CHAPTER THREE

This section contains the affected environment and environmental consequences analysis of effect by alternatives for each resource area. Both sections have been combined in this chapter and are listed alphabetically. Many terms used in the analysis are defined in the glossary at the end of Chapter 4.

AIR QUALITY

Changes Draft to Final

Analysis clarified in response to comments.

Analysis Area

The analysis area for direct, indirect, and cumulative effects includes the entire BDNF and adjacent areas within a 100 km from the forest boundary. This figure is based on air pollution modeling and has been used on other forests. Air pollution has the potential to impact a variety of resources on the BDNF 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 BDNF is good and typically meets national and state standards for air quality except in the case of large wildfires, where those standards may be temporarily exceeded in that location.

Analysis Methods and Assumptions

The Environmental Protection Agency (EPA) has established health-based National Ambient Air Quality Standards (NAAQS) for 6 pollutants called "criteria" pollutants. Concentrations higher than standards are considered unhealthy and are a potential violation of law; concentrations below are considered acceptable:

- **Carbon monoxide (CO)** is a colorless, tasteless, odorless gas produced primarily by motor vehicles (56%, nationwide). Other sources may include stoves, fireplaces, and wildland fires (6%). Elevated CO levels occur in high density urban areas and mountain valleys.
- **Ozone (O_3)** is a blue unstable gas with a characteristic odor. Ozone is created by a chemical reaction between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Hydrocarbons are emitted by vehicles, wildland fire and other sources, including vegetation (e.g. terpenes emitted by pine trees). The highest ozone levels generally occur in the summer when sunlight is stronger and stagnant weather conditions cause reactive pollutants to remain in an area for several days.
- **Nitrogen dioxides (NO_2)** is a reddish-orange-brown gas with a pungent odor. Nitrogen oxides or NO_x, is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. NO_2 is a common pollutant in this

family of gases that is formed during high temperature combustion such as in motor vehicle engines. A limited amount of nitrogen dioxide is emitted by wildland fires.

- **Particulate matter (PM_{10} and $PM_{2.5}$)** consists of very small particles of solid or semi-solid materials in the atmosphere. Elevated particulate matter levels are generally associated with high density urban areas or localized mountain valleys where dust, smoke, and emissions are common.
- **Lead** in the ambient air exists primarily as particulates coming from lead smelters, waste incinerators, utilities, and lead-acid battery manufacturers. The major source of lead used to be leaded gasoline, but this is no longer the case with the phase-out of leaded gasoline.
- **Sulfur Dioxide (SO_2)** belongs to the family of sulfur oxide gases (SO_x). SO_x gases are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil or metals are extracted from ore. Most SO_2 comes from electric utilities, especially those that burn coal. Some SO_2 comes from non-road diesel equipment that burns high sulfur fuel.

More information regarding the six criteria pollutants can be found on EPA websites. The discussion on criteria pollutants in June of 2006 came from this EPA website.at: http://www.epa.gov/ebtpages/airpollutants.html

Areas where the National Ambient Air Quality Standards (NAAQS) are exceeded are considered non-attainment areas. The only non-attainment area in the BDNF vicinity is Butte, Montana for $PM_{10.}$ (http://www.deq.state.mt.us/AirQuality/Planning/AirNonattainment.asp). No portion of the BDNF is currently located within the boundaries of a non-attainment area. However, the Anaconda Pintler Wilderness Class I) and the Lee Metcalf Wilderness (Class II) are air quality areas within the boundaries of the BDNF that are mandated for protection under the Clean Air Act. Class I areas have the highest level of protection for air pollutants, and very little deterioration of air quality is allowed in these areas.

All major drainages in the BDNF area are subject to temperature inversions which trap smoke and reduce smoke dispersal. Temperature inversions can occur at any time during the year, but are most common in the fall and winter. Generally, dispersion of emissions within the analysis area is very high due to the mountainous terrain and high wind activity. The Wind Energy Resource Atlas of the United States (Elliott et al. 1986) shows average wind speed for Dillon at 4.2 meter/second. All of the Reasonable Development Scenario well sites are mapped in wind power class 7 which has an annual wind speed of 7 meter/second (15.7 mph). Valley locations have much less wind dispersion than mountains and are more subject to pollutant concentration during temperature inversions.

The Ventilation Climate Information System (http://www.fs.fed.us/pnw/airfire/vcis/) shows that the BDNF area has generally excellent wind dispersion in mid-upper elevation areas with some lower dispersion areas in valley bottoms. The valley locations in and adjacent to the BDNF have the greatest potential for cumulative concentrations of urban, industrial, and transportation emissions. Up valley winds during daytime and down valley wind (cold air drainage) at night can dominate valley winds more than overall prevailing wind direction on ridge tops.

The average annual precipitation for the BDNF varies from approximately 40 inches in the higher elevations of the Pioneer Range to 10 inches in valley floors. Management actions have not caused NAAQS to be exceeded. Recreation and management use of roads have potential to directly affect particulate levels because of dust. Potential impacts, smoke and soot, from fire is short-term but can result in significant increases in smoke and particulates and can cause localized, temporary health impacts. Managed fire activities are coordinated with the Montana Department of Environmental Quality, Air Resources Management Bureau and the Montana/Idaho State Airshed Group.

Key Indicators

- Visibility
- Potential particulate emissions (tons per year) generated from prescribed fire.

Affected Environment

Regional considerations

Pollution sources for sulfur dioxide, oxides of nitrogen, and volatile organic compounds, east of the continental divide include industrial sources, wildfires, prescribed burning, agricultural burning, residential and business development, and vehicle emissions. Montana's largest air pollution problem is particulate matter. Particulate matter is the term given to the tiny articles of solid or semi-solid material suspended in the atmosphere. Particulate matter 10 microns in diameter and smaller, called PM_{10}, is considered inhalable and can have certain impacts on human health. Particles 2.5 microns in diameter and smaller, called $PM_{2.5}$, are considered to be the most damaging to human health and have the most effect on atmospheric visibility. Combustion processes produce ultra fine particles which are the bulk of $PM_{2.5}$. $PM_{2.5}$ is the principal cause of haze since it settles and is usually removed from the air by rain. PM_{10} settles in hours and is often pollen spores and some dust. A particular management concern is smoke which is full of $PM_{2.5}$ affecting visibility and human health (Hammer 2000).

The Air Resources Management Bureau has estimated for southwest Montana, including the BDNF, a NO2 background of 6 ug/m3 (annual average) and one hour NO_2 maximum of 75 ug/m3 are appropriate. These estimates can be improved and localized when more data is available. An average annual PM_{10} background concentration, for the purpose of emission concentration screening modeling, has been assumed to be 20 ug/m3. This concentration overestimate is based on measured PM_{10} levels during the fall burning season at Butte.

Sulfur dioxide (SO2) is a pollutant of concern from industrial sources in Billings/Laurel, East Helena, Colstrip, and Great Falls. Nitrogen dioxide (NO2) or nitrogen oxide (NO) in Montana includes coal fired power plants, natural gas compressor stations, and oil refineries, but is not a pollutant of major concern. Data submitted by the Colstrip Power Company has shown no violations of the NAAQS or Montana Ambient Air Quality Standards (MAAQS) for (NO2).

No active oil or gas wells currently exist on the BDNF. Scattered dry holes exist in the southwestern part of Montana, but no active production. The area is ranked as very low, low, or moderate for petroleum occurrence.

Emissions from wildland and prescribed fire are an important episodic contributor to visibility-impairing aerosols, including organic carbon, elemental carbon, and particulate matter (PM 2.5).

Agricultural burning emissions and their effects have been identified as a concern, but have not been quantified due to lack of data.

Other than statewide information, there are no data on emission or source category trends near the BDNF. This is a remote rural area and the potential for any activity besides smoke to affect air quality is low.

Forestwide Considerations

Generally, air quality within the Beaverhead-Deerlodge National Forest is excellent with limited local sources and consistent wind dispersion. All areas in and adjacent to the forest for both Class 1 and Class 2 areas are considered to be in attainment by the Montana Air Quality Division. Very limited specific information is available concerning existing air quality. A listing of stationary sources in Montana in the vicinity of the BDNF with permitted emissions greater than 100 tons/year can be found on the following EPA websites, as accessed in June of 2006: AirData: http://www.epa.gov/air/data/index.html; Clean Air Markets – Data and Maps: http://cfpub.epa.gov/gdm/ or the Envirofacts Data Warehouse: http://www.epa.gov/enviro/index.html

Three stationary sources of air pollution on the Montana Air Quality Division inventory with emissions greater than 100 tons/year occur near the BDNF. These include the Pfizer talc plant located about 7.5 miles southwest of Dillon. The AQD data base lists the Pfizer plant as emitting annual totals of 91 tons/yr of PM10, 1 tn/yr of VOCs, and 6 tn/yr of CO for a total of 121 tons/year. This is a relatively small source (less than PSD permit). The Montana Resources Mine at Butte has projected annual totals of NOx 462 tons/year, PM10 of 1727 tons/year, SO2 of 50 tons/year, and VOC of 30 tons/year. The Golden Sunlight Mine near Whitehall has projected annual totals of NOx 520 tons/year, PM10 of 886 tons/year, SO2 of 40 tons/year, and VOC of 30 tons/year. No other sources of industrial emissions occur in the analysis area other than very small local sources.

Other types of emissions in the area include vehicle and agriculture equipment exhaust, road dust, wood smoke from residential areas, smoke from pile burning, broadcast burning, and wildfires. Although the Beaverhead and Deerlodge NF's have had a low frequency of wildfires during the last 20 years, wildfire smoke has accumulated within the area during periods of extensive regional wildfire activity in 1988, 1994, 2000, and 2003. The Mussigbrod Fire in 2000 in the west part of the Pintler Range combined with the upwind Valley Fire Complex on the Bitterroot National Forest to produce extensive smoke impacts through much of the BDNF in August of 2000. The prime source of wildfire emissions are from central and southern Idaho and the Bitterroot National Forest. Smoke from wildfire in Yellowstone National Park can also impact the BDNF as it did in 1988 and 1994.

Air quality conditions in rural areas surrounding the BDNF are generally very good, as indicated by limited air pollution emission sources from few industrial facilities and residential emissions in relatively small communities and isolated ranches. Good atmospheric dispersion conditions, resulting in relatively low air pollutant concentrations also contribute to good air condition. Occasional high concentrations of CO and particulate matter (PM10) may occur in more urbanized areas with automobiles and home fireplaces (for example Anaconda and Butte) and around industrial facilities and the interstates, (Rocker) especially in the stable atmospheric conditions common during winter.

Emissions from fire, including prescribed fire, wildfire, and campfires, are a contributor to air pollution in 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 usually has been pusheding logging residue into piles and burning the piles when fire hazard conditions are low.

Prescribed fires are an intermittent source of particulates and may cause short-term visibility problems and temporary change in ambient air quality. On the BDNF approximately 7,300 acres are burn annually by prescription. Smoke permits are obtained from the Montana/Idaho State Airshed Group and Montana Department of Environmental Quality, Air Quality Resources Bureau based on estimated emissions from prescribed burn plans. The Group is notified prior to, and must give approval for, any prescribed burning activities.

Road dust from vehicle traffic on unpaved forest roads (Maintenance levels 1-3) also adds particulates to the air. In general, these emissions only cause air quality concerns in localized areas. During dry periods of the year, traffic on some roads can generate localized road dust.

Motorized use on forest roads and trails may also contribute localized emissions. Odor generated by combustion engines, particularly two-cycle engines can diminish a non-motorized user's experience of forest trails. The EPA has set standards for emissions of non-road engines and vehicles (snowmobiles, ATVs, boats, etc). The standards set for emissions of oxides of nitrogen (NO_x), hydrocarbons (HC) and carbon monoxide (CO) are to ensure compliance with the Clean Air Act, and to regulate those emissions that contribute significantly to the formation of ozone and carbon monoxide. Compliance with these standards requires manufacturers to apply existing gasoline or diesel engine technologies to varying degrees, depending on the type of engine (EPA 2006).

Because the occurrence of inversion is more likely during the winter months, snowmobile and vehicle emissions might be more concentrated in parking areas and trailheads. As a comparison, the West Entrance of Yellowstone National Park has been an area of considerable discussion relative to air quality effects from snowmobiles. The National Park Service provides information that indicates snowmobiles have a much higher per vehicle emission rate than autos and trucks. Monitoring in 1999 documented carbon monoxide (CO) and particulate matter concentrations at the West Entrance, which were very close to violation of the CO one-hour and eight-hour NAAQS. Measured concentrations were less at Madison and Old Faithful. Modeling various alternatives of winter use at the West Entrance, found that none of the alternatives for winter use management in Yellowstone Park would exceed one-hour average CO concentrations for NAAQS or MAAQS, although CO concentrations would be elevated considerably above background levels (Morris et al. 1999).

Two wilderness areas on the BDNF are the Anaconda-Pintler (Class I) and Lee Metcalf Wilderness Areas (Class II). An air quality monitoring plan for the Anaconda-Pintler Wilderness was developed in 1995. The plan includes monitoring objectives, resource susceptibility and current status, monitoring protocols, and a section on how to use the monitoring data. AQRVs are general features or properties of a Class I Wilderness which made the area worthy of designation as Wilderness and which could or would be affected by man-made pollution. The wilderness values most likely to be impacted by reduced air quality in the APW are visibility, lichens, flora, and water quality in cases of severe air pollution.

Sensitive receptors are specific components of the wilderness system through which change can be quantified. Sensitive receptors for the APW were selected based on known or suspected sensitivity to atmospheric pollutants; availability of sampling methods and analysis methods, and availability of modeling capabilities for predicting the effects of proposed increases in emissions o the sensitive receptor. The Forest Service operates a visibility monitoring station on Sula Peak, on the Bitterroot National Forest as part of the IMPROVE monitoring network. These monitoring programs provide air quality data used in local, regional, and state-wide air quality assessments and are useful for understanding current conditions, trends, and potential impacts of proposed development on air quality and air quality related values. The Sula Peak IMPROVE site has measured visibility consistently in the 180-200 km range which is some of the best visibility in the United States. Visibility data is available at http://vista.cira.colostate.edu/views/

Visibility and lake chemistry, ozone, and deposition data have been collected at nearby sites. The following table lists the air quality data for the BDNF.

Table 2. AQRV Monitoring for the AP and Lee Metcalf Wilderness Areas.

AQRVs	Sensitive Receptor	Region 1 Sampling Method (sensitive receptor indicator)	Anaconda-Pintler (baseline completion year)	Lee Metcalf (baseline completion year)
Flora	Lichens	Tissue samples, community analysis	1992, 2001	NA
Visibility	High-use vista	Camera (Haziness)	Established 1994-Sula	NA
Visibility	Scenic vistas	IMPROVE (Haziness)	Established 1994-Sula	NA
Water Quality	High altitude lakes	Phase 1 Lakes (pH, alkalinity, conductivity, chemistry, Acid Neutralizing Capacity)	1985	1985
Water Quality	Lakes with low ANC	Phase II Lakes (pH, alkalinity, conductivity, chemistry, ANC)	1992	NA
Water Quality	Perennial Streams	Phase III Lakes (pH, alkalinity, conductivity, chemistry, ANC)	NA	NA
Water Quality	Vernal Pools	NADP (Acid Deposition)	1990-present	NA

Limits of Acceptable Change: The Air Quality Related Values Monitoring Plan for the Anaconda-Pintler Wilderness (USDA 1995a) discloses limits of acceptable change for visibility, lichens, terrestrial plants, and water quality.

A National Atmospheric Deposition Program (NADP) acid deposition gage was installed above Lost Trail Pass on the Bitterroot NF in 1990 about 2 miles west of the Beaverhead NF. This gage was located to measure acid deposition (acid rain, acid snow, acid fog etc.) levels in southwestern Montana with concern that air pollution from regional sources in the southwestern

US (coal burning power plants, smelters, transportation sources) is being transported into Montana. The site provides an upwind index of wet deposition in the BDNF. Only low levels of acid deposition however, have been measured (Story 2007). Mean monthly pH averaged 5.37 during the period of record and ranged from low of 4.88 in August of 1994 and 1997 to a high of 6.05 in July of 1991. The quarterly average pH for the period of record has been trending slightly downward during the period of record (from 5.49 during 1990-1993, 5.44 during 1990-1995 to 5.33 during 1995-2000). Too much variability exists in the pH data to verify a downward trend statistically.

Of particular interest in chemical analysis of the data is the acid anion sulfate and nitrate, which are the main agents of acid rain. Sulfate concentration measurements range from a monthly average low of 0.07 mg/L in November of 1994 to a high of 0.58 mg/L in August of 1994. Average sulfate for the period of record (1990 to 2000) was 0.18 mg/L, which has dropped from 0.22 mg/L from 1990 to 1992 and 0.23 mg/L from 1990 to 1996. Nitrate concentration measurements range from a monthly average low of 0.08 mg/L in April of 1996 to a high of 1.68 mg/L in August of 1992. Average nitrate for the period of record (1990 to 2000) was 0.26 mg/L, which was similar to 0.32 mg/L from 1990 to 1992 and 0.32 mg/L from 1990 to 1996.

Nitrate (NO_3) and sulfate (SO_4) trends over the period of record are fairly stable for overall monthly and quarterly averages. However, as with pH, a strong and consistent seasonal pattern is quite pronounced with lower concentrations in the winter and higher in the summer. These seasonal patterns are typical of NADP sites nationwide and result from reduced cloud temperatures in the winter which retards the photochemical transformation of SO_2 and NO_x emissions to sulfuric and nitric acid. Overall the Lost Trail NADP site data indicates wet deposition levels which are low and comparable to other NADP sites in the region (Glacier and Yellowstone National Parks, and Helena).

Lake chemistry data was collected for 11 lakes in the Lee Metcalf Wilderness, Spanish Peaks in 1994. The acid neutralizing capacity (ANC) in the lakes averaged 231 ueq/L and varied from 67 ueq/L to 361 ueq/L. Lee Metcalf Wilderness Lakes are more buffered to acid deposition change than Absaroka-Beartooth and Selway-Bitterroot lakes, and were not selected to the USFS Phase 3 lake monitoring program since they are not as sensitive to acid deposition as the 6 Phase 3 lakes.

Ferguson and Rorig (2003) evaluated pollution trajectories for particulates, NO_x, SO_x, and NH_4 from major stationary sources in the NW United States. Pollution trajectories were plotted at the surface, 700mb, and 850mb for January, July, and October. The trajectories indicate virtually no regional pollution trajectories crossing into the BDNF since the closest major sources are in Oregon, Northern California, and Utah with trajectories that generally track north or south of the BDNF.

Environmental Consequences

Summary of Effects by Alternative

No management activities resulting in more than localized, temporary smoke PM2.5 violations of NAAQS or visibility goals are anticipated under any alternative. None of the alternatives considered are expected to substantially change existing air quality. Temporary reductions in visibility and increases of fine particulate matter may occur on the forest or in population centers downwind from sizeable wildland fires. There are no predicted long-term air quality impacts to the BNDF.

Effects Common to All

AQRVs are considered in the context of Class I protection under the Clean Air Act. Federal Land Managers of each Class I Area is charged with the affirmative responsibility to protect that area's unique attributes, expressed generally as air quality related values (AQRVs). This responsibility is carried out through the Prevention of Significant Deterioration (PSD) permit process and includes identification and determination of:

- Sensitive receptors, if any, for each AQRV.
- Potential effects, if any, on sensitive receptors from potential new air pollution sources.
- Potential adverse effects.

The Forest Service will review and comment on any PSD applications for sources that may have a potential impact on BDNF 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 comply with federal Clean Air Act regulations. The Forest Service will evaluate activities on National Forest System land that might impact the BDNF 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 Montana /Idaho State Airshed Group will help ensure prescribed fires do not violate the state standard for particulate matter.

All prescribed fire activities will conduct the appropriate level of NEPA, as determined according to current agency direction. Analysis should include current reference to smoke management provided in agency guides or other appropriate agency direction. Project level NEPA should include discussion on any current EPA policy regarding prescribed fire.

Legal considerations regarding smoke produced from wildfire, prescribed fire and wildland fire use fall under the EPA's Exceptional Events Policy. Exceptional events are events for which the normal planning and regulatory process established by the Clean Air Act are not appropriate. Properly managed prescribed fire and wildland fire use activities are "exceptional events" according to the policy, and wildfire is considered to be a Natural event—pollution caused by these events are not subject to violations of National Ambient Air Quality Standard (NAAQS).

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

Direct and Indirect Effects

Management activities can directly affect air resources such as fire management activities, travel routes, 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 results in increased vehicle emissions from additional employees and skiers driving to the ski area.

Effects to Air Quality from Aquatic Species Management

Effects to air quality from Aquatic species management are negligible and are not expected to differ between alternatives.

Effects to Air Quality from Fire Management

Compliance of Rx burn emissions with NAAQS and applicable federal, state and local standards should be done at the project NEPA level using the SIS or SASEM model (or future refined models). Schmidt

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 3, 4 and 5. Alternative 1 proposes the least. Alternatives that emphasize natural processes have the highest potential for, and the most acreage potentially impacted by, wildfire. Alternative 3 has the highest percentage of management area prescriptions emphasizing natural processes, followed by 5, 4, and 2.

Forest management and permitted activities will comply with national and state ambient air quality standards, regional haze visibility requirements, Class I and Class II Prevention of Significant Deterioration increments, conformity analysis requirements and other state and national air quality standards and coordination requirements such as the 1988 Montana Smoke Management Memorandum of Agreement.

Historically fire and smoke have been a part of the Northern Rockies ecosystem. Currently, smoke is a very sensitive issue in many areas of the Region, both from a health and visibility perspective. Several communities in Montana and Idaho are non-attainment for particulate matter which can be exacerbated by smoke impacts. To minimize impacts, the Region participates in the Montana and North Idaho State Airshed Groups, which are self-regulated cooperatives of major open burners in Montana and Idaho. Project level planning for smoke impacts should include an analysis of smoke using current modeling technology. Operational smoke management is coordinated through the Montana/Idaho Airshed Group.

Effects to Air Quality from IRAs and NWPS Additions

Effects to air quality from wilderness recommendations are negligible and are not expected to differ between alternatives.

Effects to Air Quality from Livestock Grazing

Effects to Air quality from suitable range allocations are negligible and are not expected to differ between alternatives. Livestock grazing can generate dust, which can affect visibility and particulate levels. For the next decade, the area grazed is expected to be the same for all alternatives. Dust impacts are expected to occur only in localized areas, during limited and short-duration periods. Overall the effects of this use are undetectable on an allotment, county, or forestwide scale, and the effects of livestock grazing on air quality would not vary measurably by alternative.

Effects to Air Quality from Minerals and Oil and Gas

There are no changes to any alternatives or new information that materially changes the effects discussed in the Beaverhead National Forest Oil and Gas Leasing Final Environmental Impact Statement (USDA 1995c). Air quality effects of oil and gas leasing, drilling, and development were reviewed and updated (Story 2007). The updated analysis, specific to oil and gas, can be found in it's entirety in the Mineral project file for The conclusion of this document is that the oil and gas operation 14 RFD sites evaluated in the FEIS would be in compliance with State requirements.

Effects to Air Quality from Recreation and Travel Management:

Air quality impacts from forest travel routes 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.

Forest roads and trails are typically unpaved and used recreationally and for resource management purposes. Closures by alternatives vary only by area restrictions for motorized traffic. Alternative 4 and 5 propose the least reduction in motorized traffic whereas Alternative 3 has the most reduction in road traffic. However as a matter of scale, there will be no measurable difference between alternatives as it relates to dust created by roads.

Motorized recreation occurs year-round. Summer use includes off-highway vehicles. Travel on unpaved surfaces by 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 the forest transportation system increases with visitation, road dust impacts to sensitive areas may need to be addressed.

Direct and indirect effects of vehicle emissions on air quality as a result of implementing any of the alternatives are not expected to result in measurable variations from current conditions. Most of the effects of motorized recreation are expected to be localized and temporary.

Winter motorized recreation use is mostly limited to snowmobiles. Emissions from these vehicles include carbon monoxide, oxides of nitrogen, and particulate matter. Conflicts arise when this recreation use occurs alongside non-motorized pursuits, where clean-smelling air is desirable. While snowmobiles produce what is referred to as "nuisance" emissions, the snowmobile areas on the BDNF receive much less use than West Yellowstone. By comparison, snowmobile emissions monitoring at West Yellowstone in 2002-2003 indicated no instances where NAAQS or MAAQS were exceeded. It is reasonable to expect there would be no such instances in the better ventilated, lower use areas, on the BDNF.

While some alternatives have more areas closed to snowmobiling this is expected to displace that snowmobile use rather than decrease the amount of overall use. Over the planning period, the amount of snowmobile use is expected to increase equally among all alternatives, including the No Action.

Effects to Air Quality from Timber Management

Effects to air quality from suitable timber allocations are related to the treatment of fuels created from managing timber lands as discussed in the Fire Management section.

Effects to Air Quality from Vegetation Management

Effects to air quality from vegetation management, such as prescribed burning, are likely to result in short-term impacts to visibility. Each prescribed burn will have unique characteristics, and the smoke impacts can be mitigated by following sound smoke management practices. Also see discussion in next paragraph.

Effects to Air Quality from Wildlife Habitat Management

Effects to air quality from wildlife management are negligible and are not expected to differ between alternatives.

Cumulative Effects

Cumulative effects include the list of past, present, and reasonably foreseeable future activities considered with regard to cumulative effects to air quality. Since past and future emissions do not overlap as cumulative air quality effects are caused by concurrent emissions. Generally, long-term air quality impacts will likely come from 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 on and near the BDNF. Stationary source contributions off-forest includes industrial and commercial operations.

Minor road construction could occur under any alternative. The cumulative disturbance from road construction, reconstruction, or maintenance varies little among alternatives. Recreational traffic on 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. 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.

Cumulative effects of motorized travel on air resources are unique in that past impacts to air quality are not usually evident. The emissions associated with motorized travel would be cumulative only with local emission sources described in the affected environment. Since motorized emission sources on the forest are localized and transient, actual cumulative combinations of emissions are minor and do not result in significant effects.

Very small mineral operations occur on the BDNF with negligible air quality impacts. . The cumulative impacts of these operations would not differ between alternatives. Mineral operations with the potentially affect air quality 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 Montana manage lands in surrounding counties. 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 Montana/Idaho State

Airshed Group and Montana Department of Environmental Quality – Air Resources Management Bureau are contacted for coordination and approval of prescribed fires to help prevent the cumulative impact of these burns from creating unacceptably impacts to air quality. Under all alternatives, wildfires will 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 Beaverhead-Deerlodge 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 BDNF and not contribute to air quality degradation to surrounding areas. The State of Montana has regulatory authority for controlling emissions including those with potential to adversely impact forest resources.

