensitive Species Management: The concern for protection of threatened, endangered, and sensitive (TES) plant and animal species will result in specific requirements being met. Concern about these species may result in limited or no actions taking place. Actions could be delayed beyond the appropriate biological window for treating pests depending on TES species present and their needs.

In general, those alternatives that have reduced levels of management activity and may be more beneficial to mature forest associates also tend to create stand conditions that are more susceptible to insect and disease outbreaks.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to the insect and disease resource. The next 15 years are considered the time span for cumulative effects, and the cumulative effects area of analysis is the forested area on the Big Horn mountains.

On-Forest Cumulative Effects – Natural Processes

Forest stand density, age, and size have increased and are causing an increased risk of insect and disease outbreaks on a greater number of acres. Over the life of this forest plan, this risk will remain and increase even further as the forest grows and ages. This is a common theme for all forested stands on the Bighorn National Forest.

Silvicultural treatments can change vegetation structural stage and create forests that are more resistant to large scale outbreaks on the forest. Salvage operations will occur in management areas where timber production is emphasized or where needed to reduce hazards in high use recreation areas.

As forest stands age, they pass through different stages of susceptibility to insects and diseases. Generally, mature forest stands are at the highest risk of insect and disease activity where impact may exceed management objectives. As the Forest ages, the susceptibility to insect and disease outbreaks will greatly increase.

Alternatives with more hazard-reducing activities will have the greatest reduction in insect and disease activity. Hazard-reducing activities would be treatments that change stand structure prior to an insect or disease occurrence. Alternative E is least likely to have large, landscape scale insect and disease events across the forest, followed by Alternatives A, D, B, and C. The more acres left to be governed by natural processes, the better the chance of large scale disturbance. With large areas left to natural processes, even treated acres will assume some risk if they are near disturbances. This should be considered in how management areas are located spatially. Alternative E also has the highest number of acres where prevention or suppression tactics will be

employed. This would make this alternative the least likely to have ongoing, untreated outbreaks of insects or disease, followed by Alternatives A, D, B, and C.

One of the biggest considerations will be the public acceptance of leaving much of the forest land in prescriptions that are allowed to follow natural processes. It may present a dichotomy that is hard for the general public to understand – why some alternatives manage parts of the forest and limit pest populations and others let nature take its course. Forested vegetation on the Bighorn NF is currently at a point where natural disturbances will likely make landscape level changes in the near future. The continued growth and aging of the forest will create conditions that will continue to be highly susceptible to insect and disease disturbance. Those areas where forest management is used on a larger scale will be less susceptible to landscape level changes; however, disturbances that start in areas driven by natural processes could cause change in these areas. Management area designations that emphasize natural processes are difficult, if not impossible, to manage within their perimeter and substantial effects will slop over onto adjacent management areas.

Off-Forest Cumulative Effects

Natural process will also affect non-NFS forested lands in the Big Horn Mountains. The private, state and BLM forested lands surrounding the National Forest are primarily lower elevation forests dominated by ponderosa pine, Douglas-fir, and limber pine. Therefore, these lands will be most susceptible to mountain pine beetle, Douglas-fir beetle and white pine blister rust. Some timber harvest activities are occurring on these lands; however, as on the National Forest, the rate of timber harvest is not expected to stop insect and disease epidemics from occurring over the next decade, as effects of drought and decades of fire suppression have created excellent insect habitat.

Management of the mountain pine beetle in Story is especially problematic, since some landowners do not want to cut trees on their property. It is probable that the mountain pine beetle will continue to be active in the ponderosa pine forests of the Story area.

Higher elevation subalpine forests occur to the south and north of the National Forest. Private landowners own most of the mountain on the south boundary, and many of them are using timber harvest to lessen the impact of subalpine forest insects and diseases. The Crow Indian Reservation is to the north of the National Forest, and there is little timber harvest activity adjacent to the Forest, as this is a relatively remote area. Landowners adjacent to the Bighorn National Forest have fairly comparable levels of insect and disease activity, and as on the NF, the levels of treatment are insufficient to keep all insect and disease activity at less than epidemic levels.

Invasive Species

Introduction

This discussion deals with non-native plant and animal species that can adversely affect species composition and ecosystem structure/function. Currently, non-native plants are probably the biggest invasive species threat to the resource values on the Forest, and as a result have received greater management emphasis than that placed on other non-native wildlife and fish species. Non-native wildlife and fish species can also displace native species, alter habitat conditions, and threaten native species population viabilities in the ecosystem where they exist. Although past emphasis has focused on management of invasive plants (e.g., noxious weeds), the Forest will increase monitoring efforts for invasive fish and wildlife species as well.

Non-native plant management on the Forest is coordinated with county, state, and private vegetation management efforts wherever possible. If non-native animal species become an issue in the future, management would be closely coordinated the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service.

Legal and Administrative Framework

The following laws and policy and direction from the Forest Service Directives System in Forest Service Manuals (FSM) and Forest Service Handbooks (FSH) pertaining to control and management of noxious and non-native species are listed here but not limited to:

Federal Noxious Weed Act of 1974.

February 3, 1999 Executive Order of Invasive Species.

FSM 2060 Ecosystem Classification, Interpretation, and Application.

FSM 2070 Biological Diversity.

FSM 2080 Noxious Weed Management.

FSH 2090.11 Ecological Classification and Inventory Handbook.

FSM 2150 Pesticide-Use Management and Coordination.

FSH 2109.14 Pesticide-Use Management and Coordination Handbook.

FSH 2509.13 Burned-Area Emergency Rehabilitation Handbook.

Wyoming State and County declared Noxious Weeds.

Bighorn NF Noxious Weed EA, 1998.

USDA Forest Service Guide to Noxious Weed Prevention Practices.

Key Indicators

- Acres infested with noxious weeds.
- Acres of noxious weeds treated.

Resource Protection Measures

Many invasive plants (such as smooth brome or Kentucky bluegrass), though not necessarily considered noxious, can replace native vegetation. The Federal Noxious Weed Act of 1974 authorizes the Secretary of Agriculture to use an integrated weed management approach to control and contain the spread of noxious weeds on National Forest System and adjacent lands. Through that act, the Forest Service has an obligation to work cooperatively in identifying noxious weed problems and to develop cooperative education and control programs in areas where National Forest System lands are located. Current Forest Service direction for revegetation is to use genetically local (at the ecological subsection level) native species and desirable non-native species where technically and economically feasible. Forest plan standards and guidelines are intended to direct management to maintain and improve natural vegetative conditions and native plant and animal communities and habitats. The Forest will continue to conduct a noxious weed management program that will minimize the spread of state-listed species, and that implements an integrated program focusing on prevention, early detection, and timely treatment of priority species.

AFFECTED ENVIRONMENT

Noxious Weeds

Noxious weeds as officially defined (See Project Record) are plants so designated by the Secretary of Agriculture or by the responsible state official and that generally possess one or more of the following characteristics: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host of serious insects or disease, and is native or new to or not common to all or part of the United States. In a general sense, they are plants that are usually not native to the area in which they are growing and whose growth is so rapid, dominant, or toxic that they out-compete native plants, often taking over complete site or ecosystems over time. They seldom have any natural predators, hastening their spread. They are usually forbs (weeds), but also include grasses (downy brome, crested wheatgrass), shrubs (caragana), and trees (saltcedar, Russian olive).

Noxious weeds alter plant community composition and can be detrimental to ecosystem functions and processes such as nutrient cycling and energy flow. Soil texture can be changed, affecting soil moisture regimes. Serious weed infestations degrade soil stability. Surface runoff and sediment yield can be increased substantially (Lacey 1989).

Noxious weeds most commonly become established in areas where ground-disturbing activities (coupled with import of non-native seed) have occurred and created even very

small areas of bare soil, and where a seed source is already present or in some way is brought in to the area. Once established, they often spread into adjacent stands of native vegetation. Areas where noxious weeds can be expected to occur are road and trail systems, timber harvest skid trails and decking/landing sites, campgrounds, recreation trails and trailheads, areas of livestock concentration, concentrated wildlife use areas such as wintering grounds, utility corridors, mineral developmental sites, water transportation ditches, and stream systems.

An environmental assessment for Management of Noxious Weeds on the Bighorn NF, completed in 1998, uses an integrated management approach: manual and mechanical treatments, herbicide application, and use of biological agents (such as insects and goats) (USDA Forest Service June 1, 1998). Management and control efforts, also conducted by Forest employees, are spearheaded by cooperative efforts with Bighorn, Washakie, and Johnson County Weed and Pest Control Districts, and follow direction set forth in the USDA Forest Service Guide to Noxious Weed Prevention Practices. Prevention and education efforts have been stepped up, both for members of the public as well as for Forest employees.

The following summary of noxious weed species present on the Forest was taken from the Bighorn NF Noxious Weed Management Environmental Assessment, June 1, 1998, Appendix E. It shows a total of 9 species infesting 14,762 acres of the Forest.

Table 3-56. Noxious weed species on the Bighorn National Forest.

	Buffalo/Tensleep	Tongue	Paintrock	Medicine Wheel	Forest Total
Canada thistle	1,841	7,623	411	1,078	10,953
Houndstongue	3,347	4.5		28	3379.5
Musk thistle	< 1		1	28	29
Russian knapweed		7	103	1	111
Hoary cress (Whitetop)	Suspected		144		144
Leafy spurge		4.5			5
Yellow toadflax	100				100
Spotted knapweed	Suspected		1 +		1
Russian olive			40		40
District totals	5,288.05	7,639	699	1,135	
Forest Total	14,762				

Based upon Bighorn NF Land and Resource Management Plan (September 1985) direction, treatment of noxious weeds is to be implemented in the following priority:

1. Leafy spurge, hoary cress (whitetop), yellow toadflax, and Russian knapweed.
2. Invasion of new plant species classified as noxious farm weeds.
3. Infestation in new areas.
4. Expansion of existing infestations of Canada and musk thistle, and other noxious weeds.
5. Reduce acreage of current infestation.

Numerous additional species have been observed and treated on the Forest. The following is a summary of species and acres treated by county in year 2002.

Table 3-57. Noxious weeds targeted and treated on the Bighorn National Forest by county.

	Bighorn County		Washakie County		Johnson County		Sheridan County	
Species	**Targeted**	**Treated**	**Targeted**	**Treated**	**Targeted**	**Treated**	**Targeted**	**Treated**
Spotted knapweed (*Cetaurea maculosa*)	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Leafy spurge (*Euphorbia esula*)			Yes		Yes	Yes	Yes	Yes
Diffuse knapweed (*Centaurea diffusa*)	Yes	Yes			Yes			
Houndstongue (*Cynoglossum officinale*)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common tansy (*Tanacetum valgare*)	Yes	Yes	Yes		Yes			
Hoary cress or Whitetop (*Cardaria draba*)	Yes	Yes	Yes		Yes			
Yellow toadflax (*Linaria vulgaris L.*)			Yes	Yes	Yes			
Russian knapweed (*Centaurea repens L.*)	Yes	Yes	Yes		Yes			
Common burdock (*Arctium minus*)	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Canada thistle (*Cirsium arvense*)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Musk thistle (*Canduus nutans*)	Yes	Yes	Yes		Yes	Yes		
Common mullein (*Verbascum thapsus*)	Yes	Yes	Yes		Yes	Yes		
Wild licorice (*Glycyrrhiza lepidota*)	Yes	Yes				Yes		
Bull thistle (*Cirsium vulgare*)	Yes	Yes				Yes		
Absinth wormwood (*Artemisia absinthium*)	Yes	Yes						

	Bighorn County		Washakie County		Johnson County		Sheridan County	
Species	**Targeted**	**Treated**	**Targeted**	**Treated**	**Targeted**	**Treated**	**Targeted**	**Treated**
Chickory (*Cichorium intybus*)	Yes	Yes						
Dalmatian toadflax (*Linaria dalmatica*)	Yes	Yes						
Field bindweed (*Convolvulus arvensis*)	Yes	Yes					Yes	Yes
Hemp dogbane (*Apocynum sp.)*	Yes	Yes						
Milkweed (*Asclepias speciosa*)	Yes	Yes						
Ox-eye daisy (*Chrysanthemum leucanthemum*)	Yes	Yes						
Perennial sowthistle (*Sonchus arvensis*)	Yes	Yes						
Russian olive (*Elaeagnus angustifolia*)	Yes	Yes						
$$Contributed through cooperative agreement	$25,000		$15,000		$8,500		$1,200	
Total acres treated (gross)	22,000 (est)		14,964		1,970		320	
Total acres treated (net)	306.85		210.5		60.2		8	

Prevention

Noxious weeds are introduced and spread in any number of ways: spring runoff, wind, wildfire, birds, big game and other wildlife, livestock, seeds and plant parts brought in or transported during road maintenance, fire control, and timber harvesting equipment; innocent gardeners trying an attractive new variety in their flower bed (yellow toadflax, oxeye daisy, chamomile, purple loosestrife); and recreationists and recreational vehicles of all kinds. Because of the wide array of spread vectors, it is important to have an active program of prevention.

All Forest activities will be planned and conducted in consideration of the USDA Forest Service Guide to Noxious Weed Prevention Practices, Version 1.0, dated July 5, 2001. Examples of the preventative practices include reseeding efforts after ground-disturbing activities such as fire, road construction, and timber harvest now require the use of seed (and mulch) to be free of noxious weed seed or plant parts. Fire-fighting equipment coming in from all over the country now routinely are washing undercarriages at municipal or portable wash stations. Timber sale contracts require similar cleansing of equipment coming in from areas known to contain noxious weed populations.

New and expanding populations in the Cloud Peak Wilderness are of a particular concern since these weeds can eliminate native plants and compromise the wilderness character and resource values of the area. On-going management approvals are in place for noxious weed treatment in this area.

Weed Free Forage Program

Recreational horse use is a possible source of spread, especially in stock use areas such as the Cloud Peak Wilderness. Many horse users bring in hay for feed. Because new populations of noxious weeds can start from seed or plant parts in hay, the Regional Forester in 1997 signed a statewide Weed-Free Hay Closure Order for all Wyoming National Forests. It restricted "possessing, storing, or transporting of any hay, straw, mulch, or forage product which has not been certified as free of noxious weeds and seeds." The Weed-Free Hay Closure Order has been considered successful in reducing new infestations of noxious weeds.

Roadside Monitoring and Treatment

Perhaps the most common source of weed expansion occurs along highways and Forest travel ways, particularly those used for motorized travel. Because of this the Forest will maintain a program of frequent roadside monitoring as a preventative measure.

Weed Education and Awareness

Informing people as to the identity, methods of spread, and undesirable/dangerous results of noxious weeds in ecosystems remains the single most effective way to prevent or control expansion of non-native plants on the Forest.

Noxious weed populations have increased since preparation of the 1985 Forest Plan. Forest records indicate that county treatment today requires less chemical than in the past, indicating that many populations are smaller. New species and locations are mapped when they are located, and acreages of old populations are updated as they are treated. An updated forest wide inventory has not been conducted since preparation of the Bighorn NF Noxious Weed Management Environmental Assessment, June 1, 1998.

Environmental Consequences

General Effects

Noxious weeds and other invasive plant species most commonly become established where ground-disturbing activities have created areas of bare soil and where a seed source is present. They are introduced or spread in countless ways by people, vehicles, animals, birds, wind, water, fire, and more.

Treatments for the life of this plan are expected to remain within the scope of the 1998 EA. They will be directed through implementation of the noxious weed management plan for the Bighorn National Forest.

Despite prevention and eradication efforts, some noxious weed species (such as Canada thistle) will almost certainly continue to persist, across all alternatives, due to their tenacity and the presence of existing populations. For species such as this, the Forest will continue a containment strategy, attempting control the plant in selected areas strategically chosen to minimize spread of the plant. However, other species (such as leafy spurge and oxeye daisy) that currently occupy limited areas will be managed under an eradication strategy to stop the spread to the extent possible. For these species, complete control will be the emphasis wherever they are found.

The Forest is expending weed control funding through county programs to control weed species on adjacent private lands (through authority in the Wyden Amendment). Still, existing noxious weed populations will likely continue to spread between adjacent or intermingled private and other agency lands. Similarly, populations from other-ownership lands will continue to spread onto the Forest.

Alternatives that plan for greater amounts of human presence and human-caused disturbance, and/or that plan for allowing the greatest amounts of natural soil disturbance, will generally provide more opportunity for noxious weed species to be introduced and for existing populations to expand. Alternative C plans for the least cumulative alteration of landscape and activity, and can be expected to have the least effect from noxious and invasive species. Alternatives with more cumulative activities in order from the least to the most are alternative B, A, D, and E. Alternatives B, A, and D all have moderate potential for expansion, while Alternative C has the least and Alternative E has the most.

Direct and Indirect Effects

Effects from Management of Pristine, Semi-Primitive, and Recommended For Wilderness; Backcountry Recreation, Nonmotorized Use; Backcountry Recreation, Non-Motorized Summer Use With Limited Winter Motorized Use; and Wild Rivers Designated and Eligible (Category 1): Noxious weed populations in the above listed areas and proposed areas have resulted from natural and man caused disturbances, or result from noxious weed seed carried in by those recreating, livestock permittees, outfitters, wildlife, or others. Since these areas are less accessible and often receive less use by the public than other areas of the Forest, noxious weed infestations are less common and less extensive, but can be more difficult to find and treat. The weed-free hay closure order for all Wyoming National Forests provides mechanism for limiting spread of noxious weeds by those using pack and saddle stock. No such protection is in place for other Forest users.

Treatment of weed populations in these areas must often be accomplished without the use of motorized or mechanized equipment, and can be in areas difficult to access. Herbicide treatment may be accomplished with backpack pumps or can be aided with the use of pack and saddle stock. Hand grubbing is an option, but can be time consuming and costly for

extensive infestations, and is not usually effective for the deep-rooted perennial rhizomatous weeds.

Alternative C has the greatest amount of area designated in Category 1, with Alternative D, B, A, and E following sequentially.

Effects from Research Natural Area Management: RNAs tend to experience less use by people and less associated disturbances. They are often difficult to access. Generally, the opportunity for introduction and spread of noxious weeds is lower than in many other areas. Similar to category 1 effects above, treatment can be difficult and costly.

Alternatives B, C, and D have identical new RNA designations: Mann Creek, Leigh Creek, Pheasant Creek, and Lake McClain. Alternatives A and E have no additional RNAs proposed.

Effects from Management Area 3.1 (Medicine Wheel): In this Special Interest Area, many uses such as grazing, camping, timber management, commercial use, etc. are to be limited or excluded, and the area is to be managed to appear natural. Opportunities for new or spreading noxious weeds should be relatively few, as no new road construction or timber harvest activities are planned.

The impact will be the same across all alternatives. In Alternative D, the area allocated to MA 3.1 is 20,593 acres, and the impact could therefore cover a much larger area.

Effects from Timber Management: Activities associated with timber harvest involve high amounts of human presence; they create areas of disturbed or bare soil, and very commonly result in expansion or introduction of noxious weed populations. Skid trials, decking and landing sites, and areas treated with dozers or roller-choppers for reforestation efforts all create opportunities for noxious weed infestation or expansion. Motorized transportation is common, and potential for spread of noxious weeds is great. Prevention measures can help reduce this effect. Timber sale contracts require cleansing of equipment coming in from areas known to contain noxious weed populations, and may be applied to log haul trucks, skidders, and other off-road equipment as needed. Any reseeding efforts after require the use seed (and mulch) free of noxious weed seed (or plant parts). The order of alternatives with timber harvesting activities, from least to most, is: C, B, D, A, and E.

Effects from Category 8 Management Areas: Ecological conditions are likely to be permanently altered in these areas beyond the level needed to maintain natural-appearing landscapes and ecological processes. Human activities are generally commercial in nature, and motorized transportation is common. Potential for ground disturbing activities and introduction/spread of noxious weeds is great. Infestation areas can be readily monitored and treated, but early detection and eradication is crucial.

While the acres allotted to Category 8 management prescriptions vary slightly between alternatives, the overall proportion of these acres to the total acres on the Forest is so small that there is no difference in the effects on invasive species.

Effects from Fire and Fuels Management: Wildfire has a great potential to spread noxious weeds because of the human activities, motorized transportation, potential for

ground disturbing activities, and large number of acres that can be affected by a wildfire event. Wildfires and suppression activities can create large areas of bare soil and areas of reduced vegetation cover, both of which provide ideal conditions for noxious weeds to spread rapidly, especially if populations already exists in or adjacent to a burned area.

Because of the presence of abundant seed of Canada thistle in most landscapes, wildfire will likely continue to create large increases in new populations of this species. Where eradication is not possible, control will be the objective through encouragement of healthy native vegetation and through fire rehabilitation efforts.

Suppression and support equipment and crew vehicles can carry weed seeds and plant parts. Alternatives A through E and G include provisions for washing fire-related vehicles to reduce chance of carrying noxious weed seed, while the no action alternative does not have any such consideration. Prescribed fires are less likely to spread noxious weeds because they take place under planned and controlled conditions.As more acres burn by wildfire, the risk increases of spreading existing and new noxious weed populations. Differences in wildfire risk and prescribed fire between alternatives will be minimal.

Effects from Recreation and Travel Management: Recreational activities may be responsible for the greatest spread of noxious weed populations because of the number of people with their vehicles, horses, and accessories that visit the Forest. Most noxious weed expansion occurs along roads and trails. Once established along the travel way, if left untreated, the populations begin to spread laterally from the travel corridor. Some expansion occurs at trailheads and popular horse-camping areas. Weed seeds and plant parts are brought in on vehicle undercarriages and tires, off-road vehicles, horse trailers, hay and feed products, boots and shoes, camping and fishing equipment, etc. Any activities that create bare or disturbed soil provide conditions for invasive species establishment and spread in areas including roads and roadsides, trails and trailheads, parking lots, developed and dispersed camping sites, popular fishing locations, heavy-use areas around summer homes, ski runs, and construction areas. Off-road vehicle travel has high potential to introduce and spread noxious weeds.

The weed-free hay closure order for all Wyoming National Forests provides a mechanism for limiting spread of noxious weeds by those using pack and saddle stock. Since no such protection is in place for motorized vehicles, alternatives that plan for greater levels of motorized travel (in summer) are likely to provide greater opportunity for spread of noxious weeds.

Decommissioning of roads has the effect of reducing areas populated by noxious weeds.

All action alternatives limit motorized travel to designated routes, and as a result limit potential spread of noxious weeds more than the no action alternative. The motorized summer recreational opportunities vary from highest to lowest by alternatives follows: E, A and D, B, and C.

Effects from Roadless Area Management: The effects are very similar to those for management of lands in category 1 (described above). Since these areas are less accessible and often receive less use by the public than other areas of the Forest, noxious weed

infestations are less common and less extensive, but they can be more difficult to find and treat.

Effects from Heritage Management: Effects from managing heritage resources are anticipated to be very minor in scope or acreage. If known sites are evaluated for possible nomination to the National Register (involving soil disturbance through pit evacuations, for example), noxious weed seed could be brought in, resulting in introduction or spread of noxious weeds. Effects from managing heritage resources and will be consistent across all alternatives.

Effects from Mineral and Energy Development: Effects are similar to those for recreation, described above, if mineral operations result in exploration activity and if sites go into production and result in an increase in travel. Production sites (including frequent presence of maintenance vehicles) often create areas of disturbed soil, providing areas for noxious weed infestations. Restoration of these areas following production will involve monitoring and treatment of noxious weeds. The potential for these activities is very small based upon past activity levels on the Bighorn NF. There is nothing in this analysis that indicates an increase in future levels of development.

Effects from Utility Corridors: Installation of overhead voltage lines and buried electric, cable, telephone, or other utility system lines creates areas of bare soil and effects similar to Mineral and Energy Development above. These areas are generally subject to permit provisions that include monitoring for noxious weed infestation and spread, but they can become problem areas. Effects will be consistent across all alternatives.

Effects from Livestock Grazing and Big Game Use: The majority of permitted livestock are cattle, sheep, and horses. They can introduce noxious weeds by transporting seeds in their hooves, hair/wool, or in digestive systems. Horses and sheep in particular are known to consume several species of noxious weeds after plants are mature and produced viable seed. Big game animals can also introduce and spread noxious weeds in the same way that domestic livestock can.

Horses used by outfitters/guides can also be a source of weed delivery from infested private lands, and new populations can be started at their camps and in the areas and along trails they are permitted to use. Special Use Permit clauses require that operators comply with the regional weed-free hay closure order (Noxious Weed Implementation Plan).

Livestock can also be used as a very effective control method for some noxious weeds. Goats are the most notable example. Having been trained to prefer certain species, they are extremely effective in reducing leafy spurge. Cattle are effective in reducing Canada thistle populations in some areas, as they prefer to graze the plant just as it begins to flower, thus preventing seed set. Livestock and big game populations and their effects will not differ significantly between alternatives.

Effects from Rangeland Vegetation Management: Projects that have potential to create areas of bare soil, such as prescribed fire in aspen or ponderosa stands or mechanical treatment for conifer encroachment, create the possibility of introducing or expanding

noxious weed populations; in such cases, mitigation is required to prevent or control weed populations.

The combined acres of vegetative treatment for rejuvenating aspen, maintaining native meadows, and treating sagebrush and other shrublands and associated noxious weed spread will remain relatively constant across all alternatives.

Effects from Lands Exchanges: An individual land exchange could result in a potential loss or gain of noxious weed infestations on the Forest, depending upon the size and location of the exchange and whether either the offered or selected lands contained existing populations. If an exchange results in a subdivision, or development where human activity will be greatly increased, the likelihood of new infestations of noxious weeds will also be greatly increased. The effect from possible land exchanges will be consistent across all alternatives.

Effects from Wildlife and Fisheries Management: Wildlife species can transport noxious weed seeds in the same ways livestock can. Some species of birds make it possible for plant seeds to germinate by first passing through their digestive tracts; in such instances, the seeds are unable to germinate without going through this scarification process. Animals may collect and store weed seeds such as thistles, contributing to expansion of populations as they germinate in future years. Wildlife or fisheries enhancement projects that disturb the soil surface (such as fish structures) can increase weed populations. The effect from wildlife and fisheries management will be consistent across all alternatives.

Effects from Threatened, Endangered, and Sensitive Species Management: In general, the habitat requirements in and around each known or discovered TES species location will be protected, restored, or enhanced. It is conceivable that habitat needs for a specific species could require actions (and possible ground disturbance) to manage for early seral conditions that could have potential for increased noxious weed invasion. The effect from threatened, endangered, and sensitive (TES) species management will be consistent across all alternatives.

Effects from Species Viability Management Requirements: Effects would be similar as for TES species management stated above, including any efforts that may involve ground-disturbing activities. The effect from species viability management will be consistent across all alternatives.

Effects from Soil and Watershed Management: Soil and watershed restoration or improvement projects are intended to improve condition of the land, that is, to repair or restore areas of disturbed conditions. There could be a greater disturbance to the land in the short run as a project/treatment is implemented, which could also increase the possibility of noxious weed expansions. In the long run, however, there should be an overall reduction in areas of bare soil. The effect from soil and watershed management will be consistent across all alternatives.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to invasive species. This discussion considers effects of invasive species since their first appearance in the Bighorn National Forest, and adjoining lands. The key indicators for invasive species analysis is amount (acres) of invasives and the amount (acres) of treatment. The cumulative effects area for this analysis is the four county area.

Acres of Invasive Species

On and off the forest, noxious weeds and invasive plant species often become established where ground-disturbing activities have created areas of bare soil, and where a seed source is present. Bare ground has resulted from past activities including livestock grazing, timber harvest, recreation, and road/trail development. Seed sources have included recreational livestock, permitted livestock, and motorized vehicles. Their populations have increased throughout the four counties. The county weed and pest districts map noxious weed occurrences, and their maps show the amount and type of invasive species.

Expectations are that the amount of invasive species on and off the Forest will increase as the population of local communities increases, 'baby-boomers' retire, and as more people nationwide continue to seek places like the Big Horn mountains to recreate and retire. ATV use in particular has seen a dramatic increase recently that is expected to continue although the rate of growth is not likely to be as dramatic as it has been in the past decade (See Specialist Report for Recreation). The state sponsored OHV program may result in increases in ATV use across the Forest. Locally, the current coalbed methane activity in the Powder River Basin has resulted in more demand for recreational use of the Bighorn NF, particularly for motorized uses, and this activity is expected to continue (BLM 2003). The coalbed methane ground disturbing activities of pipeline burial, road construction, and well pad development will increase the risk of invasive species.

Noxious weed populations on Forest can be directly influenced by activities on adjacent lands, and vice versa. For this reason it is critical that cooperative efforts continue in these areas, and with county and state efforts at education and control. As more travelers come from out of state, certification and treatment becomes increasingly important in noxious weed management on-Forest. Urbanization is expected to continue to result in spread of invasive plant species off Forest. As new residents come to communities adjacent to the Forest, education and control become increasingly important. Water courses are important vectors for invasive species, and since the National Forest System lands are at the head of the watersheds, Forest invasive species populations could spread to non-Forest land via streamcourses.

Acres of Noxious Weeds Treated

Management of invasive species to deal with cumulative effects will be consistent across all alternatives. The Forest is expending weed control funding through county programs to

control weed species on adjacent private lands (through authority in the Wyden Amendment). Management and control efforts are spearheaded by cooperative efforts with Bighorn, Washakie, and Johnson County Weed and Pest Control Districts, and follow direction set forth in the USDA Forest Service Guide to Noxious Weed Prevention Practices. The Weed and Pest Districts work closely with private landowners and other USDA agencies and County Conservation Districts to treat existing populations, and to educate people on the topic of invasive species. Prevention and education efforts have been stepped up, both for members of the public as well as for Forest employees.

Vegetation

Introduction

The ecosystems and vegetation of the Bighorn National Forest are dynamic. The processes of succession and disturbance patterns have produced the current vegetative conditions. These natural processes, both part of and necessary for ecosystem function, will continue to produce changes in the future. Therefore, the following descriptions of current vegetation represent only one point in time. Some of the changes will be generally predictable, others less so. Accordingly, any description of future vegetation will be a prediction subject to uncertainty. The level of uncertainty depends on the degree to which natural processes are allowed to operate. Natural disturbance events such as fire, windstorms, landslides, and insect and disease outbreaks are generally difficult to predict. On the other hand, changes associated with succession and human-caused disturbance such as logging and prescribed burning are fairly predictable. Although natural disturbance events will occur throughout the Forest, the degree to which they are allowed to occur will influence the ability to predict future vegetative conditions at any given point in time.

Legal and Administrative Framework

National Forest Management Act of 1976 (NFMA)

Code of Federal Regulations (CFRs) 36

- 217 Requesting Review of National Forest Plans and Project Planning
- 219 Planning
- 221 Timber Management Planning
- 222 Range Management
- 241 Fish and Wildlife

Policy direction from the Forest Service Directives System in Forest Service Manuals (FSM) 2400 Timber Sale Management, 2200 Range Management, and 2600 Wildlife Management, and in Forest Service Handbooks (FSH) are listed here but not limited to:

- R-2 Rangeland Analysis and Management Training Guide
- Timber Resource Planning Handbook
- Timber Management Information System Handbook
- Timber Sale Administration Handbook
- Silviculture Practices Handbook

- Timber Sale Preparation Handbook
- R-2 2409.26 Silvicultural Practice Handbook
- 2609.13 Wildlife and Fisheries Program Management Handbook

Key Indicators

Forest Vegetation

- Natural disturbance levels.
- Acres, and types, of timber harvest and other management actions that change vegetation.
- Acres of aspen treated to be moved to mid or early seral condition.

Rangeland Vegetation

- Trends in cattle and sheep head months (HMs) and animal unit months (AUMs) permitted for grazing.
- Trends in acres of suitable rangeland in active allotments.
- Acres meeting or moving toward desired conditions
- Acres of noxious weeds
- Populations of big game animals

Resource Protection Measures

Numerous forest-wide and management area prescription standards and guidelines exist concerning vegetation. All alternatives provide for satisfactory regeneration of logged areas, for treatment of activity-related fuels, management of insects and diseases, and various wildland fire management strategies.

AFFECTED ENVIRONMENT

Forest Vegetation

Composition

Vegetation on the Forest has been classified into several types, including both forest and non-forest types. The descriptive names used are based on the major species found in the type. Many species, other than those listed, also occur in each type. Cover types for the Forest, their acreages, and the percent of the total Forest are listed in the following table.

Table 3-58. Percent of cover types on the Bighorn National Forest (acres rounded to hundreds).

Cover Type	Acres	Percent of Bighorn
Forest Cover Types		
Lodgepole pine	346,074	32%
Spruce/ fir	234,754	21%
Douglas-fir	100,294	9%
Ponderosa Pine	18,671	2%
Limber Pine	14,214	1%
Aspen	10,290	1%
Juniper	2,943	<1%
Cottonwood	409	<1%
Total forest Cover Types	727,240	66%
Non-Forest Cover Types		
Grass	136,983	12%
Non-Vegetated (Bare, Rock)	97,150	9%
Forb	62,517	6%
Sagebrush	55,067	5%
Other Shrubs	17,557	2%
Total Non forest	369,275	34%
Total	**1,096,515**	**100.0%**

Source: Bighorn GIS, (USDA Forest Service 1998c).

Major Cover Types on the Bighorn National Forest

Lodgepole Pine (*Pinus contorta*)

Lodgepole pine is the major tree type on the Forest, occupying 32%of the land area. It is the dominant species in the subalpine forest. Under natural succession, a spruce-fir climax association would eventually replace many lodgepole pine areas. In certain locations, however, lodgepole pine can form climax associations.

Lodgepole pine does not grow well in shade. It rapidly occupies sites disturbed by logging, fire, or other major ground disturbing activities. Young lodgepole pine stands are often found in a very dense stagnated condition. If the stand stagnates for too long, the trees will remain small until a stand-replacing event removes them. Stand-replacing events include fire, blowdown, insects, disease, and timber harvesting. Mature trees can be found in thick, dense stands or open, sparse stands.

Lodgepole pine is a relatively short-lived species, and trees older than 200 years are rarely found. This is because of the frequency of stand-replacing events such as fire typical of this series.

Lodgepole pines have two cones types:

- Serotinous cones stay closed until exposed to temperatures high enough to open the cone. This usually occurs during fires or when exposed to full sunlight on the forest floor.
- Non-serotinous cones open when the cone reaches maturity. With seed dispersed every year, and good seed years averaging every 7 years.

The difference between the two is important when regenerating the species. Where the majority of the cones are serotinous, care is taken to protect these cones, as there is no future cone crop to rely on for a seed source. Any regeneration treatment must also plan for increasing cone temperatures, either through broadcast burning or solar heating, so the cones will open. Stands that have typically been regenerated naturally by wildfire will have a larger percentage of serotinous cones than other stands (Lotan, 1974). The lodgepole forest is highly important in providing scenic quality, watershed protection, wildlife habitat, and wood products.

Engelmann Spruce (*Picea engelmannii*)/Subalpine fir (*Abies lasiocarpa*)

The mixed forest series of Engelmann spruce and subalpine fir occupies 21 percent of the Forest. It can be found in the alpine tundra region as well as down to the upper montane forest region. This series represents the climax association for most of the subalpine forest. Without further disturbance such as windthrow, insects, disease or fire, it would replace lodgepole pine over many acres through natural plant succession. Engelmann spruce life span averages 350 to 400 years while subalpine fir trees over 250 years old are rare. Both species can reproduce in their own shade with spruce also able to regenerate on open mineral soils. These forests often form multi-aged stands. Subalpine fir is the most shade tolerant tree species on the Forest. Both species are highly vulnerable to windthrow because of their shallow root systems. They are also vulnerable to various wood rots, as they age. The spruce-fir forest is highly important in providing scenic views, watershed protection, wildlife habitat, and wood products.

Douglas-fir (*Pseudotsuga menziesii*)

While only occupying about nine percent of the Forest, the Douglas-fir series is more important than its area implies. Typically occurring on steep, north-facing slopes at lower elevations, Douglas-fir occurs in pure stands or in combination with ponderosa pine, aspen, or lodgepole pine. Douglas-fir reproduces best under partial shade and does not tolerate either thick dense canopies or completely open sites well.

This long-lived species has high value for wildlife habitat, scenic quality, and watershed protection. The Forest has not harvested Douglas-fir extensively in the past resulting in mostly mature and overmature stands.

Douglas-fir and ponderosa pine are often intermixed with the more tolerant Douglas-fir able to regenerate under a canopy better than the less tolerant ponderosa. Without further disturbance such as windthrow, insects, disease or fire; Douglas-fir would replace ponderosa pine over many acres through natural plant succession. However, because the Douglas-fir branches close to the ground it is considered a ladder fuel taking ground fires to the crowns of trees.

Ponderosa Pine (*Pinus ponderosa*)

Ponderosa pine occupies almost two percent of the Forest. At its upper elevational limit, it borders the subalpine forest region of lodgepole pine, Engelmann spruce, and subalpine fir. At the lowest elevational limit, it borders the short-grass prairie. Thick bark on older, large trees makes them resistant to fire. Ponderosa pine foliage can have very low moisture content during hot weather and droughts. Where tree crowns are not separated from the understory vegetation, fire can burn into the tree crowns and cause extensive mortality in stands.

A diverse ponderosa pine forest provides wildlife habitat for many species. It is winter range for deer and elk. Young ponderosa stands are often very dense which can lead to stagnation. Mature stands typically grow in open park-like stands with well-developed shrub and herbaceous under-stories. The leading causes of mortality are: disease, insects, fire, and windthrow.

Ponderosa pine is moderately shade intolerant, and young ponderosa are often out-competed in the understory by the more fire susceptible Douglas-fir. Historically this cover type had short interval low intensity fires that would thin younger pine, and remove the more tolerant Douglas-fir. However, with over 100 years of fire suppression much of the ponderosa cover type has become denser and is being converted to the more shade tolerant Douglas-fir.

Limber Pine (*Pinus flexilis*)

Limber pine stands are found on just over one percent of the Bighorn NF, and may be found as a component of the series above. Limber pine is known as a tree of high cold windy ridges, growing on sites where other trees can't grow. The seeds are large and lack wings, being primarily distributed and utilized by wildlife. Limber pine is an effective pioneer and colonizes disturbed and harsh sites. It is very slow growing reaching heights from 30 of 50 feet (Alexander, Hoffman et al. 1986). The introduction of the exotic disease white pine blister rust, *Cronartium ribicola*, is dramatically reducing the population of this species, and is discussed further in the insect and disease section.

Aspen (*Populus tremuloides*)

The aspen series, noted for its brilliant fall colors, occupies about one percent of the Forest. It typically occurs mixed in with grasslands, meadows, mountain brush, or other forest series. Aspen contribute to wildlife habitat, watershed protection, and scenic quality.

The aspen on the Forest are typically mature to overmature with a high level of decay, disease, mortality, and succession by conifers. Aspen regenerates almost entirely through root sprouting. To stimulate root sprouting, most aspen clones require a major disturbance that removes most or all of the existing trees. Wildfire has historically been the primary disturbance initiating root sprouting. The control of wildfire and lack of fine fuels from ungulate grazing on the Bighorn NF has permitted most of the aspen stands to become overmature with few means of regeneration. Without disturbance, either natural or man-made, much of the aspen will convert to conifer types within the next rotation, approximately 75 years.

Juniper (*Juniperus species*)

Utah juniper in the Bighorn Mountains is found on the lower western slopes between 1,520 and 2,140 meters on coarse textured soil (Despain 1973). Rocky Mountain juniper (*Juniperous scopulorum*) is a minor component in the moister portions of drainages. Less than 600 acres of the Bighorn National Forest is classified as Juniper Woodland. It is also a component in stands with other cover types, mainly along the lower elevations of the Bighorns.

Structure

Forested ecosystem elements are created in the interplay of succession and disturbance. Succession is an orderly process of biotic community development that involves changes in species, structure, and community processes with time. It is reasonably directional and, therefore, predictable (Schwarz, Thor et al. 1976). Forest stands develop recognizable stand structures over time, that can be described in terms of the horizontal and vertical distribution of components including height, diameter, crown layers and stems of trees, shrubs, herbaceous understory, snags and down woody pieces (Thomas, Miller et al. 1979).

Different arrangements of these components provide different conditions that make up the diversity of the forest. Structure and diversity are discussed in the Biodiversity section of this document.

Function

Ecosystem functions deal with energy and material flows within and between ecosystems. Accordingly, ecosystem functions are closely tied to ecosystem processes. Ecosystem processes cause composition and structure to change with time. Conversely, changing composition and structure leads to a change in the processes. It follows that ecosystem functions are also very dynamic, changing over time. Specifically, the functions associated with vegetation are quite complex. For example, nutrient cycling and photosynthetic production change in relation to composition and structure.

Rangeland Vegetation

Rangelands are a major component of ecosystems in the western United States and on the Bighorn NF. They are lands that include strong representation by herbaceous and graminoid species. Rangelands include, but are not limited to grasslands, forblands, shrublands, open-canopied forests, and associated riparian, wetland and aquatic areas. Well-managed rangelands provide forage and cover for wildlife and domestic livestock, in addition to high quality water and numerous recreational values. (USDA Forest Service)

There are a total of 1,112,429 acres within the administrative boundary of the Bighorn NF, 99% of which are National Forest System acres (BNF GIS CVU database 2002). Based only upon vegetation types that are largely grass/forb, 21% (233,046 acres) could be classified as rangelands. In addition, 36% of all vegetative types have 10-34% grass/forb, and provide considerable herbaceous vegetation for various uses. Forty-three percent of vegetative types include 0-9% grass forb components and provide smaller amounts of forage.

Grasslands are scattered throughout the Bighorn NF, particularly in the north where fine-textured soils are more widespread. Forb-dominated areas are mostly in the alpine and subalpine meadows. Shrublands containing sagebrush (*Artemisia spp*), juniper (*Juniperus osteosperma),* or curlleaf mountain mahogany (*Cercocarpus ledifolius*) are scattered throughout the Forest, but they occur primarily in the foothills of the western flank (Knight).

The majority of shrub covertypes on the Forest are sagebrush. Most sagebrush is of the *Artenisia tridentate vaseyana* type, indicative of the high elevations and moisture regimes at elevations on the forest as compared to surrounding basins. This type is also more resilient to disturbances, since it occurs on more productive sites with more precipitation than those at lower elevations. More of the shrub communities occur on the western side of the range than the east due to climate. Mountain brush communities are the next most abundant, and includes species such as chokecherry, mountain mahogany, snowberry, serviceberry, and others. Due to lack of fire in most of these shrub types, there are fewer communities in an early seral condition than would be expected under historic ranges of variability. The Forest has been conducting prescribed burning in primarily the sagebrush types over the past two decades for the purpose of range forage and wildlife habitat enhancement. These treatments have been localized, such as in Shell Canyon, Horse Creek Mesa, and other sites primarily on the west side of the mountain range. Currently, inventories to determine age class distributions of shrub communities occur at the project level. Similar to forested structural stages, it is desirable to have a balance of age classes to provide for a diversity of wildlife and resilience to disturbance processes such as fire (Thomas).

The numerous sharp boundaries between grassland and forest are an interesting feature of the Big Horn Mountains, particularly in the northern part of the forest (Despain). Such boundaries appear to be caused by differences in soil texture, with forests occurring on the more coarse soils and meadows on finer textured soils. The physical location of many mountain meadows and grasslands appears to be quite stable. (Despain). In some instances,

however, changing climatic conditions have allowed tree seedling establishment on areas that were historically occupied by meadows. (Knight)

Dominant upland (non-riparian/non-wetland) species are Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Psuedoroegneris spicata*), mountain mahogany (*Cercoparpus spp.),* big sagebrush (*Artemesia tridentate*), and black sagebrush (*Artemesia nova*). (Regan et al 2003)The extensive montane grasslands of the Bighorn NF tend to occur on fine-textured sedimentary soils, mostly at low-elevations with low precipitation (<2,300m) or at high elevations too cold or snow-covered to support continuous forests (2,750 m) (Jack 1900, Despain 1973). Idaho fescue (*Festuca idahoensis*) is the most common grass from 1,840 m to about 3000 m (timberline); bluebunch wheatgrass (*Elymus spicatum*) dominates the grasslands at lower elevations. Both grasses also can be found with curl-leaf mountain mahogany and big sagebrush. The relatively high precipitation on the east slope has resulted in more forest than on the west side, even on sedimentary substrates (Despain 1973,Meyer and Knight 2001).

Approximately 104,596 riparian acres occur on the Forest. (DEIS Aquatics and Fisheries) Geomorphology, topography, and other environment attributes influence riparian vegetation community development. Stream channel type, soil characteristics, parent material, landform, and elevation are some of the important factors. Disturbance regimes in riparian areas are more complex than in the uplands because of the stream dynamics associated with riparian areas. Succession usually proceeds slowly and sometimes changes cannot be detected during a person's lifetime (Girard).

Natural disturbances, most often involving water availability, result in riparian succession. Examples are stream flooding, meandering, undercutting, down cutting, sediment deposition, beaver dam building and breaching, and fluctuating water tables (Girard 1997, Clements 1991). Natural riparian succession can result from disturbance events on upland areas that affect moisture levels in riparian areas such as timber harvest or fire activity. Other disturbance events are human-caused such as livestock grazing, channelization, road and dam construction, and recreation use. Tie hacking had a tremendous influence on some riparian areas in the early 1900s (Girard).

Livestock grazing throughout the Forest occurred at a heavy level from the late 1800s through the mid-1900s. A variety of factors have led to the adjustment of livestock numbers to more sustainable levels in recent decades (Regan et al. 2003; Meyer and Knight 2001).

The Bighorn NF and the surrounding watersheds have been grazed by wild ungulates for thousands of years (Knight). The large wild ungulate species of interest on the Bighorn NF are elk, moose, bighorn sheep, deer (both mule and white tailed), and pronghorn; with elk, mule deer, and moose the major species currently using the Forest. At their present levels, elk, deer, and moose populations have an effect on certain plant communities. Often the most noticeable effects occur on winter ranges (including fall and spring transition ranges) and in the higher elevations on the highly preferred plant communities such as aspen and willow. Plant reproduction and long-term health are influenced.

The long term effects of large wild ungulates in some areas has the potential to influence growth, form, reproduction, and long-term health of vegetation if their densities become high enough in a given location. Once livestock enter an area, the combined utilization of the two animal groups can continue to increase effects to resources.

The most commonly recognized effects of large wild ungulates include:

- Impacts on fall, winter, and spring range as animals migrate seasonally across elevation zones. Large concentrations of animals on wet soils can cause trampling or displacement damage and uproot grass plants. Due to the nutritional needs of these animals, palatable shrub and tree (aspen) species that provide the highest nutritional value are the focus of browsing and grazing. Effects can be severe locally in highly preferred areas and migration corridors or can be minimal in areas little used by the wildlife.
- Impacts on summer ranges include grazing and browsing impacts on aspen, riparian, and wetland vegetation. Effects can include trampling of wet soils and excessive browsing of hardwood species. Long-term effects can be reductions in vigor or reproductive ability of plants and changes in species composition and cover.

These effects can be compounded or even masked by similar effects of livestock grazing and browsing. When both classes of ungulates make use of the same plant species and habitats, the effects are often magnified.

There is considerable controversy surrounding domestic and wildlife grazing. Anecdotal evidence from Bighorn N F land managers, along with limited monitoring data, indicates that there are localized problems with excessive use of certain plant species and communities. Solutions to these problems are dealt with in communications and coordination with Wyoming Game and Fish biologists and at the site-specific level of NEPA analysis during allotment management planning.

The Forest Service implements management of rangelands through a wide variety of practices as appropriate to the site-specific situation. For example, domestic livestock are managed through term grazing permits on suitable lands that are parts of grazing allotments. Impacts of vehicular use can be dealt with through travel management. Wildlife impacts and recreational stock are often challenging to manage. The state of Wyoming is directly responsible for managing wildlife populations, but the Forest Service is a managing partner for population numbers, diversity, and species viability through the management of rangeland vegetation. Forest Service rangeland management specialists and wildlife biologists coordinate and cooperate with state biologists to maintain big game herds at levels consistent with available habitat and vegetation objectives. In some instances, appropriate management or restoration activities may include revegetation with native species, use of prescribed fire, removal of invading conifer or shrubby vegetation, etc.

Rangeland Suitability

Rangeland suitability analysis for livestock grazing on the Forest was completed following the standard process provided in the Region 2 Planning Desk Guide. Definitions of rangeland capability and suitability can be found in FSM 1905. In brief, rangeland capability considers land potential, while rangeland suitability deals with the appropriateness of applying certain resource management practices to the land. See Appendix B for a complete description and maps displaying the suitability determination for livestock grazing. The following chart displays a summary of the suitability analysis compared to existing grazing allotments on the Bighorn NF.

Table 3-59. Acres of land determined as capable for livestock use.

Classification/Description	Acres Deducted	Running Totals
Net National Forest System Acres	-------	1,105,017
Deductions for other than capable acres	-------	1,105,017
-Soil types that are dominated by a large percentage of rock outcrop	332,346	772,671
-Lands that are not capable of producing 200 pounds of forage per acre	63,048	709,623
-Lakes, reservoirs, ponds, and marshes	11,913	697,710
-Major rivers within the Bighorn National Forest proclaimed boundary	0	697,710
-Perennial streams	338	697,372
-Roads and highways	1371	696,001
-Slopes greater than 60% (not capable sheep or cattle)	25,601	-------
-Slopes between 41%-60% (not capable cattle)	9,137	-------
Total capable for sheep grazing	434,617	670,400
Total capable for cattle grazing	443,754	661,263

Table 3-60. Acres of land determined as suitable for livestock use.

Classification/Description	Cattle		Sheep	
	Acres Deducted	Running Totals	Acres Deducted	Running Totals
Net National Forest System acres	------	1,105,017	------	1,105,017
Deductions for other than capable acres	443,754	661,263	434,617	670,400
Deductions for other than suitable acres	------	661,263	------	670,400
-Existing canopy cover >70%	395,792	265,471	395,792	274,608
-Shell Canyon and Bull Elk Park RNAs that exclude livestock	1618	263,853	1618	272,990
-Range exclosures	3586.9	260,266.1	3586.9	269,403.1
-Forage not available due to right-of-way fences & other limitations	1172.8	259,093.3	1172.8	268,230.0

Classification/Description	Cattle		Sheep	
	Acres Deducted	Running Totals	Acres Deducted	Running Totals
-Current grazing closures	0	259,093.3	0	268,230.0
-Threatened, Endangered, and Sensitive Species closures	0	259,093.3	0	268,230.0
-Other incompatibilities	0	259,093.3	0	268,230.0
-Economical feasibility	0	259,093.3	0	268,230.0
Total suitable acres (cattle)		259,093.3		------
Total suitable acres (sheep)		------		268,230.0

Table 3-61. Acres determined at the forest plan level as suitable for livestock use.

Classification/Description	Acres Suitable
Total suitable determination acres for cattle grazing	259,093
Total suitable determination acres for sheep grazing	268,230

Forage Allocations

There are currently 86 grazing allotments on the Bighorn National Forest. Approximately 13% (147,333 acres) of National Forest System lands are outside the boundaries of any kind of allotment. Of the 86 grazing allotments, 10 are vacant (vacant allotments are those for which term grazing permits are not currently issued for livestock use) and represent 5.8% of acres that are in allotment status. Of these 10 vacant allotments, 6 are commonly stocked through annual authorization as a means of providing management flexibility to respond to situations such as fire, drought, or needs to rest areas for a variety of resource reasons. In effect, these allotments operate as "forage reserves." This leaves approximately 2.2% of the total grazing allotment gross acreage not stocked in most years. (Bighorn NF INFRA database 2001)

Based upon rangeland analysis data, the average allotment gross acreage is 41% suitable acres (Bighorn NF INFRA database 2003). This is the area on which domestic livestock routinely make use of a portion of the available forage. The remaining area (59%) receives only occasional, incidental, or no use by livestock (for example, lodgepole and ponderosa pine with forage in the under story, steep slopes, areas without available water, and so forth).

Cumulatively, this means that while a majority of the forest is in an active grazing allotment, livestock grazing actively takes place on only about 35% of the Forest. Forage in the remaining balance is used primarily by wildlife and recreation interest.

On that 35% of the total Bighorn NF actually used by livestock, much will have only minimal or light livestock influences to any appreciable degree. In these areas, standards and guidelines specify the portion of annual vegetation production that may be utilized by livestock and wildlife. In most cases, they are restricted to using on 40% to 50% of the

annual forage production, leaving the remainder, generally 50-60%, also available for other uses and values.

Because of variation in palatability and in distribution of livestock across the landscape, actual use in most areas is lower then 45%. If you consider the 45% use-level consistent throughout all grazing allotments, livestock would *have available* for use about 39% (45% use-level times 87% of the Forest in grazing allotments) of annual forage production. The remainder is reserved as habitat for game and non-game species of wildlife, scenic recreational values, litter for protection from erosion and for plant and soil health and sustainability, and other values.

Rangeland Health

Succession is the replacement of one plant community by another (Smith 1980). In the absence of disturbance, succession progresses to a stable terminal community called climax or potential natural community. This somewhat orderly and often predictable process is called natural succession. When disturbance occurs, succession may not reach the climax potential natural community (Girard). The assessment of range condition and trend remains a source of controversy, despite years of practical experience and discussion (Laycock; Friedel).

Until the mid 1990s, rangeland health in the form of rangeland condition and trend was assessed on Bighorn NF rangelands by looking in detail at existing plant communities, species composition, vigor, and soil conditions. These were compared to a defined desired composition and cover, and rated according to their relative status along the continuum. Range condition was interpreted through a *Range and Ecological Condition* scorecard specific to the range type, through which a range condition rating was derived. This process was thoroughly described in FSH 2209.21, Rangeland Analysis and Management Handbook (superceded).

Beginning in the mid-1990s with the development of *Region 2 Rangeland Analysis and Management Training Guide,* scorecards were no longer used as the reference for "scoring range condition." Data describing rangeland vegetation has been collected in a fashion as before (with different protocols), but scored against a desired vegetation condition defined in the Forest Plan or in project-specific NEPA decisions. In addition, a classification of riparian communities on the Bighorn NF was developed in 1997, and has been used to describe potential, desired, and existing riparian plant communities. (Girard 1997)

"Rangeland condition" can be defined as the relative degree to which the present plant community resembles the desired plant community. Trend is the direction of change in vegetation and /or soil over time. It is described as moving toward, remaining static, or moving away from a desired condition or objective. A rangeland is considered to be in satisfactory condition when the desired future condition is being met or short-term objectives are being achieved to move the rangeland toward the desired future condition (USDA Forest Service1996). A rangeland is considered to be in unsatisfactory condition when desired future condition is not being met or short-term objectives to maintain a rangeland in or move it toward the desired condition are not being met.

A "desired condition" for rangeland vegetation on the Bighorn NF is included in the 1985 Bighorn NF Land Management Plan which defines goals as "concise statements describing a desired condition," and lists among its goals the following:

- Manage all allotments to reach "satisfactory" range condition by 2000. Satisfactory is defined as good or better range conditions with a stable trend, or fair condition with an upward trend.
- Manage riparian areas to reach mid to late seral ecological condition with rangeland riparian areas managed to achieve "satisfactory" or better condition by 2000.

The Bighorn NF (along with all national forests) reports rangeland condition on established grazing allotments periodically, through the National INFRA data base, by listing all acres of rangeland vegetation within existing allotments into one of three categories: (1) meeting forest plan objectives, (2) moving toward forest plan objectives, and (3) not meeting or meeting toward forest plan objectives. Verified acres are those on which data has been gathered, assimilated, and summarized. As monitoring and analysis are accomplished, the number of acres in each category is expected to change. On the Bighorn NF, acres reported annually have most often not been based upon hard data, but rather have been derived from qualitative observations by rangeland management specialists at the district level.

Table 3-62. Summary of Forest Service rangeland condition report (capable rangeland within allotments, INFRA 2000).

	Verified acres	Estimated acres	%
Area meeting desired condition		47,551	38.34%
Area moving toward desired condition		78,030	
Area not meeting or moving toward desired condition	150	37,819	11.60%
Area of undetermined status	164,001	0	50.07%
Total acres "capable" in INFRA data base = 327,551 acres	164,151	163,400	
Area monitored in this FY		139,411	
Riparian area meeting desired condition	0	1,775	13,17%
Riparian area moving toward desired condition	0	4,417	
Riparian area not meeting or moving toward desired condition	0	7,982	16.97%
Riparian area of undetermined status	32,850	0	69.86%
Total "Riparian" acres in INFRA data base = 47,024 acres	32,850	14,174	
Riparian area monitored in this FY		17.821	

According to 2002 INFRA data, 38% of all rangeland vegetation on the Bighorn NF grazing allotments is reported to be meeting or moving toward desired conditions, 50% is undetermined, and 11% is not meeting or moving toward desired conditions. 150 acres (5% of INFRA capable) are 'verified' as not meeting or moving toward desired conditions. 13% of all rangeland riparian vegetation is reported as meeting or moving toward desired conditions, 69% is undetermined, and 16% is not meeting or moving toward desired conditions. No riparian acres are 'verified' to be "not meeting or moving toward desired conditions." INFRA data indicate that "acres verified" in the various categories represents a small percentage of total acres in allotments, and "acres of undetermined status" represents a high percentage. It also indicates that the goals defined in the 1985 plan were not met.

An example of a site-specific determination of rangeland vegetation condition was reviewed to validate estimates. A riparian inventory of some key areas of the Clear Creek and Crazy Woman watershed (147,000 acres) was completed in 1996, using the riparian classification to determine the potential vegetation of a site and whether it was different from current vegetation. The riparian classification was used to assess whether existing plant communities were 1) close to or at potential, 2) far from potential, or 3) intermediate. "Intermediate" sites may or may not have been meeting a desired condition, but they were clearly not at potential, nor were they far from potential.

No acreage calculations were produced from these maps, however, relative abundance of the ratings of polygons verified were as follows: 108 total polygons sampled; 67 were "close to or at potential", 31 were "intermediate", 10 were "far from potential". A relatively small portion of the total riparian sites in the Clear/Crazy watershed was sampled. However, the sampling was directed to areas identified as to whether the Forest Plan goal of mid to late seral ecological condition is being met due to natural or anthropogenic disturbances (USDA Forest Service1997). This inventory indicated that a small part of riparian areas in these watersheds was known to be not meeting the desired condition (mid to late seral), and it is consistent with estimates in the INFRA report discussed above.

Areas not meeting or moving toward desired conditions may fall into this category as a result of natural or human-caused disturbances, both historical and more recent (Girard 1997). They may result from disturbances such as beaver activity, mechanical disturbances such as road construction and their effects in water distribution, or they may result from past or present livestock or other activities. They may represent areas where livestock use may have been frequent, repetitive, and heavy during the summer growing season, and may include parks with gentle terrain, available water and dry soils, or short sections of riparian areas. Some that received heavy historical grazing pressure may not have yet recovered, but they are limited in size relative to overall areas supporting livestock use. Through application of Forest Plan standards and guidelines, and through allotment planning and implementation, these areas are expected to decrease in size and eventually disappear.

About 47,000 acres of the Bighorn NF total acres outside of grazing allotments (active and vacant) were determined to be "capable", according to the suitability analysis recently completed (Appendix B). For these acres outside of grazing allotments, very little data is available regarding health of rangeland vegetation. Data such as that described throughout

this section is generally collected to assess impacts of livestock grazing, and since these areas are outside of allotments, similar data is not available. Changes in rangeland vegetation in these areas result from prescribed and wild fire (or lack of fire), invasive species introduction and spread, wildlife use, historic livestock impacts, recreation impacts, etc., described in "Environmental Consequences" below, as well as in the Invasive Species report of this DEIS. Areas not meeting or moving toward desired conditions or otherwise outside the historic range of variability likely result from these factors, or other natural or mechanical disturbances, some of which may have occurred long ago and are on sites slow to recover due to short growing season, shallow soils, low productivity, etc.

ENVIRONMENTAL CONSEQUENCES

General Effects

The composition and structure of the Forest will continue to be influenced by the same succession and disturbance processes that shaped it. Accordingly, the vegetation will change with time. Natural disturbance events and succession will continue to be the dominate force of change regardless of alternative. Implementation of any given alternative will influence vegetation by the degree to which natural disturbance events are allowed to operate and according to the levels of various human-caused disturbance events, such as mechanical treatment and prescribed burning.

Succession will continue to move vegetation communities toward a mature condition. However, both natural and human-caused disturbance processes will influence succession on the Forest. The degree to which succession is influenced depends in large part on the magnitude and type of disturbance. Vegetative composition resulting from the interaction between succession and natural disturbance is difficult to predict in anything but general terms.

Forest Vegetation: Vegetation Composition

Direct and Indirect Effects

The composition of the forest vegetation will continue to be influenced by the same succession and disturbance processes. Although the vegetation will change with time, cover types will remain relatively stable. Early seral stages of forest development can only occur from both natural disturbances and land uses. Natural disturbance events and succession will continue to operate regardless of the alternative; however the amount of land upon which natural processes operate as the primary disturbance agents varies by alternative.

Implementation of any given alternative will influence vegetation by the degree to which natural disturbance events are allowed to operate and according to the levels of various human-caused disturbance events, such as mechanical treatment and prescribed burning.

The following table displays the allocation of land where natural process will predominate. Management emphasis is described in later tables.

Table 3-63. Allocation of management areas where natural process will normally predominant by alternative (acres/percent).

	A	B	C	D	E
Natural Processes Predominate	485,831	686,629	800,989	492,395	289,386
	44%	62%	72%	45%	26%

Management scenarios are similar for many management areas. They can be grouped into areas where natural processes dominate, and those where active management is included in the desired future condition. To facilitate the understanding of the consequences of allocation of habitat structure stages, management areas with similar management scenarios (emphasis) have been grouped into primary emphasis categories. The following table displays the grouping of management areas into primary emphasis categories.

Table 3-64. Management areas for primary emphasis categories

Natural Processes Predominate	Managed for Recreation Emphasis	Managed to Meet Ecological and Human Needs
MA 1.11, MA 1.13	MA 4.2	MA 5.11
MA 1.2, MA 1.5	MA 4.3	MA 5.12
MA 2.1, MA 2.2	MA 4.4	MA 5.13
MA 3.1, MA 3.23	MA 8.22	MA 5.41
MA 3.31, MA 3.4, MA 3.5		MA 5.4, MA 5.5, MA 8.1

The following table displays the allocation by alternative and management area by the above emphasis categories.

Table 3-65. Acres allocated by management areas for primary emphasis categories.

Alternative	Natural Processes Predominate	Managed for Recreation Emphasis	Managed to meet ecological and human needs
A	44%	2%	54%
B	62%	13%	25%
C	72%	15%	12%
D	45%	12%	44%
E	26%	1%	73%

Alternative E allocates the greatest amount of land to active management to meet the ecological and human needs, then in order, Alternatives A, D, B, and then C. Part of the goal of active management to meet the ecological and human needs, is to establish and maintain a more even distribution of age classes to provide a sustainable and even flow of goods and services, including more diversity over time. This more even distribution of age classes is different than what currently exists on the forest and different than the variation in age classes that would be created exclusively by natural process. This more even distribution of age classes, if and when it is achieved, would be directly reflected in habitat structure stages which would tend to follow the same pattern and would provide a sustainable even flow of structural stages and ecological function.

For the past 100+ years, roughly 20% of the Forest has been harvested, and this trend would continue under all alternatives. All alternatives emphasize natural processes with Alternatives C and B allocating the greatest amount of land to management areas in which natural processes are the primary stand and landscape disturbance agents. In the short term, this may result in an increase in late successional habitat as the existing stands age. In the longer term, as natural processes operate with little restriction, the creation of different habitat structure stages will fluctuate greatly over time and space.

Since wildfires and insects are both influenced by stand structure and drought, the potential exists for a large area of the forest to be subject to large scale events with high risk conditions. The arrangement of late successional habitat may be limited to fire refugia (areas characteristically resistant to fire such as north slopes, riparian areas, etc.) or areas particularly resistant to insects at particular times in the future.

Projecting changes in vegetation structure and composition over time is an important part of predicting the environmental consequences of changes in the occurrence and distribution of ecosystem aggregates and in the maintenance of biological diversity from management area allocations.

Vegetation patterns across landscapes are the result of complex interactions between biotic and abiotic disturbances, processes, and constraints. Vegetation changes due to a variety of factors such as fires, insects, pathogens, human activity, animals, weather, growth, and competition. It can be difficult to project the combined effects of these

complex interactions over long periods of time. Changes in vegetation structure over time for each alternative were predicted using growth and yield models. Succession models covering one to fifteen decades were formulated for each cover type for each alternative. Successional pathways were modeled based on forest conditions.

For each cover type, vegetation development followed a pathway based upon basic successional processes. Silvicultural treatments including timber harvest were used in the growth and yield model used to calculate the ASQ. Because of the stochastic nature of natural disturbance events, such as wildland fire, wind, insect and disease; they were not estimated, but rather discussed qualitatively in their respective sections. Management activities such as prescribed fire and mechanical treatment from unsuited lands were estimated as shown below, but have traditionally been at such a low level as not to change the successional direction of vegetation on a forestwide scale.

Table 3-66. Average annual other vegetation management estimates by alternative.

	Alternative				
	A	B	C	D	E
Aspen	10	20	10	20	20
Forested mechanical treatment	100	400	100	400	600
Forested prescribed fire	500	1,100	250	1,050	250
Non-Forested prescribed fire	2,000	3,000	1,500	2,500	2,500
Total	2,610	4,520	1,860	3,970	3,370
Post harvest prescribed burning	600	259	153	380	671
Total other vegetation management	3,210	4,779	2,013	4,350	4,041

As discussed fully in the biodiversity section, over the life of the plan there will be an increase in the amount of mature habitat structure stages 4c, and 5 for all alternatives, and a decrease in the early structural stages 1 and 2. Those alternatives with the greatest amount of timber harvest (E and A) show the greatest increase in habitat structural stage diversity, in the absence of natural disturbance processes.

Aspen Management

As shown in the table above, we anticipate treating aspen with the intent of regenerating aspen clones and attempting to expand the aspen cover type. Although new tools may allow us to accomplish more, the proposed levels are similar to existing program levels. Since there is limited aspen on the Forest, when it is regenerated, ungulate browsing can cause regeneration failures unless the clone is adequately protected from both domestic and wild ungulates. This added expense also contributes to limiting the amount of regeneration the Forest can accomplish.

Habitat Structure Stages

Direct Effects

Changes in successional stages are set in motion by management actions and disturbances that create early seral vegetation, but continue on the successional path until actions or events alter them. This sequential development of forest stands and changes from early seral cover types to later successional cover types would occur over time following management actions or disturbances. A full discussion of affects of alternatives on habitat structural stages is found in the Biological Diversity section. However, it can be seen in the table below that only a small percentage of the Forest is planned for active successional change under all alternatives.

Table 3-67. Land uses associated with early forested successional stages after first decade (acres).

	A	B	C	D	E
Clearcut harvest Decade 1					
Conifer	5,340	2,650	1,300	3,910	7,399
Aspen	100	200	100	200	200
Prescribed Fire Decade 1	2,500	5,500	1,250	5,250	1,250
Total Decade 1	7,940	8,350	2,650	9,360	8,849
% Forested lands in early structural stage	1%	1%	>1%	1%	1%

The allocation of habitat structure stages to different management scenarios helps to determine how each management area contributes to biological diversity and how combinations of management area allocations contribute to biological diversity. This is discussed fully in the biodiversity section.

Indirect Effects

Habitat structure development indirectly affects other resources, some of which are listed below. The effects are discussed in more detail in their individual sections:

- Biological Diversity
- Wildlife Habitat
- Insect and Disease
- Fire and Fuels
- Recreation

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered with regard to cumulative effects to the insect and disease resource. The next 15 years are considered the time span for cumulative effects.

Many forces affect the change in forested structural stages, including growth, senescence, fire, insects and disease, wind, timber harvest and related activities, recreation, and fire suppression. Large scale fires in the late 1800s have created a preponderance intermediate size, dense forested stands. While natural disturbance events such as wildfire and management activities such as forest harvesting has replaced some older mature forest stands with younger stands, natural succession or growth is the largest influence on the successional pathways. This is because under any alternative, the amount of planned management activity compared to the overall growth of the forest is relatively minor. This sequential development of forest stands and changes from early seral stages to later successional stages and eventual senescence will occur over time following the disturbance event, irregardless of which alternative is selected.

Rangeland Vegetation

General Effects

Livestock grazing managed through term grazing permits, along with the combination of vegetative treatment for rejuvenating aspen, maintaining native meadows, treating sagebrush and other shrublands to improve wildlife habitat and forage production, and fire treatment in ponderosa pine to replicate natural stands, will all help move rangelands vegetation toward desired conditions. Current trends in motorized recreational use, a lack of fire, and increases in noxious weeds, and livestock management outside of established standards and guidelines may contribute to movement away from desired conditions in rangeland vegetation.

Direct and Indirect Effects

Effects from Wilderness Management: Suppression of wildfire in wilderness is limited to non-motorized and mechanized means. Prescribed fire is not a management option in the Cloud Peak Wilderness. Vegetative communities are likely to move to late seral stages. This may have the effect of reducing the amount of earlier seral vegetation that would be expected under the Historic Range of Variability (HRV) and can affect plant and animal diversity.

Alternatives are identical in allocation of Management Areas 1.11 and 1.13. Alternative C has an addition of 126,575 acres in “Recommended Wilderness, (MA 1.2).

Effects from Fire and Fuels Management: On rangelands, fire tends to alter the successional pathway, at least temporarily, and generally sets back succession to an earlier seral stage. It also tends to alter the structure of the vegetative communities. Wildfire, and more specifically high intensity wildfire, will often be a greater

disturbance (more often move succession to an early seral stage and reduce or eliminate taller structure in sagebrush or other shrub communities) than will prescribed fire because planned/managed fires are often designed specifically to avoid drastic alterations on the landscape. Fire is a natural factor in the maintenance of natural diversity of vegetation across rangelands. It retards or prevents conifer or shrub encroachment in meadows and parks, regenerates aspen stands, and is responsible for maintaining a mosaic of vegetation necessary for wildlife habitat diversity. In general, the greater the use of prescribed fire, the greater the number of acres on which vegetative succession will be moved to an earlier seral stage and on which tall structure will be reduced.

Table 3-68. Acres treated using prescribed fire, by alternative.

	A	B	C	D	E
Aspen	10	20	10	20	20
Non-Forested	2500	3000	1500	2500	2500

The use of prescribed fire for fuels treatment and vegetative management is greatest in Alternative B, and the least in Alternative C, however, differences among alternatives are not great, and implementation in all cases is subject to budget constraints and priorities.

Effects from Recreation Management: Recreation use generally has little effect upon rangeland vegetation except in the case of repeated or continual uses such as camping, fishing, and hiking, or especially off-road vehicle use. Repeated use by recreation horse or ATV use in popular areas can alter plant and soil characteristics over time. Such uses tend to return succession to an early seral stage, even to bare soil on trail systems and in very popular dispersed camping sites and along popular fishing areas, generally the number of acres impacted is a very small percentage of the total rangeland acres across the Forest.

Off Road Vehicle (ORV) activities that create bare or disturbed soil provide conditions for invasive species establishment and spread, including on roads and roadsides, trails, and trailheads, parking lots, developed and dispersed camping sites, popular fishing locations, and heavy-use areas around summer homes. Off-road vehicle travel has high potential to introduce and spread noxious weeds, and in turn move rangeland vegetation away from desired conditions.

Alternatives that emphasize summer recreation opportunities, especially motorized recreation may have a slightly greater effect on rangeland vegetation. The alternatives with summer-motorized travel, from most to least, are E, A, D, B, and C.

Effects from Research Natural Area Management: Designations that reduce the amount of human-caused disturbances are likely to direct succession of the included rangelands toward late seral conditions (barring natural disturbance). RNAs are generally managed to promote "natural" succession and disturbance. Unless fire is allowed to play its role, some of these areas will progress to later seral communities and

can lose the natural mosaic of seral stages that are necessary for rangeland health and the provision of a variety of wildlife and plant habitats.

Alternatives B, C, and D have identical new RNA designations: Mann Creek, Leigh Creek, Pheasant Creek, and Lake McClain.

Effects from Travel Management: Effects are similar to those for recreation (described above) except they occur on a greater number of acres (roads versus trails). Past road construction has had the effect of contributing to a reduction of acres of native meadows and shrublands; roads constructed in and along valley bottoms have reduced and/or altered riparian vegetation and sometimes changed stream channel location and function. Roads tend to create a large impact on the health and sustainability of stream/riparian/wetland systems. Effects include lowered water tables, altered morphology, changed sediment regimes, and removal of canopy cover and other vegetation. Other uses may subsequently contribute to these effects. Currently, unauthorized off-road vehicle travel has had a great effect in moving rangeland vegetation to an earlier seral condition; this use is unplanned and can be widespread, with erosion and riparian degradation resulting.

Roads in the uplands tend to fragment rangeland vegetative stands, to alter hydrologic relationships by intercepting overland and sub-surface flow, and are potentially a significant contributor of seed and propagules for invasion of noxious weeds and other non-native vegetative species.

The levels of motorized and summer travel opportunities, from highest to lowest, are Alternatives E, A and D, B, and C.

Effects from Oil, Gas, and Mineral Development: Effects are similar to those for Recreation (see above). The amount of rangeland vegetation that could move to an earlier seral stage is dependent upon the amount of exploration and resultant production. Production sites often create areas of disturbed soil, providing areas for noxious weed infestations. Restoration of these areas following production will involve monitoring and treatment of noxious weeds, along with re-establishment of native species. The potential for these activities is very small based upon past activity levels on the Bighorn NF. There is nothing in this analysis that indicates an increase in future levels of development.

Effects from Livestock Grazing and Big Game Use: Livestock, big game animals, and other wildlife that graze and browse the herbaceous and shrub cover on rangelands can be considered disturbance agents. These animals also create a disturbance through hoof action, which effects vegetation and soils. Their effect depends on a number of factors including intensity, timing, and frequency of grazing, kind of herbivore, soil moisture and condition, and existing seral condition of the vegetation.

Use by ungulates, when properly managed by vegetative type and within habitat capacities, tends to provide for a mix of seral stages across broad landscapes.

High intensity of use, repeated use during times of rapid plant growth, frequent use of individual plants or plant communities, or longer periods of use tend to result in more

vegetation developing into early-to-mid plant succession, while lighter, shorter, or less frequent use tends to result in a higher percentage of mid and late seral vegetation.

High historic levels of grazing use across the Forest were very likely responsible for maintaining large acreages including riparian zones and wet meadows, in early to mid-seral condition.

Reductions of grazing use over the last several decades coupled with increases in management intensity and improved knowledge regarding habitat requirements and plant ecology have likely resulted in increases in herbaceous production and trends toward the mid to later seral stages. Browsing and grazing of young aspen shoots can restrict aspen regeneration. These areas may need to be fenced, depending upon extent and location, or otherwise managed to control use by grazers and browsers until young trees are big enough to avoid being detrimentally browsed.

Big game populations are less manageable or predictable than domestic livestock, but their effects on managing for desired conditions are similar to those of domestic livestock. Elk tend to impact meadows and more open grasslands types, while deer impact shrublands, grasslands, and riparian areas, and moose impact riparian/wetland habitats. High numbers of big game species will result in maintenance of rangeland vegetation in an early or mid seral condition. Lower numbers allow more acres to move toward a later successional stage. In addition, seasonal use (such as big game moving up the mountain very early following green up each year) impacts plants when they are most vulnerable, sets back succession, and can damage wet soils. In the same way, seasonal and intense use on palatable shrubs such as mountain mahogany and antelope bitter brush can retard succession

Currently, in some areas heavy utilization of willows by moose may be preventing riparian areas from achieving desired conditions. Moose browsing in some aspen stands has resulted in heavy "barking" of trees and hedging or elimination of young trees.

Grazing by permitted livestock and wild ungulates is not expected to differ significantly between alternatives.

Effects from Timber Management: There is no effect to existing rangeland vegetation from timber harvest. However, as timber is harvested it may open areas in the canopy so that an increase in forage occurs in the understory, or it may create new acreages of transitory (e.g. short term) rangeland vegetation in small harvest units. This transitory rangeland remains in this state until the forested stands once again close in or the young trees become dense enough that rangeland vegetation no longer occupies the site. In a dynamic forest, with some tree stands closing in while others are opening up, there is no net change in rangeland vegetation acres, except through large-scale natural disturbance events.

The order of alternatives with effects from timber harvesting activities, from least to most, is C, B, D, A, and No Action, and E.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to the rangeland vegetation. This discussion considers effects to rangeland vegetation from the early 1900s through the life of the plan on the Bighorn National Forest.

Historic use of the Bighorn NF continues to be evident in rangeland vegetation today. For example, some areas are continuing to recover from impacts of heavy grazing in the early 1900s. Riparian areas altered by tie hacking activities also continue to recover. Fire suppression activities in the past have resulted in conifer encroachment in areas, which in turn reduce total acres of rangeland vegetation, as well as forage production and availability.

There continue to be conflicts about allocation of forage resources between livestock and wildlife and the effects of their activities, considerations necessary due to wildfire and prescribed fire management, and recreation and timber harvest activities that result in bare soils and spread of noxious weeds.

Expectations are that the impact to rangeland vegetation from many uses on the Forest will increase as the population of local communities increases, 'baby-boomers' retire, and as more people nationwide continue to seek places like the Bighorn NF to recreate. ATV use in particular has seen a dramatic increase recently that is expected to continue although the rate of growth is not likely to be as dramatic as it has been in the past decade (See Specialist Report for Recreation). Locally, the current boom in coalbed methane activity in the Powder River Basin has resulted in more demand for recreational use of the Bighorn NF, particularly for motorized uses, and this boom is expected to continue (BLM). Use of prescribed fire will likely increase in coming years due to political influences effecting fuels reduction efforts nation wide. This may result in plant communities more similar to the HRV.

Management of rangeland vegetation to deal with cumulative effects will be consistent across all alternatives.

Wildlife

Introduction

The wildlife section focuses on effects to Management Indicator and Demand species, serving as surrogates for terrestrial wildlife species and their habitat in general. Riparian areas provide the most important habitat attribute for these species, and are described in more detail in the Aquatics section of Chapter 3.

Threatened and Endangered species are addressed in the Biological Assessment (Appendix F), and Forest Service sensitive species are addressed in the Biological Evaluation (Project Record), with effects to both groups of species summarized in the Biodiversity section of Chapter 3 in the Single Species Assessment. Effects to Species of Local Concern are also summarized there, with additional information contained in the Viability Process document (See Project Record).

Legal and Administrative Framework

The **National Environmental Policy Act** (1969), as amended, requires the Forest Service to address fish and wildlife concerns during the environmental analysis process.

The **National Forest Management Act** (1976) requires the Forest Service to consider all resources in the land management planning process.

The Forest Service is directed by **36 CFR 219.9** to maintain habitat for viable populations of existing native and desired nonnative vertebrate species. Viable populations are defined as those with the estimated numbers and distribution of reproductive individuals to ensure their continued existence and that they are well-distributed. In order to ensure maintenance of viable populations, habitat must be provided to support at least a minimum number of reproductive individuals, and it must be distributed so that individual sub-populations can interact.

36 CFR 219.19 additionally directs the Forest Service to estimate the effects of changes to wildlife habitat; consult with biologists from other agencies; consider access and dispersal problems of hunting, fishing, and other uses; evaluate the effects of pest and fire management; and select management indicator species to be monitored (36 CFR 219(a)(1)).

The Wyoming Game and Fish Department (WGFD) is responsible for managing wildlife populations, while the Forest Service can directly affect population numbers, distribution, diversity, and species viability through the management of habitat. The

Forest and the WGFD work in partnership to address habitat and population management issues for wildlife.

Key Indicators

- Habitat Composition (cover types), Structure and Function (structural stages, snags and coarse woody debris), Pattern (fragmentation)– see Biodiversity Section
- MIS and Demand Species Habitat and Population Trends

Resource Protection Measures

Terrestrial wildlife species on the Forest are very diverse in their habitat use and needs. Numerous standards and guidelines, primarily Forestwide, are included in all of the proposed alternatives to ensure that quality habitat for wildlife is maintained or enhanced.

Most management area prescriptions (MAs) provide general direction to protect or manage habitat, while others provide for a special emphasis on habitat requirements. MAs 3.5 and 5.41 for example, provide management direction to benefit all species, and big game, respectively.

Forestwide direction for other resource management activities will accommodate many of the habitat requirements for most species, particularly riparian dependent species. Livestock forage utilization guidelines are designed to result in maintaining or improving riparian and grassland habitats. Timber management direction directs adequate regeneration in harvested areas, and adequate snag and coarse woody debris amounts. Biodiversity guidelines direct retention of old forest habitat and creation of younger seral stages as well. Direction for other resource disciplines will benefit some wildlife species, including direction for caves, riparian resources, fire, and noxious weed management. The most significant changes for wildlife in this revision include increased protection for riparian, old growth, sensitive species, and elk security areas.

In addition to Forestwide and management area direction, the Revised Forest Plan sets a wide range of goals, objectives, and strategies for meeting the Forest's commitment to a sustainable natural resource base for the American people. Goal #1 is to ensure sustainable ecosystems; Objectives 1.a, 1.b, and 1.c contain strategies to benefit habitat for wildlife and ecosystem processes.

Direction for all alternatives identify many activities designed to improve the overall conditions on the forest. These activities include restoring terrestrial habitat through such activities as prescribed burning or harvesting to regenerate aspen, sagebrush habitats, and decommissioning unneeded roads. Resource inventory and monitoring would also be included.

Abstract

The habitat of most species may be altered by management actions, but their population levels and distribution will likely remain close to existing conditions. The primary effects to structural stages of wildlife habitat will continue to be from natural processes including wildfire, insects and disease, and blowdown, largely regardless of alternative, as described in the Biodiversity section of Chapter 3. Timber harvesting, as indicated by suited acres, would affect a maximum of up to 35% of the forested acres over time in Alternative E, with approximately 20% of the forested acres being affected by current and past harvests. Non-forested habitats would continue to be altered from wildfire, prescribed burning, and livestock grazing, also largely similar by alternative. Elk security areas, used as a model of habitat for this Management Indicator Species (MIS), would be at more risk in Alternatives E and A due primarily to increased road construction. Elk security areas would be at less risk in Alternative D, remain somewhat similar to existing levels in Alternatives B, and possibly increase in Alternative C if existing roads were closed in proposed wilderness in future project specific decisions. Habitats for other MIS would remain largely similar to existing conditions at the forest-wide scale. As lands adjacent to the Forest may continue to be developed, a higher value for the Forest is indicated for wildlife species and their habitat.

AFFECTED ENVIRONMENT

General

The Bighorn NF provides a wide diversity of habitats that support over 300 vertebrate species, and hundreds of invertebrate species. Wildlife species interact in many ways with their environment as key components of ecosystem processes. These species provide Forest users and visitors with a full range of opportunities that include sport, commercial, and viewing activities.

Historical records reveal that some species on the Forest were extirpated in the early 1900s. Examples are the grizzly bear, gray wolf, and otter. Animals with diminished populations include lynx (if they still occur at all), bighorn sheep, and beaver. Introduced species (desirable non-natives) include moose, wild turkey, chukar, and gray partridge. Other introduced predators such as feral cats and dogs may also have an affect on wildlife. Wolves may re-establish on the Bighorn NF, as recent sightings have occurred, though depredation measures have taken place and may also inhibit establishment of wolf packs as acknowledged in the State's management plan.

Big game numbers and management on the Forest mirrors what occurred over much of the western United States during the last 50 years of the 20th century. Big game numbers throughout the West increased dramatically before World War II. Regulated harvest, game preserves, winter feeding programs, and re-introductions were the

management focus. On the Forest, as over much of the West, an era of biological game management followed. Scientific research increased dramatically, and hunting was adopted as the primary management tool to manage populations. Habitat management also became a large focus. As of 2002, elk populations are at, or exceed, WGFD objectives over much of the Forest, while mule deer are at or below objectives.

Habitat, in terms of composition of cover types and structural stages, was described in the Biodiversity section of Chapter 3. For most terrestrial wildlife species, the three most important cover types are riparian, aspen, and spruce-fir. Other unique communities include the alpine meadows, cliffs and rock, and caves. The more abundant or common cover types of lodgepole pine, meadows, and shrublands are also important for wildlife, though are less unique to the Big Horn Mountains ecosection and are viewed to be less limiting factors in wildlife abundance and distribution as compared to the other communities.

Several aspects of habitat importance to wildlife have already been described in the Biodiversity section of Chapter 3, including composition, structure (habitat structural stages), snags and Coarse Woody Debris (CWD), and fragmentation. Other sections including the Aquatic, Rangeland Vegetation, and Forested Vegetation also describe elements of importance to wildlife and their habitat.

The largest change in habitat conditions on the Forest from pre-settlement times has been the development of a road network and associated facilities. This involves a direct loss of habitat and disturbance to some wildlife species, and opportunities for expansion of noxious weeds or other non-native plant and animal species. However, roads also provide the primary method of access for people to enjoy wildlife and other associated values of the Forest. Of more minor effects to habitat have been fire suppression efforts in some cover types (ponderosa pine and sage brush), and the introduction of non-native species such as the white pine blister rust and noxious weeds. Emerging habitat and species issues include the decline or effects to amphibians and invertebrate pollinators, and balancing the amount of human use versus potential disturbance to species and their habitat.

Cumulative effects in general are presented at the scale of the Bighorn NF and those lands immediately adjacent to it, or in some cases the Big Horn Mountains ecosection.

Current program emphasis focuses on improving habitat through treatments including prescribed burns, aspen enhancement, and riparian exclosures and improvements. Other projects including structural improvements such as nest boxes and inventory for rare species also occur. Biologists on the Forest are actively involved in support and analysis of other resource programs including timber, recreation, and livestock grazing.

Emphasis Species

Emphasis species were identified to facilitate analysis and monitoring of effects to wildlife. These emphasis species serve as surrogates for other terrestrial wildlife species. The Emphasis Species Categories document (See Project Record) describes the

selection process for these species. As mentioned previously, the Single Species Assessment in the Biodiversity section of this chapter describes the effects to TES and Species of Local Concern. The Ecosystem Assessment portion of the Biodiversity section describes the condition and effects to habitat in general on the Forest for purposes of assessing viability for wildlife. The main approach for species viability is to ensure that ecosystem components and processes remain functioning, and then verifying needed habitat components persist for rare species and species representative of others due to similar habitats.

While Management Indicator Species (MIS) are required for use in management plans as described below, the use of Demand species is a new addition to the planning process, and is optional. Demand species are identified for their social importance, usually relating to the commercial or sport value (e.g. hunting, fishing, collecting) of the species. In conjunction with the WGFD, the Forest identified 10 terrestrial wildlife Demand species, including **mule deer, moose, mountain lion, black bear, wild turkey, ruffed grouse, blue grouse, sharp-tailed grouse, chukar, and gray partridge**. Their existing condition and associated effects from alternatives are described below.

