3.6 WATERSHED HEALTH

3.6.1 Watershed Management

Issue Statement

There are divergent opinions about how much emphasis to give watersheds in forest management. Forest Plan revision will determine the approach taken to management activities in watersheds. Measures to protect and enhance watersheds (including soil, water, and riparian characteristics) could either remain as they are in the current Forest Plans or provide direction for enhancing and restoring watersheds.

Overview of Mapping Systems

Watersheds

This overview of the nation-wide hierarchical mapping system for watersheds should help in understanding information presented for indicators 1, 2, and 8, which describe effects as the "number of watersheds" in various categories. The description of watersheds used for these indicators is based on the Hydrologic Unit Code (HUC) system (Seaber et al. 1987), which is a standard watershed map system used by State and federal agencies.

The mapping system for watersheds consists of multiple levels. The U.S. Geological Survey has completed mapping of the 1st through 4th levels nationwide. The 1st level is the largest scale of watershed mapping, and each 1st level watershed has been assigned a unique 2-digit identifying Hydrologic Unit Code. First level watersheds have been subdivided into smaller 2nd level watersheds, and each 2nd level watershed has been assigned a unique 4-digit code. Watersheds in each mapping level are progressively subdivided into smaller watershed mapping levels, and with each subdivision, two digits are added to maintain a unique identifier code for each watershed. The 5th level (10-digit HUC) and 6th level (12-digit HUC) of watershed mapping are most relevant to individual National Forests, and are the levels used in this forest plan revision watershed analysis. Fifth and 6th level watersheds within or intersecting the boundaries of both Forests are displayed on a map in Section 3.1 of this document. See Table WSM-1 for a crosswalk between watershed mapping level and HUC category and for the approximate size classes for 5th and 6th level watersheds on the Chippewa and Superior NFs.

Table WSM - 1. Watershed Mapping Levels, Approximate Size Classes, and Hydrologic Unit Code Categories by National Forest

National Forest	Watershed Mapping Level	Watershed Size Classes (Approx. Acres)	Hydrologic Unit Code Category
Chippewa	5th	50,000-330,000	10-digit
Superior	5th	60,000-190,000	10-digit
Chippewa	6th	1,000 - 180,000	12-digit
Superior	6th	10,000 – 50,000	12-digit

Ecological Land Units

An overview of the USDA Forest Service Eastern Region Ecological Classification System for ecological land units is important to understanding information presented for indicators 4, 5, and 6. Criteria used to distinguish ecological land units include climate, physiography, soil, and vegetation. Within this hierarchical system, mapping units range from provinces, which are thousands of square miles in size; to landtype associations (LTAs), which are broad geographic areas with similar soils, landform, bedrock type, geomorphic process, and plant associations; to ecological landtypes (ELTs or LTs), which are more site-specific. Mapping on both Forests has been done at the landtype association (LTA) level; at the smaller, more site-specific, ecological landtype (LT/ELT) level; and at the even more site-specific ecological landtype phase (ELTP) level.

The ecological landtype level is used in the analysis of indicators 4, 5 and 6 in this EIS, and further information on this particular mapping level can be found in the Glossary. See Section 3.1 of this EIS for maps which show the locations of landtype associations and ecological landtypes on the Chippewa NF and landtype associations on the Superior NF.

Indicator 1 - Trend of Watershed Impacts from Transportation System

The first indicator for watershed health is a relative measure of how additional roads needed for vegetation management can potentially affect riparian resources.

This indicator highlights the relative differences between alternatives because it indicates the trend of potential riparian impacts from roads on factors such as sedimentation, riparian function, aquatic habitat and connectivity for aquatic species. All these factors are important in the maintenance of water quality and the status and populations of fish and other aquatic or riparian-dependant species. For a more detailed discussion of potential impacts of roads, see *General Effects Common to All Alternatives* later in this section.

This indicator is described as a "relative" measure because the assessment of how additional roads potentially affect riparian resources under each alternative is based on a ratio (the ratio of potentially affected riparian habitat to available riparian habitat) rather than an absolute measure. Additional roads to access areas for vegetation treatment under each alternative were estimated using road construction miles for typical timber harvest activities from 1997-2002. The interdisciplinary planning team decided that this road construction information from the recent past would provide the closest approximation of access needs in the next two decades. Locations and acres of vegetation management treatments requiring access were derived from the Dualplan model.

The measure chosen to assess the potential impact of roads is the number of 6th level watersheds that increase from one riparian road interaction class to the next higher class. These classes were derived by first determining, for each watershed, the current ratio of potentially affected riparian area to total modeled riparian area. For this analysis, potentially affected riparian area is defined as the acreage occupied by roads plus a 100 zone on either side of the road. Total modeled riparian area includes palustrine wetlands identified by the National Wetland Inventory, streams and lakes identified in the USFS 1:24,000 scale GIS layers, plus a "buffer" area of 100 feet around those streams and lakes. Ratios determined for individual 6th level watersheds were then grouped into classes based on the size of departure from the mean percent riparian impact across all the 6th level watersheds of each Forest. Four riparian road impact index classes were developed for each Forest and labeled very low, low, moderate, and high.

Interaction ratios were then recalculated to reflect new roading projected from the first two decades of timber harvest treatments under each alternative. The number of watersheds projected to move from one interaction class to the next higher class by the end of decade 2 under the revised Plan was then determined for each alternative.

For the Superior NF, the interaction classes are based on a relative scale that compares all of the 6th level watersheds that are contained within the 5th level watersheds (next larger scale) that fall within the boundary of the Forest or that have portions of the watershed that intersect the Forest. Because of the less consolidated ownership pattern, the Chippewa National Forest assigned interaction classes to only those 6th level watersheds that are wholly included within the Forest boundary or those that have some portions therein.

Because this Plan revision process does not direct specific amounts of road decommissioning or timeframes for temporary road obliteration, this indicator does not account for these or similar actions that would tend to reduce road impacts on riparian areas through time. Thus the indicator portrays a maximum level of impact from all roads. Analysis for the Superior NF excludes winter roads.

Indicator 2 - Stream Crossing Density

The second indicator for watershed health is stream crossing density. This indicator assesses the change in the average number of stream crossings per mile of stream in Forest 6th level watersheds for the first decade of management under each alternative. Stream crossing densities are calculated by extrapolating miles of additional roads needed for vegetation treatment in each alternative as modeled by Dualplan. The increase in stream crossings associated with additional road construction was estimated by reviewing typical road building activity associated with timber harvest from 1997 – 2002.

The magnitude of change in stream crossing density is displayed by alternative. This indicator highlights the potential impacts to streams and aquatic resources on each Forest as a result of increased road construction and stream crossing activities. The potential impacts include loss or changes in aquatic habitat quality and connectivity, and changes in hydrologic regime. (For a more detailed discussion of impacts, see *General Effects Common to All Alternatives* later in this section of the EIS.)

Because this Plan revision process does not direct specific amounts of road decommissioning or timeframes for temporary road obliteration, the indicator portrays a maximum impact from crossings associated with all roads on the Chippewa NF, and all non-winter roads on the Superior NF.

This analysis treats all stream crossings the same. It should be recognized that standards and guidelines that would be part of any revised Plan require that impacts from crossings be minimized, and that these effects would generally be reduced from historic levels.

Indicator 3 - Portion of National Forest Land with Watershed Management above the Stewardship Level

The third indicator for watershed health addresses the proportion of each Forest assigned a watershed management approach above the stewardship level (e.g. to be managed for a higher-than-base level of watershed health). For this analysis, the stewardship (base) level represents management directed solely by existing laws, regulations, policy, best management practices for the control of non-point source pollution, and the Minnesota Forest Resource Council site-level forest management guidelines (MFRC 1999d).

This indicator enables a generalized determination of differences between alternatives based on the mix of acreages assigned to each management area and the relative level of focus on watershed health associated with each management area. The mix of acreages

Table WSM-2: Characterization of Management Areas by Relative Level of Management Focus on Watershed Health

Level of Management Focus on Watershed Health	Management Areas
At Stewardship (base) Level	--General Forest --Minimum Investment (Superior NF Alternative A only) --Recreation Use in a Scenic Landscape --Semi-primitive Motorized Recreation
Above Stewardship (base) Level	--Longer Rotation --Potential Candidate Wild, Scenic, and Recreational Rivers --Semi-primitive Non-motorized Recreation --Unique Biological, Aquatic, Geological, or Historical Areas --Riparian Emphasis Areas --Experimental Forest --Research Natural Areas --Potential Research Natural Areas --Wilderness

assigned to management areas (and thus the relative forest-wide level of management focus on watershed health) is an attribute that is unique to each alternative. Table WSM-2 displays how, for this analysis, individual management areas were characterized as either at or above the basic stewardship level for watershed health.

Indicator 4 - Soil Quality Associated with Treatment Activities, Temporary Roads, Objective Maintenance Level 1 (OML-1) Roads, Skid Trails, and Landings

The fourth indicator for watershed health focuses on the soil component and is a relative measure of how different treatment activities under each alternative potentially affect soil quality through disturbances such as compaction, rutting, puddling, and changes to soil hydrology. Potential effects would also include those related to temporary roads needed for access to harvest sites, use of Objective Maintenance Level (OML) 1, skid trails, and the establishment of landings in timber harvest areas.

For each alternative, vegetation treatment methods projected in the Dualplan timber-scheduling model were simplified into two groups: even-aged activities (treatment methods 1-5) and uneven-aged activities (treatment methods 6-16). (See Appendix B for a description of treatment methods.) Landtypes (LTs) on the Chippewa NF and Ecological Landtypes (ELTs) on the Superior NF, land unit level ecological units, were grouped into classes based on sensitivity to compaction. These groupings were based on soil strength bearing capacity, a characteristic which relates to ability of a given soil to maintain its structure. Two classes are identified as having a tendency to compact: those that can only be operated on when the ground is frozen and those that can only be operated on when the ground is either frozen or dry.

This indicator highlights the differences between alternatives based on the relative trends of possible combined impacts of harvest activities, associated road use, and use of skid trails and landings.

Indicator 5 - Soil Quality Associated with Fire Activities

This indicator for watershed health addresses the amount of land under each alternative that may potentially be impacted by management-ignited fire used for site preparation, hazardous fuel reduction, or ecosystem restoration. The amount of soil disturbances, such as extremely burned mineral soil and loss of organic layer, may be related to soil capability or inherent soil characteristics. Landtype (LT)/Ecological Landtype (ELT) components can be used as a basis for discussing these capabilities and characteristics. Site preparation and hazardous fuel reduction fire techniques and maintenance fire techniques differ in regard to the outcome desired from the management ignited fire and how they may affect individual LTs/ELTs.

This indicator shows the differences between alternatives by highlighting LT/ELTs that may be sensitive to fire-induced nutrient loss or to changes in physical properties of soil that may affect soil productivity, water yield or water quality. It allows a relative comparison of alternatives by using the estimated possible acres of management ignited fire opportunities that exist for each Forest. Because possible use of fire for site preparation, hazardous fuel reduction, or ecological restoration has not been determined spatially, it is not possible at this time to do a comparison by location, by LT/ELT, or by specific treatment.

Indicator 6 - Soil Nutrient Cycling on Sensitive Sites

This indicator for watershed health addresses the possibility that some land under each alternative might be selected to undergo re-treatment activities, such as multiple rotations on the same site, throughout a 100-150 year time period. This indicator focuses on the portion of such land that is characterized by sensitive soils that are inherently low in productivity and that might be selected for retreatment.

Low productivity ecological landtypes (LTs/ELTs) are generally either shallow to bedrock (soils less than 40” deep) or characterized by deep sandy material. Nutrient storage in shallow soils is limited simply by lack of soil to act as a storage medium. Deep sandy soils typically do not have the texture or the amount of organic matter that is needed to effectively keep nutrients from being leached away from the rooting zone. Though natural processes such as deposition from precipitation and air, weathering of rock, and biological fixation contribute to the replenishment of nutrients, on many sensitive sites the rate of replenishment may not be enough to offset the combined losses from leaching and the effects of some management practices.

This indictor looks specifically at individual ecological landtypes (LTs/ELTs) that have been designated sensitive to these types of activities because of their inherent nutrient status based on cation exchange capacity, site index, and physical characteristics that indicate low nutrient capital.

This indicator provides a generalized assessment of the amount of vegetation management treatments that would occur on sites of low productivity that may be sensitive to nutrient losses. On low productivity sites, multiple harvests on the same site can "drain" nutrients from soil through the combined effect of timber removal (removal of nutrients stored in the bole of trees) and uptake of nutrients by trees while they are growing. Nutrients like calcium can become limiting on some low productivity sites, for example where high calcium demand species such as aspen are grown and harvested at short rotations. Nutrient effects on low productivity sites can be controlled to some degree by harvesting at longer rotations and through careful selection of reforestation practices.

Indicator 7 - Recreation Effects

This indicator for watershed health will provide a general characterization and differentiation among alternatives on effects related to four facets of recreation use:

- Motorized summer (ATV) trails—maximum miles of additional designated trail
- Motorized winter (snowmobile) trails—maximum miles of additional designated trail
- Cross country ATV and snowmobile use—level of use restriction
- Water Access—maximum facility level of development

Indicator 8 (Cumulative Effects Indicator) - Portion of Watershed in Upland Open and Upland Young (less than age 16) Forest

The eighth indicator is a cumulative effects indicator. It's being used to help ensure that actions carried out under revised Forest Plans do not result in watersheds having more than 60 percent of their surface area in upland open or upland young forest condition. This 60 percent threshold is derived from Upper Midwest-based hydrological research showing that watershed's exceeding this threshold are subject to levels of peak stream flow which reshape stream channels; increase in-channel erosion and sedimentation; and decrease physical and biological diversity within streams (Verry 2000).

The measure for this analysis is the number of 6th level watersheds where the level of National Forest harvest activity will exceed a prorated share (of upland young forest and upland open areas) for National Forest System Lands within the watersheds. For each of the 12-digit watersheds, circa 1996-satellite imagery was updated using forest stand data for State, county and National Forest System land. For each alternative, Dualplan's projected acres of regeneration harvest were used to determine the percent of young forest at two points in time: at the end of the first decade and at the end of the second decade.

The way "upland young forest" was tallied is somewhat different between decade 1 and decade 2. For decade 1, it is the total of all acres treated for regeneration harvest in the preceding 15 years; for decade 2, it is the total of all acres treated for regeneration harvest in the preceding 20 years. Therefore, the acreage of upland young forest at the end of the 2nd decade is recognized as an overestimate.

The acreage of upland young forest at the end of each decade is added to the acres of land considered to be in an upland open condition on a permanent basis. The combined acreage is compared to the National Forest

System (NFS) prorated (based on NFS acres as a percentage of total watershed acres) share of 60 percent upland open and young forest. This is a good cumulative effects indicator because it uses watersheds (natural integrators for effects related to water flow and water quality), accounts for the amount of open and young forest resulting from harvest on NFS lands, and at the same time recognizes and allows for similar conditions on other lands within the watershed.

Analysis Area

Indicator 1 (Trend of Watershed Impacts from Transportation System), Indicator 2 (Stream Crossing Density), and Indicator 8 (Portion of Watershed in Open and Young Upland Forest)

On the Chippewa NF, the analysis area for indicators 1 and 2 includes all 6th level watersheds that are wholly included within the National Forest or that are intersected by portions of the Forest. The analysis area for indicator 8 includes all 6th level watersheds that fall within the 5th level watersheds that are wholly included or intersect the Chippewa NF.

On the Superior NF, the analysis area for all three indicators includes all 6th level HUC watersheds that fall within the 5th level HUCs that are wholly included or intersect the SNF, including those watersheds that are entirely or partially within the Boundary Waters Canoe Area Wilderness (BWCAW).

For both Forests, the discussion of direct, indirect, and cumulative effects considers the areas described above. Timelines used for indicators #1, #2, and #8 on both Forests are:

Indicator 1: 20 years
Indicator 2: 10 years
Indicator 8: 10 years and 20 years

Indicator 3: Portion of National Forest Land with Watershed Management above the Stewardship Level

The analysis area for this indicator is the National Forest System land within the Chippewa NF and Superior NF.

Indicators 4, 5, and 6: Soil Quality and Soil Nutrient Cycling

For the Chippewa National Forest, the analysis area for these indicators is all National Forest System land within the Forest. All Landtypes (LTs) that are partially or wholly within the Forest boundary are addressed, but the analysis focuses only on those portions that are inside the boundary.

For the Superior National Forest, the analysis area is the portion of the National Forest System land outside the BWCAW. Ecological Land Types (ELTs) in all Landtype Associations (LTAs) that are partially or wholly within the Forest boundary are addressed, but the analysis focuses only on those portions that are inside the Forest boundary. For those LTAs partially inside and partially outside the BWCAW, only the portion outside the BWCAW is focused on in this analysis because no treatment activities are scheduled inside the BWCAW.

Landtypes (LTs) and ELTs were selected as the land unit mapping scale to use in this analysis because this scale provides the best indication of how treatments or activities would directly impact sites susceptible to compaction, nutrient loss, erosion, or changes in other physical properties of soils.

For Indicators 4, 5, and 6, analysis was done for potential conditions at the end of decade 1 and decade 2.

Indicator 7: Recreation Effects

The analysis area for each of the four facets of recreation effects is forest-wide. The four facets are:

- Motorized summer (ATV) trails—maximum miles of additional designated trail
- Motorized winter (snowmobile) trails—maximum miles of additional designated trail
- Cross country ATV and snowmobile use—level of use restriction
- Water Access—maximum facility level of development

(Also see the Recreation discussion in Section 3.8 of this EIS.)

3.6.1.a Affected Environment

Impaired Waters

A key component of the affected environment for watershed health is the current water quality status of streams and lakes within the borders of, or affected by, the Chippewa and Superior National Forests. In compliance with the federal Clean Water Act, the state of Minnesota has adopted water quality standards to protect all State waters, both inside and outside the National Forests. These standards define how much of a pollutant can be in a water body, while still allowing the water to meet its legally established designated uses such as drinking, fishing, swimming, irrigation or industrial purposes. Under section 303(d) of the Act, the State of Minnesota is charged with publishing, every two years, an updated list of streams and lakes that are not meeting their designated uses because of excess pollutants. This list can be found at http://www.pca.state.mn.us/water/tmdl.html. The State is also charged with conducting a Total Maximum Daily Load (TMDL) study identifying the point and nonpoint sources of each pollutant that causes a water body to be placed on the list.

Several streams and lakes on the most current USEPA-approved (2004) "impaired waters" lists, reside within the boundaries of the Chippewa and Superior National Forests. Specific impaired waters located within the boundaries of the Forests are identified in the Plan Revision Record. Based on the 2004 list, the occurrences of impaired waters on the two National Forests can be summarized as follows:

Chippewa NF—A total of 36 water bodies (34 lakes and portions of 2 rivers) appear on the 2004 impaired waters list. Of these waters, 33 lakes and 1 river (a portion of the Big Fork River) are on the list solely because of presence of mercury in fish and/or in the water, and the associated potential health threat posed by human consumption of fish. One lake, Jessie Lake in the Rainy River basin, is on the list due to the presence of both mercury and excessive nutrients, such as nitrogen and phosphorus, which pose a threat to aquatic recreation uses. One river (a portion of the Mississippi River) is on the list due to limitations on aquatic life posed by seasonally low levels of dissolved oxygen. The projected starting date for TMDL studies on Jessie Lake (for nutrients) and the listed portion of the Mississippi River (for low oxygen) is 2005.

Superior NF—A total of 335 water bodies (326 lakes and portions of 9 rivers) appear on the 2004 impaired waters list. Of these waters, 324 lakes and 7 of the rivers (portions of the Brule, Pigeon, St. Louis, Kawishiwi, Rainy, Sturgeon and Vermilion Rivers) are on the list solely because of presence of mercury and the associated potential health threat posed by human consumption of fish. Two lakes, Ojibway Lake in the Rainy River basin and Winchell Lake in the Lake Superior basin, are on the list due to the presence of both mercury and PCBs. Two rivers (Beaver and Poplar) in the Lake Superior Basin are on the list due to the presence of mercury, as well as the limitations on aquatic life posed by more "conventional" pollutants such as pH and turbidity. A projected starting date of 2005 has been established only for TMDL studies of the conventional pollutants affecting Beaver River and Poplar River.