Legal and Administrative Framework

Laws and Executive Orders

The Federal Clean Air Act - Congress passed the Clean Air Act in 1963, and amended it in 1972, 1977, and 1990. The purpose of the act is to protect and enhance air quality while ensuring the protection of public health and welfare, through implementation of National Ambient Air Quality Standards (NAAQS). The CAA designates wilderness over 5,000 acres and in existence as of August 7, 1977 (including later expansions) as Class I areas. Class I areas have the highest level of protection for air pollutants, and very little deterioration of air quality is allowed in these areas. Moderate deterioration, associated with well managed growth, is allowed in Class II 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 Montana Department of Environmental Quality, Air Resources Management Bureau is the state regulatory agency responsible for air quality and is primarily responsible for enforcing Montana and EPA 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 (April 23, 1998) provides guidance on mitigating air pollution impacts caused by wildland and prescribed fires while recognizing the current role of fire in wildland management.

Montana Air Quality Standards and Regulations – these standards and regulations are revised in an ongoing effort by the Montana Department of Environmental Quality, Air Resources Management Bureau to implement mandated Federal environmental programs in a manner that best meets the needs of the State of Montana.

AQUATIC RESOURCE MANAGEMENT

This section contains analysis of watersheds and riparian areas along with aquatic species. The topics are addressed together under Analysis Area, Effects and Environmental Consequences. Under Some sections discuss watersheds and riparian areas separately.

Analysis Area

Watersheds and Riparian Areas

The analysis area for the direct and indirect effects is temporally bounded by the planning period (usually about 15 years) and spatially bounded by those lands (within and downstream of the forest boundary) contained within all 6^{th} level watersheds originating on the BDNF.

Aquatic Species

The analysis area includes the entire Clark Fork River drainage down to the mouth of Rock Creek on the east side of the forest and all streams, lakes ponds and wetlands within the forest boundary west of the Continental Divide.

Analysis Methods and Assumptions

Watersheds and Riparian Areas

The approach used in this analysis is to take a programmatic look at the forestwide scale of past, present, and reasonably foreseeable activities on the forest that may positively or negatively affect water resources. Since the forest plan makes no "on the ground" decisions, the most appropriate indicators for cumulative effects are reflected in the size and magnitude of different resource programs most likely to affect water resources either positively or negatively.

When water quality is affected, off site effects can occur. Yet, since the forest plan prescribes no specific activity in any specific area, potential spatial and temporal effects to water quality cannot be attributed to any specific watershed. Therefore, cumulative effects to water quality can only be described in terms of potential to generally affect trends on a forestwide scale. In other words, the cumulative effects of a program at the forest plan scale as opposed to the effects from a project at the project scale can only be discussed in terms of general programmatic tendencies either toward improved or declining water quality at no specific site. Consequently, there is no easily defined area that may experience cumulative effects beyond the forest boundary. Therefore, the potential cumulative effects from forest programs to water quality will generally be discussed at the forest scale. The temporal scale for this analysis will be limited to the life of this plan, generally 10 to 15 years.

Watershed conservation practices and forest plan standards prescribe extensive measures to manage aquatic and riparian resources. If all applicable measures are implemented and if they are effective, adverse effects from any of the alternatives should be minimized. 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 resources pose greater inherent risks to aquatic and riparian resources.

This analysis did not directly model the effects on stream processes and water quality, because predictions of outcomes for delivery and routing of water, sediment, and woody debris and their effects on streams and river systems are not applicable at the broad scale. Therefore, broad-scale outcomes were qualitatively estimated for effects on hydrologic function and watershed processes for NFS lands within the project area.

Qualitative estimates of effects are inferred from predicted outcomes for certain landscape and aquatic variables that evaluated vegetation, disturbances, and varying activity levels with considerations to specific land allocations and analysis requirements. The rationale for using these outcomes is that they are key processes or activities that influence hydrologic systems and contribute to the protection and maintenance of ecological functions required for healthy watersheds.

Aquatic Species

Land management can positively or negatively affect aquatic resources. The magnitude of effect commonly relates to the scope (size of area) and intensity of an action; its proximity to aquatic resources, and the effectiveness of mitigation standards applied.

This analysis considers effects individual alternatives would have on 3 important elements of our aquatic resources. These are: 1) fisheries (trout populations that provide recreational angling); 2) Threatened, Endangered, and Sensitive (TES) fish; and 3) amphibians. Based on our data and public comment, these represent the aquatic resources of greatest concern. We believe aquatic species not discussed in this analysis would experience effects within the range of those presented. This is supportable, because: 1) This analysis focuses on effects to aquatic systems and the habitat they provide, and 2) species not discussed, occupy the same waters and habitats as those which are analyzed.

Two foundational assumptions for this analysis are: 1) Those species utilizing an aquatic ecosystem should benefit when it is functioning properly or when it is improving; and should be negatively impacted if aquatic habitats are degraded or in a downward trend; and 2) The most immediate potential for irreversible and irretrievable commitments of aquatic resources, are associated with Threatened and Sensitive aquatic species (there are no species listed as endangered on the BDNF).

Consideration of selected species and their habitat during viability analysis is well accepted in the literature (Haufler et al. 1996). Coarse filter analysis helps assess conservation at the community level. It assumes that by maintaining a set of ecological communities of sufficient size, composition, structure and distribution, the viability for most species is maintained. For species which need specific requirements to provide for viability, a fine filter analysis can identify shortfalls in meeting those needs. Species typically needing fine filter analysis include those that: 1) have undergone significant declines in abundance or distribution, 2) are known to use highly specialized or unique habitats, or 3) are isolated endemics. These species are typically at higher risk and concern is high for their continued existence. On the BDNF species identified for aquatic fine filter analysis include: bull trout, westslope cutthroat trout, fluvial arctic grayling, and boreal toad.

Effects Indicators

Watersheds and Riparian Areas

The effects on hydrologic function and watershed processes are qualitatively described as they are influenced by:

- Watersheds that trend toward providing favorable hydrologic function and watershed processes;
- Physical and biological processes within the project area are moving in an improving trend, characteristic of their geomorphic setting and natural disturbance and recovery regimes;
- Implementation of the “key watershed” strategy;
- Protection of riparian areas and aquatic habitats through designation of riparian conservation areas.

Aquatic Species

- Change in quality and/or quantity of fisheries resources
- Change in the potential to conserve and or restore westslope cutthroat trout, bull trout, and arctic grayling
- Change in the quality and/or quantity of amphibian habitat

Affected Environment

Watersheds

There are a variety of aquatic and riparian ecosystems on the BDNF: streams, rivers, ponds, reservoirs, wetlands, and riparian areas. These ecosystems support complex communities of vertebrate and invertebrate aquatic life along with an assortment of riparian and aquatic plants. Complex, species-rich communities of phytoplankton, zooplankton, macro-invertebrates, and fish can be found in many of these habitats. In addition, aquatic, riparian, and wetland habitats support a variety of submerged and emergent aquatic plants.

Historically, humans have used aquatic ecosystems for many purposes. Examples of the common utilitarian uses of aquatic ecosystems by humans include: water-development facilities for agricultural and municipal uses; mining, power generation, and, water-dependent recreational uses. Clearly, the human demand for forest water resources is increasing. Meeting public demands while maintaining a healthy aquatic ecosystem is a material challenge for forest resource managers.

Forest-management activities can affect the physical, chemical, and biological characteristics and functions of aquatic ecosystems. The challenge to forest resource managers is to implement multiple-use activities in a manner that protects, maintains, and restores aquatic biodiversity, watershed/stream health, and riparian/wetland condition.

Watersheds are natural divisions of the landscape and the basic functioning unit of hydrologic systems. Watersheds can be considered in a variety of scales ranging from large river basins, to individual streams. Commonly used terms referring to watershed scales are illustrated here.

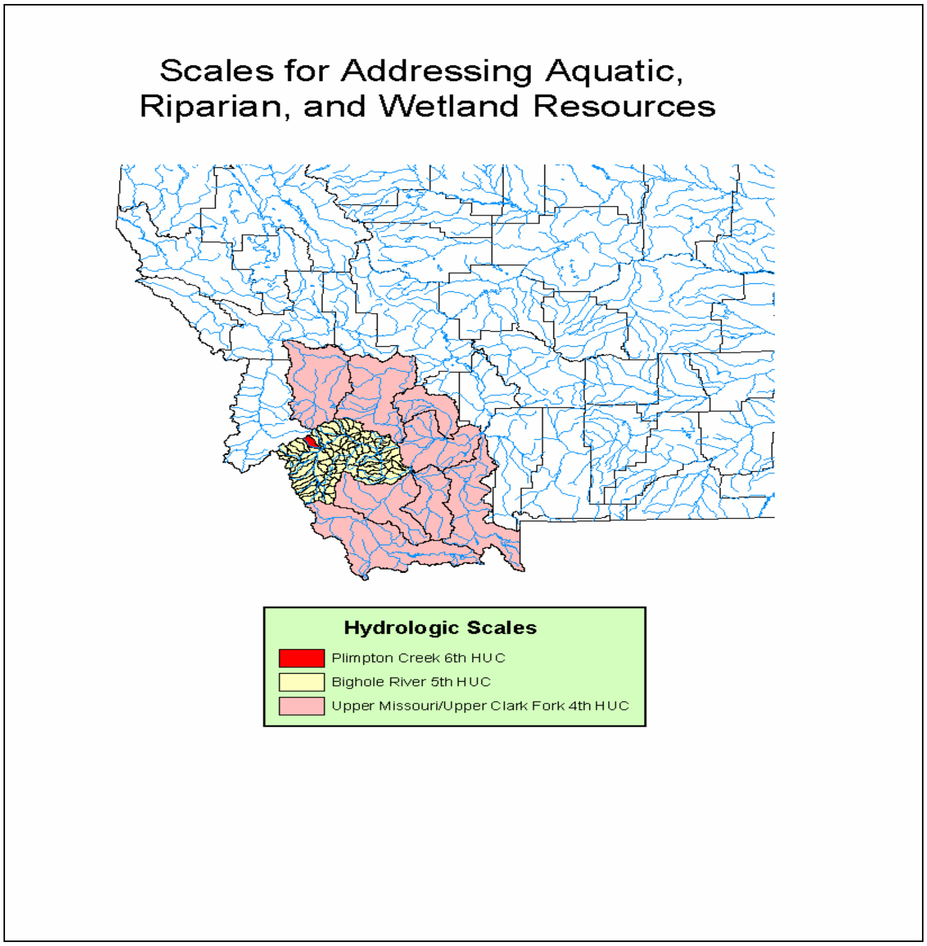

Figure 1. Scales for Addressing Aquatic, Riparian and Wetland Resources

Watersheds are natural divisions of the landscape and are the basic functioning unit of hydrologic processes. Watersheds are hierarchical (smaller ones are nested within larger ones) making them an appropriate context for considering many ecological processes. Physical processes such as rainfall, runoff, erosion, and sedimentation interact within the watershed boundaries to shape the landscape. Biological processes also occur within watershed boundaries. For example, most aquatic species do not cross over watershed divides. Environmental changes commonly culminate and appear at the watershed scale. Changes in soil, vegetation, topography, and chemicals change the quantity and quality of water, sediment, and organic material that flow through a watershed. Factors that govern how a watershed may respond to environmental change include the size and location of changes, the physical and biological characteristics of the watershed, and the history of natural and human disturbances.

Surface Water Quantity and Distribution

The BDNF is located in both the Upper Missouri and the Upper Columbia River ecosystems and lies within the Rocky Mountain physiographic province. Sitting astride the continental divide, the forest gives rise to both the Columbia and Missouri Rivers. The Upper Missouri River basin and its tributaries (Madison and Jefferson Rivers) flow east to the Mississippi River, while the tributaries to the Upper Columbia River (Upper Clark Fork River) flow west into the Pacific Ocean. The Continental Divide separates these major watersheds.

There are approximately 10,779 miles of perennial streams within the BDNF. Along the southern mountains are the headwaters of several very well known rivers, the Big Hole, Beaverhead, Madison, Jefferson, Rock Creek, Boulder, Clark Fork, and Ruby all begin within the forest. Water generated in the high precipitation zones of the mountains becomes increasingly valuable as it flows into the low precipitation zones of the valleys. There are many competing demands for this water. Balancing the need for consumptive uses such as agriculture with instream values such as recreation and ecosystem health will continue to be a major challenge for resource managers in the future.

Table 3. Major Watershed Name, Number and Size

Watershed Name (4th level HUC*)	Watershed Number	Watershed Size (acres)	Watershed Size (square miles)
Beaverhead River	10020002	932,171	1,456.5
Big Hole River	10020004	1,794,273	2,803.6
Boulder River	10020006	486,450	760.1
Jefferson River	10020005	859,168	1,342.5
Madison River	10020007	1,243,019	1,942.2
Red Rock River	10020001	1,481,807	2,315.3
Rock Creek	17010202	1,145,411	1,789.7
Ruby River	10020003	625,214	976.9
Upper Clark Fork	17010201	1,218,871	1,904.5

**Hydrologic Unit Code*

In general, mountains receive more moisture throughout the year than is lost through evaporation and transpiration. This means that mountains are the primary source of water for lowland areas where less measurable precipitation falls. Most surface runoff from the mountains comes during the spring after snowmelt. Summer thunderstorms and may generate short-duration high-intensity rainfall. However, they generally do not contribute appreciably to basin-wide runoff amounts. The amount of surface water draining from a mountainous watershed depends on at least six factors: the water content of the snowpack; the nature of the vegetation; the water-holding capacity of the soil and sapwood of trees; climatic characteristics; the proportion of the water that percolates into the groundwater; the patchiness of the vegetation mosaic, including the potential for snowdrifts.

Changes in land use patterns can alter the amount or timing of water generated from the National Forest. Altered flow regimes can result from: diversions, flow impoundment (reservoirs), roads, and vegetation manipulation by changing the rates and timing of stream flow, sediment and organic-material transport. Timber harvest, fire suppression, and improper livestock grazing can all alter the timing and volume of stream flow by changing on-site hydrologic processes. Changes can be either short-or long-term depending on which hydrologic processes are altered or by the intensity of alteration.

People in the valleys depend on water generated in the mountains on national forest land. Therefore, the Agency, through special use permits, allows the construction of diversion structures on national forest system lands to facilitate water use on private lands. In some cases, these structures can alter the flow regimes of the watershed and change habitat conditions, especially for species with survival strategies that are adapted to natural flow patterns.

Surface Water Quality

Surface water quality is typical of other forested lands in Montana. Water quality is generally very good, however there are places where concentrated uses such as livestock grazing, recreation, or roads have created a detectable decrease in water quality.

A TMDL is a plan to establish the maximum amount of pollutant load that can flow into a water body from point sources, non-point sources, and natural background sources without exceeding state water quality standards. Montana law and federal regulations require DEQ to develop TMDLs for all waters that are not meeting water quality standards (these waters are collectively called water quality limited segments or WQLS). TMDLs are required by Section 303(d) of the federal Clean Water Act and by state law. The list of waters needing TMDLs is known as the "303(d) list." The Montana DEQ updates the 303(d) list periodically and stream segments may be added or removed from the list based on credible data. See Figure 2 on the next page.

In 1996, the state of Montana identified 269 impaired stream reaches within the 4th level HUCs encompassing the BDNF in the semi-annual Montana 303(d) list. It is important to note that not all of the reaches are within the boundary of the BDNF.

Table 4. Number of Stream Segments in the Analysis Area on the 1996 State 303(d) report.

Fourth Level Watershed Name	Number of Impaired Stream Segments*
Beaverhead River	20
Big Hole River	61
Boulder River	19
Flint/Rock	40
Jefferson River	17
Madison River	24
Red Rock River	16
Ruby River	26
Upper Clark Fork	46
Total	269

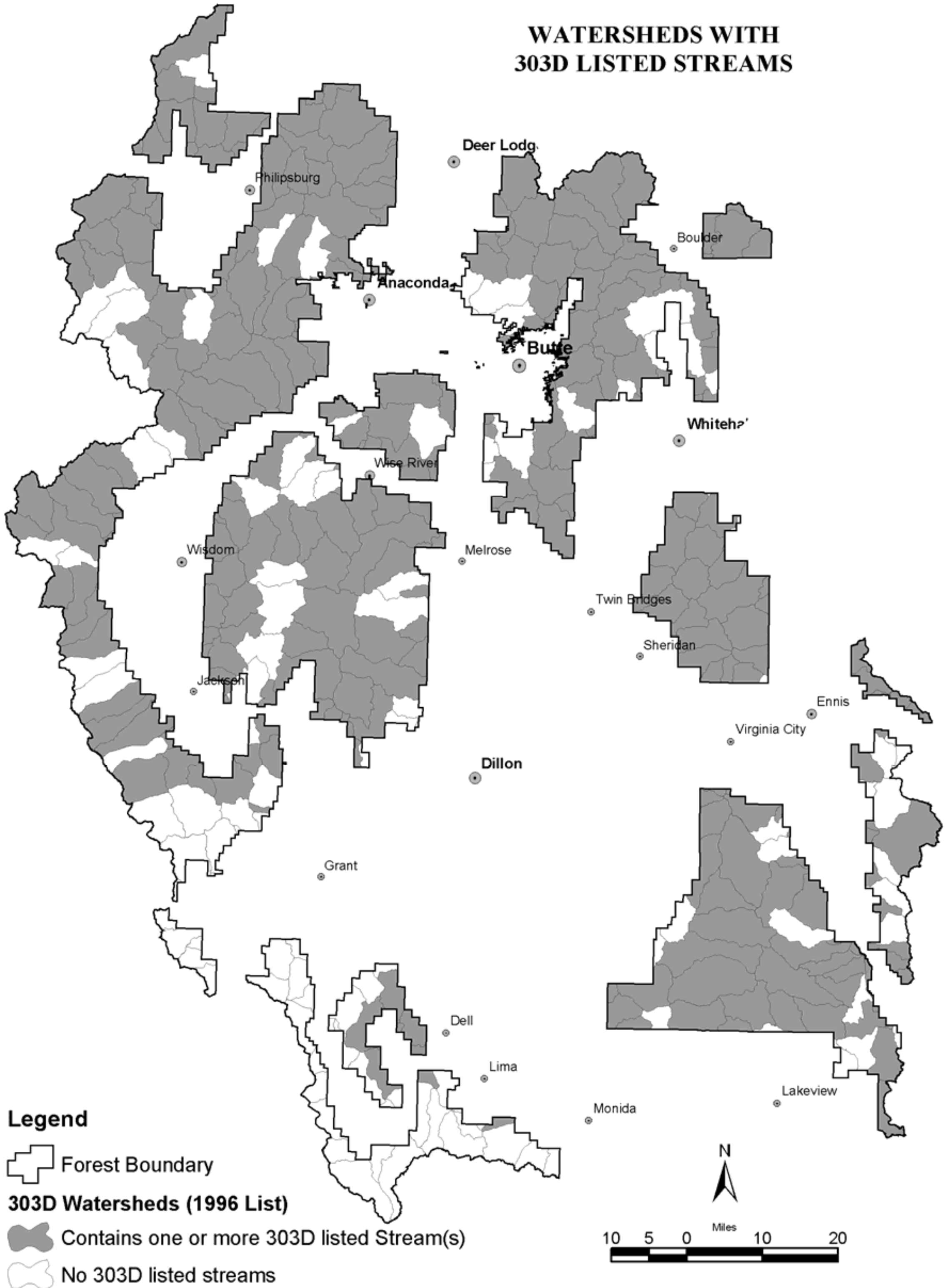

Figure 2. Watersheds with 303D Listed Streams

The Montana Department of Environmental Quality (DEQ) and the U.S. Environmental Protection Agency (EPA) have developed a proposed schedule to create Total Maximum Daily Loads (TMDLs) for waters on the State's 1996 list of impaired and threatened waters. The most current State of Montana 305(b) and 303(d) lists can be found on the internet at http://www.deq.state.mt.us/wqinfo/tmdl/index.asp.

The State found mining, timber harvest, and roads were the primary sources of impairment in the Boulder, Flint/Rock, and Upper Clark Fork watersheds. These watersheds have experienced considerable amounts of mining and timber harvest over the years, more so than watersheds in the southern half of the forest. Watersheds in the southern half of the forest were found to be impaired more frequently by agriculture, namely livestock grazing.

We work cooperatively with the DEQ to restore impaired waters in a manner that will also allow land management projects to continue. The Forest Service develops a plan, in consultation with the state, to address the pollutants of concern for those portions of a watershed on National Forest System (NFS) lands having impaired waters. The Forest Service has a process whereby State-listed 303(d) waters on NFS lands are assessed for verification and level of impairment. This process consists of the following steps:

1. Field surveys to verify impairment and identify pollutant sources, and work with the state to refine the list of impaired streams, if necessary;
2. Prioritize the pollutant sources, and estimate the percent of pollutant load caused by natural sources and each anthropogenic source, for each listed pollutant on every verified impaired stream;
3. Develop a TMDL plan for each watershed having impaired waters.

This plan includes preventative watershed conservation practices and curative restoration programs consisting of management changes and land treatments as needed. It also includes disconnecting pollutant sources from waters in priority order, monitoring effectiveness of any changes, treatments, programs, or practices, and reporting the progress to the state in 305(b) reports every two years.

The program that the USFS uses to control non-point sources of pollution works on the premise that non-point sources can be controlled by relying on state BMP programs, as intended by Congress in CWA Section 319. As applied by the USFS on National Forest System lands, the BMP program consists of:

1. Defining practices, based on the best information available, that are expected to protect water quality;
2. Monitoring to ensure the practices are applied;
3. Monitoring to determine the effectiveness of practices;
4. Mitigation to address unforeseen problems; and,
5. Adjustment of design specifications of BMPs for future activities, where appropriate.

Non-point sources of pollution are the primary cause of degraded water quality. A non-point source of pollution is water pollution, whose source(s) cannot be pinpointed, but that can be best controlled by proper soil, water, and land management practices. Examples of non-point sources of pollution include: roads, bank erosion, stream crossings, and cattle trails.

Uses of Surface Water

Surface water is used on and off-forest, both consumptively and non-consumptively. Non-consumptive uses of water include recreation, wildlife, fisheries, channel maintenance, and aesthetic and spiritual qualities of the resource. Consumptive uses meet administrative needs such as campgrounds, firefighting, and administrative sites. Other permitted activities on the BDNF include stock watering facilities, summer home wells, snowmaking at ski areas. Irrigation, municipal water supplies with permitted water diversion, transmission, and storage facilities, related to individuals exercising water rights, are also located on the BDNF.

Municipal Watersheds

Six cities adjacent to the forest rely on surface water that originates on the BDNF. The following watersheds have been identified by the State of Montana as being suitable for drinking water and have been identified by the Environmental Protection Agency as serving community water systems.

Table 5. Watersheds Identified by the State of Montana as Suitable for Drinking Water and by the EPA as Serving Community Water Systems

Watershed	State Surface Water Classification	Water Systems that Serve the Same People Year-Round
Big Hole River	A-1	Butte
Rattlesnake Creek	A-1	Dillon
Indian Creek	A-1	Sheridan
Warm Springs – Flint Creeks	A-1	Anaconda and Butte
South Boulder Creek	A-1	Philipsburg
Yankee Doodle Creek	A-Closed	Butte
Tincup Joe Creek	A-Closed	Deer Lodge
Fred Burr Lakes	A-Closed	Phillipsburg
Hearst Lake – Fifer Gulch	A-Closed	Anaconda
Basin Creek	A-Closed	Butte

The most up to date information regarding water quality management in the State of Montana can be found on the internet at http://deq.state.mt.us/wqinfo/Index.asp.

Stream Channels

Streams carry water, sediment, dissolved minerals, and organic material derived from hillsides and their vegetation cover. The shape and character of stream channels constantly and sensitively adjust to the flow of this material by adopting distinctive patterns such as pools-and-riffles, meanders, and step-pools. The vast array of physical channel characteristics combined with energy and material flow, provide diverse habitats for a wide array of aquatic organisms.

Varied topography coupled with the irregular occurrences of channel-affecting processes and disturbance events such as fire, debris flows, landslides, drought, and floods, result in a mosaic of river and stream conditions that are dynamic in space and time under natural conditions. The primary consequence of most disturbances is to directly or indirectly provide large pulses of sediment and wood into stream systems. As a result, most streams and rivers undergo cycles of channel change on timescales ranging from years to hundreds-of-years in response to episodic inputs of wood and sediment. The types of disturbance, that affect the morphology of a particular channel depends on watershed characteristics, size, and position of the stream within the watershed. Many aquatic and riparian plant and animal species have evolved in concert with stream channels. They develop traits, life-history adaptations, and propagation strategies that allow persistence and success within dynamic landscapes.

Human uses, often through the exercise of water rights, have altered stream channels by varying degrees since the 1890s. Stream channels have changed as a result of channelization, wood removal, water diversion, dam building, and indirectly by altering the natural incidence, frequency, and magnitude of disturbance events such as wildfire. Initially, heavy livestock grazing impacted riparian areas and stream channels. Historic photographs show riparian areas heavily impacted by large numbers of livestock. After the turn of the 20^{th} century, logging became common in some watersheds. Other indirect effects are the result of mining, road building and beaver trapping.

Aspects of channel morphology most affected by land management include the frequency and depth of large pools, the width-depth ratio of stream channels, and the amount of fine sediments stored in the channels. Low gradient stream channels show the most response to land management activities. Lower pool frequencies and higher fine sediment concentrations are most obvious in watersheds with higher road densities and where grazing has been a major management emphasis. These findings are consistent with observations that indicate improper road construction/maintenance, grazing, and timber harvest practices increase delivery of fine sediment leading to filling pools and causing stream aggradation.

Cumulative effects of land management have caused an overall change in the scale and frequency of landscape disturbances. The result is a distinctly different character of watersheds and their stream systems when viewed from a forestwide perspective. Rather than individual watersheds, riparian areas, and stream channels being periodically affected by large disturbances (i.e., floods, fire, and insect infestations) leaving the neighboring watersheds largely unaffected, land management practices have distributed those disturbances across more watersheds and at a higher frequency of occurrence. Consequently, more watersheds, stream channels, and aquatic habitats are now subject to continued cumulative effects of watershed disturbance. This contrasts with a more pulse-like pattern of disturbance under which most streams and associated species evolved. Consequently, most stream channels are in a somewhat “unnatural” condition. Habitat conditions are less than optimal for aquatic and riparian-dependant species, which evolved in environments that had many more high-quality habitat areas spread across the landscape.

In 1991, the Beaverhead Forest began to use stream surveys as the dominant inventory/monitoring tool to assess stream function. Following the consolidation of the two forests in 1996, the Deerlodge Forest initiated a similar program. By the end of 2002, roughly 700 non-randomly sampled stream monitoring reaches have been permanently established on the combined BDNF. The results of these surveys show that over half of the reaches surveyed are functioning properly as compared to reference conditions from similar valley bottoms. However, a quarter of the reaches are determined to be non-functional and lack the necessary components of a healthy stream. These reaches are important to track through time to see if management or restoration techniques are effective. The following table displays the results of the forestwide stream surveys to date.

