Panjabi (2003) found that average breeding bird species richness in shrubland habitat was 8.8 species/count, the highest of any habitat surveyed in the Black Hills. Panjabi (2003) attributes this, in part, to the mosaic of different habitat types found in the shrubland survey area. In spring, bird life is abundant and conspicuous. Species that primarily nest and forage in shrublands include the Brewer's sparrow, dusky flycatcher, white-throated swift, Virginia's warbler, and spotted towhee. Where forest edge or scattered trees are present, breeding bird diversity increases to include species such as the American kestrel, red-tailed hawk, western tanager, and chipping sparrow. Where shrublands abut low-elevation habitats (i.e., prairie grassland and low-elevation riparian), the vesper sparrow, American goldfinch, mountain bluebird, violet-green swallow, and brown-headed cowbird are common breeders (Panjabi 2002).

In winter shrublands, host species that may move from summer to winter range to exploit available cover and forage (browse and seeds). In the Black Hills, species such as mule deer and elk exemplify this movement.

3-2.2.2. Resource Conservation Measures

Objectives, standards, and guidelines—both Forest-wide and specific to selected MAs—are included in each alternative to conserve and manage grassland and shrubland habitat on the Forest. The following examines the changes to grassland and shrubland management in the 1997 Revised LRMP that are being considered under Phase II Amendment alternatives.

- Objective 205 calls to restore 12,000 acres of prairie grasslands and 2,400 acres of meadows under Alternatives 3. Alternative 6 sets to manage 122,000 acres of grasslands and 3,600 acres of meadows. Under Alternatives 1, 2, and 4, grassland communities would be restored by 10 percent over 1995 conditions.
- Guideline 2107 limits pine encroachment into grasslands under Alternatives 1, 2, and 4. This guideline is changed under Alternatives 3 and 6 to include limiting all conifer encroachment into grasslands and adds emphasis species habitat as a reason for treating conifer encroachment.
- Under Alternatives 1, 2, and 4, Objective 209 manages at least 5 percent of a timber harvest area for the grass/forb structural stage. This objective is deleted under Alternatives 3 and 6 and is replaced by ponderosa pine structural-stage objectives under MAs 4.1, 5.1, 5.6, 5.4, and 5.43. Objectives in MAs 4.1, 5.1, 5.4, 5.43, and 5.6 target a combined grass/forb and shrub cover of 5 percent of each MA.
- One objective would be established under Alternatives 3 and 6. Objective 200-09 manages for low grassland structure in the vicinity of prairie dog towns in alternative 3. Alternative 6 sets acres of prairie dog towns to manage toward. Alternative 3 prohibits major soil disturbances in prairie dog towns (Standard 3118).
- Objective 11-04 is designed to encourage and conserve the establishment of shrubs in moderate-to-high intensity burn areas in the first 5 years following a wildfire under Alternatives 3, 4, and 6. Under Alternatives 1 and 2, Guideline 2208 would alter the age classes of shrubs in a planning unit by no more than 25 percent in a 10-year period. Alternatives 3, 4, and 6 have deleted Guideline 2208. In addition, no authorized use will be allowed by domestic livestock on known occurrences of the three willow emphasis species (Standard 2505e).
- In MA 5.4, Objective 203 enhances understory shrubs by varying tree densities under Alternatives 1 and 2. This objective is deleted under Alternative 3 and 6 because this objective is covered in the structural-stage objectives.
- In MA 5.1A, Objective 205 requires removal of pine encroachment in shrublands and grasslands under Alternatives 3 and 6.

3-2.2.3. Direct And Indirect Effects

The Final EIS for the Black Hills National Forest LRMP provided general direct and indirect effects on grasslands and shrublands (USDA Forest Service 1996a p. III-146-150). High-frequency fires help to maintain an open forest character that contains gaps to support understory herbaceous and shrub communities. Fire can keep the boundaries of conifer and hardwood communities in check by preventing the expansion of trees into grasslands, prairies, and shrubland. Fire suppression in the Forest has resulted in changes in the distribution and structure of herbaceous and shrub communities. At the periphery of the Black Hills, the forest/prairie interface has shifted from being historically higher in elevation to lower in elevation. Some native shrubs and trees have had the chance to become dominant over areas of grasses and forbs. The interior prairies (e.g., Reynolds Prairie) have declined in size due to encroachment of ponderosa pine. Shrub community expansion (e.g., snowberry) into herbaceous sites has produced a taller vegetative component in these areas. Structural changes of the forest communities include an increase in ponderosa pine and spruce canopy densities. The relatively closed canopies then support less extensive understory communities.

Grazing and browsing by livestock and wildlife can affect grassland/shrublands, and improper timing, intensity, and frequency of grazing over multiple years can result in a structural shift from shrubs and tall grasses to shorter vegetation. The removal of grasses can allow some native shrubs to become dominant. Trampling of the vegetation and soil disturbance can also occur.

3-2.2.3.1. Effects Of Species-viability Management On Grassland/Shrubland Ecosystems

Currently, the Forest contains approximately 110,000 acres of grassland and approximately 5,000 acres of shrubland (See **Table B-4** Forest Vegetation Types).

Under Alternatives 1, 2, and 4, Objective 205 provides for the restoration of grassland and prairie communities across the Forest by 10 percent over 1995 conditions. However, this level of restoration would ensure only that existing grassland and prairie communities would not be overtaken by ponderosa pine encroachment. Under Alternative 3, this objective targets the restoration of 12,000 acres of prairie grasslands (approximately 13-percent increase) to remove pine encroachment and restore 2,400 acres of grassland to approximately triple the current grassland acres during the life of the plan. Alternative 6 sets objectives to manage 122,000 acres of grasslands and 3,600 acres of meadows. Thus, restoration objectives would likely result in an appreciable increase in grassland and meadows under Alternative 3 and 6.

Pine and spruce encroachment would be managed in grasslands under all alternatives, but the approach would differ by alternative. Under Alternatives 1, 2, and 4, Guideline 2107 would promote treating pine encroachment in areas that have formed over grasses or meadows to maintain structural diversity and a forage base. Under Alternatives 3 and 6, this guideline would promote treating conifer encroachment, not just pine encroachment, in these areas because white spruce as well as pine is encroaching into grasslands. Alternatives 3 and 6 also emphasize conifer treatment to conserve habitat for threatened, endangered, and Region 2 sensitive species and species of local concern (SOLC). These actions, however, would not appreciably affect the total amount of grassland or shrubland on the Forest but could slightly change its distribution.

Under Alternatives 1, 2, and 4, structural diversity would be targeted by managing at least 5 percent of timber-harvest project areas for the grass/forb structural stage. Under these alternatives, grass/forb openings should be 1 acre in size or larger and can include those created by wildfire or other natural disturbance events and openings greater than 1 acre within low-density stands. Alternative 3 would

manage structural diversity by targeting grass/forb and shrub structural stages to be 5 percent of the Forest by the end of the first decade and then to maintain this percentage. The grass/forb and seedling structural stages would include natural and created openings, grasslands, and shrublands of various sizes. Under Alternative 6, a greater portion of the Forest would potentially be maintained in the grass/forb/shrub structural stages because the objective would apply over a greater proportion of the Forest and would not be limited to individual project areas.

Within grasslands, certain objectives, standards, and guidelines would address the types of desirable vegetation that is expected to provide suitable habitat for emphasis species. New Objective 200-09 would manage for low grassland structure in the vicinity of prairie dog towns under Alternatives 3. While this action would provide greater structural diversity in grassland, it would not change the overall acreage of grassland nor would it change its distribution.

New Standard 3100-10 under Alternatives 3 and 6 would conduct a prescribed burn on no more than 60 percent of any contiguous grassland area at a time. This action could help restrict ponderosa pine in a given area but generally would not affect the total acreage of grassland nor its distribution.

Within shrublands, Standard 3100-5, under Alternatives 3, and 4, would require management of cover types within 3 miles of active sage grouse display grounds to support 15- to 25-percent canopy cover of sagebrush. This standard would favor sagebrush, but sage covers a very small portion of the Forest, there would be no appreciable change in the total amount or distribution of shrubland on the Forest.

3-2.2.3.2. Effects Of Research Natural Area Management On Grassland/ Shrubland Ecosystems

Under Alternative 4, Lemming Draw, which represents the montane grassland type, and under Alternatives 3, 4, and 6, Fanny/Boles, representing the mountain-mahogany/skunkbrush shrubland type, are both candidate RNAs. Standard 2.2-1001 requires that candidate RNAs be managed to maintain and enhance the character and ecological values for which the areas have been identified until formal establishment.

If Lemming Draw or Fanny/Boles were designated as RNAs, standards and guidelines for RNAs (MA 2.2) would prohibit timber harvest, mineral entry, and mechanized or motorized travel and could potentially restrict public access and livestock grazing. Guideline 2.2-1002 allows uses that maintain or improve the ecological characteristics for which the RNA was designated, subject to monitoring. If monitoring determines an adverse effect on the ecological values for which the RNA was designated, then the use would be limited or prohibited. These restrictions could help conserve these small areas of grassland and shrubland but would not appreciably affect the extent or distribution of grassland/shrubland associations Forest-wide. All the candidates have small amounts of grasslands and shrublands and their designation could help conserve these small areas of grassland and shrubland but, again, would not appreciably affect the extent or distribution of grassland/shrubland associations Forest-wide.

3-2.2.3.3. Effects Of Fire-hazard And Insect-risk Management on Grassland/ Shrubland Ecosystems

Grasslands and shrublands are not the primary focus of the alternatives with a fire-hazard and insect-risk management emphasis. The primary focus for the alternatives is to reduce the fire-hazard rating, with Alternative 6 proposing the largest reduction. Grassland and shrubland restoration would generally occur where ponderosa pine has encroached into these cover types and will in principle reduce crown-fire hazard and insect risk.

3-2.2.4. Cumulative Effects

Cumulative effects in the grassland ecosystems result from the incremental impact (direct and indirect effects) associated with the alternatives when added to past, present, and reasonably foreseeable actions. The cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Ecoregion as defined by Bailey (1995).

Grasslands and shrublands occupy a relatively small part of the Forest, and under all alternatives, are expected to remain constant or increase. Because a large part of the grassland within the Black Hills is in private ownership and the Forest is essentially surrounded by prairie grassland, actions on the Forest are not likely to contribute to any cumulative effects or exceeding known thresholds that would impact grasslands or shrublands on the Forest. While privately owned grass and shrub lands in and around the Forest are being subdivided and developed, grass and shrub lands on NFS lands will remain as open space and will likely increase.

3-2.3. Riparian And Wetland Ecosystems

3-2.3.1. Affected Environment

Although the Final EIS for the Forest LRMP does provide information on Riparian Areas and Wetlands (USDA Forest Service 1996a, p. III-293, III-306), recent publications (Marriott et al. 1999; Marriott and Faber-Langendoen 2000b) have since increased the knowledge base of riparian and wetland communities found in the Black Hills. This information is included in the following discussion.

Marriott and Faber-Langendoen (2000b) described dry riparian forest and woodland types in the riparian and wetland plant communities of the Black Hills. These types, in particular the aspen communities, were included in the hardwood ecosystems discussion in the 1996 EIS, and emphasis species associated with these dry riparian types are primarily considered hardwood associates and not riparian associates and are discussed in section 3-2.1.3 Hardwood Ecosystems. The riparian and wetland types discussed in this section are primarily those associated with very high moisture to saturated conditions.

Riparian areas account for approximately 1 percent of public and private land in the Black Hills and are typically located adjacent to streams and around natural springs, seeps, fens, and reservoirs (USDA Forest Service 1996a). About 107,600 acres of riparian habitat are within the Forest administrative boundary and about 70 percent of these riparian acres are on NFS lands (Table 3-11). Due to the presence of water, these areas frequently receive a disproportionate amount of use from wildlife, livestock, and humans (USDA Forest Service 1996a).

Riparian areas and wetlands on the Forest range from sedge and grass/forb/shrub communities to shrub/deciduous tree/conifer communities (USDA Forest Service 1996a). These habitats are some of the most productive and biologically diverse lands on the Forest and provide living conditions for a greater variety of aquatic and terrestrial wildlife than any other habitat type (USDA Forest Service 1996a). For example, of the emphasis plant species identified by the Forest, about 60 percent occur in riparian or wetland habitat; and of the emphasis animal species, approximately 40 percent utilize or depend on riparian or wetland habitat. The quality and extent of these riparian/wetland habitats are important factors because they have a direct influence on the associated aquatic ecosystem that is home to fish and amphibian species.

Based on National Wetlands Inventory data, there are approximately 5,800 acres of wetland habitat within the Forest administrative boundary. **Table 3-11** below summarizes the acres based on adjacent land ownership. Wetlands include all the mapped wetland polygons except the larger bodies of water over 100 acres. Water bodies include Pactola, Deerfield, and Sheridan reservoirs for NFS lands and Stockade Lake and part of Angostura Reservoir for non-NFS lands.

Table 3-11. Wetland Acres, Including Streams, And Riparian Acres Within The Black Hills National Forest.

Black Hills NF	Wetlands	Water Bodies	Total	Riparian
NFS	723	1,581	2,304	76,883
Non-NFS	1,612	1,926	3,538	30,696
Total	2,335	3,507	5,842	107,579

Source: USDI Fish and Wildlife Service 1995, National Wetlands Inventory (NWI), Black Hills NF GIS Riparian Coverage

Historically, low-elevation riparian plant communities were probably composed of deciduous hardwoods such as green ash, boxelder, and American elm; at higher elevations they probably consisted of white spruce (Parrish et al. 1996). Riparian habitat historically also included an extensive shrub component including willows, birches, and red-osier dogwood (Froiland 1990).