MIS are required (36 CFR 219.19) for Forest Plan analysis and monitoring purposes. MIS are selected to represent management issues and effects to wildlife species. MIS are intended to act as a surrogate for analyzing and monitoring all wildlife species. In addition to providing a comparison among alternatives in the Forest Plan, monitoring of population trends and habitat is meant to provide an indication of the level of effects of management activities on wildlife. During plan implementation, MIS are used in project level analysis to assess effects to wildlife. Several categories of species are to be considered when selecting MIS, though there is no requirement to have a MIS for each habitat type, species group (e.g. TES), or management issue. The requirement to monitor population trends at the Forest scale is a challenge with significant costs, and many factors other than management activities (e.g., prescribed fire, timber harvest, livestock grazing, recreation use) can affect populations of MIS, with climate and prey/forage levels being the most common elements driving population trends.

The Bighorn NF considered over 100 species when selecting MIS for the Revised Plan. Six species were selected: **elk, rainbow trout, beaver, red-breasted nuthatch, red squirrel,** and **Brewer's sparrow**. The only species of viability concern selected as an MIS is the Brewer's sparrow. Refer to Appendix G in the Forest Plan for a summary of the selection process, results, and management implications with regard to MIS. In addition, the MIS Selection Process document (See Project Record) lists details of the selection process, and the Monitoring Plan in the Revised Forest Plan contains monitoring aspects of MIS. Species assessments (See Project Record) for MIS assess current habitat and population trends, and conservation measures. A summary for the species' habitat, indicator representation, and rationale for selection of each species is listed in the table below.

Table 3-69. MIS selected for the Bighorn NF.

Species	Habitat Association	Indicator	Rationale for Selection
Elk	Forested stands (cover), and grasslands/shrub (foraging)	Security Areas (Acres)	Elk are of high social and past management importance and are sensitive to road densities and vegetation alterations. Research on the Forest supports habitat associations, and security habitat can represent needs of other species where larger blocks of cover away from roads is needed. Management activities such as timber harvest, motorized recreation, road construction or decommissioning, and prescribed burning are issues for this habitat/species. Population monitoring is provided by WGFD.
Beaver	Riparian	Occupied Watersheds	Beaver were selected due to their ecological role as environmental engineers. With riparian areas of high management importance and concern, their presence provides improved functioning and quality of riparian areas. Beaver numbers are reduced compared to more historic abundance. Management activities in riparian areas including livestock grazing, dispersed recreation, and road reconstruction, construction, and maintenance are issues for this habitat/species. Monitoring of populations is feasible through aerial/ground surveys.
Red-breasted nuthatch	Mature Conifer, Snags	Mature Structural Stages, Snag abundance	Red-breasted nuthatches are a resident avian species using snags for nesting habitat. Management activities including timber harvest and prescribed burning may change habitat for this species. Their widespread distribution on the Forest and vocal detectability will facilitate monitoring through avian point counts.

Species	Habitat Association	Indicator	Rationale for Selection
Red squirrel	Mature conifer, Coarse Woody Debris	Mature Structural Stages, Coarse Woody Debris abundance	Red squirrels are resident mammals occurring forest-wide. Though somewhat habitat generalists in conifer, they are most abundant in mature habitat with CWD, and respond to changes in that habitat. They are a primary prey species, serving as a "keystone" for many predators. Management activities including timber harvest and prescribed burning may change habitat for this species. Their vocal detectability will facilitate monitoring through associated avian point counts.
Brewer's sparrow	Sagebrush	Shrub age class diversity	Brewer's sparrows, though migratory, are strongly associated with sagebrush, in typically mature age classes. They have a forest-wide distribution, are a sensitive species, and are detectable through avian point counts for monitoring. The Forest has sought to actively manage sagebrush habitats to restore habitat diversity currently lacking, and this species would provide an indicator for this issue and habitat type.
Rainbow trout	Aquatic	Riparian habitat quality	Rainbow trout, an introduced species, are associated with quality riparian habitats and respond to changes in the habitat. Populations occur forest-wide. Management activities including livestock grazing, dispersed recreation, native species, and road construction, maintenance, and decommission are issues for this species/habitat. Population and habitat monitoring currently occurs in conjunction with the WGFD.

The habitat conditions and effects to rainbow trout are described in the Aquatics section of this chapter.

The following affected environment and environmental consequences sections describe effects to the MIS and Demand species listed above. MIS species sections occur first, due to the higher importance of this category associated with planning regulations. Not

all management activities are assessed in the environmental consequences, as only those deemed to be most significant were described.

Management Indicator Species (MIS)

Affected Environment
Elk Security Habitat

Elk were greatly reduced in abundance on the Forest in the late 1800s due to unregulated hunting. Elk were transplanted back onto the Forest beginning in 1910 to reestablish huntable populations. Elk have been the subject of management emphasis and concern since that time, largely due to public interest in hunting and viewing. The 1985 Forest Plan contained management direction (i.e. hiding cover amounts and habitat capability) specific to ensuring habitat for this species, as it was a selected MIS. Timber harvest was the primary management concern. Harvest units on the Forest were laid out in the 1960s and 1970s as larger clearcuts to efficiently produce wood products. A byproduct was forage for big game species including elk. The trend in harvest sizes switched to smaller patch cuts in the 1980s and 1990s in response to public concern, and as a result higher levels of big game cover were maintained than previous methods, but with forage still generated. Forage quantity, however, has not been identified as a limiting factor in big game populations on the Forest, due to the natural distribution of meadows and shrublands on the Forest. These actions were based on the recommended practices at the time.

Beginning in 1991, the Forest and the WGFD began to address habitat concerns associated with roads and timber harvest and sought to improve management direction in the ASQ amendment (1994), which was never completed. Specifically, it was recognized that hiding cover, which is defined as cover that will hide 90% of an adult elk at 200' (Lyon and Christensen 1992), did not incorporate the larger concern of the effect of road densities on elk distribution. Through telemetry research conducted in 1993 - 1996, it was demonstrated that elk began selecting more remote locations (away from roads) beginning in July, when human use of the Forest increases (Sawyer 1997; Jellison 1997). Both an elk habitat effectiveness model and an elk security habitat model were generated by the WGFD in response to this research to better coordinate management activities with the Forest. These models produced different values than the elk habitat effectiveness model that was used in the ASQ amendment, as developed in 1991 by the interagency wildlife task force. As both the Forest and the WGFD desired to only use one model to assess effects to elk at both the programmatic and project scales of analysis, the elk security model was selected for this plan revision and adopted by the Forest. This also alleviates the "non-spatial" aspect that can be associated with using habitat effectiveness rather than the more spatially explicit elk

security model (Rowland et al. 2000). All of these actions are typical of recommendations in recent literature (Christensen et al. 1993).

Elk security habitat is defined as "any area that will hold elk during periods of stress because of geography, topography, vegetation, or a combination of those features" (Lyon and Christensen 1992). Hillis et al. (1991) quantified elk security areas as nonlinear blocks of hiding cover ≥ 250 acres in size and ≥ one-half mile from any open road. They noted that elk vulnerability increases when less than 30% of an analysis unit is comprised of security areas.

For planning purposes, the nine geographic areas (5th level watersheds) described in the Revised Plan were selected as the analysis units. The potential and existing amounts of security habitat were assessed by the Forest in these areas. Existing security areas were defined as those areas that met the habitat criteria (forested structural stages 3B,C and 4B,C with 60% canopy cover, ≥ 250 acres, >1,200' wide) that were greater than one-half mile from any open road (Level 2 – 5) or motorized trail. Potential elk security areas were also assessed to delineate areas that could meet existing security if road closures were conducted on Level 2 roads or motorized trails. For potential security, the same habitat parameters were used, although it was assumed that the Forest would never likely close a road if it were a Level 3 – 5 due to investments (gravel, etc.), so areas within a ½ mile buffer of these type of roads could not be considered potential. Sites that may grow into suitable cover within the next decade or two (e.g., the Lost Fire of 1988) were not considered in potential security areas. Existing and potential security areas were based on current habitat structural stages. The biological potential of the Forest to provide security areas, in other words without any roads, was not assessed due to the unrealistic ability to change densities of the higher maintenance level roads (3 – 5). Refer to the map in the project record to view the location of existing and potential elk security. The following table displays the amount of existing and potential elk security in each of the nine geographic areas.

Table 3-70. Elk security habitat areas by geographic area on the Bighorn NF.

Geographic Area	Total Acres in Planning Unit*	Percent Forested	Existing Security Habitat Acres and Percent of Total Area	Potential Security Habitat Acres and Percent of Total Area	Existing Security as a Percent of Potential Security Habitat
Clear/Crazy	155,936	72%	9,506 (6%)	29,735 (19%)	32%
Devil's Canyon	61,198	58%	5,685 (9%)	12,748 (21%)	45%
Goose Creek	116,952	80%	18,786 (16%)	43,053 (37%)	44%
Little Bighorn	141,815	69%	22,551 (16%)	33,855 (24%)	67%

Geographic Area	Total Acres in Planning Unit*	Percent Forested	Existing Security Habitat Acres and Percent of Total Area	Potential Security Habitat Acres and Percent of Total Area	Existing Security as a Percent of Potential Security Habitat
Paintrock Creek	107,943	51%	5,992 (6%)	10,227 (9%)	59%
Piney/Rock	110,255	79%	30,988 (28%)	64,197 (58%)	48%
Shell Creek	140,130	48%	4,690 (3%)	14,780 (11%)	32%
Tensleep Creek	101,130	57%	647 (1%)	7,678 (8%)	8%
Tongue River	177,069	69%	26,976 (15%)	51,411 (29%)	52%
Totals	1,112,428	~60%	125,821 (11%)	267,684 (24%)	47%

* = All NF lands within planning unit.

As described above, elk were selected as a MIS due to the social interest in the species, and the species' habitat associations with alterations in forested canopy cover and road densities. Security areas provide an analysis function for species with similar habitat associations, namely larger blocks of forested stands that have less human disturbance as they are greater than one half mile from a road. *Other emphasis species that may benefit from this type of habitat include marten, lynx, wolverine, goshawk, boreal owl, flammulated owl, great gray owl, pygmy nuthatch, golden-crowned kinglet, and black bear*. As displayed above, some geographic areas do not have the potential for enough security to meet the recommended level of 30% per analysis unit, largely due to a lack of forested cover from naturally occurring meadows and shrublands. Many geographic areas are also well below the potential they could have due to Level 2 roads and motorized trails. There was no identified minimum threshold of elk security for a species viability perspective, however the ID Team recognized the need to maintain at least the existing amount of elk security (47% of potential) and seek to improve it where possible in plan implementation activities, as described in the Revised Plan strategy (see Objective 1b in Plan Chapter 1 Forestwide Direction).

Aside from the association with fragmented forested habitat and road densities, the second issue surrounding elk security areas is the desire to be able to achieve hunter harvest on public lands. Currently, elk begin moving to secure areas on the Forest starting in July and increasing as hunting seasons begin. During hunting seasons, elk routinely leave the Forest to seek even more secure areas such as private lands where hunting is not allowed, resulting in a difficult situation with regard to maintaining herd objectives as harvest does not occur. It is not certain that improving security areas on the Forest will reverse this trend, as the escape behavior has become instilled in most of

the elk herds; however, it remains a possibility for a chance to improve this condition. Elk security is not intended to bolster populations of elk, as most herds are at or above objective. The intent is to encourage elk to stay longer on public lands, where harvest objectives may be more easily met. The following table displays the herd objectives and current populations for the herd units for which a portion of the habitat occurs on the Forest. Population objectives are developed at the herd unit scale. Also, hunter success in the hunt areas on the Forest, which are subsets of herd units, is listed, along with the hunting season type. All data is from the WGFD (2001, 2002).

Table 3-71. Elk herd objectives, populations, and hunter success by herd unit and hunt area as of 2002.

Herd Unit/Hunt Area	Population Objective	Current Population	Hunt Strategy	Hunter Success
North Bighorn HU	4,100	4,800		
HA 35			Limited	39%
HA 36			General/Limited	17%
HA 37			General/Limited	19%
HA 38			Limited	29%
HA 39			Limited	36%
HA 40			Limited	30%
Medicine Lodge HU	3,000	3,000		
HA 41			Limited	19%
HA 42			Limited	17%
HA 45			Limited	41%
HA 46			Limited	33%
*South Bighorn HU**	2,900			
HA 34		1,200	Limited	35%

* = Only a small portion of the herd unit occurs on the SE portion of the Forest.

Elk security has also been shown to have economic importance to local communities, where increased hunter opportunities due to having these security areas generates local income. This becomes evident where general hunting season areas have been switched to limited entry, reducing the number of hunters afield, and hunter success (Jellison 1997). This has been especially evident in Hunt Area 35, near Buffalo. Road densities must be balanced with the desire of the public to have motorized access for hunting and other recreation pursuits, including wildlife viewing, fishing, and scenic viewing. Adequate access is also necessary to achieve harvest levels desired. Closed roads and non-motorized trails are also main avenues of recreation access, providing larger disturbance potentials to wildlife from recreation as compared to areas where no trails

or roads occur at all. While changes in road density can be very effective through seasonal closures during hunting seasons for elk, the aspect of year-round secure habitat for other species is also beneficial. The main challenge to this type of habitat has been from the increased use of ATVs as compared to conditions projected in the 1985 Plan. Snowmobiles may also reduce the winter availability of secure areas, mainly for species other than elk.

Currently, no specific habitat monitoring occurs on the Forest for elk, other than verification of application of standards and guidelines in projects. The 1985 plan directed habitat monitoring and treatment for big game winter ranges, which also has largely not occurred, though some project specific treatments (e.g. prescribed burns) have occurred with monitoring for that purpose. The Forest provides little winter range with respect to surrounding lands, and is primarily used by elk in the spring through the fall. Issues with winter range primarily focus on human disturbance and stress, for which the 1985 plan contained management direction, as would the revised plan. Refer to the section on mule deer for more discussion on this topic.

Economics and recreation (hunter day) factors surrounding elk hunting on the Forest are listed in the respective sections in Chapter 3.

It is the desire of the Forest to coordinate with the WGFD to improve security habitat on the Forest, to improve the ability to maintain elk herds within the population objective and to provide improved hunter opportunity.

Environmental Consequences
Elk Security Habitat

Direct and Indirect Effects

Existing elk security areas were incorporated into several different management prescriptions by alternative. For example, in Alternative B, most of the elk security areas were included in management prescription 3.5. Where elk security occurs in prescriptions 5.11, 5.12, 5.13, 5.4, and 5.5, it is more difficult to retain due to multiple use objectives in those areas. The opposite would be true for management prescriptions in categories 1 and 2. The following table displays the acres of existing elk security by management prescription, by alternative.

Table 3-72. Acres of existing elk security areas by management prescription and alternative.

Management Prescription	Alt A (Acres)	Alt B (Acres)	Alt C (Acres)	Alt D (Acres)	Alt E (Acres)
1.11	5,286	5,285	5,286	5,286	5,285
1.13	3,911	3,912	3,911	3,911	3,912
1.2			48,048		

Management Prescription	Alt A (Acres)	Alt B (Acres)	Alt C (Acres)	Alt D (Acres)	Alt E (Acres)
1.31		14,564		11,520	262
1.32	22,460	7,960	12,870	12,039	6,404
1.5	2,218	3,378	3,562	2,169	2,011
2.1		887			
2.2	525	8,654	8,654	8,654	8,653
3.1				2,338	
3.31	1,341	4,639	16,719	13,299	569
3.4	365	322	138		
3.5	17,867	51,336	9,949	28,632	
4.2	159	1,267	1,267	1,485	89
4.3		3,007	8,531	691	244
4.4		217	217		
5.11	23,361	8,114	4,775	16,640	15,958
5.12	9,749	3,827	1,012	6,929	
5.13	33,379	7,573		11,011	29,383
5.13.1					
5.21	640				
5.4					35,000
5.5					15,000
5.41	4,099	417	420	754	2,588
Total	125,358	125,358	125,358	125,358	125,358

Effects from Timber Harvest and Travel Management: In addition to management prescription analysis, the likelihood of road construction or timber harvest in elk security areas was also assessed by alternative. Timber harvests are conducted to accomplish other resource objectives in addition to providing commercial products. There are benefits from harvest activities in terms of forage production for elk and other wildlife, and general habitat diversity in terms of a variety of age classes created (structural stages). Timber harvests also remove a cover component of elk security habitat, and frequently rely on roads to be constructed to access timber stands, which are the two main variables in assessing elk security areas.

Alternatives B and C would likely retain existing elk security areas in their current configuration for the next planning period. Small areas of existing elk security would likely be entered in Alternative D. Larger areas of existing elk security would be

entered in Alternatives A and E. This is indicated by the amount of acres suited for timber production by alternative within elk security areas. The overlap of suited acres with security areas does not mean that harvest or road construction would necessarily occur. However, the likelihood of harvest and road construction activities increase with the number of acres of overlap given the higher objectives for timber harvest associated with those acres. The following table displays the acres of suitable timber within existing elk security by alternative.

Table 3-73. Approximate acres of suited timber within elk security habitat.

Alternative	Suited Acres in Existing Elk Security	Suited Acres in Potential Elk Security
A	51,235	107,025
B	14,171	36,863
C	4,694	13,113
D	21,949	56,122
E	60,508	124,454

An additional analysis would be to examine the number of acres predicted for harvest within elk security habitats by the timber model. With the Final EIS, it is anticipated that spatially explicit possible harvest areas as generated by the model would be available. The following table displays the results of acres predicted for harvest within elk security habitat.

Table 3-74. Acres of predicted timber harvest within elk security habitat by alternative during 1st decade (planning period).

Alternative	Acres Predicted for Harvest in Existing Elk Security
A	3,355
B	930
C	236
D	1,381
E	3,772

As displayed in the tables above, Alternative C would have the least potential effect on elk security, whereas Alternative E would have the most. Within this range, Alternatives B, D, and A would have impacts to elk security, in order of least to greater potential impacts. It should also be noted that acres of predicted harvest within elk security areas may or may not result in a loss of security areas, depending on the road network needed to access an area harvested. Specifically, the areas including Piney and Rock Creek and areas bordering Walker Prairie would be roaded under these alternatives, with the Piney/Rock Creek main access road likely being left open to motorized vehicles.

While elk security areas can theoretically be maintained by closing roads following uneven-aged harvest prescriptions, the risk of losing the integrity of the security area increases as more acres are harvested and more roads are built. This is because people will continue to use roads and skid trails for ease of access, whether by foot or horseback, depending upon the closure effectiveness. Impacts can also be offset as areas are identified for future timber harvest, since areas adjacent to it could be manipulated with regard to open road levels to "create" elk security prior to entering the adjacent area.

It is also important to note that the elk security areas can also be used to serve as reserves to meet the old growth biodiversity guideline, and it is beneficial to manage for these acres within elk security areas for other species benefits, and this was an approach used in the modeling process for timber harvest.

It is also likely that some improvements to elk security would occur with implementation. In recent timber sales on the Forest, more miles of existing roads have been closed as compared to miles of new roads built. In addition, the Forest will likely be decommissioning or realigning approximately 4 miles of road per year in the next planning period, regardless of alternative, resulting in the potential to improve elk security habitat. However, there may also be additional user-created trails and roads from motorized vehicles that may reduce the effectiveness of what has been identified as existing elk security, or potential elk security. It should be noted that user-created roads are not included in the model since they are not Forest Service system roads, and often locations are not specifically known.

It is assumed that by entering any existing elk security areas that security areas would be created within the geographic area through road closures to mitigate any additional created roads. However, this has yet to be tested at the project implementation scale, given known resistance to road closures. The Forest anticipates that it is feasible to rotate elk security areas on the landscape. In other words, as harvest or other vegetation management is conducted in one area, an adjacent area could have roads successfully closed to allow for elk and other species to use those areas. Similarly, as forested areas are either harvested or grow up, the forested cover aspect of security habitat can be rotated on the landscape. Travel management decisions would need to incorporate considerations for elk security, as would other vegetation management (e.g. prescribed fire) projects. The current projections for prescribed fire that have the potential for reducing forested canopy were described in the Fire and Fuels section of this chapter and are relatively minor acres of forested habitat (approximately 500 acres per year).

Timber harvest and other vegetation management projects are also important for elk and other animals that rely on early seral stages for forage or other habitat needs. It is not desirable to retain mature forested canopies over the entire Forest to keep security areas, but rather a balanced need for a diversity of structural stages also needs considered (Toweill and Thomas 2002). The creation of additional forage in Alternatives E and A would benefit summer range conditions, though the availability of the forage may be offset if roads are not effectively closed and elk do not use the areas. Also, summer

forage quantity has not been a limiting factor for elk due to the natural interspersion of meadows on the landscape. It was this need for recognizing some treatment, and the likelihood of wildfires or prescribed burns that resulted in allowing a lower "percent of potential" to manage for in the forest-wide guideline as compared to what is currently existing on the landscape (i.e. 47% vs. 40% of potential in the guideline). In addition, flexibility was deemed necessary as the Forest implements the "C" area closures. The Forest intends to manage towards maintaining the 47% but not drop below the 40% figure.

One final consideration with elk security that would be addressed at the site-specific level is the juxtaposition of slope. It is assumed that the most valuable wildlife habitat occurs on more gentle slopes, as soils are more productive in these sites, offering greater vegetative diversity and structure regardless of vegetation type. It is noted that many activities (livestock grazing, timber harvest) also occur within these zones, and this would need accounted for to allow for better distribution of elk security habitat at the site-specific project scale if needed.

Effects from Livestock Grazing: Livestock grazing would have no effects on elk security habitat. With regard to forage availability, livestock grazing may remove forage that would otherwise be available to elk and other wildlife. Forage utilization standards and guidelines were developed with this in mind, and administration of these measures would largely address this issue. Currently, only localized areas within individual allotments have problems with this cumulative use of rangeland vegetation.

Effects from Recreation Management and Special Uses: Recreation activities may affect elk security, as displacement of elk typically only occurs in response to human disturbance in the absence of other predators. This is largely addressed in the discussion above on travel management. Where higher road densities occur, there is greater viewing and hunting pressure on elk, providing the disturbance that causes elk to seek secure habitat. Studies have shown that hunters, and presumably most recreationists, stay within ¼ mile of open roads and trails (Lyon and Burcham 1998). Disturbance is largely a function of dispersed recreation use, as developed campgrounds are a small scale and localized source of disturbance. A surrogate for dispersed recreation would be the motorized recreation opportunities on the Forest, which largely follow trends in road development associated with timber harvest as described above.

With regard to effects on winter range, disturbance from recreation is typically of concern, as stress during this period can increase mortality. Most of the activity on winter range involves collection of antler sheds. Similar to the 1985 plan, areas of identified winter range were mapped by the WGFD and would be closed to motor vehicle traffic on Level 2 roads as prescribed by the Forestwide guideline. There have been few vegetation management projects in winter range to improve forage conditions in the past several years, with the exception of the west side of the Forest. There would likely be no differences among alternatives with regard to disturbances or treatments on big game winter range.

Special use activities such as recreation cabins, lodges, and other uses displace some wildlife, though these activities are not currently thought to be as significant as dispersed recreation.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for elk, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions and increased recreation use (OHV, demographics) are most significant.

As described in the Biodiversity section, it is likely that wildfire will continue to influence the majority of cover and forage attribute conditions of elk security regardless of alternative. It has been the increased road densities and recreation use that has led to the current lack of elk security, even less than the recommended 30% by geographic area, though some areas are naturally lower than 30% due to the amount of meadows vs. forested areas. The Forest has also begun to address this in recent timber harvest and travel management decisions, seeking lower overall road densities.

The likely increase in recreation use due to population factors surrounding the Bighorns, regardless of alternative, will continue to increase on the Forest and challenge us in managing the creation of additional roads and trails, and in the additional disturbance to wildlife. The Forest provides the majority of summer habitat in the cumulative effects area, with winter range occurring primarily off of the Forest.

On lands adjacent to the Forest within three miles of the Forest boundary, private land is often viewed as refuges, as many landowners currently restrict hunter access either by charging high fees or through simple denial. Elk use of these areas is often highest during the late summer and fall disturbance periods. The WGFD continues to work with landowners on this issue to gain access to achieve a better elk harvest. It is not known if improvements in elk security habitat on the Forest would alter or reverse the migratory behavior of elk to these areas during periods of stress, though it is possible over time (Thompson and Henderson 1998).

It is also known that elk from the North Bighorn herd unit winter in Montana on the Crow Indian Reservation. Both harvest and disturbances occur on this area, though effects are not well known. Finally, the development of timber resources on private land adjacent to the Forest, primarily in the southeast corner, also occurs, creating some roads and removing some cover aspects of elk security habitat. The additional roads and loss of cover is somewhat mitigated by restricted access on private lands, and the effects of this use are fairly localized.

Losses of elk security areas would presumably lower the habitat available for the other wildlife species associated with this type of habitat.

It is not likely that the effect to elk security from the alternatives would have a measurable effect on elk populations in the next planning period. Elk populations respond more to changes in climate (e.g., drought), which influences availability and quality of forage in summer and winter. Loss of winter range is another issue for elk populations. However, hunter harvest levels are a large determinant on population levels, which can be directly affected by levels of elk security areas on the Forest. Should improvements in elk security occur, it is likely that the WGFD would be able to better manage elk populations with regard to objectives due to the increased effectiveness of hunter harvest. The Forest may also try additional seasonal road closures to improve security habitat in areas. For economic relevance of hunter harvest, refer to the social section in Chapter 3.

Refer to the Monitoring and Evaluation plan for details on how this habitat attribute would be monitored through plan implementation.

Affected Environment
Beaver Habitat

Beaver are native and widespread throughout Wyoming. They are currently not well distributed and occur at substantially reduced levels from what historically occurred on the Forest. Heavy trapping of beaver occurred throughout Wyoming in the late 1800s and early 1900's, followed by active reintroduction programs through the 1930s and 40s (Blair 1987). This same trend was evident on the Forest (USDA 1914-1941). While not at risk from a viability perspective, improvements in distribution on the Forest are warranted, as beaver have long been recognized as ecological engineers responsible for raising water tables and stabilizing riparian ecosystems (Olson and Hubert 1994). Current observations and past detection flights (WGFD 1995) indicate their decline throughout the Forest.

On the Bighorn, beaver occupy primarily willow dominated riparian systems, and may utilize willow, aspen, and conifer trees in dam building. Beavers are also a disturbance agent causing regeneration of the shrubs and trees they harvest for dams. Where they are absent from historically occupied watersheds, the WGFD and the Forest have begun transplanting beaver back into them. A cooperative inventory with WGFD of occupied and historic beaver habitat was completed in the fall of 2003, which will also provide an estimate on the population level of beavers on the Forest. In total, there are approximately 101,000 acres of riparian areas on the Forest, of which 42% are dominated by forested cover types and 18% are shrub cover types. There are a total of 1,400 miles of perennial streams and 6,000 acres of ponds and reservoirs on the Forest, at least half of which provide potential habitat for the species. Streams that are too fast due to gradient and volume of water are less likely to hold beaver, as they often lack food sources (willow, etc.) along these types of streams.

Occasionally, beaver are removed from roadside areas where culverts are routinely plugged or flooding of the road occurs. The Forest has begun retrofitting culverts to address this, and roads are also moved out of riparian areas when it is feasible to do so. Beavers may also be taken through legal trapping, as they are designated furbearers in the State. Approximately 25 beaver are removed form the Forest each year (WGFD 2000), but the WGFD restricts areas for trapping in association with population restoration needs. Trapping harvest is not likely the largest source of mortality on beaver, but rather disease elements.

Beaver have also been implicated as undesirable when dams are not maintained (following emigration or loss from occupied waters), and a breach occurs causing downstream streambanks to be eroded. However, this is typically not a problem where streambanks are stable with the desired potential vegetation such as willow and sedges. Where downstream banks are not stable, then stream channel incision can occur. This can occur in areas where livestock grazing, wildlife browsing, or recreation disturbances have degraded riparian conditions. Declining amounts of aspen, which often are near stream courses, could also be having an effect on beaver due to a lack of forage and dam material.

As beaver are ecological engineers associated with healthy, functioning riparian areas, they were selected as an MIS. Many other wildlife species are associated with beaver pond habitat including waterfowl, and aquatic species (McKinstry et al 2000). In addition, riparian conditions associated with other uses (grazing, recreation) have an affect on beaver habitat and populations. Beaver populations may also fluctuate in response to disease elements, such as tularemia. Where stable colonies of beaver occur, individuals disperse from them yearly colonizing other habitat. Beaver are capable of overland travel, but mainly follow stream corridors. Beaver are also prey for coyotes, bobcats, and other predators. For further information, refer to the species assessment in the project record.

ENVIRONMENTAL CONSEQUENCES
BEAVER HABITAT

Direct and Indirect Effects

Beaver habitat is expected to improve for all alternatives as livestock grazing standards and guidelines are implemented, dispersed recreation sites are managed, and wildlife browsing is monitored. Livestock grazing is likely the largest potential threat of the management activities considered, followed by dispersed recreation. Reintroduction work in association with the WGFD would occur regardless of alternative, and guidelines to reduce killing in association with road maintenance would also occur for all alternatives. With combined habitat and transplant improvements, it is expected that beaver populations will improve for all alternatives, with little difference among them, if any. Continued coordination with WGFD would occur with regards to selection of

suitable trapping sites, as this is a guideline. The Monitoring Plan lists the expected monitoring procedure for this MIS.

Where beaver are limited in dispersal, it is often associated with road networks in riparian areas. The Forest would likely be reconstructing some of these roads in the next planning period, moving them out of riparian areas where possible, or decommissioning riparian area roads. There would not likely be any roads constructed along riparian areas due to implementation of riparian protection measures, though roads may cross these areas. Culverts could be designed at this point to avoid negative interactions with beavers. It is anticipated that approximately 4 miles of road per year would be reconstructed or de-commissioned, regardless of alternative, as this is largely a funding driven activity. Refer to the Biodiversity section for anticipated road construction, and the aquatics section for the number of stream crossings anticipated by alternative.

The least amount of new construction would occur in Alternative C, followed by B, and D, with the most new construction likely in A and E. However, the most reconstruction would also occur in the reverse order for alternatives, potentially removing problem roads from riparian areas. In other words, where more active construction is needed, more reconstruction or removal of problem roads would also likely occur. Conversely, the alternatives with the most roadless areas could also provide less potential for negative interactions with beaver, reducing human access into habitats. Roadless areas are maximized in Alternative C, followed in order by Alternatives B, D, A, and E.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for beaver, the past and present activities of vegetation management (including livestock grazing), roads, and water quality are the most significant, and the reasonably foreseeable future activities of subdivisions and increased recreation use (OHV, demographics) are most significant. These uses could increase more developed demands on the Forest in riparian areas, possibly creating a more difficult situation in which to manage for beaver.

There would not likely be a difference in provision of habitat by alternative, though there is some risk associated with additional road crossings in Alternatives A and E. Beaver populations are likely to improve for all alternatives due to reintroduction efforts. Trapping mortality may reduce some populations, though as habitat improves in riparian areas, trapping should be less of an impact due to higher populations. Habitat on the Forest would likely improve slowly in response to improved riparian habitat management.

Beaver are noted to frequently occur adjacent to the Forest and throughout the Big Horn Mountains ecosection, though populations may be higher on the Forest. Often, more aggressive removal of beaver occurs in areas adjacent to the Forest due to the conflicts

with irrigation diversions. However, several ranches in the surrounding plains have also begun reintroducing beaver as a means of habitat enhancement (Jellison 2003). Habitat condition on the land surrounding the Forest may have less potential, due to the more developed or more intensively used nature of these lands. Certainly the higher moisture regime on the Forest improves its carrying capacity for this species, though the gradients of some streams may be limiting. There is no anticipated increase in the demand for trapping of this species. Elements of climate (drought or flooding) would likely be the largest impact on both habitat and populations for this species.

Affected Environment
Red-breasted Nuthatch Habitat

Red-breasted nuthatches are a non-migratory, native avian species on the Forest. They are widespread in distribution in coniferous forests on the Bighorn and throughout Wyoming. They are associated with mature structural stages, primarily due to their association with soft snags for nesting cavities, and from both insects in bark and cone crops as forage. They would be most strongly associated with Habitat Structural Stage 4C and old growth. They would also likely occur in stages 4A and 4B, and have been known to occur in the younger stages if snags are present. For information on habitat structural stages, old growth, and snags, refer to the Biodiversity section of Chapter 3. Currently, approximately 34% of the forested habitats are in structural stage 4, of which approximately 60% (145,000 acres) is in the 4C category. This is within the range of what likely historically occurred on the Forest (Romme 2002; Knight and Meyer 2003). Nuthatches are not known to be sensitive to edge or fragmentation issues, including effects of roads or timber harvest. Continued availability of their habitat (4C, snags, etc.) would be the issue of concern. Snags and habitat structural stages were described in more detail in the Biodiversity section in Chapter 3.

The Region 2 Habitat Capability (HABCAP) model was updated in 1993 to display habitat conditions for several species, including the nuthatch, as a function of structural stage distribution (Hoover and Wills 1987). The model assumes that structural stage 3 is worth 20% of optimum (100%), and all structural stage 4 is worth 100% of optimum for both feeding and cover habitat attributes. The model recognizes no differences in cover types, snags, coarse woody debris, or other habitat attributes. The following table provides the results of this model by geographic area and Forestwide describing the current condition of **forested** acres as obtained from the CVU GIS vegetation database.

Table 3-75. HABCAP model values of existing red-breasted nuthatch habitat on Bighorn National Forest.

Geographic Area	HABCAP Value
Clear/Crazy	37%
Devils Canyon	65%
Goose Creek	39%
Little Bighorn	57%
Paintrock	52%
Piney/Rock	41%
Shell	57%
Tensleep	52%
Tongue	43%
Forestwide	47%

As less than 20% of forested acres have had harvest activities on them forestwide, the existing condition is largely a result of the natural disturbance processes that have shaped structural stage distribution. An example of this would be the results for Piney/Rock Creek Geographic Area. Most logging activity, historical and current, has taken place in the Clear Creek/Crazy Woman Creek and Tongue River watersheds. The 1985 plan used a similar version of HABCAP from which to base compliance with the general management direction of providing a minimum of 40% habitat capability for MIS. While this model provides results applicable to this species and those associated with it, it is not valid to maximize habitat for this MIS only.

Currently, there are no results from systematically gathered surveys on just the Forest to indicate population trend. However, avian point count monitoring began in 2002 on the Forest, indicating that nuthatches were widespread, though at relatively low abundance in the two randomly selected conifer habitats monitored (high elevation and mid-elevation conifer, no target of structural stage). An abundance of .06 to greater than 1.34 birds per point were observed, which correlated to a density of approximately 40 birds per square mile of habitat on the Forest. Detections for monitoring purposes by this method were deemed adequate (RMBO 2003), which was a contributing factor to their selection as an MIS. Loud vocalizations make their detection relatively easy. Population trends from this monitoring effort should be available beginning in 2007, after five years of monitoring. Statewide results from avian monitoring showed approximately 5 nuthatches per square mile in habitat. This may indicate a difference in sampling power, or could also indicate the abundance of mature conditions on the Bighorn.

There are two transects run on the Forest from the Breeding Bird Survey monitoring effort, both having detections of nuthatches. One transect indicates an upward trend, and the other a downward trend, however the statistics surrounding these observations

are not reliable. At the statewide scale, Breeding Bird Survey results indicate an upward trend of 5%, with similar unreliability of data (Sauer et al 2003). Determining trend with this type of data on the Forest is difficult at best due to the separation of transects, scarcity of transects, and variableness of data.

ENVIRONMENTAL CONSEQUENCES
RED-BREASTED NUTHATCH HABITAT

Direct and Indirect Effects

The primary factor describing the effects to red-breasted nuthatches would be both the availability and distribution of HSS 4C and old growth, and snags. Both of these elements were described in the Biodiversity section of Chapter 3.

In summary of effects to habitat from management activities, Alternatives C, G, and B would likely provide the greatest amount of this type of habitat (4C, old growth and snags) in the next planning period. Alternative D would follow, with Alternatives A and E having the least of any of the alternatives, but still an adequate amount of this type of habitat within the range of HRV as designed by the snag guidelines adopted in the Revised Plan. These effects are from the results of timber harvest, though the natural processes of insects and disease and fire would continue to be the largest source of influence on the availability of 4C and old growth stages and snags. Timber harvest would only occur on suited acres, which occur in a range from 30% of the total forested acres on the Forest in Alternative E to approximately 7% in Alternative C. Recent and past harvest activities have occurred on approximately 20% of the forested acres.

The Region 2 Habitat Capability (HABCAP) model provides an indication of habitat availability as a function of the structural stages (Hoover and Wills 1987). Results from anticipated timber harvest activities are summarized at the forest-wide scale in the following table by alternative, but do not include estimates from natural disturbances that will likely occur. It is estimated that at least one 10,000 acre wildfire will occur in the next decade, and a similar number of acres of insect and disease. Refer to the Fire and Fuels, and Insects and Disease sections within the DEIS for further information. Prescribed fire was not included in the HABCAP as the effects anticipated to forested areas were anticipated to be minimal (less than 10,000 acres in the next decade). Model results are from forest-wide results, whereas timber harvest would occur in more limited areas where suited acres occur, resulting in site specific alterations in habitat within certain geographic areas as compared to the forestwide scale.

Table 3-76. HABCAP model values of likely red-breasted nuthatch habitat by alternative at 10- and 50-year intervals.

Alternative	HABCAP Value – 10 Year	HABCAP Value – 50 Year
A	49%	67%
B	49%	68%
C	49%	69%
D	49%	67%
E	49%	65%

In general, the tables show that there would be little difference among alternatives in habitat for this species at the forest-wide scale, and that forests continue on a trajectory towards mature structure stages when the only variable is timber harvest acres. Even a conversion of 20,000 acres by fire to young structural stages in the first decade (10,000 acres lodgepole, 10,000 acres spruce-fir) would produce only a 3% reduction in the HABCAP value, which would be similar for all alternatives, regardless of decade.

The most specific removal of snag habitat occurs with firewood harvest. This effect typically only occurs within a few hundred feet along open roads. Where additional roads are constructed in support of harvest activities, there would be more of this type of habitat removed. Again, this would be most in Alternatives E and A, decreasing with D, B, and least in C. However, it is also likely that due to the large expanses of habitat away from roads remaining, more than adequate snag abundance would be provided regardless of alternative, and desirable snag abundance levels would still be ensured in project areas, even following harvest. Timber modeling indicates that regardless of alternative, the forested acres would continue to mature with an abundance of mature structural stages. Wildfires and prescribed burns would create snags by killing live trees, and mosaic patterns typically leave green recruitment trees for future snags.

With regards to effects to forest-wide populations, it could be assumed that populations would follow the trend of the habitat as discussed above, which would largely be driven by natural disturbance processes. However, as with any wildlife species, elements of climate would have a greater influence, affecting forage and prey available and thereby reproduction success. Red-breasted nuthatches are relatively unaffected by human disturbance. Population trend monitoring would need correlated to changes in known habitat conditions at the sites surveyed to display any effects.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for the nuthatch, the past and present

activities of vegetation management are the most significant, and the reasonably foreseeable future activities of subdivisions and vegetation treatments on adjacent lands are most significant. These uses could reduce habitat available for nuthatches adjacent to the Forest, placing a higher value on habitat provided on the Forest.

The Forest would continue to be influenced by the natural disturbance processes, and only secondarily by timber harvest or prescribed burns. Alternatives A and E would have the most potential for timber harvest and fuelwood harvest, which can lower the number of snags in an area for this species. Logging activities and firewood harvest occur on private lands adjacent to the Forest, though this is typically limited by slope and road access, and occurs mostly in the southeast corner of the Forest.

As the Bighorn NF has the majority of the coniferous habitat in the Big Horn Mountains ecosection, populations of this MIS would be relatively unaffected by treatments occurring in other areas of the mountain range. This bird is not hunted, but populations fluctuate in response to abundance of cone crops and insects. It is anticipated that populations would continue similar to current levels and trends in all alternatives, with some potential for reductions in Alternatives A and E due to reduced habitat abundance in the long term.

Affected Environment
Red Squirrel Habitat

Red squirrels are a native, non-migratory small mammal on the Forest. They are widespread in distribution in coniferous forests on the Bighorn and throughout Wyoming. They are associated with mature structural stages, primarily due to their association with soft snags and coarse woody debris for nesting cavities, and cone crops as forage. They would be most strongly associated with Habitat Structural Stage 4C and old growth. They also commonly occur in stages 4A and 4B, and 3B and 3C. For information on habitat structural stages, old growth, and snags, refer to the Biodiversity section of Chapter 3. Currently, approximately 34% of the forested habitats are in structural stage 4, and 145,000 acres or 20% of the forested acres are in structural stage 4C. This is within the range of what likely historically occurred on the Forest (Romme 2002; Knight and Meyer 2003). Squirrels are not known to be sensitive to edge or fragmentation issues, including effects of roads or timber harvest, nor are they sensitive to human disturbance. Continued availability of their habitat (4C, coarse woody debris, snags, etc.) would be the issue of concern. Coarse woody debris, snags, and habitat structural stages were described in more detail in the Biodiversity section in Chapter 3. They are more dependent on coarse woody debris than the red-breasted nuthatch.

The Region 2 Habitat Capability (HABCAP) model was last updated in 1993 to display habitat conditions for several species, including the squirrel, as a function of structural stage distribution (Hoover and Wills 1987). The model assumes that structural stage 1 is worth 10% of optimum (100%), with maximum capability assigned to structural stage

4 only, with different cover types taken into account (spruce-fir and lodgepole of highest value). The model recognizes no differences in snags or coarse woody debris, or other habitat attributes. The following table provides the results of this model by geographic area and Forestwide describing the current condition of **forested** acres as obtained from the CVU GIS vegetation database. The higher values reported as compared to the nuthatch indicate the squirrel's adaptability to more structural stages than the nuthatch.

Table 3-77. HABCAP model values of existing red squirrel habitat on Bighorn NF.

Geographic Area	HABCAP Value
Clear/Crazy	67%
Devils Canyon	76%
Goose Creek	72%
Little Bighorn	75%
Paintrock	70%
Piney/Rock	73%
Shell	72%
Tensleep	70%
Tongue	70%
Forestwide	71%

As less than 20% of forested acres have had harvest activities on them forest-wide, the existing condition is largely a result of the natural disturbance processes that have shaped structural stage distribution. An example of this would be the results for Piney/Rock Creek Geographic Area. Most logging activity, historical and current, has taken place in the Clear/Crazy and Tongue River watersheds. The 1985 plan used a similar version of HABCAP from which to base compliance with the general management direction of providing a minimum of 40% habitat capability for MIS. While this model provides results applicable to this species and those associated with it, it is not valid to maximize habitat for this MIS only.

There is no actual population trend information based on surveys currently known for the Forest. Avian point count monitoring began in 2002, and was designed to include detections of red squirrels. Results indicated that squirrels were widespread. An abundance of .06 to greater than 1.34 squirrels per point were observed, which correlated to a density of approximately 87 squirrels per square mile of habitat in spruce/fir, and approximately 29 squirrels per square mile in lodgepole pine. Detection for monitoring purposes by this method was deemed adequate (RMBO 2003), which was a contributing factor to their selection as an MIS. Loud vocalizations make their detection relatively easy. Population trends from this monitoring effort should be available beginning in 2007, after five years of monitoring. There are no population trends known from other areas in the state.

ENVIRONMENTAL CONSEQUENCES
RED SQUIRREL HABITAT

Direct and Indirect Effects

The primary factor describing the effects to red squirrels would be both the availability and distribution of HSS 4A, B, C, and old growth, coarse woody debris, and snags. These elements were described in the Biodiversity section of Chapter 3.

In summary of effects to habitat from management activities, Alternatives C, and B would likely provide the greatest amount of this type of habitat in the next planning period. Alternative D would follow, with Alternatives A and E having the least of any of the alternatives, but still an adequate amount of this type of habitat within the range of HRV. These effects are from the results of timber harvest, though the natural processes of insects and disease and fire would continue to be the largest source of influence on the arrangement of structural stages and availability of coarse woody debris and snags. The Region 2 Habitat Capability (HABCAP) model provides an indication of habitat availability as a function of the structural stages (Hoover and Wills 1987). Results from anticipated timber harvest activities are summarized in the following table by alternative. Prescribed fire was not included as the effects anticipated to mature timber were minimal. Timber modeling did not take into account wildfires or insects and disease. Even if 20,000 acres total of fire and insects and disease occurred, a difference of approximately 2% in the model values would be evident in the first decade at the forest-wide scale (i.e. 77% instead of 79% for Alt. A).

Table 3-78. HABCAP model values of likely red squirrel habitat by alternative at the 10 and 50 year intervals.

Alternative	HABCAP Value – 10 Year	HABCAP Value – 50 Year
A	79%	79%
B	79%	85%
C	79%	86%
D	80%	86%
E	79%	82%

The most specific removal of coarse woody debris and snag habitat occurs with firewood harvest. This effect typically only occurs within a few hundred feet along open roads. Where additional roads were constructed in support of harvest activities, there would be more of this type of habitat removed. Again, this would be most in Alternatives E and A, decreasing with D, B, and least in C. However, it is also likely that due to the large expanses of habitat away from roads remaining, more than adequate coarse woody debris and snag abundance would be provided regardless of alternative, and minimum abundance levels would still be ensured in project areas, even

following harvest. Distribution would also remain relatively even over the Forest due to the expanses of non-harvestable areas.

With regards to effects to forestwide populations, it could be assumed that populations would follow the trend of the habitat as discussed above, which would largely be driven by natural disturbance processes. However, as with any wildlife species, elements of climate would have a greater influence, affecting forage availability and thereby reproduction success. Red squirrels are relatively unaffected by human disturbance. Population trend monitoring would need to be correlated to changes in known habitat conditions at the sites surveyed to display any effects.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for the squirrel, the past and present activities of vegetation management are the most significant, and the reasonably foreseeable future activities of subdivisions and vegetation treatments on adjacent lands are most significant. These uses could reduce habitat available for squirrels adjacent to the Forest, placing a higher value on habitat provided on the Forest.

The Forest would continue to be influenced by the natural disturbance processes, and only secondarily by timber harvest or prescribed burns. Alternatives A and E would have the most potential for timber harvest and fuelwood harvest, which can lower the number of snags in an area for this species. Logging activities and firewood harvest occur on private lands adjacent to the Forest, though this is typically limited by slope and road access, and occurs mostly in the southeast corner of the Forest.

As the Bighorn NF has the majority of the coniferous habitat in the Big Horn Mountains ecosection, populations of this MIS would be relatively unaffected by treatments occurring in other areas of the mountain range. This squirrel is hunted, though the amount killed is low. Approximately 90 squirrels were taken in 2001, by 27 hunters on the Bighorns (WGFD 2001), though more are taken from unreported shootings. Populations fluctuate primarily in response to abundance of cone crops. It is anticipated that populations at the forest-wide scale would continue similar to current levels in all alternatives, with some potential for localized reductions in Alternatives A and E in the long term.

AFFECTED ENVIRONMENT
BREWER'S SPARROW HABITAT

Brewer's sparrow are a migratory species that is known to nest and rear young on the Forest. They are widespread in distribution in sagebrush habitats on the Bighorn and throughout Wyoming. They are associated with mature canopies in sagebrush, primarily due to their selection of nesting sites. They migrate to winter in the southwest U.S. and Mexico.

As the Forest lacks detailed information to describe conditions of sagebrush habitat forest-wide, a more qualitative description is used. From the CVU GIS vegetation database, approximately 262,000 acres of sagebrush habitat types occur, primarily on the west side of the Bighorns. It is unknown what percentage of this is in the mature condition (canopy cover greater than 15%) versus a more grass dominated stage. However, as described in the fire and fuels section in this chapter, the sagebrush community is regarded as being in mature condition forest-wide. This is a result of having missed several fire events due to fire suppression, and possibly combined with livestock grazing removing some fine fuels. Another example is a recent assessment conducted for the Forest in the Tensleep drainage. It concluded that the area was dominated by mature sage conditions, with aerial photo mapping of the sagebrush habitats supporting the determination. The Forest does not contain the majority of this habitat type in the Big Horn Mountains ecosection. This condition may be outside HRV for this cover type.

The issue for this species and its habitat is retaining a balance of age class structures on the Forest that is more resilient to large-scale fires with reduced risk of noxious weed invasion following. Prescribed burning, wildfire, and to a lesser extent noxious weeds and livestock grazing are issues of concern for this species. There were no suitable habitat models available for this species from which to describe current habitat or from which to evaluate effects of alternatives.

There is currently no systematically gathered survey results that provide population trend information just for the Forest. Avian point count monitoring began in 2002 on the Forest, indicating that Brewer's sparrows were widespread, though at relatively low abundance in the sagebrush-grassland habitats monitored. An abundance of .06 to greater than 1.34 birds per point were observed, which correlated to a density of approximately 31 birds per square mile of habitat. Detection for monitoring purposes by this method was deemed adequate (RMBO 2003), which was a contributing factor to their selection as an MIS. Loud vocalizations make their detection relatively easy. Population trends from this monitoring effort should be available beginning in 2007, after five years of monitoring. Results from statewide avian monitoring indicate approximately 17 birds per square mile of habitat. This may indicate differences in sampling power, or may also indicate the higher abundance of mature sage habitat on the Forest.

There are two transects run on the Forest from the Breeding Bird Survey monitoring effort, both having detections of Brewer's sparrows. Both routes indicate a substantial decline, however the statistics surrounding these observations are not reliable. At the statewide scale, Breeding Bird Survey results indicate a 1% downward trend, with similar unreliability of data (Sauer et al 2003). Unreliability is a function of sample size and variableness of data, among other functions.

ENVIRONMENTAL CONSEQUENCES
BREWER'S SPARROW HABITAT

Direct and Indirect Effects

Effects from Prescribed Fire and Fire Management: The primary effects to Brewer's sparrow habitat will continue to be from prescribed fire and wildfire. The Forest has traditionally conducted prescribed burning in this habitat type. Historically, this was done to generate forage for livestock, but more recently has been focused on the need for a diverse canopy cover of sagebrush, with fuels treatment money providing the impetus. Most of these treatments have been focused in the Shell Canyon, Horse Creek Mesa, and Sunlight Mesa in the past decade. Additional treatments are planned for portions of Tensleep Canyon. None of these have reduced mature canopy covers in these locales below approximately 40% of the overall habitat available. Forestwide, the following acres are possible in all grass/brush habitat types by alternative, of which sage is the largest component.

Table 3-79. Acres of non-forested prescribed burning or mechanical habitat treatment on Bighorn NF.

Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
2,500	3,000	1,500	2,500	2,500

With continued management direction for a diversity of age classes in shrub habitats, and with direction to follow the sage grouse management guidelines, it is not likely that enough prescribed burning would take place forest-wide to significantly alter the condition class of sagebrush with regards to the overall fire regime. Project specific improvements would occur, though uncertainty exists as these areas regenerate over time, as more acres would continue to move into a higher condition class than are possible to treat. This also assumes that no large-scale wildfires occur, though some would certainly occur in the next planning period and in the long term. Due to their locations near the edge of the Forest, there may be less opportunity for sagebrush sites to fall under the wildland fire use prescriptions where larger fires could occur. There may be some variation in this effect by alternative, as alternatives with more areas in management categories 1 – 3 may result in larger fires, such as Alternatives B and C.

As prescribed fire would not likely occur in areas with noxious weed infestations due to forest-wide direction, there is not an anticipated spread of weeds as a result of this activity. In addition, prescribed burns are typically conducted in cooler seasons to avoid detrimental effects to soils. Noxious weeds would more likely spread after wildfire events that occur under more severe conditions, where soil disturbance is more active.

Effects from Livestock Grazing and Non-native Species (Noxious Weeds): Forestwide direction for livestock grazing and noxious weed management has been improved in the Revised Plan, though levels of either activity do not vary by alternative. There would likely be little difference to sagebrush habitats among alternatives with regards to effects of management for these activities or resources. Livestock grazing can provide a direct transfer mechanism for establishment of noxious weeds to new sites on the Forest. As there are no anticipated increases in livestock grazing, expansion opportunities are limited to the rates currently occurring. Rates currently occurring may result in a loss of a few hundred acres of sagebrush habitat, though it is not anticipated to be in the thousands of acres in the next planning period.

Livestock grazing can also affect migratory birds by increasing cowbird parasitism. With rotational grazing systems and later turn-out dates (after June 15th) typically used on the Forest, these effects are somewhat minimized. Cowbird parasitism is not likely a large effect to Brewer's sparrows on the Forest. Livestock grazing may facilitate conditions for Brewer's sparrow by contributing to the persistence of mature sagebrush canopies, as fine fuels can be reduced, lowering chances for wildfire.

Effects from Dispersed Recreation and Travel Management: If increased road construction occurs in Alternatives A and E, there may be some risk of noxious weed introduction where roads are constructed in sagebrush. There would likely be little difference in other alternatives with regards to this effect. User-created trails and roads have the potential to disturb additional habitat and introduce noxious weeds. This effect would continue regardless of alternative, though it may be higher in alternatives where motorized recreation opportunities are more prevalent, such as in Alternatives A and E.

Dispersed campsites would likely continue to expand into this habitat type, creating some effects, as campsites are moved away from riparian areas in accordance with plan direction.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for the sparrow, the past and present activities of vegetation management (including livestock grazing) are the most significant, and the reasonably foreseeable future activities of subdivisions and vegetation treatments (e.g. BLM prescribed burns) on adjacent lands are most

significant. These uses could reduce habitat available for sparrows adjacent to the Forest, placing a higher value on habitat provided on the Forest.

The projected amounts of prescribed burning, regardless of alternative, would not likely create a condition where populations of birds are significantly affected on the Forest by reductions in mature sagebrush canopy. With the current habitat being outside of HRV, it is desirable to manipulate some of this to achieve more balance in terms of age class diversity.

While increased road building evident in Alternatives A and E carries some risk to the habitat type both from a loss of habitat and introduction of weeds, the amount of habitat lost may not be significant. This is because most access roads already exist where necessary in sagebrush types, and minimal additional habitat would be lost to this use.

Lands adjacent to the Forest would likely have higher impacts to habitat both through increased wildfire and noxious weed expansions due to the drier moisture regimes and additional sources of disturbance on private lands. Cheatgrass is also a common element off of the Forest that may expand, with loss of habitat value to Brewer's sparrows and other sagebrush obligates. As weeds and undesirable species increase on lands adjacent to the Forest, this may increase the potential for the spread of these onto the Forest.

Population trends on the Forest may continue to decline for the Brewer's sparrow, particularly given largely unknown effects on its winter range in the southwest U.S. and Mexico. This may place a higher value of retaining mature sagebrush canopies on the Forest to counteract the shrinking availability of this habitat on surrounding lands and regions. However, this is currently unknown, and leaving the habitat on the Forest in a more dense condition than historically occurred could set up the Forest for larger fire events that could reduce habitat availability even further, with increased potential for noxious weeds. For a more in-depth analysis of this species, refer to the Biological Evaluation in the Project Record.

Demand Species

As mentioned previously, Demand Species are selected due to their social value primarily associated with hunting or other commercial values. Demand species were recommended by the WGFD, and include **mule deer, moose, black bear, mountain lion, wild turkey, blue grouse, ruffed grouse, sharp-tailed grouse, chukar, and gray partridge**. The existing condition for each species' habitat and their population trend, where known, is described, along with the likely consequences of plan implementation to habitat and populations from the various alternatives.

Small game species such as red squirrel (covered under MIS), snowshoe hare, and cottontails occur on the Forest but were not selected as demand species. All of these species utilize habitats as analyzed through other species, and none of them have population trends that are of concern. Fur-bearers including marten (Sensitive), beaver

(MIS), badger, bobcat, mink, weasel, and muskrats all occupy the Forest, and are considered analyzed through other species and habitats. River otters were likely extirpated in the early or mid 1900s, with no known plans to reintroduce them.

Affected Environment
Mule Deer and Mountain Lion Habitat

Mule deer are largely generalists in terms of the habitat they occupy, including meadows and shrub-steppe for foraging and timber for cover. Due to this factor, they were not considered as an MIS in the revised plan. Mountain lions closely follow mule deer herds, and thus were included together. Mountain lions prefer areas with rock outcrops or cliffs for escape cover and hunting, though they are also capable of exploiting a variety of habitats and are capable of long-range movements.

The Forest provides mostly summer and spring/fall transition range for deer, though areas of winter range occur as identified by WGFD mapping efforts. No crucial fawning habitat has been mapped as this is mostly well dispersed on the Forest. The 1985 plan identified winter range as a priority improvement area, with scheduled habitat treatments to improve winter range. These improvements were not conducted as planned, though some prescribed burns in the past decade (e.g., Tongue River Canyon, South Slope burns near Buffalo, planned Little Bighorn) have benefited winter range. The prescribed monitoring of winter range and an increase in capacity for animals in the 1985 plan was generally not conducted, possibly due to the increased emphasis in TES species management and other priorities.

Summer range conditions are generally good on the Forest, with some localized areas of degraded conditions due to the combined forage use of domestic and wild ungulates. Key habitats include riparian (willow), meadows, and aspen. Shrubs on winter range are comprised primarily of mature conditions, with the exception of where recent burns have taken place. Deer avoid roads primarily during hunting season, though they are less sensitive to road influences and disturbance as compared to elk. Mountain lions have shown preferences for areas with lower road density to avoid hunting and other disturbances (Van Dyke et al. 1986).

Population trends west-wide for mule deer are down from the higher levels noted in the 1950s and 60s, with speculated reasons including competition among ungulates, reduction in predator control, and habitat degradation or loss, primarily on winter ranges. Population estimates are provided by the WGFD and are based on harvest data and aerial post harvest counts conducted on winter range. The following table indicates a similar trend for those herds that occupy the Bighorn NF for at least a portion of the season. Geographic locations (maps) of Hunt Areas are described in WGFD hunting regulations.

Table 3-80. Mule deer herd objectives, populations, and hunter success by herd unit and hunt area (2002).

Herd Unit/Hunt Area	Population Objective	Current Population	Hunt Strategy	Hunter Success
North Bighorn HU	25,000	21,000		
HA 25			General	18%
HA 28			General	21%
HA 50			General	34%
HA 53			General	32%
Paintrock HU	13,000	10,000		
HA 46			General	21%
HA 48			General	12%
*Southwest Bighorn HU**	28,000	19,260		
HA 43			General	25%

* Only a small portion of the Hunt Unit occurs on the Forest.

There are no population data available for mountain lions due to the difficulty in surveying for this species. However, quotas for hunting have been fluctuating in recent years, in response to population levels. Increases in mountain lion populations have been noted in many areas of the west, and are likely a response of reduced mortality from predator control in recent decades. Increased observations of lions off of the Forest may also indicate higher population levels on the Forest. The WGFD estimates that approximately 100 mountain lions may inhabit the Forest based on average home range sizes.

Environmental Consequences
Mule Deer and Mountain Lion Habitat

Direct and Indirect Effects

Timber harvest and roads have minor effects to mule deer habitat, though any loss of habitat due to road construction would be negative, unless other roads are closed and revegetated to mitigate the loss. Clearcuts and harvest are considered beneficial for deer due to the increase in forage. Timber harvest in some winter ranges has been done to open canopies and increase forage quantity and quality, though this has been minimally practiced in the past. Harvest levels would be greatest in Alternatives A and E and remain largely the same as current levels in Alternative D, with the least in Alternatives C and B. Mountain lions tend to prefer secluded areas, though largely their

occurrence on the steeper edges of the Forest reduces any potential effects from harvest or road construction.

Prescribed burning would likely continue to be conducted to improve winter range conditions, though the levels conducted may not sufficiently regenerate enough ranges to meet the demand of wildlife use. An exception would be areas where mountain mahogany is a primary forage component, as fire can potentially reduce this shrub on the landscape for many years. However, the competing invasion of juniper into mahogany stands may be a result of fire exclusion. Wildfire occurrence may account for significant changes in the next planning period, as the shrublands are regarded to be in a condition where they have missed fire cycles due to suppression, and could be more susceptible to catastrophic loss of larger acreages. There would be little difference in alternative with regards to this potential, although the proposed wilderness in Alternative C in the Rock Creek area may influence small acres of winter range with regards to fire suppression, possibly increasing the potential for loss in this area.

Although winter range would be managed regardless of alternative, it is most emphasized in Alternatives D, B, and A, respectively, with E and C having less but similar levels as described in the table below.

Table 3-81. Big game winter range prescription acres by alternative.

Mgmt. Area	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
5.41	27,680	28,213	21,325	28,852	23,452

Human disturbance on big game winter range has been of increased concern, primarily due to the stress imposed on big game for activities such as antler hunting. Similar to the 1985 plan, the revised plan would designate travel closures to motorized vehicles in winter range, except where main arterial roads and highways occur. WGFD (2002) winter range maps are the basis for delineating these areas. Refer to the project record for the most recent maps. Hiking and antler hunting would not be prohibited through the plan at this time. This would not vary by alternative.

Potential conflicts with livestock grazing have been of concern in both summer and winter range areas, where combined use of forage can result in degraded habitat conditions. Revised plan direction would address this, though instances of localized problem sites would likely continue in all alternatives for the next planning period. This issue is dealt with at the individual allotment scale, and includes shrub and grasslands on winter range, as well as willow and aspen cover types.

No management conflicts with mountain lions are currently known to occur, other than dispersed recreation use displacing lions in localized areas.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for deer and lions, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions and increased recreation use (OHV, demographics) are most significant.

Winter range is in the zone with the most potential for increases in noxious weeds and non-natives (cheatgrass) due to the elevation and lack of forested canopy cover. While possibly limited amounts of winter range would be lost by this effect in the next planning period, the likelihood increases with time as has been demonstrated in other winter ranges in the State. Where roads, livestock grazing, recreational horse use, and wildlife use occur in these areas, those uses would be the most likely vectors. As weeds and other non-native species are expanding on private lands surrounding the Forest, this has the potential to increase risk on the Forest with similar effects. Any additional loss of winter range or other habitat on the Forest would translate into reduced carrying capacity on the Forest, eventually resulting in a downward trend or reduced population levels on the Forest. Any reduction in mule deer herds would translate similarly into a reduction in lion populations.

In addition, continued growth of housing developments in areas adjacent to the Forest may reduce carrying capacity of winter range. This may place a higher value on the availability and condition of winter range on the Forest. Lions are less displaced by human activity as deer, as they are largely nocturnal.

The proliferation of user-created roads on the Forest could continue to be of concern in the next planning period, as habitat loss or disturbance may occur to deer, and consequently lions.

Disease may continue to play an increased role in the abundance of mule deer herds, though currently this portion of Wyoming is thought to be minimally impacted by diseases such as chronic wasting disease. Displacement of mule deer by white-tailed deer may occur in localized areas, as white-tailed deer appear more able to persist with increased human occupation in lands adjacent to the Forest.

The subject of mule deer population declines is currently of research interest within the State and many western states, and is typically related to a combination of many of the factors mentioned above.

Climate (drought and winter severity, annual forage production), hunting, and vehicle related mortality would continue to be the primary factors associated in determining population levels and trends for both species. Forage quality on the Forest can also affect the condition of deer heading into winter ranges, with competition by livestock and increasing noxious weeds being a potential problem. Yearly coordination meetings

will continue to be held with the WGFD to discuss habitat conditions and population objectives. There would not likely be a difference among alternatives overall with regard to deer and lion habitat and populations in the foreseeable future.

AFFECTED ENVIRONMENT
MOOSE HABITAT

Moose are a desirable non-native species introduced to the Bighorns beginning in 1948 with additional supplemental releases. Since their release, moose have thrived on the Bighorns, and have become a favorite wildlife viewing species along highways and roads. Moose are typically not sensitive to road densities and human disturbance, except in hunting season related instances. Moose on the Bighorn NF are also a highly sought after hunting trophy.

Primary moose habitat involves willow riparian communities primarily for summer range, though year-round use occurs to some extent depending on geographic location on the Forest. Winter habitat and escape cover is associated primarily with spruce-fir forests, typically on north aspects, though use of lodgepole is also common. Mature conditions (multi-storied in spruce-fir) are preferred by moose.

Moose are managed as one herd unit on the Forest, with four separate hunt areas as described in the table below. Populations are estimated from aerial and ground observations, though these estimates are often difficult to interpret due to difficulty in observing moose in forested habitats. The following populations are based on high-end estimates from the WGFD.

Table 3-82. Moose herd objectives, populations, and hunter success by herd unit and hunt area.

Herd Unit/Hunt Area	Population Objective	Current Population	Hunt Strategy	Hunter Success
Bighorn HU	500	475		
HA 1 (NE portion of Forest)	350	285	Limited	90%
HA 34 (SW portion of Forest)	70	120	Limited	100%
HA 42/43 (W portion of Forest)	80	105	Limited	100%

Of concern is the ability of moose to heavily browse willow cover types, particularly with regard to overlapping use with domestic livestock and recreation impacts (e.g., dispersed recreation, fishing). In localized areas of the Forest, this is presenting concerns over long-term sustainability of suitable habitat conditions. Over-utilization of willows may also remove sustainable conditions for beaver. Aspen may also be heavily used by moose in localized areas. The Forest continues to coordinate with

WGFD in identifying monitoring sites and potential issues with regard to carrying capacity of population objectives.

Environmental Consequences
Moose Habitat

Direct and Indirect Effects

Effects to winter habitat (mature spruce-fir) and willow (riparian) are described in the Biodiversity section (see composition and habitat structural stages). The Aquatics section also discusses riparian habitat conditions. Effects to spruce-fir are primarily associated with timber harvest, though wildfire would continue to be the main disturbance agent for this resource. Moose often take advantage of burned areas to eat sprouting shrubs and trees. Alternatives A and E would likely have the highest levels of harvest for spruce-fir, although uneven-aged harvest (selection) prescriptions would likely retain habitat values in spruce-fir. Roads do not likely have a major effect on moose.

Livestock grazing would continue to be an effect on willow communities, with improvement over time through implementation of standards and guidelines. There would be little difference by alternative with regards to effects from livestock grazing. Areas of combined over-utilization would be addressed through allotment planning and coordination efforts with the WGFD.

Winter recreation may have an effect on moose, displacing them from some areas, such as riparian zones, where heavy snowmobile traffic may occur. Cross-country skiing is not likely of sufficient amount or intensity to displace moose. Effects from snowmobiling are generally in localized areas rather than Forestwide. Snowmobile use would be allowed to occur under all alternatives, but the amounts and types of use would vary according to any use of the 1.2 or 1.31 management prescriptions that limit snowmobile use, which would primarily be in Alternative C.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for moose, the past and present activities of vegetation management (including livestock grazing) and roads are the most significant, and the reasonably foreseeable future activities of subdivisions and increased recreation use (OHV, demographics) are most significant.

Combined livestock and wildlife browsing of willows and aspen will likely continue to be an impact throughout the next planning period, regardless of alternative. Efforts in

management would continue to address bringing the use levels within the carrying capacity of the resources.

Increases in noxious weeds which affect riparian resources by decreasing native vegetation would have a negative effect on moose habitat.

Effects from lands adjacent to the Bighorn NF are less significant, as moose spend the bulk of their time on the Forest.

Moose populations would likely continue to increase in absence of additional hunting or weather related mortality. Hunting pressure in the past was applied to restrict population growth, then eased, and is currently being increased again to keep moose within population objectives, though this is speculative based on data from WGFD. Past harvests were effective at regulating moose populations, though the past decade has allowed moose to expand in numbers. The WGFD and the Forest continue to strive for effective riparian habitat management for this species, other wildlife, and domestic livestock, which should allow for stable populations of moose.

Affected Environment
Black Bear Habitat

Black bears are native to the Forest, and occupy a variety of habitat types in the summer in search of food. In winter, they prefer more secluded habitats where adequate denning habitat (rock outcrops, caves, large downed trees) can be found, with minimal human disturbance. Summer foraging habitat includes forests, shrublands, and riparian cover types, though bears are considered omnivores. Black bears, like grizzlies, may also seek out human refuse as forage, raiding garbage or other sources of food. This occurs largely near campgrounds, summer cabins, and lodges located on the Forest.

Bears are largely an elusive species, and therefore seldom seen, though they are a popular species to hunt. Bear-baiting for hunting occurs on the Forest, under permit by the WGFD.

In addition to black bears, grizzly bears historically occurred on the Forest, but were extirpated in the early 1900s. Grizzlies may reoccupy the Forest as a result of increased population levels in the Greater Yellowstone Area, though they would be managed against in the Bighorns as mandated by the WGFD management plan, likely through trapping and relocation.

Black bear population levels or trends are largely unknown due to the difficulty in surveying them, though harvest quotas are used as a surrogate similar to mountain lion populations. Populations are estimated to be stable on the Forest.

ENVIRONMENTAL CONSEQUENCES
BLACK BEAR HABITAT

Direct and Indirect Effects

Effects to bears or their habitat from management activities could include an increase in disruption through increased road densities or recreation use, an increase in garbage sources from increased recreation levels (typically causing bear mortality due to human safety issues), and predator removal associated with livestock (sheep) grazing. These effects are currently thought to be minor on overall populations. As recreation levels will likely increase regardless of alternative, the Forest added an additional guideline in the Revised Plan (see recreation – general) to address this issue, and the Forest continues to work with the public in association with the WGFD in educating the public regarding bear interactions and food/refuse management.

Road densities, and therefore potential human disturbances, may be greatest under Alternatives A and E, and least in Alternative C, followed by B and D. There is no known threshold of road densities that eliminates black bear use of habitat, though research shows a preference for lower road density areas (Kasworm 1990). Research conducted for grizzly bears indicated that densities greater than one mile per square mile were detrimental (McLellan and Shackleton 1989). Many areas on the Forest have a low road density, as indicated by the undeveloped nature of the Forest. Approximately 53% of the Forest is in roadless areas as defined by the 2003 inventory combined with the Cloud Peak wilderness. There are also higher densities in areas where past timber harvest has occurred.

Livestock grazing may continue to affect some forage sources for the bear, though this would not vary by alternative, and management of this use is likely to improve over time through application of forest-wide standards and guidelines in the Revised Plan. Sheep grazing is at a historical minimum for the Forest, and removal of bears in protection of this use (predator control) is considered minimal.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for bears, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions and increased recreation use (OHV, demographics) are most significant. Any increase in road densities typically reduces habitat potential for black bears as they prefer more secluded areas.

Bears also occur on lands adjacent to the Forest, where human interaction leads to some displacement as impacts to human safety, or ranching, or bee-hives may be of concern. None of these mortality sources are likely to affect populations on the Forest, however.

As discussed for other wildlife species, impacts from loss of native vegetation due to non-native species would also have an effect on bears and their habitat. Loss of habitat is likely to increase under all alternatives, though increased road construction in Alternatives A and E could result in additional risks. Weed expansion from private lands via livestock and wildlife would continue as a risk in all alternatives.

Black bear populations would likely continue to be stable, with climate (forage availability) and hunting being the largest factors determining trends.

Affected Environment
Upland Game Bird Habitat

Upland game known to occupy the Forest include the wild turkey (Merriam's, non-native), ruffed grouse, blue grouse, sharp-tailed grouse, gray partridge (non-native), and chukar (non-native). The chukar and partridge are primarily associated with grass and shrub habitats, with the chukar occurring more frequently where rocky areas may occur and in steep canyons, with both mainly on the west side of the Bighorns. The blue grouse is known forest-wide to occupy high elevation conifer sites in the winter, but uses mid-elevation riparian sites in the spring and summer for brood rearing, along with meadows, shrublands, and timber in the fall as foraging sites. Ruffed grouse are located mostly in the northeast corner of the Forest, using primarily aspen and mountain shrub communities, with some use of conifer habitat. The turkey uses a combination of small meadows, shrub sites, and trees (roost sites), primarily only occurring in the southeast portion of the Forest. Sharp-tailed grouse (plains variety) have been known to occupy meadows and shrublands also on the southeast corner of the Forest. The Forest is best known for its role in providing hunting opportunity for blue and ruffed grouse, similar to other NF's in Wyoming.

Population estimates are not available for these species, as they tend to fluctuate largely in response to climate (forage and nestling survival) related factors. All populations are considered to be stable on the Forest, where they occur. Turkey have been observed to be expanding on the Forest, primarily in ponderosa and lodgepole pine habitats, dispersing up riparian corridors.

Environmental Consequences
Upland Game Habitat

Direct and Indirect Effects

While timber harvest can have an affect on turkey habitat if adequate roost trees are not retained, this has not been an issue to date on the Forest, and the turkey is a highly adaptable species. Management guidelines for turkey were included in Revised Plan guidelines (see wildlife section) (CDOW 1993). Wildfire or prescribed fire would have a much larger impact on their habitat, as it tends to be at the lower elevations on the Forest where harvest is minimal. Ponderosa pine that is outside of its HRV due to fire suppression would benefit from habitat restoration as older, mature trees would be retained that would serve as roost trees. Refer to the Brewer's sparrow section above for anticipated levels of treatment by alternative of upland game habitat. Blue grouse also use intermittent meadows and shrublands in addition to conifer forests, with maintenance of these habitats being important. For ruffed grouse, refer to the composition section of the Biodiversity section of Chapter 3 for aspen conditions and effects.

Livestock grazing can affect riparian, meadow, and shrubland cover types that provide habitat for several upland game species. Grazing levels would not vary by alternative, and forest-wide standards and guidelines were updated for all alternatives for this resource use to provide sustainable resource conditions. Cattle grazing may also provide benefits to species such as butterflies or other pollinators, where meadows in lower seral stages may have more occurrences of wildflowers, presuming bare ground is not increased. Grazing may also increase plant vigor in some circumstances, providing improved forage conditions for other species.

While birds are easily flushed due to human activity, they also return readily to habitats from which they displaced. Increasing recreation use may continue to have some impacts, but the most significant effect to these species would be from habitat loss due to roads, should additional roads be constructed in their habitats and other roads not reclaimed as mitigation. Increases in road density could occur in Alternatives A and E.

Cumulative Effects

In general, cumulative effects are assessed for the Forest and the lands adjacent to it within three miles of its boundary. Cumulative effects include the past, present and reasonably foreseeable future actions, as mentioned in the summary of activities table in the introduction to Chapter 3. From this table, for upland game, the past and present activities of vegetation management and roads are the most significant, and the reasonably foreseeable future activities of subdivisions and increased recreation use (OHV, demographics) are most significant.

Wild turkey occur in greater abundance on lands adjacent to the Forest, as do chukar, sharp-tailed grouse, and gray partridge. Effects on these lands from habitat conversion

to urban development or intensive agricultural uses or noxious weeds would have the predominant effect on these species' populations. Turkeys are thriving in cottonwood dominated riparian areas adjacent to the Forest, and many people supplemental feed the birds. The native sharp-tailed grouse may be losing the most habitat of any of the species, as it is likely less adaptable than the others, and holds affinities to strutting grounds for spring courtship. Chukar are able to do well given cheatgrass or other non-native plants, and are likely affected the least. It is unknown to what extent the non-native bird species may be displacing the native gallinaceous birds. Blue grouse are some of the most abundant game bird on the Forest, and likely receive the majority of hunting pressure.

Populations for each of these species would likely remain stable for all alternatives. Species dependent on meadows or early structural stages in forested conditions may benefit from increased timber harvest in Alternatives A and E. Other disease elements such as West Nile Virus may play a role in diminishing populations in the short term.

Summary of Effects to Wildlife from Proposed Management Activities

Effects from Oil and Gas Leasing

Oil, gas, and minerals development can impact wildlife primarily through alteration or destruction of habitat and disturbance (noise and human activity). Disturbance and activity can cause displacement abandonment, increased mortality and reduced reproductive success of some wildlife species (Ingelfinger 2001). Effects are mitigated through land reclamation and through standard lease terms, and standards and guidelines in the revised plan.

Oil and gas development on the Forest is expected to be minimal, and no well drilling is expected in the planning period, based on the BLM Reasonably Forseeable Development Report. Because of this low potential, none of the Alternatives are expected to have an adverse effect on wildlife. Alternative C may have the least potential for impacts to wildlife from this resource use due to the proposed wilderness.

Effects from Locatable Minerals

Potential effects from locatable minerals development are similar to oil and gas leasing. Effects are mitigated through land reclamation and standards and guidelines in the Forest Plan. Locatable minerals are available for exploration throughout the forest, except where specifically withdrawn from mineral entry.

Effects from Fisheries and Riparian Management

Managing fish and riparian habitat includes many techniques, including in-stream structures, riparian plantings, exclosure fences, and bank stabilization. Usually these management tools also result in higher quality habitat conditions for terrestrial wildlife, especially riparian-associated species. Planned activities (based on the first decade) include restoration of streams or riparian areas and restoration or enhancement of lakes and wetlands. While the stream, riparian and lake restorations and improvements may have site-specific positive impacts on riparian associated terrestrial species, there would not be a measurable forest-wide change in the first decade.

Effects from Fire and Fuels Management

Fire and fuels management can have a variety of beneficial and adverse effects on wildlife habitats. The composition, structure, function, and pattern of wildlife habitats on the forest have been influenced by fire historically, with many being fire dependent. Active fire suppression over the last 100 years has also played a role in these communities. Effective control of fire during the last century has resulted in forested wildlife habitats dominated by late-successional stages in low elevation cover types, though fire suppression in lodgepole and spruce-fir has had less effects due to the typically longer fire return interval.

Managing fire and fuels can have a beneficial effect on wildlife habitats by increasing the diversity of vegetation, especially in early successional stages. Fire/fuels management can be used as a primary management tool for improving and stimulating changes in wildlife habitat, particularly in creating early successional conditions that are favorable to big game forage production and other species that require early seral conditions. Fire/fuels management can also have negative impacts on those species requiring dense tree or shrub canopy cover. Alternative B would likely have the most acres of prescribed fire, forested and non-forested, followed by Alternatives D, A, E, and C respectively. While the lands restored, improved, or maintained by prescribed fire may have site-specific beneficial or adverse impacts on terrestrial species habitat, there would not be a Forestwide measurable difference on terrestrial wildlife populations between alternatives.

Effects from wildfire can have both beneficial and adverse effects. A negative aspect of fire is reduction of cover and forage caused by stand replacement fires. Loss of forage is generally short-term in nature. Alternatives with the most potential for larger wildfires would be Alternatives C and B followed by D, A, and E respectively.

Effects from Insects and Disease Management

Forest insects and diseases have always been a natural component of the forest. Along with fire, they are some of the most important disturbance agents that have created the current composition, structures, and pattern of wildlife habitats. The primary insect

species are mountain pine beetles, followed by the spruce beetle and wood-boring insects of aspen. Primary coniferous and deciduous tree diseases include lodgepole pine dwarf mistletoe, Douglas-fir dwarf mistletoe, Armillaria root disease, and several decays and cankers of aspen. Many species of wildlife (such as the lynx, marten, and three-toed woodpecker) depend on snag and downed woody dependent species may benefit most from periods of increased insect and disease activity. Infrequent epidemic levels of activity often resulted in large stand-replacing fires that were part of the ecological processes helping to shape the current ecosystems on the forest. The infrequent epidemic outbreaks can also have negative impacts on wildlife habitats in several ways. Some examples include reductions in standing live biomass for species associated with late-successional and old growth habitats and removal of large areas that provide cover and security habitat for big game species. The alternatives do not differ on predicted levels of endemic insect and disease levels at the forestwide scale.

All alternatives may implement management actions to control, to varying levels, insect and disease infestations, mainly through timber harvesting and thinning. Timber harvesting, thinning, and related silvicultural activities can provide tools for preventing or reducing the risk of small and large insect or disease outbreaks that may have negative effects on wildlife habitats for certain species. No management actions for the control of insect and disease outbreaks are planned, but site-specific control projects may be implemented.

Based on management area allocations, Alternatives E and A have the greatest number of acres where direct suppression would be used and where insect and diseases would be actively suppressed or controlled. Alternatives C and B have the greatest predicted amounts of insects and diseases based on lack of active management.

Effects from Domestic Livestock Grazing

Activities related to domestic livestock grazing can have beneficial and/or adverse effects on wildlife and wildlife habitats, depending on the species. Livestock may utilize dense vegetation, stimulating new growth that increases forage nutrient content and availability, and improving habitat for species that associate with more open habitats. Adverse impacts occur when shrub or grassland communities are grazed to a level that decreases habitat quality for species associated with dense vegetation, including many ground-nesting birds. Social interaction and competition for forage, space, and water can occur between wildlife and livestock, but timing and distribution of livestock can effectively reduce or eliminate the majority of these conflicts. The focus of most grazing effects is typically in riparian areas, which is also where the most wildlife species habitat use occurs.

Domestic livestock grazing would continue to be permitted under all of the alternatives. Livestock management standards and guidelines apply to all MAs that permit livestock grazing, so impacts to wildlife generally will be the same under all alternatives.

Another activity associated with livestock grazing is predator control. Target species on the Bighorn NF are largely the coyote, with very few, if any, black bear or mountain lions taken. Some bobcats can also be potentially killed through non-target trapping impacts. These activities are undertaken by the USDA Wildlife Services. Control activities are currently primarily limited to support of domestic sheep grazing, which is at greatly reduced levels compared to historic levels. Population levels of predators are not affected at the forest-wide scale through these activities, as coyotes rebound plentifully following control activities, and other species are seldom taken. Refer to the Biological Assessment for lynx on potential effects to this species, and ongoing consultation by USDA Wildlife Services.

Effects from Noxious Weeds

Controlling noxious weeds in infested areas will help maintain habitat for wildlife. Noxious weeds can adversely impact herbaceous cover and forage for most species, by replacing native vegetation with species that may have no forage or cover value for wildlife. Control actions are directed by the Revised Forest Plan including general direction to control noxious weed infestations and implement the forest-wide noxious weed plan. It is not expected that any of the alternatives will provide adequate control to halt or reverse the spread of noxious weeds on the Forest, although rates of spread over the long-term should be reduced. The dispersal mechanisms or vectors of livestock and wildlife grazing and browsing, and recreation use would largely be the same for all alternatives. The vector of roads would be greatest in Alternatives A and E.

Effects from Recreation Management

Some types of recreational activities can result in direct loss of wildlife habitat, increase disturbance, and temporary or permanent displacement of species (Joslin and Youmans 1999). Effects on wildlife would primarily be associated with increased disturbance from dispersed recreations. Any expansion or construction of new facilities would involve a loss of habitat, though this is anticipated to be minimal or non-existent for all alternatives, with the exception of a few trails and a highway rest area.

Dispersed recreation, whether motorized or non-motorized, has the potential to disturb and displace some wildlife species. The effects of motorized use and road density on habitat effectiveness and big game hunting have been discussed under the elk security area discussion in this chapter.

Research has shown that snowmobile use has the potential to displace wildlife, can result in habitat loss, and can sometimes lead to mortality (Boyle and Samson 1985; Bury 1978, Dorrance et al. 1975). Behavioral responses can be of both short and long duration (Knight and Gutzwiller 1995). Snowmobiling can also damage non-woody plants, shrubs and saplings, reduce vegetative standing crop, and create changes in species composition, thus resulting in indirect impact to habitats. In general, these effects are small and localized, and are not known to be creating a viability issue for either rare plants or animals, or any of the MIS. There may be some fuel spillage and

small, localized areas where incomplete combustion leads to oil remaining in the area possibly contaminating soil resources or species dependent on them, however there are no known areas of concern currently. Ice dams created by snowmobile creek crossings can also be of concern if runoff patterns of snowmelt are affected, however this is also currently not known to be of concern in any area, as runoff is typically more rapid and under more even thaw conditions to minimize this effect. The greatest impact to wildlife appears to be on those animals that winter under the snow (subnivean) (Boyle and Samson 1985; Bury 1978). Snowmobiling effects from current levels of use were estimated for both the riparian and meadow habitats forest-wide, since these are the primary areas where snowmobiling occurs, with results shown in the following table. Snowmobiling also provides for winter wildlife viewing and research activities, resulting in positive public benefits.

Table 3-83. Acres of riparian and meadow wildlife habitat affected by snowmobiling, estimated in 2003.

Meadow/Grassland Acres	Riparian Acres*
99,578 acres within 0.5 miles of groomed/designated snowmobile routes. (42% of Total)	30,014 acres within 0.5 miles of groomed/designated snowmobile routes. (34% of Total)
35, 489 acres within Cloud Peak Wilderness (no motorized uses) (15% of Total)	15,737 acres within Cloud Peak Wilderness (no motorized uses) (18% of Total)
236, 052 acres total on Forest	88,770 acres total on Forest

* = From riparian inventory on GIS (Girard, 1997)

From this analysis, which assumed that the majority of snowmobiling occurs within 0.5 miles of groomed routes, it is estimated that the majority of these habitat types and wildlife associated with them are not affected by snowmobiling.

Snowmobile use would be allowed to occur under all alternatives, but the amounts and types of use would vary. Where additional wilderness or non-motorized winter recreation (Prescription 1.31) is proposed, there would be less. In order by alternative, snowmobile use would have the most potential in Alternative E followed by A, D, B, and C. In crucial big game winter range (as mapped by WGFD), winter motorized recreation is prohibited between November 15 and April 30 to minimize disturbance to wildlife. The current level of snowmobiling is estimated to increase with loss of opportunity in Yellowstone NP and from an aging population.

Few studies show a good understanding of the direct and indirect effects of recreational disturbance on wildlife (Knight and Gutzwiller 1995). Most studies have focused on overt behavioral responses. Minimal information or research exists that addresses possible impacts at the population or community level. Forest Plan standards and guidelines exist which will help reduce impacts from recreational activities for some

wildlife species (e.g. elk calving and winter range areas, caves, protection of known active and inactive raptor nests).

Effects from Travel Management

Roads and trails can impact wildlife species by direct removal of habitat during construction and reconstruction or indirect loss of habitat associated with increased human use and disturbance associated with the use. This loss is greatly reduced when roads are closed, re-vegetated, or decommissioned. Generally those alternatives proposing the fewest miles of road construction and the most miles of decommissioning pose the least risk to sensitive species and their habitat. Based on this, potential adverse effects to wildlife from travel management from most to least are E, A, D, B, and C. Motorized travel occurring off designated routes is prohibited in all alternatives.

Effects from Timber Management

The direct effects of vegetative management, especially timber harvest, would be an immediate change to the structure and often the composition of the treated areas. Timber management can result in both beneficial and adverse effects on wildlife.

In place of the historical disturbance agents such as fire, insects and diseases, timber management can help retain the diversity of habitats and vegetative composition, structure, and pattern. Timber management and related roading can also result in loss of habitat effectiveness and increase wildlife disturbance and displacement. Cutting of dead trees and snags for firewood following logging can affect the availability of cavities for nesting and security, for snag dependent species.