Table 6. Forestwide Stream Function Determinations

Functioning Reaches	Reaches Functioning at Risk	Reaches that are Non-Functional
380 or (56%)	129 or (19%)	166 or (25%)

Based on this non-random sample, there are several notable differences between watersheds in the northern half of the forest versus those in the south half of the BDNF:

- Levels of channel disturbance are greater on the northern half of the forest than in the south.
- Northern watersheds are more likely to be affected by a combination of land uses, with roads being identified as the major contributor of sediment.
- Watersheds in the northern half of the forest are composed of predominately sensitive land types making them at greater risk for increased erosion from land management activities.
- Southern watersheds are more likely to be affected by livestock grazing. Close to 40% of the reaches surveyed there are being notably affected by livestock.
- Water quality risks are greater in the northern half of the forest due to persistent chemical effects from mining.
- Long-term watershed restoration in the northern watersheds will likely involve mechanical treatments (i.e., road decommissioning, mining reclamation) designed to reduce sediment production and restore channel geometry. Improvement in livestock grazing should be the primary focus for watershed restoration in the southern half of the forest.

Groundwater

Ground water is an important resource in Montana and it will likely become more important in the future as the state's population and industries grow. For example, ground water provides 94 percent of Montana's rural domestic-water supply and 39 percent of the public-water supply. On average per day in Montana, approximately 90 million gallons of water are used for irrigation, 16 million gallons are used to supply water for livestock, and 20 million gallons are used to support industry. Water generated in the mountains of the forest is an important source of recharge for valley aquifers and is therefore an important forest product. The quantity, distribution, quality, and uses of groundwater resources on the forest are described below.

Groundwater Quantity and Distribution

Precambrian aquifers underlie most of the forest. Precambrian rocks are not a principal aquifer and therefore groundwater storage is localized and limited in most places. Development of groundwater resources tends to only occur in shallow alluvial aquifers.

Groundwater Quality

Groundwater quality information for the BDNF is minimal, although there is extensive off-Forest data available. The most frequently reported ground-water contamination sources off-forest are leaking underground storage tanks, septic tanks, landfills, agricultural activities, and abandoned hazardous waste sites.

Campground wells have been tested for baseline water quality. Results of those tests indicate that primary drinking water standards (e.g., iron) are rarely exceeded. Bacteriological and nitrate sampling is conducted periodically while the campgrounds are operating. Results of these tests generally meet state drinking water standards. However, since the wells are located in shallow alluvial aquifers, they can be contaminated by events such as storm runoff and standards can be exceeded for short periods of time. Based on this limited information, we believe the existing BDNF groundwater quality is good, though surface contamination and bacteriological and nitrate contamination can be a concern.

Past management has not had measurable adverse effects on groundwater. Activities such as oil and gas exploration and development have not impacted groundwater. Potential adverse effects from wastewater treatment and chemical spills, such as diesel fuel, have also been minimal. Groundwater contamination due to human waste has been reduced because modern pump-vault outhouses that better contain potential contaminants are replacing old, pit-type outhouses. Best Management Practices such as locating developed recreation sites away from riparian areas will help protect groundwater quality.

Groundwater Uses

Because of limited supply and lack of development opportunities, beneficial use of forest groundwater is generally low. Consumption is limited to stock-water facilities, special- use permits, and Forest Service campgrounds or administrative sites with domestic wells. Off-forest, groundwater is used extensively for pump irrigation and drinking water wells.

Lake Environments

There are many high mountain lakes on the BDNF representing one of the most pristine ecosystems. They range from less than an acre to large reservoirs. Unlike lower elevation lakes, mountain lakes are seldom affected by pollution, habitat alteration or unnatural water level fluctuations. However, some have been affected by recreation and livestock use. Activities such as backpacking, horse packing, recreational vehicle use, and road and trail development result in damage, particularly near-shore areas. Water transfers and diversions for drinking water or irrigation water supplies have and continue to affect many lakes throughout the forest, especially where drought and diversion of inflow caused very low lake levels. Dozens of lakes have shorelines influenced by modification and control of outlet streams. Regulation of lake levels for water supply purposes affects near-shore aquatic and wetland plant and animal communities, and the success of near-shore fish spawning.

Table 7. Lists of Lakes in Acres by Landscape

Landscape Name	Surface Acres of Lakes
Big Hole	1,954
Boulder River	852
Clark Fork-Flint	8,917
Gravelly	12,987
Jefferson River	2,215
Lima-Tendoy	313
Madison	3,947
Pioneer	1,386
Tobacco Root	779
Upper Clark Fork	1,280
Upper Rock Creek	1,112

Riparian Areas

Riparian areas are water-dependent systems along, adjacent to, or contiguous with streams, rivers, and wetland systems. Riparian ecosystems are the ecological links between uplands and streams, and between terrestrial and aquatic components of the landscape. Many riparian areas have wetlands associated with them. While riparian areas are defined primarily on the basis of their nearness to streams and rivers, wetlands occur wherever the water table is usually at or near the ground, or where the land is at least seasonally covered by shallow water. Wetlands include marshes, shallow swamps, lakeshores, sloughs, fens, and wet meadows. They are an important part of the overall landscape and provide major contributions to ecosystem productivity and biological diversity, particularly in arid southwest Montana. For the purposes of this analysis, riparian ecosystems, wetlands, lakeside zones, and floodplains will be referred to collectively as riparian ecosystems or riparian areas.

Quantity, Quality and Distribution

There is great variability in the size and vegetation complexity of riparian zones on the BDNF. Ecological drivers such as geology, climate, glaciation, and stream gradient all influence the type and complexity of riparian and wetland ecosystems. Most riparian and wetland areas in the project area 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 forest has a broad-scale map of the riparian areas on the forest. The following table displays the approximate acres of riparian within each of the planning units on the BDNF.

Table 8. Acres of Riparian and Wetland Resources on the BDNF

Landscape Name	Acres of Riparian	Percent of Area in Riparian
Big Hole	28,143	3
Boulder River	8,069	2
Clark Fork-Flint	29,788	3
Gravelly	64,521	3
Jefferson River	10,181	1
Lima-Tendoy	28,385	3
Madison	8,215	3
Pioneer	17,024	2
Tobacco Root	8,241	2
Upper Clark Fork	7,284	3
Upper Rock Creek	7,279	2

Riparian Area Quality

Riparian conditions on the BDNF are highly variable. Overall, riparian areas on the forest are functioning at or near their potential or are considered to be improving. However, there are areas where they are functioning below their potential. Improper livestock grazing, mining, timber harvest, fire management, road development, and water diversions are the major factors leading to this condition. To a lesser degree, disturbances associated with recreational use have also impacted riparian area function. On grasslands, improper livestock grazing has been the most important factor leading to bank damage, species conversion, and sedimentation. On forested landscapes, silviculture, road building, and fire suppression have altered riparian conditions by changing flow regimes and altering channel morphology.

Riparian Area Uses

Although riparian zones occupy a small part of the forest, they are a critical source and support of diversity within western 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 area enters the groundwater where some is released later. This increases later summer and fall streamflow. Riparian areas produce stream cover and shade which keeps the water temperatures cool for fish and water-loving animals.

Benefits of riparian areas include food, cover, and nesting habitat for birds, small and large mammals, reptiles, and amphibians. Many animals visit or live in riparian areas. They come for water, food, and relief from temperature extremes. 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. People often seek water and riparian environments for recreation activities.

Aquatic Species

Fisheries on the BDNF provide a diversity of quality angling and recreation experiences. Opportunities range from scenic, remote high-mountain lakes and headwater streams to easily vehicle accessible mid-elevation waters like widely renowned Rock Creek and Georgetown Lake. A substantial portion of headwater streams and lakes are also important water sources for nationally renowned trout fisheries like the Madison, Big Hole, and Red Rock rivers.

Native westslope cutthroat, bull trout, grayling and lake trout and non-native rainbow, brown brook and Yellowstone cutthroat trout populations are interspersed across the landscape. The current pattern of species occurrence in the analysis area reflects a public preference for more diverse fishing opportunities than native trout alone provide. Between the late-1800s and the mid-1900s widespread non-native fish planting was very successful. This is exemplifies the fact that the most popular fisheries in the analysis area are streams with rainbow and brown trout.

The most heavily fished populations are below the forest boundary in larger streams and rivers. Rainbow and brown trout fisheries represent only 26% and 13% of the stream miles they occupy within the analysis area. Brook trout are present in nearly twice the stream miles occupied by rainbows and browns. Brook trout are the most prolific species in the analysis area, occupying approximately 3,145 stream miles. They are found in 1,227 miles of stream inside the forest boundary (Table 8). Their extensive distribution seems associated with the fact brook trout seem better suited for mid-elevation streams common to the BDNF. They are popular with anglers, but enjoy diminished status among elite angling enthusiasts, because they tend to be smaller. They remain a favorite, however, for many local residents and are enjoyed by a high percentage of family groups during day trips and camping trips.

Success in establishing non-native fisheries has caused substantial reductions in the number of native trout populations. Competition and hybridization are the most significant causes of reductions in the range of WCT. These same factors continue to influence bull trout distribution. Concerns over the future of native trout have prompted changes in public perspectives and desires over the last 20 years. Many people express a desire for balance between ecological integrity and recreational opportunities. Except for a very limited number of native fish reintroductions planting fish in streams no longer occurs within the analysis area. It still occurs in lakes where planting is necessary to sustain angling opportunities. However, westslope cutthroat have replaced non-native Yellowstone cutthroat as the MTFWP species of choice for most of our mountain lakes. Twenty-five percent of the lake acres on the BDNF (1 acre or larger) are fishless (Table 9).

Westslope cutthroat is the most common native trout occupying 481 miles of stream. It is followed by bull trout (167 miles), and grayling (70 miles) and lake trout. Lake trout persist only in two native relict populations. They are not present in streams and so are not displayed in Table 45. Despite impacts that native trout fisheries have experienced through non-native management objectives, they remain a source of recreational angling in many places across the forest. Catch and release opportunities for bull trout remain, even though it has been listed as “threatened” under ESA. Cutthroat can still be harvested in certain lakes and streams. In others, protection through catch and release regulations are necessary to reduce impacts.

Arctic grayling have been introduced into the Ruby River and are present in a few other streams, but in low densities. Grayling also occur in a couple of mountain lakes. Despite low numbers in streams, some anglers spend time fishing for, and enjoy catching, grayling, because they are unique, colorful and very catchable.

Burbot (also known as "ling") is another species commonly sought by anglers in southwestern Montana. Its distribution is limited, as it only occupies about 174 miles of stream on the BDNF (Table 9). Burbot rarely reach a catchable size and densities are usually low in BDNF streams. This suggests environmental conditions along with the short growing season in our mid to high elevation streams are marginal. Thus, when anglers are targeting burbot they most commonly fish in lakes where "catchable" size fish are most common. Clark Canyon Reservoir is the most notable burbot fishery within the analysis area, but it is outside the forest boundary.

Table 9. Extent of Selected Sport Fish in the Analysis Area and Inside the Forest Boundary

Species	Miles Inside Analysis Area	Miles Inside Forest Boundary	Sub-watersheds within Analysis Area*	Sub-watersheds *Inside Forest Boundary
Brook Trout	3,145	1,227	319	196
Rainbow Trout	1,885	492	264	113
Brown Trout	1,362	173	205	59
Bull Trout	281	167	41	31
Westslope Cutthroat Trout	1280	481		139
Arctic Grayling	443	70	59	21
Burbot	738	174	91	35

** 6th field Hydrologic Unit Code*

Introduction of diseases is a growing concern. Whirling disease made its first Montana appearance in the Madison River in the early 1990s. Fish populations dropped dramatically there and have never fully rebounded. This disease has subsequently been found in the Beaverhead, Big Hole, Ruby, Red Rock rivers, and Rock Creek with varying levels of impact. While no cases of whirling disease have been documented in streams on the BDNF, it may occur, because of the close proximity of the pathogen in neighboring streams.

The combination of native and non-native fisheries provides an attractive recreational resource. An estimated 166,900 forest visitors in 2001, indicated fishing was the primary purpose for their trip. BDNF fisheries also provide an economic boost to local communities, generating an estimated $9,000,000 in expenditures by those visitors

Table 10. Acres of Lakes With or Without Fish by Drainage

Drainage	Lake Acres Fish	Lake Acres No Fish	Total Acres
Beaverhead River	59	141	200
Big Hole River	1,042	1,561	2,603
Boulder River	95	5	100
Jefferson River	1,371	155	1,526
Madison River	336	1,303	1,639
Red Rock River	542	360	902

Drainage	Lake Acres Fish	Lake Acres No Fish	Total Acres
Rock Creek	1,227	3,101	4,328
Ruby River	83	110	193
Upper Clark Fork	3,498	1,179	4,677

Status, Distribution and Life History Requirements of Selected Fish Species

Bull Trout

Bull trout are native to the Columbia River Basin, west of the continental divide. They were historically found throughout the northwestern United States and Canada. Distribution and abundance have been greatly reduced throughout its range. A status review in 1992 estimated that it inhabits approximately 42% of its historic range in Montana. An estimated 38% of populations are declining, 20% are stable to increasing, and the status of the remaining 42% is unknown.

In our analysis area bull trout are present in the upper Clark Fork River and Rock Creek drainages. Historically we estimate they occurred in about 650 miles of stream. The miles were split between drainages with 329 miles in Rock Creek and 323 miles in the upper Clark Fork. Bull trout remain in about 206 miles of stream in the Rock Creek drainage (63% of historic). In the Upper Clark Fork drainage they inhabit only about 75 miles of stream (23% of historic).

Both migratory and stream-resident bull trout move in response to developmental and seasonal habitat requirements. Migratory individuals can move great distances (up to 250 km) among lakes, rivers, and tributary streams in response to spawning, rearing, and adult habitat needs. Stream-resident bull trout migrate within tributary stream networks for spawning purposes, as well as in response to changes in seasonal habitat requirements and conditions. Open migratory corridors, both in and between tributary streams, larger rivers, and lake systems are critical for maintaining bull trout populations. Historically, the bull trout in Rock Creek were part of a more widely distributed population in the Clark Fork River drainage

Fragmentation into separate populations is primarily attributed to water pollution from mine tailings. Water quality conditions have largely eliminated the upper Clark Fork River as suitable habitat or as a migratory corridor. Bull trout in the upper Clark Fork are confined to Warm Springs Creek and its tributaries. It is a relatively small isolated population making it quite vulnerable to natural or human caused impacts.

Rock Creek supports one of the strongest population s of bull trout in Montana outside of the Flathead and Blackfoot river drainages (Thomas 1992). Fish live in the mainstem and migrate throughout its length to spawn in tributaries. The drainage is designated a “priority” watershed under INFISH. It contains several core areas in Montana’s restoration plan for bull trout; including the East, Middle, Ross and West Fork of Rock Creek (5th field HUCs).

Rock Creek provides habitat for all life stages of bull trout within the confines of the drainage. However when bull trout captured below Milltown Dam were moved above that barrier, they migrated to known spawning sites in tributaries of Rock Creek (Gerdes 2005). This suggests the Rock Creek subpopulation may not have vehicle access to its entire historic range.

Bull trout in Rock Creek likely constitute a single population with separate stocks spawning in specific tributary streams. Adult fish spend the winter throughout the main-stem and some of the lower ends of certain tributaries. They typically move to spawning areas in July and August. A segment of the population performs a more complex migration moving into tributaries prior to runoff, then back to Rock Creek before migrating further to their spawning tributaries.

Small populations persist in Kaiser, Moose and Mud Lakes. An isolated population inhabits the East Fork Reservoir. The Dam at East Fork Reservoir poses a barrier to bull trout in the East Fork of Rock Creek. An isolated population persists above the dam, but degraded channel conditions just above the reservoir limit spawning success and juvenile survival. The population in the reservoir uses the East Fork for spawning and rearing. The East Fork is primarily inside wilderness, except for about a mile of stream immediately above the reservoir.

Because of declines throughout its historic range, bull trout was listed by the United States Fish and Wildlife Service (USFWS) as a Threatened Species within the Columbia River Basin. Section 7(a)(2) of the Endangered Species Act (ESA) of 1973 as amended, requires all federal agencies to review actions authorized, funded, or carried out by them to ensure such actions do not jeopardize the continued existence of listed species. Critical habitat was designated for bull trout in October of 2005. In Montana the USFWS designated 1058 miles of stream and 31916 acres of lakes as critical habitat. No critical habitat is on BDNF lands. Currently there is a draft recovery Plan for bull trout.

Fluvial Arctic Grayling

Fluvial (permanently stream-dwelling) arctic grayling became a major concern in Montana in the late 1970's and early 1980's. Concerns escalated for over a decade until a conservation plan was adopted. While numerous lake-dwelling populations are present here and throughout the northern Rocky Mountains, the only confirmed self-sustaining fluvial population remaining outside of Canada and Alaska occurs in the Big Hole River. Historically, they were distributed throughout the upper Missouri River basin, with populations in the Big Hole, Red Rock, Beaverhead, Jefferson, Madison, Gallatin, Smith, and Sun Rivers providing most of the habitat (Kaya 1990). The species appeared to have been irregularly distributed, with the Sun and Smith Rivers providing the only habitat downstream from Three Forks.

Conservation efforts over the last 13 years resulted in grayling reintroduction in the North and South Forks of the Sun Rivers as well as the Ruby and Beaverhead Rivers. They have all been limited in their success. The most promising place to reestablish grayling seems to be the Ruby River, upstream of Ruby Reservoir. Limited reproduction has been documented. While adult numbers are quite low, individuals seem to be distributed over about 47 miles of stream. Stocking is ongoing in the Ruby in attempt to establish a naturally sustained population. Recovery of grayling on the BDNF is largely focused on assisting with recovery objectives and ensuring management actions don't impede recovery.

Westslope Cutthroat Trout

Westslope cutthroat trout, (WCT) inhabit streams on both sides of the continental divide. Its eastside distribution is largely in Montana in the Missouri River drainage. Historically, within the Missouri basin, the downstream distribution extended to Great Falls and included headwaters of the Judith, Milk, and Marias rivers. On the west side, the subspecies occurs in the upper

Kootenai, Clark Fork, Clearwater, and Salmon rivers. It also inhabits the Spokane River above Spokane Falls, and the Coeur d'Alene and St. Joe drainages.

Based on the most thorough evaluation to date, WCT historically occupied about 33,000 miles of stream in Montana. This represented about 59% of the range-wide distribution (Shepard et al. 2002). About 9,300 of those miles (28% of the statewide distribution) are in the BDNF analysis area. WCT were broadly distributed across the Beaverhead, Big Hole, Redrock, Madison, Ruby, Boulder, Jefferson, and Upper Clark Fork Rivers and Rock Creek drainages. Our best information suggests only 10 of 433 sub-watersheds (6^{th} field HUCs) did not historically host westslope cutthroat trout.

Their distribution in the analysis area was fairly balanced between public and private lands. An estimated 48% of the stream miles were on Federal lands. Thirty-nine percent (3,630 miles) are assumed to have been on the BDNF. Streams on private lands constituted about 46% (4250 miles) of the total. State lands made up the remaining 6% (600 miles) of WCT occupied streams. Westslope cutthroat distribution and abundance has declined substantially.

Describing current WCT distribution is complicated by an abundance of populations with varied levels of genetic purity. The question that invariably surfaces is: "At what point has a WCT population become sufficiently hybridized that it fails to have conservation value, and its importance remains primarily as a recreational fishery? This has management implications, since the importance of individual populations must be defined to meet legal and regulatory requirements regarding species viability forestwide. Shepard et al. (2002) used specific criteria to designate conservation populations. Basically they are genetically unaltered; or those which are hybridized or the genetic status is unknown, but have ecological, genetic and behavioral attributes of significance. Populations that occupy habitat likely to become part of a WCT conservation focus were also included. These criteria have been used broadly by state and federal management agencies and seem reasonable. As such, they will be applied in this FEIS and the associated biological evaluation for WCT. Currently about 301 WCT populations live in streams in the analysis area. Fifty-seven percent, or 173 of these are conservation populations. The table below displays the distribution across river drainages. Conservation populations occupy about 1,280 stream miles, representing approximately 14% of historically occupied stream miles within the analysis area.

Table 11. Distribution of Conservation and Non-Conservation Populations by River Drainage

River Drainage (equal to 4th level HUC)	Conservation Populations	Approximate Non-conservation Populations*
Beaverhead	18	7
Big Hole	48	27
Boulder	6	1
Jefferson	7	2
Madison	9	20
Red Rock	40	22
Rock Creek	8	5
Ruby	16	19
Upper Clark Fork	21	25
Total	173	128

** Unlike conservation populations, beginning and end points of individual non-conservation populations were not defined in this analysis. Thus, an approximate number of populations could only be determined by counting stream segments WCT currently occupy. This method is fairly accurate east of the continental divide, but less accurate on the west side.*

Total stream *miles* occupied by conservation populations are nearly even east and west of the Continental Divide, 646 on the west side and 635 on the east side. However there are 29 conservation populations west of the divide, while there are 144 populations east of the divide. These data point to notable differences between populations separated by this geographic boundary. The average stream length occupied on the west side is 22.3 miles, while it is only 4.4 miles on the east side.

Influences from non-native trout and other factors have resulted in severely disjointed WCT distribution patterns east of the divide. While WCT conservation populations are present in a reasonable number of sub-watersheds/6th HUCs (Table 11), they have been eliminated from most mid-sized and larger streams and rivers. This leaves harsh, less productive headwater streams as their most common refuge. Even in headwaters, they are often restricted to relatively short, stream segments where fish passage barriers protect them against upstream invasion by non-native trout. Individual WCT are exposed to invasion by non-native trout and unnatural competition and hybridization risks when they move below barriers, and are essentially lost to the population. Consequently, selective pressures result in the strong tendency for east-side populations to be isolated, non-migratory residents lacking the characteristics and benefits of a metapopulation.

While non-native trout have influenced WCT populations west of the continental divide in the same manner described above, the extent and magnitude of effects are greater on the east side. The percentage of sub-watersheds containing conservation populations in Rock Creek and the Upper Clark Fork River are notably higher than those east of the divide (Table 12). Further, conservation populations persist in 36% of the historically occupied stream miles west of the divide and in only 8% of historic habitats east of the divide.

Table 12. Comparison of Sub-Watersheds* in the Analysis Area with the Number of Sub-Watersheds Containing WCT Conservation Populations

River Drainage	Sub-Watersheds in Analysis Area	Sub-Watersheds with One or More Conservation Populations	Percent of Sub-watersheds With One or More Conservation Populations
Beaverhead	39	13	33%
Big Hole	94	35	37%
Boulder	24	8	33%
Jefferson	31	4	13%
Madison	51	7	14%
Red rock	82	32	39%
Rock Creek	49	40	82%
Ruby	29	13	45%
Upper Clark Fork	34	19	56%
Total	433	172	39%

** Sub-watersheds are the common term for 6th Field Hydrologic Units or its common abbreviation "6th HUCs"*

Current WCT distribution in the analysis area shows a shift from historic distribution, relative to land ownership. Approximately 66% of cutthroat conservation populations occur on Federal land versus 48% historically. The BDNF contains 760 (90%) of 841 stream miles on federal lands. Thirty percent of the stream miles are now on private land (46% historically). State lands currently contain about 4.5% of the WCT Conservation Population stream miles (6% historically). The shift in distribution away from private lands is largely a reflection of populations being more restricted to headwater streams, which are typically found on the forest or BLM.

Most of our WCT populations are now resident, but had some form of migratory tendency in the past. In most locations, we attribute the loss of the migratory component to non-native competition and hybridization impacts. Within the analysis area, resident life histories are present in 1,223 miles of stream. Migratory life histories are present in 413 miles. Notable differences in migratory tendencies exist between the east and west sides of the continental divide. Migrating individuals are found in 382 miles of stream on the west side compared to 31 miles of east-side streams.

The length of stream available for populations is important. The more stream available, the greater the chance all biological requirements can be consistently met over time. Also, as available stream length increases, so does potential for populations to interact. At the forestwide scale, 5% of conservation populations occupy 15 or more miles of connected stream. Sixty-nine percent have less than six miles of connected stream. Seventy-eight percent of populations with 15 or more miles are west side of the Continental Divide. Ninety-three percent with less than 6 miles are on the eastside. The isolated nature of populations east of the Divide and the short lengths of stream they occupy, suggest they are at higher risk. Risks to individual populations will vary with the quality of their habitat.

Cutthroat populations that have been tested and found to be genetically pure exist in 569 (44%) of the 1,281 stream miles that contain conservation populations. An additional 342 miles are occupied by populations suspected to be pure, but have not been tested.

Hybridization continues to be a risk for genetically pure populations. In 423 miles of stream, species with the potential to hybridize with WCT exist in the same stream segment, or nearby, with no barrier to separate them. This represents a third of the total miles occupied by conservation populations.

Eastern brook trout is the most influential non-native competitor for WCT in the analysis area. While the nature of the competitive advantage is not fully understood, the magnitude of the effects on WCT distribution is well known. Fish biologists are documenting that brook trout continue to invade new areas and displace cutthroat many decades after the original introduction.

East of the continental divide 57% of WCT Conservation Populations are competing with brook trout (Table 13). Because there is a mix of resident and migratory populations in a number of the same streams west of the divide, the numbers are a little less clear. However, in 49 of 66 west-side sub-watersheds (6th field HUCs), cutthroat populations live with competing brook trout. We do not fully understand why there has been a greater retention of the migratory life history in Rock Creek and Upper Clark Fork populations.

Table 13. Number of WCT Conservation Populations Compared to Populations that Compete with Brook Trout and Percentage in River Drainages East of the Continental Divide

River Drainage	Conservation Populations	Populations Competing with Brook Trout	Percent Competing with Brook Trout
Beaverhead	18	9	50%
Big Hole	48	36	75%
Boulder	6	5	83%
Jefferson	7	3	43%
Madison	9	1	11%
Red Rock	40	19	48%
Rock Creek	n/a	n/a	n/a
Ruby	16	9	56%
Upper Clark Fork	n/a	n/a	n/a
Total Forestwide	14	82	57%

Changes in WCT distribution from Historic conditions have not been driven as much by habitat conditions as by non-native trout influences. However, conditions in various streams across the analysis area are limited by effects from grazing, mining, roads, irrigation diversion and/or timber harvest. Where Conservation populations occur, streams range from properly functioning to non-functioning condition. Where they are limited to very short stream segments, habitat conditions become even more critical, since opportunities to move and find suitable conditions for biological and survival needs are restricted.

Shepard et al. (1998) assessed extinction risk for 144 known populations, on federally managed lands, east of the Continental Divide, using a ‘customized’ Bayesian viability assessment procedure. Results indicated 90% of the populations were at a high, to very high risk of extinction over the next 100 years. The viability analysis indicated the presence of non-native fish, livestock grazing, mineral development, and angling had the greatest relationship to the probability of WCT population persistence. These are largely consistent with major factors suggested in other papers as causes for declines in cutthroat distribution (Liknes and Graham 1988). However, non-native fish influences are the greatest threat to many of the populations in this analysis area.

Westslope cutthroat was petitioned for listing throughout its historic range in 1997. In 2000, the USFWS found WCT “Not Warranted for Listing”. A recent lawsuit resulted in the determination being remanded to the USFWS for reevaluation. Following a new status assessment the August 2003 finding issued in response to the amended petition, again found WCT “Not Warranted for Listing”.