The vast majority (98 percent) of National Forest lakes and streams that appear on the 2004 impaired waters list are impaired solely due to mercury. Because the primary sources of mercury are atmospheric deposition from sources outside the National Forests, and the impacts of mercury are expressed throughout the entire region of northern Minnesota, it's likely that the TMDL studies for mercury will be done on a regional or statewide basis. The State of Minnesota is in the early stages of developing plans for a regional TMDL study for mercury, with an anticipated completion date sometime in 2005.

One study addressing both mercury and conventional pollutants, and that might eventually contribute to a TMDL determination, is ongoing for the Lake Superior Basin on the Superior National Forest. However, no conclusive link has been demonstrated between common forest management activities (such as timber harvest, road building and maintenance, use of prescribed fire, forest recreation development, etc.) that serve as the basis for comparison between alternatives in this EIS and the abundance and bio-accumulative potential of mercury in Forest waters. Current evidence suggests that if there is a link, it's likely to be associated with sediment transport that might arise from these activities (Kolka 2004). Thus, prudent management dictates that measures such as best management practices (BMPs) be used to minimize sediment transport from sites of forest management activity. Regardless of which Alternative is selected, these practices will be incorporated in the Forest Plan (specifically, see standards and guidelines in Chapter 2 addressing use of Minnesota Forest Resource Council site-level guidelines in the "All Resources" section, and use of water quality BMPs in the Watershed Health section.) The Forests will implement and monitor these practices in accordance with federal and state guidelines, and work to improve these practices through adaptive management.

Since the source of any additional mercury is primarily atmospheric, the Forests will continue their ongoing effort to limit or reduce mercury emissions that threaten water resources throughout northern Minnesota. This will be done by using administrative tools such as the federal Clean Air Act-mandated role for federal land managers in permit decisions for new emission sources, and by playing an active role in multi-state regional air quality partnerships. The Superior National Forest will also continue to support research to investigate how prescribed burning practices may influence mercury cycling in watersheds.

There is currently one lake and one river on the Chippewa, and the two rivers on the Superior, that are on the impaired waters list due to "conventional" pollutants (excess nutrients, low dissolved oxygen levels, pH, or turbidity). These waters have some potential for being further influenced by common forest management activities conducted on National Forest Systems lands and other ownerships within contributing watersheds. Additional National Forest waters influenced by conventional pollutants may be added to the impaired waters list via future required biannual list updates.

For current and future lists, and under all alternatives, the Forests will aggressively implement, monitor, and work to improve BMPs in watersheds of waters that are listed due to conventional pollutants. The Forests will actively partner with the State and other agencies and landowners in TMDL studies to assess culpability and in the restoration of waters where National Forest System management actions contribute to impairment by conventional pollutants. The Forests will also manage with the objective (O-WS-7 in the Forest Plan) of decreasing the contribution of non-point pollutants from National Forest System lands in areas where TMDLs have been developed.

Indicators 1 and 2: Trend of Watershed Impacts from Transportation System and Stream Crossing Density

Road systems on public lands often evolved from historic routes that followed the most accessible path to a particular area. Many of the routes followed, and still do today, along riparian areas that include lakes, streams, and wetlands. Roads and trails have important influences on aquatic and riparian habitat quality. Interactions between water and road surfaces or crossing structures often cause detrimental impacts. These impacts are described in *General Effects Common to All Alternatives* later in this section.

On the Chippewa and Superior National Forests, riparian areas (lakes, streams, and wetlands) cover approximately 49 percent and 34 percent, respectively, of the land within the proclamation boundaries. As a result of this water-richness, roads are prevalent in riparian areas. In addition, roads cross streams, on average, once for every 1.3 miles of stream on the Chippewa NF. On the Superior NF, the average is one stream crossing for every 1.4 mile of stream.

Recent monitoring of the condition of stream crossings on both Forests indicates that roads are having some impact on riparian areas, especially stream and wetland systems. Impacts generally include geomorphic or hydrologic changes, and alterations or loss of aquatic habitats through sedimentation.

Indicator 3: Portion of Forest with Watershed Management above the Stewardship Level

The level of emphasis on watershed health as a focus for current management is suggested by the accumulated acreages of the various management area allocations under the 1986 Forest Plans for the Chippewa and Superior National Forests. Because Alternative A essentially represents continuation of the

1986 management area allocations on each Forest, the level of emphasis on watershed health under current conditions is about the same as ascribed to Alternative A (see discussion later in this section). The current approach to management on both Forests, with few exceptions, (most notably the wilderness allocation on the Superior NF) manages watersheds at, but not above, the basic stewardship level. The current approach to management provides relatively little emphasis on watershed health—a condition which all of the action alternatives (Alternatives B through G) improve upon to varying degrees.

Indicators 4, 5, and 6: Soil Quality and Soil Nutrient Cycling

Portions of the Chippewa and Superior National Forests have experienced mechanical harvest treatments and site preparation treatments from the late 1800's through present. Early logging techniques using horses probably resulted in less impact to soil than has been associated with use of mechanical equipment in more recent decades. As mechanical equipment became normal practice during the mid 1970's, compaction, rutting, and soil displacement has occurred. More recent advances in equipment in the late 1980's and early 1990's have lessened impacts on soil. Mitigation techniques directed by the Chippewa NF and Superior NF 1986 Forest Plan standards and guidelines have been implemented to either reduce these impacts or restore sites that have been impacted.

Fire, both natural (from lightening) and human-caused, has also caused impacts to soil. The human-caused source of fire impact, as well as other soil effects associated with human uses of the land (such as use of soil for road building), has generally increased through time. Effects often result from areas subject to long term removal of forest canopy and/or creation of compacted or impervious surfaces that change how a watershed stores and releases water.

Some natural replenishment of soil nutrients lost by harvest, fire, insects, diseases, or human uses, occurs by atmospheric deposition, weathering, and biological fixation (of nitrogen).

Minor amounts of natural displacement of soil occur as a result of wildlife activity such as bird nesting and denning by wolves or bear.

It's also possible that nutrient balance in Forest soils may be affected by current and past acid deposition, which could possibly change soil pH and ultimately affect the ability of soil microorganisms to release nutrients. Although acid deposition may be buffered by alkaline materials in soil, soils on the Superior NF in particular tend to be slightly to highly acidic. Acid deposition on these soils can result in possible loss of soil nutrients available to plant growth and release of toxic substances (such as aluminum) that can reduce tree growth. (USEPA 2004)

Indicator 7: Recreation Impacts

Recreation use on both Forests is tied nearly exclusively to the rich water and riparian resources within the Chippewa and Superior National Forests. Most campgrounds and campsites are located near the water. Most special use permitted recreation residences are also adjacent to major lakes or rivers. Trails frequently come within close proximity to lakes, rivers, and wetlands. Current amounts of ATV/snowmobile trail and numbers and classifications of existing water access sites are discussed under Recreational Motor Vehicle and Water Access (sections 3.8.3 and 3.8.4 of this EIS). No systematic monitoring or surveys have been done to quantify the effects existing trails and access sites, or cross country use by ATVs or snowmobiles, are having on soil, water, or riparian resources. It is likely, however, that existing trails and access sites do result in some localized geomorphic, hydrologic, aquatic habitat, and soils impacts of the type described under *General Effects* later in this section. In addition, casual observation on both Forests suggests that ATV use on locations other than road or designated trails ("cross-country" use) does occur and is causing site-level impacts to soil, water, and riparian resources. Off-trail or off-road corridor use of snowmobiles also occurs on National Forest System land, but the amount of this use and associated soil/water impacts tends to be less than those associated with ATVs.

Indicator 8 (Cumulative Effects Indicator): Portion of Watershed in Upland Open and Young Upland Forest

In 1998, the Department of Agriculture and the US Environmental Protection Agency developed the Clean Water Action Plan to restore and protect America's waters. One of the four tools cited in the Action Plan to achieve clean water goals is a Watershed Approach. Embodied in this approach is the notion that the public and private sector both play a role in sustaining healthy conditions and protecting and restoring watershed health (USEPA 1998b). Upper Midwest-based hydrological research shows that the cumulative impact of many local actions within a watershed can influence levels of peak stream flow that reshape stream channels; increase in-channel erosion and sedimentation; and decrease physical and biological diversity within streams. As discussed in the earlier description of this indicator, a critical threshold is reached when combined upland open plus upland young (<age 16) forest comprise approximately 60 percent or more of the watershed (Verry 2000). Currently there are nine (out of a total of 346) watersheds that exceed the 60 percent threshold at the 6th level watershed scale on the Chippewa NF. On the Superior NF, none of the Forests' 253 6th level watersheds currently exceed the 60 percent threshold.

3.6.1.b Environmental Consequences

Effects Common to All Alternatives

Resource Protection Methods Common to all Alternatives

All alternatives incorporate a base set of management direction that provides for maintaining, and where practical, restoring watershed health. This direction consists of desired conditions, objectives, standards, and guidelines that apply to and limit the effects of any alternative selected for implementation in the Forest Plan. Key examples of this management direction include:

Desired Conditions of:

- Maintaining the condition of watersheds and restoring watersheds where needed, to provide appropriate quantity, quality and timing of flow, and to support viable populations of fish, freshwater mussels, and other aquatic species.
- Retaining or restoring the stability of stream channels.
- Providing sources of coarse woody debris to lakes and streams.
- Maintaining, improving or restoring hydrologic connectivity for water flow, sediment transport, and fish passage.
- Providing soil conditions with capacity to recover from most human-caused and natural disturbances.

Objectives to:

- Improve understanding of how watersheds function, through inventory of the composition, structure and function of individual lakes, streams, wetlands.
- Assess ecosystem condition and vulnerability on a watershed scale, including identification and assessment of factors limiting native and desired non-native fish species.
- Maintain, restore or enhance soil productivity.
- Restore soil conditions where impaired or contributing to degraded health of a watershed.
- Provide forest floor soil and subsurface conditions that allow infiltration of rainfall, provide a seedbed, and provide nutrients and thermal cover for plant growth.
- Increase the amount of forest cover of age sixteen or greater in any 12-digit watershed where the total combined acreage of upland open plus upland young forest is equal to or greater than 60 percent of the total watershed area.

Standards or Guidelines that:

- Cap the amount of upland open plus upland young forest on NFS lands in each 12-digit watershed where the total combined acreage of upland open plus upland young forest is equal to or greater than 60 percent of the total watershed area.

- Provide for restoration of eroded sites, minimize loss of forest floor as the result of management activities, and minimize compaction and nutrient depletion in soil.
- Control management actions based upon identified limitations and capabilities of mapped terrestrial ecological units.

General Effects Common to all Alternatives

All alternatives involve management practices or activities commonly needed to produce the products and services characteristic of a managed forest. These practices include road and trail construction and maintenance, timber harvest, and use of recreational motor vehicles. Although projected amounts of some activities can vary greatly between alternatives, each activity is associated with a set of characteristic effects or potential effects that shape watershed health. Key effects associated with specific forest management activities are summarized below.

Effect of Roads and Trails Common to all Alternatives

Gucinski and others (2000) describe the effects of roads on watershed health, particularly those aspects related to riparian areas and wetlands:

Geomorphic effects of roads on streams range from chronic and long-term contributions of fine sediment into streams to catastrophic mass failures of road cuts and fills during large storms. Roads may alter channel morphology directly or may modify channel flow paths and extend the drainage network into previously unchannelized portions of hillslopes. The magnitude of road-related geomorphic effects varies by climate, geology, road age, construction practices, and storm history. Improvements in designing, constructing, and maintaining roads can reduce road-related erosion at the scale of individual road segments; but few studies have evaluated long-term and watershed-scale changes to sediment yields as roads are abandoned or obliterated.

Roads have three primary effects on **hydrologic processes**. Roads intercept rainfall directly on the road surface, road cutbanks, and subsurface water moving down the hillslope; roads concentrate flow, either on the surface or in an adjacent ditch or channel; and roads divert or reroute water from flowpaths that it would otherwise take if the road were not present. Problems of road drainage and transport of water and debris, especially during floods, are a primary reason roads fail, often with major structural, ecologic, economic, or other social consequences. The effect of roads on peak streamflow depends strongly on the size of the watershed. For example, capture and re-routing of water from one small stream to another stream can cause major channel adjustments in the stream receiving the additional water. In large watersheds, roads constitute a small proportion of the land surface and have relatively inconsequential effects on peak flow. Roads do not appear to change annual water yields, and no studies have evaluated their effect on low flows.

Roads also typically influence the hydrology (water flow) in the wetlands they cross. The disruption of natural wetland water flow by road crossings is usually attributed to either equipment rutting of the wetland surface or compression of the upper layers of wetland soil. If flow disruption is serious enough, it can cause flooding on the upslope side of the road crossing, and drying on the downslope side. Although some disruption of natural water flow patterns across wetlands can be expected in all wetland road crossings, serious disruptions are generally avoidable through use of design and mitigation practices such as providing adequate cross drainage (using culverts or other means), or by limiting road use to frozen conditions.

The effects of roads on **aquatic habitat** are believed to be widespread, although direct, quantitative cause-effect linkages are difficult to document. At the landscape scale, correlative evidence suggests that roads are likely to influence the frequency, timing, and magnitude of disturbance to aquatic habitat. Increased fine-sediment composition in stream gravel (a common consequence of road-derived sediments entering streams) has been linked to decreased emergence of fish fry, decreased juvenile fish densities, loss of winter carrying capacity, increased predation of fishes, and can reduce benthic organism populations and algal production. Roads can act as barriers to migration of many aquatic organisms, lead to water temperature changes, and altered streamflow regimes. Improper culvert placement at road-stream crossings can limit or eliminate fish passage. At the landscape scale, increasing road densities and their attendant effects have been correlated with declines in the status of some non-anadromous salmonid species.

The effects of temporary roads, landings, and skid roads on **soil displacement** vary by season of operation. Construction requires shaping, filling, and leveling of the ground surface. Areas with irregular terrain or stony surfaces are subjected to more disturbances during frost-free harvest seasons. Very level terrain can also be disrupted. The amount of soil displacement is typically less with winter operations. There is localized scalping, or displacement of small amounts of surface soil, removal of trees, and intermittent removal of ground vegetation resulting in lower vegetation regeneration numbers and reduced growth rates. Natural **erosion** on undisturbed sites is very low. The potential for erosion is dependent on the amount of mineral soil exposed, slope length, slope gradient, and soil porosity. Erosion is primarily associated with landings, temporary roads, and skid trails. Erosion causes soil particles and dissolved nutrients to be redistributed or carried off the site and may contribute to sedimentation into streams, lakes, or wetlands.

The effects of trails can be equal to those described for roads. In general, the greater the increase in roading or trails the greater the probability for the effects described above. The impacts of roads and trails on water quality and riparian habitat vary widely, depending on design. For instance, stream crossings can be designed to reduce the risks of negative impacts to water quality and aquatic habitats if they simulate key stream geomorphic processes occurring at the site before the crossing was built. Also, roads and trails designed for year-round or multipurpose use (as opposed to use only under frozen conditions) generally have more potential for the effects described above due to placement of greater amounts of fill material at stream crossings and wetlands. Regardless of the alternative selected, standards and guidelines in the revised Forest Plans are directed toward minimizing the potential negative impacts to riparian habitats and water quality.

Effects of Management Activities, Including Timber Harvest, Common to all Alternatives

The principle effects of timber harvest on watersheds, riparian areas, and soils are those related to roads and skid trails (as described above). Additional effects can result from other silvicultural activities such as the removal of forest cover or general trafficking of harvest areas. Key additional effects are discussed below:

Effects at the Watershed Scale

Timber removal over large percentages of any given watershed may increase water and sediment yields, leading to stream channel destabilization and loss of aquatic habitat. A thorough description of this effect can be found in the supporting information provided for Watershed Indicator #8 in this section.

Effects at the Riparian Area Scale

Timber removal from riparian areas, without appropriate controls, may decrease woody instream cover, contribute to destabilization of streambanks or lakeshores, reduce shading, increase water temperatures, and reduce inputs of fine litter which provides biological “energy” to adjacent bodies of water.

Effects to Soil Common to all Alternatives

Discussion of the effects of silvicultural practices (including timber harvest) on soil can be found in the Forest Soil Productivity discussion in the Minnesota Forest Resources Council site level guidelines (MFRC 1999d). Key potential effects are related to soil compaction and rutting. **Soil compaction** that can result from timber harvest activities (such as trafficking by heavy equipment, dragging of logs, slash disposal) without appropriate controls disrupts soil porosity. Soil compaction can disrupt water and air movement into and through the soil. This results in poor soil aeration, which negatively affects root growth and activity of soil organisms involved in nutrient cycling. Soil compaction also increases resistance to root penetration, resulting in limiting the volume of soil available for roots to grow. Effects also include reduced soil faunal activity, and reduced seedling survival. Reductions in water infiltration will also contribute to increased surface runoff and potential erosion. Soil compaction also occurs under frozen ground conditions, but does not result in a major decrease in soil productivity. (Stone and Elioff 1997).

Jaakko Poyry (1992a) indicates that compaction resulting from use of heavy equipment on treatment sites reduces productivity by 2 percent to 15 percent. Through freeze-thaw cycles, wetting and drying cycles, and flora and fauna activity, compaction generally returns to pre-harvest growing conditions within two years (Mace 1971) to eight years (Thorud and Frissell 1969) after harvest. Stone and Elioff's 1997 long term soil productivity study of a site near Marcell, Minnesota, demonstrated compaction remained five years after harvest, and recent observations suggest that site has not yet fully returned to pre-harvest conditions (Elioff personal communication 2004). Generally, recovery time is proportional to the amount of detrimental compaction that developed during the treatment activity. Skid trails that are heavily used during the frost-free period usually have reduced aspen suckering for 3 to 5 years after the harvest and may have reduced growth for a longer time period.

Compaction can be controlled by imposing season-based limitations on operations on sensitive sites. Limiting activities to periods of frozen or dry soil on those sites provides for the use of heavy equipment only under conditions where soil strength is maintained and soil has low susceptibility to rutting, compaction or puddling (Jaakko Poyry 1992a). Observations of sites that have been winter harvested vs. summer harvested indicate major differences in overall levels of soil disturbance. One study (Mace 1971) reports medium and heavy disturbance occurred on an average of 47 percent of summer logged sites vs. 9 percent of winter logged sites.

Most past and current research on compaction has been largely focused on sites that have been subject to clearcut harvest (Alban et al. 1994: Stone and Elioff 1997). Compaction resulting from partial cut harvest treatments, although less studied, can also negatively affect soil productivity under some conditions. Although partial harvest treatments are frequently assumed to result in comparatively lower amounts of potential resource damage, each of the alternatives addressed in this EIS projects some level of partial harvest treatments. It's important that these treatments be subject to equipment and seasonal limitations similar to those applied to clearcut harvest. (Jaakko Poyry 1992a)

Some lands are so susceptible to compaction and related effects that timber production operations based on existing technology and knowledge cannot be conducted without causing unacceptable damage to soil productivity or other key watershed conditions. None of the alternatives addressed in this EIS project timber harvest to occur on these highly susceptible lands.

Rutting of soil can occur when soil is too wet to support an applied load of vehicle traffic. Rutting affects water movement through surface soils, physically severs roots, and degrades the rooting environment by reducing aeration and infiltration. Rutting can dam water flowing over the soil surface, creating increased soil saturation up gradient from the rut, or it can divert and concentrate surface flows to accelerate rate of runoff, or sometimes, erosion.

Nutrient loss in soil is associated with vegetation removal and with the loss of the forest floor and the surface organic layer. Soil organic matter plays a vital role in providing a nutrient source as well as maintenance of the site productivity, soil water retention capabilities, and cation exchange capacity (Jurgensen et al. 1986). The microflora and microfauna that are found in soil organic matter are important in nutrient cycling and soil formation. Soil organic matter is an essential component of soil because it provides a carbon and energy resource for soil microbes (USDA-NRCS 1996). Organic carbon in the forest floor organic layer is what energizes most soil biotic processes, promotes nutrient and water flow, and provides for soil aeration (Powers 2002).