All alternatives would have some level of timber harvest, although the quantity and objectives for harvesting vary by alternative. Forestwide and Management Area standards and guidelines are designed to reduce adverse impacts to wildlife. Examples of Forestwide direction includes maintaining minimum levels of old growth habitat, snags, and coarse woody debris. Potential adverse impacts from timber management, based on harvest levels from most to least by alternative are E, A, D, B, and C. Alternative B would maintain the approximate current levels of harvest, within which no known emphasis species would likely face a significant loss or modification of habitat. Alternatives E and A would approximately double the current amount of harvest activities, with some risk associated, though suited acres would still remain at less than 30% of the total forested acres. Alternative D may have a slightly higher output than current levels, and this output level is similar though slightly higher than the output prescribed with the ASQ amendment nearly completed in 1994, for which emphasis species, such as elk as an MIS, were a focal element. Alternative C would have less than the current levels of harvest as an output, reducing any perceived risk over current levels of harvest to emphasis species' habitat. Improvement in elk security habitat would likely be most difficult under Alternatives E and A, due to the likely increase in road densities necessary to accomplish timber harvest objectives and public

resistance to road closures or the effectiveness of the closures. Potentials for additional road construction would be least in Alternative C followed by B and D.

There has been concern that the road construction and timber harvest activities conducted on the Forest have occurred in the best or most productive wildlife habitats, as described by gentler slopes and more productive soils. To summarize this potential effect, the table below shows the amount of tentatively suited forested lands, comprised of gentler slopes and good soils, and the portion of those areas designated as suited by alternative, which is a function of the management prescription allocations and forest-wide standards and guidelines.

Table 3-84. Tentatively suited and suited acres by alternative describing effects to wildlife habitat.

	Alt. A	Alt. B	Alt. C
Forested Acres	727,400	727,400	727,400
Tentatively Suited Acres	340,589	340,589	340,589
Suited Acres	271,895	124,521	62,093

Uses and Designations of the Forest

Lands

Introduction

This section addresses those aspects of Forest Service management relating to land ownership, special uses (e.g., communications sites, utility corridors), and rights-of-ways. The Bighorn Forest Plan Revision provides for a variety of special uses across all alternatives. Current major uses are continued through all alternatives.

The demand for the use and occupancy of the Bighorn National Forest continues to grow, with accompanying challenges to permit administration. Use and occupancy of National Forest System lands may be authorized when such use is determined to be in the public interest. Use and occupancy for both non-recreational activities as well as certain recreational activities is approved through the issuance of special use authorizations.

Legal and Administrative Framework

Act of 1866 General Mining Law authorizes rights-of-way across public lands for ditches and roads.

Alaska National Interest Lands Conservation Act, 1980 provides direction for providing access to non-federally owned land within the boundaries of the Forest.

An Act to Repeal Timber-Culture Laws, 1891 authorizes ditch easements across public lands and Forest Reserves.

Organic Act of 1897 provides for rules to regulate occupancy and use of the Forest Reserves.

General Exchange Act of 1922 authorizes land adjustments within Forest boundaries.

Federal Land Policy and Management Act of 1976 updated authority for management of National Forest lands, provided general authority for use and occupancy of Forest lands, required fair market value for uses on the Forest, and repealed sections of many previous acts.

Water Conveyance Act of 1986 amended FLMPA to authorize permanent easements for agricultural water systems.

Occupancy Permits Act (March 4, 1915) authorizes use and occupancy of National Forest land for recreation purposes including resorts and recreation residences.

Key Indicators

Lands

- Number of rights-of-way acquired for roads and trails.

Special Uses

- Number of communication sites.
- Number of lands special use authorizations.
- Miles of utility corridors.

AFFECTED ENVIRONMENT

Land Ownership

Acreage ownership within the boundaries of the Bighorn National Forest are shown in the following table.

Table 3-85. Land ownership on the Bighorn National Forest.

Land Ownership	Acres
National Forest System (NFS)	1,104,978
Other (non-NFS)	7,450
Total	1,112,429

Land Ownership Adjustments, Rights-of-Way, and Access

There are limited opportunities for land ownership adjustments on the Forest due to the intact nature of the National Forest lands. Only a few fragmented non-federal parcels exist within the Forest boundary. Two of these parcels are for reservoir use. Over the past 15 years, the Forest has used purchases, exchanges, donations, and Small Tract Act sales to improve land ownership patterns.

Most funding for purchases would come from the Land and Water Conservation Fund. This is a competitive national fund and is not a reliable source of funding for land purchases on the Forest. In the future, it is expected that most adjustments will be done with land exchanges.

The Forest utilizes the Small Tracts Act (Pub L. 97-465) to resolve land disputes and management problems by conveying, through sale, exchange or interchange, three categories of tracts of land: parcels encroached upon, road rights-of-ways, and mineral survey fractions. All applications must qualify under the guidelines of the Small Tracts Act.

Particularly on the east side of the Forest, lack of public access to the Forest is an ongoing and growing problem as public demands to use the Forest increase. Some private landowners adjacent to Forest boundaries often enjoy nearly exclusive use of nearby National Forest lands through control of public access through their property. Some landowners are reluctant to allow public access and in some cases have been unwilling to negotiate rights-of-way across their property.

However, according to the Social Assessment of the Four County Area, there was a marked variance in opinion among residents of the four counties with regard to providing more roads for access. Out of 14 desired future condition issues, this issue ranked in priority from 6th (Washakie County) to 14th (Sheridan County) with Johnson (12th) and Big Horn Counties (7th) situated in between. As a whole, this issue was ranked 10th out of 14 issues, with a ranking of "1" being the highest priority (State of Wyoming 2002).

The Forest has acquired one right-of-way for road access to National Forest System lands since 1990, achieved through the landownership adjustment program. In 1990, the Forest identified 10-15 priority cases needed to further provide access to the Forest. Further complicating the issue is the fact that when land changes hands as the result of a sale it is often subdivided, making access negotiations more difficult since more landowners are involved.

Special Uses

Special use authorizations are used to authorize occupancy and use of National Forest System lands by federal, state, and local agencies; private industry; and individuals. Several different public laws regulate activities under special use authorizations. The Organic Act of 1897 and the Federal Land and Policy Management Act (FLPMA) of 1976 authorize the majority of the uses. The Occupancy Permits Act of March 4, 1915 authorizes use and occupancy of National Forest land.

Applications for lands special uses are increasing as more people desire to make use of National Forest lands. The demand for the use and occupancy of the Bighorn National Forest continues to grow, making permit issuance and administration a challenge as Forest staff review and process new authorizations for many uses every year. As of May 2003, there were 123 non-recreational special uses authorized. The following table lists the number of permits by type as of May 2003.

Table 3-86. Number of special use permits on the Bighorn National Forest.

Special Uses	Number of Permits
Powerlines	5
Road Easements/Permits	10
Ditches - irrigation	9
Communication Leases	20
Dams / Reservoirs	11
Pastures/corrals	9
Fish Hatchery	1
Telephone Lines	4
Gravel Pits	2
Water Pipelines/spring developments	9
Fences	5
Agricultural Residence	4
Roadside Chapel	1
Wildlife Water Supply	2
Research Area	4
Construction Camps	5
Hydroelectric / FERC Exempt	1
DOT Easements	8
FRTA Easements	3
Stream Gauging Stations	2
Stockwater	1
Weirs	5
Monument	1
Sign	1
Total	123

Source: SUDS (Special Use Data System)
Note: Current as of May, 2003

Grazing permits are addressed in the Livestock Grazing section of the DEIS and corresponding specialist report.

Utility Corridors

Presently, there is one proposed non-priority utility corridor on the Bighorn National Forest as designated in a 1992 Western Regional Corridor Study by the Western Utility Group (WUG). This corridor follows Highway 14 and is not classified as a "priority corridor" in the 2002 Priority Corridor Designation (WUG, 2002). Given that it is a non-priority utility corridor, it would be addressed through the standard permitting

process at a later time if a project were proposed within the corridor. There are no priority corridors located within the boundaries of the Forest. The Forest only designates corridors for transmission lines over 69 kilovolts and for pipelines more than 10 inches in diameter. Local distribution lines and smaller pipelines have not been identified as corridors and are normally located in conjunction with the existing road system or other previously disturbed areas in order to minimize environmental impacts.

Designated Communication Sites

Communication sites are identified in the following table. Any additional sites for commercial or Forest Service use will require approval through the National Environmental Policy Act process and designation by the Regional Forester.

Table 3-87. Bighorn National Forest communication sites.

Site	Used by Forest Service	# Communication Leases
Medicine Mountain	Yes	8
Dome Peak	No	1
Bosin Rock	No	6
Little Goose Peak	No	1
Meadowlark	No	3
Pole Mountain	No	0
Hunter Mesa	Yes	1

Source: SUDS.
Note: Leases are issued to building owners who may rent space to other users.

ENVIRONMENTAL CONSEQUENCES

General Effects

Across all alternatives, the issuance and administration of special use authorizations will continue to provide for a variety of recreation and non-recreation activities on the Bighorn National Forest.

Land Adjustments and Acquired Rights-of-Way

There are approximately 7,450 acres of non-federal lands located within the boundary of the Bighorn National Forest. The Bighorn National Forest's land exchange program is very limited in size and scale as a direct result of the way the Forest itself is situated – very little private acreage exists within the boundaries of the Forest.

The amount of potential and opportunity for land exchanges is not expected to vary by alternative. Across all alternatives, through cooperation with other landowners, the

Forest will emphasize improved landownership and access patterns that benefit both private landowners and the public.

As per a forestwide standard, across all alternatives, the Forest will prohibit motorized access from private land where access for the general public is not available, except by special authorization.

The opportunities for rights-of-way acquisition do not change by alternative. The Forest rights-of-way inventory identified more than a dozen roads and/or trails that need to be acquired to provide improved access to the Forest. However, the most readily obtainable rights-of-way have already been acquired and the remaining rights-of-way needed are more complex.

Utility Corridors

At the current time, there are no utility corridors crossing the National Forest. There is one proposed utility corridor which would follow Highway 14 through the Forest (if implemented) and would not be affected by (nor would it affect) the Wild and Scenic River recommendation of the Tongue River as put forth in Alternatives A, B, and C since the proposed corridor is not located adjacent to the recommended stretch of the Tongue River.

Consistent across all alternatives, new or replacement power lines will be designed to reduce the risk of electrocution to raptors. Also consistent across all alternatives, electrical utility lines of 33 kilovolts or less and telephone lines will be buried unless it is not technically feasible.

Communication sites

The number of communication sites does not change by alternative. Communication sites are identified in Table 3-87. Any additional sites for public use will require designation after appropriate NEPA analysis and approval by the Regional Forester.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered with regard to cumulative effects. The next 15 years are considered the time span for “reasonably foreseeable future” cumulative effects.

The Forest has gained access to one right-of-way for a road since 1990, achieved through the landownership adjustment program. In 1990, the Forest identified 10-15 priority cases needed to further provide access to the Forest.

In terms of reasonably foreseeable future actions, the Forest is working on an approximately 100-acre land exchange proposal involving the City of Buffalo, Tie Hack reservoir and land on a nearby National Forest. This is scheduled to be completed in 2004.

There are no other anticipated reasonably foreseeable future actions specific to a particular alternative that would differ from the other alternatives, for communication sites, utility corridors, or land adjustments and rights-of-way acquisition.

Recreation

Introduction

America's National Forests provide a diversity of outdoor recreation opportunities on over 191 million acres of public lands. As the largest provider of outdoor recreation in the country, the National Forests received over 850 million visits in 1996. National Forests provide a wide spectrum of outdoor recreation opportunities, from the more developed to the most primitive, primarily in a forested setting.

The Bighorn National Forest is located in the Big Horn Mountains of north central Wyoming. It is an isolated mountain range situated between the Black Hills range to the east and the main range of the Rocky Mountains to the west and shares a border with the state of Montana. Interstates 25 and 90 and Highways 14, 14A, and 16 channel traffic around and through the Forest.

Market Area

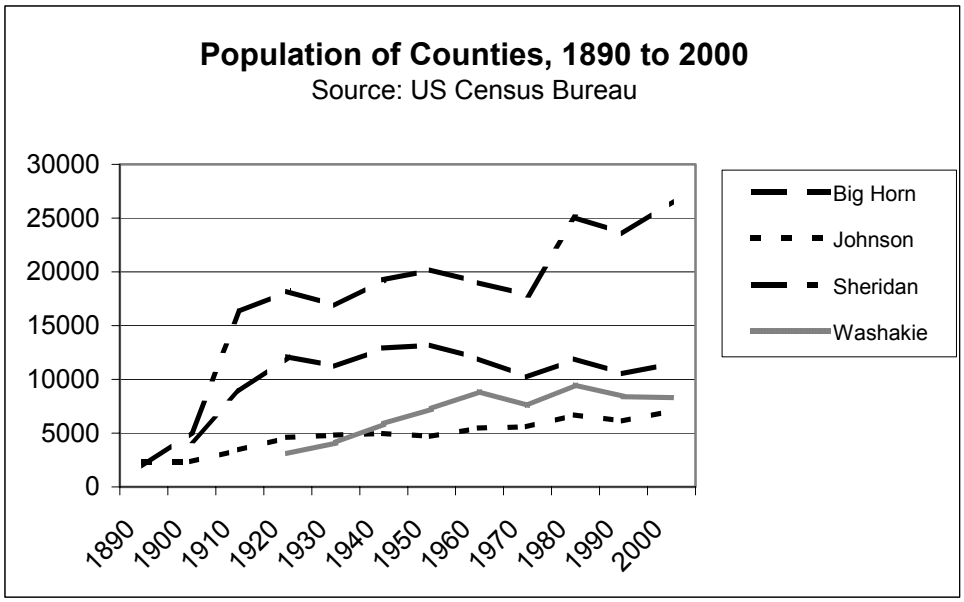
Market area for the Bighorn National Forest can be defined on both a local and national scale. Locally, the market area for the Bighorn National Forest primarily consists of users from the four county area - Big Horn, Johnson, Sheridan, and Washakie Counties. The secondary market consists primarily of a subregional influx of visitors from within several hundred miles of the Forest (e.g., Casper, Gillette, Billings, MT and Rapid City, SD). On a national level, the Bighorn National Forest receives visitors from a much wider geographic area, with a marked tendency towards the Midwest (ND, SD, MN, WI, MI).

According to the 1998 Scenic Corridor Management Plan, most users of the Forest in the spring and early summer are residents of the four-county area. As the summer progresses, visitation by local and non-local users increase, but visits by travelers from outside the area increase at a faster rate. Use is highest during the four weeks between July 15 and August 15, when many of the campgrounds are full. By late August, visits by families, especially non-local families, taper off. Local users are the predominant visitors to the Forest in the late summer and early fall, citing less crowded conditions and hunting season as reasons for coming. Winter use, particularly with regard to snowmobiling, sees a return of a higher proportion of nonlocal users, especially from the Midwest, although local users still remain active recreators on the Forest throughout the winter.

Local Population Trends

Big Horn, Johnson, Sheridan, and Washakie counties contain the entirety of the Bighorn National Forest, totaling 53,435 people in 2001. The population shifts for the four counties have been quite volatile over the past fifty years. On the west side, the ever-changing market for sugar beets along with substantial shifts in minerals, account for some of the fluctuation. On the east side, a downward slide in agriculture has had some impact on population figures, but much of the volatility is due to changes in energy production such as the coal boom in the 1970s for Sheridan and coalbed methane gas production in the late 1990s for Sheridan and Johnson counties.

Figure 3-8. Area county population trends.



Agency Perspective on Recreation in America's National Forests

Recreation participation has grown, and continues to grow with the expanding population. Survey results from the National Survey on Recreation and the Environment (NSRE) estimate that 97.5 percent of Americans 16 years of age or older participated in some type of outdoor recreation in the 12 months prior to being interviewed, which means that almost 202 million people age 16 or older are involved in some form of outdoor recreation (The Interagency National Survey Consortium 2000).

National Recreation Agenda

In response to the growing importance of the National Forests for recreation, the Forest Service, in the spring of 2001, finalized a Recreation Agenda meant to direct recreation management on National Forests into the Agency's second millennium. As stated in the Agenda, "Both our deteriorating infrastructure and our recreation visitors are demanding more attention. This agenda focuses on meeting as much of this demand as possible within ecological and social limits…" including "impacts on the resource, impacts on experiences of other visitors, and limits on the recreation infrastructure… The realities of diverse interests, finite budgets, and environmental considerations will each influence the choices to be made in the management of forest and grassland resources" (USDA Forest Service 2000a).

The Agenda includes direction for Forest managers, some of which are included below:

- Invest in some facilities to meet health, sanitation, and accessibility standards, and at the same time, remove those that no longer meet our needs, are out of tune with the natural setting, present significant health and safety problems, and are too expensive to maintain.
- Manage OHV use to assure high quality motorized opportunities and quality experiences, while maintaining acceptable and balanced environmental impacts on trails, and understanding that some settings are inappropriate for this use.
- Provide access to recreation opportunities, including securing rights-of-way, and incorporating universal design in our facilities.

Unmanaged Recreation – A "Chief's Threat"

In the summer of 2003, Forest Service Chief Dale Bosworth outlined the four primary threats facing the National Forests and Grasslands. One of the four threats was unmanaged recreation. Following are excerpts from his July 17, 2003 speech to the 81st Annual Izaak Walton Convention (Bosworth, 2003):

> "Back when we had light recreational use, we didn't need to manage it so much; but now that it's heavier, we do. There are still uses like blueberry picking that we don't need to manage much. But if every blueberry was picked, we would need to manage it more. At one time, we didn't need to manage mushroom picking much, but now we do in some areas.
>
> "…OHVs are a great way to experience the outdoors, and only a tiny fraction of the users leave lasting traces by going cross-country. But the number of OHV users has just exploded in recent years. Even a tiny percentage of impact from all those millions of OHV users is still a lot of impact.
>
> "…Each year, the national forests and grasslands get hundreds of miles of unauthorized roads and trails due to repeated cross-country use. We're seeing more and more erosion, water degradation, and habitat destruction. We're seeing more and more conflicts between users."

Bighorn National Forest Major Recreation Issues

Issues and management concerns related to recreation on the Bighorn National Forest have increased substantially since the 1985 Plan. These issues were highlighted as a result of numerous public meetings as well as written comments that the Forest received. In summary, the predominant issues related to recreation on the Bighorn National Forest are:

- Motorized users seek additional opportunities while other visitors participating in non-motorized recreation activities demand additional areas free from the sights and sounds of motorized recreation.
- Since 1985, changes in technology have introduced new recreational activities or have expanded recreational opportunities (e.g., ATVs and enhanced capabilities of modern snowmobiles, etc) which have in some cases resulted in increased conflict with existing users.
- As use increases, resource impacts associated with many recreational activities are on the rise, including damage to riparian environments and vegetation in heavily used areas, recreational stock damage, soil compaction, and widening and pioneering of new travel routes, and improper disposal of litter, and human waste.
- Winter sports, snowmobiling in particular, are more popular than originally anticipated, extending the visitor season. There was some demand shown for quiet winter recreation areas which are nonmotorized.

Other Recreation Opportunities Provided by Public Agencies

To grasp the recreation niche that the Bighorn National Forest provides, a comparison with the recreation offerings provided by other public entities is helpful.

Wyoming is 49% federally owned. Federal public land management agencies include the National Park Service, the Bureau of Land Management, the Bureau of Reclamation, and the Forest Service.

Wyoming is home to three firsts – the Nation's first National Forest (Shoshone NF), the first National Park (Yellowstone NP), and the first National Monument (Devil's Tower NM).

The Bureau of Land Management in Wyoming manages over 18 million surface acres of public land and an additional 23 million subsurface acres of mineral estate, including National Forest acres. The agency primarily focuses on providing undeveloped recreation opportunities such as fishing, four-wheeling, sightseeing, river floating, hiking and hunting. Unless otherwise posted, all public lands are available for recreation use.

Established in 1902, the Bureau of Reclamation is best known for the dams, powerplants, and canals it constructed in the 17 western states. The Wyoming Area Office of the BLM manages 20 reservoirs and 19 dams in the state, although the agency

manages recreation facilities (boat launches, etc.) at some of these sites in partnership with either the BLM or state and local government.

The State Parks in Wyoming are premier providers of flat water recreation, working in partnership with the Bureau of Reclamation at some sites. These facilities provide opportunities not available in the higher altitudes of the Forest. Wyoming State Parks also manage the state's Historic Sites, providing a valuable interpretive complement to recreational opportunities in the state.

Wyoming Game and Fish provides public access areas for numerous outdoor recreation opportunities (primarily focused around fish- and wildlife-based activities) along with "an adequate and flexible system for the control, management, protection, and regulation of all Wyoming wildlife" as defined in W.S. 23-1-103.

These various management "niches" all complement one another, serving various clientele and responding to a diverse range of local, regional and national needs.

The Bighorn National Forest's Recreational "Niche"

The Bighorn National Forest, as part of the regional and national network of National Forests, provides a complimentary offering of recreation opportunities to many of those listed above. The predominant recreational "niche" of the Bighorn National Forest encompasses nature-based, developed and dispersed recreation in a forested environment, including undeveloped settings but also built environments protecting and reinforcing natural character, and wild land settings that complement enjoyment of special places (USDA Forest Service, 2003).

Some features that are particularly distinctive to the Bighorn National Forest when compared to other National Forests in the area include the Forest's easily accessible terrain for winter and summer motorized travel (due to its numerous open parks set within a predominantly rolling terrain) which creates both opportunities and challenges for management; numerous opportunities for interpretation of nationally significant cultural phenomena from the last vintage of free-roaming Plains Indian groups; and easily-accessible high-elevation (i.e. long season) winter recreation areas areas in a scenic montane setting in a location that allows for easy access to a multi-state clientele.

Legal and Administrative Framework

Department of Agriculture Organic Act of 1862 (7 U.S.C. 2201).

The Multiple-Use Sustained-Yield Act of 1960 (74 Stat 215; 16 U.S.C. 528).

The Wilderness Act of September 3, 1964 (78 Stat 890; 16 U.S.C. 1121).

The Land and Water Conservation Fund Act (Act of September 3, 1964) (16 U.S.C. 4601-4).

Architectural Barriers Act of 1968 (Act of August 12, 1968).

National Trails System Act of 1968 (Act of October 2, 1968).

Forest and Rangeland Renewable Resources Act of 1978 (16 U.S.C. 1600).

Americans with Disabilities Act of 1990 (Act of July 26, 1990).

Key Indicators

The amount and range of opportunities based on the Recreation Opportunity Spectrum (ROS).

Resource Protection Measures

Mitigation measures to reduce or prevent significant effects of developed and dispersed recreation on the resource are outlined in the standards and guidelines for recreation and other resource activities. Impacts to the recreation resource itself through management actions can be addressed by manipulation of site-specific factors at the project level, which involve a level of detail not associated with Forest Plan Revision.

AFFECTED ENVIRONMENT

Current Recreational Use and Management of the Bighorn National Forest – An Overview

The Big Horns are a popular travel-through route between the Black Hills National Forest and Yellowstone National Park. In 1985, there were 2,226,159 visitors to Yellowstone, increasing to 2,838,233 visitors in 2000. This represents an increase of 27% or an average of 1.8% annually, although use has fluctuated during the past fifteen years.

Prior to the 1960s, management of recreation activities and opportunities on the Bighorn National Forest was largely custodial in nature. As recreation use increased, the Forest assumed a more active management role. However, while there has been marked growth in recreational activities on the Bighorn National Forest dating back to 1989, Forest Recreation Use Data (FRUD) have shown that growth, while still occurring, has slowed in more recent years (post-1993).

Historically, the Forest Service has reported visitation not in terms of direct numbers of people who come to the Forest, but in terms of a Recreation Visitor Day (RVD) which is defined as any recreational use on Forest sites which results in 12 visitor hours. This information is recorded for all recreational activities in an attempt to determine not only how many people are visiting but also what they do when they are there. According to FRUD, from 1989-2000, numbers of total RVDs on a forest-wide basis for all activities fluctuated from a low of 1,295,100 in 1989 to a high of 1,712,800 in 1998. RVDs increased by 26% (340,000 RVDs) with an annual average increase of approximately 2.3%.

In 1990, all three major highways crossing the forest (US14 – Bighorn Scenic Byway, U.S. 14A-Medicine Wheel Passage, and U.S.16-Cloud Peak Skyway) were designated as National Scenic Byways.

National Visitor Use Monitoring Survey Results

Between October 2000 and September 2001, the National Visitor Use Monitoring Survey was conducted on the Bighorn National Forest. Some survey findings are discussed in the following paragraphs.

- The average length of stay for recreation visitors was 16.4 hours, with visitors going to an average of 1.3 sites (i.e. campsites, picnic areas, trails, interpretive centers, resorts, etc.) during their visit. The average length of stay in the Cloud Peak Wilderness was 35.4 hours. Twenty three percent of visitors stayed overnight. Average length of stay at developed sites was 1.4 hours.
- Eighty percent of visitors during the reporting period were Wyoming residents from within the local area, 10% were Wyoming residents from outside of the local area, and 10% were nonresidents (English, 2004):
- Basic descriptors of Forest visitors were also gathered. Males accounted for 62% of visitors, with females accounting for 38%. A high percentage (73%) of visitors were between 21 and 60 years of age, with the most visitors being between the ages of 41 and 50 years of age. Visitors categorized themselves into one of five race/ethnicity categories, the top four categories being 97.6% being white, .4% Spanish, Hispanic or Latino, .3% were American Indian/Alaskan native, and .1% were Asian.

According to the NVUM survey, the key factors of importance to both local and nonlocal visitors with regard to the quality of their recreation experience was (in order of preference): scenery, condition of the natural environment, attractiveness of the Forest landscape, and available parking/condition of Forest roads/adequate signage.

It is worthwhile to contrast the priorities placed by visitors to the Bighorn from a national scale with those of local users. In 2000, the Bighorn National Forest Social Assessment surveyed residents of the hour-county area in an attempt to obtain Plan-relevant social information. One of the results of this survey was a ranking of public benefits provided by the Bighorn National Forest:

1. Water
2. Future use
3. Wildlife
4. A place to relax
5. Support traditional ways of life
6. Recreation
7. Timber
8. Grazing
9. Minerals

Recreation-related expenditures

Outdoor recreation expenditures contribute significantly to Wyoming's economy. Tourism in Wyoming is the second largest industry behind minerals. The National Visitor Use Monitoring for the Bighorn National Forest determined that in a typical year, visitors to the Bighorn National Forest spent an average of $2341.80 on all outdoor recreation activities, including equipment, recreation trips, memberships, and licenses (USDA Forest Service, August 2001).

The economic section of this DEIS discusses in greater detail, within a 2001-2010 timespan, the economic benefit of Bighorn National Forest recreation specific to tourism (i.e. from visitors outside of the four-county area).

Recreation Supply

Recreation Settings

Some people desire an emphasis on undeveloped, remote recreation settings, while other people want a mix of developed and undeveloped settings and yet others are interested in seeing more developed settings and easier access. The resource manager's goal is to provide an appropriate mix of recreation settings or recreation opportunities, as appropriate, for obtaining each of these experiences.

The Forest Service uses the Recreation Opportunity Spectrum (ROS) to describe different recreation experiences using the setting, activities, and the experience. These experiences are categorized into ROS classes.

In 1992, the Forest updated the original 1979 ROS inventory used in the 1985 Forest Plan to reflect changes in the land resource for the Forest Plan ASQ Amendment. The new inventory included differences based on new road development, new timber sales and other facility construction, management area prescriptions that dictate specific ROS classes, refinement of the Wilderness boundaries, and the incorporation of the "Roaded Modified" subclass of "Roaded Natural." In 1998, the 1992 map was updated in anticipation of revision of the Forest Plan.

The following ROS classes and acres have been identified on the Bighorn National Forest:

Primitive (P)

181,232 acres (16%); 137,707 wilderness acres and 43,525 non-wilderness acres

These areas are primarily unmodified with a very high probability of experiencing solitude, freedom, closeness to nature, tranquility, self-reliance, challenge and risk. There is a low likelihood of encountering other users. Access and travel is nonmotorized on trails or cross country.

Semi-Primitive Nonmotorized (SPNM)

278,108 acres (25%); 54,189 acres Wilderness and 223,919 non-Wilderness acres

Acres in a semi-primitive nonmotorized class are in a natural appearing environment with a high probability of experiencing solitude, challenge and risk. There is a low probability of encountering other users, but there may be evidence of other users. Access and travel is nonmotorized on trails, some primitive roads or cross-country.

Semi-Primitive Motorized (SPM)

372,549 acres (33%); all non-wilderness acres

The setting is in a predominantly natural appearing with two-track roads and/or motorized trails. These areas provide for a more solitary experience with a high degree of challenge and risk in using motorized equipment. There is a low concentration of users, but often evidence of others on trails.

Roaded Modified (RM)

106,532 acres (10%); all non-wilderness acres

This class is a sub-class of the Roaded natural class and was not used in the 1985 Plan. These areas are located where concentrations of roads occur due to past timber harvest. The environment is substantially modified except for campsites. Roads, landings, slash and debris may be strongly dominant from within yet remain less noticeable from distant sensitive roads and highways. There is opportunity to get away from others, but with easy access. There is some self-reliance in building own campsite and use of motorized equipment, but little challenge and risk. There is moderate evidence of other users on roads and little evidence of others or interaction at campsites. Conventional motorized access includes sedans, trailers, atvs and motorcycle travel.

Roaded Natural (RN)

140,393 acres (13%); all non-wilderness acres

The environment is mostly natural appearing, as viewed from sensitive roads and trails. These areas are mainly found around developed sites where the forested environment is managed to meet the needs of the visitor. They provide scenic driving opportunities, trailheads, dispersed campsites, and wildlife viewing, fishing, and hunting areas. Access and travel is motorized including passenger cars, trucks, RVs and some motorhomes.

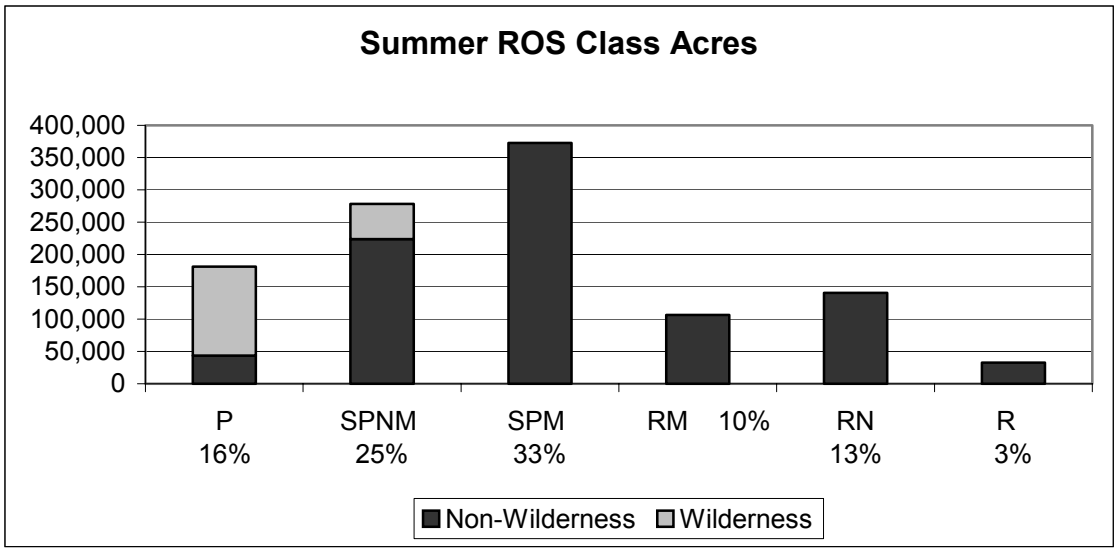
Rural (R)

32,544 acres (3%); all non-wilderness acres

This class provides highly developed opportunities, specifically along the scenic byways (US14, US14A, US16). Use levels are high, development of facilities provides for greater numbers of visitors than other areas on the Forest, management is more obvious, and visitors can expect opportunities to interact with others.

The following chart displays the acres of summer ROS classes on the forest.

Figure 3-9. Summer Recreation Opportunity Spectrum class acres.



General Recreation Use Trends

The concept of "demand" represents what could occur in the way of future Forest visitation. It portrays the desires of the public for recreation opportunities. "Demand" is not necessarily the same as "use," which is generally thought of as what actually occurs if demand is satisfied. In other words, "use" is influenced by available supply or capacity. For example, a campground may accommodate 50 people because of its design limitations. If it were full with campers, its use would be recorded as 50. However, if 100 people wanted to camp, but only 50 could, the "demand" for that particular recreation would instead be recorded as 100.

The four-county area that includes the Bighorn National Forest has experienced some significant fluctuations in population over the past 25 years, due to booms in oil and gas production, among other things. The state of Wyoming estimated that by 1995, the population of the four counties will have nearly recovered the gains made in the 1970s. In addition, population forecasts for the period of 2000 – 2010 predict further steady increases resulting in an increase of approximately 0.5% each year (State of Wyoming, 2002). The current development associated with coalbed methane activities may further contribute to population growth and is described in additional detail in the cumulative effects section. It is difficult to predict exactly how increased local population will affect visitation on the Forest, but it is likely that as local populations increase, so too will Forest visitation.

Other influences include trends that are occurring in terms of visitations to other regional attractions that require them to pass through the Bighorn National Forest on their way to other destinations. All Wyoming, South Dakota, and Montana destinations that summer visitors cited as their primary destination expect to experience increased use over the next ten years.

National trends in outdoor recreation also have the potential to affect Forest visitation. Recreational use of forests and grasslands has been increasing for decades, and is expected to continue to increase. The most popular activities at the national level are walking, nonconsumptive wildlife activities (birdwatching, etc.), biking, sightseeing, non-pool swimming, fishing, family gatherings, and picnicking. The five fastest-growing outdoor recreation activities at the national level through the year 2050 are projected to be: visiting historic places, downhill skiing, snowmobiling, sightseeing, and participating in nonconsumptive wildlife activities.

In comparison to the national statistics on most popular recreation activities, the NVUM reported that the top five recreation activities reported by the visitors to the Bighorn National Forest during the period of October 2000 through September 2001 were viewing natural features, viewing wildlife, relaxing, hiking/walking, and driving for pleasure.

Recreation use on the Forest between 1989 and 2000 has been increasing at an overall average rate of 2.3% annually. Original estimates in the 1985 Forest Plan were based on local population trends and a static marketing program in the Big Horn Mountain area. The updated estimates take into account historical growth patterns (Bighorn RVD data) adjusted to reflect national projections by activity (Bowker, English, Cordell).

Table 3-88 Bighorn National Forest total recreation visitor days projections.

	All Activities
Decade	**Total MRVDs**
2000 Base Year	1648.8
2000-2005	1705.0
2006-2015	1826.9
2016-2025	1962.7
2026-2035	2114.6
2036-2045	2284.5
2046-2055	2475.2

Note: One MRVD constitutes 1000 RVDs.
Source: FRUD

Several future trends can be suggested from this information such as that growth over the next five decades will steadily increase, with variations of both decreasing and increasing use in various activities. As a result, it is likely that some of the use areas that are already

receiving high levels of use will be increasingly unavailable and less popular areas that currently receive less use may be forced to accommodate the displaced visitors.

In 1998, a Scenic Byway Corridor Management Plan was completed. The plan asked both general visitors and campground users whether or not they had experienced crowding while engaged in any activities on the Bighorn National Forest. Of those responding, 70% indicated "no" and 27% indicated "yes." The areas most frequently identified by those who indicated they had experienced crowding were the following: Sibley Lake (9 responses), "campgrounds (6), "everywhere" (4), Sitting Bull campground (2) and Medicine Wheel (2) (Edaw, Inc. 1998)

Developed Recreation Supply

Developed recreation opportunities are located primarily along major travelways. They include such activities as camping at developed campgrounds, picnicking, visiting resorts, interpretive sites, recreation residences (under special use permit), boat landings, and organizational camps.

There are 89 developed sites on the Forest totaling 6,243 PAOTs (persons at one time capacity), with a season site capacity of 871,918 PAOT days. The following table displays developed recreation capacities in greater detail:

Table 3-89. Developed site capacities.

Developed Site Type	Total # of Sites	Total PAOTs	Season-long Capacity (PAOTs)
Campgrounds (504 campsites total)	37	2,520	264,360
Picnic Grounds	16	925	113,190
Trailheads	11	1,001	165,610
Warming Huts/Nordic Parking Areas	5	102	27,463
Interpretive Sites	10	1,295	226,695
Other Sites (boat landings, RV dumps, etc)	11	400	74,600
Subtotal	89	6,243	871,918
Developed sites under special use permit	281	3,147	822,224
Total Sites	370	9,390	1,694,142

Individuals operate 281 sites under special use permits within the Forest, including two downhill ski areas. These areas have a total site capacity of 3,147 PAOTs and a season capacity of 822,224 PAOT days. (additional information found in recreation special uses section). Combined, there is a total of 370 sites, 9,390 PAOTs and a season capacity of 1,694,142 PAOT days.

Due to fiscal constraints, very few new developed recreation sites have been built since the mid-1960s. Beginning in 1993, the Forest upgraded several of the facilities to better accommodate modern recreational vehicles, although more upgrades are still needed. A significant determining factor as to whether or not a campsite can accommodate today's larger RVs and trailers is spur length. A reasonable spur length that can accommodate the majority of today's modern RVs is 50 feet. Slightly more than one third of the Bighorn National Forest's campsites are able to accommodate a large, modern RV based on a minimum necessary spur length of 50 feet.

All but four campgrounds are managed through a concessionaire program. The season is generally from May to September with many campgrounds open only during a portion of May and September.

Major interpretive experiences are available at three sites: Burgess Visitor Center on US Highway 14, Shell Falls Visitor Center on US Highway 14, and Medicine Wheel National Historic Landmark on US Highway 14A. Preparations are underway for the redesign of Shell Falls to improve access and amenities, but no increase in capacity is feasible given the constraints posed by the fact that the facility is located between a U.S. Highway and a canyon. The Medicine Wheel site was recently redesigned, although concerns related to recreation capacity at the Medicine Wheel site are subordinate to the National Forest's Medicine Wheel Historic Preservation Plan, signed in 1996, which directed that this area be managed in a manner which protects the integrity of the site as a sacred site and a nationally important traditional cultural property (USDA Forest Service 1996).

Table 3-90. Major interpretive site capacities.

Site	Yearly Operating Days	Capacity - PAOTs	Season-long cap PAOTs
Burgess	147	605	88,935
Shell Falls	179	250	44,750
Medicine Wheel	153	80	12,240
Total	479	935	145,925

Trailheads are discussed in the dispersed recreation section under "trails."

Developed Recreation Demand and Trends

Demand for developed recreation opportunities is expected to continue to rise. From 1989-2000 developed recreation accounted for 29 percent of the total Forest RVDs and increased at an annual average of 2.57 percent. Original estimates in the 1985 Forest Plan have been updated and revised using historical growth patterns (Bighorn RVD data specific to developed recreation) adjusted to reflect national projections by activity (Bowker, English, Cordell).

Table 3-91. Projected demand for developed recreation (excluding downhill skiing).

Decade	Total MRVDs
2000 Base Year	473.1
2000-2005	489.8
2006-2015	525.3
2016-2025	564.0
2026-2035	606.0
2036-2045	651.5
2046-2055	701.0

Forestwide trend data indicates that demand for developed site camping is likely to increase 31% by 2055, as shown in the table below.

Table 3-92. Projected demand for camping at developed campgrounds.

Decade	Total MRVDs
2000 Base Year	73.6
2000-2005	75.4
2006-2015	79.1
2026-2025	83.1
2026-2035	87.3
2036-2045	91.8
2046-2055	96.5

Based on concessionaire records for 2002, campground usage rates amounted to 26.5% of forestwide theoretical PAOT capacity. In 2003, it increased slightly to 27.3% of forestwide theoretical PAOT capacity. While this does not exceed a theoretical campground capacity of 40% of maximum, this is a season-long average and includes times of the year when campground demand is lower since use fluctuates depending on the month.

To get a better overall picture of campground demand, it is important to look at how many campgrounds are experiencing high levels of use, as well as the timing of the use. The table below illustrates how many campgrounds, by month, experience average occupancy rates higher than 40% of theoretical capacity.

Table 3-93. Bighorn National Forest campgrounds with high (>40% of theoretical capacity) average monthly occupancy levels (1998-2001).

Month	# Campgrounds	% of campgrounds*
May	3	12%
June	5	20%
July	23	92%
August	19	76%
September	9	36%

* Table includes the 25 concessionaire-run campgrounds only.

The occupancy levels in July and August show there are not enough developed camping opportunities during the short, high use season. This indicates that people are likely being turned away and that demand as expressed by use is probably being under-reported to some degree.

Table 3-94. Bighorn National Forest campgrounds with low (<10% of theoretical capacity) average monthly occupancy levels (1998-2001).

Month	# Campgrounds	% of campgrounds*
May	4	16%
June	3	12%
July	3	12%

* Table includes the 25 concessionaire-run campgrounds only.

As mentioned previously, most of the developed campsites on the Forest were designed prior to the advent of today's larger, modern trailers or RVs. Some have been upgraded as funding has become available. The trend toward large, self-contained camper homes has been a relatively recent phenomenon, which only a minority of facilities can accommodate. Concessionaire records from the 2002 camping season are shown in the following table.

Table 3-95: 2002 Campsite use types.

Category	% of 2002 campsites occupied
Motorhome	16%
Tent	36%
Trailer	48%

* Table includes the 25 concessionaire-run campgrounds only.

Nationally, participation in picnicking is expected to increase by at least 1% per year by 2020, amounting to a total 62% by 2050 years (Bowker, English et al. 1999). This is in

line with Bighorn National Forest FRUD projections which predict a total increase in picnicking of 67% by 2055.

Among the major interpretive sites on the Forest, the Burgess Visitor Center had an average of 55,000 visitors per year (1997-2002) with a 10% increase between 1997 and 2002, although since Burgess is a relatively new facility it is likely that visitor levels are continuing to rise compared to early operational years. Shell Falls had an average of 350,000 visitors per year and that number has remained fairly constant from 1997 to 2002. Medicine Wheel National Historic Landmark had an average of 15,536 visitors per year, remaining fairly constant between 1997 and 2002.

Based on growth trends for developed recreation on the Bighorn National Forest, usage at the Burgess Visitor Center should not exceed capacity during the next planning period. Shell Falls, on a sheer PAOT basis, is already exceeding capacity in theory but expansion of number of parking spots available (which is the primary limiting factor here) is not feasible given the terrain and proximity of the site to the highway, in addition to the fact that the average visitor stays at Shell Falls for a relatively short period of time. The Medicine Wheel National Historic Landmark is slightly exceeding capacity, although use trend records over the last ten years (1993 - 2003) indicate visitation has stabilized at an acceptable level consistent with the management goals set in the Medicine Wheel Historic Preservation Plan (1996).

Developed Recreation – Issues

While a popular component of the Bighorn National Forest's recreational experience, developed facilities are a large investment for the American public, requiring regular maintenance and labor-intensive upkeep. Although the Forest strives to upgrade existing campgrounds, outdated facilities are still commonplace. Deferred maintenance costs accelerate as facilities age. In 2002, estimated deferred maintenance for developed sites exceeded $2 million on the Forest. This estimate takes into account annual maintenance requirements and capital improvements, as well as accessibility upgrades. While many campgrounds continue to exceed acceptable levels of capacity at various times of the season, unfortunately, any need for additional facilities is overshadowed by a shortfall in maintenance and rehabilitation funds for existing facilities and the high cost of construction around the forest.

The fact that many campgrounds are approaching or exceeding acceptable capacity levels during peak times of the summer season may be contributing to both use and proliferation of dispersed campsites, resulting in associated impacts to water and soil resources.

The National Recreation Agenda advocates closing under-used facilities. "Under-used" was not defined in the Agenda but the earlier table displaying average monthly occupancy levels of less than 10% could be a useful starting point for future, more detailed analysis that could potentially be part of Forest facility master planning activities.

Use by the elderly is likely to increase proportionately faster than other demographic groups given the national aging phenomenon. As visitation increases and the state and national population ages, there is also likely to be an associated increased demand for recreation opportunities on the developed side of the ROS. Examples of sites where demand could increase markedly include interpretive sites and picnic areas.

Dispersed Recreation Supply

Dispersed recreation includes all those activities that occur outside of developed sites (i.e., campgrounds, picnic areas, visitor centers, etc) and Wilderness. Particularly popular dispersed recreation activities include dispersed camping, fishing, hunting, driving for pleasure, hiking, horseback travel, all terrain vehicle and motorcycle use, and viewing wildlife.

From 1989 to 2000, dispersed use accounted for 70% of the total Forest RVDs and increased at an average of 2.25%. All activities identified as "dispersed use" increased during this period except fishing, which remained generally constant.

Many nearby areas off the Forest provide hunting opportunities for deer, antelope, and small game. By comparison, local public opportunities for elk, moose, and lion hunting are found almost entirely on the Forest. Quality fishing opportunities are available in areas off the Forest, but occur in different settings and sometimes for different fish species than those which are found on the Forest.

Several caves are located within the Forest, four of which have been determined significant, as defined and described in the Federal Cave Resources Protection Act, of 1988. One of these caves, Tongue River cave, receives a tremendous amount of recreational use due to its relatively easy access and close proximity to several communities.

Two activities in particular deserve special mention: dispersed camping and off-highway vehicle (OHV) use.

Dispersed camping is defined as anyone who stays overnight in the National Forest outside of developed facilities. Use usually involves a temporary shelter (tent, van, pickup camper, recreational vehicle, etc.). Campers select a location that meets their needs, erect their own accommodations and often use the "site" as a central base camp for participation in other outdoor activities. Attributes or qualities of the site's location (e.g. nearby stream, scenery, ease of access, vegetation, topography, etc.) help to determine a site's popularity among campers. These attributes explain why so many of the Bighorn National Forest's approximately 3,000 dispersed campsites (outside of wilderness) are located along waterways. These sites are finite in number and often located in a fragile (riparian) ecosystem.

According to the 1999 Bighorn National Forest monitoring report, 20% of the inventoried dispersed campsites did not meet 1985 Forest Plan standards and guidelines (i.e. they were not Frissell Condition Class 1-3).

The following chart displays those campsites by geographic area.

Table 3-96. Dispersed campsites by geographic area (outside Cloud Peak Wilderness).

Geographic Area	# sites	% of Forest total
Tongue	633	21.1%
Goose Creek	490	16.4%
Clear/Crazy	484	16.2%
Tensleep	335	11.1%
Little Bighorn	254	8.5%
Shell	247	8.3%
Devil's Canyon	241	8.1%
Paintrock	162	5.4%
Piney/Rock	146	4.9%
Total	2992	100%

There are an additional 1,387 dispersed campsites that were inventoried in the Cloud Peak Wilderness in the mid 1980s.

Off-road vehicle (ORV) use use has experienced significant growth in popularity on the Bighorn National Forest since the beginning of the current planning period. Participation in this activity depends on a system of roads or trails for primary access. Transportation is by a motorized vehicle (for the purposes of this discussion this category includes use by ATVs, snowmobiles, or motorcycles). The term ORV is being used for purposes of this discussion even though the literal meaning of "ORV" (off-road vehicle) is not entirely an appropriate descriptor of use related to the Bighorn National Forest since under plan revision (under all alternatives), motorized travel will be restricted to system roads and trails – in other words, no off-route travel will be allowed.

There are over 700 miles of system trails open to ORVs, 286 miles of which are snowmobile trails. Trails are discussed in greater detail in the "Trails" section below.

While motorized travel on most of the Bighorn National Forest is currently restricted to system roads and trails, there are currently four remaining "C" areas designated on the forest travel map which allow travel off of system roads and trails provided that such travel does not inflict damage to the land. These "C" areas are described in the table below:

Table 3-97. Bighorn National Forest "C" areas.

Existing C Areas	Acres
Med Wheel/Paintrock District - general vicinity of Horse Creek Mesa	30,203.96
Tongue District - general vicinity of Woodrock	23,867.96
Powder River District - general vicinity of Hazelton Peaks area	22,859.98
Powder River District - general vicinity of Elgin Park	46,653.23
Total Existing C Area Acres	123,585.10

Trails - Supply

Forest system trails provide the means of access for many dispersed recreation activities. The Forest has approximately 1,158 miles of combined winter and summer trails with 143 miles within the Cloud Peak Wilderness, including 12 miles of National Recreation Trail (Bucking Mule Falls). This mileage also includes groomed snowmobile and ski trails. There are a total of 11 developed trailheads with a capacity of 1,001 PAOTs. The majority of trailheads are undeveloped with no facilities, some with spacious area for parking, others with limited parking area.

Motorized system trails include those trails where ATVs and/or dirt bikes are acceptable uses. There are over 432 summer miles open to motorized vehicles. Nonmotorized trails include those trails for hiking, horseback riding and mountain biking. There are 399 miles of summer nonmotorized trail miles on the Bighorn National Forest. Total miles includes miles of trail added to the Forest trail system with the 1997 Little Goose/Park Reservoir decision on the Tongue Ranger District and miles of trail in the Cloud Peak Wilderness. The following table displays approximate trail miles on the Bighorn National Forest.

Table 3-98. Bighorn National Forest trail system mileage.

Use Type	Snow Trails	Non-snow Trails
Motorized	286	432
Non-motorized	41	399
Totals by Snow/Non-snow	327	831

Snow and non-snow trail miles shown in the above table are not exclusive of each other. In other words, some but not all of the 327 miles of snow trails are also used as summer trails, in part because some snowmobile trails are located in wet areas and are not suitable as summer trails due to the high potential for resource damage that can occur when the ground is not frozen.

The following table shows allocation of snowmobile trails within the Forest by county.

Table 3-99. Forest snowmobile trail miles by county.

County	% of total snowmobile trail miles
Big Horn	38%
Sheridan	37%
Johnson	20%
Washakie	5%

Trailheads are an important point of access to the Forest's trail network. Currently, the majority of trails (634 miles) are not accessed by a developed trailhead, although these facilities attract a large share of the overall users. Trailhead use is generally split unevenly between weekend and weekday, but the following table provides an average.

Table 3-100. Summer use developed site trailheads and associated trails.

Trail Name and Trailhead Location	Nonmotorized Trails outside Wilderness (miles)	Wilderness Trails (miles)	Motorized Trails (miles)	Capacity (PAOT)*	Season-long Capacity**
Bucking Mule Falls	12.0	0.0	2.6	90	12,510
Coney	5.6	1.8	0.0	80	11,120
Battle Park	0.9	6.4	18.5	75	9,300
Circle Park	2.4	13.0	0.0	70	11,550
Edelman	0.6	5.6	0.0	50	6,200
Hunter	26.7	22.7	1.8	133	21,945
West Tensleep Lake	3.6	17.5	0.0	250	34,750
Elgin Park	2.6	0.0	9.3	70	11,550
Paintrock Lake	0.0	8.3	13.9	60	7,440
Coffeen Park	1.0	20.1	0.0	25	3,475
Total	55.4	95.4	46.1	1,001	129,840

*PAOT Capacity is defined as 3.5 people at one time per parking site.

**Season-long Capacity is PAOT capacity multiplied by number of days in a season.

Access issues have been a continuing concern of the public. This is discussed in additional detail in the Lands section of this chapter.

Dispersed Recreation Demand and Trends

Demand for dispersed recreation opportunities is expected to rise. From 1991-2000 dispersed use increased at an average of 2.25 percent annually. Original estimates in the 1985 Forest Plan have been updated and revised using historical growth patterns (Bighorn RVD data specific to dispersed recreation) adjusted to reflect regional projections by activity (Bowker, English, Cordell).

Table 3-101. Dispersed recreation use projections.

Decade	Total MRVDs
2000 Base Year	1,096.5
2000-2005	1,132.5
2006-2015	1,211.2
2026-2025	1,299.9
2026-2035	1,400.2
2036-2045	1,514.1
2046-2055	1,643.5

Source: FRUD

Use projections based on a combination of historic forest RVD data and national projection indices by Bowker et al. (1999) predict that by 2055 dispersed nonmotorized recreation will increase by 128%; dispersed motorized recreation will increase 24%; big game hunting will increase 31%; fishing will increase 1%; and non-consumptive wildlife recreation will increase 150%.

According to the Social Assessment of the Four-County Area, favorite activities among local residents included (in order of ranking): fishing, camping/picnicking, hunting, enjoying the scenery, and hiking/backpacking.

The Rocky Mountain region is expected to experience an increase in hunting participation though 2050 even though hunting participation has declined 7% nationwide in the past decade – this is likely due to the fact that the Rocky Mountain Region is largely a rural region and rural Americans are more likely to be hunters (CSF 2003) in addition to the fact that this region is rich in public lands acreage and will be attractive to users from other areas. It is also important to realize that "hunting" is not an exclusive category – among anglers, hunters, and wildlife watchers, there is a considerable overlap in activities. In 2001, 71% of hunters also fished, and 27% of anglers hunted. In addition, 58% of anglers and 62% of hunters participated in wildlife-watching activities, while 33% of all wildlife watchers reported hunting and/or fishing during the year (USFWS 2002).

Bighorn National Forest recreation projections indicate that big game hunting demand will grow during the next planning period and beyond, although the growth will not be as marked as with such activities as wildlife watching, viewing scenery, interpretive

experiences or ATV riding. The following table displays hunter demand projections, in thousands of RVDs.

Table 3-102. Big game hunting projections (in MRVDs).

Decade	Total MRVDs
2000 Base Year	41.20
2000-2005	42.22
2006-2015	44.35
2026-2025	46.6
2026-2035	48.97
2036-2045	51.48
2046-2055	54.12

Tongue River cave receives a notable amount of recreation use year-round, with many visitors coming unprepared with little knowledge of resource protection or safety. There is an opportunity to manage this cave with an emphasis on caver education and resource protection. Other caves on the Forest receive very infrequent use, primarily due to more difficult access.

As in the "supply" side of the dispersed recreation discussion, two specific groups of dispersed recreation activities merit special attention in the demand/trends discussion:

Dispersed camping is a primary use of the Forest, particularly among state residents. Unlike other activities, use increases as income decreases. Rural residents are more likely to dispersed camp, than urban residents. In contrast to campers in developed campgrounds, the majority of dispersed campers are Wyoming residents (83%) (Strong, 1997).

On a forestwide scale, the demand for dispersed camping is projected to increase, as shown in the following table:

Table 3-103. Dispersed camping projections (in MRVDs).

Decade	Total MRVDs
2000 Base Year	197
2000-2005	201.8
2006-2015	211.8
2026-2025	222.4
2026-2035	233.4
2036-2045	245.2
2046-2055	257.6

The demand associated with dispersed camping has resulted in an increase in the number of dispersed campsites throughout the forest since unlike developed campsites,

dispersed campsites are created by the user. A dispersed campsite survey was conducted prior to the 1997 Clear Creek and Crazy Woman Landscape Analysis arrived at some conclusions which can also be applied forestwide:

- The number of dispersed campsites increased 93% over a 6-year period to a total of 664.
- Damage to trees surrounding the dispersed sites was more prevalent than in previous surveys.
- The "core" of these campsites (that most-used area of the campsites) that was devoid of all vegetation, grew in size (up to 900% at some locations).
- 39.7% of the surveyed sites were within 100 feet of a stream, contrary to 1985 Forest Plan standards and guidelines.

Dispersed camping occurs forest-wide along roads and trails and is one reason the developed roads on the Forest are highly valued.

ORVs: Nationally, ATV and snowmobile use continue to grow in popularity. This same growth is likely to occur on the Bighorn National Forest. Because of this growth, there is a greater potential for future conflicts between motorized recreationists and those seeking a more primitive experience on the forest as well as other users of the Forest (range permittees, etc.). In addition to the actual increase in use of ATVs and snowmobiles on the Bighorn National Forest, the technology itself is improving, allowing users an ever-increasing range of movement within the forest.

Summer motorized trail recreation levels increased tremendously between 1989 and 2000, over 400%. This dramatic percentage of growth is a result of the fact that the ATV is a recent phenomenon – it was nearly nonexistent on the Forest in the 1980s – and such a tremendous growth rate is not likely to continue into the future now that the number of users is so much higher, although marked growth will still likely occur. Bowker, et al (1999) predicts that percent of participants in motorized off-highway recreation will increase 37% from 2000 levels by 2050. Although motorcycles are a popular form of travel on the Bighorn National Forest, the recent increase in ORV numbers on the Forest came overwhelmingly from ATVs instead of motorcycles. According to the Bighorn Social Assessment, respondents indicated a desire for designated ATV trails, although neither snowmobiling nor ATV/ORV use ranked among the top favorite activities for these local respondents.

Corresponding with the increased ORV use on the Forest is a greater demand on Forest personnel and resources with regard to enforcement of ORV-related travel regulations. Forest law enforcement is spending a greater amount of time on ORV-related offenses as a percentage of total offenses. ORV-related offenses as a percent of total offenses increased from 24% in 2002 to 33% in 2003.

As of January 1, 2002, all ORVs (ATVs, dirt bikes, etc.) are required to display a Wyoming ORV permit while operating on public lands and other designated trails and areas, mirroring the current snowmobile registration requirements. Just as snowmobile

use increased dramatically in the 1990s, ORV use will likely increase due to an increase in information and advertising by the State Division of Tourism.

Forest-wide use data indicates that snowmobile use has increased 32 percent over a twelve year period from 1989 to 2000. This is in line with NSRE's growth figures over a fourteen-year period (1982-1995) of 34%. This growth is likely to continue, as demonstrated by a 2002 issue of SnoWest magazine which ranked the Bighorn mountains ninth in the nation among the "Top 10" snowmobile trail systems (SnoWest, 2002).

However, it is interesting to note that that the Bighorn Social Assessment of the Four County Area (2002) indicates that fewer than five percent of the four-county area respondents list snowmobiling, skiing/snowshoeing, or ATV/off road among their three favorite Forest activities. This indicates that much of the projected increase in motorized use could likely be from non-local visitors.

Trails - Demand

Trailhead capacity is not the same thing as trail use, although trailheads are important factors in terms of trail use. Where supply doesn't meet demand, parking doesn't necessarily match the level of use actually occurring on the trail system. In some cases, trailheads may be unused because of the lack of trail opportunities, or season of use. Not all trails provide a desirable year-round experience. Trails along Highway 14, 14A, and 16 are particularly popular, due to the easy access. The Story-Penrose Trail is also an especially popular motorized trail because of ease of access, miles of trails accessed, and popular destination attractions.

The Scenic Byway Corridor Management Plan identified a need for trails accessed from the three highway corridors. Also identified in this plan, was a desire for more and larger parking areas for winter recreation.

Summer motorized trail uses include riding vehicles such as ATVs and motorcycles on trails and two-track roads. As discussed previously, motorized trail participation rates increased tremendously between 1989 and 2000, over 400%. This was overwhelmingly from ATVs, as motorcycle use actually decreased slightly. According to the Bighorn Social Assessment, respondents indicated a desire for designated ATV trails.

Dispersed Recreation – Issues

In meetings leading up to plan revision, conflict between motorized and non-motorized users was a frequently cited concern from the public. Conflicts can interfere with the experiences of both users. User conflicts are most often associated with user behavior, and although managers can't dictate behavior, user conflicts on 'multiple use trails' are a growing concern.

Trail use changes that weren't anticipated in the 1985 Forest Plan include increases in the amount and type of mechanized uses; bicycles, snowmobiles, and off road vehicles (ORVs). Studies indicate that on a national level, opportunities for this type of land-

intensive activity are expected to decrease with the increasing trend toward development (commercial and housing subdivisions) of farm and ranchlands. The Forest has 432 miles of summer motorized trails, and use of licensed ORVs on open Forest Service roads is allowed, unless otherwise noted.

Much discussion thus far in this section has pertained to motorized recreation. That does not mean that nonmotorized recreation does not have impacts – however, the ease of access and the greater distance that can be covered by a motorized recreator, and as a result the potential for disturbance is also greater. In addition, the amount of comments received during re-revision scooping meeting around the four-county area regarding a concern over existing motorized use far outweighed similar concerns over nonmotorized use

Some commenters on the Forest planning effort noted that they would like to see the Forest restrict motorized travel to designated routes and close areas to motorized use where it disturbs wildlife and damages riparian areas. They expressed the need for trails for hiking, ATV and motorcycles, and mountain bikes, but would also like areas for non-motorized use that are designated, managed and enforced, both for winter and non-winter. There are currently 399 miles of nonmotorized trail on the Forest, 256 of which are outside the Cloud Peak Wilderness. Nonmotorized trail uses are expected to increase substantially over the next 50 years. In order to maintain current experiential satisfaction for these additional users, the Forest may need to build additional trails.

However, due to budgetary limitations, the ability of the Bighorn National Forest to construct or reconstruct trails is limited and fluctuates significantly in accordance with funding levels. For example, in FY 2001, the Forest employed a seven-person trail crew, accomplishing fifteen miles of heavy trail maintenance, rerouting and segment reconstruction (restoration of the Kearney Creek Bridge). In FY 1999, 1.5 miles of trail were reconstructed (east Tensleep Lake Trail Reroute). In 2002, the Forest was unable to fund a trail crew.

As per agency requirements, the Bighorn National Forest conducts condition surveys on approximately 20 percent of its Forest trail system annually. Analysis of recent maintenance surveys, coupled with observations from field personnel and public trail users, confirms that the priority list of "critical maintenance" needs is increasing and that overall trail conditions on the Bighorn National Forest continue to decline (USDA Forest Service, 2001). A major factor contributing to the deterioration is that Forest system trails are often based on historic user-created trails which were improperly located when they were initially created – particularly with regard to riparian areas, fall lines and erosive soils. When heavy use occurs in conjunction with improperly located trails, rapid trail deterioration occurs.

Other advances in technology beyond the advent of newer and more effective transportation continue to change the face of dispersed recreation. The dramatic increase in popularity of Global Positioning System (GPS) devices has made backcountry orienteering much simpler and reduced the associated risk as well as the level of proficiency needed to access remote areas of the Bighorn National Forest. It

has even resulted in a new form of recreation – geocaching – which is essentially a 21st century version of "hide and seek" whereby individuals or organizations set up caches and share locations of these caches on the Internet. GPS users locate the cache by coordinates and find a variety of 'treasures' and a sign-in logbook. At present there are several geocache sites on the Bighorn National Forest but based on past growth in other adjoining states – Colorado experienced a ten-fold increase in geocache sites between 2002 and 2003 (Swain, 2003) – the Bighorn National Forest will likely see a proliferation of geocache sites as well.

Volunteers have been, and continue to be, a critical component of trail maintenance and improvement on the Bighorn National Forest. In FY2001, volunteers, working with Forest personnel, accomplished approximately 60 miles of light maintenance. In FY 1999, volunteer groups cleared downfall on over 160 miles of trails and did extensive drainage work on an additional 5 miles of trail (USDA Forest Service, 2000). In FY 2001, the Forest completed three trail bridge inspections.

Unrestricted motorized travel in "C" areas as designated on the travel map has encouraged the development of new, as well as reinforced existing, user-created trails. During public meetings, these areas raised concerns due to the potential for resource damage that can occur when travel is not concentrated along designated system routes. Illegal motorized vehicles causing resource damage is the most frequently cited offense on the Bighorn National Forest, accounting for more than 20% of the total violations issued (USDA Forest Service, 2002). These "C" areas are being converted to "A" areas as part of the Forest Plan revision, which will prohibit motorized travel off of system routes. System trail composition within these former "C" areas will be determined as part of project-level travel management planning. This is discussed in the Environmental Consequences section.

Several commenters also expressed the desire for restricting snowmobile use to established roads and trails and designating areas for non-motorized use. As mentioned in the Scenic Byway Corridor Plan, snowmobiling use has created conflicts with both family snow play areas and cross-country skiing, from both a safety standpoint (mixing motorized traffic and sledders) as well the potential for conflict over the aesthetic differences of motorized versus nonmotorized winter recreation (particularly with regard to noise). Also identified in the Scenic Byway Corridor Plan was a desire for more and larger parking areas for winter recreation, which would be most appropriately addressed at the project level versus Plan revision.

Winter Recreation Supply

In this section, winter recreation will primarily include nonmotorized winter recreation activities. Snowmobiling, the dominant winter activity in the Bighorn National Forest, is also discussed in the "Dispersed Recreation" section.

There are two developed downhill ski areas on the Forest that provide over 10,000 skier visits per year with a total of 620 PAOTS. Both ski areas have expanded and improved

operations within the past five to ten years. Both areas primarily service local residents from the four-county area.

There are 41 miles of cross-country ski trails groomed by the Forest Service and volunteers. There are three warming huts and two Nordic ski parking lots/trailheads providing a total of 102 PAOTs.

A concentrated winter use area is located around Meadowlark Lake where snowmobiling, cross-country skiing, family snow play, ice fishing and downhill skiing are popular activities. Other parking areas along Highway 16 provide access to snowmobile and/or cross-country ski trails. Similarly, snowmobile use is heavy on the north end of the Forest along Highway 14 and 14A in the Burgess Junction area, with access gained via roadside parking areas. Cross-country skiing occurs in these locations as well as at the Antelope Butte ski area.

Pole Creek and Willow Park on Highway 16 and Sibley Lake and Antelope Butte on Highway 14 are the only areas reserved solely for cross-country skiing. Snow play occurs at a few locations.

A separate ROS classification is given to winter recreation activities. The primary factors that distinguish one class from another are motorized verses non-motorized access and ease of that access. The following classes have been identified:

- Primitive (P): 113,689 acres (10%); *all wilderness acres*

  No motorized access is allowed. This encompasses the "core" of the Cloud Peak Wilderness Area and at least three miles from snowmobile routes and trailheads accessed by motorized vehicles.

- Semi-Primitive Nonmotorized (SPNM): 153,272 acres (14%); 78,208 wilderness *acres and 75,064 non-wilderness acres*

  This includes areas a minimum of one-half mile from motorized routes where motorized access is restricted by travel regulation. These areas are a minimum of 2,500 acres in size.

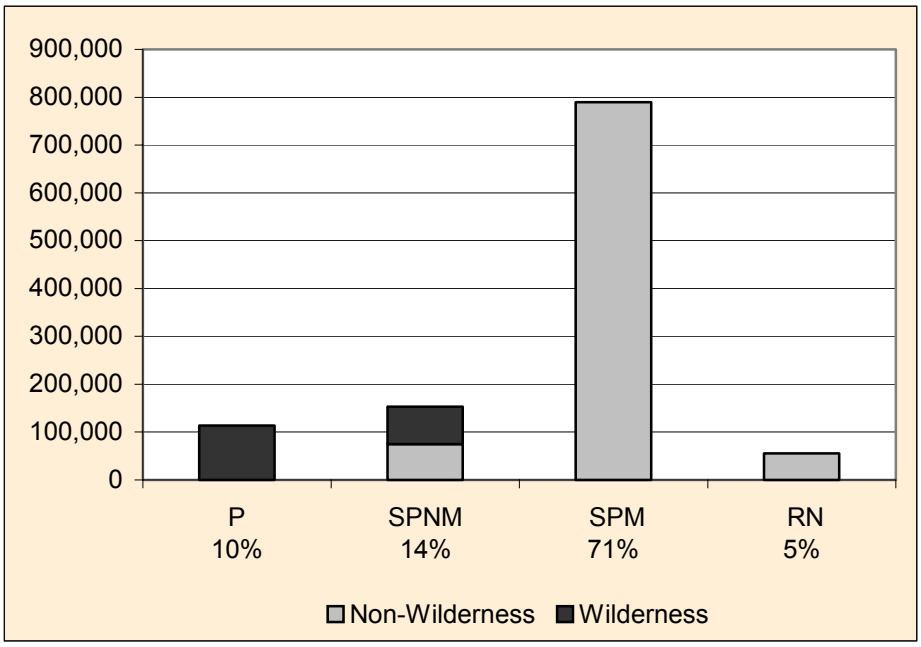
- Semi-Primitive Motorized (SPM): 789,854 acres (71%); *all non-wilderness acres.*

  This is the largest ROS class for winter recreation. It includes all areas not in the primitive, semi-primitive non-motorized, and roaded natural classes. Use of snowmachines is allowed on all but a few restricted trails or areas that are smaller than 2,500 acres in size.

- Roaded Natural (RN): 55,613 acres (5%); *all non-wilderness acres*

  These areas are located along the major highways, US14 and US16. There is more concentrated activity along these corridors since most winter trailheads and parking areas are located along these routes.

Figure 3-10. Winter ROS Class acres.



Winter Recreation Demand and Trends

Demand for winter recreation is also expected to rise. From 1989-2000, downhill skiing accounted for less than one percent of the total annual Forest RVDs, with all other winter recreation comprising an annual average of seven percent of the total Forest RVDs. Original estimates in the 1985 Forest Plan have been updated and revised using historical growth patterns (Bighorn RVD data specific to downhill skiing) adjusted to reflect the national projection index by activity (Bowker, English, Cordell). All other winter recreation has been included in the dispersed recreation projections.

According to a study completed in 1990 by the University of Wyoming and the Big Horn Marketing Coalition, the following information regarding winter visitors was collected:

- Eighty-five percent (85%) indicated the Bighorn National Forest was their destination
- Forty-six percent (46%) were from Wyoming
- Twenty-five percent (25%) were from the Plains states
- Twenty percent (20%) were from the Rocky Mountain states
- Top three factors in choosing a destination were: 1) Recreation opportunities, 2) Opportunities to enjoy the scenery, 3) Natural attractions
- Seventy percent (70%) were snowmobiling

- Forty-four percent (44%) were relaxing
- Thirty-two percent (32%) were sightseeing

By contrast, the 1997 Winter Recreation User Survey completed for the Forest indicated that two-thirds of those contacted at lodges and use areas were residents of the four-county area. The top factors in choosing a destination were: 1) Proximity to home, 2) Reliable snow, 3) Solitude/remoteness, 4) Visual interest, 5) Quality of the landscape. The activities most frequently engaged in were: 1) Snowmobiling (57%), 2) Downhill skiing (57%), 3) Sightseeing, fishing, and cross-country skiing (all 29%).

Table 3-104. Projected demand for snowmobiling.

Decade	Total MRVDs
2000 Base Year	52.3
2000-2005	53.3
2006-2015	55.4
2026-2025	57.6
2026-2035	60.0
2036-2045	62.5
2046-2055	65.1

Table 3-105. Projected demand for downhill skiing.

Decade	Total MRVDs
2000 Base Year	8.70
2000-2005	8.74
2006-2015	8.81
2026-2025	8.89
2026-2035	8.97
2036-2045	9.05
2046-2055	9.13

Downhill skiing on the Forest has remained stable over the years. Use projections indicate that demand for downhill skiing will only slightly increase. At this rate, the existing supply should accommodate anticipated demand. Even if skier demand should exceed the anticipated growth rate, it can be accommodated with the potential expansion capability within the existing permit areas.

Recreation Special Uses Supply

There are 344 recreation special use permits within the Forest. The breakdown is as follows:

- 265 Recreation Residences.
- 53 Outfitter and Guide permits.
- 10 Resort permits.
- 3 Organization Camp permits.
- 2 Downhill Ski Area permits.
- 1 Campground Concessionaire permit.
- 10 Recreation Event permits (This is an average per year).
- Noncommercial group use permits (varies, but overall is insignificant).

Currently there are fifty-three outfitter/guides providing services throughout the year. Twenty-one of those outfitters provide service in the Cloud Peak Wilderness. The following table displays existing activities and numbers of service days* issued on the forest.

Table 3-106. Outfitter and guide service days on the Bighorn National Forest.

Outfitter/guide Service Days by activity by district				
Activity	**Tongue**	**Powder River**	**Medicine Wheel/Paintrock**	**Totals**
Spring				
Spring bear hunting	149	0	75	224
Summer				
Trail rides,camping, fishing	2,650	10,616	1,979	15,245
Fishing	80	172	206	458
Cattle drives	180		390	570
Rock climbing		160		160
Backpacking		660		660
Environmental education, backpacking			1,790	1,790
Fall				
Big game hunting	441	245	2,192	2,878
Winter				
Snowmobile guiding	1,600	1,750	790	4,140
Dog sledding			20	20
Lion hunting	40	40		80
Total service days provided for outfitting				26,225

2003 permit information

*A service day is defined as "a day or any part of a day on National Forest System lands for which an outfitter or guide provides goods or services, including transportation, to a client."

Recreation Residences: There are 265 cabins on the Forest, located within 36 summer home groups and 45 isolated cabin tracts. This comprises the largest number of recreation residence permits on one Forest in the Rocky Mountain Region. In many areas, this use has existed since 1925. The purpose of allowing recreation residences was to encourage use of the National Forests by allowing individuals to build cabins for recreational purposes and occupy them for a portion of the year. The program was very popular, and several thousand permits were issued nationwide. Permits for the recreation residences are issued for 20 years, with most permits on the Forest set to expire in 2008.

The current national policy is to not issue any additional permits but continue to acknowledge the recreational values associated with the existing Recreation Residences and to reissue those correctly issued existing permits when the current permit tenure expires provided they were operated in compliance with the terms and conditions of the existing permit. The Forest is challenged by the sheer number of permits it administers.

The majority of the recreation residences are in rural and roaded natural ROS classes. Many are located within the scenic byway corridors along Highways 14, 14A, or 16.

Resorts: Resort permits also fall under the auspices of the Occupancy Permits Act. There are 10 resort permits, with a wide range of opportunities offered. Permit owners have been working to expand operations, diversify services, and upgrade facilities to address the changing needs of the public.

Recreation Special Uses Demand

Demand for outfitter and guide special use authorization continues to grow. Prior to the 1997 limit on the issuance of new permits, there was a significant increase in requests for new permits. The Forest received over 60 inquiries for new permits and uses during 1996 including a variety of uses from mountain biking to hang gliding to ATV tours. At the time, hunting and fishing outfitter-guide use was already considered to be at capacity. By updating the number of service days on the existing permits, moderate changes in demand have been accommodated.

In February, 2002, a needs analysis questionnaire was sent out to a mailing list of 128 recipients that included existing outfitter/guides permitted on the Bighorn National Forest, several persons that have requested to be permitted as an outfitter/guide, and local Chamber of Commerce Offices and other interested parties. According to respondents:

- There was a need for additional outfitter/guide services on the Forest;
- Environmental education-related outfitter services were frequently mentioned as needed;
- Other services that were requested were ‘nontraditional’ services such as rock climbing and llama trekking.

Demand for recreation event and semi-public permits, in general, also continues to rise. From 1989-2000, resort use (includes resorts, organization camps and recreation residences) accounted for an average of 57 percent of the total Forest RVDs for developed recreation and an average of 16 percent of the total Forest RVDs. Use in these three activities (RVDs) increased at an average of 3.35 percent.

Demand for recreation events and institutional permits has also risen as evidenced by the number of requests received from the public.

Recreation Special Uses – Issues

The Forest has initiated a capacity determination analysis outside of the Forest Plan Revision process which will help it to determine proper outfitter/guide service levels.

ENVIRONMENTAL CONSEQUENCES

General Effects

Recreation management is concerned with providing a range of recreation opportunities to meet the needs of users and local communities in balance with protection of forest resources. All forest management alternatives provide for recreation opportunities, but to varying degrees.

In general , recreational use of the Bighorn National Forest is expected to increase at a slightly higher rate (50%) than U.S. population growth projections (48%) to the year 2050 of (U.S. Census Bureau, 2002). It is likely that this increase will occur, regardless of the alternative chosen although a slight variance is expected based on the ability of the recreation program to maintain its offering of developed facility-based recreationopportunities. In Alternatives A and E it is likely that the recreation budget would be slightly reduced and in Alternative C it is likely that the recreation budget would be slightly increased. In Alternatives B and D, recreation budget levels (as a share of the total Forest budget) would not be noticeably different from the current situation.

The economic analysis in the Communities section of this chapter highlights the economic importance that tourism-based recreation has on the local economy. The timeframe of the economic analysis is from 2001 to 2010, and based on this timeframe as well as historic levels of forest management, very little variance in recreation use is anticipated among alternatives.

Range of Opportunities Based on Recreation Opportunity Spectrum (ROS) Classes

The Forest is managed to provide opportunities for a wide variety of recreational experiences. The Recreation Opportunity Spectrum (ROS) has been developed to help identify, quantify, and describe this resource.

Vegetation, scenery, water, topography and wildlife are all important elements of a recreation setting. They influence where people go and the kinds of activities that are possible in those areas. They help to define the type of recreational experience the visitor is likely to have. Changing these elements is likely to change the mix of recreation opportunities.

The following table illustrates the "mix" of adopted ROS classes (based on management area prescription guideline) by alternative. The adopted ROS class displays the maximum level of change that an area could experience in terms of ROS over the life of the plan. It is likely that actual "on-the-ground" shift from the current ROS composition will be less extreme than portrayed below, given the amount and magnitude of annual management that has historically occurred on the Forest and will likely occur over the next planning period.

Table 3-107. Adopted ROS by alternative.

ROS Category*	1998 Forest ROS inventory	Alternative				
		A	B	C	D	E
P	181,232	154,769	178,190	190,827	173,219	148,674
SPNM	278,105	185,277	223,212	262,605	175,920	96,785
SPM	372,549	172,972	331,361	385,763	180,471	61,953
RM	106,532	454,766	203,017	89,022	394,429	631,486
RN	140,393	127,327	139,813	147,774	148,337	159,850
R	32,544	9,906	29,422	29,025	32,641	6,269

*P = primitive, SPNM = semiprimitive nonmotorized, SPM = semiprimitive motorized, RM = roaded modified, RN = roaded natural, R = rural

Based on shifts to ROS composition from the more pimitive end of the ROS spectrum to the more developed end, users and use types will most likely be affected by implementing Alternatives E followed by A, D, B, and C primarily based on the level of timber management.

The amount of ROS shift by alternative (in percent) by ROS class, compared to the 1998 Forest ROS map, is shown in the following table.

Table 3-108. ROS shift comparison to 1998 Forest ROS Map (in percent) by alternative.

ROS Category*	Alternative				
	A	B	C	D	E
P	-15.6%	-1.7%	+5.3%	-4.4%	-18%
SPNM	-33.4%	-19.7%	-5.6%	-36.7%	-65.2%
SPM	-53.6%	-11%	-3.5%	-51.6%	-83.3%
RM	+326.9%	+90.6%	-16.4%	+270.2%	+492.8%
RN	-9.3%	-.4%	+5.3%	+5.7%	+13.9%
R	-69.6%	-9.6%	-10.8%	+.3%	-80.7%

As discussed previously, the analysis that determined the above ROS acreage figures is based on the "Adopted ROS" guideline for each management area and assumes that every acre would shift under Plan management. This is not likely to be the case and as such, the magnitude of change that is likely to occur is exaggerated. The utility of this analysis is for purposes of alternative comparison.

Alternative E could most dramatically reduce the amount of primitive and semi-primitive nonmotorized acreage compared to current levels while most dramatically increasing the amount of roaded ROS acreage. This could result in a greater likelihood of crowding among nonmotorized recreationists such as hikers, horseback riders and nonmotorized winter recreationists while potentially creating additional opportunities

Conversely, Alternative C would result in the least amount of ROS shift from current conditions. As such, it would maintain the highest level of primitive and semi-primitive nonmotorized recreation opportunity.

Lying within the range of ROS shift would be (in terms of least to most magnitude of change) are Alternatives B, D, and A.

In terms of loss of primitive and semi-primitive ROS settings, the greatest loss would be experienced in Alternative E, followed by A, D, B, and C (with the least amount of loss). The primitive and semi-primitive settings are popular with many forms of dispersed recreation, primarily for the challenge and sense of risk that they offer the recreationist.

On the other end of the spectrum, roaded natural acreage, a popular setting among ORV enthusiasts and dispersed campers would remain relatively stable across alternatives, ranging from Alternative E (most) to Alternative A (least).

Though the tables above shows marked change to rural ROS class, little change is in fact anticipated over the life of the Plan with regard to rural ROS class acreage since this class is dependent on the presence of developed facilities, and few new developed

facilities are anticipated. As a result, actual deviations in rural acreage from the 1998 ROS map are expected to be minimal.

There is a difference between adopted ROS class and whether or not recreation opportunities are actually available. Opportunities need to be provided, including trail development, and other user conveniences or facilities in some cases. Simply because an area has an adopted ROS class of semi-primitive motorized, for example, does not mean that motorized travel will be able to occur there unless a motorized trail system is also present. Trails and facilities are dependent upon funding. The State Trails program provides grant funds that would be available to the Forest in any alternative.

Discussion of dispersed winter recreation opportunities can be found in the "dispersed winter recreation" effects section below.

Direct and Indirect Effects

Range of Opportunities by Activity

Developed Campgrounds

The recreation program is dependent on budget and prioritization. Whether operated under concessionaire permit or not, developed recreation is a considerable public investment that will continue to be provided in all alternatives and should not noticeably vary among alternatives. As discussed in the Affected Environment section, some developed facilities are at or near capacity during high use periods of the summer. Based on Forest use projections, this situation will both continue and become more prevalent as campsite availability will be increasingly limited since major expansion of developed campground facilities are not anticipated in the near future.

Dispersed Recreation

Dispersed camping was one of the most frequently voiced concerns in meetings leading up to plan revision, as well as a major recommendations of respondents to the Bighorn National Forest Social Assessment. Across all alternatives, the Revised Plan will restrict, or address through mitigation, as much as 8,408 acres to dispersed camping (in addition to existing Special Orders already in place). These provisions are based on the following standard and guideline:

- Standard: Prohibit or mitigate dispersed camping within 100 feet of lakes larger than ¼ acre or perennial streams that are either state-listed water quality impaired streams or are the mainstem of the 6th level municipal watersheds of Clear, Goose, Tensleep and Shell Creek as well as the Tongue River.
- Guideline: Restrict camping within ¼ mile of developed campground facilities.

This is a tradeoff – some of the acreage includes areas that are currently popular dispersed camping areas which will result in added competition for existing, compliant

dispersed campsites as well as demand for additional areas where dispersed camping opportunities will be available.

In Alternatives A and E, approximately 12-15 miles of road construction may be needed to access timber in the Piney/Rock area and given the length of the road needed, it is likely that, unlike the majority of other timber roads, this road would remain open to public use as a level 3 road. This could create additional dispersed camping opportunities and would be addressed at the project level.

Travel management: Trails help disperse users and provide them with a sense of solitude. Eleven percent of the Forest is currently designated as a "C" area on the existing travel map where unmanaged cross-country travel is still permissible. With increasing visitor levels and an increasing number of vehicles such as ATVs and motorcycles, it is no longer possible to allow this sort of unmanaged motorized travel.

The following "C" areas as designated on the travel map, will become "A" areas under the revised plan where travel off of designated routes by motorized means except for snowmobile travel is prohibited. Snowmobile travel off designated trails over snow is still allowed from November 16 through May 15 in these "A areas."

Table 3-109. "C area" acreage.

C Area	Acres
Woodrock area	23,868
Horse Creek Mesa area	30,204
Hazelton Peaks area	22,860
Elgin Park area	46,653
Total	123,585

This amounts to 11.1% of the Bighorn National Forest's 1,112,429 acres. In three (Woodrock, Hazelton and Elgin Park areas) of the four areas, public travel management planning efforts are determining which routes will be part of the travel system. It is anticipated that travel management planning excercises will also take place for the Horse Creek Mesa area.

Given that motorized travel will be restricted to system routes on a forestwide basis, differences across alternatives in terms of motorized travel opportunities will generally be subtle, especially in the earlier years of the Revised Plan. However, the long-term potential for construction of new motorized routes (which is dependent on management areas which allow motorized travel) will be greatest in alternative E (based on the amount of motorized ROS classes), followed by Alternatives A, D, B and C. Conversely, the long-term potential for maintaining the greatest amount of nonmotorized recreation opportunities will be highest in Alternative C, followed by Alternatives B, D, A, and E.

Access to the Forest continues to be a concern. As per a forestwide standard, across all alternatives, the Forest will prohibit motorized access from private land where access for the general public is not available, except by special authorization.

Anticipated annual trail construction / maintenance levels do not vary by alternative aside from a slight potential increase in trail construction that could be possible in alternative C compared to the rest of the alternatives, given anticipated program funding levels. Travel provisions regarding individual roads and trails are not being addressed through plan revision, but will be addressed through more site-specific travel management planning such as is taking place currently in the Woodrock and Clear/Crazy areas.

Under a forestwide strategy (discussed in Chapter 1 of the Revised Plan), the Forest will develop or identify one day-use trail system on a scenic byway during Planning period. This would provide for an easily-accessible trail opportunity to the majority of Forest visitors traveling along one of the three scenic byways.

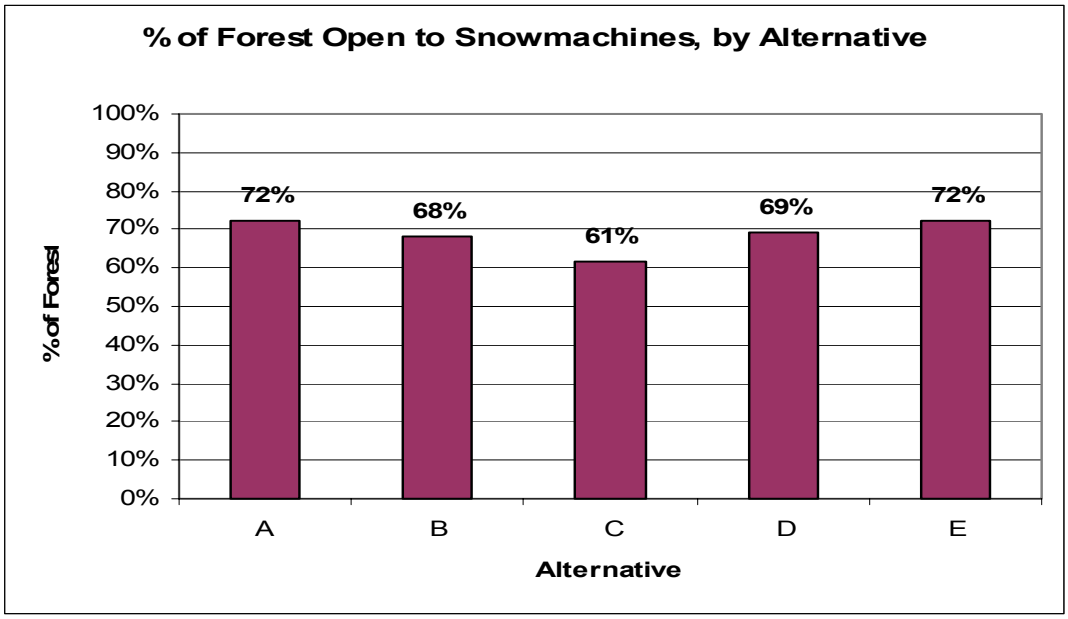
In Alternatives A and E, road construction may be needed to access timber in the Piney/Rock area and given the length of the road needed, it is likely that (unlike the majority of other timber roads), this road would remain open to public use as a level 3 road. This could create additional roaded travel opportunities as well as the activities that typically go along with road-based recreation (fishing, hunting, camping, viewing scenery, etc). With this would also come the potential for additional conflict between nonmotorized users and the new introduction of motorized recreationists into an area that was previously generally unroaded.