Lake Trout

The native range of Lake trout includes most of Canada and northern United States from Montana to New England. Relic native populations persist in only 4 lakes in Montana. Two of these are on the BDNF; Elk Lake in the Red Rock River Drainage and Twin Lakes in the Big Hole River Drainage.

Numerous authors describe the occurrence of native lake trout in Elk Lake in the late 1800’s. The dates of documentation predates the period when this species was first introduced in the intermountain west in 1990. Currently, lake trout appear to be relatively stable and at low densities. From 1991 through 1999, the majority of fish captured ranged from 16.5 -19.5 inches in length. Sampling procedures didn’t allow for determination of spawning and recruitment success.

In Twin Lakes, lake trout are less abundant than in Elk Lake and data from 1964 to present indicates there is extreme variation in recruitment success. The cause is not yet determined, but suggests this population is at high risk of extinction. Limited productivity and a short growing season may enhance predatory effects on this population from other species in the lake.

Burbot

Burbot are native to the headwaters of the Missouri River Drainage in southwestern Montana. They occur in the Red Rock, Beaverhead, Big Hole and Jefferson River drainages and reside in lakes, rivers and streams and can successfully spawn in all. In Montana they tend to live primarily in larger rivers and lakes downstream from the forest boundary. Burbot provide a relatively popular fishery in Clark Canyon Reservoir south of Dillon.

Paragamian and Willis (2001) report adult burbot in lakes spend most of their time on the bottom. Temperature seems to be important relative to their distribution in streams. Selected habitats in flowing systems have higher sediment loads. Burbot are common in northern rivers where stream temperatures tend to stay below 65 degrees Fahrenheit. They are uncommon in rivers at the southern edge of their range where temperatures often exceed 68 degrees.

Burbot exist on NFS lands in only a few streams in the Big Hole Drainage. Distribution is awkwardly fragmented, and indicates distribution in southwestern Montana has been reduced. However, little is known about this species in this area and its trend and status is speculative. Spawning usually happens in late winter or early spring. They typically spawn in lakes in shallow areas over cobble or gravel. In rivers, they use low velocity areas in the main channel and in side channels behind deposition bars. Newly hatched larvae, drift passively in the water column, until their swimming performance improves and they become more mobile. Even as adults, however, they tend to have relatively low swimming performance. This suggests they are poorly suited for BDNF streams which are typically steep and fast-flowing (Paragamian & Willis 2001)

Adult burbot feed primarily on fish, although they will also eat some insects and macroinvertebrates. Juveniles rely more heavily on invertebrates. Additional research is necessary to fully understand status and trend of this species in southwestern Montana.

Amphibians

Amphibians native to southwestern Montana include the long-toed salamander, tiger salamander, plains spadefoot, boreal chorus frog, tailed frog, Columbia spotted frog, northern leopard frog and the western toad. Long-toed salamanders and spotted frogs are the most widely distributed and abundant amphibian species (Table 13). Northern leopard frogs and western toads are sensitive species on the BDNF.

Four amphibian species are limited in their distribution across sub-watersheds, or in the suitable habitats in the sub-watersheds they occupy. As shown in the table below, the tiger salamander was present in 38% of sampled drainages. The boreal chorus frog was more broadly distributed (58% of sub-watersheds), but were relatively rare (13% of suitable habitats).

Maxell (2000) lacked enough data to quantitatively assess occurrence of tailed and leopard frogs and the Plains spadefoot. As such, he provided a qualitative assessment of their occurrence. Tailed frogs are common west of the continental divide, but less common east of the divide. The Plains spadefoot is rare and the northern leopard frog may no longer be present.

The tiger salamander and the boreal chorus frog and Plains spadefoot are eastern great-plains species whose natural distribution tends to extend east of the divide, but does not cross over to the west. Similarly, tailed frogs are a pacific-northwest species that protracts slightly over the divide into the Big Hole drainage. This forest straddles the divide and so encompasses the outer edge of distribution for these species. Their pattern of occurrence likely reflects natural suitability limitations on the periphery of their range, rather than man caused influences.

Table 14. Percent Occurrence of Five Native Amphibian Species and Breeding Sites in 50 Randomly Selected Sub-watersheds (6th field HUCs) in the Analysis Area

Species	Detected Presence in Sampled Sub-watersheds	Detected Occurrence of Breeding in Sampled Sub-watersheds	Detected Occurrence in Suitable Habitats* when Present in Watershed	Detected Occurrence of Breeding in Suitable Habitats* when Present in Watershed
Long-toed salamander	68%	68%	88%	87%
Tiger salamander	38%	38%	21%	21%
Western toad	37%	26%	7%	7%
Boreal chorus frog	53%	53%	13%	11%
Columbia spotted frog	81%	71%	58%	32%

**non-flowing water sites*

Plains Spadefoot

The Plains spadefoot is an eastern great-plains species, whose distribution extends into our analysis area, but is relatively uncommon. Its presence on the BDNF is doubtful because preferable habitats are found in the valleys below the forest boundary.

Columbia Spotted Frog

Columbia spotted Frogs are highly aquatic and tend not to stray far from the water. Breeding occurs from March to June, depending on snowmelt and temperature. Eggs are deposited in along the edge of shallow water where there is emergent vegetation. Eggs hatch in 5-21 days and tadpoles metamorphose from mid-summer to late fall. Adults seem to prefer not to migrate during the year, however, movements of 6 to 7 kilometers has been documented (Maxell 2000).

Spotted frogs are the most common frog in the mountains and mountain valleys in western Montana. Similarly, they are the most common amphibian in the analysis area. Surveys in 2002-2003 detected them in 81% of the sub-watersheds that were inventoried. They were present in 58% of the suitable wetlands (Maxell 2004).

Long-toed Salamanders

Long-toed salamanders are the most common salamander in Montana. They are found in a variety of habitats ranging from sagebrush to alpine areas. They breed primarily in ponds or lakes, but very occasionally will use low gradient, slow flowing streams if fish are absent. Adults migrate to breeding ponds shortly after snowmelt and typically breed earlier than other amphibians in Montana. Eggs hatch in 3-6 weeks and metamorphosis occurs after 2-14 months. Egg masses are usually attached to underwater vegetation or submerged branches.

Larvae are found in ponds. Adults will also be in the water during the breeding season. During the rest of spring, summer and fall, adults may be found in and under logs on the forest floor. Surveys in the analysis area indicated they are present in 68% of the sub-watersheds, and occur in approximately 19% of the suitable habitats (Maxell 2004).

Tiger Salamanders

Tiger Salamanders occur in a wide range of habitats, so long as a water body is nearby and the ground is suitable for them to dig a burrow. Adults typically remain underground, except for the breeding season. Breeding may occur where predatory fish are absent, in a variety of conditions ranging from clear mountain ponds to seasonal manure-polluted pools in lowland areas (Maxell 2000). Adults will migrate up to several hundred meters between breeding sites and terrestrial burrows.

Eggs hatch in 2 to 5 weeks. Metamorphosis of larvae occurs at the end of the summer following hatching, or if the growing season is short, it may not occur until the second or third summer. In some locations larval salamanders never transform, but rather become sexually mature and breed while retaining gills (Reichel & Flath 1995). These salamanders are often called “axolotls”. Amphibian surveys within our analysis area, detected this species in 38% of the sub-watersheds, within its natural range.

Boreal Chorus Frog

Boreal chorus frogs are very small, reaching a maximum length of around 1.5 inches. They are found in water primarily during the spring breeding season. After mating they typically move into the uplands and are rarely seen. They use small ponds and lakes with shoreline vegetation that ranges from prairie to open forest. Eggs hatch in about 2 weeks and metamorphosis from the tadpole stage occurs after 2 months.

They are found only east of the continental divide and are more common in eastern Montana. Individuals have been identified in a number of locations in the Red Rock, Madison, Ruby and Beaverhead drainages (Maxell 2004). Surveys conducted in our analysis area (on and off NF lands) during 2002-2003 detected chorus frogs in 53% sub-watersheds inventoried and in 4% of the suitable sites (Table 13).

Tailed Frogs

Tailed Frogs are found in and along small, swift, cold mountain streams. It appears to be sensitive to siltation and has been noted to disappear downstream of clear-cuts and water diversions in some areas. This has not been noted in Montana, however. Eggs are laid in late summer and hatch after approximately 4 weeks. Tadpoles metamorphose into frogs after 1 to 4 years. They reach sexual maturity at 6 or 7 years old (Daugherty & Sheldon 1982).

Their distribution seems to be quite localized in Montana. However, data is limited and they may be more widespread than is currently known. They occur on both sides of the continental divide, but are more common on the west side. At this time they are considered relatively common (Maxell 2004), however our data doesn’t lend itself to a quantitative assessment within the analysis area.

Northern Leopard Frog

The northern leopard frog and western toad were both assumed to be relatively abundant historically, but have declined in their natural range. Reductions in distribution are not specific to this forest, but have occurred larger scale (Maxell 2000). The cause of decline is largely speculative, but disease is being suggested as the cause for western toads. This seems plausible, since the geographic area where reductions have occurred is relatively large; and there seems to be no clear association between man-caused impacts and all critical habitats. This may also be the case with leopard frogs.

The northern leopard frog is found in or near water in non-forested habitats. They prefer dense vegetation like occurs in cattail marshes or dense sedge meadows. Breeding takes place in lakes, ponds, springs and sometimes beaver ponds or stream backwaters. Eggs hatch in 4-15 days and tadpoles metamorphose in 8-15 weeks.

Leopard frogs were historically widespread in Montana, on both sides of the continental divide extending across the eastern plains. They have been identified at elevations of up to 6000 feet (Maxell 2000). Currently, this species appears to be extinct throughout much of western portion of the state. Amphibian inventories in 50 sub-watersheds within our analysis area during 2002 and 2003 failed to detect any individuals of this species (Maxell 2004). They are currently presumed absent from BDNF lands. Disease may be the cause for the substantial decline in distribution of this amphibian.

Western Toad

The western toad is largely terrestrial and found in a variety of habitats from valley bottoms to high elevations. They breed in lakes, ponds and occasionally in slow flowing streams. They prefer shallow areas with muddy bottoms. Breeding typically occurs from May to July, and tadpoles will metamorphose when 2 to 3 months old (Reichel & Flath 1995). Juveniles can be found in dense aggregations adjacent to breeding grounds. They are susceptible to high mortality rates measurable disturbance occurs shortly after metamorphosis.

Adult and Juvenile toads are freeze intolerant and over-winter and shelter in underground caverns, or rodent burrows (Maxell 2000). Adults feed on a variety of ground dwelling invertebrates and are known to eat smaller individuals of their own species.

Within the last 25 years, western toads have undergone population crashes in Colorado, Utah, southeast Wyoming and New Mexico (Ross et al. 1995, Corn 1998). In the northern Rocky Mountains they have also undergone declines. Surveys in the late 1990’s revealed they were absent from a number of areas they historically occupied. While they remain widespread across the landscape, they appear to be occupying only 5 –10%, or less, of the suitable habitat (Maxell 2000).

A systematic inventory of standing water bodies in 50 randomly chosen sub-watersheds within the analysis area (on and off forest) demonstrated similar findings (Maxell 2004). In the sub-watersheds they were found to be present, they were detected and breeding in only 7% of the suitable habitats (Table 13). What this represents with regard to historic distribution and abundance in this area is not known, since there is not baseline data to compare against. However, based on declines in other western states, it seems reasonable they are depressed and a primary cause is believed to be disease.

Human Influences on Aquatic Ecosystems

Human activities can directly or indirectly affect natural processes and the frequency, magnitude, and duration of catastrophic events.

Roads, water development, fire suppression, timber harvest, mining, grazing, and recreation have been the major human-caused agents of change for water resources.

Roads: Most roads on the forest were built to facilitate timber management and harvest, although these roads now support a variety of other uses. User-created trails and off-highway vehicle (OHV) roads are also common forestwide. Many roads and trails are adjacent to streams and segments are located in floodplains. Predictably, the impacts to water resources include sedimentation and alterations in streamflow volume and timing. Duration and intensity of these effects vary, depending on various site, climate, and management variables. In recent years, the amount of timber management activity, and associated road building, has decreased considerably. Conversely, recreation use has increased appreciably, with a corresponding increase in user-created roads and trails.

Table 15. Miles of Road on All Land Ownerships by Landscape (based on 2002 road information)

Landscape	Open Road Density	Stream Density	Road/Stream Crossing Density	Roads within 300 ft. Per Stream Mile
Big Hole	1.0	1.9	0.5	0.13
Boulder River	1.2	1.8	0.7	0.24

Landscape	Open Road Density	Stream Density	Road/Stream Crossing Density	Roads within 300 ft. Per Stream Mile
Gravelly	0.8	1.8	0.3	0.13
Jefferson River	0.9	1.7	0.4	0.13
Lima-Tendoy	0.8	1.8	0.4	0.11
Madison	0.1	1.8	0.4	0.13
Pioneer	1.0	1.6	0.5	0.17
Tobacco Root	1.4	1.8	0.6	0.25
Upper Clark Fork	1.5	1.6	0.6	0.24
Upper Rock Creek	0.9	2.0	0.4	0.13

Water development: Development and use of water resources can affect water quality and quantity. The removal of water from small headwater streams affects the annual water balance, temporal distribution, flood hydrology, minimum flows, and water quality much more than many impacts on the landscape. There are more instream diversions off forest than on forest. 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 forest lands.

Water developments are mostly associated with agricultural and municipal uses. Stock watering facilities are common and are usually small wells or spring developments. Irrigation water diversions tend to be simple headgate designs and open, earthen canals to transmit water to private lands. Agricultural water uses tend to divert water only during the summer months. Municipal water diversions operate year-long and tend to be sophisticated, with multiple diversion structures feeding into larger and larger canals and pipelines. They also include reservoirs to store the water.

Fire Suppression: Fire suppression tactics may be affecting the characteristic fire regime in many western watersheds. With the advent of fire suppression, less forest is burned on an annual basis. As fuel loads increase, potential for larger, more intense fires increase. This change in fire intensity may produce different effects in aquatic and riparian ecosystems then what was previously experienced. Fire retardants, can have harmful effects on aquatic biota. Modern fire suppression beginning in the 1950's, may be changing the natural fire regime and the ecological processes it influences, but more scientific study is needed before conclusions can be drawn.

Fire retardants, an important tool in modern firefighting, can have harmful effects on aquatic biota. To reduce the corrosive effects of certain retardant formulations (e.g., Fintrol) on storage and dispersing equipment, ferro-cyanide compounds are sometimes added to the mix. If fire retardants containing cyanide compounds are inadvertently sprayed in to aquatic environments with a pH of 9.0 or less, free cyanide can be produced, a substance that is materially toxic to aquatic biota.

Timber harvest: Water resources have been influenced since the late 1800 by timber harvest. Timber harvest can produce water yield increases in local streams (Troendle et al. 2001). If 20-30% of the basal area is removed from a forested watershed, flow volume, peaks, and timing may increase. This is due to reduced interception loss from tree crowns and reduces transpiration loss from growing trees. Flow volume and peak flows tend to increase, and annual peak flows can be moved ahead several weeks. In extreme cases, peak flow increases and duration have changed channel morphology. As vegetation grows back after harvest, water yield declines. This effect is generally only noticeable near the site where the timber harvest took place and makes it difficult to detect or confirm water yield increases downstream. Timber harvest can also increase the levels of fine sediments in streams, but the majority of sediment impacts are from the road construction associated with harvest activities.

Table 16. Timber Harvest and Burned Percentages by Landscape

Landscape Name	Area Harvested	Area Burned	BDNF portion with > 60% Crown Removal
Big Hole	5.3%	6.0%	11.8%
Boulder	4.1%	1.5%	6.3%
Gravelly	3.0%	0.5%	3.9%
Jefferson	0.7%	0.0%	1.5%
Lima-Tendoy	0.9%	0.0%	1.3%
Upper Clark Fork	4.0%	0.0%	4.8%
Madison	0.1%	0.0%	0.2%
Pioneer	1.9%	0.2%	2.6%
Upper Rock Creek	5.0%	4.2%	9.6%
Tobacco Root	2.6%	0.0%	3.3%

Mining: Mining has played an important role in the settlement of the area, particularly in the north half of the forest. Butte, MT began as a cluster of mining camps in the early 1870s following the discovery of silver and copper. Largely uncontrolled mining practices of the early 1900s led to wide spread environmental impacts that persist today. Before the area was declared a superfund site, it was not uncommon for the Clark Fork River (which begins just to the east of Butte) to literally run red during heavy rains because of the heavy metals leaching into streams and groundwater.

Mining generally has two effects on water resources. First, the physical changes produced in the riparian landscape vary with the type of mining operation. Second, there is the change in water quality resulting from the exposure of heavy metals to the atmosphere. Hand panning and shoveling may have minimal effects; hydraulic operations can dramatically alter landscapes. Almost any level of mining can impact fish and aquatic insect habitat, which changes aquatic communities. The forest has seen moderate amounts of in-stream mining; the heaviest activities occurred in the Boulder and Upper Clark Fork watersheds. While some areas have recovered substantially, others still have unnatural drainage patterns and poor channel conditions. At this time, commercial mining is limited whereas there are still active recreational mining operations.

Table 17. Number of Mines by Landscape

Landscape	Active Mines	Abandoned Mines
Big Hole	46	3
Boulder	209	73
Gravelly	71	0
Jefferson	133	18
Lima – Tendoy	33	1

Landscape	Active Mines	Abandoned Mines
Upper Clark Fork	417	64
Madison	7	0
Pioneer	193	33
Upper Rock	57	13
Tobacco Root	137	29

Grazing: Grazing impacts in the analysis area have varied with the timing, distribution, and numbers of animals. Before forest reserves were established in the early 1900s, animal numbers and grazing periods were essentially uncontrolled. This caused widespread riparian damage. Continued overgrazing generally causes changes in stream morphology, water temperatures, and water quality. With the establishment of allotments and the reduction in livestock numbers, riparian areas received less use and conditions generally improved. When forage in an allotment is concentrated in wet meadows, these areas receive the highest use and greatest grazing impact. Compared to pre-settlement periods, grazing management has had a variable effect, depending on watershed characteristics and specific rangeland management. Other allotments have long-term riparian problem spots caused by sustained heavy grazing. Yearly livestock-grazing trends suggest that the requisite and existing forestwide standards are being met on a more consistent basis.

Table 18. Grazing Density by Landscape.

Landscape	Grazing AUM Density (AUMs/square mile)
Big Hole	30
Boulder River	27
Gravelly	86
Jefferson River	64
Lima-Tendoy	58
Madison	12
Pioneer	40
Tobacco Root	50
Upper Clark Fork	25
Upper Rock Creek	17

In 2003, the 682 non-randomly selected stream survey sites on the Beaverhead were stratified by their condition status to assess the effects of livestock grazing on stream channels. Of the total, 251 (40%) were determined to be Non-Functioning (N-F) or Functioning-at-Risk (F-A-R). Virtually all of the 251 N-F and F-A-R reaches are affected to some degree by livestock. However, it is difficult to attribute all impacts to a single use. Most reaches have been altered to some degree by many things both natural and management related. These impacts are variable in both space and time. However, the forest has attempted to isolate the effects of just livestock on stream channels by eliminating all reaches where more than one disturbance variable existed. All reaches that may be appreciably affected by roads, recreation, mining, upstream sources of sediment, or natural instability were dropped from further analysis, leaving just those reaches where the effects of livestock were responsible for the N-F and F-A-R status. This resulted in a dataset of 169 reaches (67% of the N-F and F-A-R reaches, 25% of all the reaches surveyed).

Recreation: 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 cause removal of and damage to riparian vegetation, soil compaction in riparian zones, streambank erosion, and increased nutrient loading and pathogen levels due to human waste. Increasing recreational use, recreation impacts on aquatic and riparian ecology are concerns in some stream reaches, riparian areas, lakes, and reservoirs. Increased recreation use and impacts are predicted in the next 10 years.

Beavers: Historically, active beaver populations in valley bottoms throughout southwest Montana created a different hydrologic situation than exists today. Early trappers, as well as the Leis and Clark expedition, describe valley bottoms with abundant riparian vegetation, complex waterways and beaver ponds. Subsequent trapping and other development activities caused a measurable reduction in beaver populations, and a consequent alteration of stream systems. Generally, removal of beaver will cause stream systems to become more entrenched, export more sediment from the immediate stream reach, and dry out the valley bottom. Riparian species are replaced by dry land species.

Restoration of beaver populations could reverse this progression, restore water across valley bottoms and stabilize stream systems, increase water storage for later in the year, provide habitat for riparian dependent species, and arrest current downward trends in riparian vegetation due to moose browsing. A recent survey on the Madison and Dillon districts identified forty-seven valley segments with indications of previous beaver use. Only three of theses segments currently contain beaver.

Range of Variability

There is limited scientific evidence to quantify the range of variability for aquatic resources. Vegetation characteristics and roads influence hydrologic processes within watersheds, but there is no evidence to suggest these upland watershed characteristics have modified hydrologic processes beyond the historic range of variability. In contrast several indicators of stream health suggest that stream health may be outside the historic range of variability in some streams. The extent and condition of riparian and wetland resources may also be beyond the historic range of variability. Introduced non-native fish species dominate aquatic ecosystems in most streams. This major change in aquatic ecosystem composition has resulted conditions beyond the historic range of variability. Direct impacts to streams and riparian resources and the introduction of non-native fish species may more meaningfully define current conditions of aquatic resources than indirect impacts to watersheds.

Watershed Conditions

Existing watershed condition varies depending on the magnitude and type of disturbance and the inherent resistance and resiliency of aquatic systems. Watershed condition includes physical, chemical, and biotic factors. Cumulative effects from human disturbance and effects from variation in ecological processes were evaluated on physical, chemical, and biological watershed conditions, relative to their natural condition using the following definitions (FSM 2521.1):

Watershed condition is defined as “the state of a watershed based on physical and biological characteristics and processes affecting hydrologic and soil functions.” There are three possible condition classes.

Class I Condition - watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. The drainage network is generally stable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are predominantly functional in terms of supporting beneficial uses.

Class II Condition - watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Portions of the watershed may have an unstable drainage network. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are at risk and may not be able to support beneficial uses.

Class III Condition - watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. The majority of the drainage network may be unstable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems do not support beneficial uses.

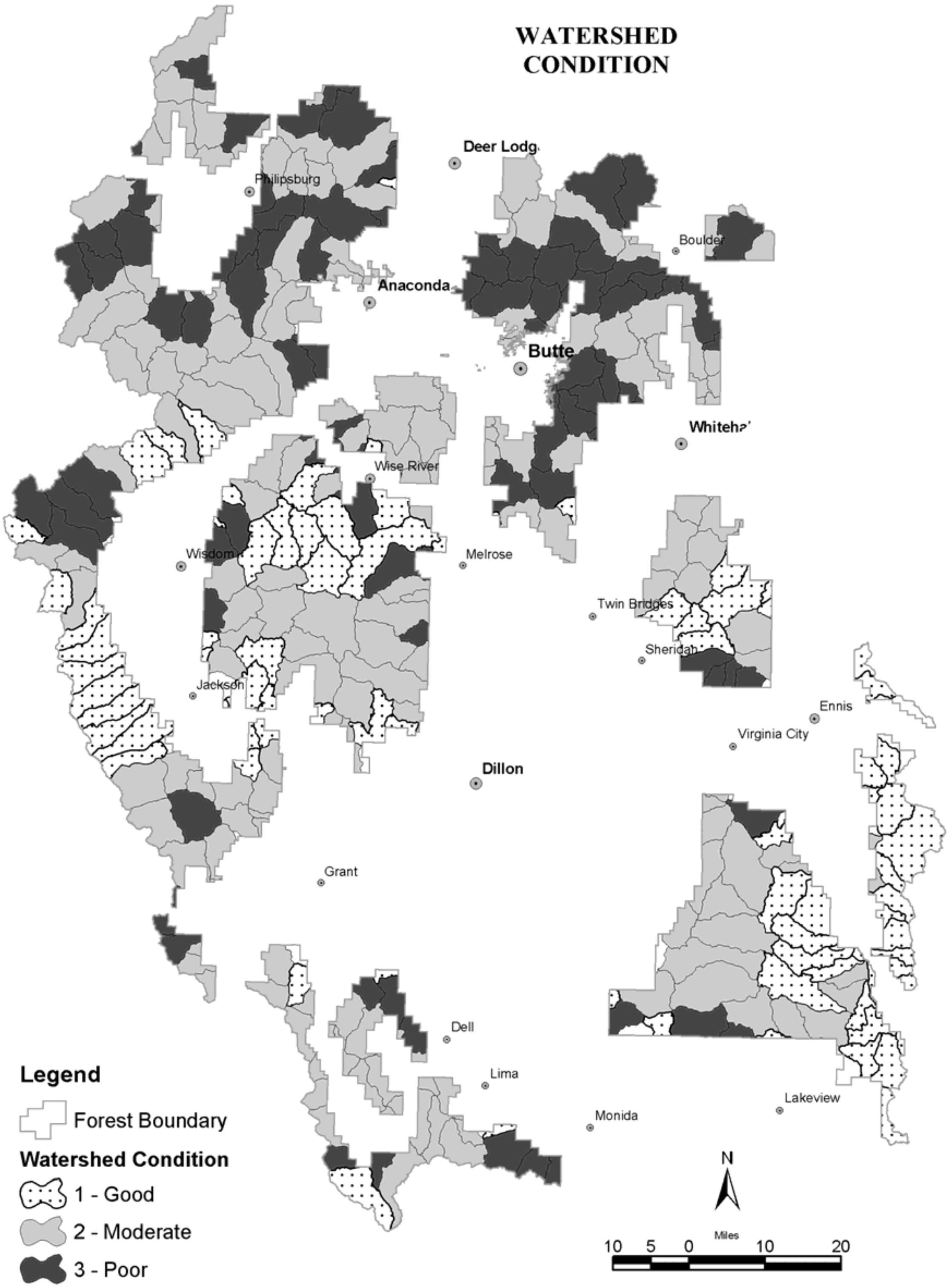

Figure 3. Watershed Conditions on the BDNF

The Inland West Watershed Initiative (IWWI) data was used to assess forestwide watershed conditions. The IWWI represents a nationwide effort to determine the condition of 6^{th} level HUCs. Each watershed was rated by geomorphic integrity, water quality integrity, and watershed vulnerability and results were assigned values of high, moderate or low. The assessments were made by resource specialists using field data, on the ground knowledge, and professional experience. The IWWI is the only forestwide data set at the 6^{th} level HUC scale.

The results of the IWWI analysis show that of the 297 6^{th} level watersheds evaluated on the BDNF, 80 (27%) were rated Class I, 143 (48%) were rated Class II, and 74 (25%) were rated Class III. The results of this assessment suggest that the cumulative effects of human disturbances and ecological processes have measurably altered the physical, chemical, and/or biological conditions from their natural potential on the majority of the forest.