Marriott and Faber-Langendoen (2000b) identified six riparian and wetland ecological groups that occur on the Forest. For the purposes of this discussion, the Dry Riparian Forests and Woodlands ecological group has been divided into two elevational constituents for a total of eight ecological groups (see **Table 3-12**). Riparian and wetland areas occur in both montane and low elevation areas. Approximately 50 percent of low elevation riparian forests and shrublands are privately owned and, therefore, have not been surveyed as extensively as other habitat types in the Black Hills (Marriott et al. 1999). Mapping of these different riparian plant associations has not been accomplished on the Forest; therefore, information on their distribution and extent in the Forest is not available.

Table 3-12. Plant Associations For Montane And Low Elevation Riparian Areas And Wetlands

Montane Riparian Ecosystems	
Ecological Group	**Plant Associations[1]**
High Elevation Riparian Forests and Shrublands	Beaked (Bebb's) willow scrub
	Sandbar willow shrubland
	White spruce alluvial Black Hills forest
Riparian/Wet Meadows	Canadian reed grass wet meadow
	Nebraska sedge wet meadow
	Prairie cordgrass-sedge wet meadow
	Black Hills streamside vegetation
Fens	Sage willow fen
	Nebraska sedge wet meadow
	Baltic rush wet meadow
Low-Elevation Riparian Ecosystems	
Ecological Group	**Plant Associations**
Plains Riparian Forests and Shrublands	Sandbar willow shrubland
	Western snowberry shrubland
	Narrowleaf cottonwood/red-osier dogwood
Riparian/Wet Meadows	Nebraska sedge wet meadow
	Prairie cordgrass-sedge wet meadow
	Creeping spikerush wet meadow
	Northern Great Plains cattail community
	Western Great Plains streamside vegetation
Marshes	Great Plains cattail-bulrush marsh

Source: Marriott et al. 1999; Marriott and Faber-Langendoen 2000b.
[1]The listed plant associations occur both on the Forest and in the Black Hills in general.

3-2.3.1.1. Montane Riparian Ecosystems

Montane riparian ecosystems have a high level of biodiversity and provide important habitat to more than 35 plant and animal emphasis species. In the 2002 bird surveys of Forest montane riparian habitats, Panjabi (2003) detected a total of 82 bird species, second only to the number of species detected in foothill riparian habitat. The average number of bird species was the second highest for all habitats.

High Elevation Riparian Forests And Shrublands

Three community types have been described for high-elevation (generally greater than 4,500 feet) riparian forests and shrublands in the Black Hills (Marriott and Faber-Langendoen 2000b). The most common montane riparian shrubland in the Black Hills is beaked (Bebb's) willow scrub. Sandbar willow shrubland occurs along streams at higher elevations but is more common at lower elevations. White-spruce alluvial Black Hills forest, found in mesic drainages, is the third high elevation riparian type and is discussed in the white-spruce ecosystems section.

The herbaceous component of beaked willow shrublands is variable. Shrub cover tends to be patchy in the wet meadow habitat. Other shrubs commonly found with beaked willow include water birch, red-osier dogwood, sandbar willow, western snowberry, and shrubby cinquefoil (Marriott and Faber-Langendoen 2000b).

At higher elevations, sandbar willow shrublands tend to be mixed with beaked willow. Sandbar willow shrublands typically occur in areas recently disturbed by flooding, such as floodplains, gravel bars, and stream banks. Stands may have close to 100 percent shrub canopy cover, with cottonwood and peach-leaf willow saplings present at lower elevations. Other shrub species that may be present include beaked willow, water birch, and red-osier dogwood. The herbaceous layer may change with every flooding disturbance to the area but may include dominant species from the surrounding riparian and wet meadow communities (Marriott and Faber Langendoen 2000b).

Herbaceous Wetlands

Riparian/wet meadow communities typically occur as mosaics of small patches and at higher elevations often contain stands of beaked willow shrubland and white spruce (Marriott and Faber-Langendoen 2000b). Common riparian/wet meadow types found in these complexes include Canadian reed grass wet meadow, Nebraska sedge wet meadow, Prairie cordgrass-sedge wet meadow, and Black Hills streamside vegetation (refer to the previous table).

McIntosh Fen is the only well-documented fen in the Black Hills. Three community types occur here: sage willow fen, Nebraska sedge wet meadow, and Baltic rush wet meadow (Marriott and Faber-Langendoen 2000b). McIntosh Fen is a relatively small wetland located in habitat unique for the Black Hills (Marriott and Faber-Langendoen 2000b). Two rare willows (sage willow and autumn willow) are found at McIntosh Fen in small stands. Other shrub species include beaked willow and shrubby cinquefoil (Marriott and Faber-Langendoen 2000b).

Canadian reed grass wet meadow is occasional in the central core at higher elevations and is strongly dominated by Canadian reed grass. Nebraska sedge wet meadows occur along streams in narrow bands and in larger patches in wet meadows. The prairie cordgrass association is found occasionally at scattered locations in wet meadows and stable stream banks (Marriott and Faber-Langendoen 2000b). These three herbaceous wetland types at higher elevations on the Forest frequently consist of the same suite of species but vary in terms of dominant plant species present. Herbaceous cover is typically high and ranges from 60 to 100 percent (Marriott and Faber-Langendoen 2000b). Scattered shrubs and trees such as beaked

willow, white spruce, shrubby cinquefoil, water birch, and aspen may be present (Marriott and Faber-Langendoen 2000b).

The Black Hills streamside vegetation association occurs at higher elevations within the central core along perennial streams (Marriott and Faber-Langendoen 2000b). This association is not well characterized. American mannagrass, redtop bent grass, fowl bluegrass, small-fruit and pale bulrushes, and western water hemlock are the most consistent species identified that have significant cover (Marriott and Faber-Langendoen 2000b).

3-2.3.1.2. Low-Elevation Riparian Ecosystems

Low elevation riparian ecosystems in the Forest are not well documented (Marriott et al. 1999). Approximately one-half of all low elevation riparian systems on the Forest are privately owned (Marriott et al. 1999). As with other riparian ecosystems found in the Black Hills, these low elevation riparian ecosystems are highly productive and have relatively high levels of biodiversity. Numerous emphasis species are associated with low-elevation riparian ecosystems.

In recent bird monitoring, Panjabi (2003) detected a total of 100 species in foothills riparian habitat, the highest total number observed in any habitat surveyed. In addition, estimated densities for 21 species were greater in foothill riparian habitat than in any other habitat surveyed. Several uncommon species, such as the black-and-white warbler, were observed only in the foothills riparian habitat or were observed in this habitat in greater numbers than in any other habitat. Although typically found in white-spruce habitat, Swainson's thrush was also detected in foothills riparian habitat (Panjabi 2003).

Plains Riparian Forests And Shrublands

Riparian plant associations in this category include sandbar willow shrubland, western snowberry shrubland, and narrowleaf cottonwood/red-osier dogwood (Marriott and Faber-Langendoen 2000b). Sandbar willow shrublands were characterized previously in Montane Riparian Ecosystems. Western snowberry shrubland occurs in drainage bottoms and draws at lower elevations (Marriott et al. 1999).

Narrowleaf cottonwood/red-osier dogwood was typically found on recently formed alluvial bars in the lower canyons of Spearfish and Little Elk Creeks (Marriott and Faber-Langendoen 2000b). Narrowleaf cottonwood dominates the tree canopy; vertical structure varies with stand age. Older stands have a sub-canopy that may include boxelder, paper birch, bur oak, American elm, and/or ponderosa pine. Young stands tend to be homogeneous and occur on rocky banks and bars. Typical shrub associates, while variable, include sandbar willow, water birch, rose, poison ivy, and red-osier dogwood (Marriott and Faber-Langendoen 2000b).

Herbaceous Wetlands

Plant associations of riparian/wet meadows at lower elevations include Nebraska sedge wet meadow, prairie cordgrass-sedge wet meadow, creeping spikerush wet meadow, northern Great Plains cattail community, and western Great Plains streamside vegetation. The Great Plains cattail-bulrush marsh is the only type of marsh found in the Black Hills and occurs in an area not under USDA Forest Service administration.

Nebraska sedge and prairie cordgrass wet meadows both occur at a wide range of elevations and are described above in the Montane Riparian Ecosystems section. Prairie cordgrass-sedge wet meadow is not well characterized at lower elevations. Creeping spikerush wet meadow has been documented from Wind Cave National Park in the southeast Black Hills (Marriott and Faber-Langendoen 2000b).

Northern Great Plains cattail community occurs throughout the Black Hills and can be found along low-gradient streams, on lake margins, in ponds, and at active springs (Marriott and Faber-Langendoen 2000b). Broad-leaved cattail or narrow-leaved cattail strongly dominates this association. Relatively few other species are present. Some wet meadow and streamside species that may also occur include willow herb, field mint, sedges, and horsetails (Marriott and Faber-Langendoen 2000b).

3-2.3.2. Resource Conservation Measures

Implementation of Forest Plan standards and guidelines and the Regional Watershed Conservation Practices Handbook (WCP Handbook; FSH 2509.25) and compliance with State Best Management Practices (BMPs) conserve and enhance riparian and wetland ecosystems on the Forest. The WCP Handbook contains proven watershed conservation practices to protect soil, aquatic, and riparian systems. The WCP Handbook covers five areas: hydrologic function, riparian areas, sediment control, soil productivity, and water purity. WCP Handbook Standards are incorporated verbatim into all alternatives. Design criteria are specific ways to meet the WCP Handbook standard. If used properly, they meet or exceed State BMPs.

State BMPs are incorporated by reference as guidelines into all alternatives. These State BMPs include *Forestry Best Management Practices for South Dakota* (South Dakota 2003); *Silviculture Best Management Practices* (WY 2004); *Hydrologic Function Best Management Practices* (WY 1999); *Grazing Best Management Practices* (WY 1997); and *Best Minerals Management Practices*, as updated (USDA Forest Service 1985).

3-2.3.3. Direct And Indirect Effects

Direct impacts to riparian and wetland ecosystems are typically obvious and occur from direct disturbances such as the clearing of vegetation, over-utilization by livestock or wildlife, roads, or trails (e.g., stream crossings), placement of fill material (e.g., development in a floodplain), and wildfire. Indirect impacts are typically less obvious and can be more difficult to identify or quantify. Examples of indirect impacts to riparian and wetland ecosystems include changes in water quantity or flow regimes, such as the loss of beaver from the system or water diversions; changes in water quality, such as an increase or decrease in sediment loading; and the spreading of noxious weeds.

Forest-wide standards and guidelines protect riparian areas, water influence zones, and wetlands. Under all alternatives, long-term riparian ecosystem health and ecological function are provided for by not allowing actions that would be detrimental to riparian- ecosystem condition (Standards 1301, 1302). Riparian and wetland areas that contain emphasis species are given additional protection from direct and indirect disturbances under all alternatives (Guidelines 3106a, b, c or 3107a ,b, c). In Alternatives 3 and 6, Guideline 3106 becomes a standard. Standard 1306 prohibits log landings, decking areas, and mechanical-slash piling within riparian areas unless the integrity of riparian areas can be protected.

Improper livestock grazing can have numerous adverse effects on riparian and wetland ecosystems such as water quality degradation and over utilization of riparian vegetation (USDA Forest Service 1996a). The level of livestock use will remain constant across the range of alternatives (Objective 301a; 128,000 Animal Unit Months). Under Alternatives 3 and 6, the Forest-wide guideline (2505) on residual levels (the remaining height of key plant species after livestock grazing) is changed to a standard and modified so that residual levels in riparian and wetland areas would have to be prescribed in allotment management plans (AMPs) or Annual Operating Instruction letters. Objective 200-03, under Alternatives 3 and 4 protects aquatic and shoreline vegetation around 50 ponds or water catchments over the life of the Plan. In Alternative 6, this objective protects aquatic, shoreline and upland vegetation around ponds or water catchments containing leopard frogs. Standard 1304 opportunistically relocates or implements mitigation

measures for water tanks or water catchments located in the Water Influence Zone. Measures to maintain proper use or residual levels of vegetative cover promote bank stability adjacent to aquatic habitats and maintain the filtering function of riparian areas adjacent to water (Guidelines 2505 and 2506). Guideline 2505c limits the utilization of willows and other deciduous vegetation to 40 percent. This guideline becomes a standard in Alternatives 3 and 6 and is treated as a standard in Alternatives 2 and 4. Guideline 2505d removes livestock from the grazing unit or allotment when further utilization exceeds proper use or residual levels. Impacts from livestock grazing in fenced riparian pastures are mitigated through Guidelines 2507 and 2508.

All alternatives contain direction to avoid the effects of roads and vehicle traffic on riparian and wetland habitat. Objective 105 strives to prohibit motorized vehicles in wetlands, wet meadows, and riparian areas. Standard 1113 minimizes sediment discharge into streams, lakes, and wetlands during road construction and other site disturbances. Guideline 4102 protects streams, lakes, and adjacent riparian areas from wildfire-suppression efforts, including the use of earth-moving equipment in stream channels and the use of fire-retardant chemicals would be avoided in riparian areas, wetlands, and open water. Guideline 9107 prohibits land vehicles from entering perennial steams where resource damage would occur. Guideline 9108 restricts vehicle traffic to roads and trails in riparian areas. Both of these guidelines become standards in Alternatives 3 and 6.