Dispersed winter recreation: Restrictions to winter motorized use based on management area allocation varies slightly by alternative. Several management areas, including Recommended Wilderness (MA 1.2), Backcountry Recreation Nonmotorized Use (MA 1.31), Research Natural Areas (MA 2.2) aside from Lake McLain, and Deer and Elk Winter Range (MA 5.41) prohibit winter motorized recreation.

In addition, mapped winter range (as compiled by Wyoming Game & Fish Department) is found in numerous areas on the Forest and prohibits winter motorized travel in some cases but does not vary by alternative. There are 27,294 acres of crucial mule deer winter range on the Forest (typed as "crucial winter yearlong"). There are a combined total of 41,077 acres of crucial elk winter range on the Forest (typed as crucial winter yearlong and crucial winter).

When the combined effects of mapped winter range, existing Special Orders, and management area allocation are taken into account, the total amount of winter motorized and nonmotorized acreage (including Cloud Peak Wilderness) can be compared by alternative. Total acreage of national forest open to snowmachine recreation by alternative is shown in the following figure.

Figure 3-11 Acreage of Forest open to snowmachine travel by alternative (including existing special orders).



The most Forest acres would be open to snowmachine travel in Alternatives A and E, followed (in order) by Alternatives D, B, and C.

In terms of an overall effect on dispersed winter recreation, there is a greater possibility of crowding among snowmobilers in Alternative C while conversely there is a greater potential for preserving "quiet" winter recreation areas for nonmotorized winter recreationitsts such as snowshoers and backcountry skiers since this alternative most reduces the amount of available acreage to winter motorized recreationists. The rest of the alternatives are generally similar in effect, essentially maintaining the current available winter motorized acreage (particularly in Alternatives A and E) or reducing it slightly (D and B).

Alternative C incorporates the concept of using Management Area 1.31 (Backcountry recreation non-motorized use) to set aside a small "quiet" winter recreation area for backcountry skiers in the Salt Creek/Cabin creek drainage vicinity south of the Antelope Butte ski area. In the rest of the alternatives, this area remains open to snowmobile travel.

Over-the-snow winter recreation within lynx habitat, both motorized and nonmotorized, will be affected across all alternatives by the lynx conservation plan, and subsequent standards and guidelines. The Proposed Action as stipulated in the DEIS for the Northern Rockies Lynx Amendment would allow for increases in designated snowmobile routes in a LAU, but only if the increases consolidate use and improve lynx habitat. Grooming could be expanded on the 25 miles designated routes in lynx habitat which are currently ungroomed, which would be in addition to the existing 25 miles of currently groomed routes within lynx habitat on the Bighorn National Forest (USDAFS

and USDIBLM, 2004).These lynx-related standards and guidelines do not vary across alternatives.

Wildlife recreation: Recreationists benefit from wildlife management. Consistent with wildlife preferences, wildlife-related recreation uses usually tend towards less modified environment, away from other people although the majority of recreationists do not usually venture far from roads and trails. Alternative C will result in the least amount of shift towards a more modified environment, with alternatives E and A (in that order) resulting in the greatest degree of ROS shift from the current forestwide settings.

Wildlife management can affect recreation opportunities through added restrictions on the nature, extent, location and timing of allowable recreation activities, which decrease the ability of recreationists to disperse. Closing or decommissioning roads has this effect. By concentrating recreationists on fewer miles of open roads, users seeking solitude are diminished. Timing restrictions on seasonal closures during sensitive periods such as calving and migration, and prescribed burning to improve habitats can temporarily displace recreationists to other areas.

Fishing use is dependent on stream health and on roads to access streams. Many anglers use OHVs to travel to streamside locations. Common to all alternatives is an annual decommissioning goal of four miles of system road per year, common to all alternatives. Stream sediment loading from unmanaged motorized use, and clearcutting upstream can affect fish populations and fishing opportunities. Fisheries would be most affected by higher levels of ground disturbing activities, such as timber harvesting and road building. Alternatives that emphasize these activities include Alternatives A and E. Assuming proper implementation of Best Management Practices (BMPs), there should be no notable increase in sediment loading from timber management across all alternatives although the potential exists for an increase in short-term loading as a result of water crossings in the higher harvest alternatives (particularly Alternative E) as roads are built.

Fishing-related recreation is success-dependent on adequate amounts and distribution of habitat. Activities related to maintenance, restoration and protection of aquatic resources are similar across all alternatives.

Ski areas: Allocation of land for potential ski area development is consistent with the Forest Planning process. Allocation does not preclude the need for a Master Plan, complete with NEPA, as required by Forest Service regulations. Alternative A would maintain the existing ski area boundaries shown as management area 8.22. Alternatives B, C, D, and E would expand the 8.22 boundaries to the extent of their combined approved master plans of nearly 2,600 acres. Capacity at existing ski areas will be adequate to meet demand during this planning period.

The Lynx Conservation Assessment and Strategy (Ruediger et al. 2000) for the Northern Rockies, as incorporated into the forestwide standards and guidelines, contains a provision which could potentially limit future expansion of Antelope Butte given that

it is located within a Lynx Habitat Unit, although this is not likely since the permit area boundaries were consulted upon with the U.S. Fish and Wildlife Service in 2000 and as a result this should not be an issue during the upcoming planning period. The lynx conservation measures are discussed in additional detail in the "Effects from Wildlife Management" below.

Recreation-related special uses: The number of recreation residences does not vary by alternative. At the current time, no other uses have been identified for the areas occupied under permit for recreation residences. Future use determination would be to continue to permit recreation residences and work in partnership with permit holders in all alternatives until conditions change or the appropriate environmental analysis shows a higher need for these lands.

The number of resorts does not vary by alternative. Existing resort permits would continue to be administered as such in all alternatives. No additional resorts or lodges will be authorized on the Forest until expansion at existing resorts is complete under all alternatives and a determined need exists. Approval of future expansions and improvements at existing resorts will be addressed on a case-by-case basis through the administrative permit process.

Opportunities for would not be affected based on the amount of acreage recommended for wilderness (MA 1.2). Alternative C designates 126,575 acres as recommended wilderness. None of the other alternatives contain any additional acreage recommendations for wilderness. Under Wyoming law 23-2-401, nonresidents wishing to hunt in designated wilderness must be accompanied by either a licensed professional guide or a resident guide. However, since the allocation of Management Area 1.2 is only a recommendation to Congress (and not a designation per se), nonresidents would be able to hunt without being accompanied by a licensed professional guide or a resident guide. Should Congress eventually designate some or all of the MA 1.2 areas in Alternative C, Wyoming law would apply to those designations.

The designation of additional Research Natural Areas (RNAs) carries the potential to limit opportunities for the issuance of new outfitter-guide activities as permits for new outfitter guides in designated RNAs will not be issued in the future. Numbers and acres of RNA designations by alternative are discussed later in this section.

Winter outfitting opportunities (snowmobiling, etc.) could potentially be affected by the Lynx Conservation Assessment and Strategy (LCAS) for the Northern Rockies as incorporated into the forestwide standards and guidelines. These conservation measures allow for amendment of winter recreation special use permits (outside of permitted ski areas) if it is determined that they promote snow compacting activities in lynx habitat.

Cave management – Cave resources are considered non-renewable because of the unique geologic and hydrologic conditions under which they formed, the time it took them to develop, and the sensitivity of microclimates within caves. The Federal Cave Resources Protection Act of 1988 requires the protection of significant caves found on federal lands. Forest plan direction may result in limitations on human access to caves

in an attempt to protect cave resources. These effects would contribute to preserving recreational caving experiences into the future. In that protection of cave resources is mandated by law, these effects are common to all alternatives.

Effects from Other Activities

Effects from Oil and Gas Development: No new exploration is projected at this time for the next decade based on past history (1 dry well in the past 30 years). This projection estimate may be revised at a later date pending release of the Reasonably Foreseeable Development (RFD) report by the Bureau of Land Management.

However, if it were to occur, there are both short-term and long-term effects from oil and gas related activities. Exploration would disrupt recreation in remote areas with noise and visual impacts, as well as potentially displacing both wildlife and wildlife-watching recreationists.

Potential long-term effects from the drilling operations include a change in the landscape. Any new permanent structures and road corridors would increase use, based on increased access. The associated roads may or may not be open to the public, depending on the permit. The effects of additional open roads would include additional areas for dispersed camping, and motorized uses. The effects on non-motorized users would be that more interior forest is open to motorized use, and any long-term noise from operations would change their experience.

Effects from Livestock Grazing: Recreation would be affected similarly by livestock grazing in all alternatives since under all alternatives, the number of AUMs will remain at their current levels until the site-specific effects of management can be assessed current grazing allotments.

Signs of livestock grazing, such as the presence of cows or sheep, fences, driveways, stock tanks and ponds, cropped forage, trampled vegetation or manure may adversely affect the recreational experience. Conflicts can occur between visitors, their dogs, cattle herds, bands of sheep, and the dogs used to control herds. These concerns are most often expressed by recreationists who prefer a livestock-free experience. In some cases, active allotments or recently vacated areas aren't always obvious.

On the other hand, there are also those Forest visitors who are intrigued by the sight of the "old west" style of ranching in action.

Effects Cultural Resource Management: Special interest areas (MA 2.1) are designated for historical values. Within these areas, motorize and mechanize travel are prohibited where necessary to protect the values for which the individual area was proposed or established. Recreation use is allowed which emphasizes interpretation, education and inspiration when it does not threaten the values for which the area was identified. The adopted ROS class is either semi-primitive nonmotorized or semi-primitive motorized, depending on the specific area. New roads or trails are allowed when they are consistent with the values of the SIA. The following table shows SIA designation by alternative.

Table 3-110. 2.1 MA designation by alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
Total Acres	89	20,004	17,024	0	0

In addition to MA 2.1, designation of the Medicine Wheel Special Interest Area (MA 3.1) also varies by alternative. Within MA 3.1, certain recreation uses are allowed as stipulated within the Historic Preservation Plan for Medicine Wheel National Historic Landmark and Vicinity (HPP) provided they do not threaten the integrity of the site as a sacred site and a nationally important traditional cultural property. The area is managed solely as a day-use site and camping and the use of campfires are prohibited by special order. In the immediate vicinity of the Medicine Wheel, management emphasis is strictly to protect the traditional cultural values of the area. In Alternative A, the MA 3.1 is 61 acres; in Alternatives B, C, D, and E, it is slightly less than 21,000 acres.

Effects from Management of Research Natural Areas (RNAs): Research Natural Area (RNA) designation can affect the scope of available recreation opportunities for that designated area. RNA designation prohibits motorized recreation aside from snowmachine travel on designated trails. RNA designation also prohibits the construction of new roads and trails, except when they are necessary to correct resource damage occurring from existing travelways or unless needed for administrative purposes consistent with RNA establishment objectives. Permits for new outfitter guides in RNAs will not be issued in the future. RNA designations by alternative are described below:

Table 3-111. RNA designation by alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
# areas	2	6	6	6	2
Total acres	1,618	21,190	21,188	21,190	1,618

In Alternatives B, C, and D, a minimal effect on motorized system routes will occur. Approximately 1.25 miles of trail 131 ("Martini Loop"), immediately northwest of the Bud Love Big Game Winter Range would be precluded from motorized use. However, it should be noted that since this short trail is entirely surrounded by nonmotorized system routes it is currently inaccessible to motorized use and as a result, there is no actual loss of motorized trail opportunity.

Effects from Roadless Area Management: Roadless areas provide opportunities for primitive and semi-primitive (both motorized and nonmotorized) recreation. The undeveloped condition creates the feeling of solitude and, in some instances, provides an experience similar to Wilderness recreation, with additional opportunities for activities not allowed in wilderness. Provided the Management Area prescription is compatible, a motorized experience on existing system routes is an acceptable use in roadless areas on the Bighorn National Forest.

Currently, approximately 53% of the Bighorn NF is 'roadless' according to the 2000 Roadless Area Conservation Rule (RACR). Under the RACR, unless certain special conditions exist (natural disaster, etc.) road construction or reconstruction is prohibited, although maintenance of existing classified roads is permitted. Timber may not be cut, sold or removed in inventoried roadless areas unless it is done to maintain or improve one or more of the roadless area characteristics. The construction and maintenance of motorized and nonmotorized trails is allowed in inventoried roadless areas.

Alternative C is the most extensive with regard to recommendation of acres (126,575) for Wilderness as it places essentially all of the RACR roadless areas into a category 1 or 2 management area. Alternatives A, B, D, and E do not recommend any additional wilderness. MA 1.2 designation will affect a small number of trails which are currently open to motorized travel, as shown below (since motorized travel would be prohibited in MA 1.2).

Table 3-112. Motorized trails located within Alternative C Recommended Wilderness.

Trail #	Name	Mileage
8	Freezeout	3.2
52	Tillet's Hole	1.6
54	Railroad Springs	1.25
96	Boyd Ridge	1.8
146	Pumpkin	5
180	Medicine Lodge	1.6
Total trail miles affected		**14.45**

Alternative E assigns the most roadless acres to management areas that allow road building, followed by Alternatives A, D, B, and C.

Effects from Timber Management: Clearcutting and road building can create changes in the landscape, resulting in shifts from the less developed end of the ROS spectrum to a roaded modified setting. Studies have generally found that in terms of aesthetic preferences for forested landscapes, mature forests are preferred over young ones, "natural looking" stands over those with obvious human impact, and partial-cutting techniques over clearcuts (Ribe 1989).

These long-term effects of timber management can make it more difficult for recreationists who seeking out a more remote, challenging experience. Alternative E allocates the most Forest acreage to timber production, followed by A, D, B, and C. In addition to the additional access provided by roads, large open areas that are created can encourage off-road/trail traffic encroachment into previously unavailable areas, resulting in an increased number of nonsytem, user-created trails although sale roads will not remain open to the public in most cases.

For those seeking a more developed, roaded recreational experience, the long-term recreational benefits associated with timber management include new roads for

dispersed recreation (hunting, pleasure driving, dispersed camping) as well as additional opportunities to gather firewood, although the majority of timber roads will not be open to public use. Average annual road construction (over a 50-year period) associated with timber management are shown in the following table.

Table 3-113. Average annual new timber road construction (over a 50-year period).

	Alternative				
	A	B	C	D	E
50 year annual average (miles)	4.5	2.8	1.1	2.4	3.6

The numbers shown above represent an average, with higher and lower amounts possible in individual years. These roads will be built to level 2 standards but it is likely that the vast majority of them will be closed to the public after completion of harvest. Even though the road may be closed, there are still effects to the recreation setting due to the creation of a roaded environment. Though the road may be closed, it allows for easier travel into formerly unroaded areas, and a shift from a primitive or semi-primitive setting to a roaded (more specifically, roaded modified) setting. The effect is a loss of a sense of challenge and risk associated with an unroaded setting and the potential for displacement of nonmotorized recreationists who seek an unroaded setting to other areas, as well as the potential for concentration of users who seek unroaded settings into the remaining unroaded areas on the Forest.

Other cutting methods, such as partial cutting, carry the potential to enhance opportunities for wildlife-related recreation. Road development in undeveloped areas has the potential to attract more visitors to the interior of the forest where access previously had been limited.

Short-term effects include increased noise and dust levels, altered landscapes (i.e. the presence of slash piles, etc.), the presence and use of roads constructed for timber sales, the potential for disrupted travel routes due to any necessary road closures, and conflicts and potential safety hazards associated with logging trucks on main roads.

Effects from Fire and Fuels Management: Under all alternatives, wildfire could alter recreational settings, especially at developed sites. Wildfire may alter the short-term and long-term (depending on intensity) appearance of primitive and semi-primitive settings, but it is compatible with their characteristic trait of being a natural-appearing environment.

Historically, humans have been responsible for approximately half of the wildfires on the Bighorn National Forest. Wildfires, or the potential threat of wildfires, can result in restrictions or outright closures of the Forest, or portions thereof, and accompanying loss of recreation opportunities. It also has direct impacts to developed facilities such as campgrounds and recreation residences (burned structures, damage to drinking water sources, creation of hazard trees, damage to roads providing access to these sites) as

well as more dispersed recreation assets such as trails (short-term closures, burned improvements such as waterbars and signage) (Chavez and McCollum, 2004).

Active fuels management (through prescription burns, logging or other mechanical treatment) can reduce the threat (i.e. severity) of wildfire. Alternatives B and D would emphasize prescribed burning, followed by Alternatives A, E and C. A key contributing factor to human-caused fire is access – most recreationists do not venture far from a travel route - and alternatives that are associated with increased roading as a result of greater amounts of timber management are Alternatives A and E. Although the majority of timber roads will be closed to motorized travel by the public, there mere presence of a road may result in a greater number of human incursions into an area, thereby resulting in an increased likelihood of human-caused fire ignitions in these alternatives. Conversely however, roads also provide increased access for firefighting equipment and activities (which could be viewed positively with regard to fighting natural ignitions - i.e. lightning-caused fires).

Effects from Wildlife Management: Wildlife management has the potential to affect recreation in several ways. In the instance of caves, there is a potential for visitation limitations being imposed if determined necessary for the protection of bat habitat if resource damage is occurring or has the potential to occur.

Elk security areas are seen as a critical factor in retaining elk on the National Forest during hunting season, contributing to hunter success and satisfaction. Elk security areas are defined as those which met the necessary habitat criteria (as described in the biodiversity section of this Chapter) as well as were located greater than ½ mile from any open road or motorized trail. While elk are considered to be an indicator species, other wildlife could also benefit from the presence of elk security areas. This coincides with a growing concern that public hunting opportunities are suffering in light of reduced access to certain areas of the Forest as private landowners close their land to the public. Concerns have been expressed by the public that elk are escaping to inaccessible private land in advance of hunting season, and there is the potential that these elk security areas could help to alleviate this concern.

Elk security areas would be at more risk in Alternatives E and A due to an increase in road construction associated with a more active timber management program, and would be at less risk in Alternative D, remain somewhat similar to existing levels in Alternative B, and possibly increase in Alternative C.

On one hand, elk security areas provide an opportunity to view megafauna in a relatively undisturbed setting but on the other hand the nature of an elk security area is partly based on the premise that access to the area is more difficult to the public, and as a result is likely to not be as easily accessed as other parts of the Forest by wildlife viewers who do not venture far from their vehicles. Travel management decisions would need to take into account elk security as an issue with regard to miles of system roads and motorized trails in an area.

Management Area 5.4 (Plant and Wildlife Habitat Forest Products), found only in Alternative E, has several guidelines with regards to route density and stream crossings. An open summer motorized route density of 1.0 mile per square mile should not be exceeded (calculated at the 6th level HUC watershed within the management area). In addition, for roaded and motorized trail stream crossings, an average density of .5 crossings per square mile (calculated at the 6th level HUC watershed within the management area) should not be exceeded.

A GIS-based effects analysis conducted with regard to the summer motorized route density indicates that only the North Piney 6th level HUC watershed exceeds the 1.0 mile of open motorized summer route / square mile threshold, and only by a slight amount (1.028), with the rest of the watersheds significantly below this threshold. None of the 5.4 management area acreage within individual 6th level HUC watersheds exceeds the stream crossing density guideline. Additional discussion regarding both of these guidelines can be found in the wildlife section of this document.

In winter, the need for protecting critical big game winter ranges from disturbance by motorized uses can directly affect winter recreation opportunities. Effects from wildlife management pertaining to snowmachine recreation are discussed in more detail in the "Winter Recreation" effects section.

Ski areas have the potential to affect lynx denning, foraging, and security habitats, and their ability to move between areas. The stipulations found in the Northern Rockies Lynx Amendment and incorporated into forestwide standards and guidelines pertain to expansion of existing ski areas and requires that certain types of lynx habitat be retained, and that expansion not create barriers to lynx movement and dispersal. Given that Antelope Butte ski area is located within a Lynx Habitat Unit (South Tongue / Shell LHU) it would be subject to these requirements across all alternatives under any proposed expansions in the future. Big Horn Mountain Ski Area is not located within a LHU and as a result would not be subject to these requirements.

In addition to prohibitions on winter snowmobile travel, in MA 5.41 (Deer and Elk Winter Range), special use-permitted activities are limited during the winter and spring periods. New development of roads, trails and recreation facilities are discouraged. The amount of MA 5.41 by alternative is shown in the following table.

Table 3-114 Deer/elk winter range acreage by alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
Total acres	27,680	28,213	21,325	28,852	23,452

Effects from Scenery Management: A primary contributor to whether or not a recreationist has a satisfying experience on the Forest is the quality of the scenery. A primary reason for tourists to visit the Bighorns is the opportunity to view scenery. During the past decade, viewing scenery has been one of the fastest-growing categories of recreation use on the Forest.

Management activities which alter the landscape from a natural appearance to a more modified landscape can adversely affect the scenic experience of visitors to the Bighorn National Forest.

Alternative C would have the least short-term potential effect on the natural-appearing landscape of the Bighorn National Forest, whereas Alternative E would have the most effect. Within this range, Alternatives B, D, and A would have impacts to scenic opportunities, in order of least to greater potential impacts.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered with regard to cumulative effects to recreation. The next 15 years are considered the time span for "reasonably foreseeable future" cumulative effects.

Forestwide ROS Shift: Past project-level decisions (primarily timber management and road construction) on the Bighorn National Forest have resulted in a shift in forestwide Recreation Opportunity Spectrum (ROS) composition in many areas from the primitive and semi-primitive classes to the more developed classes (roaded modified and roaded natural ROS classes). This has been a long-term trend and one which is likely to continue, although to varying degrees based on the alternative chosen.

As discussed in the general effects portion of this section, the existing forestwide ROS composition would experience the least amount of shift in alternative C, followed by B, D, A and E, which would see the greatest potential over the long-term, for loss of non-Wilderness primitive and semi-primitive ROS acreage. This is primarily due to the differing level of management activities (particularly timber management and associated roading) that would take place in the various alternatives.

Off trail travel ("C areas") – past actions: In 1989 there were about 200,000 acres open to other than snowmobile off-road motorized use. Decisions such as the closure of the Lost Fire area due to vegetation, soil, and water quality impacts caused by off-road summer travel, and the Little Goose area closure reduced that opportunity to 140,000 acres as of August 1, 1997.

Further area closure resulted when the Caribou Timber sale took place in 1998. 18,000 additional acres of "C area" were converted to "A area" requiring that motorized travelers remain on system roads and trails, other than snowmobiles on snow. This particular action was proposed as a mitigation to the thinning of the forested stands by the timber harvest, which had the potential to open up the stands enough to invite and increase the amount of off-road travel.

The Tongue District of the Bighorn National Forest signed a decision notice in 1997 for the Little Goose/Park Reservoir Environmental Assessment that changed cross-country travel on 60,000 acres to travel on roads and trails. The decision also identified miles of trail for motorized and nonmotorized use to separate conflicts from the guest ranch

providing trail rides from an area that receives a substantial amount of atv and motorcycle use. This project successfully collaborated with users and stakeholders.

The Medicine Wheel/Paintrock District of the Bighorn National Forest signed a decision notice in 2002 for the Battle Park Environmental Assessment. This decision separated the nonmotorized and motorized users by designating trail use.

The "C areas" are being addressed in a forestwide standard in all alternatives. As a result, no variance in this effect is anticipated and no reasonably foreseeable future actions to address "C areas" will take place once the Plan is revised since there will be no more "C areas" on the Forest.

Coalbed methane development implications: A group of oil and gas companies has notified the Bureau of Land Management (BLM) and U.S. Forest Service of their intent to develop additional coal bed methane (CBM) resources in Wyoming's Powder River Basin. The Proposed Action, as analyzed by the BLM, includes drilling, completing, operating and reclaiming almost 39,400 new CBM wells and constructing various ancillary facilities needed to support the new wells. The Proposed Action would occur in a project area of almost 8,000,000 acres. Drilling was scheduled to begin in 2002 and continue for 10 years. This is likely to occur irregardless of alternative.

In its January 2003 Final Environmental Impact Statement regarding the Powder River Basin Oil and Gas Project, the BLM's Wyoming State Office arrived at several conclusions with regard to cumulative effects that are pertinent to consider within the framework of recreation implications for the Bighorn National Forest.

- **Population:** BLM 2003 FEIS – "The project is expected to result in significant short-term effects to local populations. Assuming the population directly corresponds to workers associated with the project, the population in the region would peak in 2007 and then gradually decrease. It is assumed that most existing full-time workers would be recruited from communities within the Project Area (all or parts of Campbell, Converse, Johnson and Sheridan Counties) and that construction employment and contractors would be available in the region. To the extent that additional non-local contractors or permanent employees are needed, they may relocate to the area for a limited period (2 to 5 years) during the major construction phase of the project…Up to 2,660 workers would be required during peak employment, in addition to the existing 2,943 workers in the region. Assuming each worker brings one person to the region, the population would increase by 5,320 in the peak year (2007), which would result in a 7 percent incremental increase in population between 2000 and 2007 from the project. After 2007, the population associated with the project would be expected to gradually decrease. During the short term, this increase in population will be noticeable in some communities and could result in hardships to the local governments, if adequate planning has or does no occur. However, in the long term, the project will not have significant long-term effects to local populations." (BLM, 2003).
- **Associated Bighorn NF cumulative recreation effects:** This increase in regional population of approximately 7% will likely be comprised of a younger demographic

with a fair amount of disposable income given the $40,000 average annual income associated with CBM activities that the 2003 BLM FEIS bases its economic assumptions on.

A younger (i.e. working age), financially robust demographic such as this can be expected to place a high level of importance on outdoor recreation (Cordell and Overdevest, 2001). Based on this, as well as the close proximity of the Bighorn NF to the CBM Project Area, recreational use is likely to increase in the Bighorn NF as a result of CBM development in the coming years.

It is difficult to predict exactly how increased local population will affect visitation on the Forest, but typically, as local populations increase, so too does forest visitation.

Wyoming State ORV program: As of January 1, 2002, all ORVs (ATVs, dirt bikes, and other unlicensed ORVs) are required to display a Wyoming ORV permit while operating on public lands and other designated trails and areas, mirroring the current snowmobile registration requirements. Just as snowmobile use has increased dramatically in the 1990s, ORV use will likely continue to increase due to increase in information and advertising by the State Division of Tourism.

Potential adverse effects that could be anticipated as a result of greater information/promotion include additional users at trailhead facilities as well as a higher number of encounters on open roads and trails, which could increase the perception of crowding.

Potentially positive effects that could be anticipated include the chance of additional funds to benefit the trail system on the Bighorn National Forest in the form of signage, enhanced education and enforcement initiatives, and additional improvements in trail opportunities (through construction or reconstruction as opportunities arise.)

Management of Yellowstone Snowmobiling Opportunities: On March 25th 2003, the National Park Service released its Record of Decision allowing continued, albeit modified, snowmobile use in Yellowstone and Grand Teton national parks as well as the John D. Rockefeller Jr., Memorial Parkway. On December 16th, 2003, a U.S. District Judge struck down the rule proposal and replaced them with the rules promulgated during the Clinton Administration which will lead to a total ban on snowmobiles in the Park. In February, a federal district judge issued a temporary restraining order setting aside the Clinton rules and instructed the National Park Service to develop temporary rules for the rest of the 2004 season. Based on these developments, it is likely that further changes will occur before any final resolution is reached.

While any change regarding snowmobiling opportunities in a premier winter recreation destination such as Yellowstone National Park could have the potential for an effect on winter recreation on the Bighorn NF, it should not be a dramatic effect on the Bighorn NF's winter recreation experience although some increase may be expected due to displaced users.

A 2000-2001 study by the University of Wyoming determined that Yellowstone National Park was not a primary destination for most nonresident snowmobilers, accounting for only 3.5% of total trips in 2000. For nonresidents, the most popular new trails to visit in Wyoming were the Snowy Range (31%), the Northern Bighorns (17%), Togwotee (17%), Dubois (15 percent), Gros Ventre (10%) and Yellowstone National Park (9%). The primary reason given for trying a new trail was to experience a new area (87%). Lack of crowds was not a major determinant in choosing a new trail system, with only 20% of nonresidents indicating that the reason for trying a new trail was that it was less crowded (McManus et al. 2001).

In other words, the influx of additional snowmobilers (3.5% of nonresidents) that would be displaced to other Forests based on the study mentioned in the preceding paragraph (assuming they would not "stay at home" and snowmobile but instead visit Wyoming even if their primary destination is no longer open to snowmobiling) would be relatively small as the "typical" snowmobile clientele of Yellowstone is somewhat different from that of the typical snowmobiler who frequents the Bighorn National Forest, where many snowmobilers relish the challenge that deep powder presents and do not always remain on system routes. This sort of opportunity is not currently available in Yellowstone, since travel is restricted to designated snow routes.

A slight variance in the ability to accommodate additional snowmobile demand exists among alternative in terms of the available acreage that is open to snowmachine travel. The most Forest acres would be open to snowmachine travel in Alternatives A and E, followed (in order) by Alternatives D, B, and C. However, since the relatively small influx of "typical" Yellowstone snowmobilers would be more likely to remain nearer to designated routes given the type of snowmobiling oppportunities that they have experienced in Yellowstone in recent years (no off-trail travel), they should not have a noticeably different experience based on the alternative chosen since the amount of snowmobile trail mileage will not noticeably vary by alternative.

BLM proposed trail projects on western boundary of Bighorn National Forest: The BLM is planning to implement two trail relocation/trailhead construction projects on the west face of the Bighorns on BLM land abutting up to the National Forest. They will involve the Cottonwood Creek trail and the Hayes trail. The trails will remain nonmotorized use. Possible effects include improved ease of public access to the northwest portion of the Bighorn National Forest as well as the need for placement of gates or cattle guards at the National Forest boundary fence. It is likely that work will commence in 2004. This is projected to occur irregardless of alternative.

The Future of National Forest Recreation Management: A number of recent trends are having a significant effect on national forest recreation opportunities. Federal budgets are being reduced and are projected to continue declining. The same trend is projected for the size of the federal work force. Therefore, the number of Forest Service recreation professionals available to deliver good quality recreation products and services has fallen. The result is a loss of technical expertise when demand is dramatically increasing. Consequently, the Forest Service is finding it difficult to

maintain the level of visitor services offered in the past, and the backlog in maintenance of recreation facilities has increased (Betz et al. 1999).

In light of this, the importance of developing effective working relationships with volunteer groups cannot be overstated, particularly with regard to trail maintenance efforts on the Bighorn National Forest.

Volunteer groups (Backcountry horsemen, hiking clubs, motorized clubs, etc.) can provide a critical source of human capital to assist the Bighorn National Forest in accomplishing trail maintenance goals. In addition, the State of Wyoming State Trail Crew, funded through a Recreational Trails Program (RTP) grant as well as Wyoming Snowmobile and ORV funds, is available to perform maintenance, rehabilitation and development work.

The above partnership options/strategies mesh well with the 2001 Forest Service Recreation Agenda:

> *"Continuing to support existing and establishing new professionally managed partnerships and intergovernmental cooperative efforts are a significant means to accomplish the recreation job." (USDA Forest Service, 2000)*

These realities will affect the Bighorn National Forest to differing levels based on the alternative chosen. Given that recreation budget levels would be slightly less in alternatives A and E (due to the emphasis placed on timber management and the need to fund a higher level of activity in that program in those alternatives), it would be more difficult to maintain the same level of services as in Alternative C (which would fund the recreation program at the higher level. As a result, this effect would be more exaggerated in alternatives A and E and minimized in Alternative C. Alternatives B and D would likely fund the developed recreation budget at or near current levels.

Research Natural Areas

Introduction

Research Natural Areas (RNAs) are selected to provide a spectrum of relatively undisturbed areas representing important natural ecosystems and environments. RNAs do the following (Forest Service Manual 4063.02):

- To preserve a wide spectrum of pristine areas that represent important forest, shrubland, grassland, alpine, aquatic, geological and similar natural situations that have special or unique characteristics;
- To preserve and maintain genetic diversity;
- To protect against serious environmental disruptions;
- To serve as reference areas for the study of succession;
- To provide on-site and extension educational activities;
- To serve as baseline areas for measuring long-term ecological changes;
- To serve as control areas for comparing results from manipulative research; and
- To monitor effects of resource management techniques and practices.

Areas that had extensive, relatively undisturbed plant communities were identified as potential Research Natural Areas for the Bighorn NF Plan revision. These areas were relatively undisturbed largely due to their unsuitability for other uses, such as timber harvesting, motorized recreation or livestock grazing.

The Forest contracted with the Wyoming Natural Diversity Database (WYNDD) to inventory potential RNA candidates. The WYNDD inventory reports of each potential RNA include detailed descriptions, distinguishing features, acreage by vegetation cover type, and the compatibility of past and present human use with the RNA criteria.

Criteria

The following criteria were used in selecting potential RNAs:

- Quality: How well a site represents the targeted ecosystem type or protected biodiversity elements.
- Condition: How much the site has been degraded or altered from natural or optimal conditions.

- Viability: The likelihood of long-term survival for the ecosystem and its protected biodiversity.
- Defensibility: Extent to which the ecosystem and biodiversity elements can be protected from extrinsic human factors.

Legal and Administrative Framework

36 CFR 219.25 (1982 regulations) - "Forest planning shall provide for the establishment of Research Natural Areas (RNAs). Planning shall make provision for the identification of important forest, shrubland, grassland, alpine, aquatic and geologic types that have special or unique characteristics of scientific interest and importance that are needed to complete the national network of RNAs."

On July 19, 1993, the Chief of the Forest Service issued a national strategy for recognizing the expanding role of RNAs in ecosystem management. Giving Regional Foresters the authority to designate RNAs was an important part of this strategy. On November 1, 1993, the Rocky Mountain Regional Forester and the Director of the Rocky Mountain Forest and Range Experiment Station directed forests in the region to expand the RNA system. The Regional Forester and the Director asked the forests to make a concentrated effort to identify potential RNAs in their forest plan revision processes.

Forest Service Manual, Title 4063 - provides specific direction concerning establishment and management of RNA's.

Key Indicators

- Acres of potential RNAs.
- Location of individual RNAs.
- Trade-off in timber, grazing, recreation, and minerals outputs and accessibility if potential RNAs were designated.

AFFECTED ENVIRONMENT

Beginning in about the mid-1990s, the Bighorn NF considered adding up to eleven potential RNAs during this revision. The following table summarizes a few key characteristics of each potential RNA. The complete WYNDD inventories for each potential RNA are approximately 50 or more pages long, and are available in the project record. Bolded potential RNAs are considered in forest plan alternatives; the other potential RNAs are not considered in any alternative.

Table 3-115. Selected features of existing Bighorn National Forest Research Natural Areas.

Name	Acres	Date Established	Special Features
Bull Elk Park	720	1952	201 acres of disjunct Palouse Prairie Climax; *Agropyron-Festuca* association. Remainder of area is primarily lodgepole pine montane forests.
Shell Canyon	729	1987	Primary reason for establishment is Rocky Mountain juniper community. Most other sites have been seriously disturbed, and Shell is considered to be in good condition.

Table 3-116. Potential RNAs considered for revision on the Bighorn National Forest.

Potential RNAs	Acres	Major Cover Types	Soil Substrate
Lake McClain	**2,302**[20]	**Subalpine/alpine, Lodgepole pine, Spruce-fir**	**Granite**
Leigh Canyon	**1,200**	**Douglas-fir, Cottonwood, Shrub/sagebrush**	**Sedimentary**
Mann Creek	**7,000**	**Douglas-fir, Grass, Ponderosa pine, Limber pine, Shrub**	**Sedimentary**
Pheasant Creek	**9,090**	**Lodgepole/Grouse whortleberry**	**Granite (<10% Sed.)**
Pete's Hole	2,770	Spruce-fir, Sagebrush, Douglas-fir, Limber pine	80%+ Sedimentary, <20% Granite
Dry Fork	10,190	Douglas-fir, Grass, Sagebrush	Sedimentary
Elephant Head	9,660	Grass, Spruce-fir, Sagebrush, Rocky Mountain juniper, Cottonwood	Sedimentary
Devil's Canyon	~6,000	Spruce-fir, Douglas-fir, Limber pine, Aspen, Grass, Sagebrush	75% Sedimentary, 25% Granite
Tongue River	5,660	Douglas-fir, Grass, Ponderosa pine, Cottonwood, Limber pine	80% Sedimentary, 20% Granite
Crazy Woman	1,580	Lodgepole pine, Ponderosa pine, Cottonwood, Shrub	50% each
Poison Creek	2,330	Lodgepole pine, Grass, Aspen	85% Granite, 15% Sed.

[20] The ecological evaluation for Lake McClain included about 6,200 acres within the Cloud Peak Wilderness, but the portion of the potential RNA within the Wilderness is not recommended in the Revised Plan for RNA designation.

ENVIRONMENTAL CONSEQUENCES

General Effects

Alternatives A, E, and No Action maintain only the acreage of the existing RNAs – the Bull Elk Park and Shell Canyon Research Natural Areas. Alternatives B, C, and D with about 21,021 acres would provide for the most existing and proposed RNAs. The rationale for selecting the same four RNAs in alternatives B, C, and D is that those four areas represent the primary vegetation and substrate types that occur on the Bighorn NF, thus providing for a 'coarse-filter' baseline to use as an RNA system. The following table summarizes the proposed RNA acres by alternative.

Table 3-117. Approximate Acres of RNAs by Alternative.

Research Natural Area	No Action	Alt A	Alt B	Alt C	Alt D	Alt E
Bull Elk Park	720	720	720	720	720	720
Shell Canyon	729	729	729	729	729	729
Lake McClain	0	0	2302	2302	2302	0
Leigh Canyon[21]	0	0	1200	1200	1200	0
Mann Creek	0	0	7000	7000	7000	0
Pheasant Creek	0	0	9090	9090	9090	0
Total Acres of RNAs[22]	1,449	1,449	21,021	21,021	21,021	1,449
Total Acres of Management Area 2.2[23]	NA	1,618	21,190	21,188	21,190	1,618

Source: Bighorn NF GIS database

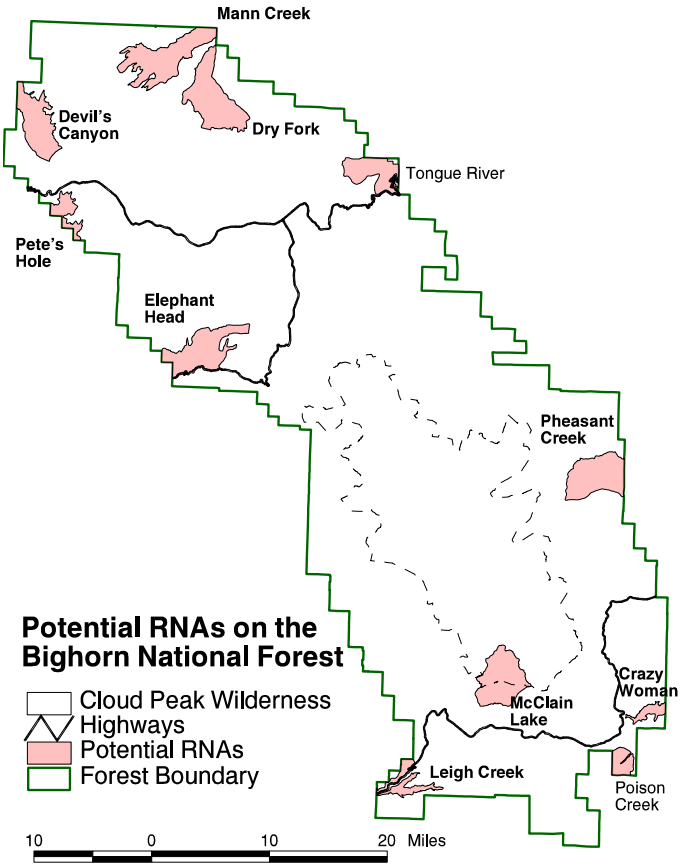
The following figure displays the location of the potential RNAs.

[21] Ecological evaluation is labeled as "Tensleep Canyon". However, Tensleep Canyon itself is not suitable, due to highway, old highway, exotic species, and cattle trailing.

[22] The GIS calculated size of Management Area 2.2 for the Bull Elk Park and Shell Canyon RNAs totals 1618 acres, which is an approximation of the actual acreage of 1449 acres shown in the establishment records. This line shows the total proposed and existing RNA acreage using the establishment record estimated size for the two existing RNAs.

[23] This line is the GIS calculated size of the 2.2 Management Area for each alternative. It differs from the preceeding line by the 169 acre discrepancy between the establishment record estimated size of Bull Elk Park and Shell Canyon and the GIS calculated size of those areas.

Map 3-1. Potential RNAs on the Bighorn National Forest.



When possible, the boundaries of each potential RNA were aligned with manageable, identifiable locations on the ground. Prior to the ecological evaluation for RNA suitability, areas were reviewed to determine if past or current activities, such as roads, logging or active grazing allotments, would conflict with potential RNA designation. Vacant allotments, or areas outside allotment boundaries, were favored for consideration of RNA designation to lessen the impacts on the Forest grazing program, and because there would be less impact from past activities. The size of each potential RNA was designed to maintain ecosystem processes and landscape scale natural disturbance patterns, where feasible.

Direct and Indirect Effects

The intent of RNAs is to provide for baseline ecological processes and systems. Humans are intervening in every ecosystem globally, so it is important to provide some representative areas that are close to 'natural' in order to make sustainability determinations on lands more actively managed. They are managed to maintain natural and relatively pristine pre-settlement conditions, while allowing ecological processes to prevail with minimal human intervention. However, under some circumstances, deliberate manipulation may be utilized to maintain the ecosystem or unique features for which the RNA was established or to re-establish natural ecological processes. Vegetation, habitat, soil productivity, water quality and ecological processes are to be in a natural condition or in as close a natural condition as practicable. Heritage resources are generally protected by RNA designation since ground-disturbing activities are limited.

A variety of uses, including most nonmotorized recreation activities, are allowed in RNAs as long as the activity or uses do not become a threat to the values for which the RNA was proposed and as long as RNA management plan direction is followed.

Effects from Facilities Management: Buildings and developed recreation sites are prohibited, unless there are exceptional circumstances that do not threaten the values for which the RNA was proposed. No known adverse effects from facilities are expected in any of the alternatives.

Effects from Fire and Fuels Management: Human-caused wildfires would be controlled in all alternatives. Where excessive fuel build-up from past wildfire suppression threatens the RNA with uncharacteristic fire intensities, fires would be controlled.

The use of scheduled prescribed fire may be permitted to restore a natural fire regime or to reduce unnatural fuel loads in all alternatives dependent on the objectives for each of the nominated or proposed RNAs. Fire control techniques would be used that minimize ground disturbance. Natural barriers would be used to confine or contain fire where possible.

Effects from Fish and Wildlife Management: Habitat manipulation for wildlife is prohibited unless it is specifically needed to restore or maintain natural ecosystem conditions. Habitat manipulation is allowed if specifically designed for the protection of threatened, endangered, or sensitive species. No known adverse effects are expected from fish and wildlife management for any alternative.

Effects from Insect and Disease Management: Natural outbreaks of native insects and disease are allowed to proceed without intervention, unless they are a substantial threat to important resources inside or outside the RNA boundary. Control methods would be designed to minimize disturbance. No known adverse effects are expected from insect and disease management in any alternative.

Effects from Oil, Gas, and Minerals Management: Oil and gas leasing is allowed however, no ground disturbing activities are permitted within the boundaries of the RNA. Protecting recommended Research Natural Areas to maintain their consideration for designation would impact oil and gas exploration in proportion to the number of acres where surface occupancy is prohibited. Alternatives B, C, and D have the most acres with the No Surface Occupancy stipulation allocated to this management area. Since there has been no oil and gas activity on the Bighorn NF in at least twenty years, there is expected to be no impact to oil and gas leasing from the designation of RNAs under any alternative.

When withdrawal from locatable mineral entry is necessary to protect the values for which the area was designated, a request for withdrawal from mineral entry will be in conformance with Section 204 of the Federal Land Policy and Management Act of 1976 (PL 94-576).

Extraction of salable mineral (sand gravel, hard rock for crushing, and landscape materials) would not be allowed in RNAs.

Effects from Livestock Grazing and Big Game Use : The potential RNAs included in Alternatives B, C, and D are either not within active allotments, or they are not accessible or used by domestic livestock. The use of grazing as a management tool – on an incidental or infrequent basis – may be needed to achieve rangeland vegetation management objectives over all or a part of the area. However, it is anticipated that this would rarely, if ever, be implemented. The management plan for each RNA will detail what level of livestock use is provided for in that area.

The only change to current grazing practices anticipated is in the potential Lake McClain RNA. Currently, that is a vacant allotment, but it is utilized most years by adjacent sheep permittees in order to reduce the grazing duration on the permitted allotment. Under Alternatives B, C, and D, the permittee would not be allowed to graze within the RNA boundary. There would be no impact on the current grazing use under the No Action Alternative and Alternatives A and E.

Effects from Recreation Management: The Forest Service would not actively advertise RNAs as destinations for recreation use. However, existing non-vehicular recreation use would be allowed as long as the use does not pose a threat to the values for which the RNA was proposed. Current levels of horseback riding, hunting, hiking, fishing, camping, and related low-impact uses by the public would be allowed to continue. If resource degradation develops from increased use, the public would be encouraged to shift use to other, less impacted areas or administrative closures might be imposed.

Trails that exist prior to RNA designation are allowed for recreation, scientific, or educational access, except when they are a threat to the values for which the RNA was proposed. The construction of new trails is prohibited except when necessary to correct resource damage occurring from existing trails.

Motorized use is not allowed in RNAs, unless necessary for research or authorized administrative access. Physically challenged individuals who require motorized transportation will not be able to access these public lands.

Effects from Special-Use Management: Proposals for non-manipulative research would require approval of the Rocky Mountain Research Station Director and the applicable Forest Service authorized officer. Special use permits are required for the collection of all products as well as for many other types of commercial uses.

Effects from Threatened, Endangered**, and Sensitive Species Management:** Populations of federally listed threatened and endangered species located within any of the proposed RNAs will be protected according to stipulations under the Endangered Species Act and applicable forest-wide standards and guidelines. Sensitive species located within any of the proposed RNAs will be protected by applicable forest-wide standards and guidelines. The overall effect of RNA designation would provide additional protection for these species.

Effects from Timber Management: The proposed RNAs are not available for timber harvest. The following table lists the approximate amount of tentatively suitable acres in each of the RNAs. Although these lands are tentatively suitable, they would not be available for timber harvest if the RNAs were established.

Table 3-118. Summary of tentatively suitable timber acres by RNA.

Proposed RNA	Total Acres Tentatively Suitable
Lake McClain	0
Leigh Canyon[24]	87
Mann Creek	181
Pheasant Creek	5,299
Total	5,567

Source: Bighorn NF GIS database

Effects from Travel Management and Motorized Use: New road construction in RNAs would be prohibited. Existing roads are restricted from motorized use or decommissioned except when needed for necessary scientific, educational, or administrative purposes. Unclassified roads or trails (routes not on the Bighorn National Forest transportation system) within proposed RNAs would be decommissioned, although there are not believed to be any in the four RNAs proposed under Alternatives B, C, and D.

Effects from Wilderness Management: The ecological evaluation for Lake McClain included part of the Cloud Peak Wilderness. However, in order to eliminate the management complexity of having two important management objectives upon the area, it was decided in the final boundary determination of the Lake McClain RNA to exclude the portion within the wilderness from RNA designation. The ID team felt the RNA values could be protected in that area by the wilderness designation. Therefore, there is no effect, either to the RNA management or to wilderness management, caused by the designation of RNAs.

Cumulative Effects

Cumulative effects resulting from designation of RNAs would include present and future loss of commodity production (principally wood products and grazing products), although these effects are small due to the negligible level of these activities currently occurring. Recreational pursuits in the future could be affected by some of the limitations prescribed by RNA direction on types of recreation allowed and limits on accessibility, but only if future use levels substantially increase over present levels. Designation of RNAs will add to the acreage on the forest where ecological processes are largely unaffected by human influences.

[24] Ecological evaluation is labeled as "Tensleep Canyon". However, Tensleep Canyon itself is not suitable, due to highway, old highway, exotic species, and cattle trailing.

Ecological assessments show that within the Bighorn Ecological Section, the Bighorn NF is a relatively distinct ecosystem – that is, high elevation, subalpine forests. The four RNAs considered in alternatives B, C, and D provide a representative baseline of coarse filter forest types and geologic substrate.

The Bureau of Land Management maintains a system of "Areas of Critical Environmental Concern" that have management objectives similar to the Forest Service RNA system. The Worland District of the BLM manages following areas of critical environmental concern in the Big Horn basin:

- Spanish Point Karst
- Big Cedar Ridge Fossil Plant
- Red Gulch Dinosaur Track

No other Areas of Critical Environmental Concern are currently proposed on BLM managed lands in the Powder River Basin or Big Horn Basin.

Roadless Areas

Introduction

This section describes the inventory of roadless areas completed for forest plan revision. The inventory includes 20 areas totaling 377,471 acres or 34 percent of the Bighorn National Forest. The effects of alternatives on the inventoried roadless areas are discussed.

Legal and Administrative Framework

The Forest Service is required to inventory, evaluate and consider all roadless areas for possible includion in the National Wilderness Preservation System.

The Wilderness Act of 1964 (P.L. 88-577) gives the statutory definition of wilderness. Section 2(c): "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined in this Act, as an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements of human habitation, which is protected and managed so as to preserve its natural conditions and which:

- Generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable;
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation;
- Has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and
- May also contain ecological, geological, or other features of scientific, educational, or historical value."

The 1984 Wyoming Wilderness Act (PL-98-550) designated the Cloud Peak Wilderness on the Bighorn National Forest. The act includes the following release language:

> "National forest areas not designated wilderness or wilderness study by this Act are released for multiple use management and need not be managed to protect their suitability for wilderness designation prior to or during revision of the initial land management plans."

The act further states:

> "The Secretary of Agriculture shall again review wilderness options for the national forest lands when the forest management plans are revised …If, in the revision of management plans, areas are recommended for wilderness, those areas are to be managed to protect their wilderness suitability. Areas not so recommended at the time need not be managed to protect their suitability for wilderness designation."

The Code of Federal Regulations at 36 CFR 219.17(a) states that "…roadless areas within the National Forest System shall be evaluated and considered for recommendation as potential wilderness during the forest planning process."

Forest Service Handbook (FSH) 1909.12.7.1 directs national forests to "…identify and inventory all roadless, undeveloped areas that satisfy the definition of wilderness found in section 2(c) of the 1964 Wilderness Act." It also describes capability, availability, and need assessments for roadless areas

Key Indicators

- Acres determined to be capable and available for wilderness designation.
- Acres recommended for wilderness designation.
- Roadless acres in management allocations that generally retain roadless characteristics consistent with the Roadless Area Conservation Rule.
- Roadless acres in management allocations that generally retain the potential to be capable and available for wilderness designation.

Historical Summary

On September 3, 1964, the Wilderness Act (P.L. 88-677) established the National Wilderness Preservation System. It provides a management philosophy and direction for designated wilderness areas.

In 1970, the Forest Service studied all roadless and undeveloped areas in the National Forest System greater than 5,000 acres for the purpose of prioritizing areas with strong wilderness characteristics for further study. This study, known as the Roadless Area Review and Evaluation (RARE), was halted after a legal challenge.

In 1977, the Forest Service embarked on another nationwide Roadless Area Review and Evaluation (RARE II) to identify roadless and undeveloped areas that were suitable for inclusion in the National Forest Wilderness Preservation System. RARE II inventory was completed in 1979. It included 17 roadless areas and a total of 689,770 acres.

In the late 1970s, the Bighorn National Forest began the development of a land and resource management plan for the Forest, which included an evaluation of roadless areas. Volume II-Appendix M of the Draft Environmental Impact Statement for the Forest Plan containing roadless area information was completed and released to the

public on August 8, 1984. The appendix inventoried and evaluated 17 roadless areas with a total of 681,068 acres.

Congress passed the Wyoming Wilderness Act of October 30, 1984 (P.L. 98-550), designating the 189,039-acre Cloud Peak Wilderness. The Cloud Peak Wilderness designated by Congress included the Cloud Peak Primitive Area, the Seven Brothers area and some additional acreage contiguous with the primitive area. The act also released all remaining (non-wilderness) roadless areas for multiple use management. This action effectively ended further analysis of roadless areas in the 1985 forest planning process.

The Final Environmental Impact Statement and Forest Plan were completed and released with a Record of Decision dated October 4, 1985. The Wyoming Wilderness Act was recognized in the final 1985 Forest Plan and all roadless areas outside of Cloud Peak Wilderness were allocated for non-wilderness management areas. Of the 623,014 roadless acres allocated for multiple use, about 587,000 acres were included in management areas allowing road construction and reconstruction, and about 34,000 acres were included in management areas that do not allow road construction and reconstruction.

The 1985 Forest Plan included a wild and scenic management area for a portion of the Little Bighorn roadless area. A 1989 *Wild and Scenic River Study Report and Final EIS on the Little Bighorn River* recommended portions of the Little Bighorn River and the Dry Fork of the Little Bighorn for designation. No areas were recommended for wilderness designation.

The Final EIS for the Roadless Area Conservation Rule (RACR) published in November 2000 included a map of inventoried roadless areas based on the 1984 Bighorn Forest Plan DEIS – Appendix M. The Roadless Area Conservation Rule (36 CFR Part 295) was published January 12, 2001. The rule applies to the roadless areas mapped in the Final EIS.

The Roadless Area Conservation Rule (RACR or roadless rule) prohibits road construction and road reconstruction in inventoried roadless areas except:

- To protect health and safety in cases of imminent threat of flood, fire or other catastrophic event that, without intervention, would cause the loss of life or property.
- To conduct environmental clean up required by federal law.
- To allow for reserved or outstanding rights provided for by statute or treaty.
- To prevent irreparable resource damage by an existing road.
- To rectify existing hazardous road conditions.
- Where a road is part of a Federal Aid Highway project.
- Where a road is needed in conjunction with the continuation, extension, or renewal of a mineral lease on lands that are under lease, or for new leases issued immediately upon expiration of an existing lease.

The rule also prohibits cutting, sale, and removal of timber in inventoried roadless areas except:

- For the cutting, sale or removal of generally small diameter trees which maintains or improves roadless characteristics and:
  - To improve habitat for threatened, endangered, proposed, or sensitive species, or
  - To maintain or restore ecosystem composition and structure, such as reducing the risk of uncharacteristic wildfire effects.
- When incidental to the accomplishment of management activity not otherwise prohibited by this rule.
- For personal or administrative use.
- Where roadless characteristics have been substantially altered in a portion of an inventoried roadless area due to construction of a classified road and subsequent timber harvest occuring after the area was designated an inventoried roadless area and prior to the publication date of this rule

Litigation concerning the roadless rule began shortly after publication. The most recent judicial decision (July 13, 2003) was issued by the Judge Brimmer, United States Federal District Court, Wyoming. It permanently enjoins the implementation of the Roadless Rule nationwide. As of the date of writing (March 26, 2004) no direction has been issued by the Forest Service for special management of inventoried roadless areas identified in the Roadless Area Conservation FEIS. If the rule goes into effect and is implemented at some future time, its prohibitions will apply within the boundaries of the inventoried roadless areas published in the Forest Service Roadless Area , Final Environmental Impact Statement, Volume 3, dated November 2000, which are held at the national headquarters office of the Forest Service, or any subsequent update or revision of those maps.

Explanation of Acreages and Data Sources: The information in the tables, figures and maps was generated from a variety of sources, including several different Geographical Information System (GIS software platforms), tabular databases, and data from a variety of models used in planning analysis. The acreage figures from the various sources do not match exactly in all cases. However, when added, acres of the National Forest System lands (regardless of the source) are within acceptable margins of error.

AFFECTED ENVIRONMENT

On many National Forests including the Bighorn, roadless area management has been a major concern for land management planning and program development. Roadless areas are valued for many resource benefits including their undeveloped fisheries and wildlife habitat, biological diversity, and nonmotorized recreation. The same areas are also valued for their development potential, particularly for wood products and

motorized recreation. Controversy continues to accompany most proposals to harvest timber, build roads, or otherwise develop inventoried roadless areas.

During forest plan revision, the Forest Service is required to inventory, evaluate, and consider roadless areas for possible inclusion in the National Wilderness Preservation System (36 CFR 219.17)

Inventory of Roadless Areas for the Forest Plan Revision

Areas included in the forest plan revision inventory of roadless areas met the following criteria from the Wilderness Act and FSH 1909.12:

- Areas contain 5,000 acres or more.
- Areas contain less than 5,000 acres, but are contiguous to the existing wilderness or areas recommended for wilderness in other federal ownerships.
- Areas do not contain classified roads. Inventoried roadless areas may contain motorized and non-motorized trails and user created roads. (Classified road are roads wholly or partially within or adjacent to National Forest System lands that are determined to be needed for long-term motor vehicle access, including State roads, county roads, privately owned roads, National Forest System roads, and other roads authorized by the Forest Service. [36 CFR 212.1]).

Roadless areas may contain improvements such as motorized trails, unautorized, user-created roads, fences, outfitter camps, and evidence of historical logging activities. Recent timber harvest areas, utility corridors, ski areas, and large reservoirs were excluded from the inventory. The following table and map show the twenty areas included in the revision inventory. Descriptions of areas are in Appendix C.

Map 3–2. Roadless areas on the Bighorn National Forest

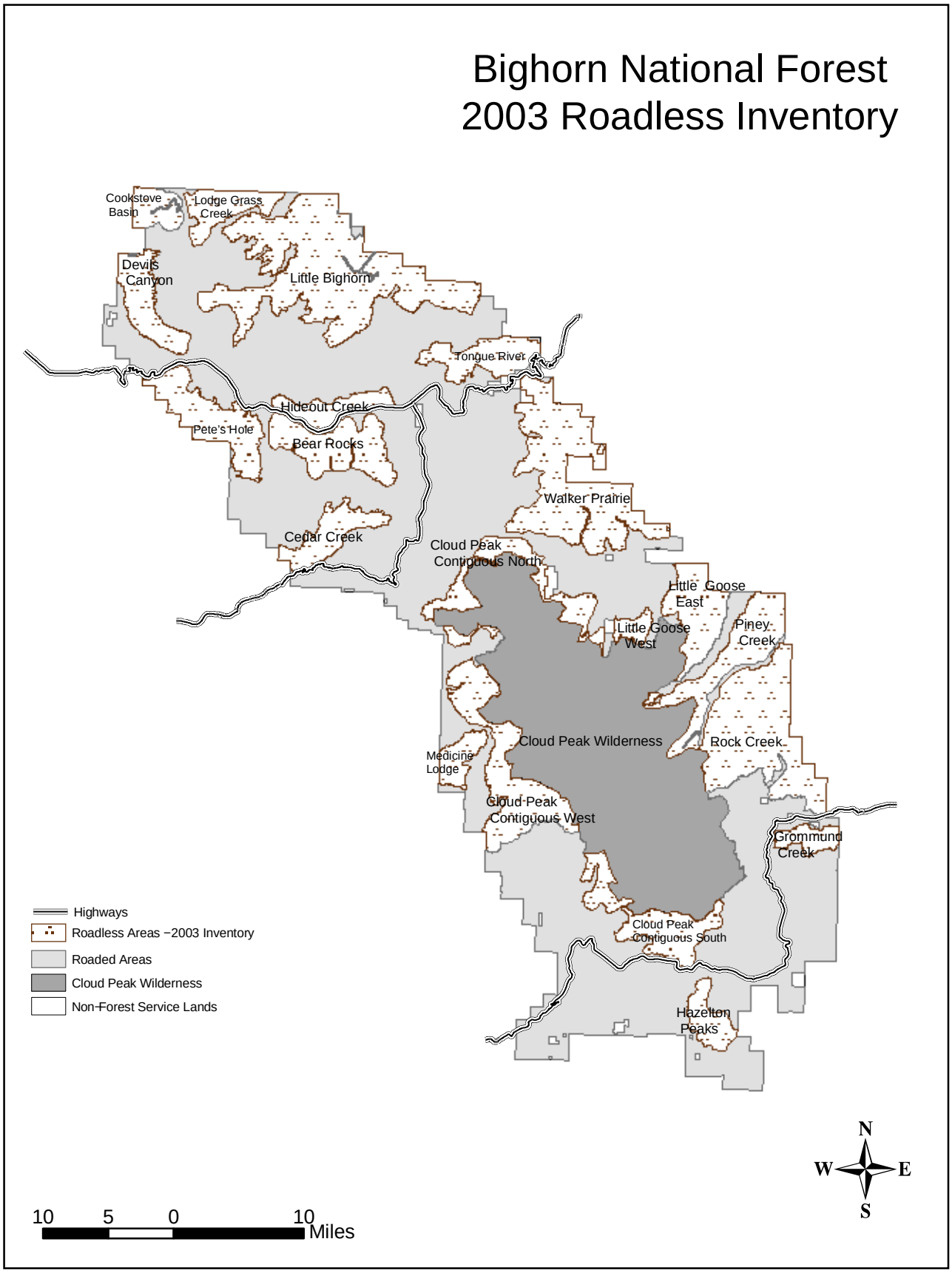


Table 3-119. Forest plan revision - roadless areas with area numbers and acreages.

Area Number	Inventoried Roadless Area - Name	Acres
BH020	Little Bighorn	67,149
BH021	Devil's Canyon	12,476
BH023	Walker Prairie	46,559
BH025	Hideout Creek	8,559
BH026	Bear Rocks	19,501
BH029	Piney Creek	20,933
BH030	Little Goose East	15,521
BH031	Cloud Peak Contiguous North	16,564
BH032	Rock Creek	42,377
BH033	Grommund Creek	5,068
BH036	Hazelton Peaks	7,230
BH040	Little Goose West	3,154
BH041	Cloud Peak Contiguous West	28,345
BH042	Medicine Lodge	5,997
BH043	Tongue River	12,424
BH044	Lodge Grass	10,045
BH045	Cookstove Basin	6,655
BH046	Pete's Hole	19,065
BH047	Cedar Creek	11,115
BH048	Cloud Peak Contiguous South	18,734
	Total Acres	377,471*

Source: GIS Inventory

The 377,471 inventoried roadless acres are 34% of the total Bighorn National Forest area. The Roadless Area Conservation EIS and the resulting rule used an older, 1984 inventory of 621,000 acres or 56% of the forest. The more recent inventory area is smaller for a variety of reasons: A partial list includes development of new roads, new timber harvest, exclusion of classified roads, and adjustments for managable boundaries (see map on preceding page).

Acres Determined To Be Capable and Available for Wilderness Designation

Each of the 20 inventoried roadless areas was studied to determine its potential for wilderness designation. All roadless areas were assessed for capability and availability. Those found to be both capable and available were assessed for a need to recommend them for wilderness designation. The steps are described below.

- **Capability** is the degree to which a potential wilderness contains the basic characteristics that qualify it for wilderness designation, without regard to its availability. Factors such as opportunity for solitude, natural character, physical challenge, primitive recreation opportunities, environmental features, and manageability were analyzed and evaluated for each area.
- **Availability** is conditioned by the value of and need for the wilderness resource compared to the value of and need for other resources. To be available for wilderness, the values of the wilderness resource should offset the value of resources that formal wilderness designation would forego. Lands that are considered better suited for development and management other than wilderness, or committed for purposes not in concert with the requirements of the Wilderness Act, may be determined as unavailable for wilderness
- **Need** analysis considers public involvement. It compares geographic distribution of wilderness areas with the demand for additional wilderness recreation opportunities on the forest. Need analysis also considers the opportunity to include examples of landforms and ecosystems not previously included in wilderness areas. The need analysis does not represent a decision to recommend, which is outside the inventory and analysis process.

The capability and availability study resulted in identification of eight areas on the Bighorn National Forest as capable of and available for wilderness recommendation (see table below). These areas contain a total 214,783 acres or 19% of the total forest acres.

Table 3-120. Roadless areas capable of and available for wilderness recommendation.

	Inventoried Roadless Area - Name	Acres	Adjacent Wilderness or area recommended for wilderness designation
1	Little Bighorn	67,149	None
2	Devil's Canyon	12,476	None
3	Walker Prairie	46,559	None
4	Rock Creek	42,377	Cloud Peak
5	Medicine Lodge	5,997	Medicine Lodge*
6	Lodge Grass Creek	10,045	None
7	Pete's Hole	19,065	None
8	Cedar Creek	11,115	None
	Total Acres	214,783	

Source: GIS Inventory

* *An adjacent area – also named Medicine Lodge - was recommended for wilderness designation by the Bureau of Land Management. The BLM area includes 3,600 acres. Combined the two areas would total 9,597 acres.*

ENVIRONMENTAL CONSEQUENCES

General Effects

Areas Recommended for Wilderness

In Alternative C, five areas are assigned to MA 1.2 Recommended Wilderness. These areas include portions of the Little Bighorn, Rock Creek, Walkers Prairie, Devil's Canyon and Medicine Lodge roadless areas. A "Recommended Wilderness" management area allocation does not create a wilderness. Congress must pass legislation designating wilderness. An MA 1.2 allocation protects the values that make the area suitable for wilderness designation.

The areas recommended for wilderness were identified using indications of public support and each area's combination special features. Special features included large areas or topography that provided opportunities for solitude and primitive recreation; under-represented geology and landforms – particularly sedimentary geology and canyons; and boundaries contiguous with existing wilderness or areas recommended for wilderness.. The presence of wildlife species, including Yellowstone cutthroat trout, water vole, sage grouse, marten or bighorn sheep, as well as records of wolverine sightings were considered. Sensitive plants, rare taxa and their representative vegetation communities were also considered. The presence of cover-types under-represented in existing wilderness – grasses, sagebrush, aspen, cottonwood/willow, douglas fir, limber pine, ponderosa pine, and pinyon-juniper were special features. For details on the special features of each area refer to DEIS Appendix C, Roadless Area Management.

Three areas suitable for wilderness designation – Lodge Grass Creek, Pete's Hole, and Cedar Creek – were not recommended for designation in any alternative. These areas generally did not possess special features that were substantially different from, or of greater quality than, those in the areas included in Alternative C. For a more detailed discussion, refer to the needs analysis in DEIS Appendix C, Roadless Area Management.

Alternatives A, B, D, and E do not contain any areas recommended for wildereness. Alternatives were developed to address a range of issues. The alternatives provide for a range of roadless area protection rather than a range of wilderness recommendations. The following table provides details on the acres and areas recommended for wilderness.

Table 3-121. Roadless areas and acres recommended for wilderness in Alternative C.

	Inventoried Roadless Area - Name	Acres Assigned to the 1.2 Management Area	Acres in Roadless Area Inventory
1	Little Bighorn	40,938	67,149
2	Devil's Canyon	4,506	12,476
3	Walker Prairie	44,075	46,559
4	Rock Creek	20,326	42,377
5	Medicine Lodge	5,304	5,997
	Total Acres	115,149	174,558

The recommended areas are typically somewhat smaller than the inventory areas. A part of the Little Bighorn and Rock Creek roadless areas was allocated to 1.5 National River System – Wild Rivers and 2.2 – Research Natural Areas. A part of the Devil's Canyon roadless area was allocated to 1.5 National River System – Wild Rivers. The part of the Medicine Lodge roadless area allocated to the 1.2 management area excludes the Lower Medicine Lodge Lake and its immediate vicinity to allow a wider range of options for resource protection. A part of the Walker Prairie roadless area near U.S. Highway 14 was allocated 4.2 – Scenery.

There is a difference between the 115,149 roadless inventory acres in management area 1.2 shown above and the 125,569 acres in Management Area 1.2 shown in management summaries elsewhere in this document. The 10,420 acre difference is made up of acres included in the 1.2 M.A. but not included in the roadless inventory. This happened because the roadless inventory boundaries have been adjusted to improve managability but similar adjustments have not been made to the management area boundaries. Adjustments to the roadless inventory boundaries generally moved boundaries to locations which could be identified more easily on the ground (ex. streams, ridge lines, road offsets, etc.).

Effects of Management Area Allocations on Wilderness Potential and Roadless Characteristics: The following chart shows the distribution of roadless acres inventoried, for the forest plan revision, across the range of management areas in each alternative. All of the acres shown are included in the roadless inventory done for forest plan revision. Forest acres outside of inventoried roadless areas are not included in this table.

Table 3-122. Roadless acres in various management areas by alternative.

Management Area	Alt A	Alt B	Alt C	Alt D	Alt E
1.2			115,149		
1.31		33,491		24,461	7,080
1.32	49,681	40,564	64,825	34,976	22,770
1.33	14,812	28,767	34,250	5,371	12,720
1.5	10,757	20,332	20,916	10,113	10,271
2.1		8,232	4,455		
2.2	1,050	19,102	19,100	19,102	1,050
3.1		6,800	6,800	6,800	6,800
3.24	63				
3.31	5,760	43,160	72,297	45,990	1,212
3.4	13,374	2,296	1,822	487	468
3.5	94,874	120,368	8,921	71,571	0
4.2	1,590	8,793	7,134	14,573	4,145
4.3		5,942	568	11,567	1,139
4.4		7,365	7,365	63	
5.11	42,001	6,564	3,644	57,122	90,519
5.12	75,597	11,804	2,050	58,687	26,764
5.13	46,742	309		2,066	32,902
5.21	2,009				0
5.4					106,480
5.41	19,132	13,581	8,174	14,522	17,674
5.5					35,477
8.1	31				0
Total Roadless Inventory	377,471	377,471	377,471	377,471	377,471

The management area allocations can be assigned to three broad groups. Assignments are based on the desired condition, standards and guidelines, and overall theme for the management area. The first group includes management areas with the potential to retain wilderness qualities based on the roadless inventory criteria. The second group includes any of the remaining management areas with the potential to retatin roadless characteristics based on the Roadless Area Conservation Rule (RACR). The third group includes management areas not included in group one or two. The following table shows how the management area allocations were categorized to evaluate the effects of alternatives on inventoried roadless areas.

Table 3-123. Groups of management areas based on area direction with implications for wilderness and roadless qualities

Management Area Groups	Management Area Numbers					
1 Allocations that generally retain the potential to be capable and available for wilderness designation	1.2	1.31	1.5	2.2		
2 Allocations that generally retain roadless characteristics	1.32	1.33				
3 Allocations that are generally inconsistent with the roadless charcteristics defined by Roadless Area Conservation Rule.	2.1 4.2 5.21	3.1 4.3 5.4	3.24 4.4 5.41	3.31 5.11 5.5	3.4 5.12 8.1	3.5 5.13 8.22

The areas in group one would be generally undeveloped. These areas would have no classified roads and very limited developed facilities (ex. trails, signs). The areas in group two would generally not be available for new roads or road reconstrution although motorized use of existing roads and trails could continue. These areas would generally not allow for cutting, sale or removal of timber, although certain exceptions are included in the RACR. The third group would allow activities prohibited by RACR.

The effect of future management activity on roadless acres in the third group of management area allocations is uncertain. For example, it is possible that all activities undertaken in the 3.5 – Plant and Wildlife Habitat management areas during the planning period will be consistent with RACR. However, the 3.5 management area does allow road construction that contributes to habitat improvement and that is inconsitent with RACR. Thus impacts on inventoried roadless areas resulting from management area allocations are potential impacts. The actual impacts will depend on the type and amount of management that actually occurs. The best potential for management that retains roadless characteristics in group three is probably in management areas 2.1, 3.1, 3.24, 3.4 and 3.5.

The following table shows the roadless acres and percentages that generally retain wilderness potential or RACR roadless characteristics. Roadless characteristics allow for motorized use on existing roads and motorized trails. The table includes only roadless acres in the 2003 inventory. Parts of the Forest outside the roadless areas are not included in calculating acres or percents.

Table 3-124. Distribution of roadless acres (2003 inventory) in management area groups by alternative

	Alt A	Alt B	Alt C	Alt D	Alt E
Management Area Group 1: Allocations that generally retain the potential to be capable and available for wilderness designation based on management area direction.					
Inventoried Roadless Acres in Group 1	11,807	72,925	155,165	53,677	18,401
Percent Of Roadless Acres In Group 1	3%	19%	41%	14%	5%
Management Area Group 2: Allocations that generally retain roadless characteristics defined by the Roadless Area Conservation Rule (RACR), not including those in Group 1.					
Inventoried Roadless Acres in Group 2	64,493	69,331	99,075	40,347	35,490
Percent Of Roadless Acres In Group 2	17%	18%	26%	11%	9%
Management Area Group 3: Allocations that are generally inconsistent with the Roadless Area Conservation Rule.					
Inventoried Roadless Acres in Group 3	301,171	235,215	123,230	283,448	323,580
Percent Of Roadless Acres In Group 3	80%	62%	33%	75%	86%

The highest percentage of wilderness potential is retained in alternatives C (41%). Alternative B (19%) and D (14%) retain lesser amounts. The least wilderness potential is retained in Alternatives E (5%) and Alternative A (3%).

The highest percentage of roadless potential is retained in C (67%), followed by B (37%), D (25%) and A (20%). The least roadless potential is retained in alternative E (14%). These numbers are based on the sum of group 1 and group 2 since both groups retain roadless potential. From most consistent with the RACR to least consistent with the RACR, the alternatives rank C, B, D, A, E.

Direct and Indirect Effects

Effects from Livestock Grazing and Big Game Use: Livestock grazing is allowed in wilderness when it was permitted prior to establishment of the wilderness. Permitted grazing will continue in roadless areas recommended for wilderness designation (1.2 management areas). To the extent that a wilderness recommendation has the potential to draw more visitors, and there is a related potential for increased grazing by recreation livestock.

Effects from Recreation Management: Areas that are recommended for wilderness will be managed similarly to lands currently designated as wilderness. Opportunities for primitive and non-motorized recreation will be found in roadless areas recommended for wilderness designation. These areas provide the best opportunities for solitude, the absence of motorized or mechanized vehicles, and the absence of human developments. Only alternative C provides areas managed like and recommended for wilderness. Recommendation of an area for wilderness designation may lead to increased recreation use. An increase in use may trigger development or improvement of trailhead facilities.

Roadless areas that are assigned to other management areas will be managed for the recreation opportunities appropriate to the assigned management areas. The existing settings are generally semi-primitive non-motorized in character although motorized trails occur in some areas. Snowmobiles traveling over snow – on trails or cross-country –occur in some roadless areas. Alternatives rank C, B, A, D, and E, from most to least semi-primitive non-motorized settings. Alternatives rank C, B, D, A, and E, from most to least semi-primitive motorized settings

Roadless areas in prescriptions that preserve roadless qualities are at risk from the recreation use of all terrain vehicles (ATV's). Unclassified user-created ATV routes encroach on some roadless areas. This long term effect of illegal motorized use can be the loss of some roadless values.

Effects from Timber Management: Roadless areas that are allocated to MA 1.2 (recommended wilderness) are not available for timber harvest. Roadless areas that are allocated to management areas other than recommended wilderness may be available for vegetation treatments, including timber harvest consistent with the standards and guidelines found in the forest plan. Alternatives E, A, and D would have the most effect on roadless areas as a result of timber harvest. Alternative E contains the most roadless inventory acres allocated to management areas which contribute to allowable sale quantity (ASQ), followed by Alternative A, D, B, and C.

Effects from Travel Management: Roadless areas may provide a variety of travel opportunities depending on the management area assigned. Roadless areas recommended for wilderness (management area 1.2) will permit foot and horse travel and will prohibit motorized travel.

Management prescriptions that do not allow additional road construction would affect roadless areas the least, thus alternatives that contain more of those management areas – C, and B - would have the least effect on roadless areas. Alternatives E, A, and D have the most roadless area in prescriptions allowing road construction.

Effects from Special Interest Areas: Research natural area proposals (management area 2.2) overlap portions of the Little Bighorn, and Rock Creek areas capable and available for wilderness designation. Wild river recommendations (management area 1.5) overlap a portion of the Devils Canyon, Little Bighorn, and Rock Creek areas. These overlaps reduce the area recommended for wilderness (management area 1.2).

Both RNA and wild river designation will protect wilderness values; although they are managed for other purposes.

Effects from Fire and Fuels Management: In 1.2 management areas dozers will not be used to manage wildfire. Wildland fire use (i.e. a fire started by lightning, but allowed to burn under prescribed conditions) may occur in 1.2 management areas if site specific fire management planning has been completed. Fuel treatment is allowed in 1.2 management areas, when it is compatible with wilderness values.

Effects from Oil, Gas and Minerals Management: Inventoried roadless areas in prescriptions which are administratively unavailable for oil, gas and mineral development will be largely unaffected by development. All other roadless areas are potentially affected by development of minerals under the mining law, although there is little history of mineral development on the Forest.

Roadless areas in prescriptions where no surface occupancy is allowed for oil and gas development would generally be somewhat less affected by development than roadless areas allocated to prescriptions with a controlled surface use. Areas with standard lease terms have the least protection from effects of oil and gas development. Alternatives rank E, A, D, B, and C from acres more likely to be affected by development to acres less likely to be affected by development. Based on the history of drilling near the Forest, it is unlikely that any oil and gas test wells will be drilled on the Forest in the foreseeable future.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered for the roadless resource

The Bureau of Land Management (BLM) has recommended 3,600 acres in the Medicine Lodge area (BLM inventory #WY-010-240) for wilderness designation. This area includes the Medicine Lodge Canyon and parts of Medicine Lodge and Captain Jack Creek under BLM administration. The Forest's Medicine Lodge roadless inventory area (inventory #BH042) connects to the BLM area and includes higher elevation reaches of Medicine Lodge Creek, Lower Medicine Lodge Lake and a part of Allen Draw. The past recommendation for wilderness designation of an adjacent area under BLM administration has the effect of strengthening the wilderness potential of the Forest's Medicine Lodge roadless area. This effect extends from the past into the reasonably foreseeable future and applies to the upper and lower Medicine Lodge Creek watersheds (6th order).

Roadless area characteristics are changed by development of all sorts – roads, timber management, recreation facilities, reservoirs, etc. The development of the Bighorn National Forest for human benefit is a long-term continuing trend. Although the total acres developed in the past planning period is relatively small, the decrease in acres with roadless characteristics is a long-term continuing trend. The development of roads

and management of timber stands has affected the most acres in the past and this trend may continue. While some development is reversible the continuing benefits of development, to individuals, groups, or society as a whole, make changes from a developed state to an undeveloped state unusual. The effect of development extends from the past into the future and applies to the general forest area (i.e. outside wilderness). The alternatives rank E, A, D, and B from more development to less. The effect is least under Alternative C where areas are recommended for wilderness designation.

The marketing of all-terrain vehicles (ATVs) and other off-road vehicle (ORV) experiences has produced accelerating growth in this use of the Bighorn National Forest. Since an ATV rider can travel across larger areas in a shorter time than most other recreation users the demand for access to more terrain is likely to increase. Advocates for ATV users are expected to often focus their requests for increased access on roadless areas. The effects of increasing ATV use and demand for access extend from the past into the future and apply to the general forest area. Effects are similar for alternatives A, D, and E. The effect is reduced under alternative B, where more area is managed for wildlife habitat. The effect is least under alternative C, where areas are recommended for wilderness designation.

Unclassified motorized routes, both roads and trails, have been created and/or extended by use in some places on the Forest. These unclassified routes or segments are not legal for motorized travel. The lack of adequate, well-maintained signing contributes to this problem. Use of unclassified routes has occurred in both roaded and roadless parts of the Forest. To the extent that this use continues to occur in the future, it diminishes roadless values and roadless areas. As both local and national populations continue to age the demand for easier access, primarily vehicle access, to destinations in roadless areas is expected to increase. The effect of user-created routes is forestwide and extends from the past into the present. User-created routes are expected decline in the future as a result of the elimination of areas open to cross-country use of vehicles (i.e. “C” areas) under all alternatives and the restoration of existing user created routes. The effect of user created routes is expected to decline in the future under Alternative C as a result of prohibiting motorized use in areas recommended for wilderness designation.

To summarize, roadless areas can be affected by development activities and motorized recreation. In general terms the alternatives rank E, A, D, B, and C from most to least impact on roadless resources in the future.

Scenery Resources

Introduction

Scenery management is concerned with providing scenic integrity, through time, to meet the public desire for attractive natural landscapes and to support recreation and tourism uses.

The Scenery Management System (SMS) replaces the Visual Management System (VMS) used in the 1985 Bighorn National Forest Land and Resource Management Plan. The Scenery Management System (SMS) is used to inventory and analyze scenery, to assist in establishing resource goals and objectives, to monitor the scenic resource, and to ensure high-quality scenery for future generations. The new system applies to all national forests and grasslands administered by the Forest Service and to all Forest Service management activities.

Legal and Administrative Framework

The Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528 (note)) authorizes and directs the Secretary of Agriculture "to develop and administer the renewable surface resources of the National Forests" for "harmonious and coordinated management of the various resources . . . with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output."

The Forest and Rangeland Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act of 1976 (16 U.S.C. 1601) directs the Secretary of Agriculture to prepare land management plans which provide for outdoor recreation and to develop and keep current a comprehensive inventory of all National Forest System, as well as state and private, lands and resources. Section 6 of this act requires an assessment of potential aesthetic impacts during the interdisciplinary review of proposed timber sale areas that would include clear-cutting and other cuts designed to regenerate an even-aged stand of timber. It also specifies treatment of cut blocks and protection of aesthetic resources, and directs that multiple use and sustainable yield guidelines be used with private lands involved with Government programs.

The National Forest Management Act of 1976 (16 U.S.C. 1600 (note) requires that the removal of trees, portions of trees, or forest products "be compatible with multiple use resource management objectives in the affected area."

Title 36 of the Code of Federal Regulations, Part 219, Subpart A, National Forest System Land and Resource Management Planning (36 CFR part 219, subpart A), includes requirements for consideration, treatment, and protection of intangible resources such as scenery and aesthetics

Title 36 of the Code of Federal Regulations, Part 219, Subpart A, 219.21 (f) National Forest System Land and Resource Management Planning (36 CFR part 219.21(f), "The visual resource shall be inventoried and evaluated as an integrated part of evaluating alternatives in the forest planning process, addressing both the landscape's visual attractiveness and the public's visual expectation. Management prescriptions for definitive land areas of the forest shall include visual quality objectives."

Title 36 of the Code of Federal Regulations, Part 223, Sale and Disposal of National Forest System Timber (36 CFR part 223), includes requirements for protection of environmental quality and for minimizing adverse effects on, or providing protection for and enhancing, other National Forest System resources.

The National Environmental Policy Act of 1969 (42 U.S.C. 4321) directs the Federal Government to "(2) assure for all Americans . . . healthful, productive, and aesthetically and culturally pleasing surroundings; (3) attain the widest range of beneficial uses of the environment without degradation, [or] risk to health . . .; (4) preserve important historic, cultural, and natural aspects" of our environment. It further directs agencies to "insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have an impact on man's environment." This act directs agencies to develop methods and procedures "which will insure that [scenery and other] unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations."

The Wilderness Act of 1964 (16 U.S.C. 1131) directs the United States to administer wilderness areas to provide for the "preservation of their wilderness character," to retain their "primeval character and influence," and to protect and manage the natural conditions of wilderness areas so that they "generally appear to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable." Scenic use is identified as one of the six public purposes of wilderness areas.

Title 36 of the Code of Federal Regulations, Part 293, Wilderness -- Primitive Areas (36 CFR part 293), includes requirements for scenic use, preservation and protection of wilderness character, and promotion and perpetuation of specific values including solitude and inspiration.

Title 36 of the Code of Federal Regulations, Part 292, National Recreation Areas (36 CFR part 292), includes requirements for preservation, conservation, and protection of natural, scenic, and pastoral values, and other values contributing to public enjoyment of these areas.

The National Trails System Act of 1968 (16 U.S.C. 1241) authorizes the Secretary of Agriculture to administer and manage national scenic trails "for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which such trails may pass."

The Intermodal Surface Transportation Efficiency Act of 1991 (23 U.S.C. 101 (note)) directs the establishment of a national scenic byways program with designation criteria to include consideration of scenic beauty. It further recommends that designated travel ways have operation and maintenance standards which include "strategies for . . . protecting and enhancing the landscape and view corridors surrounding such a highway."

The Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1271) directs the United States, in its administration of components of the national wild and scenic rivers system, to give primary emphasis to protecting "its aesthetic, [and] scenic . . . features."

- Title 36 of the Code of Federal Regulations, Part 297, Wild and Scenic Rivers (36 CFR part 297), includes requirements for the protection of scenic and natural values from the effects of any water resources project.

The Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201) authorizes the Secretary of Agriculture to permit surface coal mining operations on National Forest System lands if there are no significant recreational or other values which may be incompatible.

- Title 36 of the Code of Federal Regulations, Part 228, Subpart A, Locatable Minerals (36 CFR part 228, subpart A), includes requirements for harmonizing mineral operations with scenic values (sec. 228.8), and protecting scenic values when approving access to those operations (sec. 228.12).

The North American Wetlands Conservation Act of 1989 (16 U.S.C. 4401 (note), 4401-4413; 16 U.S.C. 669b (note)) recognizes the aesthetic values of fish, shellfish, and other wildlife; it further recognizes that wetland ecosystems provide aquatic areas which are important for recreational and aesthetic purposes. It directs the head of each Federal agency, to the extent consistent with the agency's mission and statutory authorities, to cooperate to restore, protect, and enhance the wetland ecosystems and other habitats for migratory birds, fish, and wildlife.

Title 36 of the Code of Federal Regulations, Part 254, Landownership Adjustments (36 CFR part 254), include requirements for protecting aesthetic values on lands involved in these transactions.

Title 36 of the Code of Federal Regulations, Part 290, Cave Resources Management (36 CFR part 290), includes requirements for protecting and maintaining the scenic values of significant caves.

FSM, Chapter 2380, Landscape Management provides direction for Forest Service landscape management including aesthetics and scenery

Key Indicators

- Existing scenic integrity (ESI).
- Concern levels
- Scenic classes.
- Scenic integrity objectives (SIO).
- Management Area 4.2-Scenery

Resource Protection Measures

Scenery resource protection measures are included in forest-wide and management area standards and guidelines. Scenery resource mitigation methods and techniques are described in the following USDA handbooks:

- National Forest Landscape Management, Vol. 1. Agriculture Handbook 434: 1973.
- National Forest Landscape Management, Vol. 2, Chapter 1: The Visual Management System. Agriculture Handbook 462: 1974.
- Utilities, Volume 2 - Chapter 2. Agriculture Handbook 478: 1975.
- Range, Volume 2 - Chapter 3. Agriculture Handbook 484: 1977.
- Roads, Volume 2 - Chapter 4. Agriculture Handbook 483: 1977.
- Timber, Volume 2 - Chapter 5. Agriculture Handbook 559: 1980.
- Fire, Volume 2 - Chapter 6. Agriculture Handbook 608: 1985.
- Ski Areas, Volume 2 - Chapter 7. Agriculture Handbook 617: 1984.
- Recreation, Volume 2 - Chapter 8. Agriculture Handbook 666: 1987.
- Landscape Aesthetics, A Handbook for Scenery Management. Agriculture Handbook 710: 1995

AFFECTED ENVIRONMENT

The Bighorn National Forest covers about 39% of the isolated rolling plateau that makes up Big Horn mountain range. The Forest features rugged canyons and valleys on its flanks. A distinctive pattern of large, grassy parks interwoven with large areas of coniferous forests create expansive views. The Forest is topped by granite peaks with steep slopes and striking glacial formations.