A number of natural or human-caused site disturbances can disrupt the soil organic layer and potentially lead to associated nutrient loss in forests. These disturbances include:

- Timber harvest or other silvicultural operations can result in nutrient depletion, depending on the nutrient status of the soil, and the tree species and volume of biomass removed. The majority of nutrients in trees occur in foliage, branches, and bark. Nutrients in soils are replaced through natural processes such as atmospheric deposition, biological fixation, and weathering of minerals.

- Burning, tilling, or clearing a wooded area can release carbon from organic matter in soil and convert it to carbon dioxide, possibly contributing to nutrient loss on some sites (Whipple 1997).
- Earthworm activity has recently been cited as producing possible detrimental effects to the soil organic layer in some forested sites. Activity of worms converts the fibrous forest floor layer into an exposed organic-rich mineral layer that can cause nutrients to become unavailable for plant growth or be leached/eroded away from the rooting zone (www.nrri.umn.edu/worms). At least one older study (Alban and Berry 1994) indicates some earthworms incorporate the organic layer into the mineral soil, but may not affect site productivity.

The supply of nutrients "initially" present (prior to undertaking management activities) in LTs/ELTs vary because of site characteristics such as parent material, soil organisms, landscape position, and climate. Nutrients lost to forest sites due to management activities may be a relatively small portion of the whole on sites that have initially high amounts of nutrients. Other sites may be affected more dramatically because their initial nutrient capital is limited.

Generally, considering the range of species subject to timber harvest on the Chippewa and Superior NFs, harvest of aspen and aspen-birch remove the most nutrients. Sandy, shallow to bedrock, and some organic soils are generally most affected by nutrient removal resulting from timber harvest, burning, and site preparation (Jaakko Poyry 1992a)

Maintenance of soil productivity on sites sensitive to nutrient loss requires development of a long-term strategy. Such a strategy can address factors such as time between repeated harvests on a given site. Longer rotations can provide added time for nutrients to be replenished between harvests. Some studies suggest that time between harvest be at least 50 years, and perhaps up to 75 years (Jaakko Poyry 1992a). Some computer simulation models suggest that a 60-80 year interval between harvests is needed to return nitrogen availability to pre-harvest levels in formerly upland hardwood sites (Powers et al. 1990). Other factors that can be part of the strategy include timber type conversion from aspen or upland hardwoods to species (such as jack pine or red pine) with lower nutrient demands (Powers et al. 1990); and providing for retention well-distributed slash or woody debris during harvest operations.

Impact of site preparation practices also need to be considered in the maintenance of soil nutrients on sensitive sites (Jaakko Poyry 1992a and Powers et al. 1990). Although a common reason for site preparation is to improve regeneration success by reducing weed competition at seedling microsites, some site preparation practices can result in erosion, loss of organic matter, soil displacement, and compaction. Cumulatively, or over time, this can reduce the ability of some sites to sustain long-term growth (Powers et al. 1990). Strategies for sites susceptible to nutrient loss need to balance short term weed control/better early growth with the desire for long term sustained growth that's promoted by the maintenance of site soil productivity (Powers et al. 1998).

Severe fire, whether from management actions or natural sources, can have a considerable effect on soil productivity. Fire can expose bedrock or burn off entire layers of organic matter on sensitive sites. On such sites it could take tens to hundreds of years, depending on site conditions, for soils to re-develop.

Wildland fires are expected to occur, and are much more likely to severely affect soil resources, if fuel loads are high. Fire intensities would likely be higher and the fires more severe under conditions of low soil moisture. With drier soils, the forest floor (duff layer and surface organic layer) would be consumed in greater quantities, exposing mineral soil to erosion and killing the near-surface soil organisms. Higher combustion temperatures would volatize more nutrients and convert more organic matter to ash, which can erode by wind or water and result in removal of nutrients (Debano et al. 1998, USDA-FS 2001a. Portions of both Forests are not only more prone to wildfire (have higher incidences of lightening-caused starts), but are also susceptible to total organic matter burn-off if fires occur under conditions of severe drought.

On the Superior NF assessment of LTAs prone to lightening-caused fire indicates that dominant ELTs are prone to drying out early in the spring on shallow to bedrock sites on the Laurentian Shield (Leuelling and Tine 1997, USDA-FS 1998a). On the Chippewa NF Landtypes (LTs) susceptible to lightening-caused fire are dominated by excessively drained sandy sites (Shadis 1997a, Shadis 1997b, and USDA-FS 1998g).

Management-ignited fires, which to varying degrees are part of all alternatives addressed in this EIS, can result in soil organic matter effects similar to what's discussed above for wildfire. Management-ignited fires would likely be in the form of underburns, broadcast burns or pile burning. Each form results in different potential effects on soil productivity and would be subject to guidelines designed to mitigate effects based on site (ecological landtype) characteristics and weather conditions. Many sites that are known to have the lowest nutrient levels and be most susceptible to organic matter burn-off are considered non-suitable for timber production, and are therefore off-limits to fires started to assist in timber production, under all of the alternatives analyzed in this EIS. However, such sites are not necessarily off-limits to fires ignited for purposes of reducing fuel hazards or for returning fire to its historic role on the landscape.

Knowledge gained from past use and management of fire and from collaboration with Canadian fire experts (DeGroot 1987; Van Nest and Alexander 1999) has increased the predictability of the effects fire will have under varying conditions on a broad range of soils, including the specific ecological landtypes (LTs and ELTs) present on both Forests. Factors such as selecting the proper "fire window" (seasonal weather conditions that allow for igniting fires with reasonably predictable results) will be employed in all burning operations under any of the selected alternatives for management discussed in this EIS.

Although conclusive scientific evidence does not currently exist, some concern has arisen about the loss of the organic layer resulting from fire, and how this might influence the storage and release of mercury in forest soils (Woodruff and Cannon 2001, Woodruff et al. 2003). It is possible that fire severe enough to remove the organic layer may change the ability of soil to store mercury, and perhaps either hasten or reduce, the transport of mercury to lakes and streams. The relationship between fire and storage/transfer of mercury in Minnesota forests is the subject of ongoing (Kolka et al. 2004) and planned studies.

Effects of Recreation Activities Common to all Alternatives

Effects on soil and water related to **motorized summer (ATV) trails and motorized winter (snowmobile) trails** are essentially the same as those discussed above for roads and trails. Motorized summer trails would be constructed using national trail standards that would minimize, but not entirely eliminate, the types of impacts discussed above. The type of effects of motorized winter trails are similar to those for summer trails, although the magnitude of effects from snowmobile trails tend to be much less, due to lower potential for erosion (less soil disturbance and placement of fill) and rutting (use occurs primarily under frozen ground conditions). The probability of erosion or sedimentation from snowmobile trails is highest during periods of thaw when use may occur on part of trails where snow has already melted. For both summer and winter trails, impacts are likely to be greatest during trail construction when the greatest amount of soil is in a disturbed state. Both types of trails would be monitored and repaired if erosion or rutting is observed.

Cross-country ATV use can have similar effects to that of roads and trails. This is particularly true if use is repeated and where the use of these vehicles creates ground disturbance such as rutting, deformed stream banks, and riparian vegetation damage. This effect is particularly acute where use is associated with riparian areas. Generally, if an ATV passes once through an area off a road corridor, the chance for soil and water impacts is low, particularly if the travel is in upland areas. Observations indicate that in wetlands or in upland areas where more than two or three ATV passes are made over the same route, cutting through the upper soil layers can result, causing compaction and rutting.

Cross-country snowmobile use impacts on soil and water include erosion, sedimentation, and changes to winter soil temperatures. Observations indicate that areas along portages or areas where snowmobiles intersect the contact between ice and land have potential for erosion and sedimentation during periods of thaw.

Repeated snowmobile cross-country travel may alter the soil temperature by compacting natural snow cover thereby altering its potential to insulate the ground under the compacted area. As a consequence, organic matter decomposition and humus formation could be retarded, and the survival of some plants jeopardized due to deep freezing. This affect, coupled with physical damage caused by direct contact with the machines if snow cover is not adequate, could produce changes in natural vegetation. The impacts may be greater in forested areas than in more open areas, partially because snow drifting fills tracks in open areas. (Wanek 1971) Very little of the current cross-country snowmobile use occurs in heavily forested areas due to the difficulty in driving such machines off trail through brush. Most cross-country snowmobile use occurs on unplowed roads and in open lowland areas.

Controls on cross-country use would be provided where unreasonable damage to soil or water resources is occurring. But, compared to use on designated trails, cross-country travel impacts are more difficult to monitor, so corrective actions to mitigate the effects described above are less likely to happen in a regular or timely manner.

Water access facilities can result in effects that are similar to those associated with roads and trails. One main difference is that the location of water access facilities is almost always in or near a riparian area, lake or stream. The level of effect is directly related to the level of development and type of water access that is constructed. Portage trails or carry-in accesses with parking well away from riparian areas have less potential to create negative effects to riparian and aquatic resources than do other types of accesses that focus activities at the immediate water's edge. Without proper controls, facilities that are at the upper end of the range of development levels can impact riparian areas and aquatic environments through vegetation removal and the hardening of parking areas and launching sites. This hardening effect decreases or eliminates infiltration, and results in increased overland flow that may cause sedimentation at the launching site. Improving user-developed or substandard access facilities could result in decreased negative effects by reducing sediment sources and relocating parking to environmentally suitable areas. Disturbance of near-shore habitat is another common effect of water access sites, especially at those sites that are more highly developed. Aquatic plants can be uprooted by boat traffic and riparian vegetation can be trampled by foot traffic. At access sites experiencing high levels of use, or when multiple users are launching watercraft at the same time, these effects may extend beyond the launching site itself.

Direct and Indirect Effects

Indicator 1: Trend of Watershed Impacts from Transportation System

Refer to Table WSM-3 and Figures WSM-1 and WSM-2 for a quick visual comparison among alternatives for the results from analysis of Indicator 1.

Based on analysis of this indicator, the alternatives are listed below by least to most potential intensity or extent of negative road impacts to riparian areas (thus least to most potential negative impact to watershed health).

Chippewa NF - Alternative: D, B, F, G, Modified E, A, C
Superior NF - Alternative: D, (B and F), Modified E, G, A, C

Impacts are described below by alternative, and displayed in Figures WSM-1 and WSM-2, in terms of the portion (percentage) of 6th level watersheds that would experience an increase in riparian road interaction class as a result of harvest-related road construction. On both Forests, and for all alternatives, the stated increases result primarily from projected construction of temporary roads.

An increase in riparian road interaction index class can be interpreted to mean that overall riparian health (and thus watershed health) is likely to diminish over the watersheds if concurrent actions are not taken to improve riparian and stream crossings to offset expansion of the transportation system.

The riparian road interaction index used in this analysis assumes that impacts from new roads would have roughly the same impacts as roads that have been constructed over recent past decades. Some degree of impact from new roads on riparian areas, particularly impacts from stream and wetland crossings, is unavoidable. However, objectives, standards, and guidelines that would be part of the revised Forest Plans provide the means to substantially reduce these impacts below levels associated with many existing roads which have been on the landscape for several decades.

Assuming the new road-related objectives, standards and guidelines in the revised Forest Plan are used, riparian impacts associated with new Forest roads are expected to be nominal. Further, as harvest units are accessed under the revised Plan, improvements are likely to be made to existing stream and riparian crossings on portions of the transportation system that are used for harvest access.

Alternative A

Chippewa NF: Timber harvest is projected in 198 individual 6th level watersheds. Fourteen percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. Projected temporary roads contribute almost exclusively to this increase. In less than one percent of treated watersheds is this increase due solely to projected system road construction.

Superior NF: Timber harvest is projected in 190 individual 6th level watersheds. Seventeen percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. In only four percent of treated watersheds is this increase due solely to projected construction of summer system Objective Maintenance Level 1 (OML-1) roads.

Alternative B

Chippewa NF: Timber harvest is projected in 194 individual 6th level watersheds. Nine percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. Projected temporary roads contribute almost exclusively to this increase. In less than one percent of treated watersheds is this increase due solely to projected system road construction.

Superior NF: Timber harvest is projected in 184 individual 6th level watersheds. Eleven percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. In only two percent of treated watersheds is this increase due solely to projected construction of summer system Objective Maintenance Level 1 (OML-1) roads.

Alternative C

Chippewa NF: Timber harvest is projected in 195 individual 6th level watersheds. Fourteen percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. Projected temporary roads contribute almost exclusively to this increase. In less than one percent of treated watersheds is this increase due solely to projected system road construction.

Superior NF: Timber harvest is projected in 191 individual 6th level watersheds. Twenty two percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. In only six percent of treated watersheds is this increase due solely to projected construction of summer system Objective Maintenance Level 1 (OML-1) roads.

Alternative D

Chippewa NF: Timber harvest is projected in 178 individual 6th level watersheds. Eight percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. Projected temporary roads contribute almost exclusively to this increase. In less than one percent of treated watersheds is this increase due solely to projected system road construction.

Superior NF: Timber harvest is projected in 178 individual 6th level watersheds. Seven percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. In only two percent of treated watersheds is this increase due solely to projected construction of summer system Objective Maintenance Level 1 (OML-1) roads.

Table WSM-3. Percent of 12-digit watersheds (and the number of watersheds) that change to the next higher Riparian Road Interaction Index class by end of second decade due to road construction by road type.

National Forest	Alt. A No Action	Alt. B	Alt. C	Alt. D	Modified Alt. E	Alt. F	Alt. G
	% (no.)	% (no.)	% (no.)	% (no.)	% (no.)	% (no.)	% (no.)
Chippewa							
Temporary Roads	13.1(26)	8.8(17)	14.4(28)	7.9(14)	10.8(21)	10.2(19)	11.0(21)
System Roads	0.5(1)	0.5(1)	0.5(1)	0.6(1)	0.5(1)	0.5(1)	0.5(1)
System and Temporary Roads	13.6(27)	8.8(17)	14.4(28)	8.4(15)	11.3(22)	10.2(19)	11.0(21)
Superior							
Summer System OML1 Roads	4(7)	2(3)	6(11)	2(3)	3(6)	2(4)	3(6)
Temporary Summer Roads	12(22)	7(13)	16(31)	6(11)	10(18)	8(15)	10(19)
All Summer Roads	17(32)	11(21)	22(42)	7(13)	12(22)	10(18)	15(28)

Source: Based on Dualplan projection of regeneration harvest acres during first two decades, historical data on road miles/ac of timber harvest, and extrapolation of current riparian impact area: riparian area ratio.

Modified Alternative E

Chippewa NF: Timber harvest is projected in 195 individual 6th level watersheds. Eleven percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. Projected temporary roads contribute almost exclusively to this increase. In less than one percent of treated watersheds is this increase due solely to projected system road construction.

Superior NF: Timber harvest is projected in 179 individual 6th level watersheds. Twelve percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. In only three percent of treated watersheds is this increase due solely to projected construction of summer system Objective Maintenance Level 1 (OML-1) roads.

Alternative F

Chippewa NF: Timber harvest is projected in 187 individual 6th level watersheds. Ten percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. Projected temporary roads contribute almost exclusively to this increase. In less than one percent of treated watersheds is this increase due solely to projected system road construction.

Superior NF: Timber harvest is projected in 186 individual 6th level watersheds. Ten percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. In only two percent of treated watersheds is this increase due solely to projected construction of summer system Objective Maintenance Level 1 (OML-1) roads.

Alternative G

Chippewa NF: Timber harvest is projected in 191 individual 6th level watersheds. Eleven percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. Projected temporary roads contribute almost exclusively to this increase. In less than one percent of treated watersheds is this increase due solely to projected system road construction.

Figure WSM-1. Percent of Watersheds with Planned Timber Harvest that Have an Increase in Riparian Road Influence Class due to Associated Road Construction for the First Two Decades-- CHIPPEWA NATIONAL FOREST

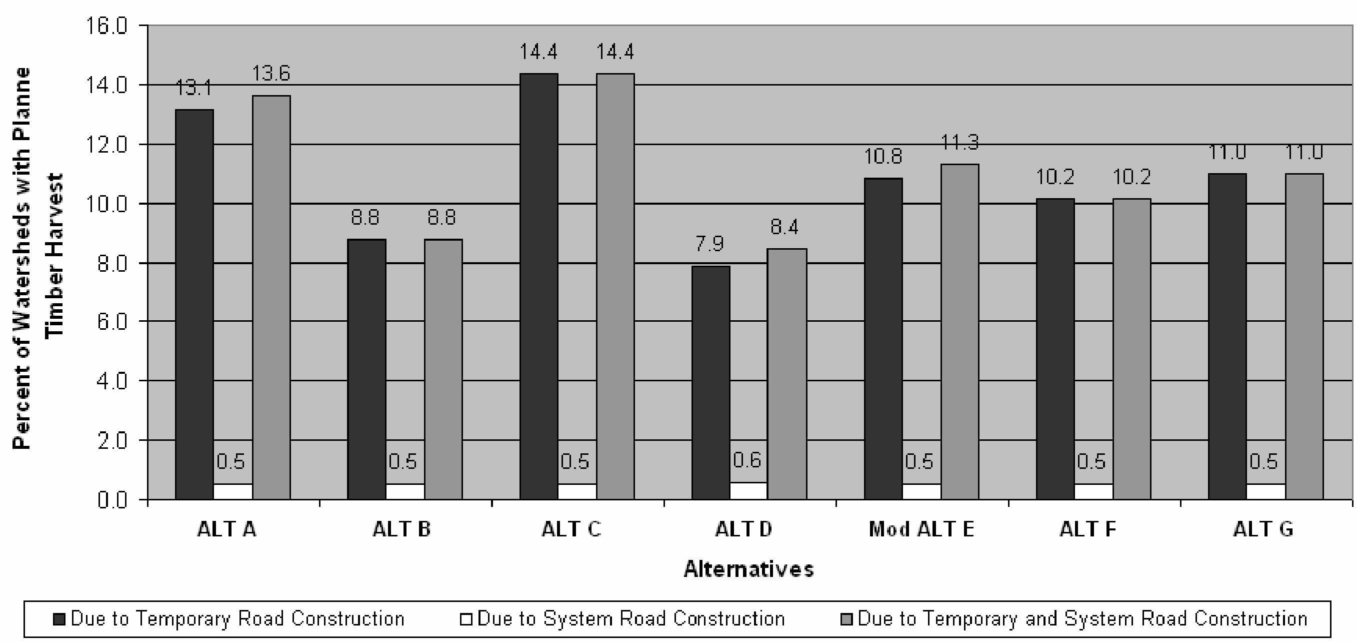
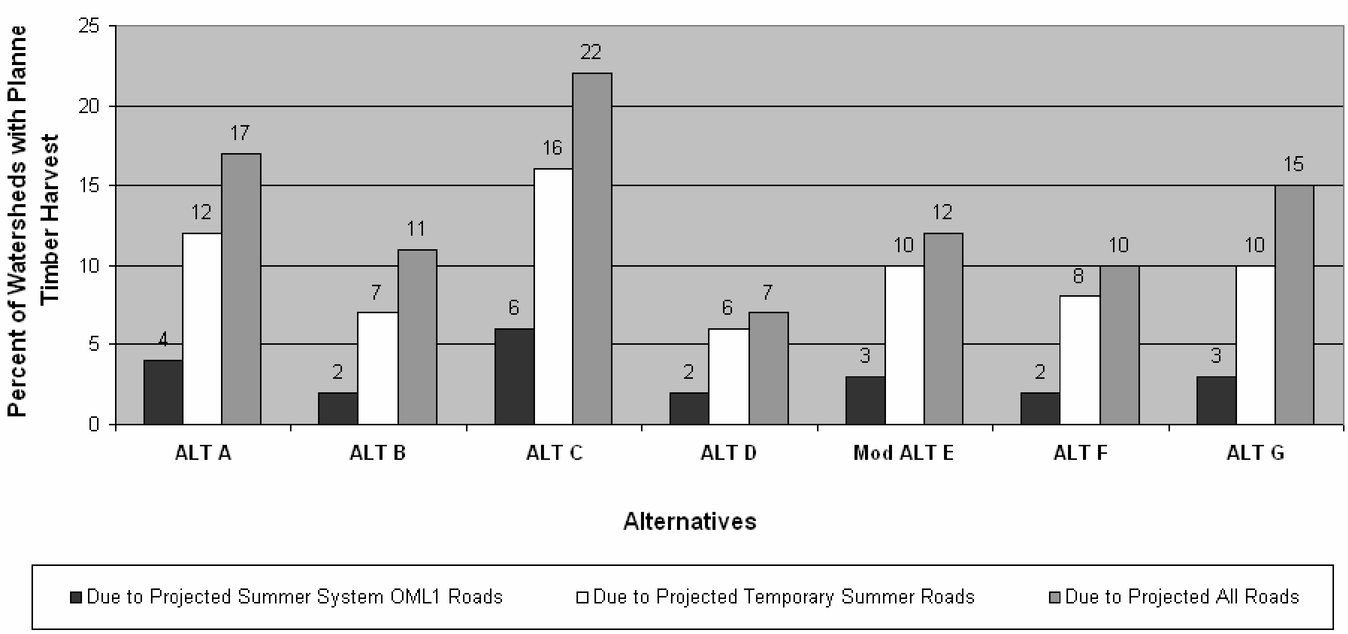


Figure WSM-2. Percent of Watersheds with Planned Timber Harvest that Have an Increase in Riparian Road Influence Class due to Associated Road Construction for the First Two Decades-- SUPERIOR NATIONAL FOREST



Superior NF: Timber harvest is projected in 189 individual 6th level watersheds. Fifteen percent of these watersheds would increase in riparian road interaction class from the combined effect of harvest-associated temporary and system road construction. In only three percent of treated watersheds is this increase due solely to projected construction of summer system Objective Maintenance Level 1 (OML-1) roads.