The effects of pollutants on water quality are mitigated across the range of alternatives to maintain wetland habitat. Standards 1211, 1212, and 1213 require the placement of new chemical and pathogenic pollutants where they will not reach surface or groundwater; require the application of runoff controls to disconnect new pollutant sources from surface-and-ground water; and require the application of chemicals using methods to minimize the risk of entry to surface-and-ground water, respectively. In all alternatives, Guidelines 4304 and 4305 minimize the impact from chemical-treatment applications through selective application at the lowest effective rates. Standard 4308 requires the use of buffers around water sources, lakes, wetlands, and streams to keep concentrations of chemical agents in the water well below those harmful to drinking, irrigation, aquatic life, and non-target vegetation. The treatment of individual plants with aquatic-labeled chemical agents may occur in buffers.

Standard 1505 and Guidelines 1506, 1507, and 1508 minimize disturbance to riparian areas by mineral activities and by requiring monitoring of mitigation measures to ensure effectiveness. The discharge of new pollutant sources is mitigated by Standards 1211, 1212, and 1213. Standard 1305 locates camping sites for contractual purposes (e.g. mining, logging, etc.) such that channel and riparian areas are not impacted.

All alternatives contain measures to minimize direct and indirect impacts to riparian and wetland habitats; however, Alternatives 3 and 6 contain additional provisions that provide additional conservation measures for these areas. Alternatives 2 and 4 continue to treat a number of environmentally protective guidelines as standards.

3-2.3.3.1. Effects Of Species-viability Management On Riparian And Wetland Ecosystems

Direction to maintain riparian and wetland habitat exists across the range of alternatives. Objectives 104 and 107 strive to achieve and maintain riparian vegetation and to restore degraded wetlands, respectively. Objective 213 strives to maintain or enhance existing riparian area biodiversity, physical structure, and size. Objective 216 manages to conserve or enhance the integrity of botanical areas, all of which are associated with riparian areas. Objective 221 strives to conserve and enhance habitat for emphasis species, many of which occur in riparian and wetland habitats. These five objectives are common to all alternatives.

Alternative 3 and 6 target ten times the amount of aspen restoration acreage as compared to Alternatives 1 and 2, and five times as compared to Alternative 4. Objective 201 targets doubling the current aspen acreage (46,000 acres) in Alternative 3 and managing for 92,000 acres of aspen in Alternative 6, focusing on sites adjacent to riparian areas that once supported beaver. Alternatives 1 and 2 would restore about 4,500 acres of hardwoods (10 percent of 1995 conditions). Alternative 4 would restore about 9,000 acres of hardwoods (20 percent of 1995 conditions). Treatments to promote aspen and hardwoods in riparian areas or adjacent to wetlands would increase vegetation diversity and benefit species that rely on these habitat types.

Objectives 214 and 215 promote the restoration of riparian shrub communities and riparian rehabilitation projects, respectively. Alternative 3 would have the greatest benefit to riparian and wetland ecosystems because it would restore 1,000 acres of riparian shrub habitat. Five hundred acres are targeted for riparian shrub restoration in Alternatives 1, 2, 4 and 6.

Under Alternatives 3 and 6 the number of stream reaches proposed for riparian rehabilitation is increased from three (Alternatives 1, 2, and 4) to five stream reaches (Objective 215) with the intent of raising the water table and restoring native wet-meadow vegetation.

New Forest-wide Objective 200-07 has been added under Alternatives 3 and 6 for the conservation of willow species found at McIntosh Fen and along Middle Boxelder Creek.

Objective 200-3 was added to Alternatives 3, 4 and 6 to protect aquatic and shoreline vegetation around ponds or water catchments. Alternative 3 and 4 target 50 ponds or catchments. This would improve water quality, bank stability, and vegetative condition. Bull et al. (2001) found that fenced stock ponds in northeastern Oregon forests had a greater density of birds than unfenced stock ponds. Alternative 6 focuses on an undetermined number of ponds or water catchments that contain leopard frogs and also protects upland vegetation.

Two new MA Objectives (8.2-207, 8.2-208-FC) have been added under Alternatives 3 and 6 to prevent and control erosion and treat noxious weeds in areas where emphasis species populations exist along Cascade Creek would benefit the riparian area at this site.

All Alternatives contain general wildlife and fish direction to protect riparian areas. Guideline 3210 maintains or establishes riparian shrub and tree species and protects riparian habitat from animal damage. Guideline 3211 provides for riparian habitat diversity through vegetation treatments or other resource activities to improve habitat. Guideline 3212 manages for high quality riparian communities. In Alternative 2, these guidelines are treated as standards.

Standard 2505e was added to Alternatives 3 and 6 to prohibit the authorized utilization by domestic livestock on sage, shining and autumn willow species. Alternatives 1, 2, 3, 4, and 6 continue to allow livestock use of forage in fenced riparian areas as designated in AMPs as long as objectives for maintaining, enhancing, or conserving the riparian ecosystem and species viability are met (Guideline 2508/Standard 2507).

Increases in the extent of riparian area on the Forest and the quality of riparian areas under Alternatives 3 and 6 could increase habitat availability for species that rely on these areas and help to conserve or increase diversity across the Forest.

3-2.3.3.2. Effects Of Research Natural Area Management On Riparian And Wetland Ecosystems

RNAs across the range of alternatives are described in Chapter 2 and are shown in Table 3-13. Alternatives 1 and 2 contain the existing Upper Pine Creek RNA. Alternatives 3 and 6 include four candidate RNAs, but not all of the same ones. Alternative 4 contains all nine candidate RNAs.

The overall effect of RNA management on riparian and wetland ecosystems is expected to be beneficial because of the limitation on land management activities. Currently, management of the Upper Pine Creek RNA under Alternatives 1 and 2 mimics management of the surrounding Black Elk Wilderness. The North Fork Castle Creek candidate RNA already receives some increased protection due to its current status as a Botanical Area (Management Area 3.1) in Alternatives 1 and 2. New standards and guidelines are included in Alternatives 3, 4, and 6 to limit land management activities necessary to preserve the natural ecosystem condition, its processes and the values for which the RNA was established.

Candidate RNAs would be subject to MA Standard 2.2-1001 that requires maintaining and/or enhancing the character and ecological values for which the candidate RNAs have been identified and to Standard 2.2-2501 that prohibits the increase in domestic livestock animal-unit-months (AUMs) prior to designation. Standards (2.2-1501, 2.2-2401, 2.2-4101, 2.2-4102, 2.2-4103, 2.2-5201, 2.2-5401, 2.2-8301, 2.2-9101, and 2.2-9102) would prevent mineral entry, timber harvest, mechanized or motorized use, special forest products collections, and may require restricted public access. Restricting public access may include obliterating closed or existing roads or in extreme cases closing an RNA or a portion of it to any public use. See Appendix D Standards 2.2-5201, 2.2-9101, and 2.2-9102. The standards would also require the use of minimum impact suppression techniques (MIST) in suppressing wildfire. This would avoid and minimize the amount of ground disturbance and other potential impacts from fire-suppression activities. RNA guidelines (2.2-1002, 2.2-4201, 2.2-5101, 2.2-5202, and 2.2-5601) would allow uses that maintain or improve the ecological values for which the RNA was designated. Should monitoring reveal that a use causes adverse effects on the ecological values for which the RNA was designated, that use would be limited or prohibited.

In Alternatives 3 and 6, Objective 10-03 strives for a moderate-to-low fire-hazard rating between RNAs and ARC and the WUI, excluding the Upper Pine Creek RNA, to reduce the potential for catastrophic fire affecting RNAs or for areas adjacent to RNAs being in a high fire-hazard rating should a fire ignite in an RNA. Wetlands and riparian habitat are generally natural fuel breaks given wetter site conditions, with the exception of some communities, such as white spruce, during drought conditions. **Table 3-13** below summarizes the acres of wetland and riparian habitat affected by RNA management across the range of alternatives. Some double counting of wetland acres as riparian acres occurred, but the amount is negligible. The Canyon City, Geis Spring, Iron Mountain North and North Fork Castle Creek candidate RNAs target riparian plant communities. Riparian habitat may also be influenced by candidate RNAs that target other non-riparian plant communities. The amount of wetland habitat in the form of streams is disclosed in the Aquatic Ecosystems section.

Table 3-13. Wetland And Riparian Acres Affected By Rnas.

RNA	Alternative 1		Alternative2		Alternative 3		Alternative 4		Alternataive 6	
	Wetland	Riparian	Wetland	Riparian	Wetland	Riparian	Wetland	Riparian	Wetland	Riparian
Canyon City					1.4	33.1	1.4	33.1	1.4	33.1
Castle Creek BA							0.0	47.7	0.0	47.7
Cranberry Springs							0.0	124.4		
Fanny Boles					0.0	24.8	0.0	24.8	0.0	24.8
Geis Spring					0.2	75.2	0.2	75.2	0.2	75.2
Iron Mtn North							1.1	59.0		
Lemming Draw							0.7	162.2		
Pine Creek	0	79.4	0.0	79.4	0.0	79.4	0.0	79.4	0.0	79.4
Sand Creek							0.4	95.7		
Sheep Nose Mtn					1.5	96.4	1.5	96.4		
TOTAL:	0.0	79.4	0.0	79.4	3.1	308.9	5.3	797.1	1.6	259.4

Source: USDI Fish and Wildlife Service, 1995, National Wetlands Inventory (NWI), Black Hills NF GIS riparian coverage.

Alternative 4 would affect the most wetland and riparian habitat acres and Alternatives 1 and 2 the least. Wetlands and riparian habitat affected by RNA management may be on the RNA boundary or completely within the RNA. The benefits to wetland and riparian habitat that occurs on an RNA boundary, particularly along streams, are contingent on the site-specific management actions, for example the location of boundary fencing if needed to exclude livestock grazing or off-road recreational uses. The Sand Creek and Canyon City candidate RNAs have 0.4 and 1.4 acres of wetlands located on the proposed RNA boundary, respectively. The Canyon City, Cranberry Springs and Iron Mountain North candidate RNAs have riparian habitat along approximately 5.4, 8.2 and 0.7 miles of stream that form their boundaries.

3-2.3.3.3. Effects Of Fire-hazard And Insect-risk Management On Riparian And Wetland Ecosystems

Higher fire hazard implies a greater probability of wildfires, which would in turn imply a greater risk to riparian vegetation. The general location of wetlands and riparian areas in valley bottoms or depressions and wetter site conditions make them less prone to catastrophic fire, except under extreme conditions. Because riparian vegetation is generally more resistant to wildfire than other vegetation, it is likely that fires in riparian areas would be derived from fires in adjacent pine forest. All alternatives would achieve some measure of fire-hazard reduction by altering structural stages and restoring other less flammable vegetation types. Alternative 6 provides the greatest reduction of high or very high fire hazard followed by Alternative 3, Alternative 1, and Alternative 2. Alternative 4 provides the least improvement in reduced fire-hazard rating. See the Natural Disturbance Processes section for a detailed discussion of fire-hazard and insect-risk reduction.

Goals 10 and 11 were added in Alternatives 3, 4, and 6 to emphasize fire-hazard and-insect-risk reduction. Objective 10-01 manages for a low-to-moderate fire-hazard rating on 50 percent of the WUI in Alternative 3 and 4, except in certain management areas. Alternative 3 Objective 10-01 adds a 50-percent

moderate-to-low fire hazard throughout the forest as needed to conserve emphasis species, except certain management areas. Alternative 6 Objective 10-01 manages for a 50- to 75-percent low to moderate fire hazard in the WUI (including ARCs) and manages the remainder of the Forest for 50-percent low-to-moderate fire-hazard rating, except in certain management areas.

Fire-hazard management generally involves fuel-load reductions through silvicultural treatments and prescribed burns. These treatments require ground disturbance, which has the potential to indirectly affect riparian and wetland ecosystems primarily through changes in sediment loads to creeks or wetlands and the introduction or spread of noxious weeds. The larger the amount of ground disturbance and/or the closer proximity to wetland and riparian areas, the greater the potential for disturbed areas to be connected to the streams and riparian areas, and the greater potential to have an indirect impact to riparian and wetland habitats. Alternatives 1, 3, and 6 propose to treat the most acreage annually (Appendix B; **Table B-1**) for commercial timber harvest followed by Alternative 4 and 2.

Treatment acres of small diameter fuels and prescribed burning vary between alternatives (Appendix B; **Table B-1**). Alternative 6 proposes the most treatment acres, followed by Alternative 3, 1, 2, and 4. Non-commercial treatments are expected to have minimal adverse effect to wetland and aquatic resources, based on the assumption that no roads will be constructed for these treatments, that most of these treatments are done by human labor using hand tools or limited mechanized rubber-tired equipment, and that some of these small diameter treatment acres will overlap commercial treatment acres. Prescribed burning usually result in a low to moderate severity fire, which protects soil characteristics and allows for the rapid recovery of organic material and ground cover. This in combination with vegetative buffers, limits the potential for sediment input in wetlands and riparian areas.

Much of the WUI encompass riparian areas. This puts fire-hazard reduction treatments in closer proximity to riparian habitats. Treatments on NFS land in the WUI will generally occur within upslope ponderosa pine stands that are adjacent to but not within riparian areas, thereby avoiding the direct disturbance of riparian habitat.