The Bighorn is a visible presence in the lives of local people. “The mountain” is a part of the identity of surrounding communities. The attractive scenery of the Bighorn National Forest is basic resource supporting local tourism and recreation: Tourism and recreation is an important segment of the economy for some communities around the

forest. Some businesses operating on the forest – resorts, campground concessions, and outfitter-guides - depend on the scenic beauty of the forest to help attract customers.

Scenery management is concerned with providing scenic integrity, through time, to meet the public desire for attractive natural landscapes and to support recreation and tourism.

Constituent Information

Studies at the national and local scale consistently show that the public places a high value on the forest's scenic beauty. Managing resources with consideration for the forest's scenery is strongly supported.

National Survey on Recreation and the Environment (NSRE)

- Surveyed 60,000 households in the United States
- 86.8 % of respondents said "Managing forest to leave them natural looking" was important or very important

Social Assessment of the Four-County Area

- Survey of 1,230 households in Big Horn, Washakie, Johnson, and Sheridan counties
- Respondents from every County ranked "consider forest appearance in making decisions" 2nd out of 13 desired future conditions

Scenic Byway Corridor Management Plan

- 60 forest users (both tourists and locals) were interviewed
- 60% of forest users thought scenic quality should strongly influence land management decisions along the Byways in order to maintain a high quality, scenic setting.
- 30% of those interviewed thought scenic quality should be given equal consideration with other resources in influencing land management decisions.

The Scenic Integrity Scale

The scenic integrity scale is used to describe both existing and desired conditions. The scenic integrity scale describes a range of scenic quality conditions. The first five are not inherently good or bad. This scale is a continuum of scenic condition ranging from a landscape where changes are natural occurrences, to a landscape where management activities and uses overwhelm the original landscape character. This scale is used to evaluate existing condition and to describe future objectives. In general, landscapes with very high, high, and moderate scenic integrity have a natural appearance; landscapes with low, very low, and unacceptably low scenic integrity are dominated to varying degrees by development and use.

Very high	The valued landscape character "is" intact with only minute if any deviation. The existing landscape character and sense of place is expressed at the highest possible level.
High	The valued landscape character "appears" intact. Deviations may be present but must repeat the form, line, color, texture and pattern common to the landscape character so completely and at such scale that they are not evident.
Moderate	The valued landscape character "appears slightly altered." Noticeable deviations must remain visually subordinate to the landscape character being viewed.
Low	The valued landscape character "appears moderately altered." Deviations begin to dominate the valued landscape character being viewed but they borrow valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed but compatible or complimentary to the character within.
Very Low	The valued landscape character "appears heavily altered." Deviations may strongly dominate the valued landscape character. They may borrow from valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles within or outside the landscape being viewed. However deviations must be shaped and blended with the natural terrain (land forms) so that elements such as unnatural edges roads, landings and structures do not dominate the composition.
Unacceptably Low	The valued landscape character being viewed "appears extremely altered." Deviations are extremely dominant and borrow little if any form, line, color, texture, pattern or scale from the landscape character. Landscapes at this level of integrity need rehabilitation. This level should only be used to inventory existing integrity. It must not be used as a management objective.

The Forest's Existing Scenic Integrity

The existing scenic integrity (ESI) inventory maps the current state of the forest landscapes at a broad scale. In rating scenic integrity, the degree to which an area appears natural is considered. Similarly, the degree of contrast between a natural appearance and the appearance introduced by management activities and uses is considered. An undeveloped area with a few trails and few signs of human use (ex.

campsites) has very high scenic integrity. An area of the forest with timber harvest units, little crown cover and new seedling trees, has low scenic integrity if the shape, size and other elements blend into the surrounding landscape. Areas of the forest are classified into one of five categories, from very high scenic integrity to very low scenic integrity. No areas were classified in a sixth category, unacceptably low scenic integrity.

Table 3-125. Existing Scenic Integrity (CY 2000) as a percent of the total area.

	Very High ESI	High ESI	Moderate ESI	Low ESI	Very Low ESI
Areas Outside of Wilderness	3%	32%	34%	19%	12%
Wilderness	72%	28%			
Forest-Wide	15%	31%	29%	15%	10%

As the table shows, the majority of the forest area (60%) has a high or moderate level of scenic integrity. Seventy-five percent of the forest is in the upper half of the scenic integrity scale with ratings as very high, high, or moderate scenic integrity. Forest users are accustomed to this level of scenic integrity.

A 1997 study of the existing scenic integrity of the Clear Creek-Crazy Woman Creek geographic area compared scenic integrity levels in 1976 and 1996. It revealed a 28% loss in acres of high scenic integrity as development (e.g., timber harvest, travel routes, fences, and reservoirs) increased. The study also showed an improvement as acres of unacceptably low integrity in areas with large clear-cuts edged by narrow leave strips. As these clear-cuts were restocked with young trees they moved into the very low category. Acres of moderate, low, and very low scenic integrity increased in the 20 year study period. The study indicates a trend toward the middle range of the scenic integrity scale with more acres in moderate and low scenic integrity categories. It also suggests a priority be given to preserving or managing areas to achieve very high and high scenic integrity in the future.

The Concern Level Inventory

Concern levels are an estimate of the degree of public importance placed on scenery viewed from roads, trails and use areas (e.g., campgrounds, overlooks, cabins). There are three concern levels:

- Concern Level 1 –People have the highest interest in scenery from these travel ways and use areas. The number of visitors using Concern Level 1 travel ways and uses areas can be high, moderate, or low. The Bighorn Scenic Byway (US 14), Tongue River Trail (FST 002), Sheep Mountain Road (FSR 445), and the Paint Rock Lakes Road (FSR 17) are examples of Concern Level 1 travel routes.
- Concern Level 2 – People have a moderate interest in scenery from these primary and secondary travel ways and use areas. The number of visitors using Concern

Level 2 travel ways and uses areas can be high, moderate, or low. Pole Creek Road (FSR 31), and Battle Park Road (FSR 24) are examples of Concern Level 2 travel ways

- Concern Level 3 – People have a low interest in scenery from these primary and secondary travel ways and use areas. The number of visitors using Concern Level 3 travel ways and uses areas can be moderate or low. Some local roads, service roads and all remaining areas not seen from travel routes and use areas are Concern Level 3.

Table 3-126. Concern levels for roads and trails.

Concern Levels	Road and Trail Miles
Level 1	670
Level 2	492
Level 3	235
No Concern Level Established	1476*

*Includes some local and service roads as well as some non-system routes.

The concern level inventory helps describe the places where scenery is viewed. These viewpoints are used in a visibility analysis of the forest.

Scenic Classes

Scenic classes indicate the relative importance of scenery in different areas of the forest. Scenic classes are used during forest planning to compare the importance of scenery with the importance of other resources in various areas. Mapping is based on a combination of scenic attractiveness and visibility. The scenic class maps on the Bighorn assign Class 1 areas a high value as scenery. Class 2 areas are assigned a moderate value, while classes 3 and 4 through 7 have low value.

Table - 3-127. Scenic Classes on the Forest.

Scenic Class	Acres	Percent
1	811809	72.6%
2	280783	25.1%
3	20723	1.9%
4 -7	4186	0.4%
Totals	1117501	100.0%

The Scenic Byways

There are three scenic byways crossing the Bighorn National Forest – The Bighorn Scenic Byway (US 14), The Medicine Wheel Passage Scenic Byway (US 14A) and The Cloud Peak Skyway (US 16). Each road provides a unique and different view of the

Bighorn because they vary in viewshed, vegetation, geologic features, and historic uses. They provide opportunities for 120 miles of scenic travel on the Bighorn. These roads provide forest access for the majority of tourists and local visitors. A 2003 National Visitor Use Monitoring study reported an annual use figure of 2,032,000 travelers viewing scenery from the Bighorn's scenic byways.

ENVIRONMENTAL CONSEQUENCES

General Effects

Changes in scenery may be the result of natural events and human activities; however scenic integrity evaluations consider only the results of human activities and use. Project planning, design and layout techniques may be used to minimize changes in scenic integrity. How noticeable changes are is affected by the observer's viewing location, distance from the change, the season, landform and vegetation screening, weather conditions and the duration of the view.

Management activities and uses such as timber harvest, road building, mining, grazing, utilities, trail construction, ski area development and developed and dispersed recreation affect scenery. Activities designed to blend in with the surrounding landscape may have a positive effect on scenic integrity; poorly designed activities that contrast sharply with the surrounding landscape usually result in an adverse effect on scenic integrity. The planning, design and layout of projects is critical to achievement of scenic integrity objectives.

Each alternative developed for the draft forest plan revision includes varied management prescriptions and each management prescription is assigned a proposed scenic integrity objective(s) based on the desired condition of management area. Scenic integrity objectives assigned to management area prescriptions influence the amount, degree, intensity, and distribution of management activities needed to achieve the desired condition. Distribution includes both distribution in space and distribution through time. Very low scenic integrity is not identified as an objective in either the current forest plan or the proposed revision. Historically, there has been strong criticism of management to the level of very low scenic integrity. In areas with very low scenic integrity, a rehabilitation scenic integrity objective may be applied.

The table below indicates that areas with very high and high scenic integrity are likely to decline while acres with moderate and low scenic integrity are likely to increase under each of the alternatives. The magnitude of this effect depends on the acres altered and time-span considered. Forestwide during the next 10-year planning period, change in scenic integrity would be significantly less than the amount indicated by the prescribed scenic integrity objectives. The acres suited for timber production vary from 20% of the allocated management area acres in Alternative A to 30% of the allocated management area acres in Alternative A. However, scenery guidelines would allow for change from the existing condition to the percent shown by alternative. In general,

Alternatives C and B, propose less change by management activities than alternatives D, A, and E.

Table 3-128. Percent of forest area assigned to each scenic integrity objective by alternative (with a comparison to the existing condition).

SIO	Alternatives					Existing Condition
	A	B	C	D	E	
Very High	12%	12%	23%	12%	12%	15%
High	17%	21%	21%	17%	14%	32%
Moderate	45%	55%	50%	49%	37%	28%
Low	26%	12%	6%	22%	37%	15%
Very Low	0%	0%	0%	0%	0%	10%

A management area prescription helps define the purpose and need for future projects in that area. The 4.2 - Scenery prescription provides for management activities that provide for the public enjoyment of scenery over time. The scenery prescription is applied to areas of concentrated recreation use (ex. campgrounds, visitor centers) and along scenic byways. The following table shows acres allocated to the scenery prescription in the alternatives.

Table 3-129. Acres in MA 4.2 scenery management by alternative.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Acres in 4.2 - Scenery	19,147	95,418	93,294	102,083	6,007
% of Total Forest Acres in 4.2 - Scenery	2%	7%	8%	9%	<1%

The scenic byways provide millions the opportunity to enjoy scenic beauty. As shown by the following table, alternatives vary in how many miles of the byway corridors would be managed for scenic values and recreation uses. Alternative D allocates the largest percent of the byway corridors to the scenery prescription followed by B, C and A. Alternative E allocates less than one percent of the total byway miles to the prescription

Table 3-130. Miles of Scenic Byway included in the 4.2 - Scenery Management Area.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E.
Miles of Byway in 4.2	46.38	103.78	100.17	113.81	7.75
% of Total Byway Miles	39%	86%	83%	95%	<1%

Direct and Indirect Effects

Effects from Insects and Disease and from Fire and Fuels Management: In all alternatives, natural disturbance factors have the potential to alter the appearance of the forest. While these changes are consistent with the landscape character of the Bighorn, people object to the appearance of widespread areas of damaged or diseased trees. It is

difficult to compare the potential effects of natural insects, disease, or wildfire to the more predictable effects of management activities and development. Opportunities to minimize natural disturbances through active management will be evaluated for scenery effects when projects are developed. Opportunities may be identified for rehabilitation work to reduce the visual effects of insects, disease and wildfire. Insects, disease, and wildfire are natural disturbance factors with a high potential to change scenic beauty but no direct effect on scenic integrity. Indirect effects to scenic integrity might result from the use of dozers in fire suppression or development of roads for timber salvage.

Prescribed fires that are used to reduce fuels, improve forest, range and habitat conditions also affect the scenery. The significance of the effect depends on the vegetation type(s), the number of acres treated and the duration of the effect. Prescribed fires in range land usually have short term visual effects. Prescribed fire with crown fires in a timber stand may have a more apparent and lasting impact. Other types of fuel treatments – for example thinning and burn piles – affect scenery as well. Based on the prescribed burning projected for forested acres, impacts on scenery would be highest under alternative D, followed by B, A, E, and C

Effects from Facilities: Forest Service facilities, including permitted facilities are required to comply with the built environment image guide and the applicable scenic integrity objective. Recreation facilities should be consistent with the applicable ROS (i.e. recreation opportunity spectrum) class. Facilities that are properly designed, located and built to fit in with the surrounding landscape may enhance visitor experiences. Many existing facilities (ex. campgrounds, trailheads, work centers, resorts) blend well with the surrounding landscape. Facilities that clash with the landscape setting as a result of poor design, construction, or maintenance have an adverse effect on scenery resources. The effect of managing existing facilities and developing new facilities on scenic integrity is expected to be similar under all alternatives.

Effects from Utility Corridors: Utility corridors have the potential to alter the landscape in all alternatives. Some negative effects occur with either new corridors or existing corridors with additional service or upgraded service. The forest-wide guideline calling for installation of new electric service lines below ground would minimize impacts on scenery for that class of utility. The scenic integrity objective for the management area(s) crossed would apply to utility lines. At present there are no proposals for major transmission lines or pipelines across the forest. The effects on scenery vary by the type and location of the corridor and should be evaluated at the project level.

Effects from Mineral and Energy Development: Mineral and energy development may affect scenery on the forest. Scenic integrity would be reduced if the landscape is modified by energy development. Location of structures (e.g., roads, pipes, pumpjacks, tanks, and fences) would affect scenery. Mineral development is likely to be for common minerals, primarily gravel. Restoration of disturbed sites is covered in standards and guidelines. Alternatives C has fewer acres available under standard lease

terms for energy development than other alternatives.

Effects from Livestock Grazing and Big Game Use: Intense forage utilization and new range improvements may affect scenic integrity. The most likely effects would be from seasonal trampling and trailing and the development of new fence and water improvements. Generally improvements are small and localized and have minor individual effects on scenic integrity. The effects of intense forage utilization would be most evident in riparian areas. The potential effects of livestock grazing are similar in all alternatives.

Effects from Recreation Management: Recreation use and recreation management may affect scenery. Unmanaged recreation use often results in resource damage and non-system, motorized travel routes. The impacts to soil, water and vegetation are detrimental to scenery.

Dispersed recreation sites have few facilities to protect soil, water and vegetation. These sites are often viewed in the foreground zone of roads. Where resource damage (ex. loss of vegetation, soil compaction, scarred trees) occurs there is a negative effect on scenery. Restoration and/or relocation could improve resource conditions and enhance scenery.

Clearing for ski trails, lifts, roads, utilities and buildings associated with ski areas affects scenic integrity. Negative effects are usually most noticeable in densely forested areas. As with other types of tree removal, effects may be reduced by use of design techniques such as partial clearing, thinning, irregular edges and shapes, variable widths for linear features and remnant islands. Effects would be similar under all alternatives

Effects from Timber Management: Timber management activities can be designed to minimize effects on scenic integrity, although design mitigations may conflict, in varying degrees, with timber management objectives. Timber harvest can be used to maintain or enhance scenic integrity over time if that objective is identified in project planning. Negative effects on scenic integrity are usually noticed when harvest units dominate the landscape. Management areas emphasizing forest products from suited timber lands (5.11, 5.12, 5.13, 5.21, 5.4, and 5.5) have the potential for reduced scenic integrity as a result of timber management. As shown below, the potential is highest in Alternative E, followed by A, D, B, and C.

Table 3-131. Percent of Bighorn National Forest acres in management area prescriptions emphasizing management of forest vegetation for wood products.

Management Area	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
5.11 Forest Vegetation Emphasis	8%	8%	8%	15%	17%
5.12 Rangeland Vegetation Emphasis	24%	7%	2%	16%	5%
5.13 Forest Products	19%	8%		9%	18%
5.21 Water Yield Increase	< 1%				
5.4 Plant and Wildlife / Forest Products					12%
5.5 Dispersed Recreation / Forest Products					18%
Totals	**51%**	**23%**	**10%**	**40%**	**70%**

Timber harvest and associated road building covers more acres and introduces more noticeable landscape changes than other ground-disturbing activities on the Forest. Generally even-aged management has a greater visual impact than uneven-aged management.

Even-aged management includes clear-cut and shelterwood harvest. The visual effects of new clearcut units, with scarified soil and slash on the ground, last longest. The effect is somewhat diminished with "green-up" when bare soil or burning is no longer visible. Establishment of a new forest with crown closure takes 20-30 years and establishment of a new forest overhead takes 60 or more years in the average lodgepole pine stand. All alternatives provide for the use of even-aged management of lodgepole pine. Shelter-wood harvest removes trees in two or three entries and the final harvest removes most large trees from the harvest unit. Extending the harvest cycle in a shelterwood, may shorten the recovery period, depending on the establishment and protection of young trees. Even aged harvest can lower scenic integrity for many decades.

Table 3-132. Projected acres of clearcut and shelterwood harvest in the first 10-year period by alternative.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Acres of Clear-cut Harvest	3,070	4,980	670	7,360	7,400
Acres of Shelterwood Harvest	25,380	4,030	5,400	3,200	11,410

Source: Woodstock model – based on average annual harvest acres

Table 3-133. Projected acres of clear-cut and shelterwood harvest in the first 50 years by alternative.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Acres of Clear-cut Harvest	15,350	24,900	3,350	36,800	37,000
Acres of Shelterwood Harvest	126,900	20,150	27,000	16,000	57,050

Source: Woodstock model – based on average annual harvest acres

The effect of uneven-aged management on scenic integrity is less pronounced. Uneven-aged management involves repeated entries on a 20-30 year cutting cycle, but some large overstory trees are retained over time. The visual impact may be noticeable but is usually not as striking as the final entry of a shelterwood harvest or a clear-cut.

The accumulation of woody debris as a result of repeated harvest and thinning operations affects both scenic integrity and recreation use. On the Bighorn, a brief warm season and limited moisture result in a slow rate of natural decomposition. As a result twigs and branches remain from harvests completed twenty or thirty years ago.

The use of a scenic integrity objective of moderate in the foreground zone of concern level one and two roads, trails and use areas reduces the effect of harvest from the most important viewpoints. This mitigation is included as a guideline in Management Areas 5.11, 5.12, 5.4, and 5.5. The guidelines for scenery in the 5.13 management areas do not provide for a moderate SIO in the foreground of most concern level one and two roads and trails. The foreground zone of six roads and three trails of varied lengths in the 5.13 management area would have an SIO of moderate.

Effects from Roads and Trails: Poorly designed and located roads or trail with bare cut and fill slopes detract from the surrounding landscape when viewed from other travel ways and use areas. Roads and trails built to fit in the landscape can support enjoyment of scenic beauty. A proliferation of regulatory and information signs, particularly on higher standard roads, can lower scenic integrity.

Development of new roads and trails has a mixed impact on scenery. Travel routes provide the platform for viewing the natural beauty of the forest. When roads and motorized trails occur at high densities the scenic integrity of the area declines. (This decrease occurs even when roads are closed to motorized use.) The development of a road system in the Little Goose/Rock Creek area would decrease scenic integrity while making the scenery more accessible. Alternatives E, A, and D are the most likely to involve new or upgraded roads.

Areas with few roads generally have higher scenic integrity and are more intact than areas with higher road densities. Decommissioning roads determined to be unneeded will not affect scenic integrity. However, decommissioning a road and restoring it to natural contour and vegetation, can improve the scenic integrity of the landscape. Alternative E is most likely to add roads and have an effect on scenic integrity followed by A. Estimated levels of decommissioning do not vary by alternative.

Effects from Wildlife and Fisheries Management: Higher levels of species richness and intact habitats are consistent with higher scenic integrity. Habitat improvements would reduce scenic integrity if large scale changes in forest age class distribution are undertaken. This is anticipated where the 5.4 Plant and Wildlife - Forest Products management area is used in Alternative E. Traditional habitat projects are small in scale and localized with minor effects on scenic integrity.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered for the scenery resource.

Any activities implemented on Forest lands (roads and trails, timber harvest, recreation development, prescribed fire, etc.) can affect scenery when viewed from nearby lands. The appraised value of property is often influenced by the proximity to the forest and the natural appearing landscapes (i.e. high scenic integrity) of the forest. A cumulative effect of urbanization and subdivision is to raise the level of concern for scenic integrity. This effect is likely to increase over time as urbanization and subdivision increases. The effect is the similar for all alternatives, although alternatives that emphasize more active management may be more difficult to implement.

Wild and Scenic Rivers

Introduction

The Wild and Scenic Rivers Act was enacted by Congress to preserve select rivers in a free-flowing condition and to protect other river-related values. As of 2003, 163 river segments and 11,302.9 miles have been afforded protection as a component of the National Wild and Scenic Rivers System (National System) as wild rivers (5,350.6 miles), scenic rivers (2,457.2) and recreational rivers (3,495.1 miles). These nationally recognized rivers comprise a valuable network of natural and cultural values.

For a river to be included in the National System, it must be determined eligible and suitable. To be eligible, a river must be free-flowing and possess one or more outstandingly remarkable river values. Suitability addresses whether identified values should be protected and, if so,whether recommendation of the river to the National System is the best method for protecting identified values.

Suitability involves consideration of a number of factors including land ownership in the area; the land uses that would be affected; public, state and local government interest in the river's designation; estimated costs; and any other issues raised during the planning process.

Rivers are added to the National System by act of Congress or by the Secretary of the Interior. Secretarial designation requires that a river be a part of a state river protection system and the state governor to make application to the Secretary. A recommendation by the USDA Forest Service for any particular river or river segment does not guarantee that Congress will proceed with the recommendation.

Legal and Administrative Framework

The **Wild and Scenic Rivers Act of 1968 (Public Law 90-542), as Amended** - established a policy for preserving selected rivers or sections thereof in a free-flowing condition. The intent was to protect water quality of such rivers and to fulfill other vital national conservation measures that would balance the development of water, power and other resources for the benefit and enjoyment of present and future generations.

The **Forest Service Handbook 1902.12 (Chapter 8)** directs the Forest Service, to evaluate rivers for inclusion in the National Wild and Scenic Rivers System through the forest planning process.

Wild and Scenic Rivers Assessment and the Forest Plan Revision Process 11/21/96 – Washington Office guidance letter regarding the Land and Resource Management Plan revision process and wild and scenic rivers assessment process.

Department of the Interior and Agriculture Interagency Guidelines for Eligibility, Classification and Management of River Areas - USDA and USDI - provides additional guidance to agencies on how to evaluate the eligibility, classification and suitability of rivers

Evaluation Process

Wild and scenic river study requires determinations to be made regarding a river's eligibility, classification and suitability. Eligibility and classification represent an inventory of existing conditions. Eligibility is an evaluation of whether a river is free-flowing (without major dams, diversions or channel modifications) and possesses one or more outstandingly remarkable values (ORVs). These values could include scenery, recreational, geological, fish, wildlife, prehistory, history, or other values. These values should be a unique or exceptional representation for the area studied and must be related to the river or its immediate environment.

If found eligible, a river is analyzed as to its current level of development (water resources projects, shoreline development, and accessibility) and a recommendation is made that it be placed into one or more of three classes—wild, scenic or recreational. The Wild and Scenic River Act provides the following direction for classifying:

- Wild rivers: those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted.
- Scenic rivers: those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.
- Recreational rivers: those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

The final step is to evaluate eligible rivers for suitability. This step includes a discussion of the consequences of designating or not designating the river as a component of the National System in terms of social and economic values, effects on other resources, and effects on private lands and other uses of the area. A suitability analysis is designed to answer the following questions:

- Should the river's free-flowing character, water quality, and ORVs be protected, or are one or more other uses important enough to warrant doing otherwise?
- Will the river's free-flowing character, water quality, and ORVs be protected through designation? Is it the best method for protecting the river corridor? In answering these questions, the benefits and impacts of WSR designation must be evaluated and alternative protection methods considered.

- Is there a demonstrated commitment to protect the river by any nonfederal entities that may be partially responsible for implementing protective management?

Key Indicator

Locations and miles of eligible rivers

Resource Protection Measures

The following guidelines set forth standards for making these determinations on rivers by classification (wild, scenic, or recreational). These guidelines should be applied to the extent of the Forest Service's jurisdiction over federal lands, federal scenic or access easements, and other interests.

Eligible Wild Rivers

- Timber production – cutting trees will not be allowed unless needed to meet management objectives (clearing trails, fire control).
- Water supply/Flood control – no major diversion or other structures will be allowed in the channel or river corridor.
- Mining –Existing or new mining activity on an agency-identified study river is subject to regulations in 36 CFR 228 and must be conducted in a manner that minimizes surface disturbance, sedimentation and pollution, and visual impairment.
- Road construction – no new roads and no motorized travel will be allowed outside designated routes.
- Recreation development – major public use sites (campgrounds, administrative buildings) are located outside the wild river corridor.
- Utilities – new transmission, gas, and water lines are discouraged. Where no reasonable alternative exists, additional or new facilities should be restricted to existing rights-of-way.

Eligible Scenic Rivers

- Timber production – A range of vegetation management and timber harvest practices are allowed, provided that such practices are designed to protect, restore, or enhance the river environment, including the long-term scenic character."
- Water supply/Flood control – major diversions and flood control dams are prohibited.
- Mining – subject to regulations (36 CFR 228), new mining claims and mineral leases could be allowed and existing operations allowed to continue provided surface disturbance, sedimentation, and pollution are minimized and the visual character of the landscape is maintained.

- Road construction – roads may occasionally bridge the river. Short, conspicuous road stretches or longer, inconspicuous, well-screened road stretches could be allowed.
- Recreation development – public use sites (moderate-sized campgrounds, administrative facilities) are allowed, provided they are outside the river floodplain and screened from view.
- Utilities – new transmission, gas, and water lines are discouraged. Where no reasonable alternative exists, additional or new facilities should be restricted to existing rights-of-way.

Eligible Recreation Rivers

- Timber production – A range of vegetation management and timber harvest practices are allowed, provided that such practices are designed to protect, restore, or enhance the river environment, including the long-term scenic character."
- Water supply – existing low dams, diversion structures, rip-rap, and other minor structures are allowed provided the river stays generally natural in appearance. New structures are prohibited.
- Mining – subject to regulations (36 CFR 228), new mining claims and mineral leases could be allowed and existing operations allowed to continue provided surface disturbance, sedimentation, and pollution are minimized and the visual character of the landscape is maintained.
- Road construction – parallel roads or railroads could be constructed on one or both riverbanks. There can be several bridge crossings and numerous river access points.
- Recreation development – campgrounds and picnic areas may be established close to the river. However, recreational classification does not require extensive recreation development.
- Structures – small communities as well as dispersed or cluster residential developments are allowed. New structures are allowed for both habitation and for intensive recreation use.
- Motorized travel – this activity, on land or water, may be permitted, restricted, or prohibited. Controls will usually be similar to surrounding lands and waters.
- Utilities – new transmission, gas, and water lines are discouraged. Where no reasonable alternative exists, additional or new facilities should be restricted to existing rights-of-way.

AFFECTED ENVIRONMENT

The Tongue and Little Bighorn Rivers were identified as eligible for potential inclusion into the NWSRS in the 1985 Forest Plan. In the 1989 Wild and Scenic River Study Report and Final EIS on the Little Bighorn River, 19.2 miles of river were found suitable (USDAFS, 1989). The area was recommended for Congressional designation in August 1990, however Congress has not acted on this recommendation. Both the Little Bighorn and Tongue Rivers remain within the 1985 Plan's Management Area 10D (wild and scenic management area - the 1985 Plan did not differentiate between wild and scenic river classifications). Their unique qualities are safeguarded by specific standards and guidelines.

In 2001, the Bighorn Forest conducted an initial screening process of all rivers on the Forest for consideration of potential eligible rivers utilizing the following inventory lists:

- National River Inventory list that was updated in April 2000.
- 1988 American Rivers list.
- December 2000 Sierra Club correspondence.

After the list was completed, an initial determination of free-flowing condition was made and the rivers were divided into homogenous sections for analysis on landform, resources and land uses. Each of the previously described steps for determining outstandingly remarkable values, classification, and suitability were completed and are documented in DEIS Appendix E, Wild and Scenic Rivers. The following table displays the results of this inventory and evaluation of streams on the Forest for eligibility.

Table 3-134. Wild and scenic river evaluation for the Bighorn National Forest.

River/Stream	Eligible Miles	Outstandingly Remarkable Values	Potential Classification		Suitable Miles
			Class	Miles	
Little Bighorn	20.01	Scenery	Wild Scenic	15.9 4.11	20.01
Tongue	32.85	Scenery Recreation Fisheries	Wild Scenic Recreational	8.10 3.00 21.75	32.85
Piney	Not eligible				
South Rock	16.28	Scenery Geology	Wild Scenic	13.04 3.24	16.28
Tensleep	6.82	Scenery Geology	Scenic	6.82	No
Crazy Woman	4.47	Scenery Vegetation	Scenic	4.47	No

River/Stream	Eligible Miles	Outstandingly Remarkable Values	Potential Classification		Suitable Miles
			Class	Miles	
Cedar	8.5	Fisheries Scenery	Wild	8.50	No
Lodge Grass	Not eligible				
Porcupine	6.25	Scenery Cultural	Wild	6.25	6.25
Shell	Not eligible				
Paintrock	14.85	Scenery Geology	Wild Scenic	9.05 5.8	14.85
Medicine Lodge	Not eligible				
Total Miles	**110.03**			**110.03**	**90.24**

Individual descriptions of rivers are found within Appendix E of this document.

Environmental Consequences

Recommendations by Alternative

The following table summarizes Wild and Scenic River recommendations by alternative, classification, and miles. As displayed in the previous table, Piney Creek, Lodge Grass Creek, Shell Creek, and Medicine Lodge did not meet the eligibility criteria.

Table 3-135. Wild and scenic river recommendations by alternative.

River/Stream	Classification	A	B	C	D	E
Little Bighorn	Wild	20.01	15.9	15.9	15.9	15.9
	Scenic		4.11	4.11	4.11	4.11
Tongue	Wild		8.1	8.1	NR	NR
	Scenic	32.85				
	Recreational		21.75	21.75		
Crazy Woman	Scenic	NR	NR	NR	NR	NR
Tensleep	Scenic	NR	NR	NR	NR	NR
South Rock	Wild	NR	13.04	16.28	NR	NR
	Scenic		3.24			

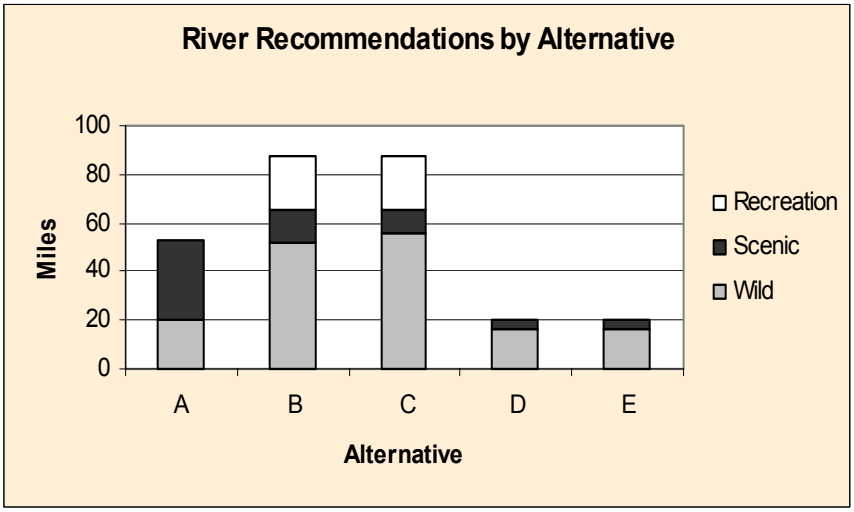
River/Stream	Classification	A	B	C	D	E
Porcupine	Wild	NR	6.25	6.25	NR	NR
Paintrock	Wild	NR	9.05	9.05	NR	NR
	Scenic		5.8	5.8		
Cedar	Wild	NR	NR	NR	NR	NR
Total by Class	*Wild*	*20.01*	*52.34*	*55.58*	*15.9*	*15.9*
	Scenic	*32.85*	*13.15*	*9.91*	*4.11*	*4.11*
	Recreational		*21.75*	*21.75*		
	Total	52.86	87.24	87.24	20.01	20.01

Note: Mileage based on GIS data – may be slightly different than mileage shown in prior table due to increased accuracy.
NR = Not recommended in this alternative

General Effects

Alternatives B and C provide the greatest number of miles of recommended wild and scenic at 87.24 miles, followed by Alternative A at 52.86 miles. Alternatives D and E have fewer recommended miles at 20.01 miles.

Figure 3-12. Recommended river mileage and classification by alternative.



The river management prescriptions allocated to these river corridors place management constraints on the type of activities that can occur within the river corridors. As appropriate, based on alternative, these rivers are placed in Management Area Prescriptions 1.5, 3.4, or 4.4 (wild, scenic, recreational) to protect their existing

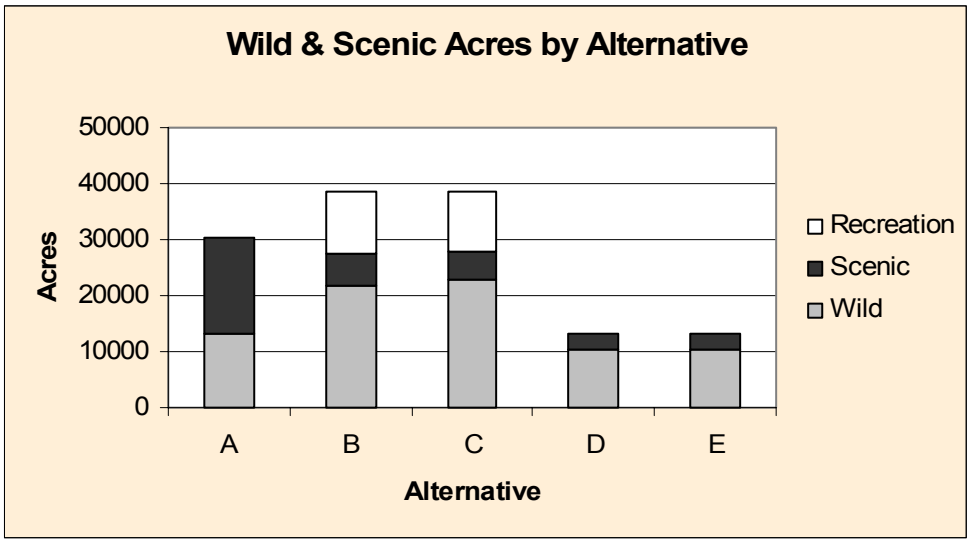
characteristics and values. The following table lists the three management area allocations by alternative.

Table 3-136. Acres of Management Areas 1.5, 3.4, and 4.4, by alternative.

	Management Areas			
	1.5 (Wild)	3.4 (Scenic)	4.4 (Rec)	Total
Alternative A	13,217	17,110	0	30,327
Alternative B	21,715	5,815	10,901	38,431
Alternative C	22,925	4,817	10,900	38,642
Alternative D	10,251	2,887	74	13,212
Alternative E	10,251	2,887	0	13,138

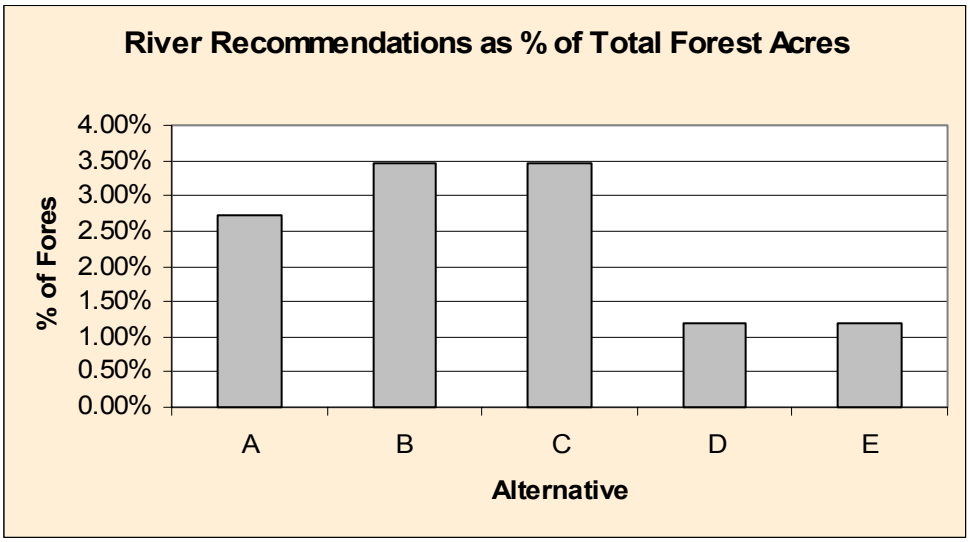
Note: Acreages may vary slightly due to information derived from GIS data source.

Figure 3-13. Wild and scenic management area acres by alternative.



Note: Acreages may vary slightly due to information derived from GIS data source.

Figure 3-14. River recommendations as % of total forest area.



Direct and Indirect Effects

Effects from Minerals Management: Anticipated effects from mineral management would be low in all alternatives, in proportion with the amount of miles designated as shown above. Mineral potential is low for locatable minerals (gold, silver, etc.) and very low for leasable minerals (oil and gas) within and around all wild and scenic river corridors. There are no current permits or operating plans for minerals exploration within the corridors. Salable mineral such as dolomite and limestone are present and could potentially be used for construction purposes, however, because of the inaccessibility of these reserves, they have not been utilized to any extent in the past.

An agency-identified study river is not withdrawn from either locatable or leasable mineral entry. The applicability of the 1872 Mining Act, as amended, is unaffected absent the area being withdrawn from mineral entry under some other statutory authority (e.g. Wilderness) or the Forest Service recommending to the Bureau of Land Management that an area be withdrawn from mineral entry. The latter requires a detailed analysis of mineral potential/area's values and an environmental assessment as well as concurrence by the Department of the Interior.

If a particular river were to be ultimately designated, the Wild and Scenic Rivers Act affects minerals management/development in several ways. First, subject to valid existing rights (i.e., subject to existing mining claims and mineral leases), the minerals located on federal lands within the bed or banks or ¼-mile of the banks of any designated *wild* river are withdrawn from all forms of appropriation under the mining lawns and from the operation of the mineral leasing laws. Second, subject to valid

existing rights (i.e., subject to mining claims where the claimant has filed a proper patent application and paid the required fees prior to the river's designation), mining claimants may only obtain title to the mineral deposits and such rights to the use of the surface and surface resources as are reasonably required for prospecting or mining. Third, the act requires regulations be developed to govern mining and mineral leasing activities within Wild and Scenic River corridors. While the Secretary of Agriculture has not issued these regulations, the USFS uses its existing regulations (36 CFR 228) to meet, to the extent possible, the nondegradation standard of Section 10(a).

There would be no anticipated adverse effects from mineral material removal as mitigation measures would be included in project level plans.

Effects from Livestock Grazing and Rangeland Management: Effects from livestock grazing are expected to be minimal under any recommended river designation. Although most wild and scenic river corridors have some acres of range allotments within them, standards and guidelines are in place to manage for desired conditions as identified in allotment management plans.

Effects from Recreation Management: Effects from recreational use and management within designated river segments are anticipated to be low. Although designated river segments may be used for camping, canoeing, hiking, and other anticipated activities, the anticipated impact of these activities on the overall river itself is expected to be minimal since they are generally low intensity.

Recreational users expect to experience primitive conditions within wild river segments, and so recreation development would not be allowed. Recreational development would be allowed under recreational and scenic designation however, the development would be carried out in such a way as to not adversely affect the reasons for scenic river designation. There are no plans for any development within any of these corridors at this time.

Additional effects (e.g., trash not disposed of properly and human-caused fires), can be expected but are anticipated to be low.

Fishing and hunting would not be prohibited under a wild or scenic classification. Fishing and hunting are regulated under state laws.

Effects from Travel Management: In general, the effects from travel management and motorized use are anticipated to be very low within designated wild river segments. Effects from nonmotorized use and permitted motorized use are anticipated to be low in recreational and scenic river segments. Within recreational and scenic segments, road building or river crossing developments to accommodate motorized traffic would be allowed. However, construction of such developments might be more costly as design specifications seek to reduce visual impacts and the number or river crossings. If motorized use, such as recreational vehicle use, were shown to be causing adverse environmental effects, travel-closure orders may be applied at the discretion of the district ranger.

Even though some eligible river segments, especially those classified as wild, are very remote and quite inaccessible, the Wild and Scenic Rivers Act does not prohibit motorized use within designated segments. Because of the remote nature or wild river corridors, versus scenic, the volume of motorized traffic by land vehicles would be extremely low.

Nonmotorized access within designated river segments would not be restricted. Floating the river corridors or hiking in on foot or horseback would likely be the primary ways to access wild or scenic river segments.

In addition, motorized boats, jet skis, hovercraft and other types of water-bound craft are allowed in wild, scenic, or recreational river segments, consistent with Congressional intent and the river management objectives as outlined in the enacting legislation and the Comprehensive River Management Plan. Motorized use would be prohibited in those river segments within established wilderness areas.

Effects from Scenery Management: Positive effects on wild and scenic rivers are expected from scenic resource management, in proportion with the amount of miles designated as shown in the general effects section. Management activities will not dominate the scenic qualities of the area.

River segments determined suitable will be treated as sensitive viewing zones, with viewshed protection for eligible wild and scenic rivers, and river corridor protection for eligible recreation rivers. The scenic integrity objectives are generally high or moderate.

Effects from Timber Management: Tentatively suited acres within the 1.5, 3.4 and 4.4 management area prescriptions were not considered part of the suited base. Timber management has the potential to change the character of rivers and the adjacent areas, primarily with regard to visual aspects. Within eligible wild river corridors, the cutting of trees will not be allowed unless needed to meet management objectives (such as trail clearing or fire control). Scenic and recreation river corridors allow vegetative treatment of timber stands, as long as the treatment meets recreation or scenery objectives. Vegetative treatments outside all river corridors can be accomplished with an emphasis on meeting scenery objectives.

Amount of tentatively suited acres within wild & scenic corridors (1/4 mile either side) by alternative are shown in the following table.

Table 3-137. Tentatively suited acres within recommended river corridors, by alternative (1/4 from bank)

Alternative	Tentatively Suited acres within recommended river corridors
A	459
B	3199
C	3199
D	342
E	342

Effects from Management of Special Uses: Construction of a major water resources project (e.g., dam, diversion structure) is likely to affect a river's free-flowing condition and therefore its eligibility for consideration as a wild and scenic river. Water resources projects of smaller size and with limited adverse effects to free-flowing character and or outstanding values might not eliminate the river from future consideration but may affect its classification. No large-scale water resources projects are anticipated within the planning horizon.

On designated rivers, Federal Energy Regulatory Commission-licensed facilities are prohibited within a designated corridor. Other federally assisted water resources projects within a designated river corridor are evaluated as to their potential "direct and adverse effect" on the values for which the river was designated. Proposed water resource projects above, below, or on a stream tributary to a designated river are evaluated as to their potential to influence the designated river area or unreasonably diminish the scenic, recreational, fish or wildlife values of the designated river.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered with regard to cumulative effects to Wild & Scenic Rivers. The next 15 years are considered the time span for "reasonably foreseeable future" cumulative effects.

In terms of past actions, the Tongue and Little Bighorn Rivers were identified as eligible for potential inclusion into the NWSRS in the 1985 Forest Plan. In the 1989 Wild and Scenic River Study Report and Final EIS on the Little Bighorn River, 19.2 miles of river were found suitable. The area was recommended for Congressional designation in August 1990, however Congress has not acted on this recommendation. Both the Little Bighorn and Tongue Rivers remain within the 1985 Plan's Management Area 10D (wild and scenic management area - the 1985 Plan did not differentiate between wild and scenic river classifications), their unique qualities safeguarded by specific standards and guidelines.

On January 2000, the Federal Energy Regulatory Commission dismissed a proposed hydropower project on the Little Bighorn River.

As part of their evaluation of the Buffalo Resource Management Plan Area, the Bureau of Land Management completed a wild and scenic rivers review of all BLM-administered public land surface along waterways within the Buffalo Planning area, culminating in 1994. This review was to determine if any BLM-administered lands meet the wild and scenic rivers eligibility criteria and suitability factors. It was determined that of 120 waterways in the BLM-administered planning area, four waterways met the test of eligibility. Of those four waterways, only the Middle Fork of the Powder River met both the additional standard of suitability and will be managed as such by the BLM (USDIBLM, 2002).

Additional designated river segments in Wyoming may create new regional attractions for visitors (Power, 2002). This would be greatest in alternatives B and C (since they recommend the greatest number of river miles), followed by A, D and E.

Although the effects of non-designation may not significantly increase recreation or tourism in or near the designated river segments, non-designation may represent a lost opportunity to protect stream characteristics that are unusual to the region. This is most likely in alternatives D and E (since they recommend the least number of river miles), followed (in order) by A, B and C.

Wilderness

Introduction

The Bighorn National Forest surrounds and manages the Cloud Peak Wilderness. The wilderness totals 189,039 acres. Congressionally designated wilderness is one type of special area designation on the forest. The *Wilderness Act of 1964* established the National Wilderness Preservation System. It mandates that these areas are to be "administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness." Wilderness is part of the National Forest multiple use management mission. Wilderness provides opportunities for solitude and for primitive and unconfined recreational experiences. Wilderness is important for maintenance of species diversity, protection of air quality and watersheds, scientific research, and various social values.

Legal and Administrative Framework

The Wilderness Act of 1964 (P.L. 88-577) directed the Secretary of Agriculture to initiate reviews of the initial 34 primitive areas and to submit recommendations regarding their future to Congress within 10 years of the act's passage. Section 2 of the Wilderness Act defines wilderness and sets forth policy and implications for wilderness designation. Lands are designated as wilderness … "in order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition."

The Wyoming Wilderness Act of 1984 (P.L. 98-550) designated the Cloud Peak Wilderness.

Congressional Grazing Guidelines (Sec. 108, P.L. 96-560, H.R. Report 96-617 dated 11/14/79) clarifies the Congressional intent that livestock grazing will be permitted to continue in national forest wilderness areas, when such grazing was established prior to classification of an area as wilderness.

Key Indicators

- Acres recommended for wilderness designation.
- Wilderness acres to standard
- Semi-primitive nonmotorized recreation opportunities outside wilderness
- Visitor use and campsite conditions in wilderness
- Forest uses adjacent to wilderness

Resource Protection Measures

The Wilderness Act established the National Wilderness Preservation System for the purposes of wilderness. Standards and guidelines included in the plan are designed to meet the intent of the Wilderness Act. The standards and guidelines for wilderness work to protect the wilderness resource from degradation. Monitoring is conducted.

AFFECTED ENVIRONMENT

Introduction

Since the Wilderness Act of 1964, the National Wilderness Preservation System (NWPS) has grown dramatically. As of 2004, Congress had designated more than 106 million acres of federal public land as wilderness. Numerous bills are pending in Congress that would create millions of acres of new wilderness areas in national forests, national parks, national wildlife refuges, and land administered by the Bureau of Land Management (BLM).

The wilderness system has been built through enactments of approximately 104 Wilderness bills, typically establishing wilderness areas in a particular state. The Wilderness Act allows additional undeveloped and unroaded lands to be added to the NWPS. The Forest Service initially inventories wilderness potential by identifying roadless areas of 5,000 acres or larger. There are three tests applied to roadless areas before they are considered for wilderness recommendation: capability, availability, and need.

Nationally in the NWPS, there are 662 wildernesses encompassing approximately 106 million acres. This is approximately 4.7% of the U.S. continental land mass. The Forest Service manages 35 million acres (33% of the NWPS) in 406 wilderness areas. This is 18% of all National Forest System land.

In Wyoming there are a total of 3.1 million acres of designated wilderness in15 National Forest wildernesses. Wyoming wildernesses administered by the Forest Service represent about three percent of the area in the NWPS.

Physical Setting

The Cloud Peak Wilderness is the only designated wilderness area on the Bighorn National Forest. The wilderness contains 189,039 acres covering 17% of the Forest and comprising 6% of Wyoming's 3.1 million acres of wilderness. There are no private inholdings within the Cloud Peaks Wilderness. There have been no changes to the size of the Cloud Peak Wilderness area since passage of the Wyoming Wilderness Act on October 30, 1984.

The interior of the wilderness landscape is dominated by a spine of granitic peaks, the highest of which is Cloud Peak at 13, 175 feet in elevation. The lowest point of elevation in the wilderness is Shell Creek at 8,000 feet.

Average annual precipitation in the wilderness is 30 inches, falling mostly as snow, although many high elevation areas receive significantly more. The headwaters of streams flowing in the Bighorn, Little Bighorn, and Powder River basins originate in the Cloud Peak Wilderness.

Geologic landtype associations within the Cloud Peak Wilderness consist of the following:

Table 3-138**.** Geologic landtype associations in the Cloud Peak Wilderness.

Description	% of total
Alpine Mountain Slopes and Ridges (granitic)	45%
Glacial Cirquelands (granitic)	32%
Glacial / Tertiary Terrace Deposits (granitic)	9%
Gentle Mountain Slopes (granitic)	13%
Steep Mountain Slopes (granitic)	<1%
Breaklands (sedimentary)	<1%
Mountain Slopes (sedimentary)	<1%

Source: GIS Inventory

The wilderness includes the highest elevation areas of the Forest. Approximately 47% of the Wilderness is in the alpine climate zone, 30% is sub-alpine, and 22% is montane/sub-alpine.

The Cloud Peak Wilderness is a Class II air quality area. Air quality monitoring began in 1992 and continues to the present. The Forest is also engaged in lake water sampling to monitor for pH changes as a result of acid precipitation. To date, no change in lake water pH has been noted. These lakes are vulnerable to acidification because the geology of the area has a low acid neutralization capability.

Biological Setting

Vegetative composition of the wilderness is shown in the following table.

Table -3-139. Vegetative composition of the Cloud Peak Wilderness.

Cover type	% of Total
Forb/grasses	13%
Bare/rock	42%
Shrubs (primarily willow)	1%
Aspen	<1%
Douglas Fir	<1%
Lodgepole	14%
Spruce Fir	30%

Source: GIS Inventory

Provisions in the Wilderness Act of 1964 specify that grazing be allowed to continue where it is established prior to designation. There are 7,884 acres of suitable rangeland (within active and vacant allotments) inside the wilderness. There is currently no grazing by sheep under permit in the wilderness. Grazing by recreation stock (horses and llamas) is substantial in some areas of the wilderness.

Several sensitive species that occur or potentially occur in the wilderness and are described in detail in the section of the DEIS on biodiversity. None of these species are found exclusively within the wilderness; they are found in suitable habitat outside the wilderness as well. Rare plants and animals found in the wilderness include the American marten, Bighorns pika, Kotzebue's grass-of-parnassus *(Parnassia kotzebuei),* northern goshawk, northern leopard frog and bighorn sheep. Wolverines may travel through the wilderness, although none are known to inhabit it.

The Cloud Peak Wilderness abounds with lakes and streams. Some of the larger lakes are stocked by the state of Wyoming. This increases recreational fishing opportunities for visitors. It also raises concerns among some sectors of the public and the Forest Service as to whether or not stocking carries the potential to for a loss of wilderness values. The majority of lakes inside the wilderness are fishless. Additional information on fish and fish stocking in the wilderness is in the Aquatics section of the DEIS.

Wilderness lakes are extremely sensitive to acid rain deposition, because the granitic parent material supplies little buffering capacity. Monitoring of water and air quality is ongoing, in partnership with the state of Wyoming.

The Cloud Peak Wilderness has not been heavily impacted by fire over time. Much of the area within the current wilderness boundary consists of high elevation sites that are primarily rock and bare soil. Those areas that are vegetated tend to be wet sites, such as high alpine meadows that are too wet to burn. Wildfire is estimated to affect parts of the vegetated wilderness every 100 to 200 years.

New and expanding populations of invasive plant species in the Cloud Peak Wilderness are of a particular concern since these weeds can eliminate native plants and compromise both the resource values as well as the character of the wilderness. On-going management approvals are in place for noxious weed treatment in this area.

Recreation

The Cloud Peak Wilderness is a popular recreation destination among visitors to the Bighorn National Forest.

The Forest Service uses the Recreation Opportunity Spectrum (ROS) to describe the recreation settings available in relation to the opportunities for recreation experiences. These opportunities are separated into (ROS) classes. The following ROS classes and acres have been inventoried for the Cloud Peak Wilderness.

Table 3-140. Recreation Opportunity Spectrum classes in the Cloud Peak Wilderness.

Primitive (P)	137,708 acres	72% of the wilderness
These areas are primarily unmodified with a very high probability of experiencing solitude, freedom, closeness to nature, tranquility, self-reliance, challenge and risk. There is a low likelihood of encountering other users. Access and travel is nonmotorized on trails or cross country		
Semi-Primitive Nonmotorized (SPNM)	54,189 acres	28% of the wilderness
Areas in a semi-primitive nonmotorized class are in a natural appearing environment with a high probability of experiencing solitude, challenge, and risk. There is a low probability of encountering other users, but there may be evidence of other users. Access and travel is on nonmotorized on trails or cross-country.		

Heavy use corridors within the Cloud Peak Wilderness are shown as management area (MA) 1.13 - Semi-Primitive Wilderness and are primarily ROS class SPNM. Approximately 32% of the wilderness (or 61,100 acres) is in MA 1.13, with the remaining 68% (approximately 130,800 acres) in MA 1.11 – Pristine Wilderness. (Note that ROS inventory areas and management areas are not identical so acres and percentages differ)

In 1998 the Forest Plan was amended. The amendment decision updated management areas, standards and guidelines. The recreation use regulations for the Cloud Peak Wilderness were also updated following the decision.

Recreation visitor day (RVD) use since 1993 is shown below. An RVD is defined as any recreational use of the forest which results in 12 visitor hours. The RVD numbers reflect Cloud Peak registration data, which includes “number of people in party” and “length of stay” data. Based on forest experience, registration compliance levels are very high (at or exceeding 95%). Wilderness use has been generally stable with an

average annual use of slightly more than 65,000 RVDs. A trend line indicates an average annual increase in use of 0.6%. Many variables influence a use in a particular year; local weather and a variety of socioeconomic conditions are among the influences on a decision to visit the wilderness.

Table 3-141. Cloud Peak Wilderness visitation (RVDs).

Year	RVDs
1993	67,700
1994	77,400
1995	55,000
1996	67,000
1997	54,000
1998	61,000
1999	65,000
2000	70,500
2001	70,000
2002	62,500

The predominant recreation activity inside the wilderness is hiking, followed by horseback riding along with a small amount of winter travel by either cross-country ski or snowshoe. The season of accessibility for hiking runs from June 15 to September 30 under average snow conditions. The following table illustrates the mix of recreation activities inside the wilderness.

Table 3-142. Travel modes in the Cloud Peak Wilderness.

Method	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY00	FY 01
Hiking	87%	93%	90%	89%	86%	90%	90%	90%
Horseback	12%	7%	10%	11%	14%	10%	10%	10%
Ski	<1%	<1%	<1%	<1%	<1%	0	0	0
Snowshoe	<1%	<1%	<1%	0	0	0	0	0

Between October 2000 and September 2001, the National Visitor Use Monitoring Survey was conducted on the Bighorn National Forest. Some findings of the survey relate to wilderness visits. The average length of stay for visitors to the wilderness was 35.4 hours, compared with a Forest wide average of 16.1 hours. The wilderness visitor was, on average, older than the forest-wide visitor, and came from a wider geographic area.

There are no overnight facilities in the wilderness: visitors staying overnight must camp. Most camping occurs around lakes. During the summer seasons of 2001 and 2002 campsite conditions, including campsite density, were monitored. Seventy percent or 28 of the 40 lakes surveyed in the 1.13 – Semi-Primitive Wilderness management area exceeded campsite density guidelines. One hundred percent or 15 of

the 15 lakes surveyed in the 1.11 – Pristine Wilderness management area, exceeded campsite density guidelines.

Campsites were inventoried in 1996 and again in 2000 for the area of bare ground where vegetation has been lost. An increase in the area of bare ground of nearly 30% was documented. Both campsite density and bare ground at campsites indicate that current levels of human use are having an impact on the wilderness resource.

The National Visitor Use Monitoring Survey collected visitor satisfaction information pertaining to how crowded the wilderness felt to visitors. This is shown in the following table. Opinions related to General Forest Areas are also included for comparative purposes. The perception of crowding is an indicator of social conditions in the wilderness. It relates to visitor satisfaction and is a one indicator of the relationship between wilderness supply and demand.

Table 3-143. Visitor perceptions of crowding in the Cloud Peak Wilderness (percent of site visits).

Perception of crowding	Wilderness	General Forest Areas*
10 (overcrowded)	0.0%	19.6%
9	0.0%	1.5%
8	0.0%	0.4%
7	12.5%	1.9%
6	0.0%	31.5%
5	25.0%	14.9%
4	12.5%	1.8%
3	37.5%	11.7%
2	12.5%	10.0%
1 (hardly anyone there)	0.0%	6.7%

*General forest area is undeveloped area outside of developed sites and special areas.

Commercial opportunities for permitted outfitter and guide services are at the capacity determined in a study undertaken in 1986 to implement the 1985 Forest Plan. There are currently 21 outfitters providing a range of services in the Cloud Peak Wilderness during summer and fall seasons.

ENVIRONMENTAL CONSEQUENCES

General Effects

Protection of wilderness values may occur in designated wilderness or in other undeveloped areas (i.e. roadless, recommended for wilderness, semi-primitive nonmotorized). In either case careful management is needed to minimize the impacts of human use. Alternative C followed by B and D protect the wilderness value of the most

area by management area prescription. Alternatives A and E protect the least area by. Protection of wilderness values has become more challenging with the increase in specialized motor vehicles for backcountry travel and increased motorized trespass.

Alternatives A, B, D, and E do not recommend any acres for wilderness designation. Alternative C recommends five areas – Rock Creek, Walker Prairie, Little Bighorn, Devils Canyon and Medicine Lodge – for wilderness designation. Congressional action is required to designate a new wilderness. A forest plan allocation to M.A. 1.2 – Recommended for Wilderness is an administrative action.

The Rock Creek area is contiguous with the Cloud Peak Wilderness and Congressional designation would enlarge the existing wilderness by about 42,000 acres. The Medicine Lodge area is contiguous with a BLM Medicine Lodge area, where about 3,600 acres were recommended in 1990 for wilderness designation. Congressional action to designate both areas would create a wilderness of about 8,900 acres.

In all alternatives, the existing Cloud Peak Wilderness acres would remain the same.

Direct and Indirect Effects

Effects from Recreation Use and Management: Alternative C would recommend new areas for wilderness designation. Alternatives A, B, D, and E do not include areas recommended for wilderness designation. Designation of new wilderness may change patterns of recreation use and reduce pressure in the existing wilderness. Motorized and mechanized travel on trails and unclassified roads would be prohibited in areas recommended for wilderness designation. To the extent it currently occurs in the recommended areas, ATV, motorcycles, snowmobile, and bicycle use would be displaced. The average elevation in each of the five areas recommended for wilderness designation in Alternative C is lower than the average elevation of Cloud Peak Wilderness. The new areas would generally have a longer snow-free season and a longer season of use.

Recreation impacts to water quality in the wilderness are the same as the impacts to water quality across the Forest: increased runoff and sediment into streams as a result of both trail and off-trail activities; stream bank erosion and channel instability as a result of repeated camping near streams; and water contamination from human or animal waste. Overall, wilderness recreation on and off-trails disturbs a relatively small portion of the watershed. However, short-term acute recreation impacts around heavily used lakes and streams are a concern.

By providing nonmotorized opportunities outside wilderness, social and physical impacts inside wilderness may decrease. The 1998 ROS inventory of semi-primitive nonmotorized (SPNM) recreation opportunities included 25% of the forest (278,105 acres); approximately 20% of that opportunity was outside designated wilderness. Alternative C would recommend adding 24,181 acres of primitive area and 104,388 acres of semi-primitive nonmotorized area to the wilderness system. Alternative B would have the most SPNM acres outside wilderness, followed by Alternatives D and

C. Over time, Alternative A and E would reduce the SPNM recreation opportunity outside of wilderness to less than one percent of the current inventory. The semi-primitive nonmotorized acres outside designated wilderness are expected to decline under all alternatives. The numbers in the following tables are based on the ROS guideline for each management area (M.A.). Note that management areas that allow for a combination of SPNM or SPM are not included.

Table 3-144. Acres and percents of Semi-primitive Nonmotorized Recreation (SPNM) opportunity by alternative.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Total acres of SPNM	62,716	116,557	208,092	107,001	70,410
Percent of forest in SPNM	6%	11%	19%	10%	6%
SPNM acres in wilderness (M.A. 1.13)	61,098	61,094	61,100	61,100	61,090
SPNM acres recommended for wilderness			104,388		
Total SPNM acres outside wilderness (M.A. 1.13) and recommended for wilderness (M.A. 1.2)	1,618	55,462	42,604	45,901	9,320
Percent of forest in SPNM outside of wilderness	<1%	5%	4%	4%	<1%

Source: GIS Inventory

Illegal use of ATVs (all terrain vehicles) and snowmobiles in designated wilderness is a management concern. Where there are no natural barriers, from trees or terrain, monitoring for unauthorized use is especially important. Monitoring and law enforcement are continuing efforts.

Effect from Management Areas: Adjacent management activities can have a direct effect on the Cloud Peak Wilderness. Although the law forbids buffering wilderness, management along the boundaries can affect both management and use of the area inside the boundary. Areas with nonmotorized use are usually compatible with wilderness.

Table 3-145. Miles of common boundary between management area groups and the Cloud Peak Wilderness.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Nonmotorized management areas (M.A. 1.2, 1.31, 1.5*, 2.2*)		9.51	9.88	9.53	
Limited development and motorized use (M.A. 1.32, 1.33, 3.31, 3.4, 3.5)	83.16	95.88	119.02	63.95	34.21
Motorized recreation and commodity use (M.A. 4.3, 5.11, 5.12, 5.13, 5.4, 5.5)	49.11	28.72	5.21	60.62	99.79

*Limited winter motorized use may occur)

Source: GIS Inventory

Non-wilderness uses adjacent to wilderness can have a negative affect on the quality of wilderness recreation experiences. Where roads and motorized activities occur along the wilderness boundary, the incidence of illegal use of motorized and mechanized vehicles in the wilderness may increase. High standard roads close to the boundary provide easy recreation access to wilderness and tend to increase day use. As use numbers increase – particularly day use –concentrated use affects physical, biological, and social conditions in the wilderness.

Management areas bordering the wilderness and providing motorized use are more likely to affect wilderness condition and uses. The most highly developed areas – for commodity production or recreation use – are generally those areas in category 4 and 5 management areas. If new development occurs adjacent to the Cloud Peak Wilderness, impacts could include noise, modified landscapes, and motorized incursions. In terms of negative effects from adjacent land uses, Alternative E could have the greatest impact on existing wilderness, followed by Alternatives D, A, B, and C.

Effects from Aquatic Resources (Fisheries) Management: About 10% of the more than 300 small lakes inside the wilderness are stocked by the Wyoming Department of Game and Fish. In some cases the fish species are not locally native. Stocked lakes attract visitors, which can result in overuse and loss of campsite vegetation, particularly in areas managed for pristine conditions. Designation of additional wilderness areas with fishing opportunities could reduce any overuse associated with fish stocking in the Cloud Peak Wilderness.

Effects from Exotic Species: Exotic species invasions may include non-native plants, pathogens, insects, birds, mammals, and fish. Exotic species can threaten the integrity of wilderness ecosystems. While introduced fish species are the most ubiquitous, non-native plants are also found in the wilderness and have a potential to increase.

Visitors and livestock from outside wilderness are most likely to introduce non-native plants. Certified weed-free hay is required if hay is used for pack stock. The Forest currently monitors for non-native plant species and uses mechanical controls (e.g.,. hand-pulling, hand tools) when possible. Chemical controls are approved if necessary.

Non-native plant control is a joint effort between the forest and the county weed and pest control.

The effects from exotic species do not vary by alternative.

Effects from Fire and Fuels Management: The high elevation environment of the Cloud Peak Wilderness is believed to be within the historic range of variability for natural fire occurrence. Historic fire suppression may have moved areas recommended for wilderness designation in Alternative C outside the historic range of variability. Guidelines allow for the use of wildland and prescribed fire in these 1.2 management areas. Fire cannot be successfully returned to these areas without approved fire management plans that allow wildland fire use and burns under appropriate conditions. Use of fire must consider opportunities to minimize threats to property and life outside wilderness and 1.2 management areas, as well as protection of wilderness values.

Within designated wilderness, restrictions on use of mechanized equipment and access limitations may make fire suppression more difficult and increase suppression costs. This effect may be off-set by reduced costs associated with wildland fire use instead of expending funds for suppression and by the resource benefits derived from the fire on the landscape.

Fire management does not vary by alternative.

Effects from Livestock Grazing: Commercial livestock grazing is permitted in wilderness, where it was established prior to wilderness designation in accordance with Congressional Grazing Guidelines. Livestock can impact streambanks and lakeshores, including altering soil and vegetation and increasing stream sedimentation; however, these effects are not wilderness-specific. For additional discussion of livestock grazing impacts on aquatic resources, see the Aquatic Resources section in this chapter.

Recreational pack stock grazing activities are not necessarily regulated by a permitting process; only pack stock used by commercial outfitters and guides is under permit. Guidelines and monitoring included in the forest plan revision provide a framework for monitoring effects of recreational livestock grazing impacts and determining the appropriate management response. Commercial livestock grazing and pack stock management also relies on monitoring to provide for protection of wilderness values.

Effects from Minerals Management: The Cloud Peak Wilderness has been withdrawn from mineral entry and is not available for new leases or claims. Surface and mineral estates within the Cloud Peak are entirely federal. There are no private lands or private land interests. The roadless section of this document discusses the potential for leases and claims as well as private interests for the areas recommended for wilderness designation in Alternative C. Minerals management has no effect on the Cloud Peak Wilderness.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered with regard to cumulative effects to the wilderness resource.

Wilderness management in accordance with the standards and guidelines in the forest plan revision is designed to maintain or improve conditions in the Cloud Peak Wilderness. Current monitoring indicates that impacts of concentrated recreation use exceed guidelines in some areas and management actions may be needed to improve conditions. Management options include restoration activities, visitor information and education, limits on use, recommendation of additional areas or some combinations of options.

The coalbed methane development in the Powder River basin had generated several public proposals for power plant development. Development of a large point-source could have an impact on the air and water quality in the Cloud Peak Wilderness, although the prevailing winds are typically west to east. The effect of a new power plant on the Wilderness would be the same under each alternative.

Population growth and development increases the need for public open space. Increasing urbanization in Sheridan and Johnson Counties, as well as population growth in Gillette, Billings, and Casper is likely to increase recreation use on the Forest including an increase in wilderness use and impacts of use. The effect of urbanization and population growth on wilderness use and resource conditions is likely to be very gradual and extend well beyond the planning period. The effects would be less under alternative C because increased use would be spread across more acres offering wilderness and semi-primitive nonmotorized opportunities. Although no areas are recommended for wilderness designation, some area is allocated for semi-primitive nonmotorized use. The effect on would be greatest under alternatives A and E because no area is allocated for wilderness recommendation or nonmotorized backcountry.

Our relationship to wilderness and wild lands is changing in response to societal changes including technological advances, environmental attitudes, knowledge of natural processes and disturbance factors, and the diversification of the economy. Balancing environmental protection with the maintenance of existing lifestyles is a continuing public debate. The media has raised awareness of natural disturbances – fire, insects and disease, wind – where they threaten homes or economies based on timber or tourism. These issues will influence the public's knowledge and understanding of wilderness in the future.

Utilization of Natural Resources

Livestock Grazing

Introduction

Stockmen have been using the grasslands of this continent since the first Spanish settlers arrived in the early 1500s (Smith-Thomas 1994). Grazing by domestic livestock has occurred on rangelands of the Bighorn NF since the late 1800s. The industry has been an integral part of community economies, development, and lifestyles. For the livestock producer today, summer forage on the Bighorn NF often represents a vital part of their total program. Term grazing permits for livestock grazing, normally issued for 10-year periods, are in effect on allotments throughout much of the Bighorn NF. Permit holders pay a grazing fee for use of forage each year and are required to abide by terms and conditions of their permit which address livestock and land ownership, range improvements, resource concerns, management practices and requirements, etc. Most permitted livestock spend about three months out of the year on the Forest, less time if allotments are at higher elevations. Implementation of required management practices and the long-term effects of livestock use on the environment are monitored, and adjustments are made, as needed, to assure compliance with permits and to address other resource concerns.

Legal and Administrative Framework

The Bighorn National Forest Land and Resource Management Plan (LRMP), September 1985.

FSM 2200 – this manual summarized laws and regulations governing rangeland management and forest planning.

FSM 2600 – this manual summarizes laws and regulations governing fish and wildlife management and forest planning.

R-2 Rangeland Analysis and Management Training Guide

FSH 2209.13 – Grazing Permit Administration Handbook

FSH 2609.13 – Wildlife and Fisheries Program Management Handbook

Code of Federal Regulations (CFR) 36

- 219 Planning
- 222 Range Management
- 241 Fish and Wildlife

National Forest Management Act (NFMA) of 1976 – this act identifies information requirements concerning NFS grazing and browsing resources.

Section 8 of the Public Rangelands Improvement Act (PRIA) of 1978 – this section allows for consultation and cooperation in the development and execution of allotment management plans for grazing permits.

Federal Crop Insurance Reform and Department of Agriculture

Reorganization Act of 1994 amended the 1987 Agricultural Credit Act to provide for mediation of grazing permit cancellation and suspension actions as a part of the existing administrative appeals process.

Section 504 of the Rescissions Act of 1995, Public Law 104-19, directs the Forest to complete site-specific National Environmental Policy Act Analysis and decisions on allotments on a scheduled basis.

Key Indicators

- Trends in cattle and sheep head months (HMs) and animal unit months (AUMs) permitted for grazing.
- Trends in acres of suitable rangeland in active allotments.
- Acres in active allotments monitored annually to determine whether allowable use standards were met.
- Acres in active allotments that were monitored that did meet allowable use standards.
- Acres that are meeting or moving toward desired conditions relative to livestock grazing effects.
- Riparian acres that are meeting or moving toward desired conditions relative to livestock grazing effects.

AFFECTED ENVIRONMENT

Management Direction

The 1985 Plan provides management guidance regarding livestock grazing at the broad, programmatic, forestwide scale. It includes goals, objectives, management area direction, and standards and guidelines. Site-specific direction is addressed in

environmental assessments and decisions that are focused on individual allotments or groups of allotments. This direction is then implemented through Allotment Management Plans (AMP) specific to each allotment. Desired rangeland vegetation conditions are described in the Forest Plan and are made more specific for individual allotments through the project level decision. Allowable forage utilization level, along with other standards and guidelines, are stipulated on a site-specific basis. When livestock graze to allowable utilization levels or otherwise meet required standards, livestock are to be moved from the pasture or grazing area by permit holders, or removed from the allotment for the season. The Region's Rangeland Analysis and Management Guide provides information on documenting rangeland monitoring, inventory, analysis and management activities.

Historic and Current Grazing Use

The lands within the Bighorn NF and the surrounding watersheds have been grazed by wild ungulates for thousands of years (Knight 1994). As a result, the native plants and plant communities have evolved to tolerate some level of intensity, timing, frequency, and duration of grazing and browsing. Livestock grazing probably began with the Americans Indians. Eventually, Euro-American settlers brought livestock with them as they settled in the valleys and plains surrounding the Big Horn Mountains(Knight 1994). By the late 1800s, large herds of livestock were brought into and through the Big Horn Mountains (Knight 2001). From this time on into the early 1900s, heavy and improperly managed livestock grazing became the norm. At times, significant numbers of cattle and horses moved off of the Crow Reservation in Montana and onto the Forest (Knight 2001).

At their peak, livestock numbers on the Bighorn NF were extremely high (Knight 2001). Severe damage was experienced and documented in many of the more accessible areas (Walcott 1899; Meyer and Knight 2001). Often these impacts took the form of changes in plant species composition, accelerated erosion, downcutting of streams, lowered water tables, and declines in production. These impacts were compounded by removal of beaver and extended drought cycles that hit much of the western U.S. during this period.

Resource impacts resulting from livestock use in late 1800s and early 1900s were evident, and were documented by Professor John G. Jack. In 1900, he observed that, east of the Bighorn divide, the southern portion was very fully stocked with sheep but very few bands were grazed north of the Middle Fork of Clear Creek (Jack 1900). He found the whole area (Big Horn Mountains) south of the 13th Standard Parallel was badly overgrazed (Murray 1980), and recommended that the number of sheep on the Reserve be restricted.

With the advent of the Forest Service and the establishment of the Bighorn Reserve in 1897, improved livestock management slowly came to the Big Horn Mountains. A permit system was set in place, numbers were reduced, permit holders were assigned to specific grazing areas (i.e., "allotments"), and some limited fencing and water

development was begun. At first, control was very limited and livestock numbers may have actually increased to over 30,000 cattle and 374,734 sheep by 1904. Grazing seasons remained quite long, limited primarily by snow (Knight 2001). Actual use was probably even greater as trespass was a significant problem.

Over time, improvements in management have focused on bringing permitted numbers and seasons in line with grazing capacity, development of improvements such as fencing and water sources to better control livestock, and implementation of the latest science. Major reductions in both numbers and seasons were instrumental in initiating the recovery process for damaged resources. Permitted livestock grazing has continued to decline during the past 4 to 5 decades, due significantly to reductions in sheep grazing, primarily associated with operator economics. More recently, implementation of forest plan standards focused on meeting desired conditions and has resulted in reductions in authorized and actual use (Regan et al. 2003).

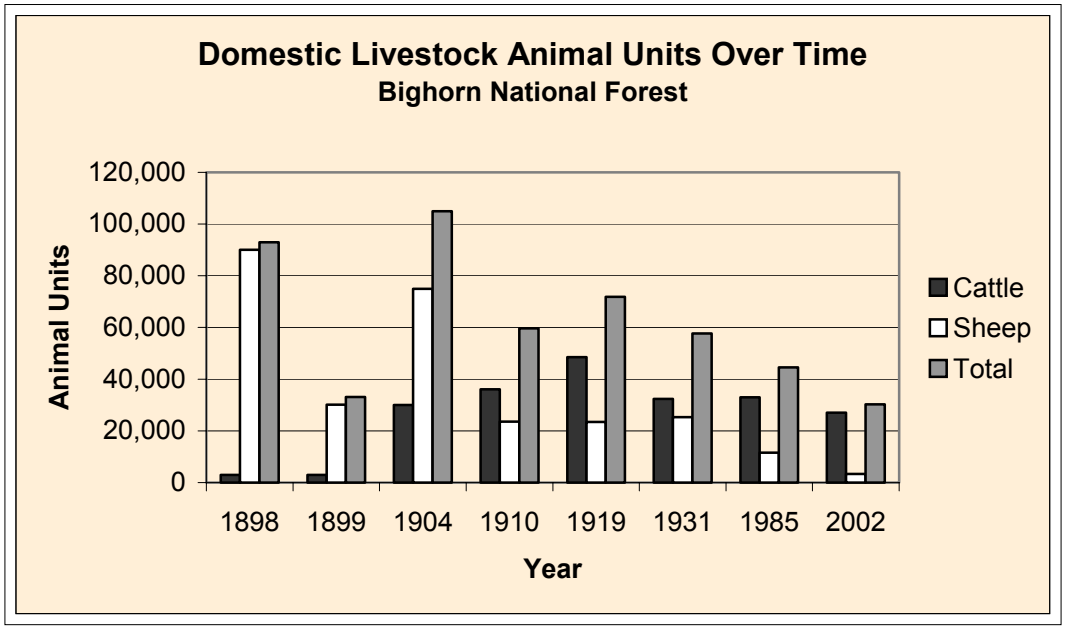
The following table and figure show approximate information regarding livestock numbers. Numbers in the table represent rough estimates, and should be used to define trends rather than to indicate exact stocking rates. It should be noted that in the early years of grazing permit administration, trespass could have added greatly to the estimated numbers. In addition, it took many years for the actual grazing seasons to get shortened from the situation where the livestock ran from snowmelt to snowfall, to where they are today at 2.5 to 3.5 months on average. Changes in permitted numbers cannot tell the entire story as the change in season was equally, or perhaps more, important in terms of livestock influences on aquatic, riparian, and wetland resources. In interpreting the table below, note that in terms of forage use, one mature cow is generally considered to be equivalent to five sheep (Regan et al. 2003).

Table 3-146. Approximation of livestock trends.

Year	Cattle (head)	Sheep (head)
1870s	Minor	Minor
1898	3,000	450,000
1904	30,000	374,734
1912	34,000	105,000
1916	36,000	108,000
1918	43,000	113,000
1919	48,500	117,000
1924	29,000	94,000
1931	32,352 (Season reduced to 3.5 mo.)	126,765 (Season reduced to 2.5 mo.)
1980s	33,000	58,000
1985	33,000	58,000
2001	29,229	21,187

Source: Data from Meyer and Knight 2001 and various other U.S. Forest Service sources.

Figure 3-15. Domestic livestock animal units for cattle, sheep, and total (cattle and sheep combined) on the Bighorn National Forest over time.



Source: (Meyer and Knight 2001; Murray 1980).

Trends in livestock numbers on the Forest, surrounding counties, and statewide are included in the following table.

Table 3-147. Trends in livestock numbers on the Bighorn National Forest.

	Bighorn National Forest		
	1956	**1981/85 data**	**2002 data**
Cattle number estimates	28,450	33,000	28,025
Sheep number estimates	119,335	58,000	13,830
Total of sheep + cattle AUMs	226,839 AUMs	143,000 AUMs	118,396 AUMs

1956 estimates are made based upon "Range Survey in Wyoming's Bighorn Mountains", page 23, Wyoming Agricultural Experiment Station Bulletin 341, April 1956, A.A. Bettle.

1981-1985 AUMs were taken from the Bighorn National Forest Land and Resource management Plan, September 1985, PAGE II-48

2002 data was summarized from USFS data, manually, in April, 2002

Bighorn National Forest livestock numbers are those "permitted, that is those animals permitted under a term, private land or free-use grazing permit.

An AUM is defined as the amount of forage required to sustain a 1,000-pound animal for one month, or 780 pounds of forage (air-dry weight). For purposes of displaying data, an animal unit factor of 1.32 is used to describe a permitted mature cow with calf, a factor of .7 is used to describe permitted yearling cattle, and a factor of 0.30 is used for a ewe with a lamb.

Table 3-148. Trends in livestock numbers statewide.

	Statewide Wyoming										
	1960	1965	1970	1975	1980	1985	1990	1995	2000	2001	2002
Historic cattle Estimates(1000 head) NASS	585	688	732	819	632	630	660	780	830	850	820
Historic sheep Estimates (1000 head) NASS	2,248	1,989	1,713	1,226	960	740	705	538	460	420	NA

Wyoming Agricultural Statistics Service, Historical cattle estimates: Wyoming, January 1 inventory, annual calf crop, all cows
Wyoming Agricultural Statistics Service, Historical sheep and wool estimates: Wyoming, January 1 inventory, annual lamb and wool crops, breeding sheep and lambs

The above data and discussion describe a decrease in total livestock numbers and AUMs on the Bighorn NF since the early 1900s. Sheep numbers statewide and on the Bighorn NF have declined consistently since the later half of the century, while cattle numbers fluctuated. In 2002, the Bighorn NF maintained term grazing permits for summer grazing of 28,025 cattle and 13,830 sheep.

Relative to the **four counties** surrounding the Bighorn National Forest, permitted use in year 2002 represents *in numbers* 12% of the 233,000 cattle and 20% of the 68,000 sheep for year 2002. Relative to **state,** this represents *in numbers* 3% of the 850,000 cattle for year 2002, and 3% of the 420,000 sheep for year 2001. This permitted *number* of livestock would represent a far lower percentage of *AUMs,* since livestock spend only about 3 months on the Forest each year. Recent estimates indicate that in year 2002 the Bighorn National Forest permitted in head months (HM's) roughly 3.5% of the cattle and 6% of the sheep relative to the **four counties** surrounding the Bighorn National Forest.

Table 3-149. Trends in livestock numbers in counties surrounding the Bighorn National Forest.

Bighorn National Forest Surrounding Counties, 2002		
	Sheep**	Cattle*
Big Horn	10,000	53,000
Johnson	44,000	58,000
Sheridan	6,000	90,000
Washakie	8,000	32,000
Total	68,000	233,000

**Wyoming Agricultural Statistics Service, breeding sheep on Wyoming farms and ranches, by county, January 1, 1995-2002
*Wyoming Agricultural Statistics Service, all cattle and calves on Wyoming farms and ranches, by county, January 1, 1995-2002

Some Rationale for the Decline in Livestock Numbers and AUMs

The above described decline in actual and permitted AUMs from the late 1800s to year 2002 is a result of some combination of a reduction in length of permitted season, a reduction in permitted numbers, and to a lesser extent to a matter of interpretation of data. It has to do with changes that have occurred in forage availability, the economics of the livestock industry, changes in knowledge and understanding of rangeland and riparian ecosystems, and changes in social priorities for public land management.

Forage Availability

Forage available for livestock on the Bighorn NF is subject to some change over time as a result of many variables, including:

- Forage being made available due to fire.
- Forage being made available due to timber harvest activity.
- Forage rendered unavailable due to shrub or timber encroachment, or regeneration.
- Increases or reductions in availability due to changes in range condition or ecological seral stage (successional stage).
- Forage rendered unavailable due to changes in land use such as campgrounds, fenced rights of way, dispersed camping, water impoundments, road construction, or other priorities for National Forest land use.
- Forage being made available through application of new grazing strategies and technologies

Economics of the Livestock Industry

The sheep industry has experienced a decline throughout the country and on National Forest lands that has resulted in the decrease in numbers. This is likely a result of at least some of the following factors:

- Low lamb prices and high production cost faced by the sheep and wool industries.
- Increasing effects of international markets.
- A reduced ability to control expanding predator numbers and resultant herd losses.
- A reduced source of individuals able and willing to work as herders.
- Requirements to meet other resource needs on National Forest System Lands.

On the Bighorn N F, sheep allotments have often been converted to cattle allotments at the request of permit holders who chose to no longer run sheep in these areas. Many high elevation sheep allotments are remote, difficult to access, short in production, highly fragile, unfenced, and have been found to be unsuitable for cattle. In some cases, all or portions of these allotments have been consolidated with neighboring sheep allotments to improve the viability of remaining operations. However, in other cases,

grazing permits associated with these difficult to manage allotments have been waived back to the Forest Service and allotments either closed or left vacant. Because sheep producers consider some of these areas undesirable, they have not been restocked when existing producers have discontinued their use.

The decline in permitted use by sheep and cattle is in part a result of not stocking small or remote areas of existing allotments that are not well suited for grazing, and may never have been. Often in these areas, the benefits to producers of utilizing forage no longer justify the cost of managing livestock to harvest the forage.

Producers who choose to take advantage of better marketing opportunities may prompt a change in off-dates.

Changes in Social Priorities for Public Land Management

As the Bighorn NF receives more use by the public, more opportunities for conflicts arise, and costs incurred by producers to administer grazing permits increase. Livestock operators may choose not to stock areas where demands by other users are high.

Management has used reductions in livestock numbers and season of use as a tool to restore degraded rangeland and riparian areas. In cases where permitted AUMs are returned to the Forest, reallocation of those AUMs occurs through the grants process (FSH 209.13), only when the range resource forestwide can support that use. Often, available capacity is used to resolve stocking or resource conflicts elsewhere on the Forest.

Interpretation of Data

Some degree of caution is prudent in comparing livestock numbers and AUM data from different sources and timeframes (Hinnant 1994; Perrier 1996). For many years, into the late 1970s, an animal unit equivalent for a cow calf pair was considered to be 1.0; today a factor of 1.32 is used for a cow/calf pair. The end result is the appearance of significant difference in AUMs under permit when in fact nothing may have changed. In some display of data and interpretation, animal unit months were not considered, but animal months (AM) or cow months (CM) were calculated and used and may have been called AUMs. For purposes of Forest Service billing, animal months (AM) are used rather than AUMs, which can lead to confusion.

The relative size of most cows and many calves is very likely larger than those historically permitted. Producers often manage so that cows bear calves earlier in the season today than in years past, and many take advantage of genetic characteristics of different breeds of cattle. Forty years ago, a cow may have averaged 900 pounds, while one today may average 1,250 pounds, and she and her large calf may consume a far greater volume of forage, resulting in fewer numbers supported by a given area. In this case, fewer animals would consume the same amount of forage (AUMs), while data would show that a reduced number of AUMs is being permitted.

Livestock Management

There are currently 86 grazing allotments on the Bighorn NF. Portions of the Bighorn National Forest and the surrounding watersheds are stocked by livestock at rates that are considered to be relatively high (USFS data for Rocky Mountain Region). Management has intensified over the past few decades on the Bighorn NF, although not uniformly across the landscape. Thus, some allotments are well and intensively managed and others continue to need improvement. There are a few remaining active sheep allotments, but much of the area suited to sheep grazing has been vacated and the allotments closed. Most of these vacant (e.g., there is no permit currently in effect but the allotment remains available for grazing upon appropriate decision) and closed allotments (the allotment is no longer available for permitting of livestock use) came into that status for economic reasons when the livestock operators determined that it simply was not economically feasible to continue to operate on those lands and waived (relinquished) their permits back to the Forest Service. Today, most of the Bighorn NF permitted use is by cattle.

Livestock grazing (and in some instances, grazing by large wild ungulates) tends to have the greatest influence on the following:

- Low-gradient riparian and wetland areas.
- Fine textured soils with a minimal amount of rock, cobble or boulders
- Open canopy or low shrub vegetation types
- Areas with available water (although there may be some avoidance of standing water areas).

The magnitude of the influence depends on the timing of use, the kind of livestock (sheep vs. cattle), the intensity of grazing use, the duration and frequency of grazing; and the associated management practices, including the level of permittee interest and involvement.