Indicator 2: Stream Crossing Density

Potential impacts associated with additional road building and stream-crossing construction varies by alternative, but the trend is similar between the Forests. Table WSM-4 and Figures WSM-3 and WSM-4 display the percent change in mean crossing density by alternative by Forest.

The alternatives are listed below in order from the lowest to highest percent increase in stream crossing density (least to most potential affects on stream resources).

For Chippewa NF - Alternative: D, F, B, G, Modified E, A, C.
For Superior NF - Alternative: D, B, F, G, Modified E, A, C.

On the Superior National Forest data was available to separate crossings associated with winter roads from crossings on summer roads, using the following groupings:

- "Summer OML 1" roads include only objective maintenance level 1 (OML 1) system roads that are constructed for dry weather use.
- "All Summer Roads" include summer OML 1 system roads plus summer use (or dry weather) temporary roads.
- "All Roads" includes the summer (or dry weather) temporary and OML 1 system roads, plus those temporary and OML 1 system roads that are constructed for frozen period use only ("winter roads").

All road types on the Superior NF, regardless of season or maintenance level (summer OML 1, all summer, or all roads, which includes winter temporary and OML 1 roads), show similar trends in stream crossing density.

On the Chippewa National Forest road analysis did not define temporary or system roads as winter or summer, so all projected roads are included in the total.

See the Transportation System Appendix (Appendix F) for further definitions of road classifications.

This plan revision does not direct specific amounts of road decommissioning or timeframes for temporary road obliteration, so this indicator portrays a maximum potential impact from stream crossings associated with additional road construction. In addition, this analysis assumes that all stream crossings have the same potential impacts on stream resources, and that new stream crossings would have the same impact as existing stream crossings. However, most of the new roads would be temporary roads, which would be in place from one to five years, on average. System road construction would follow new standards and guidelines for stream crossings, as specified in the revised plan, and these additional design considerations should minimize potential impacts from system road construction. Therefore, potential effects from new stream crossings on system roads should be reduced from historic levels.

Existing roads and stream crossings will be evaluated as part of project level analysis, and if negative impacts on ecological function (such as stream stability, floodplain function, or wetland function) are found, mitigation actions will be prescribed. Mitigation actions may include removal, relocation, or redesign of the roads or crossing structures.

Potential effects from construction of additional roads and stream crossings are discussed earlier in this section of the EIS under *General Effects Common to All Alternatives – Effects of Roads and Trails*.

Alternative A

Chippewa NF: Mean stream crossing density would increase by 10 percent in Alternative A. This Alternative ranks second with regards to potential impacts on watersheds and their stream systems.

Superior NF: Overall mean stream crossing density would increase by 13 percent in Alternative A, with the greatest increase coming from stream crossings associated with temporary summer roads.

Alternative B

Chippewa NF: Mean stream crossing density would increase by 6.5 percent in Alternative B.

Superior NF: Overall mean stream crossing density would increase by 7 percent in Alternative B, with the greatest increase coming from stream crossings associated with temporary summer roads.

Alternative C

Chippewa NF: Mean stream crossing density would increase by 13 percent in Alternative C. This would be the greatest increase of all alternatives.

Superior NF: Overall mean stream crossing density would increase by 17.5 percent in Alternative C, with the greatest increase coming from stream crossings associated with temporary summer roads.

Alternative D

Chippewa NF: Alternative D would have the lowest increase (five percent) in mean stream crossing density and the lowest percent increase overall. Low timber harvest levels associated with this alternative would result in the least amount of road building and the lowest potential for impacting aquatic resources.

Superior NF: Alternative D would have the lowest percentage increase in mean stream crossing density, at 6.3 percent for all roads.

Modified Alternative E

Chippewa NF: Modified Alternative E would have the third greatest percentage increase in mean stream crossing density, with an increase of 8.5 percent.

Superior NF: Modified Alternative E would have the third greatest percentage increase in mean stream crossing density with a 10.6 percent increase. Summer temporary road/stream crossings would account for over half of that increase.

Alternative F

Chippewa NF: Limited road building in Alternative F would result in the second lowest increase in mean stream crossing density (6.3 percent) and a low overall mean stream crossing density.

Superior NF: Alternative F would have a mid-range percent increase in mean stream crossing density, with an 8.5 percent increase for all roads. Summer temporary roads would account for the largest portion of this increase.

Table WSM-4: Change in mean stream crossing density in 12-digit (Hydrologic Unit Code) watersheds where DualPlan treatments result in additional road building for the Chippewa and Superior National Forests.

National Forest	Existing Condition	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod Alt. E	Alt. F	Alt. G
	(Units)	(Units)	(Units)	(Units)	(Units)	(Units)	(Units)	(Units)
Chippewa:								
Mean stream crossing density (# of stream crossings per stream mile) --ALL Roads	0.79	0.87	0.84	0.89	0.83	0.85	0.84	0.85
Superior:								
Mean stream crossing density (# of stream crossings per stream mile) – ALL Roads	0.71	0.80	0.78	0.84	0.77	0.80	0.78	0.78

Source: Dualplan harvest outputs and historical road-building estimates used to predict road building and associated stream crossing activity in 12-digit watersheds.

Figure WSM-3. Percent Increase in the Average Number of Stream Crossings per Stream Mile for Road-Related Activities Associated with Planned Timber Harvest for the First Decade--CHIPPEWA NATIONAL FOREST

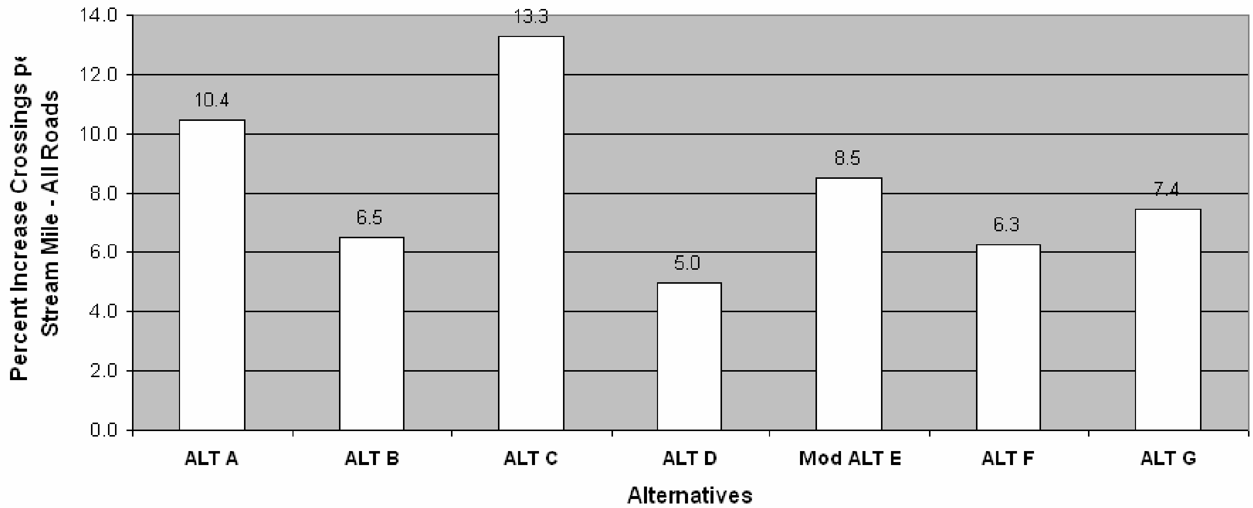
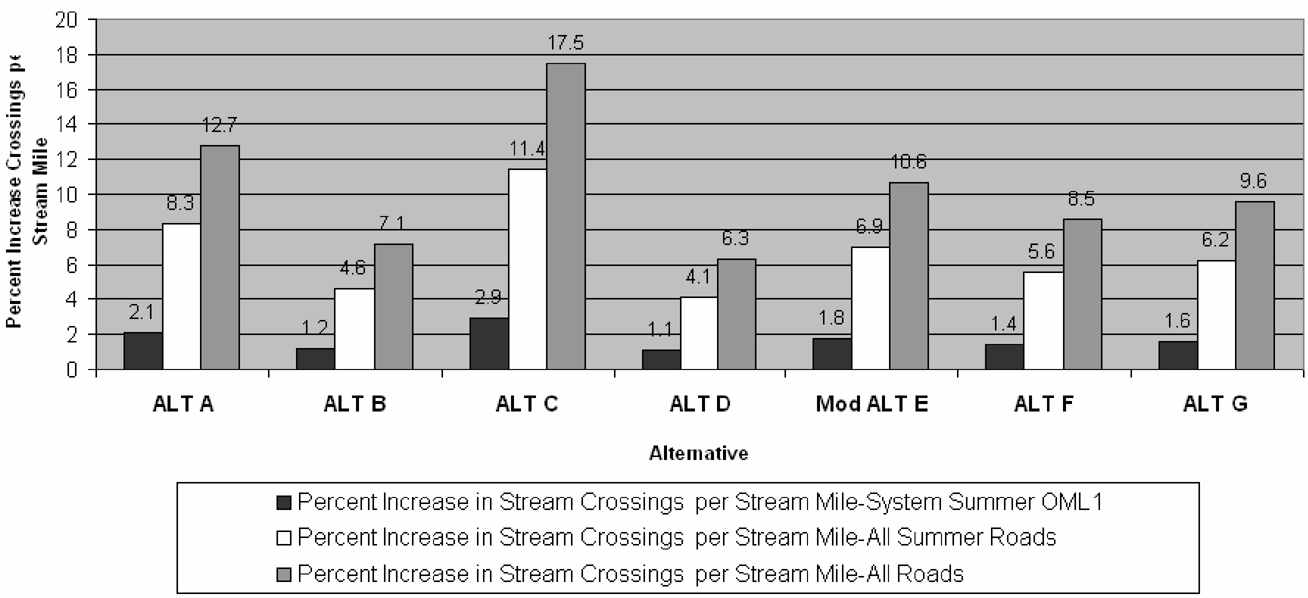


Figure WSM-4. Percent Increase in the Average Number of Stream Crossings per Stream Mile for Road-Related Activities Associated with Planned Timber Harvest for the First Decade-- SUPERIOR NATIONAL FOREST



Alternative G

Chippewa NF: Alternative G would have a mid-range percent increase in mean stream crossing density, with a 7.4 percent increase for all roads.

Superior NF: Alternative G would have a mid-range mean percent increase in stream crossing density. This is estimated to result mainly from construction of temporary summer (dry use) roads.

Indicator 3: Portion of National Forest Land with Watershed Management above the Stewardship Level

Refer to Table WSM-5 for a comparison of alternatives regarding the results from analysis of Indicator 3.

Based on analysis of this indicator, the alternatives are listed below in order of the most to least acreage of watershed management above the basic stewardship level (thus most to least benefit to watershed health).

Chippewa NF - Alternative: B, D, F, G, Modified E, C and A.
Superior NF - Alternative: B, F, G, D, Modified E, C and A.

To derive this indicator each management area was characterized by its relative level of emphasis on watershed health as a focus for management. The starting point for the percentages used in this indicator is the accumulated acreages allocated to each of the various management areas, an allocation which is unique to each alternative. The percentages have been adjusted where necessary to reflect legal requirements (such as the Shipstead-Newton-Nolan Law on the Superior NF) and the alternatives' proposed approach to management of riparian areas on both Forests.

The percentages appear to show less relative difference between alternatives on the Superior NF than on the Chippewa NF. The primary reason for this difference is the large number of Superior NF acres assigned to Wilderness Management Areas in the BWCAW. These acres, which have been characterized as above stewardship level, are constant across all Superior NF alternatives, thus tending to mute the differences between the alternatives.

Alternative A

Under Alternative A, 7 percent of the Chippewa NF and 41 percent of the Superior NF would be subject to watershed management above the stewardship level. Relative to other alternatives, Alternative A offers the least amount of focus on watershed management above the stewardship level.

Alternative B

Under Alternative B, 99 percent of the Chippewa NF and 97 percent of the Superior NF would be subject to watershed management above the stewardship level. Relative to other alternatives, Alternative B offers the highest amount of focus on watershed management above the stewardship level.

Alternative C

Under Alternative C, 12 percent of the Chippewa NF and 43 percent of the Superior NF would be subject to watershed management above the stewardship level. Relative to other alternatives, Alternative C offers a low amount of focus on watershed management above the stewardship level.

Table WSM-5: Percent of Forest Managed Above Basic Stewardship Level for Watershed Health

National Forest	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod Alt. E	Alt. F	Alt. G
	%	%	%	%	%	%	%
Chippewa	7	99	12	98	47	94	77
Superior	41	97	43	77	66	80	79

Source: This is a byproduct of the allocations to management areas made in each alternative, and subjectively assigning each management area to one of two categories: "at" stewardship level or "above" stewardship level.

Alternative D

Under Alternative D, 98 percent of the Chippewa NF and 77 percent of the Superior NF would be subject to watershed management above the stewardship level. Relative to other alternatives, Alternative D offers a high amount of focus on watershed management above the stewardship level.

Modified Alternative E

Under Modified Alternative E, 47 percent of the Chippewa NF and 66 percent of the Superior NF would be subject to watershed management above the stewardship level. Relative to other alternatives, Modified Alternative E offers a medium amount of focus on watershed management above the stewardship level.

Alternative F

Under Alternative F, 94 percent of the Chippewa NF and 80 percent of the Superior NF would be subject to watershed management above the stewardship level. Relative to other alternatives, Alternative F offers a high amount of focus on watershed management above the stewardship level.

Alternative G

Under Alternative G, 77 percent of the Chippewa NF and 79 percent of the Superior NF would be subject to watershed management above the stewardship level. Relative to other alternatives, Alternative G offers a high amount of focus on watershed management above the stewardship level.

Indicator 4: Soil Quality Associated with Treatment Activities, Temporary Roads, OML 1 Roads, Skid Trails, and Landings

Refer to Tables WSM-6 through WSM-9 for a summary of the results from analysis of Indicator 4 for the Chippewa NF and Superior NF.

The alternatives are listed below in order from the least to most potential negative impacts of vegetation management treatments, and associated roads, skid trails and landings, on wetlands and soils.

Chippewa NF - Alternative: D, B/ F, G, Modified E, A, C.
Superior NF - Alternative: D, B/Modified E, F, G, A, C.

For this analysis on both Forests, treatments from the Dualplan model were grouped into two categories: “even-aged” which consist of Dualplan treatment methods 1-5 and “uneven-aged” which consist of treatment methods 6-16. (Treatment method descriptions can be found in Appendix B.) Landtypes (LTs) on the Chippewa NF and Ecological Landtypes (ELTs) on the Superior NF that are sensitive to compaction were grouped into two categories: compaction class 1 (wetlands and other sites where operations are limited to frozen conditions) and compaction class 2 (moderately well drained sites and sites where use of equipment is limited to dry periods or frozen conditions). The Chippewa NF also has a third compaction class for sites in low elevations that are poorly drained; these are sites where operations are limited to frozen conditions. These categories represent the potential areas where soil quality may be affected by mechanical treatment.

Construction of temporary roads, use of OML 1 roads, skid trails, and use of landings are associated with mechanical treatment, and may be a source of detrimental soil disturbance such as compaction, soil displacement, and rutting. The amount of temporary and OML l roads, and the number of landings associated with modeled Dualplan treatments, were estimated for each alternative using information from Appendix F of this EIS.

Using the numbers derived from this analysis, the alternatives reflect a relative ranking of total potential compacted acres (arising from both even and uneven-aged treatments) that could be present over two time periods: decade one and decade two. The alternatives were ranked on a scale of one to seven, with one representing the least potential for overall impact, and seven representing the most potential for overall impact.

The rankings for Indicator 4 only take into account a comparison of treatment units with soil characteristics that would have a tendency to be impacted. Not all treated acres would be compacted. For all alternatives, impacts can be reduced considerably if standards (including soil quality standards) and guidelines, and other mitigation techniques designed to protect long-term productivity of the soil are implemented as activities take place.

It should be noted that projects related to recreation, wildlife, fisheries, and other resources on both Forests may impact soil quality, but these effects are usually less than that associated with harvest treatments.

Long-term impacts on soil quality affect not only timber growth but may also affect other aspects of watershed health by indirectly affecting water yield.

Alternative A

In decades 1 and 2 for both Forests, Alternative A ranks sixth overall among the alternatives because there is high potential for the most treatment units, roads, landings, skid trails, and wetlands to be impacted.

Alternative B

Depending on decade, Alternative B ranks either second or third among the alternatives, on both Forests. This ranking is based this alternative's relatively low potential for treatment units, roads, skid trails, landings and wetlands to be impacted.

Alternative C

In decades 1 and 2 for both Forests, Alternative C ranks seventh overall among the alternatives. The highest potential for the most treatment units, roads, landings, skid trails, and wetlands to be impacted occurs in this alternative.

Alternative D

In decades 1 and 2, for both Forests, Alternative D ranks first overall among the alternatives because it has the lowest potential for treatment units, roads, skid trails, landings and wetlands to be impacted.

Modified Alternative E

In decades 1 and 2, for the Chippewa NF, Modified Alternative E ranks fifth overall amount the alternatives and has medium potential to have the most treatment units, roads, skid trails, landings and wetlands to be impacted. Depending on decade, Modified Alternative E on the Superior NF ranks either second or third best, with a low to medium potential for negative impacts due to compaction from treatment units, roads, skid trails, and landings.

Alternative F

Depending on decade, on the Chippewa NF, Alternative F ranks second or third overall among the alternatives, with relatively low potential for impacts. In decades 1 and 2 for the Superior NF, Alternative F ranks fourth overall among the alternatives and has a medium potential for the most treatment units, roads, landings, skid trails, and wetlands to be impacted.

Alternative G

In decade 1 and 2 for the Chippewa NF, Alternative G ranks fourth overall among the alternatives and has medium potential for the most impacts. On the Superior NF, Alternative G has medium to high potential for impacts, ranking fifth best among the alternatives.