Table 19. Forestwide Watershed Condition Class Summary

Watershed Condition Class I	Watershed Condition Class II	Watershed Condition Class III
80 watersheds	143 watersheds	74 watersheds

Watersheds on the north end of the forest are inherently more sensitive to watershed disturbance because geology on the south end of the forest tends to be less sensitive to disturbance. The north end watersheds also show lower water quality than the south. The causes are determined to be timber harvest, mining, and associated roads. Causes for lower water quality in the south end watersheds are shown to be agriculture and livestock grazing. Both the north and south halves of the forest have had the geomorphic integrity lowered in over 50% of their 6^{th} level watersheds with the north end having considerably more impacted watersheds.

Aquatic Restoration Priorities

Priority watersheds are defined in the Unified Federal Policy for a Watershed Approach to Federal Land Management publication thus:

> *"Priority watersheds: Watersheds selected for focusing of Federal funds and personnel for the purpose of accelerating improvements in water quality and watershed condition." (65 CFR 62566, 10/18/00)*

The Unified Federal Policy for a Watershed Approach to Federal Land Management suggests identifying watersheds that may have "significant human health, public use, or aquatic ecosystem values." In addition, watersheds that are vulnerable to or currently have "water quality impairment, impacts to aquatic resources, and/or changes to flow regimes" should be considered for identification as a Priority Watershed. BDNF aquatic specialists used existing data sources and professional knowledge to identify watersheds where important aquatic values and opportunities to restore or improve water quality, aquatic habitat, and watershed conditions occur. This information was collected and analyzed as part of the Inland West Watershed Initiative (IWWI).

The BDNF has approximately 74 sixth level HUC watersheds that may have degraded watershed conditions (Table 19). These watersheds are in need of further evaluation to determine whether degraded conditions actually exist, and if so, what needs to be done to correct the problems.

Environmental Consequences

Watershed Summary of Effects by Alternatives

- Specific outcomes (such as water quantity, water quality, instream and riparian area habitat considerations) from the alternatives pertaining to lakes, streams, rivers, riparian areas, and wetlands are not predictable without site-specific NEPA analysis.
- Alternative 1 does not incorporate a watershed approach to the management of hydrology and watershed processes; there would not likely be watershed scale consideration and protection of hydrologic and riparian area/wetland processes and functions. This would likely result in the continued protection of areas currently in satisfactory condition and areas currently in unsatisfactory would remain unchanged.
- Alternatives 2, 3, 4, 5, and 6 would emphasize a watershed approach to the management of hydrology and watershed processes. These alternatives would facilitate management of multiple ecological goals and long term ecological sustainability on a landscape basis. Updated aquatic objectives and standards applied in a consistent manner across the forest would provide a mechanism to effectively prioritize activities and weigh multiple risks to various resources. Alternatives 3, 5, and 6 would more readily provide a mechanism to restore watersheds across the forest and would aid in overall improvement in lakes, streams, rivers and riparian areas and wetlands.
- Alternatives 1 and 4, with their higher activity levels, could pose greater short-term risks to aquatic ecosystems than would the lower activity rates and amounts of alternatives 2, 3, 5, and 6.
- Watershed restoration levels would be greatest for Alternatives 3, 5, and 6 and are expected to result in greater long- and short-term benefits to lakes, streams, rivers, riparian areas, and wetlands compared to the other alternatives.
- Alternative 1 does not have consistent forestwide direction for riparian area protection and is not predicted to adequately protect riparian area function.

Riparian Area Summary of Effects by Alternative

Alternatives vary by aquatic standards and objectives (Table 19). Alternative 1 contains current direction under the Beaverhead and Deerlodge Forest Plans and all amendments. The Inland Native Fish Strategy (USDA 1995), as it was amended to the Deerlodge Plan in 1995, is unchanged from its original wording in Alternatives 1 and 2. For Alternatives 3, 4, 5, and 6 a handful of changes were incorporated to improve consistency in riparian management and to address region-wide concerns. With incorporation of those changes the modified version is referred to as INFISH 2005. The Beaverhead-Deerlodge Aquatic Strategy includes changes incorporated in INFISH 2005 and expands protection beyond inland native fish to include all sensitive aquatic species.

Table 20. Aquatic Standards and Objectives displayed by Alternative

Standards and Objectives	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
West of Continental Divide	Deerlodge Forest Plan Including INFISH-1995 Amendment	INFISH-1995 Amendment	INFISH-2005 and Additional Forestwide Direction	BDNF Aquatic Strategy and Additional Forestwide Direction	INFISH - 2005 and Additional Forestwide Direction	INFISH-2005 and Additional Forestwide Direction
East of Continental Divide	Deerlodge Forest Plan East of the Continental Divide Beaverhead Forest Plan including Riparian Amendment 1997	WCT Strategy and Stream Reference Reach Approach	INFISH - 2005 and Additional Forestwide Direction	BDNF Aquatic Strategy and Additional Forestwide Direction	BDNF Aquatic Strategy and Additional Forestwide Direction	BDNF Aquatic Strategy and Additional Forestwide Direction

Comparison of Effects by Alternative on Water and Riparian Resources

The most significant change between Alternative 6 and the existing plans, Alternative 1, is the incorporation of forestwide standards that are specifically designed to protect aquatic resources. If all applicable measures are implemented and if they are effective, adverse effects from alternatives 3, 4, 5, and 6 are expected to be minimized, and watershed conditions would be expected to improve.

Activities that disturb the soil surface have the greatest potential to adversely affect these resources if they occur in proximity to stream channels. These effects are typically expressed as inputs of fine sediment where activities occur along stream channels and have an associated crossing or other surface disturbances. Watersheds whose physical, chemical, or biotic function is at risk may be near their capacity to assimilate further impacts, or may need remedial action to reverse a downward trend. As activity levels increase, BMPs may not be entirely effective. Therefore, alternatives that propose higher levels of land disturbing activities 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 water and riparian resources. The top line indicates higher degrees of impact and the bottom line indicates lower degrees of impact.

Table 21Alternative Ranking by Benefit or Risk to Watershed and Riparian Resources

Effects from Resource	Less		← RELATIVE SCALE→			More
Effects of Timber Management	3	5	6	2	4	1
Effects of Wildlife Management	No difference between alternatives					
Benefits of Watershed Restoration	(1, 2, and 4)				(5 and 6)	3
Riparian Protection Afforded	1				(2, 3, 4, 5, and 6)	

Effects from Resource	Less		← RELATIVE SCALE→		More	
Effects from Recreation and Travel Management	3	2	(5 and 6)		4	1
Effects from Fire Management	3	6	5	4	2	1
Effects from Livestock Management	6	(3 and 5)		(1, 2, and 4)		
Effects from Wilderness Designation	3	6	5	2	4	1

Watershed and Riparian Effects Common to All Action Alternatives

Management activities affecting watershed processes are described in terms of their potential to increase erosion and sediment yields, their ability to alter the physical, chemical, or biological properties of both soil and water, or by their influence on the timing or magnitude of surface water runoff. Management activities may directly, indirectly, or cumulatively impact riparian and wetland habitats, resulting in undesirable changes to channel stability, water quality and aquatic habitat quality.

Effects from Land Use Authorizations

Various laws prior to the Federal Land Policy and Management Act of 1976 (FLPMA) provide rights-of-way over public lands. The Forest Service has the responsibility for all existing grants and permits located on NFS lands, including their administration, amendment, and renewal when authorized and appropriate.

Water developments 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 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 released water seeks sediment carry 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 original forest plans contained provisions to protect aquatic habitats and stream channels from the potential adverse effects of water development. Some water use permits were reviewed to ensure 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. This forest plan revision includes standards to ensure flow in perennial streams and protect against gully erosion. Permits are authorized consistent with the forest plan and the Endangered Species Act. As permits are amended, renewed, or issued, environmental effects will be analyzed to ascertain if mitigation or additional terms and conditions are required to meet the proposed forest plan standards and guidelines. 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 noteworthy, 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 than forest programs or budgets. Second, many water facilities are operated under perpetual easements or other authorizations that are subject to limited environmental mitigation.

Effects from Water Developments

The hydrologic effects of water development include flow depletion, flow augmentation, and flow regulation downstream of dams and reservoirs. Flow depletions can result in lost riparian habitat and reductions in fish populations and aquatic habitats. In-channel structures fragment habitats by blocking fish migration or by dewatering sections of streams. Increased stream flow can result in altered channel form, channel widening, bed aggradation, or increased channel migration rates, all of which can lead to lost riparian vegetation and increased sediment loads. Numerous streams are diverted at or near the forest boundary for use in irrigation or for domestic water supplies.

The impacts to soil and water resources from existing permitted or authorized water developments will not vary by alternative. Under all alternatives, vehicle access and maintenances of these water development facilities will continue to be allowed.

The effects on soil and water resources from new water developments vary by alternative according to restrictions on the ability to develop the water. The main restrictions would be from no motorized vehicle access or ability to build roads in order to construct the water development. The potential for new future development of some water sources on the forest would be limited by recommended wilderness and or roadless areas because no motorized vehicle access is allowed in wilderness.

Watershed and Riparian Direct and Indirect Effects

There are three aquatic topics tracked through the effects analysis on riparian and water resources. They are riparian condition, water quality and water yield. These three topics will be addressed in each of the ten management categories.

Nearly all activities carried out on the forest and described in this analysis have the potential to adversely affect aquatic and riparian resources to some degree. Activities that alter the quantity, timing, or quality of water resources have the greatest potential for adverse effects, and the risk of adverse effects increases as the distance to streams or wetlands decreases.

Surface water, groundwater, floodplains, riparian areas, wetlands, aquatic habitats and other aquatic organisms 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.

Watershed conservation practices Best Management Practices and forest plan standards prescribe extensive measures to protect soil, riparian, and aquatic resources. When applicable measures are implemented and effective, adverse effects to these resources from management activities will be minimized or eliminated. However, as the level of activity increases, the risk that conservation practices will not be implemented or will not be cumulatively effective also increases. Consequently, alternatives that propose greater levels of activity for various resources generally pose greater risk to aquatic and riparian resources.

Implementation and effectiveness monitoring of Best Management Practices are typically carried out as an administrative review and does not involve water quality measurements. Implementation and effectiveness monitoring of watershed conservation practices, and forest plan standards 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 can include field notes, memos, contract daily diaries or monitoring reports. Systematic monitoring and adjustment of land management activities, where necessary, will ensure the highest possible level of Best Management practice implementation and effectiveness.

Individual activities generally do not, by themselves, result in watershed scale responses. However, the impacts of multiple management activities over long time periods can create such responses. All alternatives have objectives and standards pertaining to the maintenance and restoration of riparian areas and wetlands.

Effects on Restoration Key Watersheds and Riparian Areas from Aquatic Resource Management

Restoration key watersheds identified in Alternatives 3, 5, and 6 would provide a mechanism to prioritize activities that contribute to maintenance and restoration of integrated ecological processes at the watershed scale. Higher levels of landscape restoration would occur in high priority restoration watersheds. Restoration opportunities would be identified and prioritized during Ecosystem Analysis at the Watershed Scale (EAWS), with the expectation of higher success in restoration and reductions in short term risks.

Alternatives 1, 2, and 4 do not incorporate restoration key watersheds. However, Alternative 4 does have fish emphasis key watersheds and activities are expected to be implemented using a restoration emphasis. However, these activities would be distributed over a much larger landscape, and effectiveness in meeting broad-scale watershed improvement objectives would be limited. Alternatives 1 and 2 do not have either restoration or fish emphasis key watersheds. Activities in these alternatives focus on protection and restoration of hydrologic processes without considering an integrated, ecological strategy at the broad scale. These efforts are assumed to have little bearing on larger scale watershed and ecosystem processes that create and maintain water quality and aquatic habitats through time.

Table 22. Fish and Restoration Emphasis Key Watersheds by Alternative

Watershed Emphasis	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Fish Emphasis	0	0	27	57	57	56
Restoration Emphasis	0	0	78	0	15	15
Total	0	0	135	57	72	71

Riparian Habitat Protection and Management

Intact and functioning riparian areas are critical components on the landscape that integrate aquatic systems with uplands, forming the basic ecological system. All Alternatives have goals and objectives that would manage for the protection and restoration of riparian areas. The ecological functions of riparian areas occur at varying distances depending on the range and character of riparian and wetland vegetation. The extent of the areas under riparian consideration and emphasis varies by alternative. Key differences among the alternatives include elements that provide flexibility in riparian area designation which determines the amount of area within the designated riparian area. However, these differences could generate local risks to ecological function of riparian and aquatic ecosystems.

Alternatives 2, 3, 4, 5, and 6 incorporate INFISH that requires specific criteria for delineating riparian areas with emphasis on the protection of riparian areas forestwide. Alternative 1 does not have forestwide criteria for delineating riparian areas. This alternative may not be as effective in maintaining watershed processes and hydrologic function as the other alternatives.

303(d) Streams

Alternatives 3, 5, and 6 propose to implement key restoration watersheds. The rate and effectiveness of active restoration combined with the overlap of key restoration watersheds and 303(d) listed segments could shorten the time for bringing 303(d) waters into compliance. In Alternative 3, the number of key restoration watersheds is higher than Alternatives 5 and 6. Therefore, it is likely that Alternative 3 would result in greater decreases in the sources of impairment and subsequent improvements in water quality.

Effects on Watersheds and Riparian Areas from IRAs and NWPS Additions

The additions of recommended wilderness areas are very likely to confer beneficial effects to water quality and aquatic biota. In addition, stream miles located within existing wilderness boundaries are increased over the existing condition. By altering wilderness boundaries to include hydrologic divides, aquatic habitats are expanded from the existing condition by increasing the amount of stream miles that are afforded additional protection under wilderness designation. Also, important headwater stream segments located upstream and outside of wilderness areas are afforded protection that is consistent with the protection afforded to stream segments located immediately downstream. Finally, by extending the downstream lengths of stream segments that are located within existing wilderness, aquatic biota, especially native cutthroat trout, benefit from habitat expansion and from the additional protection (e.g. MTDEQ Class I waters) afforded streams located within wilderness areas. Existing stream habitats protected for wild cutthroat trout and associated native fishes within their historic range are relatively small compared to the amount of stream habitats that support non-native fish.

Table 23. Relative Impacts between Alternatives for Recommended Wilderness

Category	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Acres of Recommended Wilderness	174,000	196,000	707,000	0	249,000	331,000

Alternative 3 would provide the protection afforded to aquatic systems through the acres recommended for wilderness. Alternatives 6, 5, and 2 would provide decreasing levels of protection. Alternative 4 would provide no additional protection as a result of wilderness recommendation.

Effects on Watersheds and Riparian Areas from Livestock Grazing

Livestock grazing can directly impact soil infiltration by trampling, soil compaction and loss of vegetation cover on both upland and riparian sites. Fecal wastes can increase bacterial concentrations in water through direct introductions into live water or riparian areas. Soil and water quality can be indirectly affected by the resulting increased soil runoff and erosion, and sediment delivery to adjacent riparian areas and streams. Impacts are often greater in riparian zones because they are preferred by livestock due to the availability of shade, water and more succulent vegetation. Over long time periods, grazing can result in increased fine sediment loads from stream bank erosion, loss of riparian habitats by stream channel widening or degradation, and lowering of water tables, though channel degradation.

Overgrazing can have detrimental effects to aquatic resources, particularly in allotments where much of the usable forage is found only in riparian areas. Grazing in riparian areas directly affects vegetation condition and habitat quality in a number of ways. Alternatively, proper livestock, wildlife, and rangeland management can mitigate the grazing impacts to riparian areas and wetlands and can be compatible with maintaining desired watershed conditions.

Long-term grazing 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. Also, overgrazing by livestock and wild ungulate can reduce bank stability through vegetation removal and bank trampling, it can compact soil, increase sedimentation, cause stream widening or downcutting and often changes riparian vegetation, resulting in insufficient overhead cover for fish. 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 use of the same areas by livestock. 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.

Watershed conservation practices and updated grazing standards designed to protect water quality and riparian areas, where needed, will be included in allotment-management plans as they are revised and updated.

For the purposes of this analysis, potential livestock grazing impacts are assumed to be proportional to the acres in active grazing allotments, as shown below. The number and type of animals permitted, as well as overall use, follows the same relative trend as the acres in active allotments.

The following table displays the range of the alternatives regarding the implementation of various grazing standards. All alternatives except Alternative 1 would provide elevated compliance standards then the existing condition. Alternatives 3, 4, 5 and 6 would provide the most protection for the key watersheds identified in each alternative.

Table 24. Comparison of Alternatives for Livestock Grazing.

Category	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Acres of Suitable Rangeland	846,000	846,000	804,000	846,000	810,000	802,000
Grazing Standards	Deerlodge NF/ Beaverhead NF /INFISH	INFISH	INFISH	INFISH Modified	INFISH/ INFISH Modified	INFISH/ INFISH Modified

Livestock grazing under any of the alternatives is assumed to have some potential for direct impact on riparian and aquatic resources. Alternative 6 has the least number of acres in active allotments followed by Alternatives 3 and 5. Alternatives 1, 2, and 4 maintain the existing number of acres in active allotments. Incorporation of Best Management practices into project level analysis will minimize the effects of grazing on aquatic resources in all alternatives. Monitoring has shown that the proper implementation of livestock grazing standards leads to improved stream conditions.

Effects on Watersheds and Riparian Areas from Minerals and Oil and Gas

Locatable Minerals

Locatable or hard rock minerals include deposits of gold, silver, copper, etc. There are approximately 1,900 active unpatented mining claims on the forest. This number represents a sharp decline since the late 1980's when there were over 10,000 such claims. Since the closure of the Beal Mountain mine in 1998, there has been very little serious mining activity on the forest. However, as a result of a long mining history on this forest, there are many abandoned mines. Abandoned mines pose a threat to watershed conditions through erosion, acid mine drainage, toxic metals, and chemical processing agents.

Existing mining operations on the BDNF are typically small and limited in number. At present, much of the mining is recreational. Recreational mining, like suction dredging, is regulated by federal mining laws and regulations, particularly when potential impacts are possible. Large 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 NFS lands. All alternatives will require remedial action and protection of soil and water resources.

Leasable Minerals (Oil and Gas)

The Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS) provide oil and gas potential information for forest planning purposes. None of the lands within the BDNF has been classified as having high potential for oil and gas. There are areas with moderate potential however. Permits and leases have been issued to companies for oil and gas exploration.

All of the exploratory wells were found to be dry. Therefore, it is expected that there will be little if any new exploration in the foreseeable future.

The potential development potential for oil and gas is moderate to very low across most of the BDNF. Because of limited potential for oil and gas leasing, this issue has not been a primary concern for aquatic resources. However, protection measures for riparian and aquatic resources are important to ensure adequate protection exists in the areas that may be developed for oil and gas. Standard mitigation measures control surface erosion, protect groundwater, and ensure the safe use and storage of drilling fluids.

Risks from oil and gas well drilling include the potential for contamination by petroleum products, drilling mud, and other contaminants. Road and drill-pad construction also increases the risk of erosion and sedimentation. If exploration discovers economic quantities of oil or gas, a producing field can be developed. Effects from such a field would include more surface disturbance and potential contamination from water and oil brought to the surface.

Standard stipulations and procedures are used to protect riparian areas, stream channels, and water quality. The state of Montana and the Bureau of Land Management drilling regulations require isolation of water-producing zones as wells are drilled and before wells are abandoned. Stipulations more stringent than “standard stipulations”, such as no surface occupancy, can be applied to minimize the impacts of leasable mineral operations.

Table 25. Acres of Oil and Gas Potential within Key Restoration Watersheds by Alternative.

Alternative	1	2	3	4	5	6
Very Low Potential	NA	NA	434,000	0	139,000	150,910
Low Potential	NA	NA	284,500	0	41,000	30,030
Moderate Potential	NA	NA	67,000	0	20,000	7,190
High Potential	None	None	None	None	None	None

Effects on Watersheds and Riparian Areas from Recreation and Travel Management

Recreational impacts may include rutting, erosion, and loss of ground cover from user created roads and trails, trampling of vegetation, vegetation removal, and soil compaction of streamside and upland sites. They may be similar in type but of a different magnitude than the impacts associated with livestock grazing. Rutting may increase surface erosion associated with heavily used hiking or horse trails and off-road vehicles. High use campsites may cause root damage in trees resulting in reduced vigor and mortality. When snow packs do not provide adequate cover, over the snow vehicles can damage vegetation and cause ground disturbance.

In general, people who recreate in national forests participate in activities such as driving, horseback riding, hiking, and camping in the vicinity of lakes and streams. Protection of water quality, quantity and riparian habitat near these recreationally important water bodies is achieved through the implementation of Watershed Conservation Practices.

Recreational activities can degrade aquatic, riparian, and wetland environments. Because many existing roads, trails, developed and dispersed recreation sites in the BDNF are located adjacent to wetlands and riparian areas, or in some cases, within the flood prone areas of streams, these sites have been subjected to the following impacts: damage to and displacement of riparian vegetation; soil compaction and soil erosion; increased rates of overland flow; sedimentation; and pathogenic contamination of potable and non-potable waters. Often, the aforementioned 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.

Water quality conditions in national forest both affects and is affected by recreation activities. Recreationists are strongly advised to drink treated water only, because streams throughout the BDNF are assumed to contain the protozoan Giardia species and some streams may contain fecal coliform bacteria. Recreational use will almost certainly increase in the coming decades. Projected increases in recreational use are commensurate with all alternatives. Watershed conservation practices implemented to protect aquatic and riparian resources notwithstanding, impacts to these resources will likely increase given increased use because stream and lake environments will continue to disproportionately attract forest users.

Motorized and Non-Motorized Winter Recreation

These activities have relatively low potential to adversely affect aquatic and riparian resources. These categories of winter recreational use, however, are not environmentally benign. Non-motorized winter uses include cross country skiing and snowshoeing. Motorized winter uses include snowmobiling and snow cat use for research and maintenance. Clearly, damage to vegetation and soil erosion can occur if there is inadequate snowpack to protect these resources. Also, winter motorized activities can result in compacted snow which often form 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 . The likelihood and magnitude of the aforementioned 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 forestwide scale. Appropriately, winter activities that appear to be problematic will be identified and rectified during project-level analysis.

Improperly designed or poorly maintained roads can modify natural drainage networks and can accelerate erosion processes that result in increased stream sedimentation, degraded aquatic habitats and altered channel morphology. Road impacts generally increase as they become more connected, in terms of hydrology, to the natural channel network. Roads and their drainage systems typically act to intercept surface and subsurface runoff and route excess runoff into the channel system resulting in increased streamflow and sediment delivery to streams. In steep terrain, roads can increase the rate of hill slope failures and soil mass wasting. Fine sediments can be delivered to streams by erosion of road surfaces as well as from non-vegetated road cut and fill surfaces. Roads can impact aquatic habitats by restricting fish passage through culverts at road-stream crossings and by increasing fine sediments that can result in reduced salmonid spawning success.

Many of the aforementioned effects of roads can be mitigated by design changes that disperse, rather than concentrate road runoff and by gravel surfacing, seasonal road closures, or by designating undisturbed protective buffers along streams to allow for filtering of fine sediments.

The effectiveness of riparian buffers generally increases with increased width; however the effects of large-scale or chronic road impacts may still impact streams even when streams are protected by wide and intact buffers.

This section describes the effects on water resources from travel management. Roads associated with vegetation management and oil and gas activities are addressed in their respective discussion.

There are more than 6,100 miles of classified motorized roads and trail under BDNF management. In addition, there are numerous other roads managed by other entities within the forest boundary, including Highways and a variety of county roads. Of these motorized routes approximately 938 miles are located within 300 feet of streams. These routes provide a background level of disturbance that contributes to direct and indirect effects on aquatic and riparian resources. Trends in increased recreation are likely to continue and will accelerate these effects.

Compliance with forest plan standards including watershed conservation practices and improved road designs should minimize problems with new or reconstructed roads. However, bringing existing roads into compliance with new protection measures is a major challenge. Roads managed under other jurisdictions on private land or run across easements also contribute cumulatively, along with forest roads, to the alteration of watershed conditions.

Future road management should consider relocation or obliteration of existing roads and ways to reduce associated impacts, because road and trail effects can be greatly reduced by proper location and design. Good location keeps roads and trails 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 trails so 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.

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 macro-invertebrate life, adhering to gills of aquatic life, changing channel morphology, and damaging habitat.

Relative to the existing road network, the effects of proposed road construction under the various alternatives are minimal, because impacts are dominated by the existing transportation system. Maintenance, reconstruction and decommissioning all address the existing BDNF transportation system and are expected to influence aquatic resources more than road construction over the planning period.

The total miles of roads and motorized trails are expected to decrease under alternatives 2, 3, 4, 5, and 6. This which will benefit aquatic resources due to the decreased risk of road and trail related sediment. Alternative 3 has the greatest potential to reduce adverse effects to aquatic resources from motorized routes, followed in order by Alternatives 5, 2, 6, 4, and 1.

Developed Winter Recreation

These sites may adversely affect aquatic and riparian resources. Maverick Mountain Ski Resort operates under a special use permit. 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. Stream channel damage can result. 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 erosive. Aquatic habitat can be damaged as a result. 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 area.

Fishing

For some recreationists, fishing is the primary reason to visit the BDNF. For others, it is important, but subordinately tied to activities like backpacking, camping, and horseback riding. Streams, lakes and reservoirs on the forest provide a variety of angling opportunities in locales that range from developed sites with amenities to subalpine wilderness areas.

Hiking Trails

Hiking trails are popular among forest users in the BDNF, though trail networks and trail use can adversely impact aquatic, riparian, and wetlands environments. In addition, 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. Whirling disease has profoundly impacted trout fisheries in the western United States and chitrid fungus appears to be a causal agent in the decline of boreal toad populations in the Rocky Mountains. Other native amphibians may be impacted by the Chytrid fungus too. Finally, trails can provide relatively easy vehicle access and opportunities to those who would introduce exotic species into aquatic environments. Given the popularity of trail networks among forest users, it is reasonable to expect increasing demands by the public for additional hiking trails over the coming decades. If those demands are met, the expanded trail networks could result in the alteration and degradation of aquatic, riparian, and wetland resources.

Again, demand for a variety of recreational opportunities will continue to increase on the BDNF whether there are adequate recreational facilities to meet the increased demand, or not. If facilities are insufficient for developed recreation, then recreational use may be shifted to dispersed sites, the result of which could be additional and unregulated deleterious effects on soils, vegetation, and riparian values.

Recreational use is expected to increase in all alternatives. The direct impacts to fisheries and fishing experiences will be proportional rather than variable by alternative. Impacts on riparian and aquatic habitats from recreational travel are also discussed in the Recreation and Travel Management sections, earlier in this chapter. The magnitude and extent of motorized recreation trends have a greater effect on aquatic resources than non-motorized recreation. Therefore, recreation impacts on aquatic, riparian areas and fisheries are assumed to be proportional to the amount of area available to motorized recreation, as shown below. Using the percent of the forest available for summer motorized recreation as an indicator; Alternative 2 has the highest risk for potential adverse effects to aquatic resources from motorized recreation, followed in order by Alternatives 1, 4, 5, 6, and 3.