Most allotments are managed through a rotation grazing system, designed specifically for the allotment. Management calls for sheep to be herded and moved to new bed-grounds each night. Most cattle allotments are managed under some kind of pasture rotation system that will use most or all of the pastures each year but will generally avoid the use of an individual pasture at the same time in succeeding years. A few cattle allotments are grazed under a season-long system where livestock distribution is controlled with water, salt, and herding. Salt is located to help draw livestock away from riparian areas, and most permit holders regularly move livestock out of riparian areas and into other areas of available forage.

Site-specific NEPA analysis is completed during the allotment management planning process. The Bighorn NF is on a 15-year schedule to update and revise allotment management plans as mandated by the 1995 Rescissions Act. During the first six years of that schedule (1996-2001), 13 of the 86 allotments underwent updated rangeland analysis followed by project level NEPA decisions with resultant updates and revisions

of the allotment management plans. Project level allotment NEPA decisions are developed using the goals and objectives as well as the standards and guidelines of the approved forest plan. More specific grazing prescriptions can be developed during the allotment management planning process to address site-specific issues.

Permitted livestock grazing levels are often based on historic actual and permitted use levels. Allotment management plans establish site-specific goals and objectives, and management strategies to achieve them. Management strategies may include levels of grazing use, seasons of use, rotations, and a schedule for implementing range improvement projects such as fences and water developments.

Permitted use by cattle and sheep is nearly always authorized through term grazing permits, normally issued for 10 years. These permits include numerous terms and conditions that describe responsibilities of the permit holder such as validation, payment of grazing fees, ownership requirements of livestock and base property, livestock management, range improvement maintenance and construction, and more. Allotment management plans become part of the permit. General consequences of permit non-compliance are described in the permit.

When instances of non-compliance occur, discussion about the issue normally results in resolution. Successive instances of non-compliance that continue can graduate to suspension or cancellation of all or part of permitted numbers. These cases are relatively rare and are considered a last resort by management to gain compliance. In some cases, repeated instances of improper use of rangelands or other undesirable resource impacts can indicate a need to change grazing strategies or to adjust livestock numbers or length of season (AUMs).

Forest Plan Monitoring:

A review of forest plan monitoring reports (see following table) indicates that between 1995 and 2002, a range of 42% to 73% of the allotments on the Forest were monitored annually by the Forest Service, through spot checks of forage utilization or stubble height transects. Of allotments monitored through those years, 38 to 88% of transects met standards specified. This indicates a wide degree of variance in compliance with prescribed utilization standards. Where pastures have not met standards, corrective actions have been implemented as directed and described in term grazing permits, FSM 2200, FSM 2209.13, and the Bighorn NF Vegetation Grazing Guidelines (April 9, 1997).

Table 3-150. Results of allotment monitoring on the Bighorn National Forest from 1995 to 2002.

	Percent of Allotments Monitored by Forest Service	Percent of Forage Utilization Transects that Met Standards	Allotments Exceeding Standards to the Point of Discussing/Implementing Resource Recovery Period
1995	73%	69%	4%
1996	70%	52%	14%
1997	59%	76%	3%
1998	42%	88%	1%
1999	63%	71%	6%
2000	48%	38%	16%
2001	61%	52%	18%
2002	50%	58%	15%

Source: 2003 Forest Plan Monitoring Report, Summary for Range.

According to an April 26, 2002 summary table, the Forest permitted 118,396 AUMs (shown on the face of a term grazing permit). In year 2003, according to the INFRA database, the Forest authorized 84,100 AUMs authorized (Bills for Collection were sent and paid).

Permittees have various reasons for requesting and running fewer AUMs than permitted: 1) for personal reasons they don't have stock to fill the permit; 2) they expect below average production of forage due to drought this year or in previous years; 3) they expect lower than average production because of overgrazing the previous year or years; 4) they want to 'not' use an area to allow fine fuels to build up for prescribed burning, 5) they recognize that the permitted numbers and/or time has never been set at a realistic level and can be grazed only in the very best of production years; 6) they choose to turn livestock onto the Forest later than their permitted date or come off earlier than permitted, for an array of management reasons.

The number of actual AUMs grazed is often less than that authorized because of the above reasons, but also possibly because forage ran out, and livestock needed to be removed from the Forest to prevent overgrazing or other resource problems.

The 1985 Forest Plan includes an objective of providing an annual output of 140,000 AUMs in 1991-2000, and 144,000 AUMs in 2001-2010. Data and discussion above indicate that this objective has not been met, and is probably unrealistic. In an informal review of stocking levels in Region 2, average stocking rate in acres per AUM averages 6.22 on acres with range management objectives. The Bighorn NF average stocking rate across all allotments is 2.5 acres per AUM.

The 1985 Forest Plan includes four primary goals for the "range" resource. Two involve rangeland health and are addressed in the Rangeland Vegetation section of this document. The remaining two are:

- Provide livestock grazing that satisfies requirements for local community stability.
- Use grazing systems and stocking rates that reduce conflicts between domestic livestock, recreation, and wildlife.

The above discussion and data shows the level to which the Forest has provided livestock grazing. Monitoring does not indicate whether this level has or can "satisfy requirements for local community stability." In addition, while managers recognize that conflicts continue between livestock, recreation, and wildlife, monitoring also does not indicate whether conflicts have been "reduced."

Recreational horse use on the Forest rangelands includes frequent use by local enthusiasts as well as occasional trips by individuals and organized groups from across the country. Uses vary from small parties of day and weekend riders and packers to larger groups (e.g., Backcountry Horsemen and Bighorn Trail Rides)**,** who take annual trips. Hundreds of resident and non-resident visitors and hunters visit the Forest each summer for day and pack trips, as well as in fall during mule deer and elk hunting seasons.

Grazing by recreation horses often occurs on cattle and sheep allotments and can result in forage use and impacts to streams and vegetation that often conflict with objectives and plans of term grazing holders. These effects may be localized, can be significant, and are often less well documented and monitored. Management of recreation horse use is often unregulated, with the exception of those permitted under special use permit.

Livestock Grazing Permittee Operations and off-Forest Open Space: Ranchers who hold National Forest grazing permits are required to own private lands (base property). They often also hold BLM permits and state land leases. Land management is intermingled and interrelated; a management change on any one may affect all. They often own many more acres of rangelands than are found on the Forest. These acres frequently provide big game winter range and others areas that represent important wildlife habitat. They provide "open space" on the landscape that benefits the community and the state.

There has been an increasing tendency in recent years for some ranchers to sell off a portion of their deeded lands in an attempt to keep the remainder as a viable unit, and to keep it in historic family ownership (Mitchell J.E. 2002). Subdivision of ranches can lead to an increase in free-ranging dog and cat populations, with a resultant increased predation on small mammals and songbirds, and even some larger mammals such as deer fawns. It can result in more vehicular traffic, illumination from yard lights (light pollution), invasion and spread of non-native plants, more human presence, each of which creates disturbance zones around houses and roads that can diminish wildlife populations (ibid.).

As ranchers sell portions of their base ranches, winter range for wildlife is fragmented and can be lost. The net effect is a loss of the habitat needed to maintain viable populations of native wildlife. As ranches turn into ranchettes and rural subdivisions develop across the West, many native species are declining and being replaced by species adapted to human habitation: lark buntings and bobcats by starlings and skunks, rattlesnakes and warblers by garter snakes and robins. It has been said that most Americans want to conserve native species and our western wildlife; keeping private ranchlands in ranch family hands and out of developers' plans is the single greatest environmental contribution to achieve that (Rey 2002).

ENVIRONMENTAL CONSEQUENCES

General Effects

Standards and guidelines in Alternatives A through E are identical. Changes from those in the 1985 Plan are primarily for clarification and update, and in most cases reflect changes that have already been implemented administratively. There are some differences in standards and guidelines between revised management prescriptions. The mix of these prescriptions is different between alternatives, and this difference in the mix is the main reason for any difference in effects between alternatives. On a forestwide basis, differences are usually small, often subtle, and difficult to quantify.

Permitted livestock AUMs on the Bighorn N F have decreased since the early 1900s, and data indicates that they continued to decline into year 2002 (Regan et al. 2003; Meyer and Knight, 2001). There are more demands for various uses of the Forest. Some rationale for the decline in livestock numbers and AUMs still applies; for example, the total acres of suitable rangeland in active allotments has incrementally decreased through the years, and this trend may continue (See discussion above). At the same time, widespread areas of overgrazing described in the early 1900s are no longer reported to occur (see Rangeland Vegetation discussion in the Vegetation section). Range management practices are better now than at the turn of the century and rangeland condition is probably better than at that time (Meyer et al. 2003; Powell et al. 2001).

The ability of today's permittee to maintain permitted AUMs is dependent to a large extent upon the economics of managing livestock in a rangeland setting that includes public lands. In addition, competition for limited National Forest resources, and the permittee's ability to manage livestock to meet standards and guidelines, goals, and management area direction all affect the viability of livestock operations.

Actual and permitted grazing levels are not an objective or goal of the Revised Plan, but rather a product of management recognizing that livestock grazing is an appropriate use of the Bighorn NF while applying management to meet standards, guidelines, and management area direction. Permittee involvement and commitment are critical to

sustaining current AUMs under term permit. At today's stocking levels, across all alternatives, many permittees will succeed in managing livestock within these parameters. It is possible that some permittees may be able to manage in a manner that would allow for an increase in AUMs on their allotment. However, some permittees will be unable to manage their livestock operations to meet standards and objectives and will face reductions in permitted numbers (and AUMs under permit) or significant changes in their management operations. In some cases where actual stocking has rarely approached permitted AUMs, permits may be adjusted to reflect a more realistic AUM level.

A review of stocking levels on Bighorn NF Allotments (Regan, et al. 2003) indicates that some allotments are stocked much more heavily than others. Forest Plan monitoring indicates that there continue to be areas where utilization standards are not being met. It is entirely possible that as project specific NEPA decisions are developed and applied, and where these factors and other issues occur and overlap, a decrease in AUMs permitted may result. Subsequently, total AUMs permitted on the Bighorn NF is likely to continue to decline until a sustainable stocking level is achieved on all allotments.

Direct and Indirect Effects

Effects from Wilderness Management (Management Prescriptions 1.11 Pristine Wilderness, 1.13 Semi-Primitive Wilderness, 1.2 Recommended Wilderness): These areas are to be managed to protect their wilderness characteristics. Management activities are intended to maintain a naturally functioning ecosystem. Livestock grazing "and activities and the necessary facilities to support a livestock grazing program, will be permitted to continue in National Forest wilderness areas, when such grazing was established prior to classification of an area as wilderness" in accordance with Congressional Grazing Guidelines (WO Amendment 2300-90-2, FSM 2323.2, pp. 19-26). There is to be "no curtailment of grazing permits or privileges in an area simply because it is designated wilderness." " Wilderness designation should not prevent the maintenance of existing fences or other livestock improvements, nor the construction and maintenance of new fences or improvements which are consistent with allotment management plans and/or which are necessary for the protection of the range."

Management of permitted livestock in these areas can be made more difficult and costly than in other areas of the Forest due to 1) restricted motorized travel for access, 2) restricted use of motorized equipment such as chainsaws, and 3) restrictions on other management activities such as design of new range improvements. The restriction of travel for access, however, can also be viewed as a benefit (see travel management, below). Because fewer people access areas with less motorized use, fewer conflicts occur than in areas with more motorized access.

Indirect effects from wilderness management include 1) an increased expectation of no livestock presence by forest visitors and associated complaints, 2) a need to manage around a recreational "wilderness" experience to minimize conflicts, with a potential

increase in people and horse use (and associated conflicts) over levels prior to this designation, 3) a need to manage for wilderness character and plant communities, and 4) a potential loss of opportunity for issuance of off-road travel permits for administration of grazing permits.

Alternatives are identical in allocation of management areas 1.11, 1.13, and 1.2; with the exception that alternative C has an addition of 126,575 acres in Recommended Wilderness, 1.2. The areas proposed for wilderness designation were selected based upon their present management as roadless areas.

Approximately 7,884 acres of suitable rangeland (within active and vacant allotments) are within the Cloud Peak Wilderness. An additional 10,623 acres would be added under Alternative C (see table below).

Table 3-151. Suitable rangeland in the Cloud Peak Wilderness.

Suitability analysis	Acres In grazing allotments and in wilderness, current	Acres In grazing allotments and in wilderness, Alt C
Acres suitable lands, Cattle	7,855	15,557
Additional acres suitable lands, Sheep	29	2,950
Total acres	7,884	18,507

Effects from Roadless Area Management: Implementation of the Roadless Area Conservation Rule does not affect livestock grazing.

Effects from Management of Special Interest Areas, MA 2.1: Alternative B has two new archaeological special areas: Elephant's Foot and Buck Creek Vees. Alternative C has Buck Creek Vees proposed as a new archaeological special area, but it does not have Elephant's Foot special area proposed, because in this alternative the area is proposed wilderness. Alternative A, D, and E have no additional special area (Category 2) proposed.

Livestock management is unlikely to be different in the proposed Elephant's foot and Buck Creek Vees archaeological special areas as a result of the formal 2.1 designation, since federal law requires that effects be evaluated and mitigated forestwide (National Historic Preservation Act). For this reason, effects of this designation are identical across all alternatives. However, heritage sites are more likely to occur in these areas than outside of these areas. Effects from heritage management are described below.

Effects from Heritage Management: Cattle and sheep can contribute to the deterioration of heritage resources through physical contact, i.e. hoof action, by rubbing on structures, or by contributing organic matter to a site. They can remove or alter vegetation that serves to protect sites from erosion and can make heritage resources more visible for unauthorized collection. In cases where the level of impact is determined to be unacceptable, the impacts can be mitigated with fencing, which can be costly or with changes in management (intensity or timing). If livestock are excluded

from a site or forage use levels are reduced, total available forage (AUMs) on an allotment is reduced.

Federal law requires that effects of livestock grazing be evaluated and mitigated forestwide. This takes place during development of the allotment management plans. Effects of heritage management are identical across all alternatives.

Effects from Management of Research Natural Areas, MA 2.2: RNAs are managed to maintain relatively pristine or pre-settlement conditions by allowing ecological processes to prevail with minimal human intervention. Specific management direction is to be developed addressing grazing for each Research Natural Area as part of the Establishment Record, or in separate management implementation guidelines. RNA boundaries were established in concert with district range specialists to avoid inclusion of areas currently used by permitted livestock. The impact to current livestock grazing should be very minor or none.

Analysis indicates very little suitable range in any of the proposed RNAs, but the future opportunities to use that which exists could be lost with designation of new RNAs. Of the 4 new RNAs proposed, roughly 173 acres of McLain RNA has received use by permitted livestock on a regular basis as a forage reserve for several years. Although this area is part of a sheep allotment that is vacant, sheep from the adjacent allotment have been authorized to graze this area for a short period of time each summer. In addition, 518 acres of Babywagon S&G allotment are within the proposed boundary of this RNA. Designation of McLain Lake RNA may take away the option of authorizing this annual use of 17 AUMs on the vacant Lake McLain S&G allotment, and 52 AUMs on Babywagon S&G allotment.

Alternative B, C, and D have identical new RNA designations: Mann Creek, Leigh Creek, Pheasant Creek, and Lake McLain. These designations may reduce the option of authorizing 69 AUMs of sheep grazing as described above, depending upon specific criteria included in the establishment record of that RNA. They are expected to have very limited, if any additional effects on livestock grazing.

Effects from Management of Special Interest Areas (Medicine Wheel), MA 3.1: The Medicine Wheel National Historic Landmark (110 proclaimed acres) is the 3.1 Special Interest Area proposed. In this area, vegetation, terrestrial and aquatic habitat, soil productivity and water quality are to appear nearly natural. Livestock grazing is to be managed in a way that will not detract from the spiritual and traditional values associated with the Medicine Wheel. Grazing has been and will continue to be excluded in the area immediately surrounding the Medicine Wheel (< 1 acres).

Costs to the livestock producer in this area may be greater than in other areas of the Forest. Some restrictions in travel, structural improvement design, and livestock use will occur. Trailing of cattle, forage utilization levels, herding and other management activities may be more demanding to the producer. Alternative A and the No Action Alternative would retain the existing NHL area as the 3.1 management area. In

Alternatives B, C, D, and E the area designated 3.1 is 20,863 acres, and the impact could therefore cover a much larger area.

Effects from Fire and Fuels Management: Fire and fuels management can have effects to livestock grazing, often different in the short term than in the long term. Effects depend upon the burning conditions and whether it was a controlled burn or a wildfire, since results of wildfire are often less predictable.

In the case of prescribed fire, livestock are generally managed so that the pasture(s) to be burned are rested in advance, to assure adequate fine fuels (residual grass) to carry a fire. Pastures are often rested following the burn to allow for vegetative recovery. This "resting" requires that the permittee be flexible in management, and involved in considerable advance planning and coordination, especially if it requires livestock to use other allotments or forage sources. If the planned prescribed fire does not take place on schedule, arrangements need to be made again in successive attempts, and can accrue additional costs.

Grazing is often deferred for up to two growing seasons following a fire to allow vegetation to reestablish. Deferment time can be decreased or increased depending upon the amount and timing of precipitation events following the burn. Recent fire effects studies (Perryman 2000) indicate that the amount of deferment needed is dependent on the post-fire vegetation condition desires; for example, if more forbs are a component of the desired condition (for wildlife habitat needs, for example), then grazing immediately after green-up will increase the amount of forbs by reducing competition with grasses (versus two years of rest, which would reduce the forb component in the plant community).

By managing sagebrush density and structure on rangelands, prescribed burning often results in an increase in forage production (grass/forb) and availability, and a shrub community more compatible with a variety of wildlife species. It accelerates a recycling of nutrients, and can result in making water more available across the landscape, in springs, seeps and intermittent streams. This can have the effect of simplifying livestock management, improving livestock or wildlife distribution, and increasing available AUMs.

A significant effect often results from under burns in conifers or other types of burns that can temporarily increase forage production and accessibility. Again, they also have the negative effects mentioned above (e.g., coordination, rest, deferment, etc.)

The more prescribed fire is used, the greater the impacts described above. The use of prescribed fire for fuels treatment and vegetative management is described in the following table.

Table 3-152. Prescribed fire acres by alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
Forested Rx Burn	500	1,100	250	1,050	250
Non-Forested	2,500	3,000	1,500	2,500	2,500
Total	3,000	4,100	1,750	3,550	2,750

The use of prescribed fire for fuels treatment and vegetative management in non-forested vegetation is greatest in Alternative B, followed by Alternatives A, D, E, and C. Differences between alternatives (above) are projected, and when applied across the Forest they are not large.

A wildfire can have similar effects but is likely to have unplanned effects as well. It may result in entire pastures or allotment being burned. Livestock may have to be completely removed from an allotment or pasture (sometimes even to avoid being caught in the fire). Fences and stock pipelines may be destroyed. A permittee may be forced to alter planned grazing management of other lands in his operation (private, state, and BLM). If fences are burned, grazing systems must be modified until the fences can be replaced, which can add expense to the grazing permittee as well as the Forest Service.

Wildfire may remove sagebrush and remnant grasses and forbs; it can recycle nutrients, and may result in many of the same benefits that prescribed fire provides. Since timing, location, and burn conditions are not in the control of management; however, these benefits are less likely to be realized.

Wildfire may remove trees and open the understory of timber types to a flush of grass and forb production for many years. Similar to prescribed fire in sagebrush types, this can have the effect of recycling nutrients and providing forage for livestock. It can result in making water more available across the landscape, in springs, seeps, and intermittent streams, and simplify livestock management by improving livestock distribution, and increasing available AUMs.

Effects of wildfire are described in the Fire and Fuels section of this chapter.

Effects from Recreation Management: Recreation management can alter livestock grazing in several ways. One common effect from recreation use occurs when Forest visitors open gates along National Forest System roads and trails to pass through and then do not close them**.** This frequent occurrence allows livestock to drift into pastures, allotments, roadways, or other areas where they are not intended to be and often results in unplanned livestock use and disruption of planned management. Grazing permits require that stockmen keep livestock in designated areas. To comply, and to minimize the task of gathering and returning livestock, a rapid response is necessary, and can incur considerable expense. In some cases, cattleguards can replace gates, but materials, installation, and maintenance are costly.

Recreation can add expense to livestock operators who, in springtime, must repair fences that are cut by wintertime snow-goers.

Achieving reasonably uniform livestock distribution across a landscape is one objective of livestock management, since it allows an optimization of harvest of available forage resources by permitted livestock. Areas with campers, pet dogs, ATVs and other concentrated human activity are not favored by livestock. Concentrated or frequent recreation use along roads and near popular areas can cause cattle or sheep to avoid grazing or passing through an area, and work directly against a permittee's attempts to distribute livestock evenly.

Cattle trailing along roadways can cause traffic congestion and a hazard to motorists and livestock. Cattle are sometimes shot during hunting seasons, resulting in a direct economic loss to their owners.

Summer-home owners sometimes become concerned with livestock in and around their cabin permit areas. This is also true of people using camping and picnic sites on the forest. Fences are a common solution, but require installation and maintenance that can be costly.

Fencing of scenic byways results in a safer travel way for motorists and livestock but also a loss of forage available to permitted livestock. Right-of-way fence can either disrupt planned grazing management or it can increase the management flexibility by creation of additional pastures.

Guard dogs are used by some ranchers to protect sheep. The recreating public can distract some dogs away from their sheep, resulting in a reduced effectiveness in protecting sheep and time lost to the task of locating a guard dog. The dogs can also intimidate recreationists and may contribute to conflicts between recreation and livestock grazing.

Use of the Forest for recreation is likely to continue to increase over time. Higher levels of summer recreation create increased levels of potential conflicts with livestock use. Those alternatives that allow for more areas of motorized and dispersed recreation are likely to impact livestock grazing the greatest.

Effects from Travel Management: Forest roads and trails are used by grazing permittees to conduct management operations. They are used by other Forest visitors and permit holders for a variety of purposes. The network of roads across the Forest has positive and negative effects on livestock grazing.

Livestock are trailed to and from the Forest grazing allotments along roads. Stock driveways cross the Forest and access allotments along roads. Roads are used to transport sheep and cattle to and from mountain allotments. Permit holders access cow camps and various pastures of each allotment along the Forest travel ways. Many existing roads and trails follow historically established livestock trails.

Grazing permittees may experience lowered operating costs by having motorized access to allotments on open roads. In many cases, permittees are issued limited short-term

'off-road vehicle' permits to allow them to use motorized vehicles on closed roads, or in areas where there are no roads for specific management purposes.

While roads improve efficiency of permittee activities, they also allow more public access for recreation purposes such as hunting, fishing, camping, ATV use, etc. The increase in public use of an area provides additional opportunities for conflicts between users such as gates being left open, livestock being disturbed, and cow camps or other improvements being vandalized.

In areas proposed for wilderness designation or other nonmotorized use, very little motorized use is currently taking place. Any formal designation to limit travel would make very little difference to current management.

Alternatives A through E restrict travel to designated roads and trails in the "C" areas on the current travel map where travel is now unrestricted. This designation may result in less disruption of livestock management activities by the recreating public than the no action alternative. Occasionally, permittees will be issued limited short-term off-road vehicle permits to allow them to use motorized vehicles on closed roads, or in areas where there are no roads for site-specific management purposes.

The alternatives with summer-motorized travel, from most to least, are E, A and D, B, and C.

Effects from Big Game Use management: Big game grazing/browsing is generally compatible with livestock grazing/browsing. There is a large dietary overlap (40-80%) between elk and cattle (Kufeld 1973); there is a similar, though smaller, dietary overlap between sheep and deer (Kufeld, Wallmo et al. 1973b).

Demand of big game can exceed the capability of the land and can cause detrimental impacts to vegetative and soil resources. Conflicts over the allocation of forage resources are ongoing and increasing as certain big game populations continue to expand. Forage on grazing allotments intended for use by permitted cattle or sheep can be removed by wildlife when this occurs. In certain cases, limitations may be placed on forage use by permitted livestock in order to assure adequate forage for the wild ungulate populations.

Attempts to manage rangelands can be thwarted by heavy unplanned use by wild ungulates. Heavy browse of willows by deer, elk, and moose can restrict plant community development. Barking of aspen by moose can be detrimental to a stand, and browsing of young aspen can limit attempts at stand regeneration.

These effects are consistent across alternatives.

Effects from Mineral and Energy Development: Increased mineral development can add to road systems and increased travel; effects are described in travel, above. The potential for these activities is very small based upon past activity levels on the Bighorn NF. There is nothing is this analysis that indicates an increase in future levels of development.

Effects from Rangeland Vegetation Management: Rangeland vegetation management through prescribed fire is described in "Fire and Fuels Management" above, as well as the Vegetation section.

Effects from Timber Management: As timber is harvested it may open the canopy so that an increase in forage occurs in the understory, or it may create new acreages of rangeland vegetation in small harvest units. This transitory rangeland remains in this state until the forested stands once again close in or young trees become dense enough that rangeland vegetation no longer occupies the site. In this way, timber harvesting provides forage that can be made available for livestock and wildlife.

Timber harvest can also result in removal of natural barriers to livestock movement through pastures of an allotment. Construction of fences may be necessary to mitigate this loss of a natural barrier.

Permitted AUMs are not expected to increase, because transitory range is available for a limited time, until the forested cover types once again close in and eliminate under-canopy forage.

The greatest amounts of transitory range would be created in Alternatives E, followed by A, D, B, and C.

Effects from Wildlife and Fisheries Management: The influence of large wild ungulates is described above, and effects can be expected to increase as populations increase. Other wildlife management activities may result in effects to livestock grazing such as:

- Management to increase beaver populations and activity can alter forage production and availability for livestock by expanding riparian habitat.
- Management for Bighorn Sheep could result in need for removal of domestic sheep.
- Management for fisheries and wildlife may involve adjusting length of time, intensity, and timing of livestock use, livestock exclusion, fencing, spring developments, etc. in cases where livestock use impacts riparian vegetation and stream habitat.

The primary methods used to improve wildlife habitat of the Bighorn N F include prescribed fire, fencing, and timber harvest or conifer removal. Fences constructed for fisheries and wildlife management can impede livestock movement and access, and may require specific placement or design.

Effects from wildlife and fisheries management are largely consistent across alternatives, and are budget dependent.

Effects from Threatened/Endangered/Sensitive Species Management: Habitat requirements in and around each known or discovered TES species location will be protected, restored, or enhanced. This may require changes in livestock management and are dealt with on a site-specific basis in allotment planning. Grazing strategies, locations, and forage use levels could be affected. Conservation strategies, plans for

critical habitat delineations, and biological opinions generally spell out specific management requirements during allotment management plan revision.

Management of threatened, endangered, and sensitive (TES) species will have a consistent effect on livestock grazing for all alternatives.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to livestock grazing. This discussion considers effects to livestock grazing since their first appearance in the Bighorn National Forest, and adjoining lands.

Historic use of the Bighorn N F continues to be evident, and influences livestock management today. For example, some areas are continuing to recover form impacts of heavy grazing in the early 1900s. Riparian areas altered by the tie hacking activities also continue to recover. Livestock management in these areas is tailored to enhance and continue recovery. Fire suppression activities in the past have resulted in conifer encroachment in areas, which in turn can limit forage production and availability today, and effect livestock use and distribution patterns.

Livestock grazing on the Forest today is influenced by the litany of effects described above that include the allocation of forage resources between livestock and wildlife and the effects of the activities, limitations introduced by wilderness designation, adjustments necessary to protect heritage resources, fisheries, and water quality; considerations necessary due to wildfire and prescribed fire management, recreation activities that result in gates being left open, forage being removed, livestock being poorly distributed, or impacts to the resource being unfairly attributed to livestock and managers. Most of these factors add to complexity and expense of the livestock operation that chooses to utilize forage on the Bighorn NF. Combined, these factors are likely to result in continued reduction in livestock grazing, though in smaller increments as compared to past decades.

Livestock management is generally considered more difficult on National Forest System lands than on private lands for reasons described above. In addition, the business of livestock management is subject to factors most often not under the control of livestock operators, such as national security (tourism), land values and subsequent subdivision of base ranches, retirement of ‘baby-boomers’, labor prices and availability, foreign markets and lamb/calf prices, USDA budgets and farm programs, fuel prices, predator control, social values, and federal policy.

Expectations are that the impact of recreation uses on the Forest will increase as the population of local communities increases, and as more people nationwide continue to seek places like the Bighorn to recreate. ATV use in particular has seen a dramatic increase recently that is expected to continue, although the rate of growth is not likely to be as dramatic as it has been in the past. (See Specialist Report for Recreation) Locally, the current boom in coalbed methane activity has resulted in more demand for

recreational use of the Bighorn, particularly for motorized uses, and this boom is expected to continue (BLM 2003). Use of prescribed fire will likely increase in coming years due to past fire management policies that resulted in a great risk of intense wildfire. As described above, this can result in short-term expenses and long-term benefits to livestock grazing.

Management of livestock grazing to deal with cumulative effects will be consistent across all alternatives.

Minerals and Geology

Introduction

Individuals operating under United States mining laws have a statutory right to enter National Forest lands to locate and develop mineral resources. Mineral resource activity on the Bighorn National Forest has historically been widespread but sporadic. Mineral activity is presently concentrated in a few scattered areas. Activity has fluctuated with demand, and current low prices for many minerals make exploration and development uneconomical.

The Forest Service manages mineral-related activities consistent with multiple-use management principles. The agency integrates the exploration, development, and production of mineral and energy resources with the use, conservation, and protection of other resources

Legal and Administrative Framework

The General Mining Law of 1872 allows exploration, development, and production of minerals from mining claims on public lands.

Organic Administration Act of 1897 permits access to National Forests for all lawful purposes, including prospecting and locating and developing mineral resources. This act authorizes the Secretary of Agriculture to regulate occupancy and use of the National Forests and protect National Forests from fire and depredations through compliance with existing rules and regulations. Regulations issued under the Act authorize protection of paleontologial resources from theft and destruction (36 CFR 261.9) and requirements for environmental protection during mineral operations are are listed Under 36 CFR 228.8.

The Mineral Land Leasing Act of 1920 established the leasing system for the acquisition of coal, phosphate, oil, oil shale, gas, and sodium.

The 1947 Mineral Leasing Act for Acquired Lands extends the provisions of the mineral leasing laws to federally owned mineral deposits on acquired NFS lands and requires the consent of the Secretary of Agriculture prior to leasing.

Mineral Material Act of 1947 authorized disposal of common variety minerals. It also allows free use by government agencies, municipalities, and non-profit organizations.

The Surface Resources Act of 1955 allows the sale of mineral materials such as sand and gravel and provides direction for the multiple use of surface resources of mining claims.

Federal Highways Act of 1958 the Secretary of Transportation may appropriate, for highway construction, reconstruction, or maintenance, lands or interests in lands owned by the United States, including those under Forest Service jurisdiction.

The Endangered Species Act of 1973 requires protection of habitat for endangered species.

The Federal Cave Resources Protection Act of 1988 enacted to secure, protect, and preserve cave resources, to include paleontological deposits, sediments, and minerals on Federal lands for the perpetual use, enjoyment, and benefit of all people.

The Petrified Wood Act of September 28, 1962 does not apply to Department of Agriculture; neither does the BLM regulation allowing 250 pounds and one piece, per year.

Key Indicator

- Acres open to locatable mineral entry.

Resource Protection Measures

Locatable Minerals

36 CFR 228 requires the mining claimant to file an operating plan or notice of intent for proposed mining activities. The plan must include the name and address of operators, a sketch or map of the location, descriptions of operations, access timing, operating period, and environmental protection measures. The Forest would work with the claimant to assure that standards and guidelines in the forest plan are met. The operation plan requires an environmental analysis and decision before the plan is approved.

AFFECTED ENVIRONMENT

Geology

The Bighorn Mountains are an outlying portion of the Rocky Mountains, extending approximately 80 miles from north-central Wyoming into south-central Montana. The elevations range from approximately 4,200 feet at the base of the mountains to 13,167 feet at the crest of Cloud Peak. The Big Horn Mountains begin in the north at the canyon of the Bighorn River, north of which is the Pryor Mountains. A wide basin, the Bighorn basin, extends west of the Big Horn Mountains to the base of the Shoshone

Mountains. On the east, there is the Powder River basin that extends towards the Black Hills.

The Big Horn Mountains are divisible into three units. The northern unit extends northward from near the Montana-Wyoming border to the vicinity of the Bighorn River. This segment of the Big Horn Range is about 10-miles wide. The surface on top has a gentle northerly slope, with monoclinal folding of Paleozoic and Mesozoic strata with a westward dip of approximately 70° marking the western flank of the range. To the south, this monocline becomes steeper and transitions into an eastward-dipping thrust fault. The terrain varies from steep, narrow drainage canyons, to steep-walled glacial cirque basins and windswept alpine meadows at timberline. The eastern flanks are characterized by numerous hogbacks of younger strata that dip abruptly beneath the surface along with paired anticline/syncline structures paralleling the mountain front. Sinkholes filled with younger formations and caves are common features of the Big Horn Mountains, with most caves concentrated on the abrupt faces on steeper slopes near the Forest Boundary. Sinkholes are more common on the northwest portion of the Forest along ridges. These subsurface resources can be impacted by surface activities. Refer to the biodiversity section of Chapter 3 for more description on caves.

The main core of the Big Horn Mountains is granite, while the northern third (basically north of Burgess Junction) and the flanks of the mountain are primarily sedimentary layers. The flanks of the mountains are composed of younger Paleozoic- and Mesozoic-age (500 to 60 million years old) sedimentary rocks that dip steeply away from the center of the mountain mass toward the adjacent basins. The chemical composition of the local geology significantly influences aquatic, riparian, and wetland conditions on the Forest.

The different sedimentary formations were created by different sea conditions. The following table provides a list of the major geologic formations on the Forest and associated Fossil Yield Potential Classification (FYPC). See DEIS Appendix I for a detailed description of FYPC.

Table 3-153. Geologic formations on the Bighorn National Forest and Fossil Yield Potential Classification.

Formation	Approximate Age[25] or Geologic Era	Formation Characteristics	FYPC
Morrison and Cloverly	70 million years Cretaceous	Colorful reds and pinks of badlands clays, muds and sandstones deposited on tropical, swampy floodplains which were inhabited by dinosaurs.	5
Goose Egg	250 million years	Bright red (iron oxide) deposited by tidal	2

[25] Ages and formations are from Bonney, Orrin H. and Lorraine G. *Field Book of the Bighorn Range*. Swallow Press, Inc. 1960 and Darton, N.H. *Geology of the Bighorn Mountains*. U.S. Geological Survey Report, 1906

Formation	Approximate Age[25] or Geologic Era	Formation Characteristics	FYPC
		flats.	
Tensleep Sandstone	300 million years Pennsylvanian	Thin but extensive sheet of sand deposited by shallow waters with strong currents.	2
Amsden Formation	300 million years Pennsylvanian	Local sand deposits.	3
Madison Limestone	335 million years Mississippian	Formed under warm and quiet waters, many fossils from the remnants of animals that were deposited.	2 or 3
Bighorn Dolomite	465 million years Ordovician	Same as Madison limestone. Dominant formation along North Tongue River west of Burgess Jct.	2 or 3
Gallatin Limestone	Cambrian	Deep, clear sea with quiet water.	2 or 3
Gros Ventre	Cambrian	Formed by mud and tidal flats.	3
Flathead Sandstone	Cambrian (nearly 600 million years)	Sandy beaches at edge of sea.	3
Granite	Pre-Cambrian (2.5 billion years)	Formed deep in the crust and forced upwards into the sedimentary layers about 60 million years ago.	1

Minerals

Mineral resources on federally owned lands are separated into three categories—locatable, leasable, and mineral materials (salable)—by statutory and regulatory direction. The following section discusses locatable and salable minerals. Leasable minerals (oil/gas) are addressed separately in the Oil and Gas section of Chapter 3. Some areas on the Forest, such as administrative sites, highway right-of-ways, campgrounds, ski areas, and reservoirs, have been withdrawn for exploration and development of minerals. The State of Wyoming, Bureau of Land Management office maintains records of existing land withdrawals on the Forest.

Locatable Minerals

Locatable minerals are those valuable deposits subject to exploration and development under the Mining Law of 1872 (as amended). Examples include iron, gold, copper, silver, lead, and zinc. The public has statutory right to explore for, claim, and mine mineral deposits found on federally owned lands subject to U.S. mining laws. Through a Memorandum of Understanding with the BLM, the Forest Service administers most aspects of operation under the U.S. mining law on NFS lands.

On the west side of the Bighorns, there is an active operation producing bentonite for medicinal purposes; the operation is located a few miles northwest of Meadowlark

Lake. There are several other bentonite claims about one mile west of that operation. Starch (1981)[26] indicates bentonite reserves of 45 to 54 million tons on the west flank of the Bighorn Mountains.

According to Hausel (1998) the Big Horn Mountains are part of the Wyoming craton, an ancient continental core complex more than 2.5 million years old (Kirkely et al. 1991) that has had little deformation over a very long time period. The Wyoming craton underlies Wyoming and portions of Colorado, Idaho, Montana, Nevada, and Utah. It consists of an Archean basement (Wyoming Province); mainly granite, gneiss, and supracrustal metamorphic rocks exposed during several Laramide uplifts. The Wyoming Province underlies most of Wyoming and Montana and forms the core of the Wyoming craton. Regional metamorphic events occurring between 1.7 to 1.9 million years allowed the intrusion of kimberlitic and lamprolitic dikes containing diamonds (Baer 2001).

Several mining districts, established principally for gold, existed in the area of the Bighorn National Forest around the turn of the twentieth century. These included Bald Mountain, Walker Mountain, Willett Creek, East Goose Creek, Kelly Creek, and Bull Camp. There was no significant production from any of these districts. During the 1860s, placer activities also took place in the North Fork of the Crazy Woman Creek area. Some exploration for gold may be sporadically occurring in the Bald Mountain area. The other mining districts are currently dormant.

There is a deposit of niobium (columbium) and tantalum, rare earth elements, in the Cookstove Basin area. At present the economic value is unknown.

Some copper has been found in the Walker Mine located about two miles southwest of Walker Mountain, and a copper prospect has been reported north of Powder River Pass in the southern Bighorn Mountains.

A U.S. Bureau of Mines study (Osterwald et al. 1966)[27] indicates a monazite deposit with 8.8% thorium near Bald Mountain. Ilmenite, zircon, and magnetite were also found. Currently, there is no exploration for, or development of, these minerals on the forest.

Within the Cloud Peak Wilderness, most of the past mineral activity has been in the north half along Edelman, Goose, and Medicine Lodge Creeks, and on the Edelman Creek Fault and associated faults south of Coffeen Park. Mining activity consisted of placer and underground exploration for precious and base metals. There is no mining activity in the Cloud Peak area today.

Some platinum and copper deposits have been found in the Cloud Peak Wilderness but not in sufficient quantity or quality to be profitable. Small, high-grade uranium deposits

[26] Starch, K.E. 1981. The Minerals Industry of Wyoming: U.S. Bureau of Mines Minerals Yearbook. 12pp.

[27] Osterwald, F.W.; D.B. Osterwald; J.S. Long Jr.; and W.H. Wilson. 1966. Mineral Resources of Wyoming: Geological Survey of Wyoming Bulletin 50. 287pp.

are found in the Little Mountain area, approximately 12 miles west of Cookstove Basin off the National Forest. Most deposits are 500 tons in size and may contain only a few tons or pounds of ore (Osterwald et al. 1966). Similar deposits may exist on the northern end of the forest.

The Mississippian Madison limestone is a potential source of high-calcium limestone for chemical and metallurgical uses. The limestone is located along both flanks of the forest and across the extreme northern half. A quarry operation was proposed several years ago one mile west of Story, Wyoming.

Gypsum deposits occur along the flanks of the Bighorns. They are not being explored or mined at this time. Uneconomic deposits of nickel, talc, manganese, and asbestos have been described within the forest boundary.

Exploration, development, and production of locatable minerals will continue to be dependent on market prices. With increased prices, more activity will probably directed toward locatable minerals, especially base and precious metals. Areas containing known reserves will experience continued development and production. Exploration will search for additional reserves adjacent to, or further delineate, a known mineral deposit.

With improved mining technology and a better mineral market, the demand for bentonite, calcium, uranium, and some rare earth elements may prompt development and production of these minerals on the Forest at some time in the future.

Most of the current mining activity on the Forest has been considered “recreational.” This includes panning, and suction dredging with a suction diameter of 3 inches or less for short durations in specified timeframes. The U.S. Army Corps of Engineers considers the use of a 3-inch or smaller suction dredge “recreational” and does not require a 404 permit for this activity. Wyoming’s Department of Environmental Quality issues permits for these activities. The Letter of Authorization issued by the state serves as the Notice of Intent. The Forest Service then assumes responsibility for inspecting the mining operation and making sure it complies with spacing and other requirements in the Letter of Authorization. The state’s guidelines are some of the most stringent in the nation.

Salable Mineral Materials

Mineral construction materials are generally low-value deposits of sand, clay, and stone used for building materials and road surfacing. Extracting these materials from NFS land is at Forest Service discretion. The major statutes are the Minerals Materials Act of 1947, Surfaces Resources Act of 1955, and the Federal Highways Act of 1958. The Forest has identified potential aggregate source on the Forest. The demand for gravel will increase as campgrounds, forest roads, and county roads are improved. There are off-Forest sources to meet private needs.

Sources of sand and gravel are available on the Forest. They include alluvial, terrace, pediment, and glacial materials. These common varieties include granite, dolomite, limestone, and sandstone.

"Leopard rock" is a local term for an ornamental building stone found north of U.S. Highway 14 just inside the forest boundary. There is an on-going local demand for this rock. Moss agates are found between Spanish Point and Mill Creek adjacent to the Forest. The deposit does not appear to extend on the Forest.

An increase in demand of common variety minerals may be expected as road construction and maintenance occurs on the forest. Since there are ample reserves of these minerals on private lands, demand for minerals for off-Forest uses are not expected to be significant. However, increased work associated with federal and state highway construction, reconstruction, and maintenance may increase the demand for construction materials and the Forest may be obligated to provided material under the Title 23, Section 317 of the Federal Highways Act.

The Forest Service may request withdrawal of areas from mineral activity if the activity might conflict with other management objectives. Currently, 11,361.82 acres on the Forest are withdrawn for locatable mineral entry. These withdrawals are for site-specific administrative purposes: for example, special designated areas, roadsides, reservoirs, ski areas, recreation areas, administrative sites, and campgrounds.

ENVIRONMENTAL CONSEQUENCES

General Effects

Mineral Materials

Common variety minerals may be sold for fair market value or disposed of through free use in any of the proposed alternatives. Potential aggregate sources have been identified across the Forest. The demand for gravel will increase as campgrounds and Forest Service and county roads are improved. Sources to meet private needs are available off-Forest.

Locatable Minerals

The areas with moderate to high geologic potential for discovery of locatable minerals include Bald Mountain, Walker, Willett Creek, East Goose Creek and Kelly Creek. There have been exploratory core drilling operations in each of these complexes, but there has been no further interest shown. Market prices, commodity supply and demand, and technological advances will influence future interest in exploration, development, and production.

Paleontological Resources

Paleontological resources occur on the Bighorn National Forest and range from Paleozoic invertebrates such as trilobites from the Flathead Sandstone to dinosaurs from the Cretaceous Cloverly Formation. They are managed in a similar fashion to heritage resources, although they are discussed as a fossil resource in this section of the document. Unlike heritage resources, federal statutes do not exist that specifically protect paleontological resources, except under Organic Adminstration Act and the Cave Protection Act. Petrified wood and invertebrate fossils are currently not regulated. These resources may be collected from the ground/rock surface (no digging) by the public for personal, non-commercial use and do not require a permit. Research conducted on any type of paleontological resource requires a permit. Vertebrate fossils are regulated by 36 CFR 261.9 (i), which prohibits their collection without a permit. Permits are issued to applicants meeting qualifications. Commercial collection of paleontological resources is prohibited. Effects to these resources are similar under all alternatives since potential impacts will be mitigated as a result of surveys conducted prior to site-specific project implementation. Alternatives with a higher level of resource management activities, or conversely, locatable mineral acres not withdrawn, will have a greater likelihood of identifying these resources.

Table 3-154. Acres of Fossil Yield Potential.

FYPC	Acres	Percent of Forest
1	578,311	52
2	166,142	15
3	357,507	32
4	0	0
5	9,899	1

Direct and Indirect Effects

Effects from Management Area Allocations: The Forest Service may withdraw areas from mineral activity if the activity might conflict with other management objectives. The following table displays proposed withdrawals by alternative based on Management Area allocations.

Table 3-155. Locatable mineral withdrawals by alternative (*acres based on management area allocations and GIS acres)*

Alternative	A	B	C	D	E
Acres withdrawn from minerals exploration	405,904	588,370	577,976	424,449	238,718

Existing withdrawals, many dating back to the 1930s, are not based on management area allocations. Overlap exists in many areas proposed for withdrawal in the alternatives. This table shows the relative change between alternatives based only on management areas.

Under the 1872 mining law, the Forest Service is required to provide reasonable access for locatable minerals exploration and development. The analysis of this access is addressed during site-specific project analysis.

Withdrawal of areas for minerals activity is not implemented in the Forest planning process. In order to obtain a withdrawal, the Forest Service must first request that the Bureau of Land Management (BLM) withdraw the lands. The Forest Service must then complete an Environmental Analysis (EA) for the withdrawal and a Mineral Potential Report (MPR) for the given lands. Based on the information in the EA and MPR, the BLM may or many not choose to grant the withdrawal. Areas such as recommended wilderness are not withdrawn until Congress specifically designates such an area. However, until designation is completed, activities in these areas may not preclude future designation.

Cumulative Effects

Areas withdrawn from mineral entry would result in a loss of potential production of placer metals and gemstones. Adverse impacts to the locatable minerals resource from most to least are B, C, D, A, and E. The cumulative effects table at the beginning of Chapter 3 includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to development of mineral resources.

Oil and Gas

Introduction

The Federal Onshore Oil and Gas Leasing Reform Act of 1987 expanded the authority of the Secretary of Agriculture for oil and gas leasing and authorized the Secretary to develop procedures and regulations governing leasing and development of oil and gas resources in the National Forest System (NFS). The regulations, completed on April 20, 1990, set forth procedures for making leasing decisions, and required a schedule for analyzing lands that have not already been analyzed for leasing. The leasing analysis for the Bighorn National Forest was scheduled for the forest plan revision and is being conducted as part of this analysis. After the Forest Service completes required National Environmental Policy Act analysis and oil and gas decisions, the Bureau of Land Management (BLM) can offer the leases for sale consistent with the decisions. However, most of the Forest is located on uplifts of crystalline rocks, lacks sedimentary rocks, and has very little known oil and gas development potential.

With management responsibility and authority for the federal mineral estate, the BLM also plays a role in management of oil and gas resources underlying NFS lands. The BLM is a cooperating agency in this analysis in accordance with the 1991 Interagency Agreement for Oil and Gas Leasing between the Forest Service and BLM. This oil and gas analysis addresses all federal minerals including those under non-federal surface (split estate) lands with oil and gas development potential within the boundaries of the NFS units to which this analysis applies. Based on this oil and gas analysis the Forest Service will issue leasing decisions pursuant to 36 CFR 228.102, and the BLM will issue decisions for leasing federal mineral estate under Forest Service administered surface and under non-federal surface (split estate lands) within Forest Service units, as appropriate.

Legal and Administrative Framework

Oil and gas resources on NFS lands are managed under a large body of laws and regulations. A few, however, are specific to the mineral resource itself and provide direction on the disposition of federally owned oil and gas resources, as well as administration of surface activities associated with development of these resources.

Mineral Leasing Act of 1920 – This act authorizes the Secretary of Interior to issue leases for the disposal of certain minerals (currently applies to coal, phosphate, sodium, potassium, oil, oil shale, gilsonite, and gas). The act applies to National Forest lands

reserved from the public domain, including lands received in exchange for timber or other public domain lands and lands with minerals reserved under special authority.

Mineral Leasing Act for Acquired Lands of 1947 - This act states that all deposits of coal, phosphate, oil, oil shale, gas, sodium, potassium, and sulfur that are owned or may be acquired by the United States and that are within lands acquired by the United States may be leased by the Secretary of Interior under the same conditions as contained in the leasing provisions of the mineral leasing laws. No mineral deposits shall be leased without the consent of the head of the executive department having jurisdiction over the lands containing the deposit and subject to such conditions as that official may prescribe.

Mining and Minerals Policy Act of 1970 - This act states that the continuing policy of the federal government is to foster and encourage private enterprise in the development of economically sound and stable domestic mining and minerals industries and the orderly and economic development of domestic mineral resources.

Energy Security Act of 1980 - This act directs the Secretary of Agriculture to process applications for leases and permits to explore, drill, and develop resources on NFS lands, notwithstanding the current status of any management plan being prepared.

The Federal Onshore Oil and Gas Leasing Reform Act of 1987 - This act expands the authority of the Secretary of Agriculture in the management of oil and gas resources on NFS lands. Without Forest Service approval, Bureau of Land Management cannot issue leases for oil and gas on NFS lands. The Forest Service must approve all surface-disturbing activities on NFS lands before operations commence.

Title 36 of the Code of Federal Regulations, Part 228E – These regulations specify how the Forest Service will implement the Leasing Reform Act. They prescribe methods by which the Forest Service will schedule and make oil and gas leasing decisions, and how it will subsequently manage oil and gas operations on NFS lands. These regulations lay out the process for determining lands administratively available for leasing, including the designation of stipulations and the projection and analysis of post-leasing activity. These regulations describe the Forest Service process for authorizing the BLM to offer leases for sale.

Title 43 Code of Federal Regulations, Parts 3000 and 3100 – These regulations provide the regulatory basis for federal leasing by the BLM. Both the Forest Service and BLM have responsibility for leasing decisions on the federal mineral estate underlying NFS administered lands. However, BLM is solely responsible for making leasing decisions on split estate lands where the federal government owns the mineral estate (oil and gas) but does not own the surface. These regulations describe lease rights, responsibilities, and operating requirements, and how the BLM will offer competitive and non-competitive leases.

Executive Order 13212, Energy Policy - On May 18, 2001, President Bush issued Executive Order 13212 (EO 13212) to "take additional steps to expedite the increased supply and availability of energy to our Nation". On July 13, 2001, the Secretary of Agriculture approved the Forest Service Energy Implementation Plan in accordance with the Presidents EO 13212.

Terms Used in This Section

Within the oil and gas section, there are several terms used that are specific to oil and gas leasing. A brief description of these terms is given below.

Controlled Surface Use (CSU): Use and occupancy is allowed (unless restricted by another stipulation), but identified resource values require special operational constraints that may modify the lease rights. CSU is used for operating guidance, not as a substitute for NSO or Timing stipulations.

Development Potential: Oil and gas development potentials are based on estimated average drilling density (BLM 2001) and are defined as follows:

- High – over 1.0 well/township/year
- Moderate – 0.2 to 1.0 wells/township/year
- Low – less than 0.2 wells/township/year
- Very Low – less than 0.02 wells/township/year
- Zero – no drilling.

Lease Notice (LN): Provides more detailed information concerning limitations that already exist in law, lease terms, regulations, or operational orders. A Lease Notice also addresses special items the lessee should consider when planning operations, but does not impose new or additional restrictions.

Not Administratively Available (NAA): Designation given to lands that have been identified in a leasing analysis as closed to leasing through exercise of management direction .

No Surface Occupancy (NSO): Use or occupancy of the land surface for fluid mineral exploration or development is prohibited to protect identified resource values.

Occurrence Potential

- High – There is a demonstrated existence of petroleum source, reservoir quality strata, and traps. Areas of high potential have discovered oil occurrences or free oil recovery from well tests.
- Moderate – There is direct or indirect geological evidence that petroleum source, reservoir quality strata, and trapping mechanisms are present. Discovered occurrences are not present but there may be shows of oil in core or drill stem tests.

- Low – There is geologic evidence that a petroleum source, reservoir quality strata, or trapping mechanisms are not present.
- None – There is demonstrated absence of a petroleum source, reservoir quality strata, or trapping mechanisms. Demonstrated absence means physical evidence documented in geologic literature.

Standard Lease Terms (SLT): The terms incorporated into every oil and gas lease. Standard lease terms require compliance with all laws and regulations to ensure protection of other energy, mineral, and surface resources. Under standard lease terms, the authorized officer has limited authority to modify the sitting and design of facilities and to control the rate of development and timing of activities as well as require other mitigation under standard lease terms (BLM Form 3100-11 and 43 CFR 3101.1-23).

Stipulation: A provision that modifies standard lease rights and is attached to and made a part of the lease. Stipulations have been developed for the categories of: 1) No Surface Occupancy (NSO), 2) Timing Limitations (TL) or seasonal restrictions, and 3) Controlled Surface Use (CSU).

Timing Limitation (TL) (Seasonal Restriction): Prohibits surface use during specified periods to protect identified resource values. This stipulation does not apply to the operation and maintenance of production facilities unless analysis demonstrates the continued need for such mitigation and that less stringent, project-specific mitigation measures would be insufficient.

Key Indicators

- Acres available for oil and gas leasing.
- Acre by leasing stipulation for oil and gas leasing.
- Reasonable foreseeable development for oil and gas production.

Historical Summary

In accordance with the Federal Onshore Oil and Gas Leasing Reform Act of 1987 and its implementing regulations (completed April 20, 1990), a reasonable foreseeable development (RFD) scenario on the Bighorn National Forest may be completed during the life of the plan dependent upon future oil and gas demand. Oil and gas information used in this Draft EIS is derived from *A Brief Review of the Oil and Gas Potential on the Bighorn National Forest, Wyoming* (BLM 2004) and *Reasonably Foreseeable Development Scenario for Oil and Gas Development in the Buffalo Field Office Area, Campbell, Johnson, and Sheridan Counties, Wyoming* (BLM 2001).

Title 36 CFR 228 (Subpart E) regulations prescribe methods by which the Forest Service will make oil and gas leasing decisions. These regulations lay out the process for determining lands administratively available for leasing and the Forest Service process for authorizing the BLM to offer leases for sale.

A lease, by itself, does not permit ground-disturbing activities, but because it conveys certain rights to the lessee, any mitigation measure necessary to protect other resources from ground-disturbing activities need to be addressed before the lease is issued (36 CFR 228.102(c)). Consequently, the leasing stage level of analysis (stage 1) identifies effects on other resources from potential activities and specifies necessary restrictions, if any, beyond those imposed by standard lease terms. Stipulations attached to leases specify such restrictions.

When drilling an exploratory well, (stage 2), the Forest Service has the responsibility and authority to approve the Surface Use Plan of Operation (SUPO), with conditions, as part of the Application for Permit to Drill (APD) (36 CFR 228.107 and 228.108). Environmental analysis of the proposed drilling project identifies effects on other resources from the proposed activity and specified mitigation consistent with forest plan direction, terms of the lease, and direction in 36 CFR 228.108. Approved mitigation measures are included as Condition of Approval (COA) with the SUPO. The Forest Service must approve the SUPO as part of the APD (for which BLM provides final approval) with mitigation measures before the well can be drilled.

When developing a discovered resource (stage 3), the Forest Service has the responsibility and authority to approve surface use part of a development plan, which could include one or more wells. Environmental analysis of the proposed development project identifies effects on other resources from the proposed activity and specified mitigation measures consistent with Forest Plan direction, terms of the lease, and direction in 36 CFR 228.108. Identified mitigation measures are included as COA with an approved development plan and an approved SUPO and APD for each well. Development activity can proceed only after the Forest Service and BLM have approved the development plan with specified mitigation measures.

Forest Service and BLM personnel must conduct periodic inspections of exploratory and development drilling operations and production activities to ensure compliance with mitigation measures (36 CFR 228.112) and other applicable regulatory authorities.

Affected Environment

There are several areas in the Rocky Mountains where sedimentary rocks are concealed beneath mountain-front thrusts, including the eastern flank of the Big Horn Mountains. The amount of overthrust is unknown but may only be several miles, limiting exploration to the far eastern edge of the Forest. As the thickness of the overthrust granite increases, the risk and cost of development also increases.

Most of the Forest is located on uplifts of Precambrian crystalline rocks such as granite and granitic gneiss, and as a consequence, has very little known oil and gas production potential. Areas with potential for oil and gas resources occur on the flanks of these uplifts in sedimentary rocks, found on the flanks of the Big Horn Mountains and along the Forest boundary.

Sedimentary rocks in peripheral areas of the Forest include documented reservoir rocks, source rocks, seals, and traps. However, much of this sedimentary section on the Forest is absent due to erosion or is very shallow and offers only indirect evidence of the presence of oil and gas traps. In limited areas of the Forest, crystalline rocks at the surface have been thrust over a deeper sedimentary section. The existence of traps in the subthrust sedimentary section in these areas has not been confirmed.

Demand Assessment

The Bighorn National Forest has a trivial history of oil and gas production. A well was drilled in 1984, through the Piney Creek Thrust, west of Story, Wyoming and has since been abandoned. Seismographic activity occurred along the eastern flank of the Big Horn Mountains from Story south to Buffalo in the mid 1980s. This activity was based upon a theory that there is additional overthrusting of the granites over the sedimentary formations. However, this exploration did not result in any production. There are no identified areas in the analysis area that have the potenial for oil and gas development in the near future.

Off -Forest, oil and gas development is booming, underscoring the minor contribution of the Forest for production of this resource. Industry analysts describe coalbed methane (CBM) development in the nearby Powder River Basin (PRB), an area of 20,000 mi^2, as the "fastest growing coalbed methane play in North America". The PRB is slated for roughly 51,000 CBM wells by the year 2010. Ninety-eight percent of the CBM resources are in Campbell, Johnson, and Sheridan counties, Wyoming. Converse and Natrona counties contain the remaining two percent. However, on the Forest the reservoir rocks that produced the PRB fields have long since been removed by erosion, do not extend onto the Forest, or are too shallow to have significant potential for production.

Environmental Consequences

Direct and Indirect Effects

Resource Protection Measures

Standard lease terms are incorporated into every lease and require compliance with laws and regulations to ensure protection of other energy, mineral, and surface resources, such as soil, water, vegetation, cultural, and threatened and endangered species. In addition to standard lease terms, supplemental lease stipulations may be necessary if the authority to control the activity on the lease does not already exist under laws, regulations, or orders. Using the Uniform Format for Oil and Gas Leasing Stipulations, March 1989, stipulations have been developed for the following categories: 1) No

Surface Occupancy (NSO), 2) Timing Limitations (TL) or seasonal restrictions, and 3) Controlled Surface Use (CSU).

Title 36 CFR 228.102(c)(2) requires a leasing analysis to identify alternatives "including that of not allowing leasing." For this analysis, the No Oil and Gas Leasing Alternative (See Chapter 2-Alternatives considered but not in detail) is the no leasing alternative. All lands under this alternative are not administratively available for leasing.

Alternatives A, B, C, D, and E represent an updated development scenario for oil and gas leasing. Stipulations were developed using the standards and guidelines in the proposed land use plans. This resulted in a consistent set of stipulations being applied across all alternatives (except for the No Oil and Gas Leasing Alternative). Alternatives A, B, C, D, and E vary by acres allocated to management areas, and in most cases, do not vary standards and guidelines except for those associated with management areas. All lands under these alternatives are administratively available except for those legally not available (e.g., wilderness, wild and scenic rivers, etc).

Determination of Effects

This section outlines the methods used to determine the magnitude of effects. Effects from various aspects of the Revised Land and Resource Management Plan and associated leasing decisions are discussed in the following sections.

Stipulations for new leases were developed to implement the standards and guidelines in the Revised Plan. Locations of the various resources where the stipulations would apply were mapped. Management areas were also mapped for each alternative. Throughout this analysis, resource inventories have been updated to include the latest available data. Because the stipulations developed for the LRMP represent the best management practices, a consistent set of stipulations was used in Alternatives A through E. These alternatives vary by areas allocated to various management prescriptions. The analysis uses a consistent set of resource inventories across all alternatives.

The magnitude of the effects was determined by calculating the number of acres where oil and gas leasing is constrained by either management area direction or by leasing stipulations.

Effects by Leasing Decisions

Decisions to make lands not administratively available for leasing or not to authorize lands for leasing precludes the exploration and the potential discovery of oil and gas resources and can make subsurface federal mineral estates unrecoverable. In all alternatives, wilderness is not administratively available for leasing by action of law. The Bighorn National Forest administers the Cloud Peak wilderness area; there is no oil and gas resource potential in that area.

Effects by Type of Stipulation

Lease stipulations can restrict the placement, number, and type of wells and facilities; reduce exploration and development opportunities; and increase drilling and operational costs. Types of stipulations are discussed below.

Standard Lease Terms

All leases are subject to Standard Lease Terms (SLT). Leases with SLT and no supplemental stipulations are the least restrictive types of leases potentially available for leasing. With the exceptions noted below, SLT permit year-round occupancy of leased lands, provide full access, and have the highest potential for discovery and development of oil and gas resources .

SLT require an operator to minimize adverse impacts to air, water, land, visual, cultural, and biological resources and to other land uses or users. They require that the lessee comply with all applicable laws, regulations, and formal orders. SLT increase the uncertainty of operating conditions because some restrictions may not be known until an application for a permit to drill is submitted and the site inspections are completed. If threatened and endangered plant and animal species or cultural resources are present, then development may not be possible for those portions of the lease. Known potential for these situations to exist are noted in Lease Notices attached to leases in potentially affected areas. Previously unknown threatened or endangered species and/or cultural resources may be identified during pre-drilling, on-site inspections. Effects to these resources can usually be mitigated but may substantially increase the operator's costs.

If potential negative effects to surface resources can be mitigated under the following SLT provisions (43 CFR 3101.1-2), then no additional stipulations are necessary:

- Drill site may be moved 200 meters.
- Drilling operations may be delayed up to 60 days.
- Leases issued with SLT only have the lowest level of restrictions and meet the Forest Service mineral policy direction to encourage development of mineral resources.

Lease Stipulations

Lease stipulations are a modification of standard lease rights and are attached to and made a part of a lease. Stipulations provide greater protection for identified resources and greater mitigation of negative effects than SLT. The following are categories of lease stipulation:

No Surface Occupancy (NSO): Use or occupancy of the land surface for fluid mineral exploration or development is prohibited to protect identified resource values.

Even though NSO stipulations prohibit surface occupation for exploration or development of oil and gas resources, the subsurface resources are legally available if they can be accessed by means other than occupying the surface specified in the NSO stipulation. Leasing an area with NSO, rather than declaring it "not administratively

available" for leasing, may allow development through directional drilling, if adjacent lands are available for leasing with surface occupancy or are privately owned. Technology limits the distance a well's surface location can be placed from the downhole location, and in some areas, directional drilling is technically impossible. Directionally drilled wells are more costly.

Timing Limitation Stipulation (TL) (Seasonal Restriction): Prohibits surface use during specified periods to protect identified resource values. This stipulation does not apply to the operation and maintenance of production facilities unless the analysis demonstrates the continued need for such mitigation and that less stringent, project-specific mitigation measures would be insufficient.

The TL is used, when necessary, to restrict drilling activities on leased lands for a period greater than 60 days. TLs could increase exploration costs if a well is not completed within required time limits. Shutting a drilling operation down and leaving the equipment idle or moving the equipment to another site and moving it back increases costs. TLs may push operations into the winter, where activities on frozen ground or in frigid weather can also increase operator costs.

Controlled Surface Use (CSU): Use and occupancy is allowed (unless restricted by another stipulation), but identified resource values require special operational constraints that may modify the lease rights. CSU is used for operating guidance, not as a substitute for NSO or timing stipulations. Such stipulations permit year-round occupancy and accessibility to leased lands. They maintain potential for discovery and utilization of oil and gas resources while providing mitigation of effects on other resources.

Lease Notices (LN) are attached to leases to transmit information at the time of lease issuance, to assist the lessee in submitting acceptable of plans of operation, or to assist in administration of leases. Lease Notices do not involve new restrictions or requirements. Any requirements contained in a Lease Notice must be fully supported in law, regulation, standard lease terms, or onshore oil and gas orders. Guidance in the use of Lease Notices is found in BLM Manual 3101 and 43 CFR 3101.1-3. Lease Notices attached to leases should not be confused with Notices to Lessees (NTL).

Notices to Lessees (NTL): The NTL is a written notice issued by the authorized officer. NTLs implement regulations and operating orders and serve as instructions on specific items of importance within a specified area.

Effects by Alternative

The following table displays acres of land that would not be available for leasing, available for leasing, and the area affected by each type of stipulation, by alternative.

The total acres include the entire federal mineral estate regardless of development potential, whether or not the federal government owns the surface.[28]

Table 3-156. Acres of oil and gas resource potential, by category and alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
Total Federal mineral estate	1,105,017	1,105,017	1,105,017	1,105,017	1,105,017
Acres not available for leasing	191,897	191,897	191,897	191,897	191,897
Acres available for leasing	913,120	913,120	913,120	913,120	913,120
Acres Open for Leasing with Stipulations					
No Surface Occupancy (NSO)	269,687	379,071	417,795	220,338	87,309
Timing Limitation (TL)	27,680	28,213	21,325	28,852	29,638
Controlled Surface Use (CSU)	44,611	260,795	361,959	210,449	157,894
Standard Lease Terms (SLT)	571,141	245,040	112,041	453,478	638,646
Total	913,119	913,119	913,120	913,117	913,487

Effects from Management Areas Prescriptions

This discussion focuses on management areas that, by their own direction, place area-wide limits on oil and gas activities. Some management areas are proposed as not available for leasing, some allow oil and gas leasing but prohibit surface-disturbing activities, or have other standards and guidelines which lead to stipulations more restrictive than standard lease terms. Standard lease terms apply to all leases, whether or not they have additional special stipulations. Management areas with management direction that does not require use of an area-wide stipulation may still include leases with special stipulations designed to protect specified resources.

Some management areas contain provisions that require NSO stipulations over large blocks of land. The effects of these large blocks of NSO are potentially greater than spatially small areas of NSO because the interiors may be essentially inaccessible.

For each management area that prescribes a constraint applicable to the entire management area, and which resulted in not administratively available acreage or in an oil and gas leasing stipulation, the table below displays the acres by alternative.

[28] There are areas where the federal government owns the mineral resource below ground but does not own the surface. BLM is responsible for leasing decisions on split estate lands.

Table 3-157. Acres with standard lease terms or stipulations, by management area and alternative.

Mgmt Area	MA Description	Stipulation	Alt A	Alt B	Alt C	Alt D	Alt E
1.11	Pristine Wilderness	NAA	130,799	130,803	130,798	130,798	130,808
1.13	Semi-primitive Wilderness	NAA	61,098	61,094	61,100	61,100	61,090
1.2	Recommended Wilderness	NSO	0	0	125,569	0	0
1.31	Backcountry Recreation - Nonmotorized	NSO	0	34,273	235	24,711	7,702
1.32	Backcountry Recreation - Nonmotorized Summer	NSO	58,943	42,342	71,209	36,939	27,472
1.33	Backcountry Recreation – Limited Motorized Use	NSO	20,053	32,546	36,901	6,099	15,224
1.5	National River System-Wild	NSO	13,217	20,871	22,082	10,251	10,420
2.1	Special Interest Areas	NSO	89	20,004	17,024	0	0
2.2	Research Natural Areas	NSO	1,618	21,190	21,188	21,190	1,618
3.1	Special interest area (Medicine Wheel)	NSO	61	20,863	20,865	20,863	20,863
3.24	Riparian and Aquatic Ecosystems	NSO	931	0	0	0	0
3.31	Backcountry Recreation - Year-round Motorized	CSU	25,464	118,242	193,877	82,733	12,719
3.4	National River System-Scenic	NSO	17,110	5,815	4,817	2,887	1,470
3.5	Plant and Wildlife Habitat Management	CSU	156,448	178,587	95,325	94,823	0
4.2	Scenery	CSU	19,147	95,418	93,294	102,084	6,007
4.3	Dispersed Recreation	CSU	0	36,234	63,888	25,558	4,794
4.4	National River System-Rec	CSU	0	10,901	10,900	74	0
5.11	Forest Vegetation	SLT	93,160	89,657	92,484	170,455	190,161
5.12	Rangeland Vegetation	SLT	263,636	72,155	19,557	182,093	51,528
5.13	Forest Products	SLT	210,213	83,228	0	100,930	198,977

Mgmt Area	MA Description	Stipulation	Alt A	Alt B	Alt C	Alt D	Alt E
5.13.1	Forest Products (RACR 4(b))	SLT	0	0	0	0	0
5.21	Water Yield	SLT	3,991	0	0	0	0
5.4	Plant and Wildlife Habitat	CSU	0	0	0	0	134,374
5.41	Deer and Elk Winter Range	TL	27,680	28,213	21,325	28,852	29,638
5.5	Dispersed Recreation and Forest Products	SLT	0	0	0	0	197,710
8.21	Water Impoundmentsb (Tie Hack Res.)	SLT	141	0	0	0	0
8.22	Ski Resorts	NSO	1,217	2,580	2,580	2,575	2,540
Total	----------	----------	1,105,016	1,105,016	1,105,018	1,105,015	1,105,115

Restrictions that prohibit access in areas of moderate oil and gas resource potential would have a greater effect on leasing than those same restrictions if imposed in areas with lesser potential (there are no areas of high oil and gas resource potential on the Bighorn National Forest). Such restrictions include NSO stipulations, and designation of not administratively available (NAA). The following table displays the relative impact of the alternatives on oil and gas development.

Table 3-158. Relative impact of alternatives on oil and gas development.

Stipulation	Less Restrictive ⟵ Relative Restriction ⟶ More Restrictive To oil and gas development				
Not Administratively Available (NAA)	No real difference between alternatives				
No Surface Occupancy (NSO)	E	D	A	B	C
Controlled Surface Use (CSU)	A	E	D	B	C
Timing Limitation (TL)	C	A	B	D	E

Alternative C is the most restrictive alternative with regards to oil and gas development, because of the NSO stipulation, followed by Alternatives B, A, D, and E, respectively.

The No Leasing alternative has no lands available for leasing.

Cumulative Effects

The cumulative effects table at the beginning of Chapter 3 includes the list of past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to oil and gas development.

Effects from Large Areas of No Surface Occupancy: In the area affected by NSO stipulations, wells would be displaced to areas outside the NSO area. Impacts to oil and gas would include increased costs of development and production to directionally or horizontally drill the wells.

Inside the boundary of NSO areas beyond 1/8-mile, the oil and gas resource would be essentially inaccessible with current technology. The magnitude of the loss would depend on the resources available in the particular area. In some circumstances, leaving the oil and gas in place preserves the resource for future use. When oil and gas resources adjacent to the area of no surface occupancy are developed, drainage of the oil and gas under the no surface occupancy area could occur, resulting in a loss of resource and associated royalties to the United States government.

Effects from Drainage: Drainage occurs when oil and gas migrates in the subsurface from areas of high pressure to areas of lower pressure, such as is found near a producing well. Production of migrated oil and gas without compensation to the owner and/or lessee from whose estate the hydrocarbons moved is called drainage. The remedy of choice is often drilling and completing a producing well on the mineral estate losing hydrocarbons.

The federal oil and gas lease obligates the lessee to protect federal minerals against drainage. Developing a well on the losing mineral estate is one method of drainage protection. Other protection may be achieved by including lands not leased in units, by agreements with adjacent mineral owners, or assessment of compensatory royalties. However, if the federal mineral estate is not leased, the existing mineral resource may be drained and produced from adjacent non-federal mineral estates without compensation to the federal government.

Drainage can also affect overall reservoir recovery. Spacing of wells over the reservoir is crucial to maximum reservoir recovery. When a portion of the lands are not available to be drilled, oil and gas recovery from the reservoir would be diminished, secondary recovery may be inhibited, and overall recovery and revenues reduced.

When lands are leased, the lessee can be required to protect the lease from further drainage. However, when land is not leased, there is no procedure to protect from drainage. By not allowing leasing, the recoverable reserves within a particular tract may be decreased, perhaps to the point where drilling within the federal tract is not economically feasible, even if leasing is later permitted.

Effects from Access: Access to leases across federal lands is controlled by land and resource management plan standards and guidelines. The standards and guidelines are not specifically included in oil and gas leases but apply to the lessee, as well as any forest user. Generally, when a stipulation is applied to a lease, similar or identical restrictions will apply to the placement, construction, and use of access roads, pipelines, and powerlines.

Special Forest and Rangeland Products

Introduction

Special forest/rangeland products (SFPs) are mainly plant and fungi material that are gathered from forested lands or rangelands for personal use, for barter, for commercial resale, or for sale as a craft product. They can generally be categorized under five general areas: residential comfort and use, food, herbs and medicinal, decorative, and specialty items. Special forest/rangeland products can play a role in sustainable development and are thought to provide links to sustaining rural economies and contributing to economic diversification. It is possible that as demand for these special products increases and new markets are created, harvest pressure on them will increase.

Legal and Administrative Framework

36 CFR 223.1: Trees, portions of trees, and other forest products on National Forest System lands may be sold for the purpose of achieving the policies set forth in the Multiple Use Sustained Yield Act as amended and the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended and the Program there under.

36 CFR 261.6(a) Cutting or otherwise damaging a forest product except as authorized by a permit or federal law.

36 CFR 261.6(e) Loading, removing, or hauling a forest product acquired under any permit unless such product is identified as required in such permit.

36 CFR 261.10(c) Selling or offering for sale any merchandise or conducting any kind of work activity or service unless authorized by a federal law, regulation, or permit.

36 CFR 261.10(l) Violating any condition or term of a permit.

FSM 2467 - Sales of special forest products

FSM 2467.01 – Authority: Forest officers may sell other forest products under provisions set out at 36 CFR 223.1.

FSM 2467.02 – Objective: To sell other forest products where it would serve local needs and meet land management objectives.

FSM 2467.03 – Policy: Use management measures that perpetuate or increase the production of miscellaneous forest products within applicable objectives, standards, and guidelines of the Forest land and resource management plan. Recover the fair market value of such products when it is practical to do so.

FSM 2467.04 – Responsibility: See FSM 2404.2 for delegations of authority and assignments of responsibility to agency officials by organizational level. Regional Foresters shall develop appraisal and sale procedures, including defining the conditions of sale for forest products.

FSM 2467.1- Conditions of Use for Miscellaneous Forest Products: Conditions for use of miscellaneous forest products are set forth in FSH 2409.18, section 87.

FSM R2 Supplement No. 2400-96-2: 2431.31 - Minimum and Standard Rates.

- **2431.31a - Standard Rates.** "Standard rates may be used for sale of all nonconvertible products and Special Forest Products. Forest Supervisors may establish higher standard rates when supported by an appraisal specialized for that product. Limit standard rates for convertible products to less than 4,000 CCF."

Permits are generally required for harvest of special forest product resources, as well as for research collections. The permit regulates the manner in which forest product resources are harvested, provides information for monitoring the amount harvested. Collections that qualify as non-commercial research, educational use, or incidental personal use can be authorized through an administrative use permit or a free use permit or as provided in Bighorn Forest Manual Supplements.

Key Indicators

- Number of permits and amount issued for special forest/rangeland products
- Quantities and locations of species harvested
- Amount of Forest accessible to public for permit collection.

Resource Protection Measures

Numerous forestwide and management area prescription standards and guidelines exist concerning vegetation.

AFFECTED ENVIRONMENT

Aspen and conifer transplants, Christmas trees, native seed and boughs are examples of traditional requests for permits to acquire special forest products. Special forest products may be collected forest-wide, though generally not from wilderness or research natural areas. Existing uses are often tied to historical knowledge and patterns of use. Although technically not special forest products, firewood, posts, and poles are sold to the public in a similar manner to the special forest products and are discussed here and in the timber section. According to the Cut and Sold report reports, nearly 225 transplants were taken under permit on the Forest in fiscal year 2002. About 2,050 Christmas trees were sold in that same time. The Forest sold 302 hundred cubic feet (CCF) of posts and pole permits during each of the last two years. Firewood permits remain steady, with over 2,800 cords sold in FY 2002 that contribute to the other vegetation management volume offer.

In recent years, however, requests from the general public and scientific community for the use of additional and diverse special forest and rangeland plants for specific purposes have increased. Interest from Native Americans continues in collecting traditional use plants. Existing quantities of nearly all types of desired products are dependent upon ecological conditions and existing distributions of potential habitat as expressed by forest and/or non-forest cover types (for more detailed information, refer to the Biodiversity section).

Table 3-159. Association of special forest product with cover types.

Special Forest Product	Cover Type
Christmas trees	Lodgepole, Spruce/Fir, Douglas fir
Moss	Montane Riparian within Lodgepole, Spruce/Fir
Burls	Lodgepole, Spruce/Fir, Ponderosa pine
Cones	Lodgepole, Spruce/Fir, Ponderosa pine
Mushrooms	Lodgepole, Spruce/Fir
Boughs	Douglas fir, Lodgepole, Spruce/Fir
Wildflowers & Seed	All Cover Types
Cuttings	Willow and Cottonwood
Transplants	Lodgepole, Spruce/Fir, Ponderosa pine, Aspen
Firewood	All forest cover types
Posts and Poles	Lodgepole, Spruce/Fir

Permits for collection will generally be required. Care has to be taken to assure that native and desired non-native plant populations are not adversely affected due to over-harvesting and that conflicts with other uses are minimized.

Summary of Existing Condition

Unlike timber products and fish and wildlife products where harvest of these goods is strictly regulated and quantified, special products harvest is loosely regulated and difficult to quantify at times. This is largely due to the small scale use of these special forest/rangeland products. As markets expand and demands increase, additional regulations will be necessary to sustain the resources and manage their collection.

In many cases, little is known about the distribution and abundance of specialty plants. This makes it difficult to determine that management, including permitting of some level of harvest, while providing for the long-term health and sustainability. Increasing emphasis on inventory and evaluation of life histories will become increasingly important as demand for these species increases.

Uses of and requests for Bighorn NF special forest and rangeland products continue to increase for both traditional and non-traditional types. Charge permits have long been required for such items as firewood, tree transplants, and Christmas trees; permits (charge or free) are generally required for removal of all types of products. Permit amounts and/or locations may have to be regulated in order to assure sustainability of some of the non-traditional plant species.

ENVIRONMENTAL CONSEQUENCES

Direct and Indirect Effects

The requests for special forest/rangeland products will continue to increase regardless of the alternative, though access to them will vary. Alternative C has more wilderness, thus less access, while alternatives A and E could provide easier access through timber sale roads. The number of permits issued for their use will be independent of the alternative selected.

Fire increases the potential availability of traditionally collected mushrooms. The greatest acres of potential wildland fire use would be in Alternatives C and B, as they provide for the least acres of active management.

Alternative C has the highest level of wilderness, roadless and special area allocations, reducing the areas across the Forest where products would be available for collecting.

Alternatives E, A, and D, with higher levels of open and maintained roads, will maintain or increase opportunities for the general public to access and harvest these products. Access to harvest activities is an indicator of how much of the Forest could be used to collect special forest/rangeland products, as most of the roads used to access timber harvest are kept open seasonally for a few years after harvest for just that activity. Alternatives E and A would provide the most area for special forest products collection, with C and B providing the least and D in-between them.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered with regard to cumulative effects to the special forest/rangeland resource. The next 15 years are considered the time span for cumulative effects.

The cumulative effects of vegetation composition are discussed in Biodiversity and Vegetation sections of this chapter.

Timber Resources

Introduction

The Bighorn National Forest contains valuable timber resources. They are important for providing habitat for plants and animals, and important to the people who use or are employed because of wood products. These products include construction lumber, fuelwood, transplants and Christmas trees, posts and poles, and wood for carving. Primary species include lodgepole pine in the intermediate elevations, spruce and fir dominate the higher elevations, mixed conifer of ponderosa pine, Douglas-fir and limber pine at the lower elevation, small clones of aspen, and cottonwoods found along the lower riparian zones.

Legal and Administrative Framework

The Forest and Rangeland Renewable Resources Planning Act of 1974, as amended by The National Forest Management Act of 1976 – these acts set forth the requirements for Land and Resource Management Plans for the National Forest System. 36 CFR 219 regulations require the Forest Service to identify areas suitable and available for timber harvest and the allowable sale quantity (ASQ) from those lands. In addition, regulations require us to analyze the supply and demand for resource commodities.

The Multiple-Use Sustained Yield Act of 1960 – "It is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed and wildlife and fish purposes…The Secretary of Agriculture is authorized and directed to develop and administer the renewable surface resources of the National Forests for multiple-use and sustained yield of several products and services obtained there from…the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land."

Organic Administration Act of 1897- Forests are established "to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

Key Indicators

- Acres suitable for timber harvest.
- Timber Production (ASQ and Total Sale Program).
- Mix of harvest methods.
- Acres of non-commercial treatments.
- Age Class or Structural Stage Distribution of suited lands.

AFFECTED ENVIRONMENT

Timber Production

Historical documentation shows that specific areas of the Forest were used for harvesting wood products. The history of cutting on what is now the Bighorn NF dates back to the late 1870s. One of the earliest government uses of the forests were for timber reserves. These wooded areas were set aside by the federal government to provide fuel and building materials for government installations, such as Fort Phil Kearny near Story, Fort Mackenzie near Sheridan and Fort McKinney near Buffalo. The most extensive early lumbering operations within the present forest occurred during the construction of the railroad east of the Forest. According to Murray, in 1905, one of the largest timber sales occurred when the McShane Timber Company bid on 50 million board feet of lodgepole pine. By 1916 the construction had moved on and the harvest of timber levels fell. Records from reports from 1905 to 2002 indicate approximately 7 Million Board Feet (MMBF) was removed annually from the Forest. Annual harvest volumes ranged from less than 1 MMBF to 22 MMBF (see following figure).

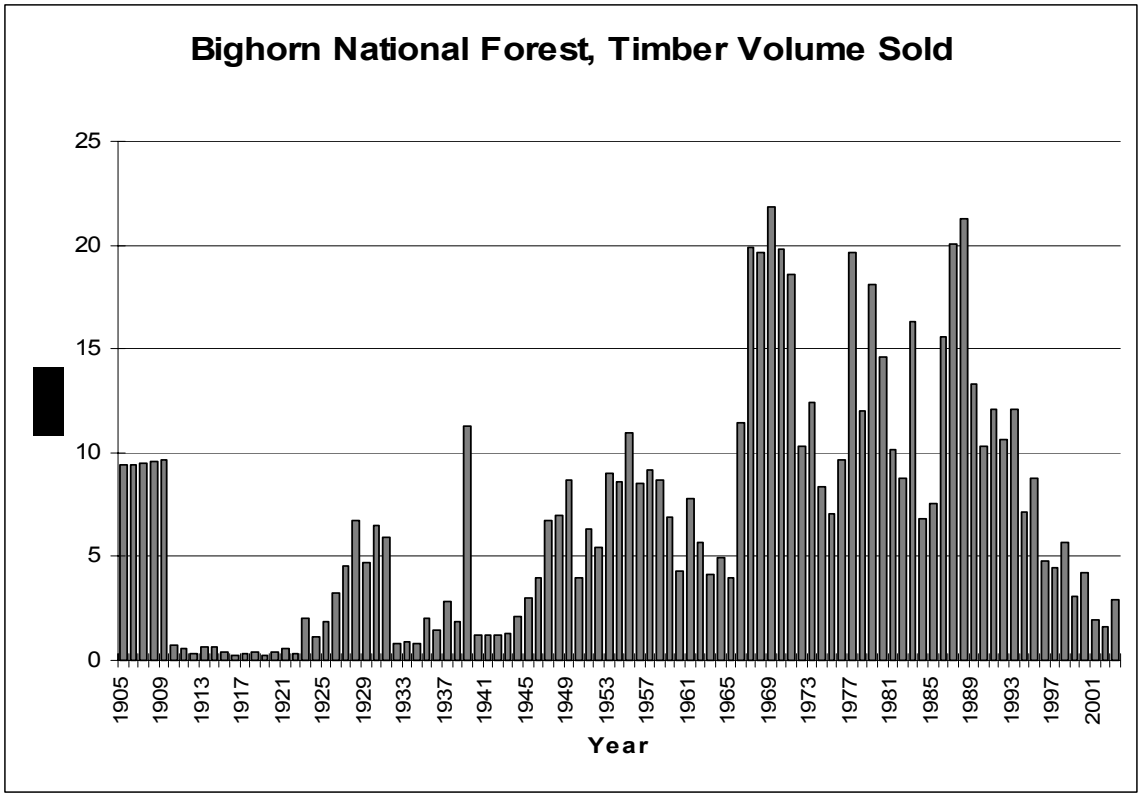
The highest volumes occurred during the late 1960s, when a stud mill was established in Sheridan. Many National Forests experienced similar cycles in harvesting as national events such as World Wars and economic ups and downs influenced the demands of the economy.

In 1975, a Timber Management Plan was approved for the Bighorn NF. This plan identified the timber management planning base acres, and established an "expected yield of wood products… [of] 66.0 M cunits including 21.6 million board feet of sawtimber." This level of harvest was not met over the planning period.

In 1985, the Land and Resource Management Plan for the Forest was implemented. This Plan identified lands suitable for timber production, and established an Allowable Sale Quantity (ASQ) of 38,600 CCF (Cunits) or 14.9 MMBF/yr (million board feet). Actual sale offerings since the plan was implemented have decreased steadily. It was noted in Forest Plan monitoring that there were inconsistencies between the Plan standards and guidelines and outputs, i.e. ASQ sale offerings. The reduction is due to a

variety of factors including these Plan inconsistencies, appeals and litigation of projects, as well as funding and staffing needs on the forest.

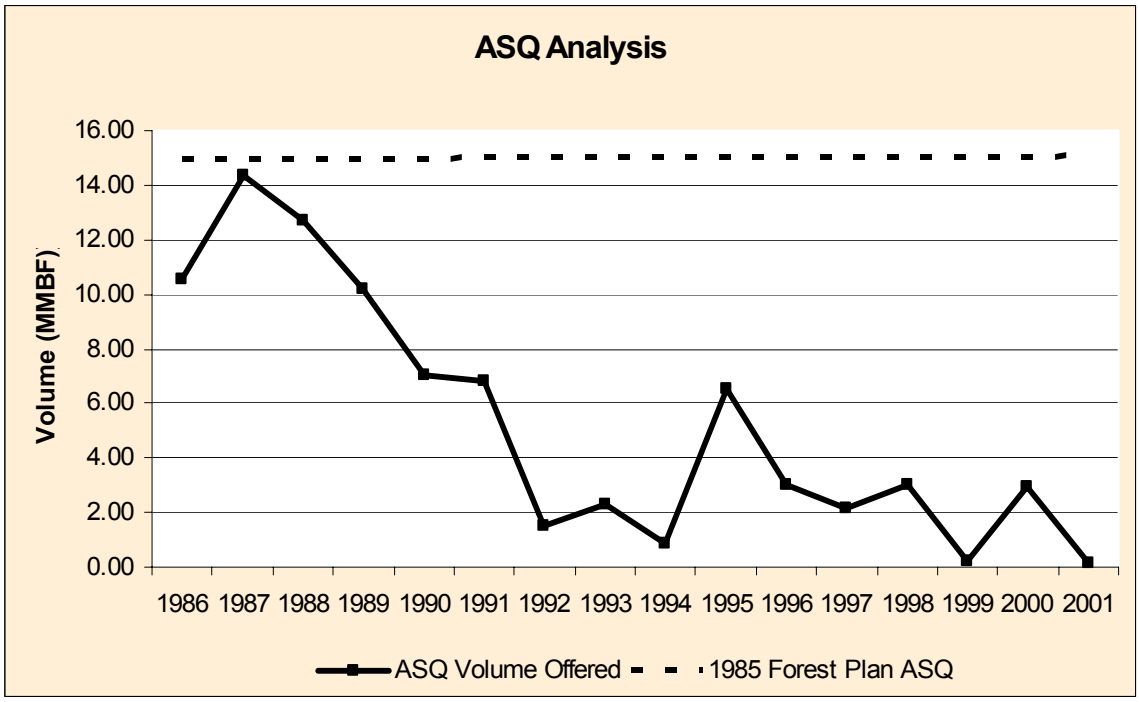
Figure 3-16. Historic timber harvest volume.