Direct impacts to riparian and wetland ecosystems from fire-hazard management actions are mitigated under all alternatives. The following standards and guidelines are common to all alternatives and mitigate sediment impacts from roads and other management activities associated with fire-hazard and insect-risk management. Standard 1105 limits roads and other disturbed sites to the minimum feasible amount. Standard 1106 stabilizes and maintains roads and other disturbed sites during and after construction to control erosion. Standard 1109 requires the reclamation of roads and other disturbed sites when use ends to prevent resource damage. Standards 1113, 1114, and Guideline 1115 avoid and reduce sediment input due to roads, disturbed sites, and vegetation management associated with surface-water runoff.

Wildland fire prevention, suppression, and rehabilitation activities may result in ground disturbing activities within or affecting wetlands or riparian habitat. Fire-suppression activities may result in the need for heavy equipment, such as dozers or engines, to cross streams. Guideline 4102a protects streams, stream banks, shorelines, lakes, and associated vegetation from degradation by wildfire-suppression efforts by avoiding the use of earth-moving equipment in stream channels except at designated points and with proper mitigation. Guideline 4111 locates slash piles that are scheduled for burning out of meadows that contribute to Waters of the United States. These two guidelines are common to all alternatives. Alternative 2 treats these guidelines as standards.

However, the accidental escape of a prescribed burn could affect riparian and wetland areas in the vicinity. Potential adverse direct impacts from an escaped prescribed burn would likely be less than those of a wildfire because prescribed burning generally occurs in the winter or early spring when snow cover or ground moisture may protect riparian areas from high-severity burns.

3-2.3.4. Cumulative Effects

Cumulative effects to riparian and wetland ecosystems result from the incremental impact (direct and indirect effects) associated with the alternatives when added to past, present, and reasonably foreseeable actions. The cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Ecoregion as defined by Bailey (1995).

Under all alternatives, riparian and wetland habitat would be maintained. Varying opportunities for enhancement also exist. Natural events such as drought also influence the availability of isolated wetland habitat.

The composition, structure and pattern of riparian areas in the Black Hills have changed over the last 120 years due to a number of influences. Due to their location adjacent to streams and rivers, many of the riparian areas and wetlands found in the Black Hills are adapted to flooding disturbance. Other types of natural disturbances include fire and beaver. Fire stimulates regeneration in some species (e.g., aspen) and opens habitat for other earlier seral types (e.g., paper birch) (Marriott and Faber-Langendoen 2000b). A reduction of fire frequency may have an impact on riparian areas (USDA Forest Service 1996a).

Historically, beavers may have been the most important biological influence on Black Hills riparian ecosystems, particularly in low gradient drainages that supported an abundance of deciduous woody species (Parrish et al. 1996). In the Black Hills, it is believed riparian and wetland habitat has been reduced from its historical abundance due to the reduced number of beaver and the habitat associated with their dams. Beaver dams impounded water that increased the width of riparian zones, trapped sediment, and stored water that could extend water flows later into the summer months (Parrish et al. 1996). Beavers were heavily trapped in the Black Hills, and by 1888 beaver populations were low and restricted to remote portions of the Black Hills (Parrish et al. 1996). The drastic reduction in beaver activity has caused a lowering of alluvial water tables and subsequently a loss of woody plants that dependent on higher water tables or flooded conditions (Parrish et al. 1996).

Efforts to restore beaver would have an additive benefit to riparian and wetland ecosystems. Alternatives 3 and 6 propose the most hardwood restoration and the Alternative 3 the most riparian-shrub restoration. Alternatives 3 and 6 propose the most stream reaches for riparian rehabilitation. Accomplishment of these objectives would improve the amount and quality of riparian and wetland habitat on the Forest. The ecological benefits associated with increased beaver populations may be decades in the future because large-scale hardwood restoration will take time to achieve. Efforts to restore beaver may be constrained due to damage complaints on NFS and non-NFS lands that result in the removal of “problem” beaver.

Offsetting the decline of beaver-created riparian/wetland habitat somewhat has been the development of reservoirs and stock dams for recreational and water supply purposes and livestock watering. Many of the artificially constructed ponds on the Forest date back to the Civilian Conservation Corps era (1930 to 1940s) and have become shallower and more vegetated over time. This may provide better habitat for species that prefer drier sites and result in a habitat decline for more aquatic species.

Human-related influences on riparian habitats include mining within streams and floodplains; browsing by domestic livestock; road construction for vegetation management activities; a drop in the water table due to the trapping and removal of beaver from the ecosystem; a reduction of fire frequency as a result of fire suppression; vegetation disturbance from recreation activities; insect infestation of willow species and the clearing or spraying of willows for agricultural purposes (USDA Forest Service 1996a); dumping of mining, mill, and domestic effluent into streams; water diversions for milling and domestic uses; and draining wet meadows (Parrish et al. 1996). As a result, natural riparian habitat on the Forest is much less

abundant today (USDA Forest Service 1996a). A shift to drier species such as Kentucky bluegrass has taken place in several drainages (USDA Forest Service 1996a).

Private in-holdings occur frequently within riparian areas. These private lands provide suitable habitat, but conditions may have been altered by private land management activities, such as the removal of beaver dams or draining to convert to drier site conditions for subsequent haying. Fencing of stock ponds, protection of seeps/springs, and other efforts to improve riparian and wetland habitats would be a positive addition to existing habitat that may have been degraded on NFS or non-NFS lands. Private landowners may take action to reduce fire-hazard and insect-risk ratings on non-NFS lands.

Alternatives 3 and 6 would have the greatest cumulative benefit to riparian and wetlands because they target the most restoration of these ecosystem types. All alternatives provide similar cumulative protections to riparian and wetland ecosystems through the implementation of standards and guidelines, watershed conservation practices and BMPs.

3-2.4. Aquatic Ecosystems

3-2.4.1. Affected Environment

The 1996 Final EIS for the Black Hills National Forest LRMP (USDA Forest Service 1996a) addressed elements of the Forest aquatic ecosystems including fisheries (p. III-387 to III-394) and groundwater recharge, water yield, and stream flow regimes (p. III-37 to III-59). The conclusions of the 1996 Final EIS and new information are presented below.

Two major biological communities have been identified in the aquatic ecosystem of the Black Hills: lakes (reservoirs) and streams (USDA Forest Service 2001b). No natural lakes exist within the Forest (Stewart and Thilenius 1964); all are constructed reservoirs. Two thousand surface acres of reservoirs within the Black Hills exist (USDA Forest Service 1996a). Large reservoirs (more than 100 acres) and small lakes (fewer than 35 acres) are considered different habitats based on differences in water temperature, oxygen levels, and susceptibility to over-vegetation, sedimentation, and pollution (USDA Forest Service 2001b). Large reservoirs are usually deeper, have cooler temperatures during the summer, and are less vulnerable to pollution, sedimentation, and decreased oxygen levels. The 19 small lakes on the Forest are more prone to increases in temperature in the summer, excessive plant development, sedimentation, pollution, and decreased oxygen levels. Fisheries management for these lakes and streams is the jurisdiction of the states of Wyoming and South Dakota. The Forest Service has jurisdiction of water levels in and releases from Sheridan Reservoir whereas the U.S. Bureau of Reclamation has jurisdiction of Pactola and Deerfield reservoirs.

The Black Hills has a unique stream network characterized by geology, climate, and constructed reservoirs that determine the ability of each stream to maintain water flow (USDA Forest Service 2001b). There are approximately 880 miles of perennial streams within the Forest administrative boundary. The stream miles based on type and adjacent land ownership are shown in **Table 3-14**.

Table 3-14. Stream Mileage Within The Black Hills National Forest Administrative Boundary

Black Hills NF	Perennial	Intermittent	Total
NFS	478	2,992	3,470
Non-NFS	408	1,163	1,571
Total	886	4,155	5,041

Source: BHNF Streams GIS coverage.

The Madison Limestone and Minnelusa Formation are two geologic formations comprising the western portion of the Forest and a peripheral band that surrounds the Forest at lower elevations. Stream flow losses occur as streams cross these outcrops, known as the “loss zone.” During periods of base flow, most streams lose their entire flow when crossing these outcrops; only Rapid Creek and Whitewood Creek maintain perennial flows through the loss zone on the South Dakota portion of the Forest (Carter et al. 2002). Spearfish Creek would also maintain perennial flow under most conditions; however, flows are diverted around the loss zone for hydroelectric power generation (Carter et al. 2002). Many miles of Forest streams disappear during drought cycles.

The streams on the Forest provide a variety of habitats important for fish species. Riffles or pools provide areas for spawning, depending on species. Exposed tree root masses, undercut banks, boulders, aquatic plants, and large, woody debris such as logjams provide refuges for fish. Stream substrates range from mud and sand to gravel, cobbles, and boulders, each of which may be preferred by different fish species. Additional information on selected stream reaches is contained in the Wild and Scenic River Evaluation (USDA Forest Service 1996a Appendix D).

Over decades, base-level streams tend to move back and forth across a valley bottom, maintaining a constant channel depth and width, unless subjected to factors that affect the amount of sediment and water that the channel carries (USDA Forest Service 1996a). Grazing and urbanization are two of the many factors that can affect sediment and water flows (USDA Forest Service 1996a). The capacity of a stream to support aquatic life can be diminished by activities that encroach on stream width or depth, including sediment deposition, parallel road construction, and bridge or culvert placement (USDA Forest Service 1996a).

The construction of dams and diversion structures on the Forest has created habitat (large reservoirs) for fish species but has also fragmented existing stream populations. Those dams and diversion structures that are impassable prevent movement of fish during spawning and over wintering and also prevent the reestablishment of species in areas where unoccupied suitable habitat exists (Isaak et al. 2003). In addition, watershed divides and an intermittently dry stream network and warmer, turbid stream conditions downstream of the Forest limit the movement of coldwater fish species between major drainages (e.g. Rapid, Spring, or French Creeks).

Timber harvest, mining, introduction of livestock, and reduction of beaver may have altered stream flow and water yields, altering former riparian and channel conditions (USDA Forest Service 1996a). These factors may alter peak flows and decrease or eliminate perennial flow of some streams (USDA Forest Service 1996a). Beaver dams (or other small in-stream obstructions) increase the size and water-holding capacity of riparian areas and raise near-stream water tables (USDA Forest Service 1996a). Streams without beaver colonies produce high volume runoff during spring snow melt while areas with a complex of beaver dams and associated wet meadows tend to extend flows to later in the summer. Beaver complexes could essentially convert intermittent drainages to perennial flows (Parrish et al. 1996).

Other natural processes that affect aquatic ecosystems include fire and floods. Erosion after a high severity wildfire may provide an influx of sediment to streams with increased surface runoff as well as contribute large, woody debris to the aquatic ecosystem (Benda et al. 2003b). Other effects of fire may include decreased stream channel stability, alteration of water temperature regimes by removal of shade trees, increased nutrient availability, and more variable discharge (Dunham et al. 2003). Fish populations in small headwater streams may be less resilient to the effects of fire than fish populations in larger interconnected systems (Dunham et al. 2003).

Historically fish-species diversity was limited in the Black Hills, with native species including longnose dace, mountain sucker, white sucker, creek chub, fathead minnow, lake chub, longnose sucker, and finescale dace (USDA Forest Service 1996a, Isaak et al. 2003). **Table 3-15** below includes many fish species found in the Black Hills and their general habitat.

The following fish species were designated as Region 2 sensitive species: finescale dace, lake chub, mountain sucker, plains minnow, and sturgeon chub. Although plains minnow and sturgeon chub are not known to occur on the Forest, they may occur in the vicinity of the planning area, and indirect effects from USDA Forest Service management actions may occur. Region 2 sensitive species are discussed in detail in Appendix C.

Table 3-15. Fish Species General Habitat, Abundance, And Management In The Black Hills

Species	Black Hills Management	General Habitat	Abundance/ Population Trend
Black Crappie	Introduced, Game Fish	Large lakes, clear water, beds of aquatic vegetation	Fairly common in Pactola and Sheridan Lakes
Black Bullhead	Introduced, Game Fish	Lakes, clear to very turbid water in small ponds	If it occurs, possibly only in Stockade and Sheridan lakes
Brook Trout	Introduced, Game Fish (Stocked)	Cold, clear streams and lakes	Many creeks have self-sustaining populations; less common than brown trout
Brown Trout	Introduced, Game Fish (Stocked)	Cold, clear streams and lakes	No longer present in Sheridan Lake; widely stocked in Black Hills streams
Creek Chub	Native, Nongame	Mainly found in small clear streams	Has declined in several creeks since the 1980s; stable population on French Creek through the 1990s
Fathead Minnow	In SD, may not be native, Nongame	Slow flowing streams with weeds, shallow lakes and ponds	Present in Deerfield Reservoir in late 1990s; populations have decreased in several streams over the last 20-40 years
Finescale Dace	Native Nongame	Pools of boggy headwaters, creeks and small rivers, lakes and ponds, and often common in beaver ponds usually over silt and near vegetation.	Present in the Redwater Drainage. No occurrences on the SD portion of the Forest. Hemler Reservoir and artesian spring ponds off of the Forest primary populations.
Golden Shiner	Introduced, Nongame	Warm lakes and ponds, prefers moderate amounts of aquatic vegetation	Very few present in Pactola Reservoir; occurs in other lakes. Not present in SD creeks.
Green Sunfish	Introduced, Game Fish	Ponds, lakes and low flow rivers; warm water	Limited populations in a few creeks on the Forest; this fish may have negative impacts on game and native species
Kokanee Salmon	Introduced, Game Fish	Cold, clear lakes and reservoirs	Small number observed in Pactola Reservoir in 1990s
Lake Chub	Native, Nongame	Standing or flowing water, large or small bodies water; most common in gravel-bottomed pools and runs or streams and along rocky lake margins.	Historically more widespread and abundant, only persists in Deerfield Reservoir.
Lake Trout	Introduced, Game Fish	Cold, clear lakes	Stocked in Pactola Reservoir