Table 26. Relative Impacts by Alternatives for Recreation.

Percent of motorized recreation	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Percent of the forest open to motorized recreation	75	78	46	69	60	60
Percent of the forest open to motorized winter recreation	84	78	54	84	63	61

Effects on Watersheds and Riparian Areas from Timber and Vegetation Management

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. Conversely, 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. 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 (see Effects from Travel Management below). Timber harvest can produce water yield increases in local streams. If 20 to 30% of the basal area is removed from a forested watershed, flow volume, peak flows, and timing may change. This is due to reduced interception loss from tree crowns and reduced transpiration loss from living trees. As trees reoccupy the site, changes to the water cycle begins to approach pre-harvest conditions.

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. Channel morphology changes as a result of forest canopy changes therefore might be expected to occur as a result of altered flow and sediment transport characteristics. Susceptibility to channel morphology changes is dependent on stream characteristics. The majority of streams on the BDNF are not highly susceptible to changes in channel morphology as a result of vegetation management since they are well armored. Harvest levels necessary to produce measurable increases in streamflow (i.e. greater than 20% of a watershed harvested) are uncommon. Forest plan standards provide a means 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 not expected to be a noteworthy issue in most areas due to the harvest levels in individual watersheds and the channel conditions present on most of the forest. Project specific analysis and mitigation should address channel instability as a result of increased water yield from vegetation management in the few cases where there may be concerns.

Increases in flows, changes in riparian vegetation, and impacts to streambanks from logging operations all have the potential to alter water quality, riparian health, and fish habitat in streams in watersheds where timber harvest occurs. Direct effects of vegetation removal are most likely to result in reduced overhead cover where fish can hide and rest. Indirect effects of streamside timber harvest to aquatic ecosystems could include changes to thermal buffering which could increase average summer stream temperatures or decrease average winter temperatures to sub-optimal levels.

Alterations of typical seasonal temperatures can cause material physiological stress in fish, especially during spawning and embryonic development. Other 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. 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 management indicator species. Extensive standards have been developed to minimize the impacts of timber harvest on aquatic resources. Implementation of effective watershed conservation practices will minimize the changes to aquatic ecosystems that could occur as a result of timber harvest.

This analysis assumes that the amount of harvest is proportional to the percentage of land suitable for timber production and there is equal risk and consequence of effects from timber harvest and related activities where allowed. In reality, risk and consequence depend on a variety of factors including the type of harvest and location relative to water resources.

A long term indirect effect of lower vegetation management levels is an increased risk of large wildfires that could consume large contiguous areas of the landscape since no harvest or vegetation treatments other than wildland fire would occur. Large wildfires could result in extensive areas with low ground cover that would be susceptible to erosion.

Table 27. Comparison of Potential for Aquatic Impacts by Alternatives, Based on Land Allocated to Vegetation Management Areas.

Aquatic Impacts	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Acres of suitable timber	676,000	346,000	0	484,000	216,000	299,000
Acres of aspen restoration	Not addressed	Emphasis	13,340 to 66,700	13,340 to 66,700	13,340 to 66,700	67,000
Riparian excluded from suitable acres (300' buffer on perennial, 150' buffer on intermittent)	No	Yes	No suitable timber	Yes	Yes	Yes
Suitable timber excluded from Key Watersheds	Not applicable	Not Applicable	No suitable timber	Yes	Yes	Yes

The risk of adverse consequences to watersheds and riparian areas increases with higher harvest levels. The potential for impacts to water resources is estimated to be proportional to the percentage of land allocated to timber management areas, and is shown below. Based on this, Alternative 1 has the highest risk of potential adverse effects to aquatic resources from timber harvesting followed in order by Alternatives 4, 2, 6, 5, and Alternative 3 would have the least risk.

Alternatives 3, 4, 5, and 6 have INFISH riparian area buffers and key watersheds that will allow less ground disturbing within the riparian area and will provide superior protection to water quality, stream channels, and riparian areas. However, effective implementation of watershed conservation practices is crucial to avoiding or minimizing impacts to aquatic species and potentially affected streams under any alternative.

Effects on Watersheds and Riparian Areas from Fire Management

Fire consumes vegetation and partially or completely removes ground cover that may or may not result in the formation of water repellant soil layers, depending upon soil temperatures during the burn and the characteristics of the local vegetation and soils. The magnitude of impact on watershed processes is dependent on physical and biologic attributes of individual watersheds and on the severity of the fire. Low severity fires have little long term effect on ecosystem functions, and in fact can be beneficial to soil and water quality by reducing fuels buildup and the potential for higher severity fires. High severity fires alter above ground vegetation, soil organic material, and litter to such an extent watershed properties, such as runoff, erosion, and sedimentation, may be outside the normal range of variability. In most of the forested areas across the forest, the natural role of fire in maintaining ecosystems has been altered by aggressive fire suppression efforts beginning in the early 1900s. This practice has provided short-term protection to local watersheds from the effects of severe fires, but it has also led to a buildup of fuels that makes the possibility of such fires more likely in the future.

Wildfire and prescribed fires and their associated suppression activities have the potential to improve or impact aquatic and riparian resources.

By burning vegetation and organic matter on the soil surface, wildfire can increase erosion rates and affect water quality. However, erosion and sedimentation following high severity wildfires is highly variable. Fire suppression efforts can increase erosion potential from fire lines constructed by heavy equipment in sensitive areas. The removal of vegetation can also increase the speed with which overland flow reaches the channel network and the amount of water added to the streamflow. In the most extreme cases, the combination of these effects can increase peak flows in burned watersheds and result in channel adjustment. When fires burn intensively through riparian areas, buffering vegetation is lost and effects on aquatic ecosystems can be severe. However, low intensity wildfire can stimulate riparian vegetation making it more vigorous over time.

Fire Management

The use of prescribed fire is a tool to treat or manipulate fuel loadings to result in desired fire behavior and effects. Prescribed fire, timber harvest, and mechanical treatments are all ways to manage fuel loads.

The effects of prescribed fire can be considerably less severe than wildfire. 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, which reduce the effects of changes in water yield and peak flow. Furthermore, the judicious use of prescribe fire can help to reduce the risk of uncontrolled high intensity wildfires that would otherwise burn through and damage watersheds and riparian areas.

Other fire management activities under AMR are tools to allow fire to occur within prescriptive criteria to achieve management objectives.

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 long-lasting consequences to aquatic ecosystems. Management response to wildfire does not vary between alternatives.

In addition, the area treated annually by fuel management (combination of prescribed fire and mechanical treatment) is expected to vary by alternative as shown below. Additional prescribed burning is intended primarily to improve wildlife habitat or reduce fuel loads. Increased fuel treatment 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 altered, the long-term benefits of fuel treatment to aquatic resources are estimated to outweigh the short-term adverse impacts.

Table 28. Relative Impacts Between Alternatives from Wildland Fire Use/AMR

Category	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Acres Available for Wildland Fire Use	219,000	2,251,000	3,355,000	2,385,000	2,841,000	3,355,000 (AMR)

Alternatives 3 and 6 have the greatest chance of reducing severe wildfire effects to aquatic resources followed in order by alternatives 5, 4, 2, 1. The effective implementation of Soil and Water Conservation Practices, particularly those that minimize severe burns, avoid heavy equipment in riparian areas, and distribute fire use/AMR both temporally and spatially, would be used to minimize potential effects from fire use/AMR. There would also be limited use of mechanized equipment and retardant near water in key watersheds.

Effects on Watersheds and Riparian Areas from Wildlife Habitat Management

Differences in management for wildlife habitat between alternatives are not expected to change effects to hydrology and watershed processes.

Cumulative Effects to Water and Riparian Resources

In some cases, activities on the forest can contribute to effects downstream and off-site, lists the past, present, and reasonably foreseeable future activities that were considered with regard to cumulative effects to watershed and riparian resources. An example of a cumulative effect would be the downstream contribution of sediment from activities occurring on the forest.

Unless specified differently, the cumulative effects analysis is for the period of expected plan implementation (roughly 10-15 years), and is bounded by the 5th level hydrologic unit code watershed boundaries, which typically close within approximately 10 miles downstream from the forest boundary.

Another potential effect, not attributed to forest management, is the urbanization or development of intermixed and lands adjacent to the forest boundary. 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 NFS lands can all be attributed to urbanization. If activities on intermixed private lands approach tolerance limits for watershed disturbance, additional activities may be limited to avoid adverse and cumulative watershed effects.

The reconstruction or development of additional roads or highways within the forest boundary is another cumulative effect. There can be both short term and long term effects from this type of development. However, no new highways are currently planned within the forest boundary. As new roads are proposed, agency staff would work closely with the Montana Department of Transportation (MDOT) to minimize effects to watershed and riparian resources and implement best management practices whenever there are ground disturbing activities.

As development expands along the forest boundary, it is anticipated that the risk of noxious weed infestation will increase. The threat of noxious weeds may be one of the more significant watershed and riparian cumulative effects in the next planning period, altering riparian vegetation communities and biota with associated impacts to water quality and watershed health.

Looking past the forest boundary to consider how Beaverhead-Deerlodge National Forest management directly and indirectly affects downstream water quality, the most important considerations are the headwaters of streams and rivers. While the effects analysis showed activities on forest can affect downstream water quality, overall the water is considered 'good' where streams leave the forest. Impacts of subdivision development, roads, agriculture, and septic systems downstream from the forest boundary are considered to be more important contributors to water pollution than BDNF management activities.

Compliance with local, state, and federal water quality regulations will ensure that future management activities under any of the alternatives will continue to protect aquatic and riparian resources. High water quality will continue to be a valuable product of the Beaverhead-Deerlodge National Forest.

In conclusion, it is anticipated all Alternatives would at least maintain the status quo of riparian and watershed conditions within the cumulative effects boundary. Alternatives 3, 4, 5 and 6 would afford additional protection whereby recovery of degraded conditions could occur and thereby improve riparian and watershed conditions within the next planning period.

Aquatic Species Direct and Indirect Effects

Summary of Direct and Indirect Effects to Aquatic Species

Alternatives 3, 4, 5 and 6 provide substantially greater benefits to aquatic resources than Alternatives 1 and 2. All four provide high levels of protection and conservation direction for fisheries and aquatic TES species. This is founded in: 1) Extensive, prescriptive standards that are largely consistent forestwide; 2) Emphasizing watershed recovery and westslope cutthroat and bull trout conservation by having an adequate number and distribution of restoration and fisheries Key Watersheds; 3) Providing protection for amphibians; and 4) Attempting to Address some of the risks posed by Aquatic Nuisance Species;

Alternative 1 is the least beneficial to aquatic species. It does the least to ensure protection of riparian areas east of the divide. It does a good job of protecting inland native fish west of the divide, and protective provisions for westslope cutthroat east of the divide are good. There is no restoration emphasis to increase the rate of attaining watershed health. The greatest long term risk to our aquatic populations is the risk of introducing aquatic nuisance species. Alternative 1 does not address this issue. Finally, it may not provide adequate direction for ensuring diversity of amphibian species across the BDNF.

Alternative 2 does a better job of protecting fisheries resources, and it recognizes the importance of amphibian breeding and larval rearing sites. Conservation of TES fish species is slightly improved over Alternative 1 although still marginal in terms of amphibian protection.

Alternatives 3, 4, 5 and 6 are all very similar with the only difference in the level of emphasis on watershed restoration. Alternative 3 provides the greatest emphasis with 78 Restoration Key Watersheds, followed by Alternatives 5 and 6 with 15. Because Alternative 4 does not identify any Restoration Key Watersheds, it would provide a slightly lower level of benefit than Alternatives 3 and 5. The reason that Alternative 6 ranks behind 5 is because it designates 1 less fisheries key watershed and there are some slight modifications to objectives and standards related to grazing and protection for amphibians.

Based on anticipated effects from multiple resource management Alternative 3 provides the greatest benefit for aquatic species followed, in order by Alternative 5, 6, 4, 2, and 1.

Effects on Aquatic Species from Aquatic Species Management

Fisheries and Aquatic Species Management

The standards and objectives in Alternative 1 are comprised of a mix of forest plan amendments and original direction from 2 separate forest plans. They provide inconsistent guidance depending on which standards apply. In addition, many of the existing standards are relatively general (non-prescriptive) and have had limited success in ensuring objectives were met.

Alternative 2 uses two different sets of standards. The Inland Native Fish Strategy implemented in 1995 would be used west of the Continental Divide. East of the Divide, a combination of the Short Term Strategy for Westslope Cutthroat from the Riparian Amendment and standards derived from reference stream conditions across the Beaverhead Unit would be used. These represent 2 fairly different management approaches that could lead to differences in the rate of accomplishing aquatic objectives. Standards east of the divide basically promote the attainment of reference conditions in streams. In theory, they are a step above “properly functioning conditions”. There are no Key Watersheds in Alternatives 1 and 2 and watershed restoration is not emphasized.

Alternatives 3, 4, 5 and 6 incorporate Key Watersheds and standards and objectives have been slightly modified from INFISH 1995 to better address current issues and concerns. The biggest differences between Alternatives 3, 4, 5 and 6 is the emphasis placed on watershed restoration. The numbers of Key Watersheds are 135, 57, 72 and 71 respectively for Alternatives 3, 4, 5 and 6. Benefits to recreational fisheries will increase or decrease with the number of Key Watersheds and the emphasis on watershed restoration. The decrease in key watersheds from 72 in alternative 5 to 71 in alternative 6 occurred after reviewing how adequately certain watersheds met selection criteria in light of our best understanding of native fish populations. Several were dropped and others added that ultimately reduced the number by 1.

Direction in Alternative 1 is sufficient to maintain and slightly improve fisheries forestwide. Alternative 2 would increase the rate of improvement over what would occur in Alternative 1. East of the Divide desired conditions would tend more toward reference conditions than properly functioning and rate of improvement may be greater than what would occur west of the Divide. The primary weakness of Alternative 2 is the lack of a restoration program.

Alternatives 3, 4, 5 and 6 provide the most comprehensive strategy for fisheries and will provide the greatest rate of improvement, because they significantly elevate the emphasis on watershed restoration and fish conservation. The rate of improvement in these alternatives is related to the number of designated restoration watersheds, but also will be dictated by available budgets. Alternative 3 would provide the greatest benefit because it has 78 Restoration Key Watersheds. Alternatives 5 and 6 would follow because they have 15. Alternative 4 has no Restoration Key watersheds, so would follow Alternatives 5 and 6.

Based on anticipated benefits of aquatic direction on fisheries Alternative 3 provides the greatest benefit for aquatic species followed, in order by Alternative 5 and 6 are the same followed by 4, 2, and 1.

Conservation of TES Fish and Aquatic Species Management

The emphasis of aquatics management on watershed restoration and meeting viability requirements for westslope cutthroat, bull trout and provides points of difference for this analysis. Direction provided by Alternative 1 is the least beneficial, because it fails to specifically promote active restoration of cutthroat, bull trout or grayling. It does provide a fair level of protection, sufficient to encourage some rate of habitat recovery through passive means. Alternative 2 is similar in its approach, but sets a higher standard for stream and riparian (stream reference condition as opposed to proper functioning condition), where grayling and cutthroat are found east of the continental divide.

Alternatives 3, 4 and 5 all contain 57 Fish Conservation Key Watersheds. Alternative 6 has 56. This change occurred after reviewing how adequately certain watersheds met selection criteria in light of our best understanding of WCT fish populations. Several were dropped and couple others added that ultimately reduced the number by 1. This change is very small with regard to comparing alternatives. All these alternatives have management direction designed to ensure the persistence of bull trout, westslope cutthroat and grayling populations forestwide. These alternatives provide the greatest potential for meeting viability requirements of these species. The table below ranks alternatives based on the level of emphasis placed on TES fish conservation. Some Benefits to Grayling may be realized through restoration emphasis Key Watersheds.

Based on anticipated effects from aquatics management direction on conservation of TES species Alternative 3, 4, 5 and 6 provides the same amount of benefit. Alternative 2 and then 1 provide less.

Amphibians and Aquatic Species Management

The emphasis of aquatics management in alternatives 3, 4, 5 and 6 is on watershed restoration and conserving westslope cutthroat and bull trout. While direction was developed to meet the needs of native fish, there will be peripheral benefits to amphibians in those areas. Riparian and watershed health are consistent with amphibian habitat requirements.

Direction provided by Alternative 1 is the least beneficial to amphibians, because it fails to address their life history requirements directly. Alternatives 2, 3, 4 5 and 6 all include forestwide direction to help mitigate activities in breeding and juvenile rearing areas used by sensitive species, until dispersal occurs. This reduces the possibility of mass mortalities, when animals are concentrated in very small areas. Alternatives 3, 4 5 and 6 will provide indirect benefits that correlate with the number of Key Watersheds identified. Alternative 3 will provide the most benefit with 137, followed by the preferred Alternatives 5 and 6 with 72 and 71 respectively. Alternative 4 is next with 57 Key Watersheds. The difference in effects between alternatives 5 and 6 based on 1 key watershed is negligible.

Based on anticipated effects from aquatics management direction on amphibians Alternative 3 provides the greatest benefit for aquatic species followed by Alternative 5 and 6 equally. Alternatives 4, 2, and 1 provide less benefit.

Prescribed Fire

Prescribed fire treatments are only implemented when conditions are within “prescription”. This means they will occur only when environmental and fuel conditions allow accomplishment of objectives while minimizing risk of the fire escaping containment. Thus, the types and extent of effects seen with wildfire shouldn’t occur.

The environmental change from prescribed fire, most likely to negatively affect fisheries is the amount of vegetation remaining for cover. There could be confined areas where mineral soil is exposed until vegetation becomes reestablished. Because many burns are done in the spring, the time until re-vegetation occurs, tends to be short. Soil erosion and resultant deposition of sediment into streams and lakes are possible, but likely limited in scope and confined to short periods.

The extent that objectives and standards in each alternative shape project design and mitigate negative effects is the basis for this analysis. The magnitude of effect is associated with the proximity of treatments to streams and the size and intensity of the treatment. Alternatives requiring riparian vegetation buffers are the most likely to minimize effects, since most sediment will be filtered before it reaches the stream.

Table 29. Alternative Comparisons with Respect to Riparian Buffers.

Catetory	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Riparian Buffer Present	Yes	Yes	Yes	Yes	Yes	Yes
Where Buffers are Applied	West of Continental Divide	West of Continental Divide	East and West of Continental Divide	East and West of Continental Divide	East and West of Continental Divide	East and West of Continental Divide

All alternatives have the same riparian buffers, but Alternatives 1 and 2 apply them only west of the continental divide. Alternatives 3, 4, 5 and 6 are best in mitigating negative prescribed fire effects on fisheries, followed by Alternative 2, since it only has riparian buffers west of the continental divide.

Timber Harvest

As discussed in the Effects on Watersheds and Riparian Areas (Page 222), timber harvest can negatively affect water resources by degrading water quality, changing the time and intensity of run-off, and changing the volume of in-stream flows. If harvest occurs in riparian areas, another effect is alteration of stream side vegetation characteristics. These translate to a myriad of possible negative effects on fisheries. Increased erosion from activities associated with harvest and log hauling can result in sediment deposition in streams and decreased spawning success. Channel destabilization from increased run-off intensity reduces fish habitat diversity. Excessive removal of vegetation cover along streams causes changes in daily and seasonal temperature regimes. Ultimately, any or all of these things reduce the carrying capacities of streams and result in fish population reductions.

Much of the timber harvest prior to the mid-1980s had greater impacts on aquatic systems because the methods used, the locations chosen, and mitigation implemented, gave less deference to aquatics and so, were less effective. Similar to prescribed burning, the magnitude of effect is associated with the proximity of harvest to streams and the size and intensity of the treatment. Alternatives with INFISH standards require riparian buffers, and are the most likely to minimize effects from sediment and restricts riparian harvest, unless it is beneficial to fisheries. Alternatives 3, 4, 5 and 6 are best in mitigating negative prescribed fire effects on fisheries, followed by Alternative 2, since it only has riparian buffers west of the continental divide.

Fisheries and Timber Management

Timber management is different from vegetation management in its primary objective, which is to produce commercial timber. Lands suitable for timber production are designated for growth and yield of timber. Table 1 displays differences in acres of land suitable for timber production between alternatives. Since 1987, 111,456 acres have been logged (greater than 60% canopy removal). Wisdom and Pintler ranger districts have been the largest timber producers, representing 69% of the total acres logged. The Upper Clark Fork, the Boulder and the Madison drainages contain 32% of historically logged acres. Timber harvest over the last planning cycle may have slowed recovery in some areas and caused some site-specific impacts. However, it has not reduced the quality or diversity of fisheries across the forest.

The potential to harvest the largest amount of wood from lands suitable for timber production is greatest under Alternative 1, the existing situation. While the largest number of suitable acres gives the impression that we can harvest more timber under existing plans, there is no correlation between acres of land suitable for timber production and the amount of commercial harvest that could actually occur.

In all alternatives, standards are sufficient to prevent timber harvest from occurring at an intensity and scope that would alter channel stability. Over the last planning period concerns centered on reduced trout spawning success from sedimentation and reduction in woody debris recruitment for diverse habitat.

Alternative 1 may protect fisheries if aquatic standards are interpreted literally and given deference over conflicting direction for other resources. This has sometimes been the case over the last 10 to 12 years. Unfortunately, consistent application isn’t guaranteed and there remains significant room for varied interpretations. The INFISH amendment to the Deerlodge Forest Plan in 1995 substantially improved aquatic habitat protection west of the continental divide. It didn't amend protection on the east side. Conflicts between the location of acres suitable for timber production and sensitive aquatic resources under Alternative would remain east of the Divide. Potential conflicts would continue to preclude efficiency in planning and implementation. For these reasons, Alternative 1 provides greater risk to fisheries than other alternatives.

Alternatives 2, 3, 4, 5, and 6 have no lands suitable for timber production within 300 feet of streams. This reduces the risk of measurable effects. However, aquatic standards in each of the alternatives should do well mitigating impacts. A standard in Alternative 2 requires that streams near new projects be in properly functioning condition. For projects to occur near impaired streams, no effect or beneficial effects to the fishery must be expected. If some level of impact is determined likely, the project must be deferred or redesigned to meet the standard for no effect or beneficial effect. Alternative 3 has no suitable acres, and so provides the least risk. .

Conservation of TES Fish and Vegetation/Timber Management

Risks to TES fish from vegetation and timber management follow those discussed for fisheries. However, subtle differences between protection provided in Alternatives 1 and 2, certain changes in INFISH standards and the implications of management direction for Key Watersheds warrant additional discussion.

Alternative 1 provides special protection for westslope cutthroat east of the continental divide but not west of the divide. This protection was provided through the Beaverhead Riparian Amendment (USDA 1997a) which incorporates a Short Term Strategy for Westslope Cutthroat Trout. Among other things, it requires all new timber and vegetation projects to be beneficial or have no impact on 90% or greater genetically pure WCT populations. Projects are to be moved or deferred if these conditions can not be met.

West of the divide, the original version of INFISH (USDA 1995b) was amended to the Deerlodge Forest Plan in 1995. It provides prescriptive direction through riparian objectives, standards and guidelines. These were intended to create an upward trend in habitat conditions for inland native fish. The specific nature of the standards improved protection for cutthroat and for bull trout.

Alternative 2 uses two sets of standards. INFISH would be implemented west of the continental divide. East of the divide standards similar to those from the Short Term Strategy for Westslope Cutthroat Trout would be used in combination with standards promoting reference stream conditions. These represent 2 fairly different management approaches east and west of the divide that could lead to differing rates of accomplishing aquatic desired conditions. Standards east of the continental divide basically encourage attainment of streams conditions that, in theory, are a step above "properly functioning conditions".

Alternatives 3, 4,5 and 6 provide the most comprehensive strategies for conserving westslope cutthroat, bull trout and fluvial arctic grayling, because of their comprehensive, prescriptive standards and because they identify Fisheries Key Watersheds.

In these three alternatives Standard RCA-1 was added and TM-1 was reworded. These changes may restrict certain riparian treatments that could occur under Alternative 1 using current INFISH standards. For timber of vegetation management projects to occur in Fish Conservation

Key Watersheds, they must be determined to likely have no measurable effect or a beneficial effect on cutthroat and/or bull trout populations. Suitable timber acres are excluded from these watersheds.

Alternatives 3, 5, and 6 also identify Restoration Key Watersheds which have direction emphasizing watershed restoration. Certain watersheds are both Fish Conservation and Restoration Key Watersheds. Increased emphasis on watershed restoration may result in greater conservation and restoration benefits to cutthroat and bull trout, than provided in Alternative 4.

Grayling are only found east of the continental divide. There are no special provisions for grayling in Alternative 1. In Alternative 2, where grayling are present and stream conditions do not meet stream objectives, new projects must have no impact or a beneficial impact on grayling to be implemented.

Alternative 1 may not provide adequate direction to meet long-term conservation requirements of WCT, bull trout and grayling. Management provides certain mitigation, but could maintain many habitats in varying stages of sub-optimal condition, because riparian areas are not protected at a level ensuring appropriate rates of woody debris recruitment and certain aspects of stream function.

Alternative 2 would conserve TES fish species better than Alternative 1, primarily because of the requirement (with any new project) to analyze of the potential for introducing disease or aquatic nuisance species.

Based on anticipated effects of timber harvest and vegetation management on conservation of WCT and bull trout. Alternative 3 provides the greatest benefit followed, in order by Alternative 5 and 6, the same followed by 4, 2, and 1.

Rank of anticipated effects of timber harvest and vegetation management on conservation of grayling. Alternatives 3, 4, 5, and 6 provide the same amount of benefit followed, in order by Alternatives 2, and 1.

Amphibians and Vegetation Management

Vegetation management will largely consist of reducing Douglas fir encroachment, restoring aspen and thinning lodgepole stands. Prescribed fire could impact amphibians more than other treatment methods. They are most active during moist periods in the spring and fall, when most prescribed burning is done. However, Douglas fir encroachment will occur in the uplands, thus much of the discussion above relative to upland timber harvest is applicable here. The scope, proximity and intensity of individual treatments are more important than the acres proposed for treatment forestwide.

Aspen restoration will most likely occur in wetter areas so the possibility of negative effects is higher. In alternatives with more acres proposed for restoration, there might be some increased risk to amphibians. The relationship, between effects and acres restored is complicated, since effects are likely detrimental in the short term, but beneficial over longer periods. If restoration projects aren't extensive and the intensity is moderate to low, short term effects will be low. As the number of acres treated increase and become more concentrated, impacts will likely increase. Over the long term, forest diversity provides greater benefits for amphibians. Since species like long toed salamanders depend on forested areas and use moist micro-habitats under organic litter and downed wood for day time refuge, deciduous aspen patches may provide increased habitat availability.

Changes in species richness may be a more important measure of timber management impacts, indicating the addition or loss of representative species (Maxell 2000). We believe long term benefits from aspen restoration will often out-weigh the short term negative effects. Thus, some change in abundance may be an “acceptable consequence” of timber harvest, so long as population and species persistence is not jeopardized.