The following figure shows the volume offered between 1986 and 2001. These figures are for conifer sawtimber only. The average ASQ volume sold during that period was 4.9 million board feet (MMBF).

Total program offering includes “mortality volume” which has been identified as personal use fuelwood. Since the 1985 Plan was implemented the Forest has consistently exceeded the amount of “mortality”, selling 180% of the projected amount in the above planning period.

Figure 3-17. Sawtimber volume sold since 1986.



The Forest reanalyzed the suited lands in 1991 in response to litigation on regeneration. The 1991 analysis resulted in a net decrease of approximately 5,000 suited acres. Suited acres were again analyzed in 1993 as a part of a significant amendment process for ASQ. That analysis yielded a net increase in the tentatively suited acres of less than 10,000 acres.

The 1993 ASQ amendment process was never implemented. At the time of decision, it was thought that the Forest would start plan revision in a couple of years, and the decision was deferred until that time. For numerous reasons the couple of years turned out to be longer than anticipated. The ASQ FEIS alternative ASQ amounts ranged from 370 to 6,570 MCF/year or approximately equivalent to 1.05 to 14.95 MMBF/year. The alternative of existing standards and guidelines yielded 1,120 MCF/year (approximately equivalent to 4.39 MMBF/yr).

Timber Suitability

The Forest determined the amount of forested land available, capable and suitable for timber production, per 36 CFR 219.14. The Bighorn NF has completed suitability analysis four times prior to this revision--once for the 1975 Timber Management Plan and second for the 1985 Forest Plan. Litigation in 1991 directed the Forest to calculate and amend the suited acres a third time, and lastly for the un-implemented 1994 ASQ amendment. The 1991 Plan amendment identified 351,916 acres of tentatively suitable

for timber production, of which 262,062 acres of the Forest were determined to be suitable, available, and scheduled for timber harvest. A complete description of timber suitability is found in Appendix B of this DEIS, which describes the process to determine lands tentatively suited for timber production. Additionally, each alternative, through management area designation, filters the tentatively suited lands to those suited for timber production.

Silvicultural System

The acres treated by commercial timber harvest from 1986 to 2001 include 1.78% of the forested lands. Acres treated with non-commercial thinning and reforestation includes 1.76% of the forested acres, but primarily includes previous commercially harvested lands.

There are two basic types of silvicultural methods: intermediate harvests and regeneration harvests. Intermediate harvests are any manipulations in a stand that occur between two harvest periods. Intermediate harvests ensure the desired composition, stem quality, spacing, and growth performance in a stand (Daniel, 1979). On the Bighorn National Forest, this includes both commercial and non-commercial harvests, such as thinning, release, and weeding.

A regeneration harvest has a primary objective to remove trees so that regeneration occurs in a predictable period of time. There are several regeneration harvest methods including clearcutting, selection, and shelterwood.

Even-aged Regeneration

The ages of the main canopy trees in managed even-aged stands do not differ more than twenty percent. Even-aged harvest methods practiced on the Bighorn Forest include clearcutting and shelterwood. Generally on the Bighorn Forest, only clearcutting uses artificial reforestation. For the shelterwood method, natural reforestation is preferred.

Clearcutting - Clearcutting is a harvest method that removes approximately 90 to 99% of all merchantable trees from the harvest site. The site is then prepared for the replacement stand. Since the harvested site is much more open, care must be taken to minimize erosion when preparing the seed bed. Reforestation is generally achieved through natural seeding with some artificial seeding required on larger units. Clearcutting is done once during the rotation (90 to 180 years) to accomplish regeneration.

The seed source for this method is the serotinous cones from harvested trees or neighboring timber stands. In most cases this will be lodgepole pine. Because this method removes almost all the trees, the conditions after cutting and seedbed preparation also favor lodgepole pine. Some acres will require additional planting. Once established, tree growth for lodgepole pine is greatest under this method.

Clearcutting opens the natural canopy the most and has the least potential for blowdown. Because most of the canopy is removed, most of the tree diseases that could infect the regenerated stand are removed. This method requires fewer road miles per

volume harvested than other methods. Clearcutting has the lowest cost per volume for Forest Service sale preparation and for the purchaser.

The National Forest Management Act of 1976 directs the Forest Service to use the clearcut harvest system only when "…it is determined to be the optimum method to meet the objectives and requirements of the relevant land management plan." Congress enacted NFMA in part to ensure that careful consideration and systematic analyses would be performed prior to harvest activities being implemented on a forested site.

Clearcutting can be an effective method of timber harvest in a variety of conditions. These may include control of pathogens such as dwarf mistletoe, regeneration of species that are shade-intolerant, or providing openings that are useful to some species of wildlife. Determination of harvest methods must be analyzed individually to identify the characteristics that define the optimum harvest method to achieve the desired management objectives.

Clearcutting is primarily used for shade intolerant cover types. On the Bighorn, this includes lodge pole pine and aspen. The amount of clearcutting on the Bighorn has reduced from 93% of total harvest acres during the 1960s, to 26% for the 1990s. Clearcut harvesting on the Bighorns has been done at various scales over the decades with clearcuts over 700 acres in the 1960s, small 3 to 10 acre clearcuts predominated the 1980s. Currently the Forest utilizes a clearcuts from a few acres to almost 200 acres designed to meet the resource needs of the individual project objectives.

Shelterwood - Shelterwood harvest is a regeneration method that removes all merchantable trees from a site except those needed to provide seed and protect the site. The amount of the remaining stand varies depending on need for seed and site amelioration. Normally between one third and one half of the stand is cut. Natural seeding regenerates the site. A stand of trees may be entered two or three times during a rotation to establish regeneration.

Shelterwood harvest requires more road miles per volume than clearcutting, but fewer than uneven aged regeneration. The remaining seed trees are the seed source for the next generation. Natural regeneration readily occurs with this method if harvest activities prepare the seedbed. The risk of blowdown is moderate; the risk of disease infection of the regenerated stand is high. Seed trees are removed after sufficient regeneration has taken place.

Shelterwood harvests are used in shade intolerant to moderately tolerant cover types. On the Bighorn, this includes lodgepole pine, spruce/fir and Douglas-fir.

Uneven-aged Regeneration

Uneven-aged stands are those with at least three distinct canopies of height and age (Smith, 1986). Regeneration is achieved using either individual tree selection or group selection methods. These harvests maintain much of the forest's natural character. They also open up the stand to establish regeneration, provide more growing space, and reduce competition for light, water, and nutrients.

Uneven-aged management generally affects larger areas. Fewer trees per acre are harvested, and generally less than 25 percent of the stand is removed. Re-entry into the stands, however, occurs more frequently (generally every 20 to 30 years). Uneven-aged regeneration relies on natural seeding to establish the new stand.

Individual tree selection - Individual tree selection (ITS) removes individual trees (or small groups) from the stand, and new trees grow in their place. This method works best with shade tolerant species such as subalpine fir and Engelmann spruce. The blowdown risk is the least of all regeneration methods. Individual tree selection is the most costly method both in terms of Forest Service preparation and costs to the purchaser.

Group Selection - Group selection creates larger opening in the stand. The openings are not so large; however, that site protection from nearby trees is lost. The groups range in size from two acres to a few trees. Smaller groups favor more shade tolerant species such as spruce/fir mix, while larger openings will favor less shade tolerant species such as lodgepole pine. The perimeters of the groups are susceptible to blowdown. Group selection is less costly than individual tree selection, but more than other methods.

Other Treatments

Intermediate Harvests - These are generally called thinnings. They include any harvest not designed to regenerate the stand of timber. This includes both non-commercial and commercial thinning.

Timber Stand Improvement - Timber Stand Improvement (TSI) is generally non-commercial thinning of trees to meet density level objectives for stand health, growth, vigor, and other resource objectives such as wildlife hiding cover. Between 1986 and 2001, the Forest has thinned 7,445 acres.

Reforestation - Artificial reforestation is necessary due to some timber harvest activities and natural catastrophes, such as wildfire.

Fuelwood - Currently, the Forest supplies fuelwood for both individual and commercial use. Fuelwood is obtained throughout much of the Forest, and is available because of commercial vegetative treatments such as timber sales or natural mortality. Between 1986 and 2002 the Forest has sold an approximate average of 6,200 cords per year, 173% of what was projected for that time period (2002 monitoring report).

The following table shows the acres of commercial harvest treatments. The total treatment acreage shown in this table is 61,506 acres, or approximately 6% of the Forest. The actual acres receiving treatment is slightly smaller because some areas have been entered more than once to complete a multiple stage silvicultural treatment.

Table 3-160. Acres of past harvest treatments by decade between 1960s and 2000.

Silvicultural System	1960s	1970s	1980s	1990s	2000
Clearcut	9,683	6,199	4,139	1,892	7
Shelterwood: Prep Cut	255	8,939	10,003	519	
Shelterwood: Seed Cut		519	3,935	1,428	895
Shelterwood: Overstory Removal	399	1,418	1149	1,027	
Seed Tree	30	386	40	54	
Selection		1,081	949	92	
Commercial Thin		900	2,105	186	
Sanitation/Salvage		710	3,474	2,321	
Pre-commercial Thin	2,537	1,811	11,776	1,109	
Blowdown[29]			581	4,500[30]	
Acres CC + SW + ST + S + S/S[31]	10,367	19,252	23,652	7,333	902

The following table displays the acres of harvest activity by silvicultural system that has occurred on the forest since the 1985 Forest Plan was implemented.

Table 3-161. Comparison of 1985 planned and actual harvest activity by silvicultural system 1986-2001.

Silvicultural System	Projected from 1985 Plan 1986-2001	Actual Acres 1986-2001
Clearcut	17,771	3,302
Shelterwood	9,946	5,836
Uneven-aged Selection	1,684	151
Commercial Thinning	None	54
Catastrophic Salvage	None	2,519
Other	None	94
Total	29,401	11,956

Source: Bighorn National Forest 2001 Monitoring Report

[29] Several blowdown events totaling several hundred acres are not included in this database: Ranger Creek, Shell Creek, and Willett Creek.

[30] The 1991 Tongue Blowdown affected approximately 1500 acres over a 6 mile long area, and the 1993 blowdown affected an estimated 3000 acres across the Forest. The most concentrated area was in the Little Bighorn River geographic area.

[31] 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.

This table displays that only 41% of the projected harvest acres has been accomplished between 1986 and 2001. This is due to a variety of reasons including inconsistencies between projected harvests and Forest Plan standards and guidelines, appeals and litigation, and budget constraints.

Reforestation

Reforestation is the reestablishment of forest cover either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting) (Helms, 1998).

The implementing regulations for the National Forest Management Act (NFMA) states:

> "When trees are cut to achieve timber production objectives, the cutting shall be made in such a way as to assure that the technology and knowledge exists to adequately restock the lands within 5 years after final harvest. Research and experience shall be the basis for determining whether the harvest and regeneration practices planned can be expected to result in adequate restocking." Further "Five years after final harvest means five years after clearcutting, five years after overstory removal cut in seed tree cutting, or 5 years after selection cutting." (36 CFR 219.27)

Generally, harvests from suitable timber lands, described above, are used to achieve timber production objectives. Harvests from lands not suitable for timber production are not addressed above, however they are generally restocked except where permanent openings are created for wildlife, habitat improvement, vistas, recreation uses and similar practices (36 CFR 219.27). Natural disturbances, such as wildfire or blowdown may also create a reforestation need; however decisions to artificially reforest these areas are made on a site-specific basis. The Bighorn National Forest relies primarily on natural regeneration. Final harvest cuts on the Bighorn are generally successful utilizing natural regeneration following harvest. Where regeneration is not expected to occur naturally, planting has been the preferred method for artificial regeneration. Between 1986 and 2001, the Forest has planted 2,644 acres.

Timber Supply and Demand

Timber markets have changed dramatically in recent years, and especially since the Forest Plan was first approved. This is true at all scales -- international, national, regional, and local. A recent assessment of timber markets in Wyoming was prepared by Dr. Douglas Rideout and Dr. Hayley Hesseln (2000), and provides the basis for this section.

In decades past, each national forest typically had local timber purchasers. Timber was rarely sold to purchasers located beyond a few hours drive from the forest. These mills were very dependent upon timber coming from one or two national forests. Competition was limited to a few firms within this circle.

Today, timber purchasers are often regional firms that reach out 500 miles for timber that can come from federal, state, and private timberlands. Trends favor corporate ownership that can invest large sums to achieve very efficient mills using modern technologies. Lumber is then shipped to other parts of the United States, sometimes under exclusive contracts with wholesalers and retailers. This "new timber economy" in the Western U.S. is the product of many market forces, including industry consolidation, international trade agreements, reduced timber supplies from national forests, and generally smaller logs.

Currently, purchasers of Bighorn National Forest timber are primarily Wyoming Sawmills Inc. (WSI) with a mill in Sheridan WY, Cody Lumber out of Cody WY, RY Timber Inc. for their mill in Livingston MT, and L&L Sawmills Inc. with a mill near Buffalo WY. The mills process a variety of log sizes and species to produce a wide variety and grades of lumber products, each with their own specialty. Combined, these mills can process over 50 MMBF a year.

There are smaller mills located within the area that offer very specialized products. The collective capacity of these mills is less than 5 MMBF annually. For purposes of programmatic Forest planning, the larger mills dominate the demand for sawtimber products in the Bighorn area.

Supply to these mills has changed dramatically since the 1985 Forest Plan was implemented. Currently these mills receive approximately 75% of their logs from private lands, 15% from tribal, BLM and state lands, and 10% from Forest Service lands. When the 1985 Forest Plan was implemented, the ratio of private and Forest Service was reversed. It is uncertain whether this mix is sustainable in the long run.

Changes in the industry come more quickly today than in the past. Lumber prices, energy costs, international imports, and alternative supply sources all influence the share of timber supplies provided by a single landownership. Consequently, the future demand for timber from the Bighorn National Forest cannot be characterized by a simple projection of historic trends. It can be stated with certainty, however, that 1) current mill capacities far exceed the volume offered in any alternative and 2) if the Forest offers timber with profitable log size and species, it will be sold and harvested.

Timber prices can change dramatically over time. The demand for sawtimber comes from the demand for lumber, and the demand for lumber is closely related to lumber prices. Higher lumber prices signal increased demand for lumber and sawtimber.

Size Class Distribution

The following table displays the size class distribution for the primary commercial timber species on the tentatively suited lands (340,589 acres).

The size classes reflect the predominant size of trees in that site or stand of the forest. Size classes are:

- E = Established size class for trees from 0 to 0.9 inches in diameter at breast height (dbh)
- S = Small size class for trees from 1.0 to 4.9 inches (dbh)
- M = Medium size class for trees from 4.9 to 8.9 inches (dbh)
- L = Large size class for trees from 9.0 to 15.9 inches in (dbh)
- V = Very Large size class for trees greater than 16.0 9 inches (dbh)

As shown on the table below, there is currently a large portion of suitable acres in the medium size classes. It should be noted that lodgepole pine rarely attains the very large diameter class due to species characteristics. From a timber production standpoint, a more even distribution of size classes is desirable to promote even flows of better quality timber, and to reduce the risk from insect and disease outbreaks generally associated with older trees.

Table 3-162. Age and size class distribution of commercial species on the Bighorn National Forest.

Cover type	Non-stocked	Established	Small	Medium	Large	Very Large
Lodgepole Pine	3%	3%	12%	57%	25%	0%
211,663	5,908	6,332	25,358	119,814	53,364	887
Spruce/fir	4%	1%	6%	43%	44%	6%
99,165	3,938	1,059	5,595	42,867	43,615	6,029
Douglas-fir	0%	0%	7%	49%	41%	2%
25,779		107	1,918	12,623	10,559	572
Total	3%	2%	10%	52%	32%	2%
336,607	9,846	7,498	32,871	175,304	107,538	7,488

ENVIRONMENTAL CONSEQUENCES

General Effects

Suitability

Identification of lands suitable for timber production is one of the key decisions made in a Forest Plan. The process to determine lands suitable for timber production is found in 36 CFR 219.14, and FSH 2409.13. It is described in detail in Appendix B of the DEIS.

Lands identified as tentatively suitable for timber production are common to all alternatives based on physical characteristics of the land as identified using current inventory and data layers in a GIS format. These factors include various physical and administrative factors such as slopes, soil characteristics, low productivity, administrative withdraws (wilderness), and site specific analysis where applicable.

Lands identified as suitable for timber production varies by alternative and are based on management area prescriptions, multiple use objectives, and economic efficiency.

Alternative E has the highest level of suitable acres followed by A and then Alternatives D, B, and C respectively.

Only management areas 5.11, 5.12, 5.13, 5.4, and 5.5 contain suited lands, available for timber production objectives, the total lands suitable for timber production are displayed in the following table.

Table 3-163. Tentatively suited acres and suited acres by alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
Tentatively Suited for timber production and Common to all Alternatives	340,589	340,589	340,589	340,589	340,589
Suitable for timber production	271,895	124,521	62,093	184,606	305,535

Source: GIS Data

Suitable Species

Only lodgepole pine, Engelmann spruce, and Douglas-fir are considered suited for timber production. Most of the suited acres are in lodgepole and spruce. The table below displays the suited lands by cover type.

Table 3-164. Suited land by cover type by alternative.

Percentage suited land	Alt A	Alt B	Alt C	Alt D	Alt E
Lodgepole pine	63%	62%	64%	59%	64%
Engelmann spruce	30%	33%	35%	34%	29%
Douglas fir	6%	4%	1%	8%	7%

Source: GIS Data

Past Management Investments Forgone

The Forest has invested in managing forested lands, some for over 100 years. There are alternatives that remove some of these lands from the suited base, even though they have been harvested in the past 40 years. The relative ranking of alternatives that remove the most acres of previously harvested, and managed lands from the classification of suited for timber production are C, B, D, and A, with E removing hardly any acres.

Suited and Scheduled Acres

Acres identified as suitable for timber production are processed using the *Woodstock*© timber modeling suite. Based on modeling constraints, and growth and yield information, the model schedules acres of appropriate harvest and uses these acres and yield tables for estimating harvest levels. Based on the constraints, the acres scheduled for harvest are reduced from the initial suitable acres input into the model. Not all suited acres are scheduled for harvest in this planning horizon. This may be due to economic inefficiencies (areas where estimated road costs are too high in comparison to the value of the timber), constraints on type and intensity of harvests in areas of concern, and certain lands may not have reached commercial size in this planning horizon.

The following table displays suitable and scheduled acres by management prescription for each alternative over the 150-year period modeled by *Woodstock* ©. Alternatives E, A, and D have the highest levels of suitable and scheduled timber, while Alternatives B and C have lower levels.

Table 3-165. Total suitable and scheduled for the 150 year period modeled

	Alt A	Alt B	Alt C	Alt D	Alt E
Suited acres	271,895	124,521	62,093	184,606	305,535
Scheduled acres	231,290	111,677	54,222	159,224	238,972

Source: Woodstock © model

Allowable Sale Quantity (ASQ) and Total Sale Program (TSP)

"ASQ is the quantity of timber that may be sold from the area of suitable land covered by the forest plan for a time period specified by the plan. This quantity is usually expressed on an annual basis as the average annual allowable sale quantity" (36 CFR 219.3). The ASQ is expressed in cubic feet, either hundred cubic feet (CCF), or thousand cubic feet (MCF). The Forest offers timber sale volume in cubic measurement units per current manual direction (FSM 2430.3). Because many people still relate to Scribner board feet, these equivalent values will be displayed where appropriate.

The ASQ for each alternative was formulated by considering the lands suitable for timber production for each alternative, other multiple-use objectives, and the management requirements in the NFMA regulations. A discussion of the analysis process and use of model constraints is found in Appendix B of the DEIS.

The ASQ is considered a ceiling for harvest from the lands suitable for timber production, and certain conditions may arise where standards and guidelines may limit what volume is actually available during site-specific project implementation. Examples are water quality guidelines or wildlife and heritage resources protection measures. Where possible, the effect of these standards and guidelines has been taken into account in the calculation of the ASQ. See Appendix B for details of modeling constraints.

Products in the ASQ volume include traditional sawlogs and products other than logs (POL). POL includes posts, poles, chips, firewood, etc and contains no Scribner board foot measure, only cubic foot measure. POL does contribute towards the ASQ if removed from suited lands.

The table below displays the amount of ASQ for each alternative. ASQ is for the full implementation level. Alternative E, A, and D provide the highest levels of ASQ.

In all alternatives only management area prescriptions 5.11, 5.12, 5.13, 5.4, and 5.5 contain suited acres that contribute towards the ASQ. Timber harvest may be allowed on unsuited lands, and in other management area prescriptions, but only to meet the resource objectives compatible with that management area. Examples of such projects could include, wildlife habitat improvement in management area 3.5 (plant and wildlife habitat management), or fuels treatments around a recreation site in a 4.3 (dispersed recreation) area. Harvest in these areas is called Other Vegetation Management (OVM) and would not contribute towards the ASQ but would contribute towards the total sale program (TSP) level.

Salvage of dead or damaged timber may be harvested from both the suitable and unsuitable land base (depending on management area), but only counts towards the ASQ if harvested from the suited land base. The volume removed from lands not suited for timber production (OVM) does not contribute to the ASQ but does contribute towards the total sale program (TSP) level but is not scheduled. Calculation of the other vegetation management is based on a variety of assumptions that are described in

Appendix B. Historically, other than salvage, OVM volume is fairly minor, as shown in the table below.

The total harvest contributing to ASQ and volume removed for other vegetation management is included in the Total Sale Program (TSP). The following table shows the anticipated average TSP for the first 10 years of plan implementation. No attempt was made to estimate the amount or type of salvage that may occur from natural events such as wildfire, blowdown, insects and disease.

Table 3-166. Average total sale program quantity per decade.

	1985 Plan (pg III-13)	No Action[32]	Alt A	Alt B	Alt C	Alt D	Alt E
Sawtimber ASQ MCF/year	3,800	900	2,723	1,387	640	1,774	2,956
POL ASQ MCF/year	100	-	633	277	142	360	585
Total ASQ MCF/year	**3,900**	**900**	**3,356**	**1,664**	**782**	**2,134**	**3,541**
Equivalent MMBF/year	15.1	4.5	11.0	5.6	2.6	7.2	12.0
Firewood MCF/Year	370	600	280	200	200	250	280
OVM MCF/year		800	173	345	86	173	518
Equivalent OVM MMBF/year		4.00	0.68	1.24	0.28	0.61	1.81
TSP MCF/year	**4,270**	**2,300**	**3,809**	**2,209**	**1,068**	**2,557**	**4,339**
Equivalent TSP MMBF/year	16.5	8.5	12.5	7.4	3.6	8.6	14.7

Source: Woodstock © reports and other vegetation management assumptions.

In addition, other factors including budgets and changes in executive and congressional direction or natural events like wind, wildfires, insects, and disease could cause actual harvest levels to be different than projected for the suited lands. For example, the Forest has not been budgeted at levels to fully implement levels projected in Alternatives A and E for over a decade. Budget reorganization and personnel adjustments from other programs such as recreation or roads would be required before the harvest levels could be increased. At current planned funding levels and distribution, the total ASQ and TSP volume could not be offered under Alternatives A, E, and D.

[32] Not an ASQ, but administrative direction from Regional Forester dated December 17, 1996.

Silvicultural Systems

A variety of silvicultural systems are available for the management of forest resources. The *Woodstock* © model produces an estimate of acreage treated by treatment types used in each alternative. The following table displays estimated treatment types by alternative. It should be noted that these are projection modeled estimates only. Site-specific project analyses will determine actual silvicultural prescriptions based on detailed, on the ground conditions and project objectives. A variety of silvicultural tools are available in all alternatives, as described above.

Table 3-167. Projected average annual harvest acres by treatment types contributing to ASQ for decades 1-5.

Treatment Type	Alt A	Alt B	Alt C	Alt D	Alt E
Lodgepole pine Clearcut	307	498	67	736	740
Lodgepole pine Shelterwood	1,561	0	406	0	74
Lodgepole pine Uneven-aged selection	0	230	6	0	1,293
Spruce/fir Shelterwood	780	354	130	264	794
Spruce/fir Uneven-aged selection	0	0	0	0	127
Douglas Fir Shelterwood	197	49	4	56	273
Douglas Fir Uneven-aged selection	0	0	0	0	44
Total Acres	2,845	1,131	613	1,056	3,345

Source: Woodstock © model reports

Even aged silvicultural methods modeled here include clearcuts and shelterwood harvests. Uneven-aged harvests include group selection cuts and individual tree selection cuts. Lodgepole pine was modeled using clearcut, shelterwood and group selection (at the stand level, these harvests are small pockets of even aged trees with all ages represented over the larger area). Spruce/fir and Douglas-fir were modeled with shelterwood and individual tree selection (clearcutting these cover types is not a standard practice for timber production objectives).

Based on the constraints, goals and objectives used on each alternatives suited acres, the model projected that Alternatives E and D would create the most early structural stages through clearcutting followed by B and A. The mix of even to un-even aged regeneration methods is one of the indicators to achieve the diversity goals for the Draft Revised Plan. All alternatives project a majority of even-aged management, with Alternative A, C, and D projecting even-aged management almost exclusively.

Actual treatment plans will be based on site-specific goals and objectives and other site specific project level information. Previous forest plans have projected harvests, and actual harvest level were disclosed in monitoring reports. The chart below shows how the projected silvicultural methods compare with monitoring results. It is anticipated that in the implementation of the alternatives with almost exclusive use of even aged management, there would be actually be more uneven aged treatments, especially in the spruce cover types than the model scheduled in the first five decades. However, all of the alternatives schedule a mix of treatments within the range of past activities.

Table 3-168. Projected and monitored silvicultural methods

	Silvicultural Methods, Projected and Monitored				
	Clearcut	Shelterwood	Uneven-aged Selection	Commercial Thinning	Catastrophic Salvage
1975 TM Plan	11%	82%	0%	7%	0%
1985 Forest Plan	56%	39%	5%	0%	0%
2002 Monitoring report	28%	49%	1%	1%	21%
DEIS Alternative A	11%	89%	0%	0%	0%
DEIS Alternative B	44%	36%	20%	0%	0%
DEIS Alternative C	11%	88%	1%	0%	0%
DEIS Alternative D	70%	30%	0%	0%	0%
DEIS Alternative E	22%	34%	44%	0%	0%

Non-commercial Treatments on Suited Lands

Each silvicultural regime modeled includes not only the commercial acres treated as described above, but also projects non-commercial treatments to achieve the vegetative goals and commercial outputs. These non-commercial treatments include: Timber Stand Improvement (TSI) that includes stand thinning, release and weeding for stocking control; site preparation for natural or artificial regeneration such as broadcast burning; and planting both fill-in and full planting after harvests. The table below summarizes the average decadal acres of each of these treatments projected for the first five decades from the *Woodstock* © Model. It should be noted that the model does not include any of the current backlog of TSI or recent decisions for TSI, which total approximately 18,000 acres, which would be scheduled throughout the planning period, adding about 1,000 acres a year, as funding became available. Projections for thinning for fuels treatment are included in the other vegetation management category, discussed in the vegetation section.

Table 3-169. Projected average annual non-commercial treatments decades 1-5.

Treatment Type	Alt A	Alt B	Alt C	Alt D	Alt E
TSI	280	364	58	477	615

Treatment Type	Alt A	Alt B	Alt C	Alt D	Alt E
Site Preparation	657	509	142	710	837
Planting	534	321	115	416	606

Source: Woodstock © *Model reports*

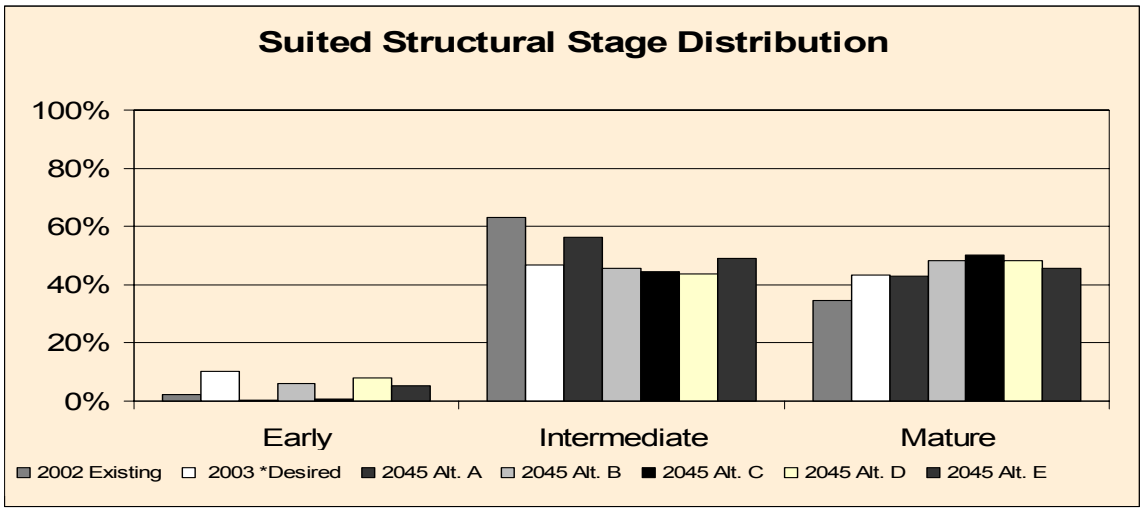
Structural Stage Distribution on Suited Lands

Size and age class distribution of timber species, on lands suitable for timber production, is a concern for maintaining healthy growing conditions and an even flow of goods and services. A condition with more timber in older age classes than can be harvested can lead to loss of volume expectations due to slow growth and risk of fire and insect and disease infestations.

Habitat structural stage is an indicator of both size, and density, which can be used as a surrogate for age class. The following figure summarizes the current distribution of structural stages on suitable lands for each alternative, the desirable distribution, and the estimated conditions after the fifth decade to show the trends in stand conditions by alternative. While not a direct correlation with age, size class provides a close approximation. The desired distribution comes from DEIS Appendix H, and the figures below can be used for comparison.

Each alternative has a different total number of suited acres, as discussed above. Each alternative reacts differently to the models goals and constraints, based on management standards and guidelines, and how they are applied to the suited lands of each alternative. Alternatives B and D which schedule the more acres, and project more clearcut acres come closer towards the desired balanced distribution of age classes, and providing early habitat structural stages for their suited lands.

Figure 3-18. Structural stage distribution on suitable lands, by cover type and alternative.



Changes Made after Analysis

There were changes made to goals, objectives, standards and guidelines after the growth and yield model was designed. Because they came too late to be incorporated into the solutions, they are displayed and summarized here. Revisions to S&Gs that may affect the timber resource include:

Forestwide

- The 100-300 foot riparian corridor is now considered eligible for timber suitability where previously it was not. This will increase the suited acres of each alternative.
- The Scenic Integrity Objective (SIO) of moderate for the middle ground of cultural landscapes was removed and replaced with individual landscape plans (to be completed later) determining the protection measures. This will reduce the number of acres where the moderate SIO constraint will be applied.

Management area

- MA 5.13

  Scenic Integrity Objective (SIO) is low, where it previously was moderate along concern level 1 and 2 roads and areas of concern. A SIO of moderate would apply along eight major routes of concern. This reduces the number of acres with the moderate SIO constraint applied.
- MA 5.12

  Isolated islands of forested lands 250 acres or less are now eligible for timber suitability, where previously they were not. This will increase the total number of suited acres in each alternative.
- MA 5.4

  Removes from eligibility the 100-300 foot riparian corridor for timber suitability. This reinstates the corridor and reduces the suited acres, but not above what they were previously.

  Removes from eligibility the isolated islands of forested lands 250 acres or less. This reduces the suited acres in each alternative.

The above changed resulted in a revised suitable lands analysis, the results of the latest analysis and the one used for modeling are displayed in the table below.

Table 3-170. Change in lands suitable for timber production made after model analysis

	Alt A	Alt B	Alt C	Alt D	Alt E
Updated Suited Acres	271,895	124,521	62,093	184,606	305,535
Suited Acres used in Model	250,470	117207	60412.8	165304	294930
Net Change	+21,426	+7,314	+1,680	+19,302	+10,605

As a result of the increase in suited acres to all alternatives, it could be expected that the final ASQ for all alternative would increase slightly.

Direct and Indirect Effects

Effects on Fire and Fuels Management: Under Alternatives C, and B, natural processes are emphasized and there is increased acceptance of wildfire in these areas. Depending largely on climatic (drought and wind events) and fuel conditions, wildfires will damage or kill trees on a variety of scales. In those alternatives where natural processes dominate, wildfire may be a dominant force of habitat change, as there would be increased acceptance of fire on these lands. Although salvage operations are allowed in some of the natural processes areas, it would be done to meet the resource objectives of those management areas and is not considered a reliable source of additional wood fiber. Under Alternatives E, A, and D, less of the forested area would be managed under natural processes, and there would be more acres actively managed for protection from wildfire with less acceptance of fire use in these management areas. Reduced fuel levels, road systems allowing easier access and fire management response would all lead to smaller wildfires. Additional access may increase the risk from human caused fires, though acreages burnt should be lower.

Effects on Insect and Disease Management: Insects and disease can affect the production of timber by killing and damaging trees. Alternatives C and B emphasize natural processes and there is increased acceptance for insect and disease damage to the timber resource outside the suited lands. This could result in damaging or killing trees on a variety of scales, depending largely on factors such as populations, stand conditions, and natural events such as wind and climate. In these alternatives there would be large areas where natural processes dominate, including insects and disease populations. Because at epidemic levels insects and disease are disrespectful to administrative boundaries there would be increased risk of damage and death to adjacent lands actively managed from these natural processes areas. Although salvage operations are allowed in some of the natural processes areas, it would be done to meet the resource objectives of those management areas and is not considered a reliable source of additional wood fiber. Under Alternatives E, A, and D, less of the forested area would be managed under natural processes and it is projected that there would be more active suppression and pretreatment of the actively managed areas. A large infestation could momentarily increase timber supplies through salvage sales, however future supply may decrease.

Effects from Lynx Amendment Standards and Guidelines: The Forest Service is in the process of amending Land and Resource Management Plans (LRMPs) for national forests in Wyoming through a separate NEPA process conducted at a multi-regional level to provide conservation and recovery of the Canada lynx, a threatened species. A draft of the amendment has been released in 2004.

The purpose and need for the proposed amendment is to establish management direction that conserves and promotes recovery of the Canada lynx. These standards and guidelines have the potential to affect timber management operations. These standards and guidelines are attached to the forest-wide list. The Canada lynx draft guidelines were included in the *Woodstock* © timber model. Given the relatively small amount of

lands suitable for timber production under all alternatives, the restrictions on harvesting in Lynx habitat are not thought to significantly affect forest-wide timber outputs.

The lynx vegetation standard that requires inventory before any salvage of portions of blowdown and insect infestation may increase the size of insect infestations due to the delay related to the required inventory. A potential result could be the loss of trees and increases in fuel loads.

An effect from the lynx vegetation standard that delays precommercial thinning within lynx habitat has the potential to reduce: wildlife habitat, old growth conditions and mature open stands. In addition, there may be more stagnated pole stands with lower wood fiber yields, and increased risk for insect damage if stands are not treated.

Effects from the lynx rangeland standard that requires protection of regeneration in natural or created openings could increase the regeneration success in these areas.

Cumulative Effects

The cumulative effects table at the beginning of this chapter includes the list of past, present and reasonably foreseeable future activities that were considered with regard to cumulative effects to the special forest/rangeland resource. The next 15 years are considered the time span for cumulative effects.

Timber harvest in the Bighorn working circle includes U.S. Forest Service, BLM, tribal, private and state lands. Estimates of harvest from these sources are listed in the table at the beginning of this chapter. As harvest from national forests has fallen other ownership lands have seen an increase, and it is not known how long they can sustain the current levels of harvest.

Given the overall size of the Forest, and the relatively small amounts of treatment under all alternatives, timber harvests from suited lands will only have a slight change in the age/size class distribution of the forested lands. The major agent of change to the forested lands will continue to be the growth and senescence, with disturbance events such as wildfire, wind, insects, and disease as the major source of deviation from that course.

Communities

Introduction

The human environment includes the biological and physical environment and people's relationship to it. The relationship between the Bighorn National Forest and the local lifestyles and economies is interdependent and complex. Year-round residents and nonresidents utilize Forest resources to make a living, find solace, and experience a good deal of their social life. Residents of the four-county Bighorn National Forest area have a close relationship with the "mountain." This section focuses primarily on the community-National Forest relationship at the county scale. Affected counties for the purposes of this Environmental Impact Statement are Big Horn, Johnson, Sheridan, and Washakie Counties, Wyoming. The following county locations map shows the counties discussed in this section.

This affected environment section of the draft EIS is a short summary of the social and economic assessments, which are a more detailed description of each county's demographic and economic makeup, and of the relationships between the counties and the National Forest. These documents are on file at the Bighorn National Forest Supervisor's Office.

This portion of the DEIS is separated into two sections and five subsections: the first section, **Communities of Place**, contains the subsections *Demographics; Economics,* which includes a section on Financial and Economic Efficiency*; and Local Governments*. The second section, **Communities of Interest**, contains the subsection *Stakeholders*. The analysis in each subsection is further subdivided into Affected Environment and Environmental Consequences discussions to mirror the organization in the rest of the DEIS.

Legal and Administrative Framework

The **National Environmental Policy Act (NEPA)** requires that consequences to the human environment be analyzed and disclosed. The extent to which these environmental factors are analyzed and discussed is related to the nature of public comments received during the public involvement process, from scoping through preparation of the DEIS.

The **National Forest Management Act** requires the examination of local economic impacts as well as economic cost-efficiency considerations when preparing or revising a forest plan.

Executive Order 12898 requires that planning alternatives be assessed to determine whether they would disproportionately affect minority and low-income populations. The concept is called "environmental justice."

The **Secure Rural Schools and Community Self-determination Act of 2000** specifies how states and counties will be compensated for impacts associated with visitors to National Forest System lands.

The **Payments in Lieu of Taxes Act of 1976** authorizes compensation to counties in lieu of property taxes that cannot be levied against federal lands within their jurisdiction.

Key Indicators

- Employment
- Income
- Local government fiscal impacts
- Present Net Value

Communities of Place Demographics

AFFECTED ENVIRONMENT

Geographic Location

The following map shows the location of counties and selected communities surrounding the Forest. The Bighorn National Forest is located in north central Wyoming.

Population Patterns – Trends in Population

The following figure shows the county populations from 1890 to 2000. In contrast with most national trends, Big Horn and Washakie counties have had population declines over different periods. Sheridan county shows an increase in population in the 1980s, which was attributable to the 'energy boom' in the late 1970s and early 1980s. This boom 'busted' in the later half of the 1980s as energy prices declined and Big Horn Coal shut down production. The bust resulted in lower housing prices and a decline in the population. Sheridan's population growth trend picked up again in the early to mid-1990s, which shows in the 2000 population estimate. This growth period was largely attributable to a combination of Sheridan's being 'discovered' as a retirement community, the 'quality of life', and low cost of living, especially relating to no income tax. There has been a large

property value increase over this period. Most people moving in are retirees or have brought their jobs with them, either as entrepreneurs or in small businesses.

Map 3-3. Location map of the Bighorn National Forest and surrounding communities.

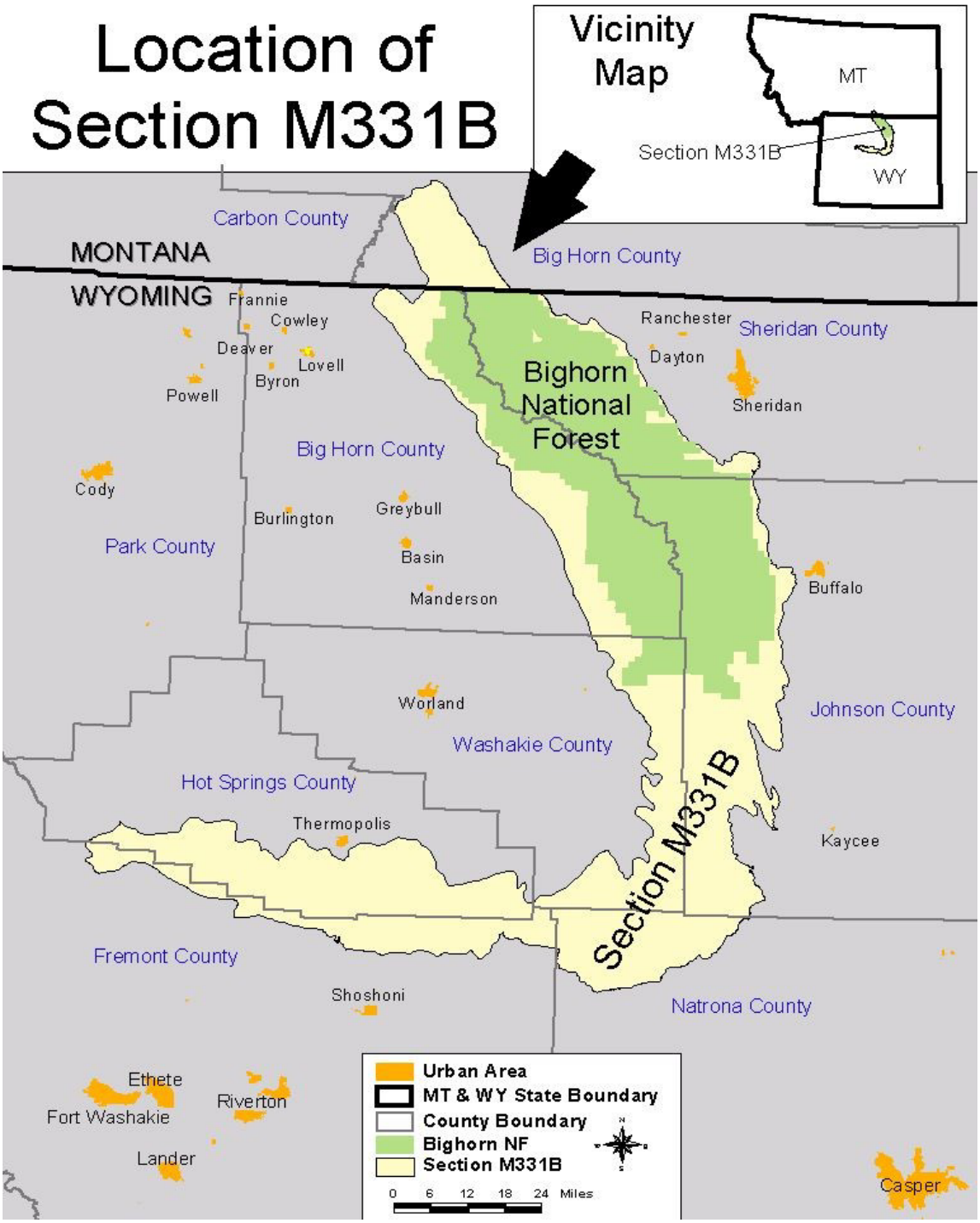


Figure 3-19. Population of Bighorn National Forest counties.

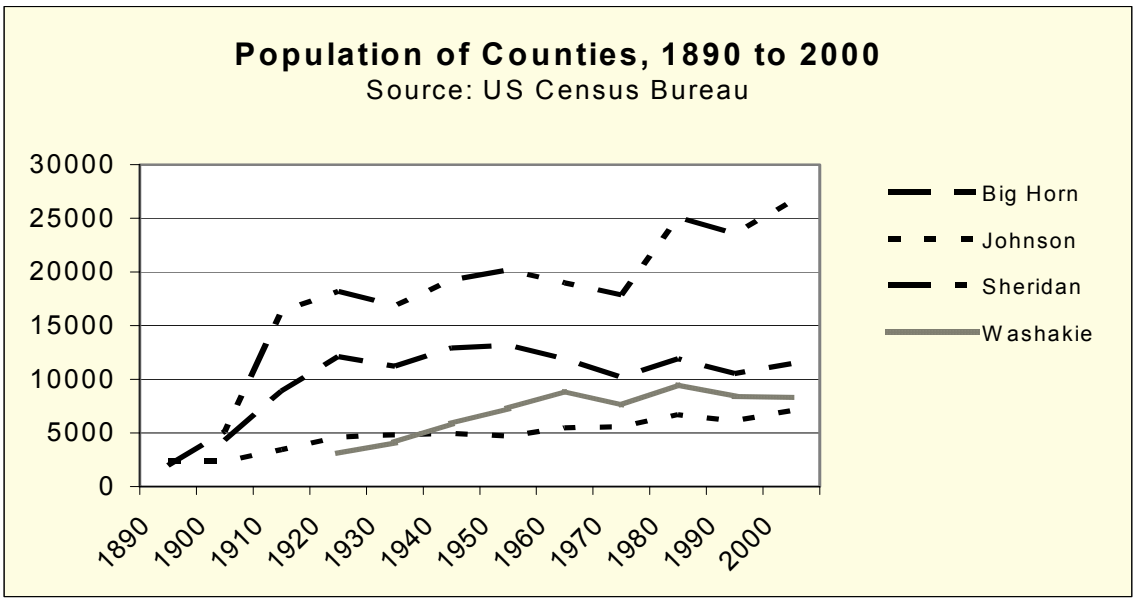


Table 3-171. Counties experiencing a long-term decline in population

County	Year	Population	Percent Decline
Big Horn	1920	12,105	5%
	2000	11,461	
Washakie	1960	8,883	7%
	2000	8,289	

Some of the smaller communities in the four-county area, including Clearmont, Tensleep, and Manderson, have had significant populations declines over the past few decades, as shown in the following table. People in these communities are concerned about the viability of their schools, which are an important factor in the "identity" and independence of a community.

Table 3-172. Population for selected communities by counties, 1950 to 2000.

County and City	2000	1990	1980	1970	1960	1950
Big Horn County						
Basin	1,238	1,180	1,349	1,145	1,319	1,220
Burlington	250	184				
Byron	557	470	633	397	417	350
Cowley	560	477	455	366	459	463

County and City	2000	1990	1980	1970	1960	1950
Deaver	177	199	178	112	121	118
Frannie	209	148	138	139	171	
Greybull	1,815	1,789	2,277	1,953	2,286	2,262
Lovell	2,281	2,131	2,447	2,371	2,451	2,508
Manderson	104	83	174	117	167	107
Johnson County						
Buffalo	3,900	3,302	3,799	3,394	2,907	2,674
Kaycee	249	256	271	272	284	211
Sheridan County						
Clearmont	115	119	191	141	154	225
Dayton	678	565	701	396	333	316
Ranchester	701	676	655	208	235	251
Sheridan	15,804	13,900	15,146	10,856	11,651	11,500
Washakie County						
Ten Sleep	304	311	407	320	314	289
Worland	5,250	5,742	6,391	5,055	5,806	4,202

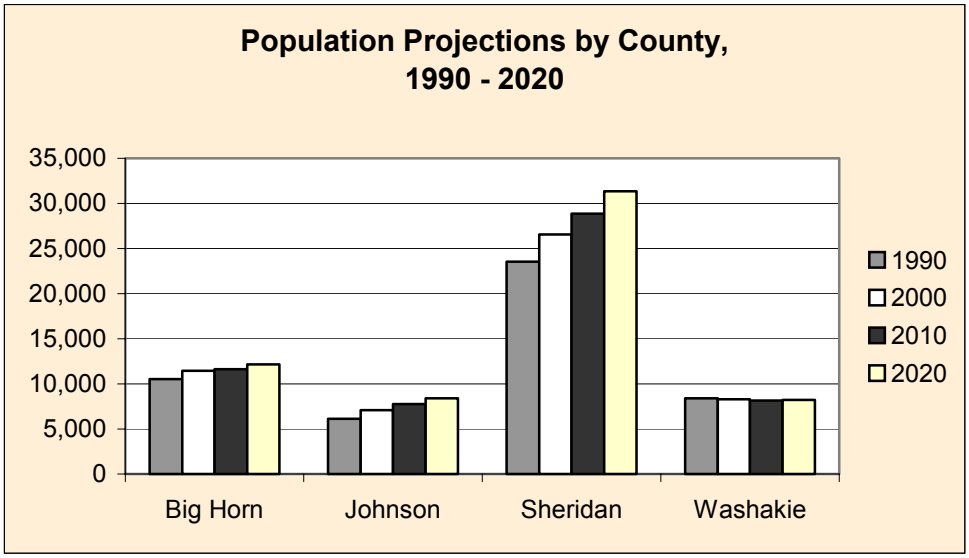
Source: Wyoming Department of A & I, Division of Economic Analysis

On the other hand, other communities have been showing growth trends. Data in the project record, based upon projected population growth estimates made by the University of Colorado's Center for the American West, show that the areas around Sheridan and Buffalo are forecast to see "urban sprawl" over the next several decades as people move to the area and build homes and ranchettes in what previously had been agricultural/ranch land. Perhaps the most significant impact of sprawl from an ecosystem perspective is the amount of habitat and open space being turned into an urban setting. One example of a habitat impact is that the elk populations summer on the Bighorn National Forest and spend their winters in the adjacent basins. Increasing urban sprawl will decrease the amount of available habitat and forage; western Wyoming elk herds are already fed in approximately 10 locations due to fact that subdivisions occupy their historic winter range. This conflict between human and wildlife "habitats" is felt by other species, such as black bear and mountain lion. Another impact from the increase in the amount of urban sprawl is the decrease in the amount of open space and low populations that current residents prize as a quality of life indicator.

The following figure shows that most counties, with the exception of Washakie, are expected to grow in population over the next 20 years. Future population levels will be affected by many local and national social and economic events. An example of the precarious nature of population forecasting is evidenced in the 1985 Bighorn Forest Plan EIS, where Sheridan County was expected to have a population of 36,573 by 2000, which overestimated population growth by 10,000. This data is still important,

however, because it is important to think about how our actions may affect these trends, and it is based on the best information available.

Figure 3-20 Population projections by county from 1920 to 2020.

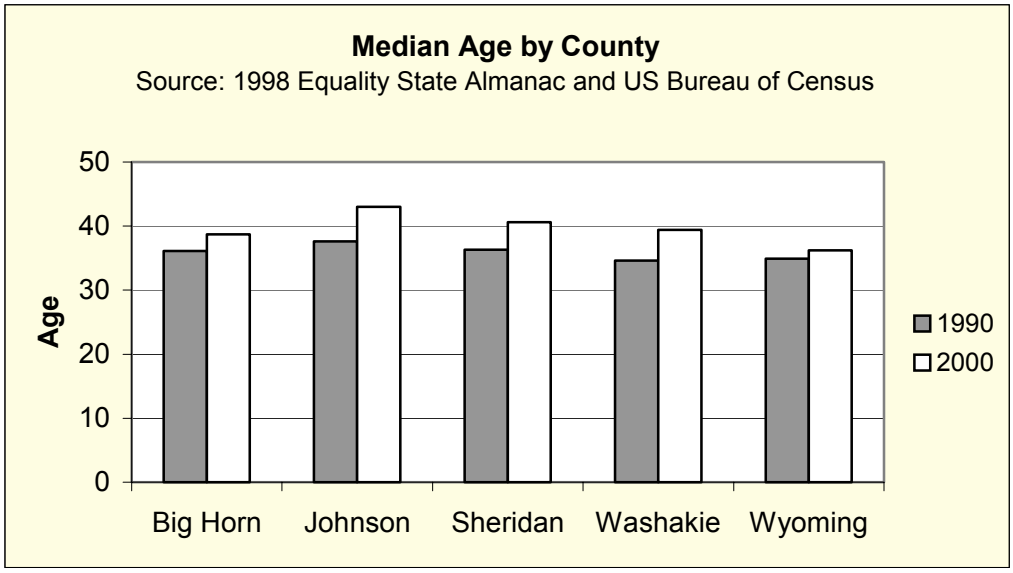


Source: Woods and Poole Economics, 2003 State Profile for Wyoming

Data shows that the population of the four-county area is old and rapidly getting older. The following figure shows that the median age of each county increased from 2.6 (Big Horn) to 5.5 (Johnson) years in the decade. This compares to a statewide median age increase of 3.3 years, and a national median age increase over the decade of 2.4 years. The United States median age change from 1990 to 2000 was 32.9 years to 35.3 years.

The aging of Wyoming's population is likely to continue into the future. According to Dr. Steven Maier, President of the Northern Wyoming Community College District, Wyoming is expected to be the only state in the United States that will see a decline in the number of high school graduates over the next two decades. This is likely due to the fact that there are relatively few good paying, entry level jobs that would keep young people and families in Wyoming. This is evidenced from increasing prominence of service sector jobs, as opposed to entry level professional and manufacturing sector jobs, which will be discussed in more detail in the economic section the existing condition assessment. This is also evidenced by anecdotal information collected in Wyoming Rural Development Council sponsored community assessments in communities around the National Forest, where this is a commonly held sentiment by area residents.

Figure 3-21. Median age by county, 1990 and 2000.



One of the implications of an aging population upon the Bighorn National Forest is likely to be different recreation demands. Activities such as driving for pleasure and the use of developed campgrounds are likely to increase, while the relative demand for more strenuous activities, such as mountain climbing or backpacking, may decrease.

Environmental Justice

A specific consideration of equity and fairness in resource decision-making is encompassed in the issues of environmental justice and civil rights. As required by Executive Order 12898, all federal actions must consider potentially disproportionate effects on minority or low-income communities. Principles for considering environmental justice are outlined in Environmental Justice Guidance under the National environmental Policy Act (Council on Environmental Quality 1997). Those principles are recognized and have been considered in this analysis.

The following figure provides demographic statistics for identifying potential communities of concern. Big Horn and Washakie counties have a higher percentage of Hispanic people than does the state of Wyoming as a whole. This reflects historic settlement patterns and the farming industry in the Big Horn basin.

Table 3-173. Population by ethnicity, 2000 census.

County	White	Hispanic	American Indian	Black	Other
Big Horn	87.8%	6.2%	1.4%	<1%	4.4%
Johnson	94.8%	2.1%	1.5%	<1%	1.4%
Sheridan	93.4%	2.4%	1.9%	<1%	2.0%
Washakie	78.3%	11.5%	1.6%	<1%	8.3%
Wyoming	85.5%	6.4%	3.0%	1%	4.1%

Big Horn and Johnson counties had large decreases in the family poverty rates between 1990 and 2000, while Big Horn and Washakie counties had the highest percentage of families below the poverty level than the other counties (see following table).

Table 3-174 Percent of families below poverty level compared with population changes.

County	Poverty Level 1990	Poverty Level 2000	Percent Change 1990-2000	Population 1990	Population 2000	Percent Change 1990-2000
Big Horn	16.4%	14.1%	-14.0%	10,525	11,461	8.9%
Johnson	12.9%	10.1%	-21.7%	6,145	7,075	15.1%
Sheridan	10.4%	10.7%	2.9%	23,562	26,560	12.7%
Washakie	11.2%	14.1%	25.9%	8,388	8,289	-1.2%
Wyoming	11.9%	11.4%	-4.2%	453,588	493,782	8.9%

Source: U.S. Census of Population and Housing, 2000

Land Use

The following figures show the landownership patterns in the four counties and the county acres on the Bighorn National Forest, respectively. Only about 6% of Big Horn County is in private ownership. In contrast, over 60% of Sheridan and Johnson counties are in private ownership.

Figure 3-22. Percent of landownership by county.

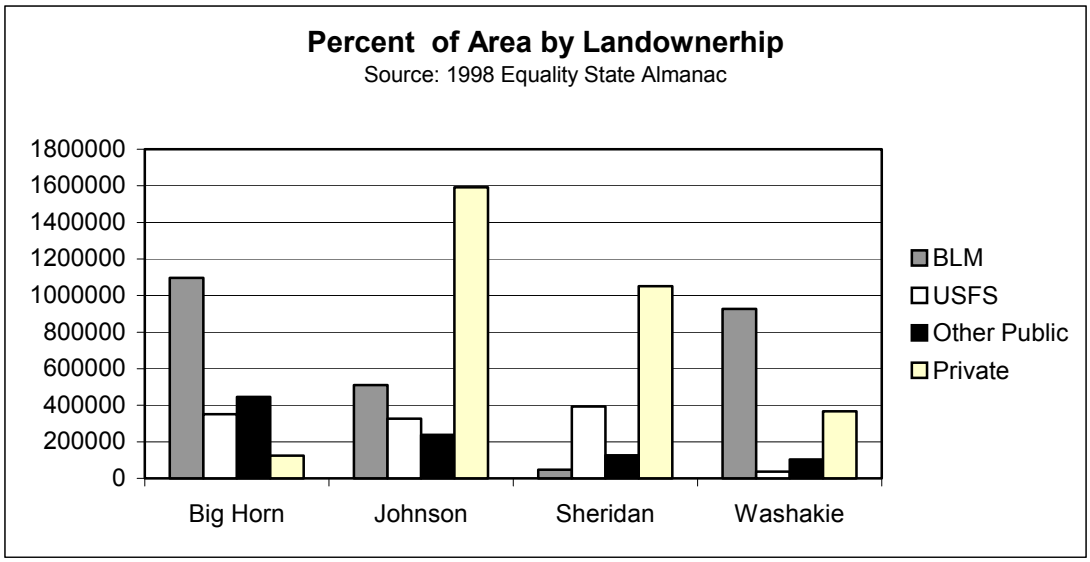
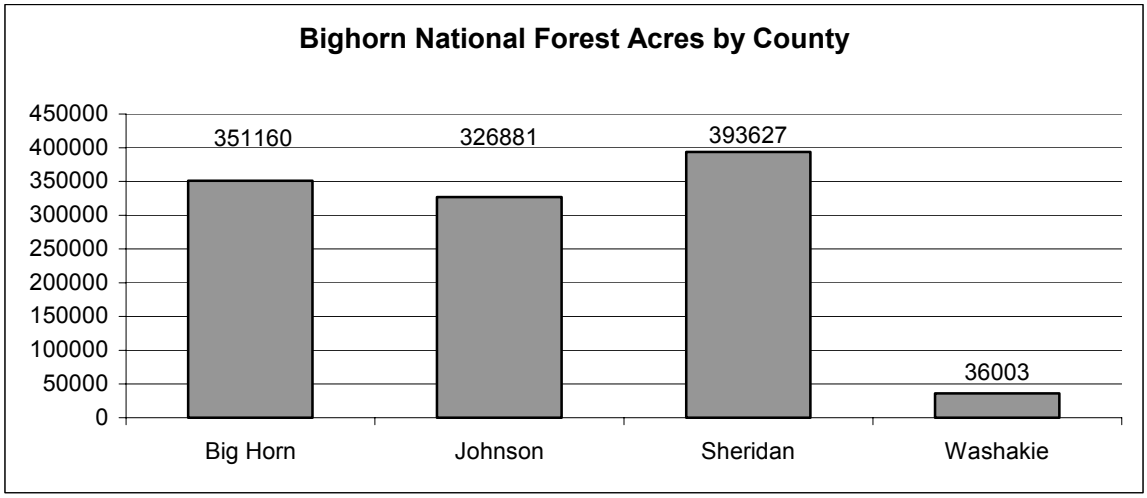


Figure 3-23. Bighorn National Forest system lands by county.



Human History, Customs, and Culture

Knowing the history and culture of an area can often provide valuable context for understanding communities and how current or future events may shape their lives. The following section is a brief historical and cultural profile of the planning area.

People have lived in the area for about as long as people have lived in North America. At the Colby site south of Worland, Dr. George Frison of the University of Wyoming found a Clovis point that indicates human habitation dating back about 10,000 years.

In the 1700s, several American Indian tribes, including the Crow, Shoshone, and Snakes, lived in the Powder River and Bighorn Basins. By 1812, the Crow were the dominant culture using the area (Murray, 1980). Within a few decades, the Powder River Basin had become part of the country dominated by the Sioux and Northern Cheyenne. Presently, several tribes, including the Crow, Northern Cheyenne, Arapaho, Shoshone and Sioux, use the Bighorn National Forest to gather tepee poles and other plants, to hold vision quests and other ceremonies, and to use the Medicine Wheel. Many spots on the National Forest are important to American Indian people, who consider their uses part of multiple use, but make a distinction between their uses and others. The difference is the spiritual dimension they assign to certain activities on National Forest System land.

The year 1802 brought the first European men of specific record to within close-up view of the Big Horn Mountains, and the first recorded crossing of the Bighorns came a decade later, when a party with the American Fur Company crossed over near Powder River Pass. While the fur trappers spent time traveling through the Big Horn Mountain country, "…there is not much indication of the kind of intensive trapping activity we find in some other mountain regions." (Murray, 1980)

Likewise, mining in the Big Horn Mountains itself was never an important activity. In his review of the Big Horn Mountains, N.H. Darton concluded that the mineral prospects proved disappointing, and there was little chance that the area would become important on account of its mineral resources (Darton, 1906). The most significant area of mining was in the Bald Mountain vicinity, where about 2 years of gold-mining took place in the early 1890s.

There are several major "recent" historical influences that have had effects upon the resources of the Big Horn Mountains to this day.

While many areas of the west were settled by Europeans as early as the 1840s and 1850s, with associated human impacts on the nearby resources, the Big Horn mountain area remained largely the domain of Americans Indians until after the Battle of Little Bighorn in 1876. Earlier attempted "civilization" of the eastern side of the Big Horn mountains was successfully resisted by the Sioux and Northern Cheyenne people in 1867 when they forced the U.S. Army to abandon Fort Phil Kearney. The city of Sheridan, for example, was organized in 1882, and most of the Bighorn Basin

communities were not organized until about 1900. Therefore, the impact of European man on the resources of the Big Horn Mountains was rather minimal until about 1880.

Numerous reservoirs were constructed in the Big Horns in the 1890s, and some of the communities, including Buffalo and Sheridan, get drinking water from streams originating in the Big Horns.

Minor logging operations for fuelwood and building materials had minor impacts along the fringes of the Big Horn Mountains. Logging for railroad ties was important in the Tongue and Clear Creek watersheds. The South Tongue River area was heavily tie-hacked between about 1893 and 1908. While there was some stream alteration for tie drives in portions of the Tongue River, a large tie-flume network was developed. Tie-hacking in the Clear Creek watershed above Buffalo did not begin until 1924 and lasted about a decade. Annual reports in the local papers listed tens of thousands of dollars of "stream improvements," which were channel straightening and debris removal, activities which have been documented to have long-lasting effects (Young, et al. 1994). One other lasting effect of the early tie-hacking was that tie hacking was largely a "high-grade" operation that left the dysgenic trees which is posited to have lasting genetic effects (Howe, 1996).

The European economic activity that most influenced resources and the settlement patterns in the Big Horn mountain area was livestock grazing. The first permanent settlers were associated with ranching activities. While the record is not totally clear on when livestock were first grazed in the mountains (Murray, 1980), it is clear that by the time the Bighorn Reserve was established in 1897 the number of livestock utilizing the summer range of the mountain was very large (Jack, 1900). Ecologically, this level of grazing had important impacts upon the resource, most of which have recovered over the past 100 years due to improved livestock management practices.

The grazing legacy of the settlement period has had several lasting effects. Despite decreases in the numbers of permitted livestock, the Bighorn National Forest remains a relatively heavily stocked National Forest. And, the communities around the Big Horn Mountains have a "cowboy/western" identity that is used for economic purposes, such as tourism promotion, and helps to define a sense of place for the people living in the area.

Attitudes, Values

In order to estimate potential affects to residents, it is important to identify and consider their values and lifestyles. Several data sets were used to help understand the relationship between the communities and the Bighorn National Forest:

- University of Wyoming Social Study
- Mail survey of 2,500 randomly selected residents in the four counties.
- Interviews with community "opinion leaders."
  - The study is available online at: http://www.fs.fed.us/r2/bighorn/projects/planrevision/forestwide/
- Content analysis of input received at 2000-2001 scoping meetings.
- Results of Wyoming Rural Development Council Community Assessments held in Buffalo, Ranchester, Lovell, Greybull, Tensleep, and Worland.

These data sets represent a large amount of information, only some of which is summarized in this DEIS. The complete data sets, methodologies, and additional conclusions can be found in the project record at the Bighorn National Forest Supervisor's Office. An important caveat must be made about interpretation of this data: *interpretations must be made after looking at the totality of the data, not just individual pieces of data*. Some selected information is shown in the DEIS, but for rational interpretations, it must be considered along with other social/economic data, as well as the biological and physical information and data.

Respondents to the mail survey were asked about nine possible public benefits that the Forest Service could undertake in terms of their importance to them (shown in the following table). Each public benefit was rated on a scale of 1 to 9, with 1 being most important and 9 being least important to the respondent. All residents ranked 'provide and protect water' as the highest priority, followed by wildlife habitat, and preserving the Forest for future uses.

Table 3-175**.** Median rank of public benefits provided by the Forest Service, with 1 being the highest priority and 9 the lowest priority.

Type of Public Benefit	Big Horn	Johnson	Sheridan	Washakie	Total
Provide and Protect Sources of Water for Human Use	1.77 (2)*	1.31 (1)	1.12 (1)	1.91 (2)	1.40 (1)
Provide Healthy Home for Wildlife	2.51 (3)	2.13 (3)	1.88 (3)	2.58 (3)	2.13 (3)
Provide a Place for People to Relax	3.62 (5)	3.73 (5)	3.33 (4)	3.68 (4)	3.46 (4)
Make Sure the Forest are Available for Future Use	1.73 (1)	1.55 (2)	1.69 (2)	1.55 (1)	1.66 (2)

Type of Public Benefit	Big Horn	Johnson	Sheridan	Washakie	Total
Support Traditional Ways of Life for Local Communities and Individuals	2.84 (4)	3.63 (4)	5.47 (6)	3.92 (5)	4.01 (5)
Provide Grazing Land for Livestock	5.56 (8)	5.54 (8)	6.63 (8)	5.32 (8)	6.18 (8)
Provide Minerals	6.99 (9)	7.31 (9)	7.55 (9)	6.57 (9)	7.35 (9)
Provide Timber	4.96 (7)	5.5 (7)	5.96 (7)	5.31 (7)	5.64 (7)
Provide Recreational Opportunities	4.08 (6)	4.4 (6)	4.16 (6)	4.03 (6)	4.16 (6)

*The figures in parenthesis are the rank order of the median scores for each county and for the total population.

The table below shows people's preferences for "desired future conditions" they would like to see on the Bighorn NF. The three highest rankings were:

- Plants and animals as a high priority.
- Consider forest appearance in making decisions.
- Continue commodity uses on the forest.

Some individuals believe that setting aside more land for preservation is the way to make sure the forest is available for future use, while others believe logging and preventing catastrophic fire is the most reasonable insurance policy. This dichotomy is reflected in the interviews with residents and in national studies (see the *Communities of Interest* section). In both figures, and throughout the survey, the four counties had more in common in responses than they had differences in opinion.

Table 3-176**.** Percent of respondent responding "Yes" to future desired conditions on the Bighorn National Forest

Desired Condition	Big Horn	Johnson	Sheridan	Washakie	Total
Set aside land for wilderness	11.9 (14)	21.3 (13)	27.2 (11)	13.3 (14)	21.1 (14)
Modern facilities for recreation	29.1 (9)	19.1 (14)	22.4 (13)	30.0 (10)	24.4 (12)
Plants and animals as a high priority	47.6 (3)	64.5 (1)	65.8 (1)	46.7 (3)	59.0 (1)
Provide more roads for access	35.2 (7)	22.4 (12)	22.2 (14)	35.6 (6)	26.9 (10)
Consider forest appearance in making decisions	49.3 (2)	63.9 (2)	59.1 (2)	50.0 (2)	56.5 (2)
Allow lightning-caused fire to burn	19.8 (11)	24.6 (9)	25.6 (12)	21.1 (11)	23.6 (13)

Desired Condition	Big Horn	Johnson	Sheridan	Washakie	Total
Continuity commodity uses of forest	55.1 (1)	51.9 (3)	46.4 (6)	61.1 (1)	51.3 (3)
Open areas for recreation that are neither wilderness or roaded (motorized)	41.0 (6)	44.5 (4)	46.6 (5)	42.6 (5)	44.6 (4)
Create designated ATV trails	43.2 (4)	33.5 (8)	38.4 (8)	46.1 (4)	39.8 (71/2)
Created separate recreation areas for motorized and non-motorized use	42.7 (5)	40.7 (6)	47.0 (4)	33.9 (8)	43.1 (5)
Designate Wild and Scenic river areas	18.9 (12)	23.6 (10)	36.5 (9)	18.3 (121/2)	28.1 (9)
Set aside Research Natural Areas	16.7 (13)	23.1 (11)	31.1 (10)	18.3 (121/2)	25.0 (11)
Close some dispersed recreation sites	28.6 (10)	43.2 (5)	47.7 (3)	31.1 (9)	40.6 (6)
Limit camping to designated sites in heavily used areas	33.9 (8)	39.3 (7)	44.0 (7)	34.4 (7)	39.8 (71/2)

Ranked percent checked in parenthesis with highest checked ranked 1.

The following table summarizes the responses to one of the items asked in the mail survey, which asked respondents to report negative, neutral, or positive effects from possible changes in Forest Service management. For example, people were asked if increased restrictions on grazing would negatively, positively, or not, affect them personally. Decreased summer motorized use is the most "polarized" issue, as the number of respondents positively and negatively affected both exceed the number of people not effected.

Table 3-177. Percent of respondents negatively, positively, or not effected by various potential management strategies.

Type of Management Decision	Negative Effect	No Effect	Positive Effect
Increased Restrictions on Grazing	21.8%	52.7%	25.5%
Decreased Winter Motorized Use	29.6%	46.5%	23.9%
Decreased Summer Motorized Use	42.0%	26.6%	31.4%
Decreased Logging	29.0%	50.1%	20.9%

Residents and county representatives expressed concern over recent changes in land uses on private lands inside and adjacent to the Forest. They were especially concerned over housing and the threat of wildfire, and maintaining watershed integrity.

Increased demand for rural subdivisions, especially in Sheridan and Johnson counties, not only has taken land out of open space and agricultural production but has increased land values for remaining agricultural land. This can lead to more land taken out of agricultural production as the cost of taxes increases and because of the money that can be made by selling the land. The table below shows the amount of land in each county taken out of agricultural production or "developed" between 1982 and 1997, and compares that to the population change over the period. In each county, while the population actually declined over that period, the amount of developed land in each county increased.

Table 3-178. Acres developed by county, and population, 1982-1997.

County	Developed Area, 1982 (acres)	Developed Area, 1997 (acres)	Percent Change 1982-1997	Population 1982	Population 1997	Percent Change 1982-1997
Big Horn	8,448	9,280	9.8%	12,791	11,255	-12.0%
Johnson	17,600	18,752	6.5%	7,128	6,831	-4.2%
Sheridan	22,784	25,280	11.0%	26,376	26,095	-1.1%
Washakie	5,440	7,296	34.1%	10,140	8,531	-15.9%
Total	54,272	60,608	11.7%	56,435	52,712	-6.6%

Source: NRCS National Resource Inventory and US Census of Population, 2000

A shift away from ranching or farming practices, including grazing on public lands, would affect wildlife grazing and migratory patterns of elk and deer. In addition, without federal leases, the grass on the private base property would be used more intensively for domestic cattle operations, with little left over for wildlife, particularly in the winter. Wildlife access is provided for on large tracts of open range.

Wyoming is experiencing growth in the number of second homes. These homes are typically for seasonal, recreational, or occasional use. Between 1990 and 2000, second homes accounted for almost 3,000 new housing units in the state or 14 percent of all new housing (Taylor and Lieske 2002). The increase in second homes changes the landscape and culture of Wyoming communities. They do not serve as primary residences, so those homeowners are not considered in the total population figures. According to the 2000 Census, Wyoming's percentage of second homes was nearly 1.8 times the national average (3.1). The table below shows the percentage of second home units in each of the four counties around the Bighorn National Forest.

Table 3-179. Percentage of housing as second homes, 2000.

County	Percent Second Homes	Percent Change, 1990-2000
Big Horn	5.2%	0.4%
Johnson	10.2%	-2.5%
Sheridan	6.3%	19.7%
Washakie	3.0%	32.9%
Wyoming	5.5%	30.9%

Timber Industry

The timber industry, in part because of its long history on the Forest, is viewed much like ranching, as part of the local way of life. Timber people see themselves as part of the solution in maintaining a healthy forest. The shift in forest management practices over the past several decades is indicative of the level of local and national involvement. Clearcutting continues to be a controversial method of harvest, in spite of lodgepole pine's silvicultural characteristics and the nature of historic disturbance events on the Bighorn NF.

As part of the existing condition assessment for the Bighorn NF Plan revision, Douglas B. Rideout and Hayley Hesseln prepared a report describing the Wyoming timber market and possible implications relevant to forest plan revisions in Wyoming. The complete report is available at the Bighorn NF Supervisor's Office in Sheridan, but the following are excerpts from the executive summary.

The findings of this study have potentially significant implications for public policy, public timber sale programs, and for the timber industry. A new timber economy is emerging in the state of Wyoming, one that has been shaped by a series of significant changes. The shape and nature of the new economy is unmistakable and markedly different from the past. The key factors shaping the new economy, characteristics of the new economy, and some potential implications are outlined below.

Factors Shaping the New Economy

International Events are affecting the Wyoming timber economy as never before. Recent events include increasing Canadian lumber imports, a strong U.S. dollar, a series of international monetary crises that occurred in the 90s with current revival. Recovering Asian economies are expected to increase U.S. lumber exports.

Domestic Events include the reduction in public land timber harvesting reflecting environmental/amenity restrictions and pressures, increased offerings of small diameter

volume, increased offerings of private timber, higher and more volatile lumber prices, and green certification.[33]

The Emerging Wyoming Timber Economy

Industry Consolidation: The key and unmistakable trend resulting from the factors shaping the new economy is industry consolidation. Small diameter volumes require more capital investment to harvest and process in an economically efficient way. With unreliable volumes from any particular National Forest and high lumber prices, the natural economic consequence is the establishment of highly capitalized processing centers (sawmills, chip plants, etc.). Large corporations are favored relative to the traditional small operator. Large corporations with national and international holdings can diversify away lumber price volatility affecting Wyoming's lumber markets, operate at scale, better deal with international inter-connectedness, and better manage the costs of green certification.

Trouble for Small Processors: Wyoming's small processors who have relied on adjacent National Forests for steady volumes have found themselves reaching farther for volume and competing with larger processors over longer distances. Securing private volumes means no Small Business Set-Aside protection. Smaller processors struggle with the capital infusions necessary to effectively compete in the new economy.

Implications

Forest Service Sale Program: Nearly half the timber volume processed in Wyoming's mills comes from private supplies. With continuing industry consolidation, Forest Service sales face increased competition from state and private sources and the prospects of fewer bidders and longer haul distances. In essence, the Forest Service stumpage market position is changing from that of a dominant supplier to competitor with other sources. To the extent that such trends continue, a natural outcome would be to see more negotiated contracts with purchasers as the agency seeks vegetative services on low quality material and receives fewer bids per sale resulting from consolidation.

Private timber supplies will play a greater role in the future of Wyoming's timber industry. Interviews with processors suggested both declining private volumes under contract and a historical recognition of underestimating the quantity and resilience of private supplies. Wyoming's private timber supplies are often associated with multi-function ranches and affected by the price of timber relative to other ranch products and services such as the price of beef.

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[33] Green certification of forest products is a method developed to regulate and encourage sustainable forest management, with "sustainable" defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. In general, sustainable development principles include 1) silvicultural, 2) ecological/biological, and 3) social/community perspectives (Bratkovich, Stephen. Green Certification. USDA Forest Service, Northeastern Area State & Private Forestry. www.ume.maine.edu/~MIAL/maine_cd/tertiary_page/frontiers/green_certification.htm.

Timber Culture: The closure of smaller and family owned mills in the western U.S. and the current struggles of such mills in Wyoming pose a public policy consideration as the mills that played a key role in the development of Wyoming's culture are in jeopardy. Owners and representatives of small family owned mills have a strong affiliation with the forest resource base and a strong sense of community responsibility. Since at least the turn of the century, local timber operators have contributed to Wyoming's natural resource culture and economic development.

The emerging new timber economy affects Wyoming and much of the West. Many elements shape the new economy, but declining volumes and lower quality volumes from National Forest System lands resulting from environmental and amenity restrictions have been the theme. Low volumes would suggest closures to reduce capacity, but when combined with lower quality volumes, it suggests a more fundamental change in processing strategy. Processing lower quality stock requires heavy investment in capital infrastructure including technological investment and innovation. Such facilities have high fixed and low variable cost structure. Operating margins are modest and dependent on volume. Processors will increasingly look to the intra-state scale for securing volumes. Expect highly capitalized mills to secure volume over extraordinary distances from a wide mix of owners placing increased pressure on state and private inventories. To survive, small processors will need well-defined niches for product, for securing stumpage, and to carefully manage the technology and financing of mill efficiency.

Wildland Urban Interface (WUI)

The interagency implementation of the National Fire Plan in Wyoming resulted from national and local concerns over continued growth in wildland-urban interface throughout the state, which places more citizens and property at risk for substantial losses from wildland fire. This effort is the result of increasing forest health problems due to fuels accumulations from past suppression and changes in land use activities, such as subdivisions adjacent to the Bighorn National Forest. Compared to other public lands in the west, the Bighorn NF has a relatively low amount of WUI, because of: 1) the largely contiguous nature of the National Forest System land; 2) because of the topographic features; and, 3) lower population and development around the forest.

A 10-year Comprehensive Strategy was developed by the state's task force (made up of local citizens and state and federal employees). The strategy outlines four goals for implementation: 1) improve fire prevention and suppression, 2) reduce hazardous fuels, 3) restore fire adapted ecosystems, and 4) promote community assistance. Communities at risk have been identified in the Federal Register.

Although many people want to live in wildland areas, many do not know how to protect themselves from the increased risk of wildfire until they have lived there for some time. A cooperative study between Michigan State University and the Forest Service found that potential wildland-urban interface homebuyers know very little about potential risks and resource management effects (USDA Forest Service 2003).

ENVIRONMENTAL CONSEQUENCES

Direct and Indirect Effects

The potential effect to residents are discussed throughout the two *Communities* sections. All alternatives are a continuation of multiple use; however each would have a different relative effect on residents' lifestyles.

Environmental Justice

Continuing interactions with communities having lower income households will occur during forest plan implementation. The National Survey of Recreation and the Environment (Cordell et al. 1997) provided the Forest Service with a profile of the individuals participating in various recreational activities on the National Forests in the Rocky Mountain Region (Montana, North Dakota, South Dakota, Nebraska, Kansas, Idaho, Utah, Nevada, Arizona, New Mexico, Colorado, and Wyoming). The survey revealed that rates of participation in recreational activities available on National Forest System lands are very similar between minority groups and Caucasians. Therefore, impacts from changes in recreation opportunities under any alternative should not have a disproportionate impact on any minority group. Impacts resulting from changes in recreation opportunities under any alternative would not be expected to have a disproportionate impact on any low income group.

Changes in Lifestyle

Over the past several decades, counties around the Bighorn NF have seen a shift from commodity uses to amenity uses, such as recreation and tourism. According to many residents, it has become more difficult over the past decade or so for young people to stay in the four-county area after graduating from high school or college because of the lack of jobs with wages to support a family. More recreation and tourism jobs are in the service sector, where jobs are relatively lower paying than manufacturing jobs. However, the trend in increasing recreation and tourism jobs is not estimated to change under any alternative over the next decade. Local tourism levels are much more dependent on the health of the national economy, oil prices, and tourism factors (quality of sites, attractions, recreation demand), than it is upon forest plan decisions, such as the level of timber harvest or number of special areas allocated on the Bighorn NF.

Another trend affecting local communities is the desire for people to live in open space 'ranchettes'. The American dream is no longer just to have a house, but it is to have a house on two to five acre lots. In Sheridan and Johnson counties, the conversion from a ranching way of life has been dramatic. This has been fueled by the attractive quality of life in the area, an aging national population with increasing numbers of retirees; and low taxes and relatively low property prices, especially when compared to states like Colorado and California. The no income tax benefit has been used in advertising at least one Sheridan County subdivision on Denver radio. This trend will continue in

spite of any forest plan alternative, because the social and demographic drivers of this change are national in nature and will not be affected by forest plan decisions. In addition, with increasing land prices in Sheridan and Johnson counties, some ranchers simply choose to sell their land, especially when nearing retirement. Changes in National Forest grazing outputs could also cause some ranchers to find subdividing a financially lucrative alternative to ranching. If public land grazing sources are cut enough, ranchers may be forced to subdivide in the face of increasing land prices and conflicting land uses. Because the forest plan alternatives do not change grazing outputs, subdividing open space due to forest plan decisions is not anticipated. However, the conversion and subdivision of agricultural land is likely to increase as national trends and local attractiveness continue to be the driving forces.

Local populations have become more leisure oriented, and they look to the National Forests and grasslands for their 'home away from home.' Some concerns over managing the Forest for recreation have to do with the influx of newcomers who crowd the local recreation areas. There are anecdotal reports by local snowmobilers that the Forest is considerably more crowded in the winter of 2003-2004 due to the 'closure' of snowmobiling in Yellowstone National Park. Local residents are most affected by visitors who have little regard for area standards, environmental ethics, and respect for the resource.

Shifts in the populations of Sheridan and Johnson Counties, in particular, are more directly attributed to global market forces than they are to Forest Service management. The price of energy products and the local availability of energy resources have long dictated the boom and bust cycles in these counties. This has recently been noted in 'coal bed methane' activity, and subsequent population influx for the past five years. Thus far, the Bighorn National Forest has not had energy development, and energy development over the next decade is unlikely.

Cumulative Effects

The cumulative effects for demographic and economic considerations are very inter-related and therefore best discussed together. Please see the cumulative effects subsection within Economics discussion.

Communities of Place Economics

AFFECTED ENVIRONMENT

The economic consequences of the Bighorn National Forest stretch across much of Wyoming and into southern Montana, but the four-county area of Big Horn, Johnson, Sheridan, and Washakie counties was recognized as most affected by the Forest. The Big Horn Mountains separate the Bighorn Basin and Powder River Basin, and these areas' economies are often distinct. The economics discussion will be focused on the county level, with occasional references at the basin scale.

Employment and Income

The current distribution of employment, the trends in employment, and average earnings per job are important measures of a county's economic health. The following table shows that employment in the all four counties is concentrated in the government, services, and trade sectors, which account for nearly 60% of all jobs.

Table 3-180. Employment by major industry and county, 1999 (jobs).

Industry	Bighorn Basin		Powder River Basin		Total
	Big Horn	Washakie	Johnson	Sheridan	
Services	900	1,325	1,047	4,422	7,694
Retail Trade	790	856	890	3,164	5,700
Government	1,403	834	794	2,975	6,006
Agriculture	609	324	473	761	2,167
Mining	672	263	130	80	1,145
Ag Services	281	118	155	329	883
Construction	375	339	353	1229	2,296
Manufacturing	324	574	169	621	1,688
Transportation, communication, utilities	385	350	155	796	1,686
Finance, insurance, real estate	265	378	455	1,257	2,355
Wholesale	169	125	101	438	833
Total	6,173	5,486	4,722	16,072	32,453

Source: U.S. Department of Commerce, Regional Economic Information System, 1969-99

The table below indicates that labor earnings in the counties are dominated by employment in government, services, and retail trade. Exceptions are found in Big Horn County, where mining and transportation is important and in Washakie County, where manufacturing is an important labor earnings contributor.

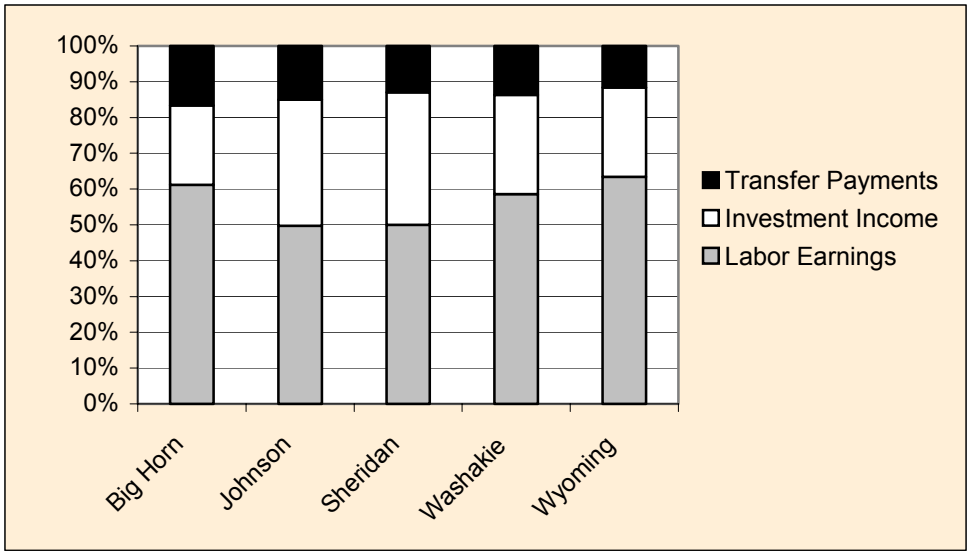
Table 3-181. Labor earnings by major industry and county, 1999 (000$).