Species	Black Hills Management	General Habitat	Abundance/ Population Trend
Largemouth Bass	Introduced, Game Fish	Larger lakes	Common in Pactola and Sheridan Lakes; rare in Rapid and Spring Creeks
Longnose Dace	Native, Nongame	Small and large cool to cold-water streams	Widespread and common in the Black Hills
Longnose Sucker	Native, State Threatened	Fairly small, clear, cold streams	Present on a few creeks in the 1990s; no records in Pactola Reservoir in late 1990s
Mountain Sucker	Native, Nongame	Rivers and streams, occurring most often in cool, clear mountain streams with moderate water velocities.	Occurs in most major drainages, localized distribution and abundance likely reduced from historic levels.
Northern Pike	Introduced, Game Fish	Lakes, ponds and slow flowing rivers with abundant aquatic vegetation; clear water	Occurs in almost all lakes in Black Hills; also found in Spring Creek
Rainbow Trout	Introduced, Game Fish (Stocked)	Variety of creeks and lakes; cool, clear lakes and cool swift perennial streams; rocky substrates, vegetated banks	Stocked in reservoirs and creeks; a few self-sustaining populations in Spearfish Creek
Rock Bass	Introduced, Game Fish	Found almost exclusively in larger lakes	Very common in Pactola and Sheridan Lakes
Smallmouth Bass	Introduced, Game Fish	Clear, clean water of lakes and impoundments; rivers/ streams with moderate current	Present in Stockade Lake, but not stocked since 1993.
Splake	Introduced, Game Fish	No information available	Found in Deerfield and Pactola reservoirs
Spottail Shiner	Introduced, Nongame	Large rivers and lakes; shallow water	Stocked in Pactola Reservoir in the early 1990s, present in 1997 but not in 1998
Stonecat	Introduced, Game Fish	Rivers and streams with rocky bottoms; prefers riffle areas	No longer occurs in SD
White Sucker	Native, Nongame	Variety of lake and stream habitats; small, cool creeks	Widespread in large and small lakes and streams
Yellow Perch	Introduced, Game Fish	Shallow waters of lakes and large ponds; clear, weedy creeks	Widespread in large and small lakes, localized in streams

Sources: USDA Forest Service 1996a, 2001b; Isaak et al. 2003; Neumann and Willis 1994; SDGFP-Lake Surveys (2002); SDGFP-Fisheries Database (April 14, 2005).

Trout, along with a number of other non-native fish, have been introduced into the Black Hills (USDA Forest Service 1996a). Several of the introduced species are no longer present in the Black Hills (USDA Forest Service 2001b) including the following: bluegill, cutthroat trout, emerald shiner, goldfish, rainbow smelt, and shorthead redhorse. Brook trout, brown trout, and rainbow trout are stocked in the streams and lakes of the Black Hills. Trout species tend to persist in streams with consistent flows but decline or are completely absent from other streams (USDA Forest Service 2001b). Native fish species tend to decline in years with high flow due to competition with trout but return during drought periods as trout decline (USDA Forest Service 2001b).

3-2.4.2. Resource Conservation Measures

Implementation of Forest Plan standards and guidelines and the Regional WCP Handbook (WCP Handbook, FSH 2509.25) and compliance with state BMPs conserve and enhance aquatic ecosystems on the Forest. The WCP Handbook contains proven watershed conservation practices to protect soil, aquatic, and riparian systems. The WCP Handbook covers five areas: hydrologic function, riparian areas, sediment control, soil productivity, and water purity. WCP Handbook standards are incorporated verbatim into all alternatives. Design criteria are specific ways to meet the WCP Handbook standard. If used properly, they meet or exceed state BMPs.

State BMPs are incorporated by reference as guidelines into all alternatives. These state BMPs include Forestry Best Management Practices for South Dakota (South Dakota 2003); Silviculture Best Management Practices (WY 2004); Hydrologic Function Best Management Practices (WY 1999); Grazing Best Management Practices (WY 1997); and Best Minerals Management Practices, as updated (USDA Forest Service 1985).

The following summarizes changes to aquatic-ecosystem management in the 1997 Revised LRMP being considered under the Phase II Amendment alternatives.

Objective 215 would target riparian rehabilitation projects for at least three stream reaches during the planning period under Alternatives 1, 2, and 4, but under Alternatives 3 and 6 would target riparian rehabilitation projects in at least five stream reaches. Riparian rehabilitation would generally be beneficial to aquatic habitat. No changes or additions were made to MA goals, objectives, standards, or guidelines relating to aquatic ecosystems.

Forest Plan standards and guidelines, WCP Handbook standards and design criteria, and State BMPs are too numerous to list in their entirety here. The most relevant ones are referenced in the effects analysis.

Aquatic ecosystem conditions are closely linked to floodplain/riparian areas and upslope areas. Resource conservation measures that maintain or improve riparian/wetland habitat or function will also benefit aquatic ecosystems. Measures that mitigate adverse impacts associated with upslope Connected Disturbed Areas (CDA) will also benefit the aquatic ecosystem.

3-2.4.3. Direct And Indirect Effects

The implementation of management activities to achieve Forest Plan goals and objectives may impact the physical, chemical, and biological components of aquatic ecosystems. These types of management activities are often associated with commodity extraction and/or production, such as logging, mining, grazing, dams/water diversions, but other less obvious activities, such as recreational use, noxious-weed treatment, and aquatic habitat enhancement itself, may also impact streams and lakes. Natural disturbances such as wildland fire and flooding can also have a major influence dependant on magnitude and severity.

Management activities may negatively impact aquatic ecosystems by reducing the quality, quantity, or connectivity of aquatic habitat, by disrupting natural ecological processes and by the direct injury or mortality of aquatic organisms. Some of these effects occur indirectly and are associated with activities in adjacent riparian and upslope areas, which are disclosed in the analysis pertinent to those ecosystems. Vegetation next to water bodies plays a major role in sustaining the long-term integrity of aquatic ecosystems. Values provided include shade; bank stability; fish cover; woody debris input; storage and release of sediment; surface-ground water interactions; and plant/animal habitat. Refer to the 3-2.3 Riparian and Wetlands Ecosystem discussion for interrelated effects.

Ground disturbing activities can cause water quality impacts by increasing sediment and nutrient concentrations in aquatic ecosystems. Most of the sediment and erosion that originate from forestry operations can be traced to roads and skid trails or log landings (Isaak et al. 2003, South Dakota 2003). Sediment is natural, but roads and other disturbed sites can act as channels that multiply sediment loads to the stream network during runoff events.

Gucinski et al. (2001) provide a synthesis of scientific information specific to the direct physical and ecological effects Forest roads cause. Roads may result in aquatic/riparian habitat loss due to floodplain encroachment or stream channel realignment. Unpaved road surfaces are a long-term source of sediment input. Roads may divert and concentrate surface flows, altering the normal runoff pattern and thereby transporting more sediment into streams, lakes, or wetlands. Poorly designed, installed, or maintained culverts may create barriers to fish passage; fragment aquatic habitat; and contribute sediment during their placement or removal or fill-material washout due to debris blockage or design-flow overages during high-flow events.

Within the Forest, there are approximately 900 locations where Forest system roads (levels 1 through 5) cross perennial streams. These crossings include fjords, bridges and culverts and the effects vary based on crossing type and site-specific conditions. There are an additional 6,500 road/stream crossings on intermittent or ephemeral channels. There are approximately 30 miles of Forest system roads in close proximity (within 30 feet) of perennial streams.

Increased sediment concentrations in water bodies can impact fisheries and other aquatic life. Increased amounts of sediments may infiltrate and degrade high quality spawning substrates or decrease the volume of pool habitats (Isaak et al. 2003). This may result in less successful spawning activity, a change in the macro invertebrate populations, or a change in the aquatic plant community (Gucinzki et al. 2001).

Additional information on the existing road network and its effects are described in Section 3-8.1 Recreation and Travel Opportunities. The road mileage targeted for construction, reconstruction, or obliteration by decade is identified in Objective 309, which is common to all alternatives. Implementation under Alternatives 1 and 2 for the 6-year period 1998 to 2003 shows that road reconstruction and obliteration and two-track obliteration is on schedule to meet the target if these activities continue at the same rate (USDA Forest Service 2004a). The rate of road construction would not meet the decade target; assuming road construction continues to occur at the same rate through the second half of the decade (only 18 percent of the total goal achieved through October 2003).

Management activities that result in ground disturbance have the potential to affect aquatic resources. These potential increases based on site-specific factors such as slope, soil types, proximity to water bodies, residual ground cover, revegetation, etc. Alternatives 1, 3 and 6 propose to treat the most acreage annually (Appendix B Table B-1) for commercial timber harvest followed by Alternatives 4 and 2. Activities such as prescribed burning, hardwood restoration, and pre-commercial thinning were assumed to use the road network serving commercial timber treatments. Treatment acres of small diameter fuels and prescribed burning vary between alternatives (Appendix B Table B-1). Alternative 6 proposes the

most treatment acres, followed by Alternatives 3, 1, 2 and 4. Non-commercial treatments and habitat restoration activities are expected to have minimal adverse effect to aquatic resources, based on the assumption that no roads will be constructed for these treatments, that most of these treatments are done by human labor using hand tools or limited mechanized rubber-tired equipment and that some of these small diameter treatment acres will overlap commercial treatment acres. Prescribed burning usually results in a low-to-moderate severity fire, which protects soil characteristics and allows for the rapid recovery of organic material and ground cover. This in combination with vegetative buffers, limits the potential for sediment input in aquatic ecosystems.

Road-related effects are dependant on site-specific conditions, such as slope, soil erodibility, proximity to water, vegetative buffers, etc. Impacts to aquatic ecosystems are likely to be less from road reconstruction than from new construction because the amount of new ground disturbance such as cut banks or loose fill is reduced. The detrimental aspect of road reconstruction is that many of the legacy roads follow drainage bottoms where construction was cheapest and easiest. Based on the past 6 years, road construction averaged a little over 9 miles per year and reconstruction averaged about 86 miles per year (USDA Forest Service 2004a), or approximately a 1:9 ratio of newly constructed to reconstructed miles.

Implementation of standards and guidelines, watershed conservation practices, and state BMPs mitigate these impacts at the project level but may not completely eliminate them. The WCP Handbook contains proven watershed conservation practices to protect soil, aquatic, and riparian systems. They are incorporated verbatim into Forest Plans as standards. Design criteria are specific ways to meet the WCP Handbook standards using current knowledge and technology. The state BMPs carry the same weight as guidelines. Proper implementation of the WCP Handbook practices meets the state BMPs.

The Forest completed an assessment of standards, guidelines, and BMPs to mitigate impacts of Forest-management activities (USDA Forest Service 2003e). The evaluation compared the effectiveness of BMPs to specific elements/functions, (i.e., buffer zones, erosion and sediment, flow regime, ground cover, water quality) relevant to the Black Hills and provided key literature citations to support the effectiveness determination. In summary, the implementation of BMPs and standards and guidelines on the Forest will be as effective or more effective at preventing erosion, sediment delivery, and flow regime changes as those studied in the literature because of the less erodible soil types, the seasonal rainfall pattern, and the gentler topography existing here.

The following standards and guidelines are common to all alternatives and mitigate sediment impacts from roads and other management activities. Standard 1105 limits roads and other disturbed sites to the minimum feasible amount. Standard 1106 stabilizes and maintains roads and other disturbed sites during and after construction to control erosion. Standard 1109 requires the reclamation of roads and other disturbed sites when use ends to prevent resource damage. Standards 1113, 1114, and Guideline 1115 avoid and reduce sediment input due to roads, disturbed sites, and vegetation management associated with surface-water runoff. Standard 1203 (WCP Handbook Standard 4) requires that all stream crossings and other in-stream structures be designed and constructed to provide for passage of flow and sediment, withstand expected flood flows, and allow free movement of resident aquatic life.

In Alternative 1, 2, and 4, Guideline 3107a/b avoids diverting stream flow from the current channel and installs sediment control features to prevent storm runoff from washing silt into streams or wetlands during trail, road, and highway construction. In Alternatives 3 and 6, these guidelines are incorporated into Guideline 3106, and additional mitigation is added to allow passage of aquatic life and to consider the needs of sensitive species in the timing, placement, and installation of temporary stream diversions.

MA direction in selected categories avoids and minimizes impacts to aquatic ecosystems through the restriction or prohibition of selected activities, such as road construction or use and off-road motor

vehicle travel. Roads and off-road travel are prohibited in the Wilderness (the Wilderness) (MA 1.1A). The headwaters of Grizzly Bear, Iron Creek, Nelson, and Pine creeks originate in the Wilderness. In late-successional Forest landscapes (MA 3.7), timber harvest is minimal, off-road motorized use is prohibited, and on-road motorized vehicles are restricted. These late-successional MAs provide some upslope protection to adjacent streams. Spearfish Canyon (MA 4.2A) encompasses approximately 20 miles of Spearfish Creek. Minimal timber harvest is allowed. Off-road vehicle use and grazing is restricted. The scenic byway (Hwy 14A) is a paved, high-traffic travel route especially in the summer. Adequate drainage and erosion control minimize any road related impacts to Spearfish Creek. Off-road motorized travel is prohibited and on-road motorized travel is limited to administrative access in MA 8.2 - Developed Recreation Complexes. The primary aquatic ecosystems protected include Deerfield, Sheridan, and Pactola Reservoirs, Bismark, Cook and Roubaix Lakes and the Cascade Complex. This protects over 80 percent of the lentic (standing water) habitat on the Forest. Additional area and road closures, both seasonal and yearlong, are implemented at the project level for resource protection, including water quality.