Table WSM-6: Soil quality associated with treatment activities, temporary roads, OML 1 roads, landings and skid trails for decade 1 (acres)—CHIPPEWA NATIONAL FOREST

Attribute	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod. Alt. E	Alt. F	Alt. G
Total Area							
All Treatments	86,189	55,337	118,460	35,123	77,323	47,542	60,996
Treatment Area							
Even Aged *(1-5)	79,453	20,428	110,756	25,356	40,879	25,950	33,728
Uneven Aged (6-16)	6,735	34,909	7,703	9,767	36,444	21,592	27,268
Compaction Class 1 (frozen wetlands)							
Even Aged (1-5)	7,430	2,508	9,830	1,128	3,310	3,460	3,264
Uneven Aged (6-16)	259	2,789	346	485	1,812	2,912	1,297
Compaction Class 2 (dry or frozen)							
Even Aged (1-5)	47,162	10,630	66,795	17,034	24,677	14,656	19,025
Uneven Aged (6-16)	2,805	19,558	5,001	6,075	25,289	12,525	15,725
Compaction Class 3 (frozen soil)							
Even Aged (1-5)	10,896	3,992	17,793	1,582	6,268	4,742	5,801
Uneven Aged (6-16)	239	6,449	295	1,643	4,886	4,303	3,662
Total Compaction							
Even Aged (1-5)	65,488	17,130	94,418	19,743	34,255	22,857	28,090
Uneven Aged (6-16)	3,303	28,796	5,642	8,202	31,987	19,740	20,683
Temporary Roads							
All Treatments	1,148	636	1,583	445	929	574	738
OML 1 Roads							
All Treatments	52	34	72	21	46	29	37
Landings							
All Treatments	1,396	877	1,920	598	1,387	760	966
Skid Trails							
All Treatments	10,343	6,641	14,215	4,215	9,279	5,977	7,320
Total Area of Roads and Landings							
All Treatments	2,596	1,547	3,575	1,064	2,362	1,363	1,741
Total Area of Roads, Skid Trails and Landings							
All Treatments	12,939	8,188	17,790	5,279	11,641	7,340	9,061
Compaction, all treatments, including total area of roads, skid trails and landings for decade 1.	81,730	54,114	117,850	33,224	77,883	49,937	57,834
Ranking	6	3	7	1	5	2	4

Source: Treatment acres from Dualplan. Numbers in parentheses in attribute column refer to the numbering of the various types of treatments as used in the Dualplan model.
Definitions: Compaction Class 1 includes LTs 65, 70, 75, and 76. Compaction Class 2 includes LTs 15, 16, 20, 25, 45, 46, and 55. Compaction Class 3 includes LTs 35 and 40. Ranking based on potential compaction associated with all treatments including roads, skid trails, and landings.

Table WSM-7: Soil quality associated with treatment activities, temporary roads, OML 1 roads, skid trails and landings for decade 2 (acres)—CHIPPEWA NATIONAL FOREST

Attribute	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod. Alt. E	Alt. F	Alt. G
Total Area							
All Treatments	89,421	54,668	98,028	29,206	82,453	59,410	60,996
Treatment Area							
Even Aged *(1-5)	74,792	20,238	74,656	17,147	41,744	25,810	33,656
Uneven Aged (6-16)	14,629	34,430	23,372	12,060	40,709	33,600	36,311
Compaction Class 1 (frozen wetlands)							
Even Aged (1-5)	8,185	2,321	6,305	1,052	3,335	3,395	3,278
Uneven Aged (6-16)	247	1,019	224	506	1,304	262	1,065
Compaction Class 2 (dry or frozen)							
Even Aged (1-5)	42,505	10,587	43,891	10,812	23,365	14,208	19,185
Uneven Aged (6-16)	8,353	22,621	18,917	7,207	30,449	22,764	23,460
Compaction Class 3 (frozen soil)							
Even Aged (1-5)	11,576	3,702	13,062	992	7,467	4,310	5,026
Uneven Aged (6-16)	571	4,215	974	3,514	4,619	5,315	3,473
Total Compaction							
Even Aged (1-5)	62,265	16,609	63,258	12,856	34,167	21,912	27,490
Uneven Aged (6-16)	9,171	27,854	20,116	11,227	36,372	28,341	27,998
Temporary Roads							
All Treatments	1,166	628	1,254	357	985	695	825
OML 1 Roads							
All Treatments	33	33	5	18	29	36	37
Landings							
All Treatments	1,400	775	1,477	444	1,182	833	1,030
Skid Trails							
All Treatments	10,731	6,560	11,763	3,505	9,894	7,129	8,396
Total Area of Roads and Landings							
All Treatments	2,599	1,436	2,736	819	2,196	1,564	1,892
Total Area of Roads, Skid Trails and Landings							
All Treatments	13,330	7,996	14,499	4,324	12,090	8,693	10,288
Compaction, all treatments, including total area of roads, skid trails and landings for decade 2.	84,766	52,459	97,873	28,407	82,629	58,946	65,776
Ranking	6	2	7	1	5	3	4

Source: Treatment acres from Dualplan Numbers in parentheses in attribute column refer to the numbering of the various types of treatments as used in the Dualplan model.
Definitions: Compaction Class 1 includes LTs 65, 70, 75, and 76. Compaction Class 2 includes LTs 15, 16, 20, 25, 45, 46, and 55. Compaction Class 3 includes LTs 35 and 40. Ranking based on potential compaction associated with all treatments including roads, skid trails, and landings.

Table WSM-8: Soil quality associated with treatment activities, temporary roads, OML 1 road type, landings and skid trails for decade 1 (acres)—SUPERIOR NATIONAL FOREST							
Attribute	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod. Alt. E	Alt. F	Alt. G
Total Area							
All Treatments	156,226	88,374	221,245	76,131	131,912	107,383	116,819
Treatment Area							
Even Aged *(1-5)	143,313	52,114	204,874	58,468	83,692	73885	86,200
Uneven Aged (6-16)	12,912	36,260	16,371	17,662	48,220	33,498	30,619
Compaction Class 1 (frozen wetlands)							
Even Aged (1-5)	64,203	22,032	85,102	25,886	16,278	32,513	37,102
Uneven Aged (6-16)	4,966	14,116	5,579	7,494	2,825	12,265	10,357
Compaction Class 2 (dry or frozen)							
Even Aged (1-5)	34,923	13,215	46,882	11,979	30,147	14,905	19,861
Uneven Aged (6-16)	2,341	9,273	3,635	5,201	7,741	7,950	7,580
Total Compaction							
Even Aged (1-5)	99,126	35,247	131,984	37,865	46,425	47,418	56,963
Uneven Aged (6-16)	7,307	23,389	9,214	12,695	10,566	20,215	17,937
Temporary Roads							
All Treatments	2,113	1,195	2,991	1,029	1,825	1,452	1,580
OML 1 Road Type							
All Treatments	699	394	990	341	583	482	523
Landings							
All Treatments	5,299	3,657	6,907	3,073	5600	4,004	4,615
Skid Trails							
All Treatments	14,060	7,954	19,912	6,852	11,872	9,664	10,514
Total Area of Roads and Landings							
All Treatments	8,111	5,246	10,888	4,443	8008	5,938	6,718
Total Area of Roads, Skid Trails and Landings							
All Treatments	22,171	13,200	30,800	11,295	19,880	15,602	17,232
Compaction, all treatments, including total area of roads, skid trails and landings for decade 1.	128,604	71,836	171,998	61,855	76,871	83,235	92,132
Ranking	6	2	7	1	3	4	5

Source: Treatment acres from Dualplan. Numbers in parentheses in attribute column refer to the numbering of the various types of treatments as used in the Dualplan model.
Definitions: Compaction Class 1 includes ELTs 2, 4, 5 and 6. Compaction Class 2 includes ELTs 1, 3, 10, 14 and 15. Ranking based on potential compaction associated with all treatments including roads, skid trails, and landings.

Table WSM-9: Soil quality associated with treatment activities, temporary roads, OML 1 road type, landings and skid trails for decade 2 (acres)-- SUPERIOR NATIONAL FOREST							
Attribute	**Alt. A** No Action	**Alt. B**	**Alt. C**	**Alt. D**	**Mod. Alt. E**	**Alt. F**	**Alt. G**
Total Area							
All Treatments	170,352	98,002	215,242	50,266	132,481	116,872	127,690
Treatment Area							
Even Aged *(1-5)	151,488	52,699	190,277	44,734	89,459	88,284	91,303
Uneven Aged (6-16)	18,864	45,033	24,965	5,532	43,022	28,588	36,386
Compaction Class 1 (frozen wetlands)							
Even Aged (1-5)	64,767	24,102	79,243	19,963	17,987	38,267	39,958
Uneven Aged (6-16)	6,226	16,240	7,820	1,631	1,877	9,636	11,838
Compaction Class 2 (dry or frozen)							
Even Aged (1-5)	35,893	14,171	45,199	8,609	33,834	20,774	22,403
Uneven Aged (6-16)	3,686	13,598	6,428	1,726	7,099	6,065	10,070
Total Compaction							
Even Aged (1-5)	100,660	38,273	124,442	28,572	51,821	59,041	62,361
Uneven Aged (6-16)	9,912	29,838	14,248	3,357	8,976	15,701	21,908
Temporary Roads							
All Treatments	2,316	1,326	2,928	680	1,849	1,595	1,733
OML 1 Road Type							
All Treatments	1,312	745	1,764	520	1,091	903	983
Landings							
All Treatments	6,099	3,801	7,564	2,030	4812	4,130	4,946
Skid Trails							
All Treatments	15,332	8,820	19,372	4,524	11,923	10,518	11,492
Total Area of Roads and Landings							
All Treatments	9,727	5,872	12,256	3,230	7752	6,628	7,662
Total Area of Roads, Landings and Skid Trails							
All Treatments	25,059	14,692	31,628	7,754	19,675	17,146	19,154
Compaction, all treatments, including total area of roads, skid trails and landings for decade 2.	135,631	82,803	170,318	39,683	80,472	91,888	103,423
Ranking	6	3	7	1	2	4	5

Source: Treatment acres from Dualplan. Numbers in parentheses in attribute column refer to the numbering of the various types of treatments as used in the Dualplan model.
Definitions: Compaction Class 1 includes ELTs 2, 4, 5 and 6. Compaction Class 2 includes ELTs 1, 3, 10, 14 and 15. Ranking based on potential compaction associated with all treatments including roads, skid trails, and landings.

Indicator 5: Soil Quality Associated with Fire Activities

The alternatives are listed below in order from the least to most potential negative impacts on soil quality from fire activities, measured in terms of total potential acreage proposed for management-ignited fire:

Chippewa NF - Alternatives: C, A, G, Modified E, B, D, F
Superior NF – Alternatives: C, A, G, Modified E, D, B, F

Refer to Tables WSM-10 and WSM-11 for results of this analysis for the alternatives on both Forests.

For both Forests, it is possible that in all the alternatives, sensitive LTs and ELTs with soil components that are low in nutrients and have thin forest floor (organic) layers may be impacted, both short-term and long-term, by management-ignited fire. It's also possible that on these sites the 15 percent limitation rule for soil quality damage by severe fire may be exceeded (USDA-FS 2002n).

For both Forests, Alternative C has the lowest, and Alternative F has the highest potential for impact to soil from management prescribed fire. Alternative A has the second lowest potential for these effects on both Forests. Of the remaining alternatives, Alternatives Modified E and G rank out somewhat better (lower potential impact to soil) than Alternatives B or D.

Table WSM-10: Soil Quality Associated with Fire Activities (Chippewa National Forest)

Attribute	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod. Alt. E	Alt. F	Alt. G
DECADE 1							
Opportunity Acres for Fire Activity	35,747	38,809	30,738	39,024	36,657	41,721	37,258
DECADE 2							
Opportunity Acres for Fire Activity	31,521	39,120	25,648	42,350	37,718	41,709	35,723
TOTAL – DECADES 1 AND 2							
Opportunity Acres for Fire Activity	67,268	77,929	56,386	81,374	74,375	83,430	72,981
OVERALL RANKING	2	5	1	6	4	7	3

Source: Proposed Maximum Available Acres of Management-Ignited Fire (Table FIR-1).
Definitions: Ranking is based on decade 1 and decade 2 total numbers of acres potentially treated by prescribed fire under each alternative. Ranking scale is 1 (lowest potential for sensitive LTs to be impacted) to 7 (highest potential for sensitive LTs to be impacted.)

Table WSM-11: Soil Quality Associated with Fire Activities (Superior National Forest)

Attribute	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod. Alt. E	Alt. F	Alt. G
DECADE 1							
Opportunity Acres for Fire Activity	75,511	82,388	65,165	78,457	79,054	88,359	79,761
DECADE 2							
Opportunity Acres for Fire Activity	68,882	82,528	53,471	82,391	78,803	89,905	77,477
TOTAL – DECADES 1 AND 2							
Opportunity Acres for Fire Activity	144,393	164,916	118,636	160,848	157,857	178,264	157,238
OVERALL RANKING	2	6	1	5	4	7	3

Source: Proposed Maximum Available Acres of Management-Ignited Fire (Table FIR-2).
Definitions: Ranking is based on decade 1 and decade 2 total numbers of acres potentially treated by prescribed fire under each alternative. Ranking scale is 1 (lowest potential for sensitive ELTs to be impacted) to 7 (highest potential for sensitive ELTs to be impacted).

It is assumed that some Landtypes (LTs) and Ecological Landtypes (ELTs) are more susceptible to fire impacts than others, and that mitigation measures would be implemented when management ignited fire is applied to these sites. Use of management ignited fire with mitigation can be less damaging to soil quality than if a natural fire occurred under conditions of extreme weather and large fuel loadings.

To assess this indicator, each alternative was characterized by the maximum potential acreage of management ignited fire as outlined in Tables FIR-1 and FIR-2 in Section 3.5 of this EIS. These proposed maximum acres consist of treatments for site preparation, hazardous fuel reduction, and for ecological reasons (such as surface fire). Burning activities for decade 1 and decade 2 were ranked based on the number of acres potentially treated by management-ignited fire under each alternative.

Indicator 6: Soil Nutrient Cycling on Sensitive Sites

The alternatives are listed below in order from the least to most potential negative impacts to soil nutrients on sensitive sites.

Chippewa NF - Alternative: B, F, D, G, Modified E, A, C.
Superior NF - Alternative: B, D, F, G, A, Modified E, C.

Chippewa NF: Refer to Table WSM-12. Interpretations to address Landtype (LT) sensitivity to nutrient drain focused on LTs 5 and 6 (LTs that would likely be impacted by short cycle rotations) Alternative B would have the lowest concern and Alternative C would have the highest concern regarding nutrient drain. The other alternatives are arrayed in between, with Alternative F having the second lowest concern, followed by Alternatives D, G and Modified E, which have moderate concerns. Alternative A has the second highest concern.

Superior NF: Refer to Table WSM-13. Interpretations to address Ecological Land Type (ELT) sensitivity to nutrient drain focused on ELTs 7, 9, 11, 16 and 17 (ELTs that would likely be impacted by short cycle rotations). Alternatives C and Modified E would have the highest acreage of treatments in low nutrient capital ELTs. Alternative A follows with the third

Table WSM-12: Acres of Treatment with Potential to Affect Soil Nutrient Cycling on Sensitive Landtypes (LTs)—CHIPPEWA NATIONAL FOREST

Attribute	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod. Alt. E	Alt. F	Alt. G
Decade 1 Even Aged Treatments 1-5 in Low Nutrient Capital LTs	13,965	3,299	16,338	5,613	6,625	3,093	5,637
Decade 2 Even Aged Treatments 1-5 in Low Nutrient Capital LTs	12,527	3,629	11,398	4,290	7,578	3,898	6,166
Total – Decades 1 and 2 Even Aged Treatments 1-5 in Low Nutrient Capital LTs	26,492	6,928	27,736	9,903	14,203	6,991	11,803
Ranking is based on total number of acres possibly impacted Decades 1 and 2	6	1	7	3	5	2	4

Source: Tied to Dualplan treatment outputs. Treatment numbers in Attribute column refer to the numbering of even-aged treatments as used in the Dualplan model.
Definitions: Low nutrient capital LTs include LTs 5 and 6.
‡Notes: For this analysis, there is no direct correlation with LTs in terms of retreatments over time (short cycle rotation). This shows acres of treatment that would occur in sensitive LTs. We do not know whether any or all of these acres would be retreated (that is, that they are undergoing a 2^{nd} or 3^{rd} harvest on the same site).

Table WSM-13: Acres of Treatment with Potential to Affect Soil Nutrient Cycling on Sensitive Ecological Landtypes (ELTs)—SUPERIOR NATIONAL FOREST

Attribute	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod. Alt. E	Alt. F	Alt. G
Decade 1 Treatments 1-5 in Low Nutrient Capital ELTs (7,9,11,17)	34,254	12,007	47,628	15,962	43,280	18,816	20,977
Decade 2 Treatments 1-5 in Low Nutrient Capital ELTs (7,9,11,17)	32,352	9,303	41,639	10,541	41,149	20,127	20,413
Total – Decades 1 and 2 Treatments 1-5 in Low Nutrient Capital ELTs (7,9,11,17)	66,606	21,310	89,267	26,503	84,429	38,943	41,390
Ranking is based on total number of acres possibly impacted—Decades 1 and 2	5	1	7	2	6	3	4

Source: Tied to Dualplan treatment outputs. Treatment numbers in Attribute column refer to the numbering of even-aged treatments as used in the Dualplan model.
Definitions: Low nutrient capital ELTs include ELTs 7, 9, 11, 16 and 17.
‡Notes: For this analysis, there is no direct correlation with ELTs in terms of retreatments over time (short cycle rotation). This shows acres of treatment that would occur in sensitive ELTs. We do not know whether any or all of these acres would be retreated (that is, that they are undergoing a 2nd or 3rd harvest on the same site.).

highest acreage to have treatments on those ELTs. Moderate concerns would apply to Alternatives F and G. Alternatives B and D would have the lowest acreage of treatments in the sensitive ELTs.

This analysis was based on acres of Dualplan treatment method numbers 1-5 that are interpreted as more likely to involve short cycle rotations. Dualplan model outputs were analyzed to determine where treatment methods 1 through 5 coincide with nutrient-sensitive ELTs. This made it possible to generally highlight potential sites where short cycle rotations would be a concern. The analysis was not specific enough to geographically identify individual treatment site where a 2nd or 3rd harvest was projected to occur. This analysis only shows where the Dualplan model selected nutrient sensitive sites for at least one treatment. Therefore, this indicator is being used as a relative measure to show which alternatives would be most to least likely to have nutrient loss concerns if 2nd or 3rd harvest treatments were to occur on the same site.

Indicator 7: Recreation Effects

Motorized Summer Trails

Based on the information from Table RMV-2, the alternatives are listed below in order from least to most potential detrimental soil and water impact associated with additional designated ATV trails.

Both Forests - Alternative: D, B, (A, C, F and G), and Modified E.

On both the Chippewa and Superior NFs, no additional designated ATV trails are proposed in Alternative D and the maximum potential new miles to meet current demand are proposed in Modified Alternative E.

Relative differences between alternatives in terms of potential negative impacts to soil and water are reflected in the maximum amount of additional designated ATV trail allowed under each alternative. Alternatives allowing the greatest increased mileage of designated ATV trail would generally have the greatest potential for detrimental soil and water impacts. See the discussion of typical "on-the-ground" impacts under *General Effects Common to all Alternatives*. Also see Table RMV-2, which identifies the maximum mileage of additional designated ATV trail associated with each alternative.

Motorized Winter Trails

Based on the information from Table RMV-3, the alternatives are listed below in order of least to most potential detrimental soil and water impact associated with additional designated snowmobile trails.

Chippewa NF - Alternative: D, B, (F and G); (A, C, and Modified E)
Superior NF - Alternative: D, B; (F and G); (A and C); and Modified E

On both Forests, no additional designated snowmobile trail is proposed in Alternative D. Maximum potential additional designated miles to meet current demand are proposed in Alternatives A, C, and Modified E on the Chippewa, in Alternative Modified E on the Superior.