Considering all factors relative to timber and vegetation management, direction in Alternative 1, could place some amphibian populations at risk. Populations east of the divide would be most vulnerable, especially where TES fish are absent. Management direction in Alternatives 2 through 6, provide the most potential to prevent loss of populations.

In Alternatives 3, 4, 5 and 6 standards 1, 26, and 27, increase protection over Alternatives 1 and 2. The difference in direction would likely prevent implementation of some projects in RCAs, which are currently allowed and could have negative effects. Protection provided in the standards in Alternatives 3, 4, 5, and 6 are the most substantial. They seem to be the most comprehensive in addressing all aspects of amphibian habitat requirements and are nearly equal in the protection provided.

Amphibians and Timber Harvest

The effects of timber harvest on amphibians will vary depending on species requirements and the characteristics of timber harvest actions. With regard to species on the BDNF, timber harvest may have greater effects on tailed frogs and long-toed salamanders. Corn and Bury (1989) found density and biomass for tailed frogs and 3 species of salamanders were lower in streams flowing through forests harvested 14 to 40 years prior, as compared to uncut forests. Researchers in British Columbia found tailed frog densities declined with increases in fine sediment, and decreases in rubble, detritus and wood. Factors related to lower densities were more commonly associated with streams in clear-cuts than in streams with a vegetation buffer between the stream edge and clear-cuts.

Alterations in upland and riparian vegetation conditions are also important considerations. After timber harvest Demaynadier and Hunter (1997) found structural microhabitat seemed to be limiting amphibians near forest edges. They noted decreases in overall abundance and in the species of salamanders present in forests disturbed by even aged management practices. Important factors included changes in overhead canopy and ground litter cover along with availability of stumps snags and their root channels. Bury (1983) found tailed frogs were absent in areas logged 6 to 14 years prior. He also found greater amphibian numbers and biomass in old growth stands than in clearcuts.

Demaynadier and Hunter (1997) indicated most northern pool-breeding amphibians face a seasonal challenge because the period of emergence and initial emigration generally occurs during the warmest and driest time of the year. Most juveniles remain relatively close to their natal pond during their first few months following metamorphosis and emigrate significantly shorter distances than adults. Thus maintaining a relatively intact forested buffer around productive breeding pools may function as preferred cover during emigration and as primary nursery habitat for young individuals during 1st metamorphic season. It is also important to sustain nearby complimentary habitats for dispersal and maintenance of meta-population dynamics.

Spotted frogs seem to be heavily dependent on riparian corridors for dispersal to other suitable habitats. This suggests continuity in riparian vegetation can be important for meeting life history requirements or for meta-population dynamics. Beyond riparian areas, upland corridors are also important. Dodd and Cade (1997) found movements of striped newts and narrow-mouthed toads between wetlands and uplands were non-random and suggest terrestrial buffers around pond breeding sites need both a distance and directional component to support adequate dispersal.

In certain instances, there may be benefits from timber harvest. Creation of forest openings might provide new basking or foraging sites. In certain instances, limited removal of trees adjacent to standing waters may enhance the length of time seasonal wetlands persist, by reducing evapo-transpiration. It may also increase exposure to the sun, warming water temperatures and speeding the development and maturation of juveniles. This might help ensure metamorphosis from larva to adults occurs before ponds or wetlands dry up (Maxell 2000)

While salamanders and tailed frogs have experienced declines in clear-cut streams, boreal toads tend to be equally susceptible (Maxell 2000). Toads use forested areas, but their requirements are undoubtedly less dependent on specific microhabitats and microclimates provided by forested than other amphibian species.

Properly functioning aquatic systems, vegetation health and continuity in riparian areas are important for amphibians. Existing standards east of the divide prevent excessive sediment introduction into streams with high fishery values. Standards in the Deerlodge Plan are more limited in scope than the Beaverhead Plan since they only emphasize protection of bull trout and westslope cutthroat streams. Thus, protection is not afforded to all streams important to amphibians.

Acres of suitable timberland are the highest in Alternative 1 and riparian areas are included in the suitable base. Where the potential to manage for timber production in riparian areas exists, then risk is higher for sedimentation and for fragmenting riparian corridors. However, effective management decisions regarding timber harvest have largely protected the integrity of our stream and riparian systems over the last 10 to 15 years.

INFISH (USDA 1995b), as it was amended to the Deerlodge Forest Plan west of the Continental Divide, prescribes standards that preclude most timber management impacts related to sediment and riparian alteration. Direction in Alternative 2 west of the Divide is the same as it is in Alternative 1. However, Alternative 2 provides slightly more protection for amphibians, because there are no suitable timber acres in riparian areas. Alternatives 3, 4, and 5 have also excluded suitable timber acres from riparian areas.

East of the Continental Divide, Alternative 2 standards are directed at achieving “reference reach conditions” in streams. In other words, desired conditions would reflect characteristics of largely undisturbed streams and riparian areas; which, in many cases is a step above proper functioning condition. Timber harvest or vegetation management projects would not be allowed unless stream conditions were at reference condition, or unless the project would result in a beneficial effect or no measurable negative effects on aquatic habitat conditions. Direction in Alternative 2 could limit harvest activities (east of the Divide) to areas well removed from streams and allow limited or no new road construction. It may also tend to direct activities to more pristine drainages where habitats are likely in the best condition.

Effects on amphibians from upland commercial timber harvest (i.e. outside riparian areas), could relate to the number of suitable timberland acres, but this is presumptuous. As distance from water and riparian areas increase, the potential for actions to impact individuals decrease. All of our species can travel distances that exceed riparian widths, but behavioral tendencies likely keep individuals within proposed buffers most of the time.

Boreal toads are the exception, but our current understanding is they are less affected by timber harvest than other species. Their mobility creates some risk upland harvest will negatively affect them. But it undoubtedly also provides some ability to cope with disturbance and changes to their environment, so long as the scope and intensity are not overwhelming. Some studies suggest desired habitats around breeding sites don't necessarily need to be adjoining, so long as the mobility of the species is sufficient to allow movement between them.

Project design and mitigating standards could reduce impacts to levels that are inconsequential to diversity and population integrity. For these reasons, it seems reasonable to believe the different alternatives could show no detectable difference in effects from upland timber harvest. The table below ranks alternatives based on their likely effectiveness of addressing factors that influence habitats required by amphibians.

Table 30. Comparison of Alternatives by Factors Related to Critical Habitat Requirements for Amphibians where 1 = best; 5 = worst

Factors		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Minimizing sediment deposition in Streams	W. of Divide	3	2	1	1	1	1
	E. of Divide	3	2	1	1	1	1
Achieving/maintaining riparian integrity	W. of Divide	2	1	1	1	1	1
	E. of Divide	3	1	1	1	1	1
Achieving/maintaining desired upland vegetation conditions	W. of Divide	1	1	1	1	1	1
	E. of Divide	1	1	1	1	1	1
Maintaining upland movement corridors	W. of Divide	1	1	1	1	1	1
	E. of Divide	1	1	1	1	1	1
Overall rating		3	2	1	1	1	1

Effects on Aquatic Species from Fire Management

Alternatives were not developed around the level of Fire Suppression or prescribed burning. The level of each that will occur in any year will be dictated by seasonal conditions and available budgets. They can be considered consistent across all alternatives. Effects from fire suppression actions especially may cause some site-specific impacts to aquatic resources, but are not expected to threaten TES aquatic species or the quality or diversity of other aquatic species or fisheries resources on a forestwide scale.

Fisheries and Fire Management

The effects on fisheries from fire use/AMR are considered comparable to those from wildfire. There is considerable discussion over whether wildfire is devastating to fisheries resources. The effects on fisheries from six large fires, which burned over 525,000 acres, between 1986 and 1994 on the Boise National Forest provide an interesting context for considering the variability of wild fire effects on fisheries.

Burton (2000) reported that all of these fires burned more severely and across larger areas than had been observed prior to 1986. Although large and hot, only 18%, on average, of a typical watershed area was burned at high intensity. Most watersheds exhibited predominantly low intensity burning, while nearly 33% of the area in an average watershed remained unburned.

Less than 5 %of the burn area experienced severe post fire floods and debris flow causing significant stream alterations. Effects tended to be relatively localized (an average of 5.5 miles in length) and non-uniform in distribution. Habitat and trout densities declined dramatically following debris flows, but typically rebounded strongly within 5 years. Post fire floods also rejuvenated habitats by delivering nutrients, transporting and redistributing sediments, and recruiting large amounts of woody debris and rock. Higher fish densities than were present before the fire, were documented.

Trout have evolved strategies to survive natural wildfire regimes at the frequency that it typically occurs (tens to hundreds of years). In many instances, even in the face of extensive high-intensity fires, extinctions of populations are spotty and re-colonization is relatively rapid.

The greatest concern over risks from fire management activities on fisheries is associated with isolated listed or sensitive fish populations. This includes westslope cutthroat, grayling and possibly bull trout in limited instances and - even though it is not sensitive - Lake trout. The majority of our fisheries have vehicle access to connected habitats and sufficient opportunities to find refuge. Declines in population densities and even extinctions have been documented from fire related effects on the aquatic environment. However, fish are also typically quick to rebound (Gresswell 1999, Burton 2000, Sestrich 2007).

The long term effects of diverse vegetation in an ecosystem produced by fire are considered beneficial for most fisheries. Current conditions may cause some fires to burn uncharacteristically because of fuel build-up, but the negative effects should typically be compensated for by the benefits of post fire processes that produce diverse vegetation.

The acres of wildland fire use vary by alternative. However, strict criteria will have to be met to allow wildfires to burn without being suppressed. The acres available are sufficiently large in Alternatives 2, 3, 4, 5 and 6 that opportunities can be considered equal. Thus, their effects should be similar. Alternative 1 allows considerably fewer acres to be available and so would be considered to have less short term impacts but be less beneficial than the others over the long term.

Conservation of TES

The effects of fire management activities on cutthroat, bull trout and grayling are the same as described for recreational fisheries above; with a couple of notable exceptions. Wildland fire use has the potential to cause extinctions in some of our WCT populations - primarily east of the continental divide. Wildland fire use may be discouraged in some watersheds, if fuel and weather conditions combine to threaten important populations. Species like migratory bull trout and fluvial arctic grayling are less susceptible to extirpation because they typically have the capability to move and avoid extreme conditions.

There is little chance that the differences in acres between alternatives are substantial enough to change the amount of wildland fire use implemented over this planning cycle. Fire management objectives and guidelines in Alternatives 2 through 6 are not requirements. However they may increase awareness of risks to aquatic resources sufficiently to provide a distinction of increased benefit over Alternative 1. On the other hand, differences between Alternatives 2 through 6 are inconsequential, when considering the number of acres that might burn forestwide.

Based on anticipated effects from wildland fire use and fuels management on conservation of WCT and bull trout Alternative 2, 3, 4, 5, and 6 effects are mitigated equally. Alternative 1 doesn't mitigate effects as well.

Amphibians and Fire Management

Wildfire has direct and indirect consequences for amphibians. Direct mortality of amphibians from fire has been documented in wetlands (Maxell 2000). Up to this point, however, there is no research on population-level effects of fire induced mortality. Species that spend the dry season in underground burrows or tunnels may be at less risk than those that use moist microhabitats under organic litter or woody debris on the forest floor. Depending on the characteristics of the fire and behavioral responses of individuals, wetlands and water bodies also might mitigate effects from temporary periods of extreme heat and changes in oxygen levels.

At greatest risk for direct mortality, might be species like the long-toed salamander. It is more likely to be associated with moist habitats above ground. Tiger salamanders and toads tend to more frequently use burrows as day time and seasonal refuges. Frogs are more often near water which might provide adequate protection.

Indirect effects of fire might be negative or beneficial. In the short-term fire might reduce overhead forest canopy, leaf litter, downed woody debris and other things that create moist microhabitats favorable for amphibians. Sediment introduction into streams and channel instability can alter or eliminate desired stream features. Creation of sterile soils can limit re-vegetation and associated insects and other foods that amphibians forage for.

The positive indirect effects of fire might include creation of openings that provide basking and foraging opportunities. Fire might open wetlands to an earlier successional stage, enhancing the life of the wetland. Removal of trees adjacent to wetlands might allow more sunlight which warms the water, accelerating maturation of tadpoles. Where ponds and wetlands are seasonal, this might ensure metamorphosis into adults occurs before the pond or wetland dries up (Maxell 2000).

The number of acres proposed for wildland fire use increase dramatically in all action alternatives, over what is currently available in Alternative 1. The only assumption that can be drawn from the table is that there is greater likelihood that some wild fires will not be suppressed in Alternative 3 than in Alternative 5. The likelihood this would occur with any frequency is low. During the last 15 years, policies in BDNF wilderness areas have resulted in less than 100 acres burned under this management guidance.

This analysis presumes wildland fire use will promote patchiness in forested environments and vegetation which are closer to natural historic conditions. These conditions are likely beneficial for amphibians and should outweigh the short term negative impacts.

Alternative 1 has the least potential to provide vegetation conditions that promote healthy amphibian populations, because it continues to promote large-scale, intense fires that are likely to burn over large areas and have a greater chance of creating monotypic forested conditions. It increases the risk amphibian populations may become isolated or lost within drainages.

As noted above, the differences between Alternatives 2 through 6 are inconsequential, considering the number of acres that might burn forestwide, since the opportunities for wildland fire use are so narrowly confined.

Effects on Aquatic Species from IRAs and NWPS Additions

Wilderness recommendations will generally benefit fisheries, threatened, endangered and sensitive fish and amphibian species, since travel and many management actions will be restricted in proposed wilderness areas. Benefits generally coincide with the total acres recommended by alternative. Thus, Alternative 4 would have the fewest benefits, increasing in order by alternatives 1, 2, 5, 6 and 3.

There are no effects of wilderness recommendations on grayling because they are not present in any of the areas recommended. Potential benefits to TES fish will primarily occur with westslope cutthroat.

Effects on Aquatic Species from Livestock Grazing

Fisheries and Livestock Grazing

Suitable rangeland occurs over most of the forest and varies little between alternatives (Table 1). Thus differences in effects between alternatives are relegated to the management prescribed in objectives and standards and the effectiveness of implementation.

Over the last 8 years, the BDNF has been successful in promoting riparian recovery in many areas. However, challenges in achieving consistent recovery across the forest remain. The difficulties are at least partially founded in achieving the fine balance between promoting riparian and stream recovery while avoiding unnecessarily restrictive management. This causes managers to attempt to define that line where livestock use can be maximized and recovery still occurs.

Unfortunately managing cows can’t often occur with the precision this line requires. Inherent expectations are that standards will always be met. This allows little room for problems created when a gate is left open, or a fence fails, or atypical movement patterns occur during drought.

Monitoring shows some streams are recovering, since the Beaverhead Riparian Amendment was implemented in 1997. Others appear not to be recovering. The data also indicates there is failure to meet standards about 20% of the time. Unfortunately, we don’t know whether meeting standards 5 out of 5 years is necessary on certain streams for recovery, or if we promote improvement for 4 years, whether 1 year of failure is acceptable. We haven't determined what it takes to lose the strides that are gained over several years of successful implementation.

The current standards (Alternative 1) are sufficient to promote recovery in riparian and stream systems. The similarity in grazing standards in all alternatives will promote about the same rates of recovery. The general trend of riparian conditions across the BDNF should be up. This analysis assumes there will be a rate of non-compliance similar to what has occurred over the last 10 years, unless budgets allow increases in range staff for monitoring. Based on this, there will be grazing impacts to fisheries across the forest, but they will tend to be localized.

Conservation of TES Fish and Livestock Grazing

The effects of livestock grazing on cutthroat and bull trout are the same as described for recreational fisheries above; with a couple of notable exceptions. Roberts and White (1992) demonstrated that humans walking on trout redds can cause substantial mortality to eggs and fry in spawning gravels. They suggested livestock would have similar effects if they walked on redds. Magee (1993) suggested cattle might be causing WCT mortality, when he noted an abundance of cow tracks in the stream bottom, while documenting redd distribution in the Cache Creek drainage in southwestern Montana. Bowersox (1998) confirmed redd trampling was occurring in the Cache Creek Drainage in 1994 and 1995. Biologists on the BDNF have also documented the probability livestock are trampling WCT redds. To help address this issue, guidance was added to Alternatives 3, 4, 5 and 6 to help protect redds where trampling might threaten important TES fish populations. Protection afforded in Alternative 6 is slightly less than in Alternatives 3, 4, and 5.

Alternatives 3 through 6 also have a standard in fish conservation key watersheds requiring action taken when non-compliance occurs with livestock grazing. Alternatives 1 and 2 are similar in the estimated effects from grazing.

The effects of livestock grazing on grayling are the same as described for recreational fisheries above. Grazing management in the Ruby River and the Big Hole River drainages are sufficient to promote stream and watershed recovery, to benefit grayling. The recovery rate will be commensurate with other fisheries on the forest.

Amphibians and Livestock grazing

The threat livestock grazing presents to amphibians varies and is site-specific. There is some indication western toads may seek disturbed areas. Maxell (2000) indicated some level of grazing disturbance, is potentially beneficial to toads, so long as it isn't excessive enough to alter water tables or important vegetation characteristics. Thus, a "managed level of disturbance" achieved through livestock grazing may be desirable.

Livestock grazing effects on amphibians largely depend on the extent of livestock use of forage and the level of change in riparian conditions. In certain areas, grazing may open up basking areas important for amphibians (Maxell 2000). Removing most of the ground cover necessary to maintain desired micro-habitat conditions and destabilizing stream channels can cause substantial impacts.

Grazing standards for all alternatives are generally equal in promoting stream and riparian recovery. Maxell (2004) indicated approximately 3% of habitats in and around the BDNF, had been impacted by ungulates to a level that would reduce suitability of the sites for amphibian use. Forage use levels may be less consistent in maintaining desired vegetation conditions for amphibians. However, rotation between allotment pastures and uneven patterns of use should allow amphibian movement between areas to reduce impacts of grazing on vegetation needed for cover.

Of greater concern are factors that create high levels of mortality while amphibians are concentrated at breeding and juvenile rearing sites. Livestock trampling can cause the deaths of thousands of juvenile boreal toads.

Alternatives 2, 3, 4, 5 and 6 have guidance which mitigates activities at known TES amphibian breeding sites until dispersal of metamorphosis occurs. Alternative 6 provides slightly less protection than Alternatives 2 through 5. Direction in all the action alternatives should help mitigate mortality from trampling where/when there are known areas with high concentrations of TES individuals.

Standards defined in all alternatives are adequate to recover streams and riparian areas. Alternative 3, 4, 5 and 6 all incorporate grazing standards similar to those currently used under Alternative 1. Alternative 2 grazing standards east of the divide are focused primarily on stream systems and lack emphasis on recovering riparian areas around lakes ponds and seasonal wetlands.

Alternative 1 is the least protective for amphibians and may sometimes impact TES amphibian breeding populations on the forest. Alternatives 2 through 6 are similar in their effects on amphibians.

Effects on Aquatic Species from Minerals and Oil and Gas

Fisheries and Oil and Gas Leasing

There are no special stipulations for Fisheries. Oil and gas leasing and development could result in site-specific impacts to fish populations, primarily due to vegetation changes and roads related to development sites. The level and extent of development will largely be determined by economic cost benefits, which cannot be predicted. Protection is adequate to prevent extensive impacts to aquatic systems. Effects should be localized and should not be realized forestwide.

Conservation of TES Fish Species and Oil and Gas Leasing

The Stipulations for oil and gas leasing apply only to WCT and fluvial arctic grayling populations on the Beaverhead portion of the forest. The stipulations displayed in Table 71, and described in detail in the stipulation package in Appendix B, are common to all action alternatives and are consistent with the intent of the Oil and Gas Record of Decision (USDA 1996a). Substantial improvements in our understanding of where WCT occur on the forest, their distributions in individual stream systems and genetic their genetic status have allowed us to establish a strategy to ensure viability will be maintained across the forest. This was accomplished through establishment of fisheries key watersheds and extending INFISH management direction to include FS lands east of the continental divide. Direction for Oil and Gas leasing should not prevent our ability to maintain viable populations, through direct or cumulative effects. Direction is consistent with conservation requirements for WCT and grayling.

The decisions made for oil and gas leases in the 1996 Oil and Gas EIS Record of Decision (USDA 1996a) identified stipulations that would provide adequate protection for sensitive westslope cutthroat trout and arctic grayling. The stipulations listed in the table below represent the translation of management direction in the Oil and Gas Decision into alternatives 2, 3, 4, 5 and 6 in this FEIS.

We believe, the effects of management based on translation of these stipulations are consistent with the original findings and do not change the accuracy of the effects analysis in that Oil and Gas document.

Because a conservation plan for westslope cutthroat had not been developed when the decision was signed, protective stipulations were conservatively provided for all cutthroat populations greater than or equal to 90% genetically pure. Since then, populations which are the foundation of cutthroat conservation and restoration efforts on the BNDF have been identified as conservation populations through a range-wide status review. These populations are primarily 99-100% genetically pure populations. Thus, the protection afforded sensitive cutthroats in alternatives 2-6 apply only to conservation populations. Also since the oil and gas decision was made, grayling have been introduced into the upper Ruby River. The protection provided grayling have been expanded to include the portion of the River that is occupied by grayling.

Table 31. Beaverhead Unit Oil and Gas Stipulations for Fish Conservation Key Watersheds, WCT Conservation Populations, and Certain Streams Containing Fluvial Arctic Grayling

Oil and Gas Stipulation	Scale for application of Oil and Gas Stipulations	Location Where Special Oil and Gas Stipulations are applied
No Surface Occupancy (NSO)/Controlled Surface Use (CSU)	6th code HUCs; Stream Reach /	Fish Conservation Key watersheds, NSO; Conservation populations outside of Key Watersheds, CSU
Controlled Surface Use (CSU)	Stream Reach,	Buffer Ruby river, trail creek, etc, as per O&G EIS, pps II-13, II-14

Amphibians and Oil and Gas Leasing and Development

There are no special stipulations for amphibians. Oil and gas leasing and development could result in impacts to amphibian populations, primarily due to displacement and disruption of vegetation characteristics around development sites. The extent of impact will depend on the level and extent of oil and gas development. Since this is related to economic cost benefits this is not very predictable. Protection is adequate to prevent extensive site-specific impacts to aquatic systems. Effects should be localized and should not be realized forestwide.

Effects on Aquatic Species from Recreation and Travel Management

Fisheries and Recreation

Increased recreational use of the forest is expected. We assume laws and regulations are adequate to prevent over-exploitation of fish populations through angling. Habitat alteration from recreational camping and day use sites might cause some site-specific impacts, but should not extensive enough to measurably limit populations.

Increases in recreational visitors increase risks to aquatic communities. The greatest threat from recreation is introduction of aquatic nuisance species. These species include any non-native plant or animal species and disease which threaten the diversity or abundance of native species, the ecological stability of infested waters, or commercial, agricultural, or recreational activities dependent on such waters.

The Montana Aquatic Nuisance Technical Committee (2002) identifies over 70 species in this category. Some, well known in Montana, include the New Zealand mudsnail, curley-leaf pondweed, whirling disease, and non-native fish. While non-native fish like brook, brown and rainbow trout are desirable in many locations, there are places where they are not. An environmental assessment by the MTFWP is now required before fish introductions can legally occur.

Most of the pathways of introduction and spread of aquatic nuisance species are related to human activities, both accidental and intentional. The New Zealand mudsnail and whirling disease can be accidentally transported and spread by way of recreational boats and wading boots. Currently whirling disease is been documented in over 95 bodies of water, with severe infections occurring in the Madison River and Rock Creek, among others. Often there are few if any acceptable controls available once they become established.

Many aquatic nuisance species fish introductions result from individuals releasing aquarium fish into streams and lakes, with little though given to possible effects.At least 20 percent of illegal fish introductions documented by FWP have occurred in the past ten years. In total there have been more than 400 unauthorized fish introductions in waters across the state, involving 49 species of fish.

Alternatives that increase vehicle accessibility and use will be presumed to pose a greater risk to fisheries. Differences in motorized and non-motorized areas by alternative are discussed below.

Fisheries and Travel Management

Roads and trails are arguably the most widespread source of disturbance to streams and watersheds of the Beaverhead-Deerlodge NF. Impacts are generally related to their proximity to streams, the passage capabilities of stream crossings and road densities in watersheds.

There are around 6000 miles of classified system roads on the forest. About 19% are within 300 feet of a perennial stream. Impacts range from virtually none to substantial disruption of hydrologic processes necessary for maintenance of fish habitat. The total number of stream crossings has not been accurately counted. However data suggest a high percentage of culverts are functioning as barriers to fish passage. Out of three hundred and eighty crossings recently surveyed, three hundred and five appear restrict movement of juvenile and/or adult trout.

Road densities are mostly moderate to low, 44% of the forest has no roads. Twenty-four percent has a road density of less than 1 mile per square mile. Only 12% exceeds road densities of 2.0. Even though Alternative 1 provides the greatest latitude for increased motorized use, a net increase in roads and trails is not presumed for any of the alternatives. From 1992 through 1996, 18.1 miles of road were built. From 1999 through 2004, 2.1 miles were built. 1997 and 1998 data were not summarized in monitoring reports and so are not immediately available. However, the miles of constructed road would likely fall within the range established from 1992 to present - and tend toward the 2.1 miles built over the last 6 years.

Projected budgets and road building trends from the last 14 years suggest the amount of new road constructed will be minimal. Although the prescriptive standards in Alternatives 3, 4, 5 and 6 would tend to be most protective, standards and BMPs in all alternatives should minimize risk to aquatic systems from newly constructed roads.

All action alternatives propose non-motorized allocations of land that will likely result in more miles of road closed than can be constructed over the life of the Plan. The difference in effects between alternatives, then, is most closely aligned with reductions in road miles and the level of emphasis placed on watershed restoration (which would address watershed impacts from roads). Alternatives with greater reductions in roads have a higher likelihood of reducing stream impacts. Alternatives with the higher number of Key Watersheds represent the greatest emphasis on restoration.

Alternative 1 maintains the highest miles of motorized roads and trails and lacks direction that emphasizes restoration. Alternative 3 proposes the greatest reduction in summer motorized use of roads and trails (491 and 556 miles). Alternatives 2, 4, 5, and 6 reduce motorized use of roads in the summer by 106, 35,144, and 104 miles respectively. They reduce motorized trail use in the summer by 136, 42,193 and 200 miles.

Alternative 3 also has the highest restoration emphasis (135 Key Watersheds) of any alternative. It is followed, in order, by Alternatives 5 with 72, Alternative 6 with 71, Alternatives 4 with 56 and Alternative 1 with 0.

The restoration emphasis in Alternatives 3, 4, 5, and 6 will most effectively reduce impairments caused by roads and trails. They outline an evaluation and prioritization approach that should maximize benefits of watershed scale restoration efforts.

Conservation of TES fish and Recreation and Travel Management

The effects recreation and travel management can have on TES fish are the same as described for fisheries. The risk of aquatic nuisance species introduction in native fish populations has some correlation with vehicle accessibility. Vehicle access typically must be considered along with other factors like: 1) type of gear recreationists use that might lead to inadvertent transport and introduction (live-wells and water intakes in boat motors can sustain zebra mussels for some time; or felt soled waders that can transport and introduce spores of whirling disease); 2) Waters recently visited by recreational users that could contain species considered to be aquatic nuisance species; and 3) disagreement over management of specific waters for certain species. Individuals sometimes choose to illegally introduce a species.