Other management activities may result in sediment input to aquatic ecosystems. Sediment delivery to streams can increase when livestock collapse stream banks and remove riparian vegetation that maintains structural integrity (Isaak et al. 2003). The end result is that in-stream habitats can become structurally less diverse while physiochemical parameters such as temperatures, dissolved oxygen, or discharges may be more variable (Isaak et al. 2003).

Improper livestock grazing can have numerous adverse affects on aquatic ecosystems including water quality degradation, loss of stream bank vegetation and stability, and subsequent detrimental changes in channel morphology (USDA Forest Service 1996a). The level of livestock use will remain constant across the range of alternatives (Objective 301a, 128,000 Animal Unit Months).

Objective 200-03, under Alternatives 3 and 4 protects aquatic and shoreline vegetation around 50 ponds or water catchments over the life of the Plan. In Alternative 6, this objective protects aquatic, shoreline and upland vegetation around ponds or water catchments containing leopard frogs. Standard 1304 opportunistically re-locates or implements mitigation measures for water tanks or water catchments located in the water influence zone. Measures to maintain proper use or residual levels of vegetative cover promote bank stability adjacent to aquatic habitats and maintain the filtering function of riparian areas adjacent to water (Guidelines 2505 and 2506). Guideline 2505c limits the utilization of willows and other deciduous vegetation to 40 percent. This guideline becomes a standard in Alternatives 3 and 6 and is treated as a standard in Alternatives 2 and 4. Guideline 2505d removes livestock from the grazing unit or allotment when further utilization exceeds proper use or residual levels. Impacts from livestock grazing in fenced riparian pastures are mitigated through Guidelines 2507 and 2508.

A variety of mining activities occurs within the Forest-administrative boundary, ranging from recreational gold panning and sluicing to open-pit mines with either heap-leach or conventional milling to recover precious metals or minerals. The exploration, extraction, or processing of these metals or minerals may have direct or indirect effects on aquatic ecosystems (USDA Forest Service 1996a). Standard 1511 allows recreational panning and sluicing outside of the Wilderness with some caveats. The impact from this activity is estimated to be low given the labor-intensive nature of this activity and the seasonal and isolated occurrence of this practice. The impacts of suction dredging (recreational gold mining) on the

Wyoming portion of the Forest are minimized by hydrologic modification BMP 10 (WY 1999) that restricts equipment type and size and the spill of pollutants. Standard 1505 and guidelines 1506, 1507, and 1508 minimize disturbance to riparian areas by mineral activities and by requiring monitoring of mitigation measures to ensure effectiveness. The discharge of new pollutant sources is mitigated by standards 1211, 1212, and 1213 (see discussion below).

Wildland-fire prevention, suppression, and rehabilitation activities may result in ground-disturbing activities that indirectly contribute sediment, including ash, into aquatic ecosystems. Fire-suppression activities may result in the need for heavy equipment, such as dozers or engines, to cross-streams. Guideline 4102a protects streams, stream banks, shorelines, lakes, and associated vegetation from degradation by wildfire-suppression efforts by avoiding the use of earth-moving equipment in stream channels except at designated points and with proper mitigation. Guideline 4111 locates slash piles that are scheduled for burning out of meadows that contribute to Waters of the United States. These two guidelines are common to all alternatives. Alternative 2 treats these guidelines as standards.

Prescribed fire may have adverse effects if the removal or reduction of ground cover results in increased sediment input into aquatic habitats. Prescribed fire could positively affect aquatic ecosystems if the controlled removal of riparian vegetation increases stream productivity by allowing more solar insulation, stimulating production, and increasing available food resources (Isaak et al. 2003). The killing of trees in riparian areas by fire may also increase the addition of large woody debris to the stream system. The removal of pine may stimulate the growth of aspen, cottonwoods, and willows. All alternatives strive to maintain and improve riparian condition that would be beneficial to fisheries.

The application or release of chemicals or pollutants may adversely impact aquatic ecosystems. Examples include treatment for noxious-weed control or fire-retardant release during fire-suppression efforts. These impacts are mitigated by the following standards and guidelines. Standards 1211, 1212, and 1213 require the placement of new chemical and pathogenic pollutants where they will not reach surface or groundwater, require the application of runoff controls to disconnect new pollutant sources from surface and ground water, and require the application of chemical agents using methods to minimize the risk of entry to surface and ground water, respectively. These three standards are common to all alternatives. In all alternatives, Standard 4308 requires the use of buffers around water sources, lakes, wetlands, and streams to keep concentrations of chemical agents in the water well below those harmful to drinking, irrigation, aquatic life, and non-target vegetation. The treatment of individual plants with aquatic-labeled chemical agents may occur in buffers. Specific to fire-suppression efforts, Guideline 4102b discourages the use of fire-retardant chemicals over riparian areas, wetlands, and open waters, and avoids applications in these areas in the Wilderness in Alternatives 1, 3, 4, and 6. This guideline is treated as a standard in Alternative 2.

Recreational activities may result in impacts to aquatic ecosystems. Several examples include dispersed camping, fishing, trail crossings, and off-highway vehicle (OHV) use. Guideline 5301, common to all alternatives, discourages dispersed camping within a minimum of 100 feet from lakes and streams unless exceptions are justified by terrain. The non-motorized trail system may result in connected disturbed areas at low-water stream crossings where foot, horse, or bicycle traffic crosses. At the landscape level, this impact is greatly reduced compared to system roads because they affect the physical environment and hydrologic process, such as surface-water concentration and diversion, at a greatly reduced level. Some trail crossings, such as those that receive frequent, high volume traffic during the summer tourist season (June – August), may result in localized sediment input and stream bank/channel degradation. Standard 1304 provides for the relocation or implementation of mitigation measures for trails within the Water Influence Zone as opportunities arise and the need dictates.

Current levels of OHV use have increased approximately 6 percent since 1998 (USDA Forest Service 2004a). Direct impacts from OHV use are bank destabilization, sediment mobilization, and channel widening at stream crossings. Alternative 1, Guideline 9107 prohibits land vehicles from entering perennial streams where resource damage would occur except at specified points. This guideline is treated as a standard in Alternatives 2 and 4 and becomes a standard in Alternatives 3 and 6. Indirect effects may result from increased sediment input from riparian and upslope ground disturbance.

The miles of motorized and non-motorized trails constructed or reconstructed (Objective 416) and the amount of off-road travel opportunities (Objective 422) are the same for all alternatives.

The demand and management emphasis (Executive Order 12962 –Recreational Fisheries) to provide for recreational fishing opportunities may impact aquatic ecosystems. All game fish species on the Forest are non-native species, some introduced illegally. These non-native species can impact aquatic ecosystems by preying upon and competing with native species for forage and habitat. Recreational fishing has the obvious direct impact on game fish due to the harvest of these species. Incidental bycatch of native species, which are primarily suckers, dace and chubs, is probably negligible because of angler preferences for game species.

In-water activities may directly affect aquatic species. The dredging or filling of waters of the U.S. may kill or injure aquatic species. Examples include bridge or culvert installation or replacement, stream bank stabilization, or pond/lake dredging. Generally, species viability will not be at risk because the area impacted is small, the rate at which in-water activities proceed allows mobile species such as fish to escape the disturbance area, and the timing usually coincides with late-summer low flows that have the minimum overlap with fish and amphibian reproductive seasons when eggs or larvae are vulnerable. In the case of pond dredging where complete dewatering occurs, aquatic species may be lost unless salvage activities occur to capture and transplant these species or unless fish or other aquatic species move upstream or downstream to available habitat during water withdrawal. Habitat loss is usually short-term because snowmelt or spring rains refill the pond.

Inventory and monitoring activities may directly kill or injure aquatic species, especially fish population surveys that use sampling gear that is lethal, such as gillnets or electro fishing, as well as the stress induced during general anesthesia and handling for data collection. These activities have a low risk to species viability because the areas sampled are small compared to the available occupied habitat and the sampling is infrequent (once per year at most) and short-term (a matter of hours usually). Monitoring has the long-term positive effect to species viability because it provides a feedback mechanism to adjust management activities for the species' benefit.

Direct effects to aquatic organisms are mitigated by Guideline 9107 that prohibits land vehicles from entering perennial streams where resource damage would occur except to cross at specified points. This is a guideline in Alternative 1; it is a guideline treated as a standard in Alternatives 2 and 4 but becomes a standard in Alternatives 3 and 6. Design criteria of WCP Handbook Standard 3 (LRMP Standard 1301) expands on this to "keep heavy equipment out of streams, swales, and lakes, except to cross at designated points, build crossings, or do restoration work, or if protected by at least 1 foot of packed snow or 2 inches of frozen soil. Keep heavy equipment out of streams during fish spawning, incubation, and emergence periods."

Large, woody debris (≥ 1.0-1.5 m long; >10 cm diameter) plays an important ecological function in aquatic ecosystems. Large wood can be an important source of cover and habitat complexity for aquatic species and removing wood from streams typically results in less pool habitat and fewer and smaller fish. (Dolloff and Warren 2003). Selective harvest of pines in riparian areas, however, can promote the growth of riparian vegetation, benefiting aquatic species (Isaak et al. 2003).

The recuitment and retention of large wood in lakes and streams is provided for across the range of alternatives. Wood recruitment processes include tree mortality in adjacent riparian areas, tree toppling from bank erosion, or wind throw and fire (Benda et al. 2003a). Guideline 2307 leaves large, woody debris on harvested or thinned sites primarily for terrestrial benefits. Recruitment of this material into lakes and streams may be limited due to its upslope location. Guideline 3212b retains woody vegetation along streams and lakes to provide shading for aquatic life and habitat for terrestrial species. This promotes the recruitment of large wood into streams and lakes. Guideline 1204 prohibits the removal of naturally occurring debris from stream channels unless it is a threat to life, property, important resource values, or otherwise covered by legal agreement. Guideline 1205 retains natural and beneficial volumes of large, woody debris for fish habitat, stream energy dissipation, and as source of organic matter for the stream ecosystem when projects are implemented that can affect large, woody debris. Guideline 3212c provides large woody material for aquatic life. These guidelines are common to all alternatives with the caveat that Alternative 2 treats these three guidelines as standards.

Opportunities for stream or lake habitat enhancement projects exist under all alternatives. Enhancement projects may have short-term adverse impacts to water quality due to in-water work activities that mobilize sediments. Objective 219 maintains or improves in-stream fisheries habitat. Objective 222 identifies structural and non-structural aquatic habitat improvements. Guideline 3213, common to all alternatives, includes consideration of lake and pond dredging as potential aquatic habitat enhancement projects. Implementation of aquatic habitat enhancement projects are likely to proceed at similar or possibly reduced levels during the planning period for all alternatives given the National, Regional, and Forest-level prioritization of vegetation treatments to reduce the fire hazard and insect-and-disease risk.

Objective 106 and Standard 1207 (WCP Handbook Standard 8) directs management of water-use facilities to prevent gully erosion of slopes and to prevent sediment and bank damage to streams. Associated WCP Handbook design criteria avoids the flushing or deposition of sediment from behind diversion structures into the stream below and further states that sediment should be deposited in a designated upland site. This avoids long-term stream damage resulting from inadequate stream capacity to transport the added sediment. Permit requirements to meet state water quality standards and the Clean Water Act also mitigate these impacts.

Beaver and their dams play a vital role in maintaining and diversifying stream and riparian habitat (Pollock et al. 2003). A complex of beaver dams with associated wet meadow soils and vegetation function like a sponge, discharging lower volumes in the spring and, especially in small streams, extending flows to later in the summer (Parrish et al. 1996). Sections of streams impounded by beaver dams are often more productive than unimpounded reaches in both the number and size of fish as well as the diversity or biomass of other taxa, such as birds, mammals, amphibians, plants and insects (Pollock et al. 2003). Beaver dams dissipate stream energy and attenuate peak flows (Pollock et al. 2003). Most studies support the contention that pond habitat formed by beaver ponds is beneficial to many fishes and that species regularly cross beaver dams in both upstream and downstream directions though they may pose a seasonal barrier (Pollock et al. 2003). Wydoski and Wydoski (2002) report a beaver dam impeded the migration of mountain sucker farther upstream in a Utah stream during the spawning season (mid-June).

Increased suitable habitat that leads to an increase in beaver numbers and distribution would benefit aquatic ecosystems and may increase the mileage and/or the duration of flow in the stream network. These assumed benefits would be greatest in Alternatives 3 and 6 because they restore the most aspen and the focus is in riparian areas (Objective 201).

3-2.4.3.1. Effects Of Species-viability Management On Aquatic Ecosystems

The most direct effect will be through the site-specific implementation of standards and guidelines, watershed conservation practices, and state BMPs at the project-level to conserve and protect this ecosystem.

Attaining objectives associated with species viability will also improve aquatic ecosystems. Objective 215 would implement riparian rehabilitation projects in at least three stream reaches (Alternatives 1, 2, and 4) or at least five stream reaches (Alternatives 3 and 6) over the life of the Plan. Riparian rehabilitation would moderate peak flows, reduce soil erosion leading to sedimentation in the stream, and provide shade that would reduce stream temperatures. In the long-term (after 10 years), stream banks would stabilize and vegetation would develop along stream edges, creating habitat for species such as beaver that could help develop and maintain perennial stream flows. These conditions would favor native species in nonstocked streams that have no introduced species and provide better habitat for fish in stocked streams. Native fish species, however, might need to be re-introduced to these streams if barriers interfere with the free movement of fish from existing streams.