Relative differences between alternatives in terms of potential negative impacts to soil and water are reflected in the maximum amount of additional designated snowmobile trail allowed under each alternative. Alternatives allowing the greatest increased mileage of designated snowmobile trail would generally have the greatest potential for detrimental soil and water impacts. See the discussion of typical "on-the-ground" impacts under *General Effects Common to all Alternatives*. Also see Table RMV-3, which identifies the maximum mileage of new designated snowmobile trail associated with each alternative.

Cross Country ATV and Snowmobile Use

Based on the information from Table RMV-5, the alternatives are listed below in order of least to most potential detrimental soil and water impact associated with cross-country ATV and snowmobile use.

Chippewa NF - Alternative: (A, B, D, Modified E, F, G), and C
Superior NF - Alternative: D, (B, Modified E, F, and G), C, and A

On the Chippewa NF cross-country ATV and snowmobile use would be prohibited in Alternatives A, B, D, Modified E, F and G. In Alternative C, cross-country snowmobile use would be prohibited and cross-country ATV use would be allowed only for big game retrieval and furbearer trapping access.

On the Superior National Forest cross-country ATV and snowmobile use is prohibited in Alternative D. In Alternatives B, Modified E, F, and G, cross-country ATV use would be prohibited throughout the Forest and cross-country snowmobile use would be allowed in most management areas. In Alternative C cross-country ATV use would be allowed only for big game retrieval and furbearer trapping access and cross-country snowmobile use would be allowed in most management areas. In Alternative A, cross-country ATV and snowmobile use are both allowed.

Relative differences between alternatives in terms of potential negative impacts to soil and water are reflected in the alternative-specific polices regarding cross-country ATV and snowmobile use. Alternatives which least restrict cross-country use would generally have the greatest potential for detrimental soil and water impacts. See the discussion of typical "on-the-ground" impacts under *General Effects Common to All Alternatives*. Also see Table RMV-5, which identifies, by alternative, the level of use restriction on cross county ATV and snowmobile travel on each Forest.

Water Access

Based on the information from Table WTA-7, and the associated discussion of direct and indirect effects of water access, the alternatives are listed below in order of least to most potential detrimental soil and water impact associated with new water access sites.

Both Forests - Alternative: B and D, F and G, A, Modified E, C.

There are no differences between alternatives in terms of the maximum total number of new water access sites. Some differences in potential negative impacts to soil and water result from the alternative-specific maximum development levels for new or reconstructed water access sites. Alternatives allowing the highest facility development levels for new sites would generally have the greatest potential for detrimental soil and water impacts. See the discussion of typical "on-the-ground" impacts under *General Effects Common to All Alternatives*. Also see Table WTA-7, which identifies the maximum development levels for new water access sites that are associated with each alternative.

Cumulative Effects

Cumulative Effects for the Watershed and Riparian Indicators—Background

Cumulative Effects for Watershed and Riparian Indicators are presented and discussed below in two different ways:

1. Cumulative effects related to Watershed Indicators #3 through #7 are addressed below in the form of separate discussions for each indicator (or, in the case of soils-related indicators numbered 4, 5 and 6, a group discussion).

2. Cumulative effects related to Watershed Indicators #1 and #2, and Riparian Indicators #1 through #4, are addressed below in the discussion of Watershed Indicator #8. Watershed indicator #8 is a good cumulative effects indicator because it uses watersheds (natural integrators for effects related to water flow and water quality), accounts for the amount of upland open and upland young forest resulting from harvest on NFS lands, and at the same time recognizes and allows for similar conditions on other lands within the watershed. The basis for using Indicator 8 as the "master" cumulative effects integrator for Watershed indicators #1 and #2, and Riparian Indicators #1-#4 is that the relative ranking of alternatives expressed as upland open and upland young forest status of watersheds should closely parallel the rankings based on the other indicators. Table WSM-14 below summarizes how watershed indicators #1 and #2 and riparian indicators #1 through #4 relate to watershed indicator #8:

Table WSM-14. Relationship Between Watershed Indicator #8 and Selected Other Watershed and Riparian Indicators Used in Effects Analysis.

Indicators	Relationship to Watershed Indicator #8
Watershed #1 and #2	Because vegetation management activities are anticipated to be the principle source of future changes in the road mileage or number of stream crossings, the amount of upland open and upland young upland forest (watershed indicator #8) will generally vary in direct proportion to the amount of road (watershed indicator #1) and stream crossing density (watershed indicator #2).
Riparian #1 and #2	Riparian vegetation age (riparian indicator #2), and to some degree riparian vegetation composition (riparian indicator #1), is addressed to the extent that the watershed-wide proportion of upland under age 15 (as represented by watershed indicator #8) is representative of riparian area conditions.
Riparian #3 and #4	Vegetation treatment acres in riparian areas (riparian indicator #3) or in the potential coarse woody debris recruitment zone (riparian indicator #4) are to some degree a microcosm of vegetation treatment acres at the whole watershed scale (expressed in Indicator #8)

Cumulative Effects for Watershed Indicator #3: Portion of National Forest Land with Watershed Management above the Stewardship Level

The relative ranking of alternatives based on the cumulative effects associated with watershed indicator #3 is the same as the ranking that results from analysis of direct and indirect effects. That ranking, listed in order of the most to least acreage having potential for watershed management above the basic stewardship level (thus most to least potential benefit to watershed health), is:

Chippewa NF – Alternative: B, D, F, G, Modified E, C and A.
Superior NF – Alternative: B, F, G, D, Modified E, C and A.

As described earlier, this indicator is designed as a subjective and relative measure of each alternative's potential to manage NFS land with a focus on watershed health. This potential arises as a product of the Management Area allocations assigned to NFS land, an assignment which is unique to each alternative. Past Management Area allocations on NFS lands will either remain largely unchanged from those which apply currently (Alt A) or will change to reflect the emphasis or theme of the "action" alternatives (Alts B, C, D, Modified E, F and G). Regardless of which alternative is eventually selected, there are no known current proposals or reasonably foreseeable future proposals for sizably changing the watershed management emphases of intermingled non-federal lands. Therefore actions of non-federal entities are not expected to exert notable forest-wide influence, either positive or negative, in the potential level of watershed management focus associated with each alternative.

Cumulative Effects for Watershed Indicators 4, 5 and 6 Related to Soil Quality

The alternatives are listed below in order from least to most potential cumulative effects overall to the soil resource on the Chippewa and Superior NFs. The effects speak to conditions on National Forest System (NFS) lands only.

Chippewa NF - Alternatives: D, B, F, G, Modified E, A, C.
Superior NF - Alternatives: D, B, F, G, Modified E, A, C.

For this analysis, an effect on the soil resource is considered a change in either soil productivity or soil properties. Past, present and foreseeable future actions within the Chippewa NF and Superior NF boundaries are considered, with a focus on ecological landtypes (LTs on Chippewa NF/ELTs on Superior NF) that are most sensitive to disturbance.

Consult Tables WSM-15 and WSM-16 for a quick visual comparison between alternatives of the results from cumulative effects analysis of Indicators 4, 5, and 6.

Table WSM-15: Ranking* of Cumulative Effects of Indicators 4, 5 and 6 for Chippewa NF (NFS land only)

Alt.	Compaction ** (Ind. #4)	Fire (Ind. #5)	Nutri-ents (Ind. #6)	Over-all***
A	6	2	6	6
B	2	5	1	2
C	7	1	7	7
D	1	6	3	1
Mod E	5	4	5	5
F	3	7	2	3
G	4	3	4	4

*Ranking scale: "1" (least potential negative effect) to "7" (most potential negative effect)
**Compaction ranking derived by adding acres for decade 1 and decade 2.
***Overall ranking derived by totaling all acres potentially impacted by all three indicators.

Table WSM-16: Ranking* of Cumulative Effects of Indicators 4, 5 and 6 for Superior NF (NFS land only)

Alt.	Compaction ** (Ind. #4)	Fire (Ind. #5)	Nutri-ents (Ind. #6)	Over-all***
A	6	2	5	6
B	2	6	1	2
C	7	1	7	7
D	1	5	2	1
Mod E	3	4	6	5
F	4	7	3	3
G	5	3	4	4

*Ranking scale: "1" (least potential negative effect) to "7" (most potential negative effect)
**Compaction ranking derived by adding acres for decade 1 and decade 2.
***Overall ranking derived by totaling all acres potentially impacted by all three indicators.

This analysis suggests that alternatives with the most emphasis on harvest activities (Alternatives A and C), have the highest potential impacts on the soil resource overall, with most of the potential impacts resulting from harvest, rather than other management activities including management–ignited fire. In those alternatives where fire treatments receive the most emphasis (Alternatives B, D, and F), the amount of potential soil damage resulting from timber harvest would be about equal to that resulting from fire, but total potential soil resource damage from all activities combined would be less that the other four alternatives. The remaining two alternatives (Modified E and G) have moderate emphasis on both fire and harvest activities (relative to the other alternatives), resulting in a moderate level of overall potential impacts to soil.

Soil disturbance associated with timber harvest is a factor associated with most of the alternatives. Despite this, timber harvest likely to occur on non-federal lands, when considered in combination with similar activities on NFS land, is expected to result in only a minor effect on soil productivity. Thus significant cumulative impacts on soil productivity are not expected during the life of the revised Plan.

Proposed harvest and potential management-ignited fire activities would have short-term and minor effects on site productivity from soil compaction, displacement, erosion, severe burning, and nutrient loss. Under any of the alternatives, implementation of forest-wide standards and guidelines, coupled with mitigations for soil management, should help to hold the negative effects on soil productivity to minimal levels. The current trend toward increased use of “lighter on the land” equipment is expected to continue, and should further safeguard soil productivity. This positive trend in technology and awareness of the need to protect soil productivity is supported on most forest ownerships via implementation of the Voluntary Site-Level Forest Management Guidelines (MFRC 1999d) and associated monitoring efforts (Phillips and Dahlman 2001)

Recreational use on both Forests is also expected to have some effect on soil nutrients and productivity. The greatest effects related to recreation occur where user-developed trails cause erosion along lakeshores and streams. In terms of amount of area affected, these effects would be minor in comparison to those associated with projected vegetation treatment and associated activities such as landings, skid roads, and temporary roads. A possible exception to this is that an escaped fire caused by recreational negligence may result is soil damage that could rival that associated with either prescribed fire or typical vegetation treatments.

As discussed earlier, for both Forests, certain ecological landtypes (LTs/ELTs) are considered sensitive to fire because of their potential for declines in soil quality from severe burning. Fire can expose bedrock or burn off entire layers of organic matter on the most sensitive sites. Treatments on sensitive LTs/ELTs may exceed the 15 percent affected area threshold for individual treatment units (USDA-FS 2002n) on rare occasions when fires are applied to areas dominated by sensitive LTs/ELTs, but are unlikely to exceed this standard when applied to the entire analysis area of the Forests as a whole. The geographic distribution of projected fire activities may result in some LTs/LTAs being affected more than others and consequently there is some potential for watershed scale effects.

Projections of fire activity under the revised Plan on the Superior NF, need to be considered in combination with fuel treatment prescribed fires currently planned in response to the July 1999 blowdown in the Boundary Waters Canoe Area Wilderness. Although fuels reduction burns are likely to be the only significant management-induced activities that would be occurring in the Wilderness, these burn do have potential to cause soil damage because of the unusually high level of fuel loading. The associated potential damage to soil productivity is considered to be less than if a wildfire, or escaped fire, were to occur in the same areas, which could result in even greater amounts of organic layer removal and mineral soil damage on the most sensitive sites. It is expected that the ongoing collaboration with State, County, and Canadian fire officials will assist in improving understanding of fire behavior, and thus promote future use of fire with increasingly predictable results.

Harvest activities on other ownerships (State, County, Forest Industry, and nonindustrial private forests) show similar trends to proposed activities associated with the most of the alternatives discussed in this EIS (White 2003), including similar levels of vegetation treatments. Although precise numbers are not available, projections across all ownerships include the possibility for increases in the amount of thinning treatments, and the possibility for a more prominent role for fire in the overall mix of forest management actions. Increased fire activity on other ownerships is likely to result in increased potential damage to soil productivity on sensitive sites.

Cumulative Effects for Watershed Indicator #7: Recreation Effects

Motorized Summer Trails

For both Forests, the net affect on a cumulative basis as measured in the terms of the overall potential for soil and water impacts associated with new summer trails are estimated to be:

- Alternatives B and D—lower potential soil and water impact
- Alternatives A, C, Modified E, F and G—higher potential soil and water impact

Cumulative effects of concern related to soil and water are of the same type discussed as typical "on-the-ground" impacts under Effects of Recreation Activities Common to All Alternatives. The judgment of relative differences between alternatives presented above is based on the following factors which help to assess summer motorized trail impacts on a cumulative (as opposed to a direct and indirect) basis:

- *Future actions (beyond the plan period) on NFS lands*—Maximum additional designated trail miles associated with each alternative applies to the time period of the next 10-15 years. These effects are accounted for in the discussion of direct and indirect effects. Trail needs beyond 15 years, and their associated potential soil and water impacts, are impossible to predict because they would be dependant upon demand that exists at that time and demonstrated evidence (through monitoring of the in-place trail system) that trails can be built and used without unacceptable levels of resource and social impact.
- *Present and future actions on all public lands*--Under all alternatives, due to existing or proposed NFS and other agency direction aimed at limiting ATV use to designated trails, the total amount of trail open to ATVs, and thus susceptible to associated soil and water impacts, should be reduced below current levels.
- *Present and future actions on non-NFS lands*—From the cumulative effects discussion of demand for summer trails (see Recreation section of EIS), Alternatives A, C, F and G are not likely to completely meet the NFS share of anticipated demand. The resulting "shortfall" on NFS lands might be small enough that other landowners could reasonably pick up the slack to fully meet the demand. Some potential for soil and water impacts would be associated with this trail construction by other landowners. Alternatives B and D would contribute few or no miles of new trail on NFS land, and the "shortfall" would probably be large enough that other landowners would not be able to fully pick up the slack. Under Modified Alternative E, the National Forests would contribute their full share toward meeting demand for new trails.

Motorized Winter Trails

The net affect on a cumulative basis as measured in the terms of the overall potential for soil and water impacts associated with new motorized winter trails on relative basis between alternatives are estimated to be no different than the direct or indirect effects. Specifically, the alternatives are listed below in order of least to most potential detrimental impact:

- Chippewa NF – Alternative: D, B, (F and G), (A, C and Modified E)
- Superior NF—Alternative: D, B, (F and G), A, C, and Modified E

Cumulative effects of concern related to soil and water are of the same type discussed as typical "on-the-ground" impacts under Effects of Recreation Activities Common to All Alternatives. The judgment of relative differences between alternatives presented above is based on the following factors which help to assess winter motorized trail impacts on a cumulative (as opposed to a direct and indirect) basis:

- *Future actions (beyond the plan period) on NFS lands*—Maximum additional designated trail miles associated with each alternative applies to the time period of the next 10-15 years. The effects of these additional miles are accounted for in the discussion of direct and indirect effects. Trail needs beyond 15 years, and their associated potential soil and water impacts, are impossible to predict because they would be dependant upon demand that exists at that time and demonstrated evidence (through monitoring of the in-place trail system) that trails can be built and used without unacceptable levels of resource and social impact. Another relevant trend expected to be evident 5-10 years from now is that the total miles of available snowmobile travel route, and thus open to potential soil or water damage attendant with snowmobile use, is likely to either stay the same as, or decrease from, current levels. In other words, regardless of alternative, the potential mileage gain in new trails on the National Forests is very likely to be offset by a reduction in open roads and trails availability resulting from the increased trend toward "designation" of routes for motorized trail use.

- *Present and future actions on non-NFS lands*—From the cumulative effects discussion of demand for snowmobile trails (see Recreation section, Section 3.8, of this EIS), the State believes an adequate primary system of trails is already in place. As the State often has a lead role in trail planning, this suggests that there is minimal potential for new snowmobile trail across non-NFS lands in the vicinity of either National Forest. State land is also expected, due to route "designation", to exhibit the same 5-10 year steady state or downward trend in net snowmobile route availability as described above for NFS lands.

Cross Country ATV and Snowmobile Use

The net affect on a cumulative basis as measured in the terms of the overall potential for soil and water impacts associated with cross-country ATV and snowmobile travel, on relative basis between alternatives, are estimated to be no different than the direct or indirect effects. Specifically, the alternatives are listed below in order of least to most potential detrimental impact:

Chippewa NF—Alternative: (A, B, D, Modified E, F, G), and C.
Superior NF—Alternative: D, (B, Modified E, F, G), C, and A.

Cumulative effects of concern related to soil and water are of the same type discussed as typical "on-the-ground" impacts under *Effects of Recreation Activities Common to All Alternatives* earlier in this section of the EIS. The judgment of relative differences between alternatives presented above is based on the following factors which help to assess cross-country ATV and snowmobile use impacts on a cumulative (as opposed to a direct and indirect) basis:

- *Present and future actions on non-NFS lands*—In those alternatives where cross-country use is prohibited on NFS lands there's some potential that ATVers and snowmobilers who now travel cross-country on the National Forests could be displaced and concentrated on adjacent lands where cross-country use is allowed. The attendant levels of potential soil and water impacts associated with motorized cross-country travel could also increase. It's not likely that this geographic redistribution of impact, when viewed on a cumulative basis, would substantially change the relative ranking of alternatives presented above.

Water Access

The net affect on a cumulative basis as measured in the terms of the overall potential for soil and water impacts associated with new water access sites, on a relative basis between alternatives, are estimated to be no different than the direct or indirect effects. Specifically, the alternatives are listed below in order of least to most potential detrimental impact:

Both Forests – Alternative: (B and D), (F and G), A, Modified E, and C.

Cumulative effects of concern related to soil and water are of the same type discussed as typical "on-the-ground" impacts under *Effects of Recreation Activities Common to All Alternatives* earlier in this section of the EIS. The judgment of relative differences between alternatives presented above is based on the following factors which help to assess water access impacts on a cumulative (as opposed to a direct and indirect) basis:

- *Future actions (beyond the plan period) on NFS lands*—The maximum number of new water access sites (five on the Chippewa NF and ten on the Superior NF) are the same for each alternative (except for Alternative D on the Chippewa, where no new accesses would be constructed) and apply to the time period of the next 10-15 years. Beyond 15 years the need for, and development level of, new water access sites are impossible to predict because they would be dependant upon demand that exists at that time and demonstrated evidence (through monitoring of in-place accesses) that accesses can be built and used without unacceptable levels of resource and social impact.
- *Present and future actions on non-NFS lands*—As documented in the Recreation cumulative effects discussion of water access, many water access opportunities are currently provided on other public and private lands within the counties occupied by the Chippewa and Superior NFs. Statewide, the State of Minnesota is expected to annually construct about 5 new water access sites and reconstruct about 35 water access sites. This rate of is expected to continue for the next ten years. The State focus during this ten year period is expected to be expansion and rehabilitation of existing sites to accommodate the increasing average size of boats and motors. This focus for water access development, and thus the associated level of potential impacts to soil and water, is likely to be the same regardless of which forest plan revision alternative is selected. The fact that some plan revision alternatives more than others will marginally contribute to the increased development levels (and attendant soils and water impacts) is the principle basis for the alternative ranking presented above.

Cumulative Effects for Watershed Indicator #8: Portion of Watershed Characterized by Upland Open and Upland Young (less than age 16) Vegetation

Refer to Table WSM-17 for a quick visual comparison between alternatives of the results from analysis of Indicator 8.

Based on analysis of this cumulative effects indicator, alternatives are listed below in order of least to most number of watersheds where the National Forest System prorated portion of the 60 percent upland open plus upland young forest threshold would be exceeded.

Chippewa NF - Alternative: (B and D), F, G, (A and Modified E), C.
Superior NF- Alternatives B, (D, F, and G), Modified E, A, and C.