Alternative 3 closed summer motorized vehicle access to about 20 miles of stream occupied by bull trout followed by Alternatives 2 and 5 and 6 (around 10 miles each) and Alternative 4 which closed about 6 miles. However, all populations of bull trout extend to areas with motorized vehicle access on and off the forest. Thus, benefits to bull trout from travel restrictions are more cosmetic than substantial.

Similar to bull trout, changes in vehicle accessibility to conservation populations of westslope cutthroat were evaluated. Alternative 2 reduced motorized vehicle access to part of the streams occupied by 33 conservation populations of WCT. This increased to 63 populations for Alternative 3, and then decreased to 36 populations for Alternative 5 and 6 and 25 populations for Alternative 4. Of 20 conservation populations that exist entirely on forest and in drainages where motorized vehicle access would be reduced by one or more alternatives, 17 saw virtually no - or very limited- change in vehicle accessibility. Alternative 3 restricted motorized vehicle access to the entire lengths of stream occupied by 3 of the 20 populations. Thus, reduced risk of aquatic nuisance species introduction from decreasing motorized vehicle access in the action alternatives is slight.

Alternatives 3, 4, 5 and 6 contain an objective in Fish Conservation Key Watersheds that promotes completion of assessments to determine impacts to WCT and bull trout populations. From these assessments it directs development of a list of restoration actions along with anticipated completion dates. This should function as a catalyst for restoration activities.

Closed roads and trails in Key Watersheds should help clear the way for remediation to occur under the new plan. Alternative 3 would result in restricting summer travel over approximately 700 miles of motorized roads and trials in Fish Conservation Key Watersheds. This decreases to about 190 miles in Alternative 5, around 170 miles in Alternative 6 and 63 miles in Alternative 4. Where summer motorized travel restrictions occur, restoring fish passage should be much cheaper since some road crossing structures may not have to be replaced, and can simply be removed. Removing most of the financial limitations should lead to a faster rate of obtaining watershed and fisheries objectives there. Where sedimentation and other factors are influencing streams, the restoration emphasis of Alternatives 3, 4, 5 and 6 will help us more efficiently meet a broader range of restoration goals.

Alternatives 3, 4, 5 and 6 provide the greatest insurance for conservation of westslope cutthroat and bull trout. This is primarily because of the identification of Fisheries Conservation Key Watersheds, the added protection provided, and an increased emphasis on active restoration.

Alternative 3 through 6 provide the same amount of protection for grayling followed by Alternative 1.

In terms of aquatic nuisance species Alternatives 2 through 6 provide increased protection over Alternative 1 because of the standard that evaluates risk of undesirable introductions.

Amphibians and Recreation

Campground facilities and dispersed camp sites may alter an area's suitability for amphibian use or might fragment movement corridors which influence meta-population dynamics and/or population dispersal characteristics. Developed and dispersed recreation sites are abundant on the BDNF. Most are located in riparian areas, but are almost never of a size or frequency in one area to influence notable lengths of stream.

At most sites, sediment introduction into streams from exposed soil is not substantial, since sources usually consist of a foot trail or two leading to the stream. Roads to dispersed sites can pose sedimentation problems, but seem to be relatively uncommon. Thus, aquatic habitat alterations from recreation sites seem not to be a major issue for amphibians at this time.

Amphibian mortality may increase around campgrounds and recreation sites, since they are at increased risks from human handling and family pets (Maxell 2000). While some mortality undoubtedly occurs, it also seems reasonable many individuals would disperse to areas with fewer disturbances.

The level of migration corridor fragmentation from campgrounds and campsites should be limited. Movement and dispersal capabilities are not lost in most cases. Many sites are on only one side of a stream, leaving the opposite riparian area largely intact. Further, important habitats don't need to be adjoining, so long as the mobility of the species is sufficient to allow movement between them. The potential for population level impacts from recreation sites at their current abundance and distribution is not substantial.

A greater risk to amphibians from recreation is the introduction of aquatic nuisance species and diseases. The American bullfrog is considered a major competitor with some of our native amphibian species. They originated from mid-west and eastern states, but were introduced into the Bitterroot Valley sometime prior to 1968. They are now found through out a substantial portion of the Clark Fork River drainage (not necessarily on BDNF lands) and continue to be illegally introduced into new areas in Montana (Maxell 2000)

Chytrid fungus is suspected of being the cause of declines in boreal toads and northern leopard frogs (Maxell 2004). Tissue samples collected recently, documented the presence of chytrid fungus in Montana. Thirty-eight percent of samples representing 4 species were infected with the fungus. Interestingly, samples from 30 museum voucher specimens representing 3 species collected in the 1970's all tested negative.

While chytrid fungi are known to have always been present in the environment, they have not been known to be parasitic to animals. We are unsure how chytrid fungus persists in the environment or how it is transmitted. Concern regarding inadvertent spread of the fungus by humans is great enough that researchers are encouraging decontamination of clothes and gear when traveling between waters; and discouraging translocation of individual animals. Thus, risks would seem to increase with increased levels of water-related recreation.

Amphibians and Travel Management

Movement barriers can be a problem for amphibians which depend on annual migrations between breeding sites and upland home ranges. Research from DeMaynadier and Hunter (1995) suggests wide roads may limit upland home-range movements by salamanders, but were less likely to restrict frogs and toads. They concluded a 12 meter wide road could still allow adequate movement to prevent isolation of salamanders. Based on these findings, there are few, if any roads on the BDNF that would isolate amphibians. Effects are most likely cumulative based on direct mortality.

Vehicle related deaths are also a consideration. A study in Germany (Kuhn 1987 as cited in DeMaynadier and Hunter 1995) demonstrated that road use levels of 24 to 40 cars per hour was sufficient to kill a substantial number of migrating toads. Risks to toads and other amphibians will also increase with road density.

Recreational use levels on most roads are substantially less than reported in research done by DeMaynadier and Hunter (1995). Current road densities and dispersed recreation sites seem compatible with sustaining amphibian populations. However, alternatives that address summer motorized travel could reduce vehicle caused mortalities in proportion to the miles of road and trail with restrictions. Total miles restricted are highest in Alternative 3, followed by Alternatives 5, 6, 2, and 4 respectively. No alternative directly promotes substantial road development.

Mitigation that addresses recreation varies between alternatives. Alternative 1 does not address amphibians directly and so provides the least protection. Amphibian populations could be threatened under this Alternative, depending on growth and recreational site development over the next planning cycle.

Mitigation in Alternative 4 may most effectively limit negative effects from recreation. It protects individuals at breeding sites until dispersal has occurred. It contains a standard requiring evaluation of the potential for aquatic nuisance species introduction from new projects. It also requires that recreation facilities - including trails and dispersed sites, avoid adverse effects on sensitive aquatic species (which currently includes boreal toads). Alternative 5 provides the same protection east of the Continental Divide as Alternative 4. But west of the Divide standard RM-1 only requires that recreation facilities avoid adverse effects on inland native fish. It does not extend protection to sensitive aquatic species. This establishes slightly less protection for sensitive boreal toads and creates slight inconsistencies.

Alternative 3 is consistent in its direction forestwide, but again, standard RM-1, fails to extend protection to sensitive aquatic species. This provides slightly less protection for sensitive boreal toads than Alternative 4.

Alternative 2, under INFISH standards establishes RCA widths west of the Divide which will ensure recruitment of woody debris on the ground for terrestrial habitats. Formal RCAs are not established east of the divide, which could result in habitat reductions in certain areas. Forestwide protection is provided at breeding sites until dispersal occurs.

Where motorized travel is restricted the risk of vehicle related mortality is lower and is presumed beneficial for amphibians. Travel restrictions will likely also reduce the level of use in an area and reduce risks of introducing aquatic nuisance species or disease. Winter travel restrictions do nothing to reduce negative effects on amphibians. Thus, relative to motorized travel, Alternative 3 would be most beneficial; followed in order by Alternatives 5, 2, 4, and 1.

Summarized Comparison of Recreation and Roads Effects on Amphibians by Alternative

Table 75 below summarizes comparisons of Alternatives, based on effects that Recreation and Roads could have on Amphibians

Alternatives 3, 4, 5 and 6 are similar in the projected effects they will have on amphibians. Alternative 4 may be slightly better than the others even though there were not substantial reductions in summer motorized travel. This difference and others between 3, 5, and 6 may be minor. Broader protection offered through Alternative 4 standards and objectives tend to outweigh risks presented through the level of allowed motorized travel. These same considerations were used in ranking Alternative 5 slightly higher than Alternative 3.

Table 32. Ranking of Alternatives, East and West of the Continental Divide, based on protection provided against recreation and road related effects on amphibians (1 = best; 5 = worst).

ALTERNATIVE		1	2	3	4	5	6
Protection from Introduced species and Disease	E. of Divide	None	None	1 tied	1 tied	1 tied	1 tied
	W. of Divide	None	None	1 tied	1 tied	1 tied	1 tied
Protection from Developed	E. of Divide	5	3	2 tied	1	2 tied	2 tied

ALTERNATIVE		1	2	3	4	5	6
and Dispersed Camping	W. of Divide	5	3	2	1 tied	1 tied	1 tied
Road related effects		6	4	1	5	2	3
Overall Rating		6	5	4	1	3	2

Effects on Aquatic Species from Timber and Vegetation Management

Vegetation management consists of actions that promote desired vegetation and ecological conditions. Common actions include reducing conifer encroachment reduction, and aspen restoration. Tools to meet resource objectives may include prescribed fire, and timber harvest. Commercial timber products may be a result of vegetation management, but will not provide the impetus for projects.

Stream systems are inextricably linked to landforms and vegetation. There may be long term benefits to fisheries from increased diversity of vegetation, like stream productivity, and more sustainable ecological conditions. However, it is unlikely these effects can be evaluated within the life of this plan. Whether vegetation management projects have more immediate beneficial or negative effects will most likely depend on issues driving them.

If protecting urban interface is the primary purpose for a project, benefits to fisheries wouldn't be a design consideration, and mitigation would be required to minimize impacts. Mitigation would likely be limited to aquatic direction in the forest plan. On the other hand, if conifers are replacing willows or aspen in a riparian when aspen or a willow-shrub community is desired to maintain fish habitat characteristics, the project would be designed around benefits to fisheries. In this case, options for design and implementation would be driven by improvements for fisheries. Additional mitigation, beyond forest plan direction, may well be incorporated.

Since mitigation is more important for projects driven by other resource needs, alternative comparison is based on their potential to minimize negative effects to aquatics.

Effects on Aquatic Species from Wildlife Habitat Management

The effects of wildlife management effects on aquatic species, is primarily related to management of road densities. Alternatives that encourage lower road densities are generally considered beneficial for watershed health and stream condition. Alternative 3 offers the lowest average road densities at 1.0 mile per square mile. They increase to 1.5 in Alternative 2, and 2.5 in Alternative 4. Road densities vary by area in Alternatives 5 and 6, and so the benefit to fisheries would be determined more site-specifically by area.

The effects of wildlife management effects on TES fish species, is primarily related to management of road densities. Effects would be the same as those described above for aquatic species.

The effects of wildlife management effects on amphibians, is primarily related to management of road densities. The effects are associated with both stream health, and vehicle related mortalities. Alternatives that encourage lower road densities will generally be of greater benefit for amphibians. Alternative 3 offers the lowest average road densities at 1.0 mile per square mile. They increase to 1.5 in Alternative 2, and 2.5 in Alternative 4. Road densities vary by area in Alternatives 5 and 6, and so the benefits to amphibians would be determined more specifically by area.

Watershed and Riparian Area Cumulative Effects

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 and are an excellent indicator of cumulative effects.

Nearly all activities proposed have the potential to affect water resources and indicator species 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. Watersheds whose physical, chemical or biotic function is at risk were 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.

In some cases, events can contribute to measurable effects far downstream. An example is the effect of water depletions from water development on the forest. The urbanization of intermixed private lands is one example. 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 lands adjacent to the BDNF 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.

Cumulative effects to aquatic and riparian resources will be managed through a three-pronged approach:

1. Apply appropriate watershed conservation practices to all activities and monitor their implementation and effectiveness.
2. Limit surface disturbance in watersheds and controlling the location of those disturbances so that the ability of the watershed to assimilate effects is not exceeded, riparian values are protected and enhanced, and the viability of aquatic populations is ensured.
3. Schedule and implement watershed and aquatic ecosystem rehabilitation measures in those watersheds that may be near or over tolerance levels.

This approach will be used to manage direct effects of existing and proposed management activities so that the overall physical integrity of aquatic and riparian ecosystems and habitats they provide is not compromised in a cumulative way. The same approach will presumably also reduce the indirect effects of management activities on the biological integrity of these ecosystems.

Past, Present, and Reasonably Foreseeable Actions

This section describes the past, present, and reasonably foreseeable actions that may have an affect on water quality. These actions include forest management actions, land use and water management in areas adjacent to the forest, and land use development, population, and recreation trends, and state and local government environmental protection programs.

The management activities on the forest that may affect water quality are: roads and vehicle access management, timber harvest/vegetation management, recreation, livestock grazing, hardrock mineral development, oil and gas activities, fire management/fuels treatments, and water developments.

Several activities have improved soil and water conditions through road and travel management. Most forest roads maintained on an annual basis are main vehicle access roads and those that have the most use. Several roads have been moved out of riparian areas or decommissioned, and culverts installed in several stream channels where ford crossing are causing sedimentation. During the last several years, many roads that are graded have had new surfacing such as gravel or oil put on them to reduce the rate of road deterioration and has reduced the rate of erosion from the road surface. The maintenance and decommissioning of roads are expected to be at similar or slightly increased levels based on experienced budget levels. Travel plans identify roads to remain open, roads to be close and decommissioned. A variety of timber harvest treatments have been used in the past and most harvest units are fully stocked. Since the 1940's, a variety of treatments have been used and include clearcut, partial cut, selection cut, shelterwood, and aspen release. Although there are some small areas, such as stream crossing, where small amounts of sedimentation occurs, at present, overall water quality has not been seriously impacted from past harvest activities.

Many recreation projects have been completed to improve water quality and protect or rehabilitate soils. During the last planning period, many developed recreation sites have been improved by placing asphalt over gravel roads, putting cement pads in campsites, moving restrooms away from streams, and installing new restrooms. Hiking and biking trails have been relocated away from streams and wet areas, and bridges have been constructed across streams to protect water quality and aquatic resources. During developed recreation site reconstruction and maintenance in the last planning period, the location of campsites and restroom facilities have been adjusted for the protection of wet areas, improvement of soil productivity and water quality. These soil and water conservation measure are expected to continue in the future.

During the last planning period, off highway vehicle (OHV) and all terrain vehicles (ATV) use has increased greatly on the BDNF. OHV use is expected to increase along with improper use of designated trails that may adversely affect soil and water resources. Unauthorized OHV use commonly occurs in areas alongside designated roads and trials because of immediate vehicle access to the areas.

Although livestock acres have not changed much during the last planning period, the actual animal numbers have dropped dramatically. New grazing standards were implemented to manage livestock and improve soil and water quality conditions within allotments. Many exclosures have been built along riparian areas that have kept livestock from trampling stream banks and have increased the overhanging vegetation along the streams. In the future, it is expected that additional guidelines will address effects such as stream bank trampling and will reduce adverse effects to soils along stream channels and improve water quality.

Abandoned mine clean up activities have improved soil and water conditions in specific areas on the forest and future activities have the potential to further improve water quality.

Past oil and gas exploration and development activities have had a very small impact on soil productivity and water quality. Soil and water conservation practices that were applied to these activities have been very effective in controlling erosion and sedimentation.

The BDNF has approximately 1,000 miles of streams on the 1996 303(d) list. For those streams not currently meeting water quality standards, specialists are working with state specialists to determine the causes of water quality impairment.

Lands within forest watersheds host a variety of land use activities. This area is diverse in terms of naturally occurring landscapes and land use practices. High mountain areas are used extensively for a broad variety of outdoor recreational purposes and the production of agricultural crops, livestock and timber. Irrigated agriculture generally includes varieties of pasture grasses, alfalfa, and small grains. Agriculture is the single largest land use off Forest. This includes irrigated and dry cropland, rangeland, and timber production.

Private land development is occurring adjacent to the forest boundary in many places. This development brings more people in close proximity and is reflected in increased road use, recreation activity, and firewood cutting. Motorized recreation is the fastest growing concern. Technology is continuing to make improvements to ATVs, snowmobiles, and mountain bikes. ATVs are more powerful, have better suspension, and better traction than ever before. With the advent of improved technology, people continue to push the limits where vehicles can go.

Several state and local programs control or improve water conditions on lands on or adjacent to the BDNF. The state identifies water development needs, and the drinking water source protection programs control water pollution, coordinate statewide watershed activities, develop source protection guidelines, assesses water quality, enforces water quality standard compliance, and prides funding for watershed improvement projects and monitoring.

Cumulative Effects of Alternatives

This section describes the past, present, and future cumulative effects between alternatives on water quality. The analysis takes a programmatic look at activities and management on and adjacent to the forest and considers general trends, levels of outputs, management controls on activities, standards, practices that minimizes adverse effects of activities. The specific effects of activities on soil and water resources have been described previously. The analysis looks at short and long term cumulative effects and irretrievable commitments of water resources.

The short term effects to water quality may include some impacts from projects that require ground disturbance. Alternatives 1 and 4 have the greatest potential to affect water quality because they propose the highest amount of timber and vegetation treatment. Alternative 3 has the least short and long term cumulative effects on water quality because of the small amount of project activities and outputs; it also has the largest amount of land allocated to recommended wilderness and roadless protection.

In the long term, this forest plan proposes changes in management that will ultimately lead to improved watershed and riparian conditions compared to the existing condition. Important improvements proposed in Alternatives 3, 4, 5, and 6 are the implementation of key watersheds with the expressed intent of improving and maintaining high quality watershed, fisheries, and riparian health. Alternatives 2, 3, 4, 5, and 6 also incorporate state-of-the-knowledge standards for managing watersheds to prevent adverse effects and to sustain healthy conditions for aquatic and riparian dependent species.

Therefore, no irretrievable or commitment of water resources have been identified in any of the action alternatives.

Aquatic Species Cumulative Effects

The analysis area for cumulative effects on recreational fisheries includes lands within the Madison, Ruby, Jefferson, Red Rock, Beaverhead, Big Hole, Boulder, Upper Clark Fork river drainages, plus the Rock Creek drainage as depicted in Figure 4.

Analysis areas for cumulative effects on bull trout, grayling, lake trout, and westslope cutthroat vary by individual species and are represented in Figures 5-8. The areas are contained in the Big Hole, Beaverhead, Red Rock, Ruby, Madison, Jefferson, and Boulder River drainages, in addition to portions of the Rock Creek, and the Upper Clark Fork River drainages.

The cumulative effects analysis area varies by amphibian species because of differences in distribution. Cumulative effects boundaries are depicted in Figures 9-15.

Cumulative Effects to Fisheries

Many cumulative factors will influence fisheries in and around the BDNF. The Bureau of Land Management recently completed a Record of Decision and Approved Dillon Resource Management Plan for the Dillon Field Office. A Proposed Planning Scenario and Draft Analysis of the Management Situation for the Butte Resource Area has been published. Multiple use management will influence riparian and stream systems through most of the same avenues described in this analysis. The projection is that fish habitat should improve over the next 10 to 15 years.

Montana Fish Wildlife and Parks (MTFWP) is the responsible agency for managing fish populations. Regulations will most likely continue to allow angling and harvest of fish, with variations on fishing limits and times when angling can occur and some gear restrictions. Populations should remain relatively stable, but may fluctuate based on seasonal weather and patterns of precipitation.

State owned school trust lands managed by the Montana Department of Natural Resources, will continue to support a variety of uses from livestock grazing to mining, timber harvest and recreational fishing and hunting. Montana law requires that school trust lands be managed to maximize income for the school trust. Management impacts may be greater on these lands than on other state or federal lands, but may not result in loss of fish populations.

A host of activities will occur on private lands within the cumulative effects analysis area. These include, water diversion; irrigation; livestock grazing; farming with varied cash crops; Timber harvest, water based hunting, outfitted and non-outfitted angling, mining, establishment of sub-divisions, housing and commercial development, building and stocking of private fish ponds, chemical treatment of aquatic vegetation in ditches, and noxious weeds, flood control and stream channel manipulation, hydropower management and mine tailings clean-up. The impacts to fisheries may range from being entirely extirpated in some stream segments to strong increases in abundance in others.

The potential for introduction of disease and aquatic nuisance species exists on all lands within the cumulative effects analysis area. The extent of influence exerted by disease or exotic species is often determined by an area's suitability. If conditions are favorable enough to promote and perpetuate them, then effects are determined by the fishery's susceptibility to be influenced. The effects of these introductions could range from extreme to negligible, based on past observations.

The cumulative effect of these uses will continue to be expressed in varying abundance in fish populations; ranging from total absence in some stream segments on private land, to healthy and abundant in others. Fish populations within BDNF boundaries will be maintained and likely increase in abundance as stream and riparian conditions improve; providing disease or aquatic nuisance species don't artificially depress them. Management actions will not contribute to an irretrievable or irreversible loss of fisheries resources within the cumulative effects analysis area.

Cumulative Effects on Conservation of TES Fish Species

The type of effects land management will have on westslope cutthroat, bull trout, and grayling are virtually the same as described in the effects on recreational fisheries. The primary difference in this part of the analysis is amount of additional protection and benefits each alternative provides for these species.

BLM management practices for the Dillon Resource Area, should lead to improved conditions for westslope cutthroat trout and arctic grayling. Healthier cutthroat populations would be encouraged, allowing them to better withstand extreme environmental conditions like drought or severe winters. Bull trout are only present in the Garnet Range, under management by the Missoula Field Office. Management direction is found in the BLM Resource Management Plan.

Recreational angling will continue to be allowed and may result in some incidental mortality in TES fish species. Angling mortality on cutthroat should be limited, because fishing pressure on most streams with WCT conservation populations is light. In situations where total population size is very small, mortality caused by angling could depress populations. Incidental mortality for and bull trout and grayling may have less effect, because they often have longer stream segments available to them, are typically less isolated and have larger population sizes. Montana Fish Wildlife and Parks, the USFS, BLM and other agencies and private organizations have been implementing conservation and restoration measures for WCT and grayling. Efforts are considered fairly aggressive, but have met with varied success. They have been extremely beneficial in furthering our knowledge of successful approaches. Conservation and restoration efforts may succeed in securing some of populations of most concern.

State owned school trust lands managed by the Montana Department of Natural Resources, will continue to support a variety of uses from livestock grazing to mining, timber harvest and recreational fishing and hunting. Montana law requires that school trust lands be managed to maximize income for the school trust. Conservation of fish species within school trust lands may occur at a slower rate, because of legal direction that over-rides other resource values.

A host of activities will occur on private lands within the cumulative effects analysis area. These include, water diversion; irrigation; livestock grazing; farming with varied cash crops; Timber harvest, water based hunting, outfitted and non-outfitted angling, mining, establishment of sub-divisions, housing and commercial development, building and stocking of private fish ponds, chemical treatment of aquatic vegetation in ditches, and noxious weeds, flood control and stream channel manipulation, hydropower management and mine tailings clean-up.

Fish conservation efforts on private lands may range from none in some areas to intensive in others with broadly beneficial results. Many private landowners in the Big Hole drainage are participating in a Candidate Conservation Agreement that should provide substantial benefits for grayling. Private landowners are also participating in cutthroat trout restoration efforts. They have been willing partners and advocates for land management practices that benefit these species. The status of grayling, cutthroat and bull trout could improve over this planning cycle because of the desire of private landowners and concerned citizens to promote restoration efforts.

The potential for introduction of disease and aquatic nuisance species exists on all lands within the cumulative effects analysis area. The extent of influence exerted by disease or exotic species is often determined by suitability. If conditions are favorable, enough to promote and perpetuate them, effects are determined by the fishery's susceptibility. The effects of introductions range from extreme to negligible based on past observations.

Hydropower management and Mine tailings Clean-up will continue in the Upper Clark Fork drainage. Mill Town Dam will be removed. These efforts will increase the likelihood migratory bull trout will have better vehicle access to habitats that completely meet their natural life history requirements.

Management actions on the BDNF will not result in any irreversible or irretrievable effects to westslope cutthroat, bull trout or fluvial arctic grayling. Non-the-less, a continued decline in cutthroat distribution east of the continental divide is likely. Their persistence there depends less on habitat management than on impacts from non-native species. Unless FWP is capable of removing threats from brook, rainbow and Yellowstone cutthroat trout, improvements in habitat condition will have a limited bearing on their abundance and distribution.

Cumulative Effects on Amphibians

Cumulative effects on Amphibians include all of the items listed in the cumulative effects section on fisheries, plus predation by introduced trout, competition with bull frogs, Chytrid fungus and possibly other diseases or pathogens.

The Bureau of Land Management's Resource Management Plan for the Dillon Resource Area should generally improve stream and riparian conditions, benefiting amphibians.

Montana Fish wildlife and Parks is responsible for managing fish populations. They will continue to stock lakes on a 4 or 5 year rotation. Additional waters may be stocked with fish, but not without an environmental analysis. Fish stocking in the analysis area resulted in reduced occurrence and abundance of amphibians from historic populations. Fish stocking over the life of this plan will not sufficiently change so habitat use and distribution in mountain lake areas could remain relatively stable, unless disease or climate change substantially influences them.

State owned school trust lands will continue to support a variety of uses from livestock grazing to mining, timber harvest and recreational fishing and hunting. Management impacts on amphibians may be greater on these lands than on other state or federal lands, and could result in loss or displacement of amphibian populations.

A host of activities will occur on private lands within the cumulative effects analysis area. These include, water diversion; irrigation; livestock grazing; farming with varied cash crops; Timber harvest, water based hunting, outfitted and non-outfitted angling, mining, establishment of sub-divisions, housing and commercial development, building and stocking of private fish ponds, chemical treatment of aquatic vegetation in ditches, and noxious weeds, flood control and stream channel manipulation, hydropower management and mine tailings clean-up, and stock pond development Effects on amphibians range from loss of populations to reestablishment of populations, depending on specific actions taken.

The potential for introduction of disease and aquatic nuisance species exists on all lands within the cumulative effects analysis area. Chytrid fungus may continue to influence several species of amphibians on the BDNF. Illegal bull frog introductions may continue at some rate, causing isolated declines in native species and possibly even population loss.

The cumulative effect of these uses will likely result in patterns in amphibian abundance and distribution similar to what we see today. Amphibian populations within the BDNF boundaries will be largely maintained and may increase in abundance as stream, riparian and upland vegetation conditions are restored. The introduction of disease or aquatic nuisance species may artificially depress certain populations. Management actions on the BDNF should not contribute to an irretrievable or irreversible loss of fisheries resources within the cumulative effects analysis area.