Industry	Big Horn Basin		Powder River Basin		Total
	Big Horn	Washakie	Johnson	Sheridan	
Agriculture	$10,157	$5,568	$(882)	$4,589	$19,432
Ag Services	$6,342	$1,149	$1,634	$2,638	$11,763.00
Mining	**$25,006**	$10,629	$4,816	$5,021	$45,472
Construction	$12,524	$6,483	$7,875	$26,469	$53,351.00
Manufacturing	$9,235	**$20,381**	$3,613	$12,729	$45,958.00
Transportation, communication & utilities	**$15,681**	**$13,432**	$6,604	$37,403	**$73,120.00**
Retail Trade	$10,166	$10,115	**$10,232**	**$39,810**	$70,323.00
Finance, insurance, & real estate	$4,309	$4,290	$4,924	$25,013	$38,536.00
Services	$13,367	**$25,225**	**$16,759**	**$88,371**	**$143,722.00**
Federal Civilian	$5,269	$8,068	$3,680	$39,184	$56,201.00
Local Government	**$24,866**	$12,353	**$14,950**	**$52,885**	**$105,054.00**
Military	$875	$667	$535	$1,957	$4,034.00
State Government	$5,578	$4,963	$3,325	$10,162	$24,028.00

Source: UW Bighorn NF Models

Another important aspect of a county's economy is the sources of personal income for workers and residents; 1) labor earnings represent wages, salaries, and proprietor (self-employed) income, 2) investment income, which represents property income including dividends, interest, and rents, and 3) transfer payments, which are primarily government payments to individuals such as Social Security, Medicare, and Medicaid (see following figure).

Figure 3-24. Personal income by source and county, 1999.



Labor earnings are considered to be "earned income," while transfer payments and investment income are considered to be "non-earned income." According to the Economic Analysis Division of the state of Wyoming, non-earned income is becoming increasingly important, representing 38.1% of total personal income in Wyoming in 1999 (State of Wyoming, 2001). The four Bighorn National Forest counties all exceed that level of non-earned income, with Sheridan and Johnson counties about evenly split between earned and non-earned personal income. Counties with a high percentage of non-earned sources of income will be less vulnerable to local economic shocks but may be more vulnerable to national economic shocks. Those counties with a higher percentage of dividends, interest, and rental income will have more exposure to fluctuations in the national economy. Conversely, because transfer payments largely consist of social security payments, counties with a high proportion of transfer payments will experience less variation since transfer payments are more stable (ibid.).

As a population ages, dividends, interest, and rent and transfer payments can be expected to increase as a percentage of total personal income. Age demographic information presented elsewhere in the DEIS shows that resident of Bighorn National Forest counties are old, and getting older, relative to the rest of the U.S. and Wyoming.

Bighorn Basin

Big Horn County

- Employment

  Employment in Big Horn County is relatively diverse; 70% of employment is concentrated in five sectors. The government sector was the largest source of employment for the county in 1999 (23%). The service and retail sectors were 15% and 13% respectively.

  Total employment in Big Horn County increased by 17% between 1990 and 1999, mainly in the mining sector (295%), followed by the construction (49%) and transportation (41%) sectors. In the government sector, federal civilian employment declined by 9%, while local and state government employment increased by 8% and 1%, respectively. The agriculture (-19%) and manufacturing (-18%) sectors lost jobs between 1990 and 1999.

- Earnings and Personal Income

  Labor earnings are the largest source of personal income in Big Horn County, representing just over 61% of total county personal income in 1999. Fifty-three percent of labor earnings in Big Horn County are concentrated in three sectors: government (25% in 1999), mining (17%), and transportation/public utilities (11%). Average earnings per job in Big Horn County have declined in real terms since 1980. In 1999, average earnings per job in Big Horn County were $22,716. The three sectors with the highest average earnings per job were federal civilian, transportation/public utilities, and mining.

  In 1999, average earnings per job in Big Horn County were 75% of the Wyoming average and 69% of the U.S. average. The gap between Big Horn County and the U.S. had been widening over time, reflecting the increase in service and retail jobs and the loss in federal civilian and manufacturing jobs that tend to pay more.

  The three fastest growing sectors in terms of total personal income (labor earnings) between 1990 and 1999 were mining (340% increase), construction (71%), and finance/insurance/real estate (52%). Two sectors lost total personal income in that same period: manufacturing (-35%) and agriculture (-25%).

  Investment income represented more than 22% of total personal income and transfer payments represented nearly 17%. Investment income is relatively more important in Big Horn County than in the U.S. (25% versus 18%). It was the fastest growing source of personal income in the county, as measured by total percent change between 1990 and 1999, followed by labor earnings and transfer payments.

Washakie County

- Employment

  Employment in Washakie County is concentrated in four sectors, based on 1999 data: service (24% of all jobs), retail trade (16%), government (15%) and manufacturing (11%). These four sectors make up over 66% of the total employment in the county. Most of the government employment is local (57%), including county school districts, and state government employment (20%). Washakie County has the largest manufacturing sector of the four Bighorn National Forest counties, led by Pepsi bottling and the Crown Cork and Seal canning factory.

  Total employment increased by 17% between 1990 and 1999, with most of that increase in the service (59%), retail trade (17%), and construction sectors (14%). The government (-15%), wholesale (-10%), and agriculture (-4%) sectors incurred employment losses between 1990 and 1999.

- Earnings and Personal Income

  Average earnings per job in Washakie County have declined in real terms over the past several decades, falling from $26,236 in 1980 to $21,934 in 1999, as measured in 1996 $. The three sectors with the highest average earnings per job were federal civilian, mining, and transportation/public utilities.

  In 1999, average earnings per job in Washakie County were 88% of the Wyoming average and 67% of the U.S. average. The gap between Washakie County and the U.S. had been widening over time, reflecting the increase in service and retail jobs that tend to pay below average wages and the loss in federal civilian government jobs that tend to pay more.

  The three fastest growing sectors in terms of total personal income (labor earnings) between 1990 and 1999 were services (91% increase), transportation/public utilities (49%), and mining (27%). Three sectors lost total personal income in that same period: wholesale (-54%), government (-7%) and agriculture (-6%).

  Investment income represented more than 28% of total personal income and transfer payments represented nearly 14%. Investment income is relatively more important in Washakie County than in the U.S. (28% versus 18%). It was the fastest growing source of personal income in the county, as measured by total percent change between 1990 and 1999, followed by transfer payments and labor earnings.

Powder River Basin

Johnson County

- Employment

  Employment in Johnson County is concentrated in four sectors, based on 1999 data: service (22% of all jobs), retail trade (19%), government (17%) and agriculture (10%). These four sectors make up nearly 68% of the total employment in the county. Most of the government employment is local (72%), including county school districts and state government employment (15%). The government employee percentages do not include the recent hiring by the BLM related to coalbed methane permit administration.

  Total employment increased by 23% between 1990 and 1999, with most of that increase in the wholesale (102%), construction (86%), finance/insurance/real estate (79%), and ag. services sectors (74%). The transportation/public utilities (-45%) and mining (-41%) sectors incurred employment losses between 1990 and 1999.

- Earnings and Personal Income

  Average earnings per job in Johnson County have declined by nearly 25% in real terms over the past several decades, falling from $21,333 in 1980 to $16,124 in 1999, as measured in 1996 dollars. The three sectors with the highest average earnings per job were federal civilian, transportation/public utilities, and mining.

  In 1999, average earnings per job in Johnson County were 65% of the Wyoming average and 49% of the U.S. average. The gap between Johnson County and the U.S. had been widening over time, reflecting the increase in service and retail jobs that tend to pay below average wages.

  The three fastest growing sectors in terms of total personal income (labor earnings) between 1990 and 1999 were services (98% increase), ag. services (89%), finance/insurance/real estate (74%), and construction (64%). Three sectors lost total personal income in that same period: agriculture (-1073%), mining (-45%) and transportation/public utilities (-20%).

  Investment income represented more than 35% of total personal income, and transfer payments represented 15%. Investment income is relatively more important in Johnson County than in the U.S. (35% versus 18%). Transfer payments were the fastest growing source of personal income in the county, as measured by total percent change between 1990 and 1999, followed by investment income and labor earnings. Labor earnings made up slightly less than 50% of the total personal income in Johnson County in 1999. This suggests a high proportion of county residents who are dependent on outside sources of income for their livelihood.

Sheridan County

- Employment

  Employment in Sheridan County is concentrated in three sectors, based on 1999 data: service (28% of all jobs), retail trade (20%), and government (19%). These three sectors make up nearly 66% of the total employment in the county. Most of the government employment is local (64%), including county school districts, and federal civilian government employment (20%). The federal civilian employment percentage is relatively high compared to the other three Bighorn NF counties, largely due to the Veterans Administration Hospital in Sheridan.

  Total employment increased by 22% between 1990 and 1999, with most of that increase in the construction (78%), ag. services (57%), and service sectors (32%). The mining (-34%) sector incurred an employment loss between 1990 and 1999, primarily due to the closure of the Decker Coal Mine.

- Earnings and Personal Income

  Average earnings per job in Sheridan County have declined by nearly 30% in real terms over the past several decades, falling from $30,089 in 1980 to $21,339 in 1999, as measured in 1996 $. The three sectors with the highest average earnings per job were federal civilian, mining, and transportation/public utilities.

  In 1999, average earnings per job in Sheridan County were 86% of the Wyoming average and 65% of the U.S. average. The gap between Sheridan County and the U.S. had been widening over time, reflecting the increase in service and retail jobs that tend to pay below average wages.

  The three fastest growing sectors in terms of total personal income (labor earnings) between 1990 and 1999 were agriculture (2200% increase), finance/insurance/real estate (88%), ag. services (65%) and construction (51%). Two sectors lost total personal income in that same period: mining (-77%) and manufacturing (-1%).

  Investment income represented more than 37% of total personal income and transfer payments represented 13%. Investment income is relatively more important in Sheridan County than in the U.S. (37% versus 18%). Transfer payments were the fastest growing source of personal income in the county, as measured by total percent change between 1990 and 1999, followed by investment income and labor earnings. Labor earnings made up 50% of the total personal income in Sheridan County in 1999. This suggests a high proportion of county residents who are dependent on outside sources of income for their livelihood.

  Dave Spencer, Wyoming Business Council Regional Director for Northeast Wyoming, points out the following concerning the economic vulnerability of Sheridan and Johnson Counties:

> "Both Counties have experienced a healthy population growth in the past decade with Sheridan County growing about 12% in the last census period and Johnson County about 15%. This growth has however masked the real underlying structural economic problems of both counties and given a false sense of prosperity to local residents. Increased construction activity and new transfer payments circulating in the economy have given each County a bustling feeling which camouflages the real problems in employment and income. Neither county is very well diversified with Sheridan County particularly dependent on Services, Retail, and Government with a strong Construction component as the main sources of the earned income portion of the economy. Johnson County is the same with an added dependence on Agriculture that is much stronger than the average in the State. Diversification has eluded both areas although Sheridan is making some good efforts now in that direction. In both counties the overwhelming drivers of the economy are Interest, Rents and Transfer Payments, not earned income. The upshot is that both counties are lagging in income growth and very vulnerable to external shock."

Economic Dependency

Every economy has one or more 'engines' that ultimately provide residents with jobs and income. In a real sense, area jobs and income depend on the size and vitality of these engines.

The economic dependency of the planning area can be discerned by breaking down employment into three components: basic industries, indirect basic industries, and local resident service (sometimes called induced) industries. *Basic industries* are those that bring money in from outside the area. This is done by exporting goods and services or selling them to non-residents. Tourism is an example of an export industry in the planning area. Other export industries are oil and gas extraction, livestock, and manufacturing. *Indirect basic industries* are those that support the basic industries. These commonly include local suppliers of goods and services to basic industries. Wholesale trade and trucking would be examples of indirect basic industries. The third component is *local resident services*. These industries provide local residents such services as grocery stores and medical care.

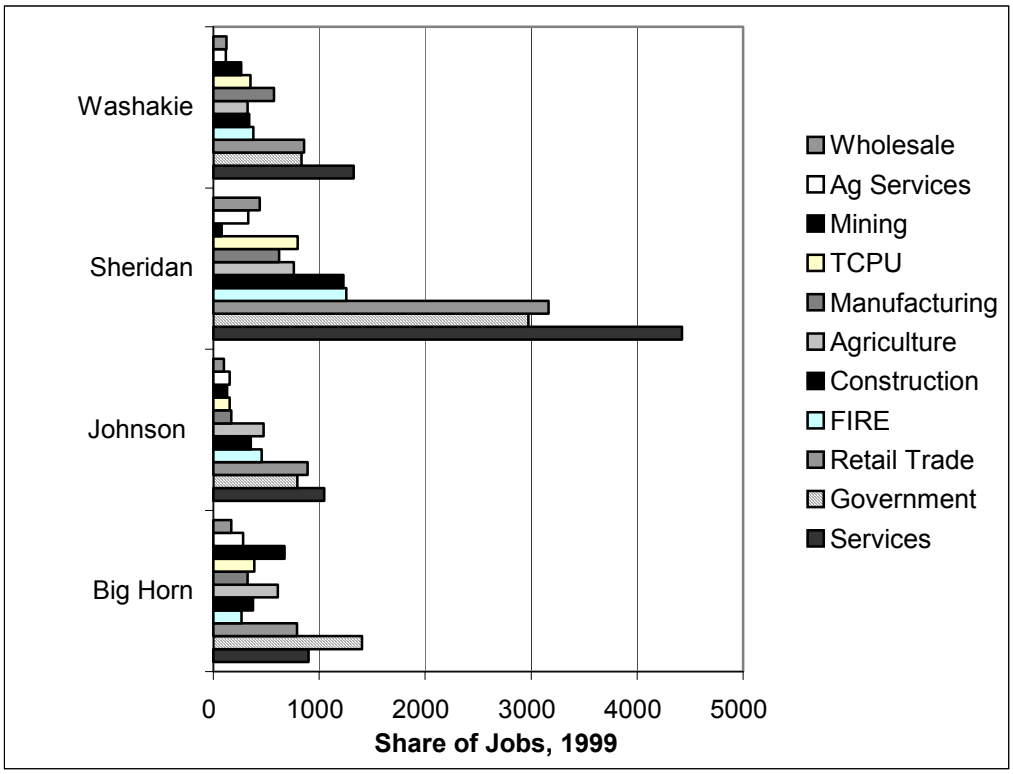
By incorporating the concept of economic multipliers to basic industries, the total effect that these industries have on the economy can be determined. The following figure shows the share of <u>all</u> jobs throughout the economy that are generated by sales in the listed industry. For instance, sawmills generate jobs in the utilities industry by purchasing electricity and in the trade industry by purchasing supplies. All of these jobs are shown under the basic industry that ultimately generated the employment, i.e. sawmills (manufacturing).

The following figure also shows that government (federal, state, and local) is consistently an important basic source of employment in the planning area, accounting

for about 20% of all jobs in a variety of sectors. Sales of goods and services in the trade and services industries ultimately provide from 20-40% of all employment. Trade and services are most important in Sheridan County. In Washakie County, manufacturing (which includes the Pepsi plant and Crown Cork and Seal) is very important to the local economy, providing about 10% of all jobs.

Agriculture plays a leading role in the custom, culture, and land uses in the planning area. It is noteworthy, however, that agriculture is not generally one of the leading economic engines. Johnson County, with slightly over 10% of all jobs derived from agriculture, is the most dependent upon the traditional western industry. Although agriculture is not the economic engine it once was, it still remains highly important to small, rural communities located throughout the planning area.

Figure 3-25. Economic dependency by county, 1999.



The following tables illustrate the employment and labor income contributed to area economies by use and management of the Bighorn National Forest. The west side area includes Big Horn and Washakie Counties, with Johnson and Sheridan Counties making up the east side area. As shown in the following table, employment associated with the Bighorn NF accounts for about 10% of the total employment in the four counties, with the major contributions made to the service and trade sectors.

Table 3-182. Bighorn National Forest contribution to the planning area employment by major industry, 2001 (jobs).

Industry	West Side Big Horn, Washakie			East Side Johnson, Sheridan		
	Forest-related	Total Area	Percent of Total Area	Forest-related	Total Area	Percent of Total Area
Agriculture	69	1,408	4.9%	103	1,890	5.4%
Mining	0	1,093	0.0%	0	270	0.0%
Construction	10	762	1.4%	26	1,862	1.4%
Manufacturing	3	867	0.4%	22	760	2.9%
Transportation, Communications, & Utilities	13	640	2.0%	25	986	2.6%
Trade	481	1,874	25.7%	899	4,692	19.2%
Finance, Insurance, & Real Estate	20	639	3.1%	52	1,795	2.9%
Services	659	2,315	28.5%	1,026	5,713	18.0%
Government	14	2,306	0.6%	22	3,843	0.6%
Total	1,268	11,904	10.7%	2,176	21,811	10.0%

The following table shows the source of the Forest Service contribution to employment in terms of natural resource programs. Recreation is by far the most important contributor to local employment. Forest Service expenditures are not included in this table since they do not vary by alternative. Under current Forest Service budget procedures, the total annual budget to a National Forest is supposed to be constant, although the proportion of each resource program could be different from year to year.

Table 3-183. Bighorn National Forest contributions to the planning area employment by program, 2001 (jobs).

Resource Program	West Side BNF		East Side BNF	
	Jobs	Percent	Jobs	Percent
Recreation, except hunting & fishing	1,079	85.1%	1,847	84.8%
Hunting & fishing	104	8.2%	181	8.3%
Grazing	82	6.4%	129	5.9%
Timber harvest	4	0.3%	19	0.9%
Total forest management	**1,269**	**100.0**	**2,176**	**100.0**

The following two tables describe Bighorn National Forest contributions to the local labor income. Labor income depends on average earnings per job. The Bighorn National Forest contribution to labor income is about half of the contribution to employment (4.6% vs. 10.7% for the west side; 6.2% vs. 10.0% for the east side). In general, service and trade related jobs are lower paying than most of the other economic sectors, and service and trade are currently the sectors of greatest relative contribution from the Bighorn NF. Because most of the employment generated by the Bighorn National Forest is tourism related, which tends to be relatively lower paying, the percent of labor income from the Forest is about one-half the percent of employment for the region.

Table 3-184. Bighorn National Forest contribution to the planning area labor income by major industry, 2001 ($ million).

	West Side Big Horn, Washakie			East Side Johnson, Sheridan		
Industry	**Forest-related**	**Total Area**	**Percent of Total Area**	**Forest-related**	**Total Area**	**Percent of Total Area**
Agriculture	$1.7	$25.8	6.6%	$2.2	$14.3	15.9%
Mining	$0.0	$56.9	0.0%	$0.1	$18.1	0.3%
Construction	$0.3	$19.1	1.7%	$0.7	$41.2	1.7%
Manufacturing	$0.1	$32.2	0.3%	$0.6	$16.8	3.4%
Transportation, Communications, & Utilities	$0.4	$26.8	1.6%	$0.8	$46.6	1.7%
Trade	$5.1	$26.9	18.9%	$11.0	$72.2	15.2%
Finance, Insurance, & Real Estate	$0.4	$10.5	3.6%	$1.0	$35.8	2.8%
Services	$5.9	$42.8	13.8%	$13.9	$118.5	11.7%
Government & other	$0.4	$68.6	0.6%	$0.8	$134.3	0.6%
Total	$14.4	$309.6	4.6%	$31.1	$497.8	6.2%

The following table shows that contributions to the local grazing and timber harvest economic sectors are relatively higher in terms of labor income than in terms of total employment. The Bighorn NF timber harvest contribution to labor income is 0.7% and 1.9% for the east and west side, respectively, compared to 0.3% and 0.9% of total employment.

Table 3-185. Bighorn National Forest contributions to the planning area labor income by program, 2001.

Resource Program	West Side BNF		East Side BNF	
	$ Million	Percent	$ Million	Percent
Recreation, except hunting & fishing	$11.1	77.2%	$24.9	80.1%
Hunting & fishing	$1.2	8.3%	$2.7	8.5%
Grazing	$2.0	13.8%	$2.9	9.4%
Timber harvest	$0.1	0.7%	$0.6	1.9%
Total forest management	$14.4	100.0%	$31.1	99.9%

Livestock-Related Employment

Data indicates that 'west side' ranchers (permittees with base properties in Big Horn or Washakie Counties) are permitted to graze 49,497 AUMs cattle and sheep, while there are about 69,468 AUMs permitted to 'east side' permittees (Johnson and Sheridan counties). Due to the substantial variability in livestock prices, a 10-year average (1992-2001) was used to value Bighorn NF livestock production. The 10-year average for cattle value of production, adjusted for inflation, was $35.96 per animal unit month (AUM). For sheep, the inflation-adjusted average value of production was $39.84 per AUM.

The following table summarizes the total economic impact of livestock grazing to the local four-county area in terms of employment and earnings. Firm-level research suggests that there are at least three possible perspectives to consider in evaluating the economic importance of Forest Service grazing: 1) considering the Forest Service AUMs only, 2) considering Forest Service AUMs and their effects on use of other forage sources in the grazing system, and 3) considering Forest Service AUMs and their effect on the economic viability of the ranching operation. Which of these perspectives is the most relevant depends on the ranch's level of dependency on the Forest Service grazing, the magnitude of the proposed change, the financial solvency of the operation, the availability of alternative sources of forage, and the desire of the producer to remain in ranching. Due to the variability in these factors between ranches, it is difficult to generalize as to which perspective is most appropriate. As a result, a range of values are provided.

Table 3-186. Total economic impact of Bighorn National Forest grazing program upon the local economies.

Bighorn NF Grazing Program	West Side BNF		East Side BNF	
	Employment (Jobs)	Labor Earnings	Employment (Jobs)	Labor Earnings
USFS permit only (118,503 AUMs)	39	$0.9 million	66	$2.2 million
Grazing System (257,096 AUMs)	82	$2.0 million	129	$2.9 million
Ranch viability perspective (555,604 AUMs)	173	$4.4 million	267	$6.3 million

Timber Industry Employment

The estimates of the 'base year' timber production from the Bighorn NF, in terms of total amount harvested and the community reaping the economic benefit, are based on the harvest history from 1996 to 2002. During that period, timber was purchased for sawmills in Buffalo, Cody, and Sheridan, WY and for a sawmill in Livingston, MT. The percentage of timber volume going to those mills was used to estimate the timber economic impact upon the west side or east side counties. The data used to determine the base year timber harvest level and what percentage of timber volume went to west side or east side communities are in the project record.

Periods other than 1996 to 2002 could be analyzed to determine what outputs best define the 'base year', as the Bighorn NF timber harvest program has fluctuated dramatically over the life of the 1985 Forest Plan. Initially, Forest timber harvest levels were near the projected ASQ of about 15 million board feet, and the primary purchaser was Wyoming Sawmills in Sheridan. However, over the life of the plan, timber harvest output declined dramatically as a result of lawsuits and conflicting forest plan direction. In addition, other purchasers became increasingly important on the Bighorn NF, as increasing stumpage prices and decreased timber supplies made longer hauls more economical. Given these factors, using a base period other than 1996 to 2002 would provide a different picture of the timber harvest amount and location of purchasers, but it would not be as reflective of the current, "no action", alternative.

Based on an annual sawtimber harvest of 4.4 million board feet, timber production on the Bighorn NF contributes an estimated $0.7 million of direct labor earnings and 23 jobs to the 4-county economy. These figures are low compared to total sawmill employment in the 4-county area because the local timber purchasers have purchased increasing amounts of raw material from non-Bighorn NF sources over the past decade.

Recreation-Related Employment

Recreation use data on the Bighorn NF has been compiled from several sources, including the Bighorn NF's Forest Recreation Use Data, the National Visitor Use Monitoring (NVUM) study, and from various state agencies, such as the Wyoming Game and Fish Department. Use data was aggregated into major categories of snowmobiling, hunting, fishing, day use, overnight stays on Bighorn NF, and overnight stays off of the Forest. Forest Recreation Use Data has been collected for about 15 years, so it provides some excellent trend information.

To estimate the economic impact of recreation, local resident use was separated from other Wyoming residents use and non-resident (tourism) use. This estimation is necessary since economic impacts are based on new dollars flowing into the regional economy. This is an input-output economic model, which is the appropriate standard for forest plan economic impact modeling. A complete explanation and the rationale behind using input-output economic modeling is included in the project record.

Resident recreation expenditures represent a part of the current distribution of existing dollars already in the regional economy. Non-resident recreation (tourism) on the Bighorn National Forest in 2001 contributed $11.1 million in labor earnings to west side county economies (Big Horn and Washakie) and $24.9 million to east side county economies (Johnson and Sheridan). As a result, over 2,900 jobs were supported.

ENVIRONMENTAL CONSEQUENCES

Direct and Indirect Effects

Direct and indirect effects on planning area jobs and income are generated by changes in recreational uses of the national forest, and the use of timber and forage resources. An increase in recreation or timber production may mean an increase in jobs and income to local communities. In addition, if production is decreased in one resource and increased in another, there is a shifting of jobs from one industry to another. To estimate changes in income and employment for each alternative, the forest used computer models. See Appendix B for a more detailed discussion of the models and analysis methodology.

The Bighorn National Forest total operating budget was not varied by alternative, and only the projected budget, which is the current as adjusted for inflation, is analyzed. Under our current budget process, the Bighorn National Forest is expected to receive a relatively stable, constant (with inflation) budget that can be divided proportionally to match differing alternative emphases.

Current base output levels vary by resource area, because of differing resource conditions, changes, and markets, just to name a few. The base period for determining

"current" output levels was determined by the ID team to be the most meaningful for plan revision effect comparison. The base periods for determining "current" outputs are:

- Recreation: the Forest Recreation User Database (information from 1989 to the present) was used to generate visitor use and trend information. The National Visitor Use Monitoring Survey (NVUM) from fiscal year 2001 (October 2000 to September 2001), recent snowmobile permit sales information from the State of Wyoming, and current Wyoming Game and Fish Department data were also used.
- Grazing: the total number of AUMs is based on the current permitted number, while the value of production was averaged over the 1992-2001 period, because of price volatility.
- Timber: The total forest product harvest and processing location was based on Bighorn National Forest data from 1996 to 2002.

Labor income is compensation paid by business proprietors to employees and themselves.

The effects of the alternatives on timber, grazing, and tourism are shown in the following table. The total number of visitors to the Bighorn NF is projected to increase across all alternatives, with only a slight variation among alternatives based on program funding levels. Developed camping and picnicking at non-consessionnaire-operated sites would slightly decrease in alternatives A and E. A slight increase in nonmotorized recreation is anticipated in Alternative C. This corresponds with a slight variation in recreation-related jobs among the alternatives. National economic and demographic conditions (across all alternatives) have a greater influence on the overall number of non-local tourists coming to the Bighorn National Forest than potential visitor displacement anticipated under any of the alternatives. As an example, a change in travel management designation might shift motorized and non-motorized users to different spots on the Forest, while dramatically higher national fuel prices might discourage visitors from driving to Wyoming to recreate on the Bighorn National Forest.

The number of AUMs is not predicted to change under any alternative for the economic analysis.[34] Draft Revised Plan direction for grazing is the same as that currently being implemented. It is estimated that some permittees can maintain, or potentially even increase, the number of AUMs with more intensive management. Reductions in AUM outputs are considered to be more a factor of markets (e.g., the sheep market) and the level of management that permittees want to invest in, neither of which vary by alternative.

[34] Forty AUMs would be lost if the proposed Lake McClain RNA is designated, a 0.03% reduction. This was considered to be too small of a change to actually detect; that is, it is within the margin of error of our projected AUMs and the economic multipliers. Therefore, the AUMs for the alternatives that include Lake McClain RNA were not changed.

Significant differences in jobs and income generated by timber harvest and processing are anticipated to occur under the different alternatives. The increased number of jobs shown in the table below for alternatives A, B, D, and E may not be additional to those existing in the industry today, but they are the ones attributable to increasing the Bighorn National Forest timber output over the 'base year' timber output. Jobs being supported today by timber supplies from private, state, or other federal lands may be supported in the future by supplies from the Bighorn NF under Alternatives A, B, D, and E. However, it is possible that some new jobs may be created. Business decisions by timber purchasers in the years ahead will determine whether the associated jobs will be new or merely existing ones that depend upon different (National Forest) timber supplies. For Alternative C, potential employment losses attributable to Forest Service management might be absorbed by increases from other timber suppliers. However, it is not known whether or not timber supplies from other lands may increase beyond today's levels.

In addition to local timber supply, other factors will determine whether or not local sawmills expand or contract their work force. Among them are:

- International timber supply and demand.
- The national economy, interest rates, and housing demand.
- Individual sawmill entrepreneurship and business acumen.
- Stumpage prices.
- Competition from sawmills outside the 4-county area.

The following tables show employment and income effects distributed by economic sector. Since changes in grazing and tourism outputs do not vary by alternative, effects would be felt in the timber industry, which directly impacts manufacturing jobs.

Table 3-187. Projected changes in employment in planning area resulting from Bighorn forest plan revision alternatives.

	Base Year (2001)	Changes in Employment by Alternative in 2010					
		No Action	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Recreation	2,926	147	140	147	162	147	140
Hunt & Fish	285	8	8	8	8	8	8
Grazing	211	0	0	0	0	0	0
Timber	23	26	88	34	3	50	99
Total	**3,445**	**181**	**236**	**189**	**173**	**205**	**247**
% Change	---	+5.3%	+6.8%	+5.5%	+5.0%	+6.0%	+7.2%

The following table shows how employment will change in specific economic sectors of the 4-county area.

Table 3-188. Employment changes by major industry by alternative in 2010.

	Base Year (2001)	Changes in Employment by Alternative in 2010					
		No Action	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Agriculture	172	1	1	1	1	1	1
Mining	0	0	0	0	0	0	0
Construction	37	2	2	2	2	2	2
Manufacturing	25	19	61	24	3	35	69
Transportation, Communications Public Utilities	38	3	5	3	2	4	6
Trade	1,380	67	70	68	70	70	72
Financial, Insurance, Real Estate	72	4	5	4	3	4	5
Service	1,685	85	88	86	91	88	89
Government	35	2	2	2	2	2	2
Other	1	0	0	0	0	0	0
Total Forest Mgt.	**3,445**	**181**	**234**	**190**	**174**	**206**	**246**
Change		5.3%	6.8%	5.5%	5.0%	6.0%	7.1%

Total earnings in 2010 by program area will increase or hold steady for every alternative, except for timber harvest under Alternative C. Real increases from 4% to just over 10% are anticipated under the alternatives. Because of the differences in wages among industries, the pattern of gains and losses is slightly different for income that it is for employment.

Table 3-189. Projected labor income in planning area resulting from Bighorn forest plan revision alternatives (figures in millions of dollars).

	Base Year (2001)	Changes in Labor Earnings, millions of dollars, 2010					
		No Action	Alt A	Alt B	Alt C	Alt D	Alt E
Recreation	$36.02	$1.81	$1.72	$1.81	$1.99	$1.81	$1.72
Hunting & fishing	$3.84	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10
Grazing	$4.90	$0	$0	$0	$0	$0	$0
Timber harvest	$0.70	$0.79	$2.61	$1.02	$0.10	$1.50	$2.96
Total forest management	$45.46	$2.71	$4.44	$2.93	$2.18	$3.41	$4.78
Percent change from 1999	------	6.0%	9.8%	6.4%	4.8%	7.5%	10.5%

Table 3-190. Projected change in labor income in planning area resulting from Bighorn forest plan revision alternatives by economic sector (figures in millions of dollars).

	Base Year (2001)	Changes in Labor Earnings by Alternative in 2010					
		No Action	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Agriculture	$3,984,141	$10,124	$13,560	$10,646	$9,332	$11,621	$14,230
Mining	$90,569	$7,047	$14,915	$8,090	$4,355	$10,199	$16,402
Construction	$1,043,159	$58,435	$94,971	$62,786	$46,390	$73,100	$102,552
Manufacturing	$673,175	$501,702	$1,653,749	$651,018	$72,301	$952,909	$1,866,566
Transportation, Communications Public Utilities	$1,207,532	$106,596	$221,368	$115,647	$54,298	$148,710	$247,702
Trade	$16,039,182	$845,498	$997,990	$863,253	$827,008	$915,162	$1,037,865
Financial, Insurance, Real Estate	$1,386,420	$85,672	$145,453	$92,906	$65,476	$109,493	$157,548
Service	$19,814,478	$1,031,903	$1,218,428	$1,061,034	$1,033,280	$1,121,598	$1,261,464
Government	$1,189,044	$61,183	$74,193	$63,396	$62,269	$67,861	$77,339
Other	$32,381	$2,000	$3,372	$2,161	$1,543	$2,545	$3,654
Total Forest Mgt.	$45,460,083	$2,710,160	$4,437,999	$2,930,936	$2,176,251	$3,413,197	$4,785,321
Change		6.0%	9.8%	6.4%	4.8%	7.5%	10.5%

Cumulative Effects

Socio-economic changes in the planning area result when individuals, businesses, governments, and other organizations initiate actions. Millions of decisions will be made by thousands of players over the next decade, all affecting such things as employment, housing, and transportation. It is impossible to account for these decisions separately. Projections of employment and income prepared for the state of Wyoming account for all of these changes. Implicitly, the projections provide a comprehensive context for considering the effects of Forest management. Projections of employment and income to 2010 were based upon estimates generated for and used by Wyoming (Woods and Poole 2002).

Employment and Income

The following table shows the estimated effects in light of west side and east side area employment and income growth. Recreation dominates the picture on both sides of the mountain, although changes to the local economies due to forest plan decisions are primarily because of changes in timber output. The influence that use and management of the Bighorn National Forest has in the area economy is expected to decrease slightly for all alternatives relative to 2001 levels.

Table 3-191. Estimated cumulative effects to employment and labor income by alternative for the west and east sides of the Bighorn National Forest.

Westside Bighorn NF (Big Horn and Washakie Counties)									
Economic Indicator	**2001 Impact Area**	**2001 BNF Total**	**2010 Impact Area**	**No Action**	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**
Employment									
Total (Jobs)	11,904	1,268	12,703	1,331	1,339	1,333	1,333	1,336	1,341
% of base	100.0%	10.7%	100.0%	10.5%	10.5%	10.5%	10.5%	10.5%	10.6%
% change				0.0%	0.6%	0.2%	0.2%	0.4%	0.8%
Labor Income									
Total ($ million)	$309.6	$14.4	$356.1	$15.1	$15.3	$15.1	$15.0	$15.2	$15.4
% of base	100.0%	4.6%	100.0%	4.2%	4.3%	4.2%	4.2%	4.3%	4.3%
% change				0.0%	1.8%	0.4%	(0.2%)	0.9%	2.1%

Eastside Bighorn NF (Johnson and Sheridan Counties)									
Economic Indicator	2001 Impact Area	2001 BNF Total	2010 Impact Area	No Action	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Employment									
Total (Jobs)	21,811	2,177	23,936	2,295	2,341	2,301	2,284	2,314	2,351
% of base	100.0%	10.0%	100.0%	9,6%	9.8%	9.6%	9.5%	9.7%	9.8%
% change				0.0%	2.0%	0.3%	(0.5%)	0.8%	2.4%
Labor Income									
Total ($ million)	$497.8	$31.1	$583.7	$33.1	$34.5	$33.3	$32.6	$33.7	$34.9
% of base	100.0%	6.2%	100.0%	5.7%	5.9%	5.7%	5.6%	5.8%	6.0%
% change				0.0%	4.4%	0.5%	(1.5%)	1.7%	5.3%

The distribution of these effects will not be equal across the 4-county area. Sheridan County will disproportionately feel these effects because of the presence of timber industry in Sheridan. All four counties will experience very little economic change because of forest plan decision effects' to the livestock industry. Changes in employment and income in the livestock industry is more likely to be caused by national and international markets, costs of production, increasing land values, and product demand. All four counties have a tourism economic component, and all will see a gradual increase in economic activity as tourism continues to grow in the area.

The table shows that the National Forest generates about 10.7% to 10% of the total employment, and 4.6% to 6.2% of the total labor income in the west side and east side counties, respectively. These numbers would make the National Forest the largest employer in these counties if it were viewed as a single, diversified employer.

A reasonably foreseeable activity that will cause a significant change in the employment and income of Sheridan and Johnson Counties is coalbed methane development. The BLM Powder River Basin EIS projected that at the peak construction time of 2007, over 5,760 workers would be needed in Sheridan, Johnson, Campbell, and Converse Counties. Currently, it appears that the BLM permitting process is proceeding slightly more slowly than was anticipated, so that peak may be later than 2007. The full EIS is available on the web at: http://www.wy.blm.gov/nepa/prb-feis/ These are typically high paying jobs, with considerable amounts of overtime.

There are no other reasonably foreseeable activities (see the Cumulative Effects table at the beginning of this chapter) with large effects upon employment and income that are not already accounted for in the Woods and Poole base forecast.

Demographics

Population trends often follow economic trends. As jobs are created, those in search of employment move into an area. Projections, as shown earlier in this section, suggest that there are no known events that would cause a major change in the current trajectory of Big Horn and Washakie Counties' population trends. Those counties have either had stable populations over time, or depending on the time period considered, have had small decreases. On the other hand, it is likely that the Johnson and Sheridan Counties' populations will increase over the next decade, primarily due to coalbed methane activity. This employment effect of the coalbed methane project is expected to last until about 2018. The small change that Bighorn National Forest activities are projected to have suggests that the National Forest will not be a major player in affecting population trends.

Financial/Economic Efficiency

Both financial and economic efficiency are analyzed in this section. Financial efficiency examines revenue and cost implications from the perspective of the Forest Service. It could also be said that this is the perspective of the taxpayer. Only those revenues and costs that are recorded in financial records are included in this analysis.

Economic efficiency examines a broader definition of benefits by including values for national forest uses that are not captured in the marketplace. Willingness-to-pay values for recreation use are the primary additions over a financial analysis. Estimated market value for meat gained by grazing livestock on public land is also included. Water values have been excluded from this analysis, because past and planned activities on national forests in the Rocky Mountain Region have not approached intensities needed to increase water yield. This is documented in the water yield analysis of Appendix B. Appendix B also includes a complete description of values used in the economic analysis.

Many non-market, non-use values are excluded from this economic efficiency analysis. Some outcomes or effects, such as biological diversity, visual amenities, and some social impacts have no monetary values or costs that have been established by USDA or the Forest Service. While some research studies have explored the development of such values, it is reasonable to handle these items in a non-monetary fashion. This is done in other sections of this EIS. The agency cost of achieving these non-monetary outputs is included in both the economic and financial analyses.

Net public benefit is an important concept for carrying out a forest plan revision. Net public benefit is defined as the overall value to the nation of all outputs and positive effects (benefits) minus all the associated Forest Service inputs and negative effects

(costs) for producing those primary benefits, whether they can be quantitatively valued or not. Thus, net public benefits conceptually are the sum of this economic analysis *plus* the net value of nonpriced outputs and costs. It is not the result of an economic analysis alone. This concept is the basis upon which the Regional Forester selects an alternative for implementation.

The main criterion used in assessing financial and economic efficiency is *present net value* (PNV), which is defined as the value of discounted benefits (or revenues) minus discounted costs. A PNV analysis includes all outputs, including timber, grazing, and recreation, for which monetary values are assigned. As noted above, the monetary values include both market and nonmarket values received by the public.

In addition, a financial efficiency analysis is completed to determine the net financial returns of each alternative. A financial efficiency analysis is the PNV of Forest Service revenues and costs. The following table displays the economic and financial PNV for each alternative. All monetary values are expressed in constant dollars with no allowance for inflation. A 4-percent discount rate was used over a 50-year period (2005 to 2055). Revenues are not reduced for payments made to states and counties. The reduction of PNV in any alternative as compared to the most financially or economically efficient solution is the economic trade-off, or opportunity cost, of achieving that alternative.

Table 3-192. Economic and financial efficiency (present net value over 50 years in millions of 2003 dollars).

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Forest Service revenues	33.1	19.3	11.0	23.6	36.8
Society benefits	810.7	803.3	804.0	807.6	814.1
Forest Service costs	241.6	241.6	241.6	241.6	241.6
Other costs	26.2	26.2	26.3	26.3	26.3
Financial net revenues	-208.5	-222.3	-230.6	-218.0	-205.1
Economic net benefits	542.9	535.5	536.1	539.7	546.2

Source: USDA Forest Service

As shown in the table above, financial PNV (Forest Service revenues minus Forest Service costs) varies from a low of -$231.6 million for Alternative C to a high of -$206.5 million for Alternative E. In all cases, Forest Service costs exceed revenues. What makes Alternative E the highest financial PNV is high timber harvest levels and associated revenues. Alternatives with preservation emphases, such as Alternative C, show the greatest net cost to the taxpayer, because there are no agency revenues associated with these emphases to offset similar levels of expense.

The economic PNV (society benefits minus all costs) ranges from a low of $534.0 million for Alternative B to a high of $544.8 million for Alternative E. The net economic benefits are orders of magnitude larger than the financial gross revenues. This

suggests that even with the limited monetary values available for this analysis, society benefits greatly from implementing any alternative fully considered in this document.

Communities of Place
Local Governments

AFFECTED ENVIRONMENT

An important aspect of a county's economy is the financial capacity of county government. This is important since it determines the ability of the county to provide local government services and maintain public infrastructure. Two aspects of county government finances are considered in this analysis: *Assessed Valuation* and *Federal Land Payments*. The following discussion includes the Wyoming counties of Big Horn, Johnson, Sheridan, and Washakie.

Costs to Counties

As population increases occur, private development often increases near National Forest boundaries. Homes situated adjacent to the National Forest boundary typically offer more privacy, better views, greater opportunities for recreation and wildlife viewing, and more pleasant immediate surroundings than might be available further away from public lands. These amenities are highly valued by homeowners, but with these developments come higher costs of services by local governments. Irregular boundaries, less-developed roads, and longer distances from community centers make for expensive law enforcement, public schools, and emergency services.

Services and Infrastructure

The costs borne by local governments for serving visitors to the National Forests includes law enforcement and judicial services, rescue and other emergency services, and wear on local public infrastructures (such as parks, streets, and water and sewer systems).

Land Use Planning

The Revised Plan has a strategy of "Recognize and coordinate with County Land Use and Conservation District Plans as part of Forest management activities." These local governments have participated in the forest plan revision process as Cooperating

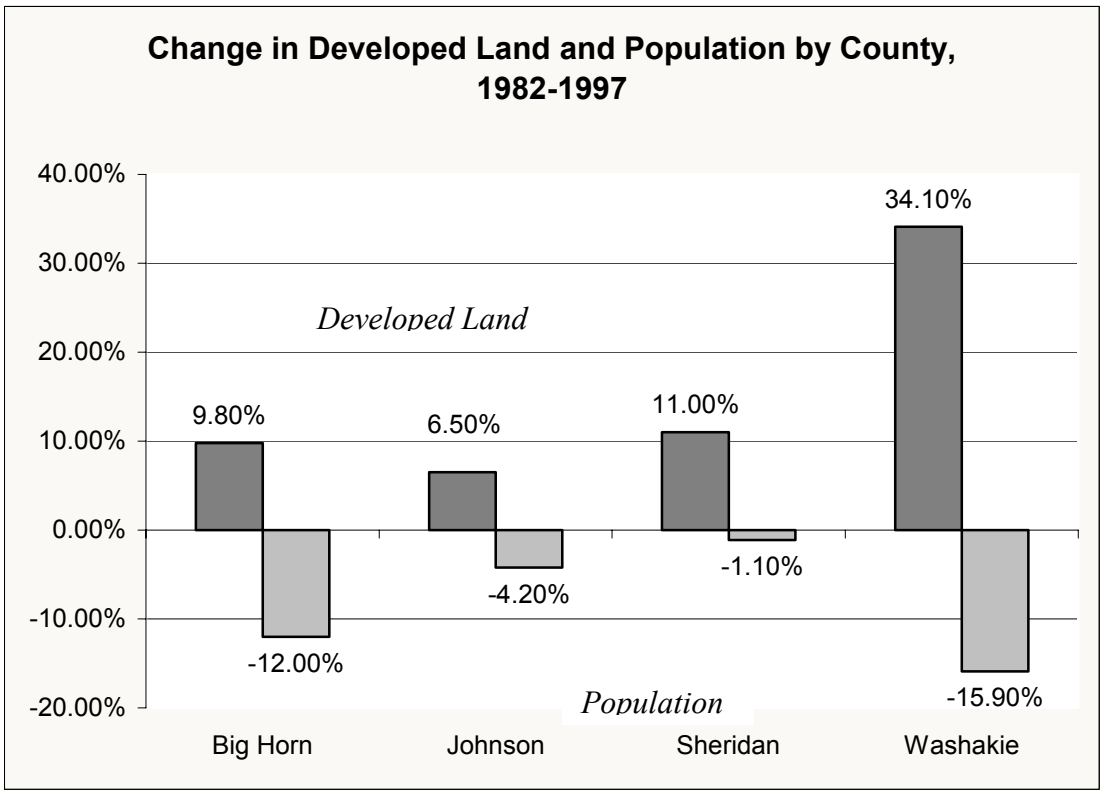
Agencies. County Commissioners and Conservation District board members have met with forest plan revision personnel on approximately 20 occasions since 2001 and have had an opportunity to comment on Revised Plan direction and alternatives.

The County Plans were used as a criteria in DEIS alternative discussions. Forest personnel reviewed these plans, and believe that all Forest Plan alternatives are consistent with the County and Conservation District Plans. There is a disagreement between Washakie County and forest personnel over how specifically the Revised Plan should address the need for a restroom facility along U.S. Highway 16.

Land Use

The conversion of agricultural land to rural residential development is a widespread phenomenon in many counties adjacent to National Forests. A recent study by the American Farmland Trust (2002) estimates that 11% of all prime ranchland (those with rural development densities, located near public lands, year-round water availability, mixed grass and tree cover, and a high variety of vegetation classes) are threaten by conversion to residential development. In Wyoming, the Trust estimates that 2.6 million acres of ranchland are at risk. Many of these ranches hold federal livestock grazing permits.

Figure 3-26. Change in developed land and population by county, 1982-1997.



One of the concerns associated with this type of conversion is that it may cause financial problems for local governments and schools. Numerous studies from across the country have indicated that the conversion of agricultural land to residential use is a net fiscal loss to county taxpayers. While tax revenues typically increase from such conversion, the increase is generally more than offset by the increase in expenses.

County Road Maintenance

Two roads crossing the forest fall under county jurisdiction. Few Forest roads serve as primary through-routes that connect communities, but several are used by communities for recreation and commercial access. Among these roads are:

- Big Goose Road, Sheridan County. Accesses the Dome Lake and other nearby reservoirs on private land inholdings. Currently, Bighorn National Forest is maintaining this road.
- Hazelton Road, Johnson County. Accesses private, BLM, and state land south and southeast of Bighorn National Forest.

County Receipts

Payment in Lieu of Taxes (PILT) payments

Federal lands are not subject to property taxes that support county governments and education, yet local communities play an important role in supporting the management of Federal lands. In 1976, Congress authorized federal land management agencies toshar income with states and counties and provided a payment in lieu of taxes (PILT) program to help offset lost tax revenue. Until recently, part of the formula for determining the each counties share of the PILT was based upon timber, grazing and other federal land management agency receipts. However, the Secure Rural Schools and Community Self-Determination Act of 2000 provided counties with a payment formula . The new law offered counties an option for payments that do not fluctuate with national forest revenues. Counties had until September 30, 2001, to decide whether they would continue with annually varying 25% Fund payments for choose fixed amounts. All of the four counties that have public lands managed by the Bighorn National Forest have elected the fixed payment option. Therefore, payments in lieu of taxes for the federal land in Big Horn, Johnson, Sheridan, and Washakie counties do not vary by the level of Bighorn NF resource outputs.

PILT payments are based upon three factors:

- Eligible federal acres in the county.
- Federal revenue sharing going to the county in the prior year.
- County population up to the pre-determined ceiling.

The following table shows the Payments in Lieu of Taxes for the preceding years.

Table 3-193. PILT payments by county, 2001-2003.

	PILT acres	2003 PILT	2002 PILT	2001 PILT
Big Horn	1,534,068	$623,309	$565,060	$530,565
Johnson	837,638	$506,573	$461,842	$432,726
Sheridan	442,411	$550,012	$492,508	$458,606
Washakie	959,682	$589,369	$515,852	$490,594

University of Wyoming, Cooperative Extension Service

County Assessed Valuation

The following tables shows each county's assessed valuation. The assessed valuation is the basis for tax revenue a county can generate. That is, state law allows a county to tax, up to a certain specified rate, the assessed property values, so the total amount of receipts a county is able to generate is directly proportional to its assessed valuation. County tax receipts fund basic services, such as roads, infrastructure, and law enforcement. County tax revenue can also fund economic development agencies or authorities, and could provide incentives for business relocation through business park development or partial infrastructure development. A county with the level of income high enough to be able to afford these types of development services is in a position to help compensate for the inevitable social and economic changes that western, rural communities undergo.

Table 3-194. County assessed valuation for FY 2002.

	Assessed Valuation	Average County Levy (mills)
Big Horn	$137,541,192	75.858
Johnson	$102,180,366	67.250
Sheridan	$225,468,629	68.061
Washakie	$87,802,133	72.092

State of Wyoming, Department of Revenue

Sales Tax Revenues

Since 1994, the state imposed sales tax rate in Wyoming has been 4%. The revenue from sale tax collections are distributed between state and local governments with 72% allocated to state government and 28% returned to local government in the county of origin. The local government share is allocated between the county and towns based on population. Wyoming counties also have the option of imposing an additional 1% sales tax through public election. The optional sales tax revenue, less administrative costs, is

returned to the county of origin. In addition, Wyoming counties may also impose a second 1% sales tax, which must be designated for specific, pre-defined, capital improvements. The following table shows the total sales tax collected for each county.

Table 3-195. FY 2003 sales tax collection and tax rates as of January 1, 2003, by county.

	Sales Tax Collection	State Tax Rate	General Purpose Option	Specific Purpose Option
Big Horn	$5,234,884	4%	1%	0%
Johnson	$5,787,535	4%	1%	0%
Sheridan	$24,988,577	4%	1%	1%
Washakie	$4,575,727	4%	0%	0%

State of Wyoming, Department of Revenue

ENVIRONMENTAL CONSEQUENCES

Direct and Indirect Effects

Development, Subdivisions, and the Cost of Community Services

There has always been interplay between public and private land management decisions in communities and jurisdictions in the rural West. Federal land management decisions can affect local landowners, business owners, and local governments. Conversely, these same parties can affect the use and management of federal lands. Two loci where such relationships might be affected by the Bighorn forest plan revision are 1) potential changes to the agriculture industry and 2) potential changes to private land development.

Van Tassell and Richardson (1998) have shown that locally sizable reductions in federal grazing can significantly affect the viability of ranching operations in Wyoming. Such losses could enhance the rate at which agricultural lands are developed for residential and second-home uses. Van Tassell and Richardson note that "…because of the price most land around national forests can demand, the danger is those lands would be subdivided into ranchettes or other residences rather than stay in productive agricultural use." However, none of the alternatives anticipate changes in grazing outputs as a result of forest plan revision decisions, so there should be no direct effect upon ranch operations viability.

As land subdivision continues to occur due to non-National Forest influences, local governments could expect an increase in the net cost of services. Coupal, McLeod, and Taylor (2002) projected the effect of land use change on the fiscal condition of counties

throughout Wyoming. They found that "…rural residential development costs more to taxpayers than it contributes in revenues; and conversely, that agricultural land contributes more to county coffers than it asks for in services."

Trends in rural residential development are expected to continue in Wyoming apart from any change in the Bighorn forest plan. Areas where development on private lands adjoins the National Forest boundary can raise special problems related to wildfire and local government services. The specialized management of adjoining National Forest System lands is one way that the Forest Service and local governments can collaborate on solutions for these unique problems. Community Wildfire Prevention Plans as authorized in the Healthy Forest Restoration Act are a likely collaborative vehicle for National Forest land managers and the owners of non-federal adjoining lands. This management collaboration has been applied on the Bighorn NF, most notably near and in Story. The more effective these collaborative efforts and fuels reduction efforts, the more likely there will be potential cost savings or increased effectiveness of services. This is not expected to vary by alternative, since wildland urban interface fuels will be treated under all the alternatives.

Revenues to Counties

Because all of the counties containing NFS lands have elected to receive the full payment amount, PILT payments are now independent of Forest outputs. Tourism tax revenues are expected to increase over the next planning period due to increased tourism caused by national demographic changes and growth of the national economy. Tourism tax revenues are not expected to change as a result of the plan revision since recreation does not vary by alternative.

Cumulative Effects

Cumulative effects analysis considers the consequences of the alternatives in concert with the consequences of other actions. Twenty-five Percent Fund payments would not be affected by these actions. Although PILT payments would not be affected by the amount in Forest receipts, PILT can be affected by changes to county populations. None of the revision actions analyzed in this DEIS would substantively alter the population growth anticipated for the planning area. PILT is likely to increase in Sheridan and Johnson counties, because of the population increases anticipated from coal bed methane activity.

As stated above, second homes and other rural residential development will likely continue regardless of decisions made in the Bighorn forest plan revision. These changes are most likely to occur in Sheridan and Johnson counties, largely because of the availability of non-federal lands compared to the west side counties. County assessed valuation based on property values will correspondingly increase, as will County costs to cover the increased costs of rural subdivisions compared to agricultural land.

Communities of Interest Stakeholders

AFFECTED ENVIRONMENT

The Bighorn National Forest receives visitations from the local vicinity as well as from a broader, national scale. As a result, a diverse spectrum of interests is involved and the geographic and ideological representation of stakeholders is very broad.

To gain an understanding of how similar and dissimilar the stakeholder interests can be, it is worthwhile to consider several resources. National stakeholder surveys and assessments, such as the National Survey on Recreation and the Environment (NSRE) can be partnered with local surveys and assessments, such as the Social Assessment of the Four County Area (SAFCA) and the Bighorn National Forest's National Visitor Use Monitoring Survey (NVUM) Results to obtain a more complete picture of stakeholder interests. The surveys themselves represent different scales: NSRE is based on national sampling, SAFCA is based on county residents, and NVUM is based on both national and local visitors to the Bighorn National Forest.

Survey Resources

National Survey on Recreation and the Environment (NSRE)

The USDA Forest Service completed its Strategic Plan (2000 Revision) in October 2000. The goals and objectives included in the Strategic Plan were developed with input from the public, some of which was obtained through a telephone survey. The Results Act requires an agency to ask for the views and suggestions of anyone "potentially affected by or interested in" its Strategic Plan. The long-term goals and objectives of the Strategic Plan must therefore reflect not only the agency's mission, but also the public's views and beliefs for our country's forests and grasslands. This report presents the results of a telephone survey in which randomly selected members of the American public were asked about their:

- **Values** with respect to public lands.
- **Objectives** for the management, use and conservation of forests and grasslands.
- **Beliefs** about the role the USDA Forest Service should play in fulfilling those objectives.
- **Attitudes** about the job the USDA Forest Service has been doing in fulfilling their objectives.

This report is based on 7,069 responses to the NSRE phone survey.

Members of the American public were asked about their values with respect to public lands, objectives for the management of public lands, beliefs about the role the agency should play in fulfilling those objectives, and attitudes about the job the agency has been doing.

This study found that, similar to other studies regarding public land management, the American public could be separated into two different clusters: those individuals who orient their thinking about forests around human uses and resources that humans can use, and those who tend to orient their thinking about forests around the value of nature and natural systems for themselves. In general, others (Bourke and Luloff 1994; Steele et al. 1994) found that women, people with higher education, and younger individuals, tend to support more environmental positions. .

The public sees the promotion of ecosystem health as an important objective, and role, for the agency. There is strong support for protecting watersheds.

The public supports multiple uses but not all uses equally. There is a lack of support for subsidies to develop and lease public lands. There is moderate support for providing resources to dependent communities. The provision of less consumptive services is more important than those that are more consumptive. Preservation of traditional uses is a somewhat important objective.

Development and use of the best scientific information enjoys wide support, as does information sharing and collaboration. A national direction for the management of National Forest System lands is a slightly important objective. Increasing law enforcement on National Forests and Grasslands is an important objective and an appropriate role for the agency. The public has a strong environmental protection orientation, has a moderately strong conservation/preservation orientation, and supports some development.

Social Assessment of the Four County Area (SAFCA)

This survey was conducted by the University of Wyoming through the State of Wyoming's Cooperating Agency Agreement to provide information on the connections between the Bighorn National Forest and the residents of the "Four-County Area" – Big Horn, Johnson, Sheridan, and Washakie Counties.

National Visitor Use Monitoring Results for the Bighorn National Forest (NVUM)

The NVUM project was implemented to better understand the use and importance of, and satisfaction with, National Forest System recreation opportunities. In any given year, 25% of the National Forests conduct on-site interviews and sampling of recreation visitors. The Bighorn National Forest participated in the NVUM project from October 2000 through September 2001.

Discussion of Survey Results

Demographics

NSRE: The average age of respondents was 44 years, with approximately 24% aged 30 and under, 41% aged 31 to 50, and 35% over 50. Forty three percent of respondents were male, 57% female. Educational levels were varied, with 11% having less than a high school diploma, 27% having completed high school, 24% having some post-high school education, 26% holding Bachelor's degrees, and 12% having a Master's degree or higher. Average annual household income was $59,000. The NSRE sample over represents non-metropolitan residents with 38% compared to 20% in the general population.

SAFCA: The median age of respondents was 54.8. Males (68.6%) are over represented in the sample population, in part reflective of the telephone and property tax listings. Median length of residence in the current county of residence was 27.4 years with most residents residing "within the city limits" (681 of 1135 or 60%). Another 146 respondents resided adjacent to a city while 308 (22.1%) indicated that they lived in a rural part of the county. Of the rural residents, 126 (11.1%) of all those who responded to the residential location question noted that they lived on a ranch or farm.

NVUM: Males comprised 62.1% of respondents. The largest number of respondents were aged between 41-50 years (30.6%). Visitors predominantly categorized themselves as white (97.6%). Three percent of forest visitors were from another country. The largest number of visitors associated with a particular zip code (82801 – Sheridan) was 15.8%.

Recreation

NSRE: Recreation opportunities can be divided into motorized and nonmotorized. The provision of increased access for motorized recreation is seen as a slightly unimportant objective for public land management and is also viewed as a slightly unimportant role for the USDA Forest Service. Non-metropolitan easterners and metropolitan westerners see motorized access as a more important objective than do non-metropolitan westerners and metropolitan easterners. Agency performance in the area of motorized recreation is viewed as somewhat favorable, except in the case of off-highway motorized access, where the agency role and performance are rated as slightly unfavorable.

The agency is viewed as doing a somewhat favorable job providing nonmotorized access. Support for nonmotorized recreation opportunities is stronger in metropolitan areas than non-metropolitan areas. Separating these often conflicting types of pursuits by designating trails for specific uses is seen as a somewhat important objective, with higher support outside of metropolitan areas.

Generally, the preservation of a "wilderness" experience and the designation of wilderness are seen by the public as at least somewhat important objectives to pursue. Metropolitan residents show the strongest support for this objective in both the East and West. Among non-metropolitan residents, those in the East show stronger support than those in the West for the designation of additional wilderness. These activities are at least somewhat important roles for the USDA Forest Service, and the agency is doing a somewhat acceptable job.

SAFCA: Respondents were in strong agreement that the federal government should balance recreation and wilderness uses with commodity uses. In terms of ranking public benefits provided by the Bighorn National Forest, local respondents ranked "Provide Recreation Opportunities" as 6th out of 9 potential priorities, behind such items as "Make sure the forest is available for future use" (1st), "Provide and Protect Sources of Water for Human Use" (2nd), "Provide Healthy Home for Wildlife" (3rd), "Support Traditional Ways of Life for Local Communities and Individuals" (4th).

NVUM: The questions posed in this survey did not address this particular issue.

Access

NSRE: The American public is divided in its opinion about the provision of access. This is evidenced by the difference between support for motorized access and support for nonmotorized access. Motorized recreation is not a high priority objective, while preserving the ability to have a "wilderness experience" is important.

The expansion of off-highway motorized access and the development of new paved roads are somewhat unimportant objectives and the provisions of trails for motorized access are slightly unimportant to the public. Contrast this with the provision of nonmotorized access, which is viewed as a somewhat important objective to the public.

SAFCA: Local divisions regarding provision of access nearly mirror the national opinion.

There was significant disagreement among residents of the four counties with regard to providing more roads for access. Out of 14 desired future condition issues, this issue ranked in priority from 6th (Washakie County) to 14th (Sheridan County) with Johnson (12th) and Big Horn Counties (7th) situated in between. As a whole, this issue was ranked 10th out of 14 issues, with a ranking of "1" being the highest priority.

There was variation amongst the four counties with regard to whether or not a county resident would regard a management shift with regard to decreased motorized use (winter and summer) with Sheridan County residents being more likely to report positive effects while residents in Johnson, Big Horn and Washakie Counties were slightly more likely to report negative consequences.

NVUM: Forest visitors reported a strong preference in "viewing activities" such as viewing natural features (94.0%), wildlife and fish (89.9%). Aside from pleasure driving (52.9%), motorized activities amongst users of the Bighorn National Forest, as

reported by NVUM, ranked low in frequency. OHV motorized recreation reported a 14.7 participation rate. Snowmobile travel reported a 3.7% participation rate although this could partially be attributed to the fact that the reporting period took place during a low snowfall year.

Preservation/Conservation

NSRE: The public sees the protection of watersheds as an important objective for public land management. In the West, those in metropolitan areas see this as a more important objective than do their non-metropolitan counterparts. The public also agrees that this is an important role for the USDA Forest Service, with metropolitan dwellers in the West viewing this as slightly more important role for the agency than those in the non-metropolitan West. The agency is also given a favorable evaluation for its performance in this area, with metropolitan westerners giving higher ratings than non-metropolitan westerners.

SAFCA: The residents of the four counties placed a high priority on providing and protecting sources of water for human use. Out of nine potential public benefit issues, "Provide and protect sources of water for human use" was ranked either 1st (Johnson and Sheridan counties) or 2nd (Bighorn and Washakie counties).

However, when asked about other preservation-related issues, including "Set aside land for wilderness," (14th out of 14) "Designate Wild and Scenic river areas," (9th out of 14) and "Set aside research natural areas" (11th out of 14) the rankings across all four counties were much lower.

NVUM: On a scale of 1 to 5, with 5 being "very important", visitors to the Bighorn National Forest in Developed Recreation areas reported that "Condition of the natural environment" and "attractiveness of the forest landscape" were highly important to them, with each receiving a ranking of 4.6. On the same scale, visitors to the Bighorn National Forest in general forest areas (outside of developed sites) reported nearly the same results – 4.4 and 4.7 respectively.

Economic Development

NSRE: These items address determination of the level of commodity uses of public lands. These objectives are supported at least moderately by the public. Members of the public more familiar with the multiple use objectives of the National Forest System lands are less likely to support policies that eliminate timber harvest and mining in order to preserve natural resources. These same respondents are also less likely to see the protection of ecosystems and watershed and the preservation of a wilderness experience as appropriate roles for the USDA Forest Service.

People more familiar with the agency also see the performance of the USDA Forest Service in the areas of watershed and ecosystem and habitat protection as less favorable than those less familiar.

Respondents with high or moderate agency familiarity are more in favor of restricting the development of minerals, while those with lower familiarity are more in favor of easing the permitting process. This group also feels that this is a more important role for the USDA Forest Service than do those with a higher level of agency familiarity.

More familiar respondents feel that the expansion of commercial recreation is a slightly unimportant role for the agency, while those less familiar see this as slightly important. Those who are less familiar with the Agency gave it a higher performance rating (where there are differences) than the other, more familiar respondents.

SAFCA: Across the four counties, the economic sectors reflected some of the largest differences by county in the assessment. The most consensus is found on summer recreation businesses and winter recreation businesses, implicitly recognizing tourists not only as economic assets, but that perhaps the Bighorns are "their mountain too." The greatest difference by county was over grazing and the least overall support was for logging (UW, 2002).

In the questions about effects of possible changes in Forest Service management decisions Big Horn and Washakie counties expressed the most concerns about possible restrictions on both recreation and commodity uses. Sheridan County reported the most positive effects of possible changes in grazing, logging, winter and summer motorized use.

NVUM: The questions posed in this survey did not address this particular issue.

Education

NSRE: More familiar respondents are in favor of informing the public about recreation concerns and about potential environmental impacts, more than respondents with low familiarity. Those with moderate familiarity are the most supportive of encouraging collaboration. However, those with high familiarity see this as a more important agency role than do those with low or moderate levels of familiarity.

Respondents with low or moderate familiarity see the role of informing the public on environmental impacts and on economic values as more important than do those who have a high degree of agency familiarity.

Again, agency performance receives the highest ratings from those with less familiarity with the USDA Forest Service.

SAFCA: The questions posed in this survey did not address this particular issue.

NVUM: The questions posed in this survey did not address this particular issue, although education-related activities ("Visiting a nature center, nature trail or visitor information service" and "nature study") ranked 7th and 19th respectively out of 26 reported activities.

Natural Resource Management

NSRE: People who are more familiar with the USDA Forest Service are more in favor of making management decisions at the local level. At the same time they are less supportive of collecting an entrance fee for National Forests and Grasslands and for increased law enforcement on National Forest System lands. This group also sees the role of increasing law enforcement as less important for the agency than the less familiar groups.

The protection of ecosystems and habitats and the restriction of natural resource extraction are also seen as important objectives. The public also sees these activities as appropriate roles for the USDA Forest Service. Again, where statistically significant differences between demographic groups occur, metropolitan dwellers are more in favor of such policies than are those living in non-metropolitan areas. The agency is doing a somewhat adequate job of protecting ecosystems and restricting extractive uses.

Respondents with low agency familiarity see increasing the total acreage of the National Forest System as a less important role for the agency than do moderately or highly familiar individuals. Higher levels of agency familiarity again correspond to lower ratings of agency performance.

SAFCA: With regard to management decisions being made at the local level, residents of the four counties felt that the federal government should include the opinions of the public, the needs and wants of local communities in management decisions.

When asked their opinion of federal land managers, county respondents were in agreement that federal land managers are in general regarded with suspicion, even if most have had good experience with local Forest Service staff, and several cited improvements in the local service of the past few years.

The questions posed in this survey did not address this particular issue.

ENVIRONMENTAL CONSEQUENCES

Direct and Indirect Effects

Based on the questionnaire data and interview with 43 stakeholders, it is recognized that shifts in forest management (biological, physical and facilities) will have social effects in the short and long term. The effects fall into the broad categories of grazing/logging, access/roads, recreation, community identity and development. These issue areas are examined in relation to broad differences in the extremes of the alternatives.

Obviously each of the alternatives pose some social and economic consequences for people residing in the four counties that contain the BHNF; yet our analysis of 1,230 residents selected by a probability sample reveals that those effects do not vary appreciably by sex or age. There are some variations that occur by occupation with

those, not surprisingly, involved in agriculture, forestry, or mining most supportive of continued or increased commodity use on the BHNF. Likewise with regard to commodity usage there are a few noteworthy differences by county and these are noted in the text.

Our data suggest that the Bighorns are a large part of the recreational, and to a lesser degree of business lives of the residents of the four counties. More than 19 of 20 Johnson County (95.4%) used the BHNF for recreation (median number of visits at 8.9) compared to the lower use by Big Horn County residents (92.1%) and fewest number of visits 7.3 for Washakie residents. Among those traveling across the Bighorns for business purposes, those in Washakie (88%) average 4.82 trips during the year compared to 1.96 visits by 71.3% of Sheridan residents with those residents in Johnson and Big Horn falling in between.

Grazing. Under all alternatives, the number of AUMs will remain at their current levels until the site-specific effects of management can be assessed. Allotments managed to meet desired conditions will maintain the same stocking levels or possibly see an increase in AUMs, while those allotments that do not meet desired conditions might experience a decrease in AUMs. This approach provides current permit holders a level of security that is based on their own ability to manage their livestock to meet objectives, and it assists them in making decisions for the future. When asked about impacts of possible grazing restrictions, 52.7% replied "no effect" while 21.8% indicated possible negative effects. Here, county differences surfaced, with only 13.6% of Sheridan County respondents indicating possible negative consequences, compared to almost three in ten for Big Horn, Johnson and Washakie Counties.

Based on survey results, a decision not to reduce grazing AUMs will be appreciated by the residents of Big Horn and Washakie counties who ranked grazing as the most important of five economic sectors for their respective counties. More than one ranching stakeholder on the west side argued powerfully that forest grazing enabled ranchers to keep from subdividing private land, thus protecting open space. Likewise, Johnson County residents place grazing in second place after tourism. Only in Sheridan County did residents rank grazing as the least significant economic sector. Grazing is recognized as significant for the economies of Big Horn, Johnson, and Washakie Counties; however, residents in all four counties, ranked grazing 8th out of 9 benefits provided by the BHNF.

Timber. Alternatives A through E vary appreciably in the amount of logging to be permitted for the next fifteen years with maximum logging under Alternatives A and E (but both are below the ASQ in the 1985 plan) and minimum logging under Alternatives C and B. Unlike grazing, selection of alternatives will have a direct impact on the three in ten (almost 4 in 10 for Big Horn County) who indicated that they would be negatively impacted by a decrease in logging. Interestingly, in Sheridan County where a mill exists only 23.7% indicated that they would be negatively impacted while 24.7% indicated that there would be some positive effects from decreased logging (compared to a low of 13.2% for Big Horn County residents). Half the interviewees who opposed

logging were from Sheridan County. Five in ten respondents indicated a reduction in logging would have no effect on them personally.

Of the five economic sectors respondents were asked to rank according to importance for the local economy logging was ranked last for every county except in Sheridan County where it was ranked 4th just ahead of grazing. Similarly, when respondents were asked to rank order nine benefits provided by the forest service with one being most important, logging was ranked 7th in all four counties just ahead of grazing (8th) and minerals (9th).

The data above is inconsistent with the degree of support for continuity of commodity use on the forest. When given a list of 14 desired conditions on the Bighorn National Forest, overall 51.3% checked yes to "continuity of commodity use." For residents in Big Horn (55.1%) and Washakie (61.1%) continuity of commodity was the most frequently checked "desired future condition" compared to 3rd for Johnson County and 6th for Sheridan County residents. These data might reflect the strong support for multiple use found in both the interviews and questionnaires, although it appears that people define “multiple use” in varying ways.

Access/Roads. In the interviews and written comments, numerous comments noted that the "mountain" was harder to access than 20 or even 10 years ago. In part, this concern is related to two diverse developments. First, there has been some consolidation of private ranches and in some cases the transfer of property to non-profit organizations who have developed conservation easements. In other cases ranches have been subdivided into smaller plots for homes and/or ranchettes. In these cases the general decline in public access to the national forest is beyond the control of the forest service. The policy of closing roads or requiring a special use permit by land owners abutting the national forest when public access is denied is the major leverage that the forest service has in keeping gates open.

Residents were asked to evaluate 14 different "future" desired conditions on the BHNF. One of those conditions was "provide more roads for access to and throughout the forest" to which respondents could check "yes." "Provide more roads" was ranked 10th (26.9% checked yes) by all respondents while "Consider plants and animals as a high priority in resource decisions" was ranked first (59% checked yes). Residents in Big Horn (35.2%) and Washakie (35.6%) were more likely to support additional roads than those living in Johnson (22.4%) and Sheridan (22.2%) counties.

The questionnaire data does not directly address the issue of fewer roads directly, but is indirectly addressed by questions regarding winter and summer motorized use restrictions, and setting aside more wilderness and natural research areas. These issues are discussed under recreation. Many of the interviewees raised the Roadless Initiative issue and held various opinions on it as an “opportunity” or an “intrusion,” but even some who took the latter perspective that the Bighorns had too many roads at present.

Recreation. Over the long term, the proposed shifts in forest management that impact various types recreation will have the greatest direct effects on the residents of the four

counties. Also, the fact that different types of recreation users compete for the same resource poses the possibility of conflict (i.e. motorized and nonmotorized). Finally, management efforts to maintain a healthy forest for future generations also have the possibility of restricting some forms of recreation. The back page of the questionnaire was devoted exclusively to recreational activities; also other questions directly address recreational endeavors in terms of most favorite and frequency of use.

Alternatives that reduce or increase wildlife viewing (78.4%), sightseeing (66.1%), fishing (63%), or picnicking (60.2%) would enhance or decrease recreational activities for more than half of the respondents although in general, most of these activities would be marginally affected at most under the alternatives. For example, Alternative C places more of an emphasis on maintaining areas for nonmotorized recreation, and Alternatives B, C and D emphasize the scenic byways. Almost half (45.6%) reported day hiking as an activity: an activity that could be impacted by access shifts as noted in the alternatives. In terms of access by motor vehicle, there is likely to be little difference in overall opportunities during the life of the Revised Plan but over the long term (i.e. 20-50 years), there is a greater potential for the creation of additional motorized travel opportunities in Alternative E and A and a lesser potential for additional motorized travel opportunities in Alternative C.

More than 1/3 (36.9%) indicated that they hunted big game (highest likelihood of retainment of elk security areas would likely occur in Alternatives B and C) and about 1/10 hunted small game (9.7%) and birds or waterfowl (11.5%). The most acreage of existing elk security area would need to be entered (primarily for purposes of timber harvest) in Alternatives A and E. Alternative C increases wilderness acreage by 67% (compared to existing). Research Natural Areas prohibit summer motorized recreation and would increase from two (1,449 acres) to six (26,989 acres) in Alternatives B, C, and D. There would be no change in the number of RNAs in Alternatives A and E.

The 25.5% who engage in four-wheeling will be most affected by the conversion of the remaining “C areas” (where motorized travel off system roads and trails is still allowed) to “A areas” which will prohibit motorized travel off of system roads and trails. The conversion from “C” to “A” areas will occur under all alternative and will affect 11.1% of the Bighorn National Forest. Yet, the restrictions on off-road/off-trail motorized travel will most likely be viewed favorably by the 25.8% who noted they go to the forest for spiritual and mental renewal and for the 18.4% who use the forest for horseback riding. Thirty-one percent indicated they visited a historical site for recreation, with most of this visitation occurring at the Medicine Wheel, which would be managed under the Historic Preservation Plan under all alternatives.

Several alternatives have the potential to somewhat impact cross country skiers (11.7%), and snowmobilers (13.7%). These are recreational activities that have potential for conflict over shared resource usage. Alternative C would create a nonmotorized winter backcountry area in the Salt Creek drainage for backcountry skiers although at the same time it restricts the greatest amount of acreage to snowmachine travel, increasing the possibility of concentrating existing snowmobilers, potentially

resulting in greater perception of crowding, although the designated snowmobile trail system will remain essentially unaffected irragardless of alternative. It also provides the greatest amount of quiet (i.e. nonmotorized) winter areas.

None of the alternatives will impact the 10.3% who boat, although it is likely that additional wild and scenic classification could positively impact those who rafted or canoed (these individuals were not coded separately).

In addition to asking about the kinds of recreational activities they participated in, respondents were asked to list their first, second and third favorite thing to do on the Bighorn NF. When these top three activities were combined, approximately one of five rated fishing and camping/picnicking among their favorite activities; approximately one in seven placed hunting, enjoyed the scenery or hiking/backpacking among their top choices; and fewer than one in twenty listed snowmobiling, ATV/off-road recreation, or skiing/snowshoeing as their favorite activities. There were few differences across counties other than that Sheridan and Johnson counties' residents were more like to be hikers/backpackers than Big Horn residents. The Forest's goal of decommissioning four miles of road per year will not vary by alternative. Alternatives A and E could potentially result in road construction into the Piney/Rock area which, given the length of road needed, could remain open to public use, unlike most timber roads. This would result in additional access within the Forest. Whereas Alternative C will most likely maintain the greatest amount of "quiet" opportunities for hikers/backpackers.

Although very few respondents list off road riding or snowmobiling in their top three favorite recreational activities, when asked about possible decrease in winter or summer motorized use respondents gave very mixed responses. About 4 in ten (42%) indicated a reduction in summer motorized use would negatively impact them compared to the 3 in 10 (31.4%) who reported possible positive benefits. Similar results were evident with reduced winter motorized usage with 29.6% reporting negative effects and 23.9% citing positive effects.

The idea of creating designated ATV trails received support by about 4 of 10 (39.8%) respondents with the greatest support in Washakie (46.1%) and least support in Johnson County (33.5%). The creation of designated ATV trails responses almost mirrored the responses to "limit camping to designated sites in heavily used areas (39.8%). With support greatest in Sheridan County (44%) and least in Big Horn (33.9%). In regard to future desired conditions, "close some dispersed recreation sites" received support by 40.6% of the respondents with 47.7% checking yes in Sheridan County compared to a low of 29.6% in Big Horn County. Across all alternatives, forestwide guideline would prohibit, or mitigate through other management practices, dispersed camping within 100 feet (or high water mark) of lakes larger than 1/4 acre and perennial streams along the mainstem of the 6th-level municipal watersheds of Clear Creek, Goose Creek, Tensleep Creek, Shell Creek, and Tongue River. This reflects a targeted effort to address resource impact and water quality concerns in high use areas and would not vary by alternative.

When queried about possible public benefits of forest management, recreation was listed 6th (one being greatest benefit) of nine possible activities. Ranking did not vary across counties and recreation was ranked just ahead of various commodity uses. Also receiving little support was the possibility of setting aside land for wilderness (21.1% checked yes, ranked 14th), "setting aside research natural areas" (25%) and "designating wild and scenic river areas (28.1%) (found most notably in Alternatives B and C, but also in the rest of the alternatives to a lesser degree. Among the interviewees there was greater support for additional wilderness and protecting the biological diversity and integrity of the land. There was also greater recognition that tourism was putting greater pressure on recreational use of the BNF.

Community Identity. Based on the comments on the questionnaire and the in-depth interviews there is no doubt that the majority of the residents of the four counties have not only economic and recreational attachments to the Bighorn Forest, but also physical attraction to the "mountain." The "mountain" represents, to some extent, a western lifestyle suggesting both strength and ruggedness. Proximity the national forest lands was ranked either 4th or 5th of nine factors by the respondents on why they chose to live in the four counties while proximity to recreation opportunities was ranked 6th by residents in each of the four counties. Reasons for living in the area, "for the wide open spaces," "to avoid big city lifestyles" were ranked either 1st or 2nd followed closely by "appreciate the rural lifestyle." From these data, it is obvious that physical location, size and nearness of the BHNF are critical elements in the defining why people choose to live on or near the forest.

Community identities (based on county data) are inextricably bound by the physical location of communities abutting the mountain. Proximity to recreation and economic opportunities provide much of the basis for small town lifestyles. Underlying much of the data discussed above is an explicit and implicit concern for possible forest management shifts. Somehow the status quo is comforting. Locals made evident that they want the "federal government to include the needs and wants of local communities in making long-term management decisions." On a five-point scale, 62% checked strongly agree on this item (low of 55.2% for Sheridan County and high of 70.8% for Big Horn County residents). Likewise 2 of 3 respondents checked strongly agree on "how the USFS manages the national lands matters to me." Dependency on forest service management is reflected in the questionnaire responses to benefits provided by the USFS where "provide and protect sources of water for human use," and "make sure the forest is available for future use" were ranked 1st or 2nd of nine possible benefits provide by the forest followed closely by "provide a healthy home for wildlife" which was ranked 3rd by respondent in the four counties. Two-thirds of the interviewees felt that their communities were dependent on public land resources and nearly half identified themselves as taking an environmental stand. Two-thirds of the 43 interviewees spontaneously discussed the aesthetic importance of the Bighorns to their communities' identities.

Development. Since the data was acquired, there has been a significant change in the economies of Johnson and Sheridan counties; in particular, there are sizeable changes

associated with coalbed methane production. These changes are beyond the influence of the Forest Service, but they put pressure on Johnson and Sheridan counties and their principal communities of Buffalo and Sheridan. Implicit in this growth is continued growth near the forest boundaries and most likely continued or even increase concern about forest access (see above discussion). More than half the interviewees speculated that the renewed growth will most likely place new demands on recreational opportunities and available water on the Bighorn NF.

Up to 2000, the population in the 4-county area was aging significantly. Such population change has significance for the local communities in terms of providing adequate health care and for the future viability of the primary and secondary schools. Likewise, an aging population will be directly impacted by forest service management practices such as road closures, limits on dispersed camping, and possibly shifts in established camping. Regardless of age, our data suggests that almost everyone in the four counties accessed the BHNF during the year preceding our survey questionnaire.

Potential Conflicts with Goals/Objectives of Other Agencies

The Forest has coordinated with various agencies in the formulation of alternatives; the development of goals, objectives, standards, and guidelines; and other important aspects of the revision process. Consultations include American Indian tribes; the Bureau of Land Management; U. S. Fish and Wildlife Service; Wyoming Game and Fish Department; county governments; Conservation Districts; and other local, state, and federal agencies. County Land Use and Conservation District Annual Plans were reviewed. For a complete list of agency coordination, please see Appendix A. The administrative record, located at the Forest Supervisors office in Sheridan, WY, contains proceedings of the coordination efforts.

The alternatives, associated effects, forestwide standards and guidelines, and management area prescriptions are generally compatible and compliment the goals and objectives of land management agencies adjacent to or near the Forest. The following summary is provided to help define areas of potential differences between the Forest Service policies, management, and responsibilities and those of other agencies.

Mitigating effects from mining activities could result in conflicts with federal mining laws. The U.S. Mining Laws Act of 1872 predates all other laws that govern Forest Service activities. Conflicts could arise between the mining activities allowed under the act and other resources, such as scenery, water, sensitive plants and animals, or recreation.

Federal requirements and authorities for maintenance and protection of water resources may conflict with the state of Wyoming's administration of water rights.

The Forest is cooperating with the Wyoming Game and Fish to investigate potential declines in big game hunting opportunities on the Forest. Increasing road densities and reductions in cover may be partially responsible for elk and other big game leaving the Forest prior to the fall big game hunting season.

Concerning a rest room facility along U.S. Highway 16, the Draft Revised Washakie County Land Use plan states that federal land use plans are "… incomplete and materially deficient unless it contains a thorough discussion and evaluation of the need for public sanitary facilities along transportation corridors in the county. The Forest has maintained that the forest plan will allow for construction of such a facility, but it is not

the proper decision level for this. In addition, the Forest has resisted being a 'lead' agency for the construction and maintenance of this facility because the Forest currently does not have the budget to maintain our existing recreation facilities.

Resource Commitments

Energy Requirements for Implementing the Alternatives

Energy is consumed in the administration and use of natural resources from the Forest. For the purpose of the Revised Plan, energy sources are gasoline, diesel fuel, liquefied petroleum, natural gas, electricity, and wood. Although many activities consume energy, the following are considered important in the implementation of any alternative:

- Energy consumption related to recreation is the amount required for visitors to get to and around the Forest, and for administrative purposes. The amount used is based on the number of dispersed and developed recreation visitor days, estimated trip lengths, and facility construction.
- Energy consumed in timber harvesting is the amount required for felling, bucking, skidding, loading, hauling, for performing road maintenance, and for the industrial traffic associated with harvest activities.
- Energy consumed in utilizing range vegetation is the amount required for hauling stock to and from the range and for permittee range improvement activities (watering, salting, and herding).
- Energy consumed in road construction and reconstruction activities is that used by contractors or Forest Service crews in completing road development.
- Energy consumed by Forest Service administrative activities includes vehicle use; lighting and heating of buildings; and fuel used in such equipment as small engines and burners.
- Proactively, the Forest is currently installing fuel cells at the Big Goose Ranger Station, a renewable energy source.

Unavoidable Adverse Effects

The application of forest-wide standards and guidelines and resource protection measures would limit the extent and duration of any adverse environmental effects. Nevertheless, some adverse effects are unavoidable. In addition, "adverse effects" for one may be a "beneficial effect" for another. For example, timber harvest may adversely affect the habitat for species that need mature, large trees while at the same time increasing the amount of habitat for species that need early successional habitat. For detailed disclosure of all effects, including unavoidable adverse effects, see the following Environmental Consequences discussions for each resource area (air, biological diversity, recreation, minerals, etc.).

Hazardous Materials

The use of motor vehicles and the transport of hazardous materials such as gasoline, other fuels, and building materials on roads and highways creates the potential for accidental spills.

Relationship Between Short-term Uses of the Environment and Long-term Productivity

Short-term uses are those expected to occur on the Forest over the next ten years. These uses include, but are not limited to, recreation use, grazing, mineral development, timber harvest, and prescribed burning. Long-term productivity refers to the capability of the land to provide resource outputs for a period of time beyond the next ten years.

The minimum management requirement established by regulation (36 CFR 219.27) provide for the maintenance of long-term productivity of the land. Minimum management requirements prescribed by the forest-wide standards and guidelines will be met under all alternatives. Minimum requirements assure that long-term productivity of the land will not be impaired by short-term uses.

Monitoring, as described in Chapter 4 of the Revised Plan, applies to all alternatives. One purpose of monitoring is to assure that the long-term productivity of the land is maintained or improved. If monitoring and subsequent evaluation indicates that forest-wide standards and guidelines are insufficient to protect long-term productivity, the Revised Plan will be amended.

Although all alternatives were designed to maintain long-term productivity, there are differences between alternatives in the long-term availability or condition of resources. There may also be differences between alternatives in long-term expenditures necessary to maintain desired conditions. These differences between the alternatives are described in Chapters 2 and 3.

Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitment of resources is defined in Forest Service Handbook 1909.15 (2/21/95).

- The irreversible commitment of resources means that nonrenewable resources are consumed or destroyed. Examples include mineral extraction, which consumes nonrenewable minerals, and potential destruction of such things as heritage resources by other management activities. These consumptions or destructions are only renewable over extremely long periods of time.

- The irretrievable commitment of resources are opportunities foregone. They represent trade-offs in the use and management of forest resources. Irretrievable commitment of resources can include the expenditure of funds, loss of production, or restrictions on resource use.

Decisions made in a forest plan do not represent actual irreversible or irretrievable commitment of resources. A forest plan determines what kind and levels of activities are appropriate on the Forest; it does not make site-specific or project decisions. The decision to irreversibly or irretrievably commit resources occurs:

- When the Forest Service makes a project or site-specific decision.
- At the time Congress acts on a recommendation to establish a new wilderness or to include a river in the Wild and Scenic River System.

The Record of Decision that will eventually accompany the Final Revised Plan will authorize the Bureau of Land Management to lease certain portions of National Forest System lands based on the leasing analysis in the future EIS and subject to the leasing stipulations in Plan Appendix E. Although surface disturbance cannot occur on leased land wityout further NEPA analysis and decision-making, issuance of a lease confers certain rights on the lessee and represents a commitment of resources. The effects of the exploratory and developmental wells on lands with low oil and gas development potential were analyzed and disclosed in all alternatives.

Examples of irretrievable resource commitments associated with Revised Plan decisions are as follows:

- Commodity outputs and uses (such as motorized recreation) would be curtailed or eliminated in areas recommended for, and subsequently designated as, wilderness, Wild and Scenic Rivers, Research Natural Areas, and some Special Interest areas.
- Opportunities for non-motorized recreation, solitude, and primitive or wilderness experiences would be foregone if portions of the Forest are not allocated or recommended for and subsequently designated for these purposes.
- Timber volume outputs would be foregone on lands determined as not suitable for harvest.
- Commodity outputs would be reduced or foregone on areas allocated to specific uses or purposes, such as developed recreation sites, old growth habitat, or botanical areas.
- Non-commodity values, including scenic resources, may be reduced or foregone in areas allocated to commodity uses.
- To the degree that an alternative preserves or encourages the development of mature and old-growth habitat, opportunities to develop early successional habitat are reduced.