When viewed on a forest-wide basis, the number of watersheds where regeneration harvests projected by the timber scheduling model have resulted in the potential for exceeding the National Forest System (NFS) share of the 60 percent threshold is very low. Even in the “worst case” alternative/time period combinations (Alternative C at the end of decade 2 for Chippewa NF and Alternative C at the end of decade 1 for Superior NF) only 2 percent of Chippewa NF 6th level watersheds (six out of a total of 345) and only 4 percent of Superior NF 6th level watersheds (nine out of a total of 253) are predicted to exceed the threshold.

Alternative A

Under Alternative A, the number of watersheds projected to exceed the NFS prorated share of the upland open plus upland young forest cap at 10 years is 3 on the Chippewa NF and 7 on the Superior NF. At 20 years, the number of watersheds would be 3 on the Chippewa NF and 4 on the Superior NF.

Alternative B

Under Alternative B, the number of watersheds projected to exceed the NFS prorated share of the upland open plus upland young forest cap at 10 years is 2 on the Chippewa NF and 2 on the Superior NF. At 20 years, no watersheds on either Forest would exceed the NFS prorated share of the upland open plus upland young forest cap.

Alternative C

Under Alternative C, the number of watersheds projected to exceed the NFS prorated share of the upland open plus upland young forest cap at 10 years is 4 on the Chippewa NF and 9 on the Superior NF. At 20 years, the number of watersheds would be 6 on the Chippewa NF and 4 on the Superior NF.

Alternative D

Under Alternative D, the number of watersheds projected to exceed the NFS prorated share of the upland open plus upland young forest cap at 10 years is 2 on the Chippewa NF and 3 on the Superior NF. At 20 years, no watersheds on either Forest would exceed the NFS prorated share of the upland open plus upland young forest cap.

Modified Alternative E

Under Alternative E, the number of watersheds projected to exceed the NFS prorated share of the upland open plus upland young forest cap at 10 years is 3 on the Chippewa NF and 5 on the Superior NF. At 20 years, the number of watersheds would be 3 on the Chippewa NF and 4 on the Superior NF.

Alternative F

Under Alternative F, the number of watersheds projected to exceed the NFS prorated share of the upland open plus upland young forest cap at 10 years is 2 on the Chippewa NF and 3 on the Superior NF. At 20 years, the number of watersheds would be 1 on the Chippewa NF and none on the Superior NF.

Alternative G

Under Alternative G, the number of watersheds projected to exceed the NFS prorated share of the upland open plus upland young forest cap at 10 years is 3 on the Chippewa NF and 3 on the Superior NF. At 20 years, the number of watersheds would be 2 on the Chippewa NF and none on the Superior NF.

Facets and Limitations of Indicator #8:

The analysis done for this indicator was a necessary cumulative effects checkpoint, and was helpful in suggesting how the National Forests can do their best to assure the 60 percent threshold is not exceeded in individual watersheds. However, it should be recognized that this indicator has a number of limitations and facets:

- The indicator is relevant in some, but not all, of the watersheds encompassed by the Chippewa and Superior NFs. It is a meaningful environmental threshold only in watersheds where upland constitutes 60 percent or more of the total watershed area. So this indicator is not meaningful in watersheds where the combined acreage of lakes, ponds, streams and vegetated wetlands

Table WSM-17: Number of 6th Level Watersheds Where Projected Dualplan Treatments Result in the NFS Prorated Share of the 60% Threshold for Upland Open plus Upland Young Forest Being Exceeded.

National Forest	Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod Alt. E	Alt. F	Alt. G
	(units)	(units)	(units)	(units)	(units)	(units)	(units)
Chippewa							
at 10 years	3	2	4	2	3	2	3
at 20 years	3	0	6	0	3	1	2
Superior							
at 10 years	7	2	9	3	5	3	3
at 20 years	4	0	4	0	4	0	0

Source: Dualplan regeneration harvest output used as input to GIS analysis of acres by 6th level watershed. Resulting acres treated by watershed were then compared against the NFS prorated share (based on NFS landownership) of the 60% upland open +upland young forest threshold.

is more than 40 percent of the watershed area. On the Chippewa NF, it is a meaningful threshold in 226 of the Forest's 345 watersheds; on the Superior NF it is a meaningful threshold in 192 of the Forest's 253 watersheds.

- The indicator does not provide or account for any young forest or temporarily open conditions that may arise from natural causes such as fire or wind.
- The analysis for the Superior NF and the associated results shown in Table WSM-17 include, but do not differentiate between, watersheds that are inside vs. outside the BWCAW. Legal and administrative limitations associated with wilderness designation result in very low (or no) likelihood of management-induced young forest or open conditions on watersheds or portions of watersheds that are inside the wilderness boundary. Except for the potential effects of future large scale wind or wildfire events inside the wilderness, and two or three 6th level watersheds influenced by the 1999 blowdown and resultant fuel treatment decision (USDA-FS 2001h), watersheds with greater than 40 percent wilderness are thus inherently immune to exceeding the 60 percent threshold. Of the 192 SNF watersheds where the portion of open plus young forest is a meaningful threshold, 46 (or 24 percent) have more than 40 percent of their surface area located inside the BWCAW boundary.
- The indicator does not directly address, or attempt to quantify, potential future actions on non-NFS lands. It should be kept in mind that the critical cumulative effects threshold is 60 percent of the surface area of a **total** watershed, including not just NFS lands, as portrayed in this EIS analysis for indicator #8, but land in **all** ownerships within a given watershed. Regardless of what measures are put in place to cap the amount of upland open and upland young forest on NFS lands, what actually happens on a total watershed basis in many watersheds is dependant on regeneration harvest or other actions which result in upland open or young forest conditions on non-NFS lands. Such actions are not only outside the scope of NFS control but are also nearly impossible to predict, particularly at the spatial scale of individual 6th level watersheds. Evidence relevant to what could reasonably be expected to happen on non-NFS land on a forest-wide basis across the Chippewa and Superior NFs may provide some general clues about what could happen at the 6th level watershed scale. Such evidence is limited, but it includes:
    1. **Effects of recent past and present actions**. This is represented by the current status of whole 6th level watersheds in relation to the 60 percent threshold on both Forests. This status was assessed as part of this EIS analysis. Specifically, as discussed under Affected Environment, the current condition is that only nine of the Chippewa NFs 346 6th level HUC watersheds currently exceed the 60 percent threshold and none of the Superior NFs 253 6th level watersheds currently exceed the 60 percent threshold. Based primarily on our understanding of state and county plans for vegetation management, we have no specific evidence to suggest that future actions, such as the amount of regeneration harvest on non-NFS forested lands will significantly change this relationship.
    2. **Trends in the amount of non-NFS upland open (non-forest) land**. These acreages are likely to experience a net increase over the next 10-20 years, reflecting the continuing forest clearing for non-forestry uses such as homes, recreation residences, pastureland, mining, and associated access roads. (MFRC, 1999b)

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The potential influence of non-NFS actions on the upland open and young forest condition is greatest in watersheds where NFS ownership is the lowest. Put another way, the reliability of this indicator as an assessor of cumulative effects is likely to be highest in those watersheds with the highest proportion of NFS land. Conversely, the influence of NFS actions on overall cumulative effects will be low or non-existent in watersheds having no or very low acreages of NFS lands.

Table WSM-18, stratifies the 226 CNF watersheds and 192 SNF watersheds where the 60 percent threshold is meaningful, by the amount of NFS land they contain. This table may be helpful in further gauging the overall reliability and utility of Indicator #8.

This limited ability to predict non-NFS actions in advance, coupled with recognition that the amount and locations of actual NFS regeneration harvests may not exactly match the harvest locations projected by the Dualplan timber scheduling model, suggests that reassessment of the upland open plus young forest condition needs to be done as part of project level analysis for projects in some watersheds. Such re-assessments should use the best and most current information about planned NFS and non-NFS actions that can be gathered at the time of project analysis.

Project level re-assessment should be considered in any watershed where: (a) large amounts of upland open and young forest land are known to be present or planned on non-NFS lands or (b) project-related NFS regeneration harvest acres are significantly larger or in different locations from projections of the timber scheduling model. The findings presented in this EIS analysis would best be used to help identify specific watersheds for which re-assessment of the upland open plus upland young forest condition as part of project-level decision making is most warranted. Watersheds in which the amount of other ownership exceeds 80 percent or watersheds where 55 percent or more of Forest Service ownership is a combination of upland open plus upland young forest, might be high priority for being re-assessed at the project level.

Table WSM-18: Amount of National Forest System Land Ownership in 6th Level Watersheds Where Indicator #8 is Meaningful (e.g. watersheds where upland comprises 60% or more of the total watershed area)

	Chippewa NF		Superior NF	
NFS Land as % of Total Watershed Area	Number of Watersheds	Percent of Watersheds	Number of Watersheds	Percent of Watersheds
>90	3	1	15	8
80 to 90	3	1	21	11
70 to 80	7	3	35	18
60 to 70	10	4	13	7
50 to 60	15	7	13	7
40 to 50	18	8	19	10
30 to 40	31	14	17	9
20 to 30	13	6	10	5
10 to 20	20	9	10	5
1 to 10	16	7	13	7
<1	90	40	26	14
Total	226	100	192	100

Source: GIS enumeration of NFS land by 12-digit HUC watershed

3.6.2 Riparian and Fish Management

Issue Statement

There is debate about how much emphasis should be placed on riparian areas and fish habitat in forest management. Forest Plan revision would determine if the approach to management in riparian areas would stay as it is in the current Plans or if the approach would change to provide direction to enhance and restore riparian functions. Revision may change the management direction for riparian areas, including the size and location of riparian management zones. Forest Plan Revision would also develop direction for the role of Forest Service managers in managing fish habitat with other agencies and American Indian tribes. This direction may include objectives for maintaining, restoring, and enhancing fish habitat.

Indicator 1 – Vegetation Community Composition in Riparian Areas

Indicator 1 for riparian and fish management is the composition of forest vegetation in riparian areas. A characterization of riparian vegetation composition was used, lumping vegetation into two classes, long-lived species and short-lived species, based on the forest types associated with stands. This indicator is described for each alternative in terms of percent change from existing condition. This indicator provides a general characterization of riparian health. The proportion of long-lived versus short-lived tree species is being used as an indirect measure of the relative amount and degree of disturbance per unit time associated with each alternative. Generally, management associated with longer-lived species should have less net disturbance per unit time. Favoring long-lived (over short-lived) species should also present more opportunities for watershed health enhancing attributes such as recruitment of larger and more rot-resistant coarse woody debris to riparian areas, temperature control in aquatic ecosystems, moderation of riparian microclimate, and providing diverse and productive sites for aquatic and terrestrial plants and animals. Favoring long-lived species should adequately provide for other riparian ecological functions such as soil and bank stability, nutrient input to aquatic ecosystems, regulation of water quality, and water storage and conservation.

This indicator highlights the differences between alternatives because each alternative presents a unique mix, through time, of the proportions of long-lived and short-lived tree species within riparian areas.

Indicator 2 – Vegetation Community Age in Riparian Areas

Indicator 2 for riparian and fish management is the age of forest vegetation in riparian areas. Riparian vegetation was categorized into three vegetative growth-stage classes (seedling/sapling, mature, old growth/multi-age old growth) based on the ages and species associated with forest stands. The measure for this indicator is Dualplan model outputs for inner (0-100 feet) and outer (100 to 200 feet) riparian zones. This indicator provides a general characterization of riparian areas. It also is an indicator of the amount of shoreline disturbed. The proportion of older versus younger forest stands is being used as a direct measure of condition of riparian areas. Also this indicator is an indirect indicator of disturbance in riparian areas. Generally, management associated with older forest should have less net disturbance per unit time, and present more opportunities for riparian health enhancing attributes. These attributes include recruitment of larger, more rot-resistant coarse woody debris; providing more diverse habitat characteristics including standing dead or dying trees, a mix of deciduous and coniferous vegetation, and a shrub and forb component; and increasing the likelihood that bank stability will be maintained. Favoring older forest should adequately provide for other riparian ecological functions such as temperature control in aquatic ecosystems, moderation of riparian microclimate, nutrient input to aquatic ecosystems, regulation of water quality, and water storage and conservation.

This indicator highlights the differences between alternatives because each alternative presents a unique mix, through time, of the proportions of various growth stages in riparian areas.

Indicator 3 – Amount of Riparian Area Subject to Vegetation Treatment Activities

Indicator 3 for riparian and fish management is the amount of riparian area on which vegetation treatment activities will be conducted. The measure used for this indicator is Dualplan model assigned treatments in the 200 foot riparian management (combined inner and outer) zone along mapped waters. For purposes of this analysis, even-aged and uneven-aged vegetation treatment activities in the model have been combined into a single activity category. This indicator highlights the differences between alternatives because where riparian areas may currently be in good condition, more activity equates to more potential opportunity for disruption of riparian area composition, structure, and function. Protecting areas in good condition is a primary focus of the Eastern Region Watershed strategy. Conversely, where riparian areas are currently in poorer condition, vegetation management activity would be used as a tool for improvement or restoration.

Indicator 4 – Amount of Planned Regeneration Harvest in the Recruitment Zone for Coarse Woody Debris

Indicator 4 for riparian and fish management is the amount of planned timber harvest, by alternative, in the coarse woody debris recruitment zone. This zone represents the source for coarse woody debris recruitment to streams, lakes, or riparian ecosystems.

This indicator summarizes the amount of regeneration harvests planned in the coarse woody debris recruitment zones for lakes, streams, and wetlands. The amount of regeneration harvest is used as an indirect measure of the potential for disruption of woody debris recruitment to lakes, streams, and wetlands. The coarse woody debris recruitment zones represent the area within 100 feet of mapped lakes, streams, and palustrine wetlands.

This indicator highlights the differences between alternatives in riparian management approaches (proactive versus mitigative) and in the intensity of timber management in riparian zones (such as in the General Forest versus Longer Rotation Management Areas).

Analysis Area

The analysis area for Indicators 1, 2 and 3 are riparian management zones as modeled in Dualplan, and assessed on a forest-wide basis. On the Superior NF, the assessment was limited to the portion of the Forest outside the BWCAW. The modeled riparian management zones represent the area within 100 feet of mapped waters (inner zone) and between 100 and 200 feet from mapped waters (outer zone). Modeled riparian management zones provide a consistent map-based template for describing relative differences between alternatives. However, it should be recognized that many streams on both Forests are not mapped on the geographic information systems base used for this analysis, so modeled riparian management zones represent a simplified subset of real world riparian areas.

The analysis area for Indicator 4 is a 100-foot coarse woody debris recruitment zone, which was mapped around lakes, streams, and palustrine wetlands. The amount of timber harvest was summarized from Dualplan model outputs, which were spatially joined to this 100-foot coarse woody debris recruitment zone. For purposes of this analysis, only those harvest types classified as “regeneration” harvests were summarized. These include clearcutting, shelterwood, and partial cut (to 30 ft^2/acre basal area) silvicultural treatments. Secondly, for the Superior National Forest, only those Ecological Land Types (ELTs) where there is a high potential to grow large trees were evaluated. The ELT’s that were excluded from the analysis were numbers 5, 6, 12, and 18. Also, for the Superior NF, acres of harvest projected to occur within palustrine wetlands are tallied along with harvest acres from the 100 foot perimeter zone.

3.6.2.a Affected Environment

Indicators 1, 2, 3, and 4

Riparian areas have received a great deal of attention in recent years as managers and scientists developed a greater awareness of their importance for fish and wildlife habitat, recreation, and as buffer zones to reduce the effects of flooding and erosion (McKee et al. 1996). Riparian areas exist around all bodies of water including lakes, wetlands, perennial streams and rivers, and intermittent and ephemeral streams. The Chippewa NF has 359,000 acres of lakes, 925 miles of mapped streams, and about 398,916 acres of wetlands. The Superior NF has 446,000 acres of lakes, 2,250 miles of mapped streams, and approximately 565,000 acres of wetlands.

When compared with upland systems, riparian vegetation is often more complex in structure and composition, (Gregory et al. 1991; Kauffman and Krueger 1984; Kauffman et al. 1984). The structure and composition of riparian areas are continuously reshaped by geomorphic processes such as erosion and deposition. Vegetation is a very important factor in regulating these processes. For example, vegetation influences runoff through interception, transpiration, regulation of snowmelt, buildup of litter and soil organic matter, and creation of soil macropores. Vegetation regulates surface erosion and nutrient loss. In the riparian area, vegetation stabilizes stream banks and lakeshores, traps sediment in overbank deposition, and provides coarse woody debris to the aquatic ecosystem and to the adjacent riparian ecosystem.

Historically and currently, flooding, fire, wind, insects, and disease are disturbance processes that modify riparian areas. These disturbances cause changes to species composition, age, and habitat features. Currently, management practices such as roads, trails, utility corridors, and vegetation management also cause habitat modifications to riparian areas. At a landscape scale, factors such as fragmented ownership patterns and differences in forest management between adjacent ownerships, has resulted in habitat fragmentation. Additional riparian fragmentation has resulted from the conversion of lakeshore riparian forest to residential development (MFRC 1999b).

Chippewa NF

The total riparian area within 200 feet of all mapped lakes, streams, and open water wetlands on the Chippewa National Forest is 158,998 acres. Of these acres, 48,300 are managed by the National Forest. Therefore, approximately 70 percent of riparian lands within the Forest boundary are managed by State, county, private, or tribal entities. In addition, over 19,600 acres of National Forest land within 200 feet of mapped bodies of water are non-forested.

The National Forest manages 12,902 forested upland and lowland acres that are within 0 to 100 feet of mapped bodies of water (inner zone) and 15,771 forested acres that are within 100 to 200 feet of mapped bodies of water (outer zone). In the combined inner and outer riparian zones the existing percent of three vegetative age groupings are 25 percent in seedling sapling, 23 percent in a mature stage and 35 percent in old growth and old growth multi-age stages.

The percentage of existing long-lived species that include red and white pine, spruce fir, oak, northern hardwoods, lowland spruce, tamarack, lowland hardwood, and white cedar within the inner (0 to 100 feet) riparian zone is 60 percent. The outer zone (100 to 200 feet) composition also has 60 percent long-lived species.

Superior NF

The total riparian area within 200 feet of all (including BWCAW) mapped lakes, streams, and open water wetlands on the Superior National Forest is 470,000 acres. Of these acres, 252,400 are managed by the National Forest. Therefore, approximately 46 percent of riparian lands within the Forest boundary are managed by State, county, private or tribal entities. Outside the BWCAW, the National Forest manages 40,915 forested upland and lowland acres that are within 0 to 100 feet of mapped bodies of water (inner zone) and 52,060 forested acres that are within 100 to 200 feet of mapped bodies of water (outer zone). In the combined inner and outer riparian zones the existing percent of three vegetative age groupings are 25 percent in seedling sapling, 39 percent in a mature stage, and 36 percent in old growth and old growth multi-age stages.

The percentage of existing long-lived species that include red and white pine, spruce fir, oak, northern hardwoods, lowland spruce, tamarack, lowland hardwood and white cedar within the inner (0 to 100 feet) riparian zone is 40 percent. The outer zone (100 to 200 feet) composition has 37 percent long-lived species.

3.6.2.b Environmental Consequences

Effects Common to All Alternatives

Resource Protection Methods

All alternatives incorporate a base set of management direction that provides for maintaining, and where appropriate restoring, the ecological composition, structure, and function of riparian areas. This direction consists of desired conditions, objectives, standards or guidelines that would apply to, and limit the effects of, any alternative selected for implementation in the Forest Plan. Key examples of this management direction include:

Desired Conditions of:

- Managing riparian areas to be within or move toward the natural range of variability in terms of composition, structure, and function. (USDA-FS 1997b)
- Providing for riparian vegetation of a variety of ages and sizes, with adequate densities and forest canopy layers to provide bank stability, shade, leaf litter, and coarse woody debris to lakes, streams, and wetlands.
- Retaining or restoring the stability of stream channels and lakeshores, and providing for lakes and streams that are biologically diverse, with a high degree of habitat diversity; (USDA-FS 2000g)
- Providing for fish populations that are productive and support human needs, while also meeting the needs of fish-dependant threatened, endangered, or sensitive wildlife species.