Efforts to increase the hardwood acreage Forest-wide, primarily in Alternatives 3 and 6, to support more beaver would benefit aquatic ecosystems given their ecological role in storing water and prolonging stream flows through the construction of their dams.

3-2.4.3.2. Effects Of Research Natural Area Management On Aquatic Ecosystems

The designation of RNAs may benefit aquatic ecosystems because of the restriction or possible reduction of activities (mineral extraction, motorized or mechanized travel, public access) permitted in these areas (see standards and guidelines for MA 2.2). This benefit may not be great because one of the goals of the RNA program is to select RNAs in areas where conflicts with existing land uses are limited (USDA Forest Service 1997b). All alternatives include the existing Upper Pine Creek RNA located in the Black Elk Wilderness. Approximately 3.4 miles of Pine Creek and Grizzly Bear Creek are completely within this RNA. Recreational use of this area will be discouraged, no managed trails exist or will be built through the area, and it is designated unsuitable and closed to livestock grazing (USDA Forest Service 2001c).

The designation of RNAs in Alternatives 3, 4, and 6 would result in additional management limitations within or adjacent to aquatic ecosystems. Alternative 3 proposes the designation of 4 additional RNAs that include approximately 10.1 miles of streams within the candidate RNAs and 5.4 miles of stream that form the boundary of RNAs. Alternative 4 proposes the designation of 9 additional RNAs that include approximately 26.3 miles of streams within the candidate RNAs and 14.4 miles of stream that form the boundary of the RNAs. Alternative 6 proposes the designation of 4 additional RNAs that include approximately 5.2 miles of streams within those candidate RNAs and 5.4 miles of stream that form the boundary of the RNAs.

Designation of RNAs under Alternative 4 that represents the highest stream mileage affected. Stream mileage within the Castle Creek candidate RNA already receive some additional protections due to this area's current designation as a Botanical Area (MA 3.1). Benefits to streams that form the boundary of an RNA would be less than streams completely within the RNA because management activities would not be as restricted on both sides of the stream. Under Alternatives 3, 4, and 6, Guideline 2.2-4201 controls populations of invasive, non-native species using measures that minimize threats to native species. The Geis Springs RNA and the North Fork Castle Creek Botanical Area RNA have the potential to benefit

the finescale dace and the mountain sucker, respectively. Both species are Region 2 sensitive fish species that have been documented downstream of these candidate RNAs. Benefits to these two species from RNA designation is likely to be immeasurable because these two RNAs comprise such a small percentage of their watersheds, and future restrictions on current management activities are not likely to have an appreciable effect on these species' habitat.

The designation of RNAs may preclude habitat restoration efforts that benefit aquatic ecosystems. Management activities designed to increase hardwood production on other areas of the Forest would not likely occur in RNAs, contingent on site suitability. In the absence of disturbance, hardwood communities in RNAs would be expected to decrease due to natural succession to spruce and ponderosa pine. The decline or disappearance of hardwood communities would discourage establishment of beaver in RNAs.

3-2.4.3.3. Effects Of Fire-hazard And Insect-risk Management On Aquatic Ecosystems

Reiman et al. (2005) discuss the implications of changing fire regimes for aquatic ecosystems. In the context of aquatic communities and native fishes, fire has an important influence on the structure and condition of habitats and can dramatically influence the dynamics of individual populations. Changing fire regimes and the potential for larger more disruptive fires may threaten the loss of aquatic habitat diversity and lead to accelerated extinction of some vulnerable populations. A simple focus on managing fuels, however, may not address the role of fire or the primary threats to the persistence of many species. Many species, like the fishes found in the mountain streams of the west, are actually adapted to and even dependent on disturbances like fire to maintain a diversity of habitats necessary to sustain spatially diverse and productive populations. Managing fuels and restoring more natural fire regimes will not remove other threats to aquatic species such as habitat fragmentation or loss. Additional management for fire-hazard and insect-risk reduction could further disrupt habitat if not done mindfully, for example by introducing chronic road derived sediments and creating barriers to fish migration.

Goals 10 and 11, and associated objectives, standards and guidelines, were added in Alternatives 3, 4, and 6 to emphasize fire-hazard and insect-risk reduction. Objective 10-01 manages for a moderate-to-low fire-hazard rating on 50 percent of the WUI. ARCs are included in the WUI in Alternative 4, except in certain management areas. In Alternative 3, this objective includes managing for a 50-percent moderate-to-low fire-hazard rating in the WUI (ARCs are included in the WUI) and throughout the Forest as needed to conserve emphasis species, except certain management areas. Alternative 6 manages for a 50- to 75-percent low-to-moderate fire-hazard rating in the WUI (ARCs and adjacent to non-NFS land are included in the WUI) and manages the remainder of the Forest for 50-percent low-to moderate fire-hazard rating, except in certain management areas.

Although high levels of fire hazard and insect risk would not impact aquatic ecosystems directly, activities to reduce fire hazard and insect risk could. The methods used to reduce these risks include timber harvest, prescribed fire, and thinning. In addition, fire-suppression activities can adversely affect surface-water quality through ground disturbance, stream bank instability, loss of riparian vegetation, and fire-retardant entering streams. The larger the amount of ground disturbance and/or the closer the proximity to aquatic ecosystems, the greater the potential for disturbed areas to be connected to the streams and riparian areas, and the greater the potential to have an indirect impact to aquatic ecosystems. Alternatives 1, 3 and 6 propose to treat the most acreage annually (Appendix B Table B-1) for commercial timber harvest followed by Alternatives 4 and 2.

Treatment acres of small diameter fuels and prescribed burning vary between alternatives (Appendix B; Table B-1). Alternative 6 proposes the most treatment acres, followed by Alternative 3, 1, 2 and 4. Non-commercial treatments are expected to have minimal adverse effect to aquatic ecosystems, based on the assumption that no roads will be constructed for these treatments, that most of these treatments are done by human labor using hand tools or limited mechanized rubber-tired equipment and that some of the small diameter treatment acres will overlap commercial treatment acres. Prescribed burning usually result in a low to moderate severity fire, which protects soil characteristics and allows for the rapid recovery of organic material and ground cover. This in combination with vegetative buffers, limits the potential for sediment input into aquatic ecosystems.

Much of the WUI encompass streams and floodplains. This puts fire-hazard reduction treatments in closer proximity to streams. Treatments on NFS land in the WUI will generally occur within upslope ponderosa pine stands that are adjacent to but not within riparian areas, thereby avoiding the direct disturbance of riparian habitat. This generally results in adequate vegetative buffers to trap and filter upslope sediments prior to entering the stream network or other water bodies.

Fire-management practices affect fire hazard, and hence the potential for changes in fire severity or frequency. With high levels of high fire-hazard acreage, there is a higher probability that a wildfire could adversely affect aquatic habitat. Wildfire is more likely to be detrimental to aquatic systems, at least on a short-term (less than 5-year) basis. As discussed in the 1996 Final EIS, loss of vegetation due to fire can have a significant effect on runoff. Fires on the Forest contribute to increased runoff, soil loss, and subsequently, to changes in surface water quality. A reduction in fire hazard positively affects surface water quality by minimizing the occurrence of such processes. Wildfire may promote the recruitment of large wood to streams, providing more diverse aquatic habitat, but this possibility is reduced in Alternatives 3 and 6 that allow the salvage of some dead trees post-wildfire (Objective 11-03).

Alternative 6 provides the greatest reduction of high or very high fire hazard followed by Alternative 3, Alternative 1, and Alternative 2. Alternative 4 provides the least improvement in reduced fire-hazard rating. See the Section 3-7 Natural Disturbance Processes for a detailed discussion of fire-hazard and insect-risk reduction.

3-2.4.4. Cumulative Effects

Cumulative effects to the aquatic ecosystem result from the incremental impact (direct and indirect effects) associated with the alternatives when added to past, present, and reasonably foreseeable actions. This may affect the quality/quantity, function and connectivity of aquatic ecosystems. The cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The cumulative effects analysis area is bounded in space as the fourth level watersheds that encompass the Forest. This equates to the headwaters of the Belle Fourche and Cheyenne rivers, and their associated tributaries, downstream to their confluence. This bounding was determined because effects to water quality or quantity from Forest Service activities may extend downstream of the Forest boundary but become negligible at a downstream point due to the underlying Black Hills geology and the overriding effects of other non-Forest activities in an ever-increasing watershed scale.

All alternatives generally maintain or enhance aquatic ecosystems through the implementation of resource conservation measures. These measures may not completely avoid adverse effects from management activities, so some additive incremental impact may occur that will be cumulative to past, present and future activities. The resource conservation measures under all alternatives attempt to avoid long-term, irreversible adverse effects.

The Black Hills have been subjected to extensive development and disturbance from human activities following the discovery of gold in 1874. Mining activities have altered aquatic habitat and may be a contaminant source affecting water quality depending on the material being mined and the process for extraction/separation. Commercial streamside placer mining activities are no longer a significant source of water quality problems in Black Hills streams (SDDENR 2004b). Additional cumulative effects from mining are described in the 3-14.3 Water Resources section.

Other activities have resulted in permanent infrastructure with long-lasting effects, such as dams and roads. Additional regulatory protection stemming from the environmental movement of the 1960s and 1970s has resulted in improved conditions to the aquatic ecosystem. Natural events, such as floods, drought, and wildfire, have and will continue to affect the aquatic ecosystem. Aquatic ecosystem management is affected by the demand for recreational activities. The increasing human population combined with a higher standard of living and more leisure time results in increased recreational activity on the Forest. These activities include fishing for non-native game species and OHV use.

Some management activities cause direct or indirect impacts to the aquatic ecosystem. Implementation of standards and guidelines, watershed conservation practices (FSH 2509.25), and state BMPs mitigate these impacts but may not completely eliminate them. Remaining impacts, though greatly reduced, are additive to similar activities that occur on non-NFS lands within or adjacent to the Forest and natural disturbance events (drought, floods, wildfire). This additive increment is reduced to levels that allow streams to maintain their dynamic equilibrium (the continual adjustment of land-and-stream forms and processes within a natural range of conditions, interrupted only by extreme disturbance events).

Sediment input or mobilization resulting from all alternatives is additive to sediment resulting from natural erosional processes and other non-NFS activities. This additive sediment input, though transported by the stream, will be deposited along with other sediments into ponds, lakes and reservoirs, shortening the design life of those impoundments and accelerating the rate of eutrophication (increased plant biomass with a loss of water depth and clarity over time). Eutrophication will alter aquatic habitat conditions that may favor some species (e.g., frogs) to the detriment of others (e.g., trout). Guideline 3213, common to all alternatives, includes dredging lakes and ponds among potential aquatic restoration projects when appropriate and cost-effective to enhance or maintain this resource, but this is effort is unlikely to maintain this aquatic habitat given the large number of small ponds, most created in the 1930s and 1940s, and the current and future funding and priority level.

Hardwood restoration and the management emphasis to increase beaver and their beneficial ecological role in aquatic ecosystems will have a positive additive impact if the duration, volume, or miles of stream habitat is increased. These benefits may be reduced if wildlife damage control efforts to reduce or eliminate “problem” beaver causing damage or harm occur on private or NFS lands.

Stream connectivity is an important aspect of stream networks because it allows for the transport of sediment through the system and the passage of fish and other aquatic organisms to maintain their distribution. The construction of dams and diversion structures since European settlement has fragmented stream habitats and prevented the types of stream movements many stream fishes make in association with spawning, over wintering, or refounding extirpated populations (Isaak et al. 2003). These human-created impoundments are not entirely negative because they have added standing water habitat that is naturally lacking on the Forest.

Existing barriers, such as dams, culverts, in-stream habitat structures that may impede the passage of aquatic organisms will persist on NFS and non-NFS lands. Natural factors, such as drought, will continue to fragment habitat on a variable basis and the underlying geology disrupts stream connectivity at the “loss zone” within or surrounding the Forest. None of the alternatives would further fragment stream

habitat above existing conditions because Standard 1203 requires that all stream crossings and in-stream structures be designed and constructed to provide for the passage of flow and sediment and to allow free movement of resident aquatic life. All alternatives have the potential to improve stream connectivity by removing existing in-stream barriers as part of general road system improvements or as connected actions to vegetation management treatments. The level of road construction, reconstruction, and road and two-track obliteration (Objective 309) is the same for all alternatives. Management emphasis to create conditions favorable for beaver may result in additional beaver dams. No study has demonstrated a detrimental population-level effect of dams on salmonids, nor has a study shown that beaver dams are more than a seasonal barrier to fish movement (Polleck et al. 2003).

Drought conditions may favor the persistence of native over non-native species because native fish have adapted to those conditions and may survive better than non-native fish that have not. This adaptive advantage favoring native species may be limited if aquatic habitat is fragmented by impassable barriers and the expansion into unoccupied suitable habitat is blocked.

Projected global warming could have a profound effect on the distribution of many aquatic species (Isaak et al. 2003). Increases in air temperature are likely to result in an increase in stream temperatures, which may reduce the amount of suitable stream habitat. Most often this shift will entail decreased fish abundance in downstream habitats that have become too warm and increased abundance in cooler upstream areas (Isaak et al. 2003). Management activities that maintain or improve stream flows or water temperatures would have a positive effect on aquatic ecosystems. Meeting Forest Plan objectives, standards, and guidelines is intended to avoid those physical barriers or water quality degradations that would have a negative incremental impact additive to the effects of global warming that may further reduce or fragment aquatic ecosystems, primarily streams.

The diatom *Didymosphenia geminata*, a single-celled algae, was first documented in Rapid Creek near Johnson Siding in 2002. Since then its abundance has increased and its distribution has been documented as more widespread, including upstream of Pactola Dam. The increase in the diatom has corresponded with a decrease in the wild brown trout fishery below Pactola Dam, though a cause-and-effect relationship has not been proven. Studies are being initiated to determine the effects of the algae on stream habitat and aquatic organisms.

The illegal or legal stocking or introduction of non-native aquatic species may adversely impact aquatic ecosystems. The illegal introduction of rock bass and largemouth bass into Deerfield Reservoir may be detrimental to native fish, such as the lake chub (Isaak et al. 2003). Indirectly, the system of Forest roads allows easy access for the illegal or incidental introduction of aquatic species into lakes and streams. The extent of the effect may be limited due to the stream fragmentation caused by natural or human-constructed barriers. Some non-native species may be adapted to only survive in standing water habitat (ponds, lakes, reservoirs), thereby limiting their expansion into unsuitable stream habitat. The opposite may apply to stream-adapted aquatic species.

Both South Dakota and Wyoming stock trout in Forest reservoirs and streams for recreational fishing. None of the Phase II alternatives directly increase the current stocking levels of desirable non-native aquatic species, such as trout. While stocking does not directly affect aquatic habitat, it may decrease native fish populations in lakes and perennial streams if non-native species prey upon or compete with native species for limited resources, such as food or cover. The diet of larger trout (> 250 mm; 9.8 inches) may include an increased percentage of other fish (Isaak et al. 2003).

Executive Order 12962 directs federal agencies to provide quality recreational fishing opportunities through habitat restoration, access, and education. Habitat enhancement projects that maintain or improve aquatic habitat, such as to tailwater fisheries below major reservoirs, may promote habitat conditions more favorable for non-native species. This may increase the level of predation on or competition with native fish species.

Alternatives 3 and 6 would have the greatest cumulative benefit to aquatic ecosystems because they target the most stream reach restoration. All alternatives provide similar cumulative protections to aquatic ecosystems through the implementation of standards and guidelines, watershed conservation practices and BMPs.

3-2.5. Cave Ecosystems

3-2.5.1. Affected Environment

The Final EIS for the 1997 Revised LRMP presents information on cave resources of the Black Hills region (USDA Forest Service 1996a p. III-97-98). The Final EIS defines caves as "… any naturally occurring void, cavity, recess, or system of interconnecting passages beneath the surface of the earth or within a cliff or ledge, whether the entrance is naturally formed or excavated by people." Abiotic attributes of cave resources, including cultural, mineral, paleontologic, geologic, and hydrologic resources, are not expected to change under Phase II Amendment alternatives. Biological resources within cave ecosystems, specifically bats and their habitats, may be affected by management actions outlined in the Phase II Amendment and are the focus of this discussion and analysis.

Caves are important to bat species of the Forest by providing cover during hibernation, roosting, and reproduction. Eight of the 11 bat species known to occur on the Forest depend on underground roosting sites during some time of the year (Tigner and Dowd Stukel 2003). Suitable shelter is a limiting factor to the persistence of many bat species, and bats are especially dependent on caves and mines (Tigner and Dowd Stukel 2003). Cave ecosystems are considered significant to bats if they contain sites with large collections of bats, high species diversity, or are used as hibernacula or maternity roosts (Tigner and Dowd Stukel 2003). Due to the importance of caves to bats, Tigner and Dowd Stukel (2003) suggest that management of significant cave ecosystems will play a vital role in the persistence of bat species in the Black Hills.

Both bat species on the Region 2 sensitive species list for the Forest (fringed myotis, Townsend's big-eared bat) use cave resources for roosting or hibernacula. In addition, all four bat species listed as SOLC on the Forest (long-eared myotis, northern long-eared myotis, small-footed myotis, and long-legged myotis) use cave resources (Allen et al. 2005). Additional information on individual bat species on the Forest is presented in the Emphasis Species section and the Biological Assessment/Biological Evaluation (Appendix C) of this document.

3-2.5.2. Resource Conservation Measures

There are numerous resource conservation measures under the Phase II Amendment likely to affect cave resources. Specific approaches in objectives, standards, and guidelines (Appendix D) that likely affect cave resources, with emphasis on their affects on bat habitat, include the following:

- Objective 110 (all alternatives) is designed to manage the majority of caves as "wild" caves, with no modifications or facilities to aid or impede use.
- Objective 111, 112, and 113 (all alternatives) provide for the management, protection of caves, and determining the significance of particular caves.
- Guideline 1401 (Alternatives 1, 2, and 4) is designed to manage caves to protect or enhance biological, cultural, ecological, hydrological, and physical characteristics. This is a standard under Alternatives 3 and 6.
- Guideline 1401a (Alternatives 1, 3, 4, and 6) call for avoidance of ground disturbing activities within 100 feet of cave openings. Alternative 2 stipulates a 500-foot buffer.
- Guideline 1401b (all alternatives) takes measures to prevent anthropogenic changes to cave ecosystems.
- Guideline 1403c (all alternatives) requires properly designed gates to allow passage of bats, air, and water.

- Standards 1503 and 1504 (all alternatives) assure that operating plans and leasing activities avoid damage and assure protection of cave resources around Jewel Cave National Monument (known hibernacula of Townsend's big-eared bat) and Minnelusa and Paha Sapa or Madison Limestone areas.
- Guideline 3102 (all alternatives) protects caves and their microclimate when designing management activities where caves are important bat nursery or hibernacula sites; in addition, Alternatives 3 and 6 protect bat day and night roosts.
- Standard 3207 (Alternative 3 and 6) requires avoiding vegetative changes within 500 feet of cave openings, except when needed to maintain bat habitat. However, Alternative 6 does allow for vegetation changes within 500 feet of cave openings if topography or other features protect the opening from disturbance.
- Guideline 3208 (Standard under Alternatives 3 and 6) provides seasonal closures of known maternity roosts or hibernacula if necessary where there are conflicts with people.
- Standard 3209 (Alternatives 2, 3, 4, and 6) requires designing cave or mine closures to ensure bat movement.

No MA goals, objectives, standards, or guidelines pertain specifically to cave resources.

3-2.5.3. Direct And Indirect Effects

Disturbance to cave and mine openings that change airflow patterns or temperature regimes can alter cave ecology and habitat suitability for bats (USDA Forest Service 2001a). Forest-management activities, including surface disturbance or vegetative changes in close proximity to cave openings, could also affect temperature and airflow patterns, and thereby affect cave ecology and bat habitat. Recreational activities, including spelunking, can cause damage or modification of cave structures, which could impact bat usage of caves. Fire-management activities, including fuel reduction or prescribed burning, if conducted in close proximity to cave openings, could affect air quality and temperature within caves, which could also impact their suitability for bats.

3-2.5.3.1. Effects Of Species-viability Management On Cave Ecosystems

Most of the resource conservation measures for caves remain the same as the current plan (Alternative 2) in all alternatives. The following discussion focuses on those conservation measures that vary by alternative.

All alternatives provide objectives for the management and protection of caves, take measures to prevent human caused changes to cave ecosystems, and determine the significance of cave resources. Alternatives 1, 2, and 4 provide guidelines in managing caves to protect or enhance biological, cultural, ecological, hydrological, and physical characteristics (Guideline 1401). This guideline is changed to a standard in Alternatives 3 and 6, providing increased emphasis on cave conservation and thus increased conservation of bat habitats.

Guideline 1401a calls for avoidance of ground disturbing activities within 100 feet of cave openings in Alternatives 1, 3, 4 and 6. This is a reduction from the 500-foot buffer in the current plan (Alternative 2). This guideline was changed to 500 feet in the Phase I Amendment (Alternative 2) to provide for conservation of bat species consistent with Pierson et al (1999). It is felt that 100 feet is sufficient for general cave protection. Therefore, in Alternatives 3, 4, and 6 this guideline was changed back to 100 feet for general cave conservation, and Standard 3207 was modified to include the 500 feet avoidance where caves and abandoned mines are used by bats.

Alternatives 2 through 6 provide guidelines for the seasonal closure of caves and mines to avoid conflict with roosting or hibernating bats, but Alternatives 3 and 6 make this a standard, providing greater emphasis on bat habitat protection.

The proposed changes, mostly related to bat species, in Alternatives 3, 4, and 6 would likely increase the potential for cave conservation.

3-2.5.3.2. Effects Of Research Natural Area Management On Cave Ecosystems

Management of RNAs, which focus on conserving natural conditions and biodiversity while minimizing any manipulative management practices, is not expected to have a negative affect on cave ecosystems. In contrast, since public use will not be encouraged in areas designated as RNAs, cave resources in these areas may not experience as much human use, thereby reducing risks to cave features and hibernating or roosting bats.

3-2.5.3.3. Effects Of Fire-hazard And Insect-risk Management On Cave Ecosystems

Fire-hazard reduction measures including fuel (vegetation) reduction or prescribed fire, if conducted in close proximity to cave openings suitable for bats, could affect air quality and temperature regimes within caves. This could negatively affect cave suitability for roosting or hibernating bats. Alternatives 1, 2, and 4 do not provide protection from vegetation manipulation in close proximity to cave openings; they only provide protection from surface disturbance activities. Alternatives 3 and 6 limit vegetation manipulation within 500 feet of suitable bat cave openings and provides the greatest protection of the five alternatives.

3-2.5.4. Cumulative Effects

Cumulative effects cave ecosystems result from the incremental impact (direct and indirect effects) associated with the alternatives when added to past, present, and reasonably foreseeable actions. The cumulative effects analysis area is bounded in time as the next 10 to 15 years. This temporal scale corresponds to projections for the desired future condition described for each alternative (Chapter 2). The spatial scale for the cumulative effects analysis generally encompasses the Black Hills Ecoregion as defined by Bailey (1995).

Cave resources are found throughout the Black Hills region, including significant cave ecosystems managed by National Parks (i.e., Jewel Cave National Monument, Wind Cave National Park). Management activities in and around these extensive cave systems could affect cave resources that extend across jurisdictional boundaries. Standard 1503 (all alternatives) addresses this potential impact in the Jewel Cave area by assuring that operating plans and leasing activities avoid damage and assure protection of cave resources within 2 miles of Jewel Cave or known passageways outside the monument. Cave conservation measures implemented on state and federal lands minimize potential cumulative effects on Forest cave resources adjacent to these lands. Management activities on privately owned lands within and adjacent to the Forest boundary are not likely to affect cave resources within the Forest.

Alternatives 3, 4, and 6 offer the most conservation for cave resources because Guideline 1401a is changed to a standard and Standard 3207 is modified to limit vegetation modification within 500 feet of suitable bat cave openings. Alternatives 1 and 2 offer less conservation of cave resources because they retain Guideline 1401a as a guideline.

3-3. Emphasis species

3-3.1. Emphasis Species Definitions

Emphasis species includes flora and fauna characterized as follows:

- Threatened and endangered species (TES)
- Region 2 sensitive species
- Species of local concern (SOLC)
- Management indicator species (MIS)

3-3.1.1. Threatened And Endangered Species

Threatened and endangered species refer to those flora and fauna protected under the Endangered Species Act (ESA) of 1973. Emphasis species include the following categories from ESA:

- **Threatened species -** any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range and that the appropriate Secretary has designated it a threatened species (Forest Service Manual (FSM) 2670.5 [21]).
- **Endangered species -** any species in danger of extinction throughout all or a significant portion of its range (FSM 2670.5 [8]).

3-3.1.2. Region 2 Sensitive Species

Sensitive species are those plant and animal species identified by the Regional Forester for which population viability is a concern, as evidenced by:

a. Significant current or predicted downward trends in population numbers or density.
b. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution (FSM 2670.5).

3-3.1.3. Species Of Local Concern

The Region 2 Planning Desk Guide (USDA Forest Service 2003b) defines species of local concern (SOLC) as species that failed to meet the criteria for sensitive status. These could include species with declining trends in only a portion of Region 2, or those that are important components of diversity in a local area. The Forest defined the local area as NFS lands within the Black Hills National Forest.

The process for of selecting SOLC is outlined in detail in "Process for Identifying Wildlife and Plant SOLC and Results" (Allen et al. 2005). The process used to identify SOLCs was adapted from the process developed and used in the Chugach National Forest (Suring and Murphy 1998) and the R-2 process to identify emphasis species, including SOLC (USDA Forest Service 2003b).

3-3.1.4. Management Indicator Species

The identification of MIS is required under the National Forest Management Act 1982 regulations as a way to estimate the effects of management-planning alternatives on fish and wildlife populations (USDA Forest Service 2003b). Science Applications International Corporation (SAIC) used the seven-step process developed by Hayward et al. (2001) and contained in the Regional Desk Guide (Appendix G: Revision Analysis Requirements for Planning Documents) to identify MIS for the Forest. The selection of

MIS and the rationale for selection/non-selection is detailed in SAIC (2005). Additional information on the scientific basis and criticism of the MIS process is discussed in Hayward et al. (2001).

Threatened and endangered species, Region 2 sensitive species, and SOLC are reviewed for potential MIS designation. The MIS identification process is guided by five principles:

1. Choose MIS to reflect major management issues and challenges.
2. Use MIS to facilitate evaluation.
3. Consider MIS chosen on neighboring planning units.
4. Consider whether employing MIS is the best approach to evaluate the management problem.
5. Choose adequate but limited number of species.