Objectives to:

- Manage riparian areas for site-suitable long-lived species most suitable for providing a continuing source of coarse woody debris, leaf litter input, bank stability, shading, sediment storage, and nutrient storage to streams and lakes.
- Restore the ecological processes and diversity of riparian areas. (USDA-FS 1997b)
- Reduce the number of road crossings of streams and wetlands. Improve crossings that remain in place by assuring that they are stable, provide unaltered floodplain and wetland function, and do not impede flow, sediment transport, and fish passage.

Standards or Guidelines that:

- Discourage the location of new facilities (such as roads, trails, campsites, and buildings) within flood prone and riparian areas
- Require that new road and trail crossings of streams permit passage of fish and other aquatic life; properly distribute flood flow, bankfull flow, and sediment transport capacity; and, where practical, favor bridges and arches over culverts.
- Minimize the vegetation clearing width associated with road and trail crossings of riparian areas.
- Minimize the number of riparian area crossings by roads and trails.

General Effects Common to All Alternatives

See the discussion of General Effects Common to All Alternatives in Section 3.6.1 (Watershed Management). Effects relevant to riparian areas and fish management are discussed in that location because they are an integral part of overall effects to watershed health.

Direct and Indirect Effects

Indicator 1- Vegetation Community Composition in Riparian Areas

Based on analysis of this indicator, the alternatives are listed below in order of most to least contribution toward achieving riparian objectives and providing aquatic and riparian habitat features beneficial to watershed health.

Both Forests - Alternative: B, D, G, Modified E, F, A, C.

This measure is based upon Dualplan model projected treatments in the inner (0 to 100 feet) riparian zone and the outer (100 to 200 feet) zone along mapped waters. Percentages shown in Figures RFM-1 and RFM-2 represent the percent increase from existing condition in the composition of long-lived riparian vegetation in the inner and outer riparian zones for each alternative in each of three decades (decades 2, 5 and 10) on the Chippewa National Forest. Figures RFM-3 and RMF-4 present the equivalent information for the Superior National Forest.

Alternative A

Chippewa NF: This alternative would contribute less toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to overall health than all other alternatives except Alternative C. In the inner (0 to 100 feet) zone the amount of longer-lived species would increase from 9 percent above existing condition in the 2nd decade to 18 percent above existing condition in the 5th decade. From that point on, the rate of increase in composition of long-lived species would decrease, resulting in long lives species composition 21 percent above existing condition in the 10th decade.

In the outer (100 to 200 feet) riparian zone long-lived species would increase from 6 percent above existing condition in the 2nd decade to 14 percent above existing condition in the 10th decade.

Superior NF: This alternative would contribute less toward achieving riparian objectives and beneficial aquatic and riparian habitat features than all other alternatives except for Alternative C. In the inner (0 to 100 feet) riparian zone, the amount of cover type in long-lived species would increase from 8 percent above existing condition in the 2nd decade to 31 percent above existing condition in the 10th decade.

In the outer (100 to 200 feet) riparian zone, percent composition of cover type in long-lived species would increase from 6 percent above existing condition in the 2nd decade to 23 percent above existing condition in the 10th decade.

Alternative B

Chippewa NF: This alternative would contribute the most toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to overall health in both inner and outer zones. In the inner (0 to 100 feet) zone the amount of longer-lived species would steadily increase from 16 percent above existing condition in the 2nd decade to 50 percent above existing condition in the 10th decade. Throughout the planning horizon, disturbance would primarily occur though natural processes, although within this inner zone restoration activities may interrupt these processes.

In the outer (100 to 200 feet) riparian zone long-lived species would increase from 11 percent above existing condition in the 2nd decade to 39 percent above existing condition in the 10th decade.

Superior NF: This alternative would contribute the most toward achieving riparian objectives and beneficial aquatic and riparian habitat features in both the inner and outer riparian zones. In the inner (0 to 100 feet) riparian zone, the amount of cover type in long-lived species would increase from 9 percent above existing condition in the 2nd decade to 47 percent above existing condition in the 10th decade. Throughout the plan period disturbance in the inner zone would occur primarily through natural processes, although restoration activities may interrupt these processes in some locations.

In the outer (100 to 200 feet) riparian zone, percent composition of cover type in long-lived species would increase from 8 percent above existing condition in the 2nd decade to 39 percent above existing condition in the 10th decade.

Alternative C

Chippewa NF: This alternative would contribute the least toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to overall health. In the inner (0 to 100 feet) zone the amount of longer-lived species would increase from 8 percent above existing condition in the 2nd decade to 19 percent above existing condition in the 10th decade. Increased harvest activities toward the end of the planning horizon would result in more disturbances in the inner zone than other alternatives. A greater proportion of species with relatively low rot-resistance would also be present in this zone.

In the outer (100 to 200 feet) riparian zone long-lived species would increase from 7 percent above existing condition in the 2nd decade to 17 percent above existing condition in the 10th decade.

Superior NF: This alternative would contribute the least toward achieving riparian objectives and beneficial aquatic and riparian habitat features in both the inner and outer riparian zones. In the inner (0 to 100 feet) riparian zone, the amount of cover type in long-lived species would increase from 8 percent above existing condition in the 2nd decade to 26 percent above existing condition in the 10th decade.

In the outer (100'-200') riparian zone, percent composition of cover type in long-lived species would increase from 5 percent above existing condition in the 2nd decade to 19 percent above existing condition in the 10th decade.

Alternative D

Chippewa NF: This alternative is very similar to Alternative B in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to overall health in both inner and outer zones. In the inner (0 to 100 feet) zone the amount of longer-lived species would steadily increase from 16 percent above existing condition in the 2nd decade to 50 percent above existing condition in the 10th decade. Throughout the planning horizon disturbance would primarily occur though natural processes, although within this inner zone restoration activities may interrupt these processes.

In the outer (100 to 200 feet) riparian zone long-lived species would increase from 9 percent above existing condition in the 2nd decade to 37 percent above existing condition in the 10th decade.

Superior NF: This alternative would be the same as Alternative B in achieving riparian objectives and beneficial aquatic and riparian habitat features in the inner zone, and only slightly less effective than Alternative B in achieving these objectives in the outer zone. In the inner (0-100') riparian zone, the amount of cover type in long-lived species would steadily increase from 9 percent above existing condition in the 2nd decade to 47 percent above existing condition in the 10th decade. Throughout the plan period disturbance in the inner zone would occur primarily through natural processes, although restoration activities may interrupt these processes in some locations.

In the outer (100 to 200 feet) riparian zone, percent composition of cover type in long-lived species would increase from 7 percent above existing condition in the 2nd decade to 35 percent above existing condition in the 10th decade.

Modified Alternative E

Chippewa NF: This alternative would be similar to Alternatives B and D. In the inner (0 to 100 feet) zone the amount of longer-lived species would steadily increase from 18 percent above existing condition in the 2nd decade to 48 percent above existing condition in the 10th decade. Throughout the planning horizon, disturbance will primarily occur though natural processes, although within this inner zone restoration activities may interrupt these processes.

In the outer (100 to 200 feet) riparian zone, long-lived species would increase from 8 percent above existing condition in the 2nd decade to 24 percent above existing condition in the 10th decade. There would be more disturbances in the outer zone than in Alternative B and D and more short-lived species.

Superior NF: This alternative would be about the same as Alternatives B, D, and G in achieving riparian objectives in the inner zone. It would be less effective than Alternatives B and D in achieving these objectives in the outer zone, though clearly more effective than Alternatives A or C in this regard. In the inner (0 to 100 feet) riparian zone, the amount of cover type in long-lived species would increase from 10 percent above existing condition in the 2nd decade to 48 percent above existing condition in the 10th decade. Throughout the Plan period disturbance in the inner zone would occur primarily through natural processes, although restoration activities may interrupt these processes in some locations.

In the outer (100 to 200 feet) riparian zone, percent composition of cover type in long-lived species would increase from 8 percent above existing condition in the 2nd decade to 28 percent above existing condition in the 10th decade.

Alternative F

Chippewa NF: This alternative would moderately contribute toward achieving riparian objectives. In the inner (0 to 100 feet) zone the amount of longer-lived species would increase from 13 percent above existing condition in the 2nd decade to 39 percent above existing condition in the 10th decade. Harvest activities would occur steadily throughout the planning horizon. This would create disturbance in the inner zone. Less rot resistant species would also be present in this zone than in Alternatives B, D, Modified E, and G.

In the outer (100 to 200 feet) riparian zone, long-lived species would increase from 12 percent above existing condition in the 2nd decade to 34 percent above existing condition in the 10th decade.

Superior NF: This alternative would moderately contribute toward achieving riparian objectives and beneficial aquatic and riparian habitat features. In the inner (0 to 100 feet) riparian zone, the amount of cover type in long-lived species would increase from 9 percent above existing condition in the 2nd decade to 39 percent above existing condition in the 10th decade.

In the outer (100 to 200 feet) riparian zone, percent composition of cover type in long-lived species would increase from 7 percent above existing condition in the 2nd decade to 29 percent above existing condition in the 10th decade.

Alternative G

Chippewa NF: This alternative is similar to Alternatives B, D and Modified E in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to overall health in the inner zone. In the inner (0 to 100 feet) zone the amount of longer-lived species would steadily increase from 16 percent above existing condition in the 2nd decade to 50 percent above existing condition in the 10th decade. Throughout the planning horizon disturbance would primarily occur though natural processes, although within this inner zone restoration activities may interrupt these processes.

In the outer (100 to 200 feet) riparian zone, long-lived species would increase from 7 percent above existing condition in the 2nd decade to 26 percent above existing condition in the 10th decade. There would be more disturbances in the outer zone than in Alternatives B and D and more short-lived species.

Superior NF: This alternative would be about the same as Alternatives B, D, and Modified E in achieving riparian objectives in and contributing to beneficial aquatic and riparian habitat features in the inner zone, but less effective than Alternatives B and D in achieving these objectives in the outer zone. In the inner (0 to 100 feet) riparian zone, the amount of cover type in long-lived species would steadily increase from 9 percent above existing condition in the 2nd decade to 47 percent above existing condition in the 10th decade. Throughout the Plan period disturbance in the inner zone would occur primarily through natural processes, although restoration activities may interrupt these processes in some locations.

In the outer (100 to 200 feet) riparian zone, percent composition of cover type in long-lived species would increase from 7 percent above existing condition in the 2nd decade to 30 percent above existing condition in the 10th decade.

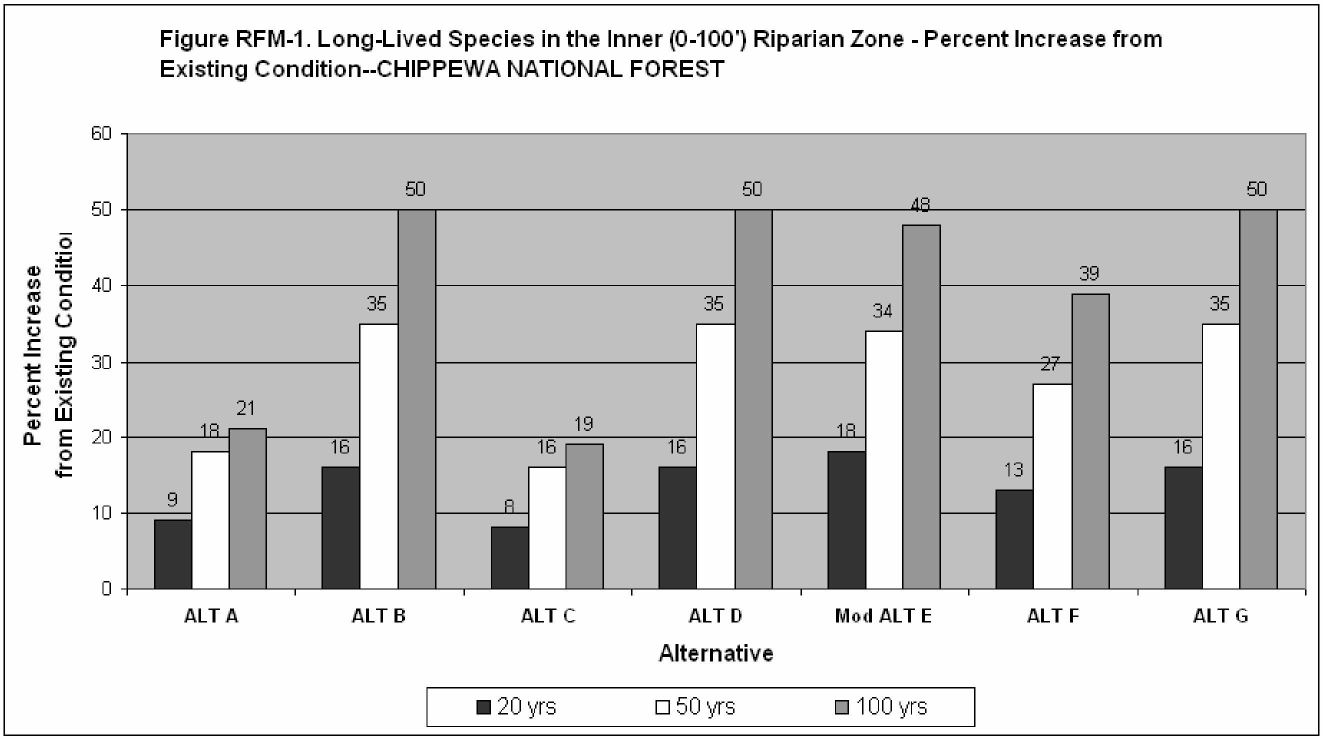


Figure RFM-1. Long-Lived Species in the Inner (0-100') Riparian Zone - Percent Increase from Existing Condition--CHIPPEWA NATIONAL FOREST
Percent Increase from Existing Conditio
0
10
20
30
40
50
60
9
18
21
16
35
50
8
16
19
16
35
50
18
34
48
13
27
39
16
35
50
ALT A
ALT B
ALT C
ALT D
Mod ALT E
ALT F
ALT G
Alternative
20 yrs
50 yrs
100 yrs

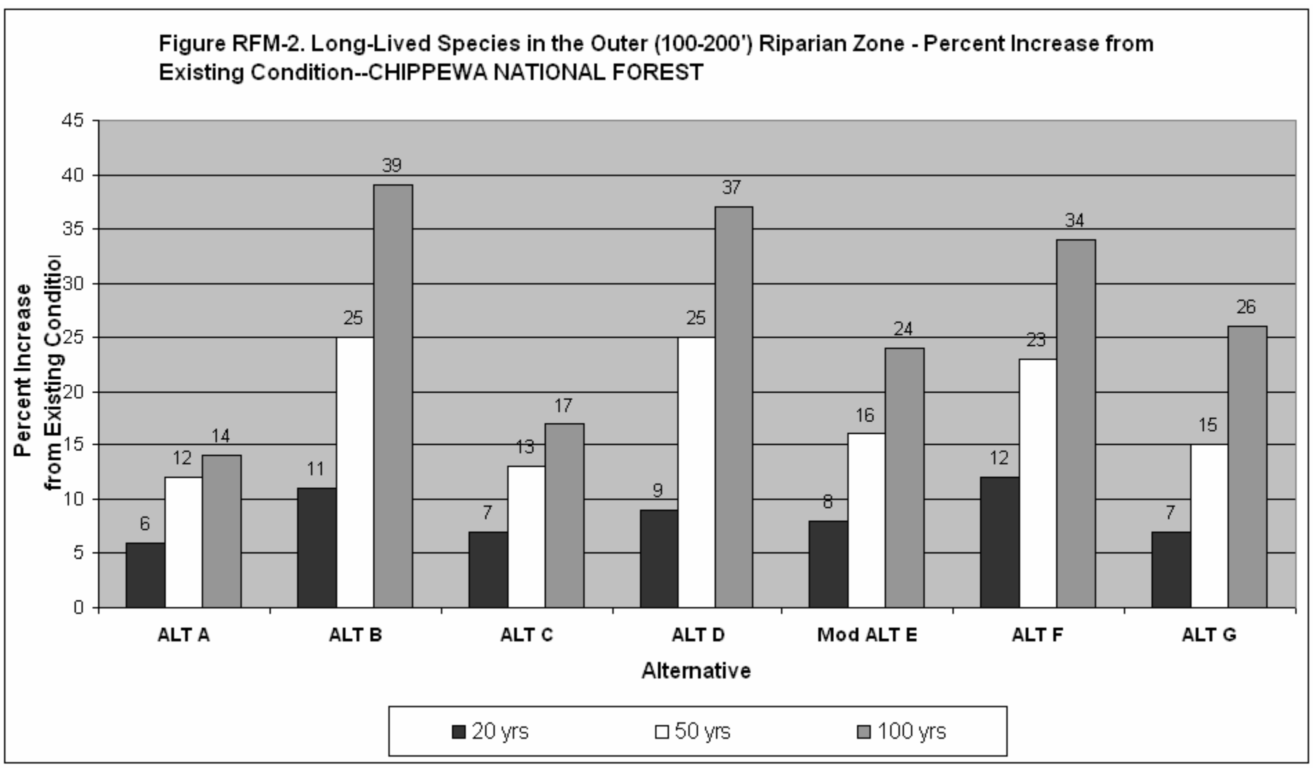


Figure RFM-2. Long-Lived Species in the Outer (100-200') Riparian Zone - Percent Increase from Existing Condition--CHIPPEWA NATIONAL FOREST
Percent Increase from Existing Conditio
0
5
10
15
20
25
30
35
40
45
6
12
14
11
25
39
7
13
17
9
25
37
8
16
24
12
23
34
7
15
26
ALT A
ALT B
ALT C
ALT D
Mod ALT E
ALT F
ALT G
Alternative
20 yrs
50 yrs
100 yrs

Figure RFM-3. Long-Lived Species in the Inner (0-100') Riparian Zone - Percent Increase from Existing Condition--SUPERIOR NATIONAL FOREST

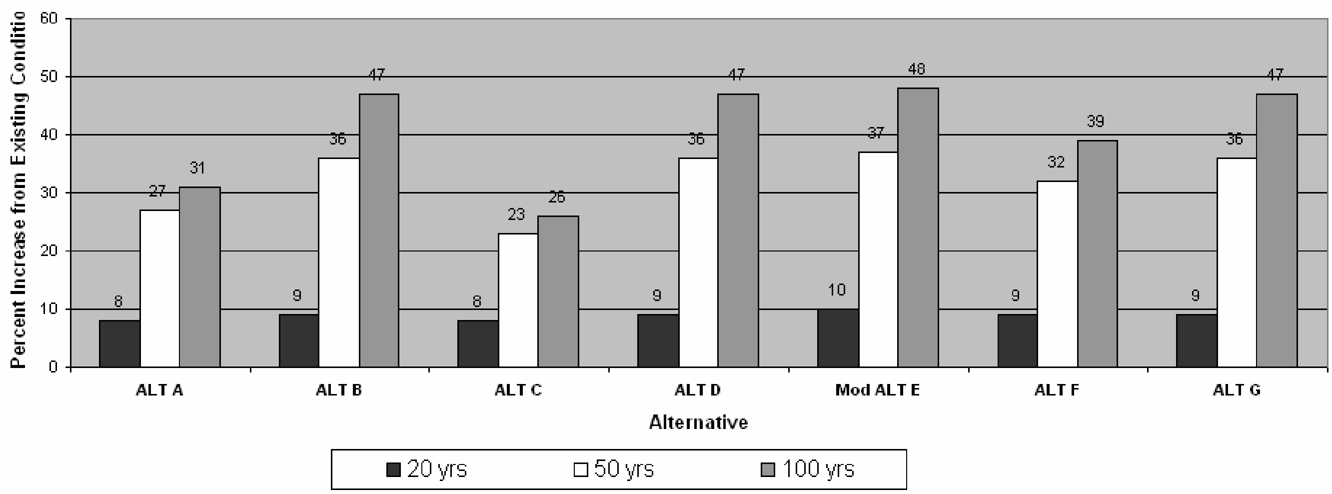
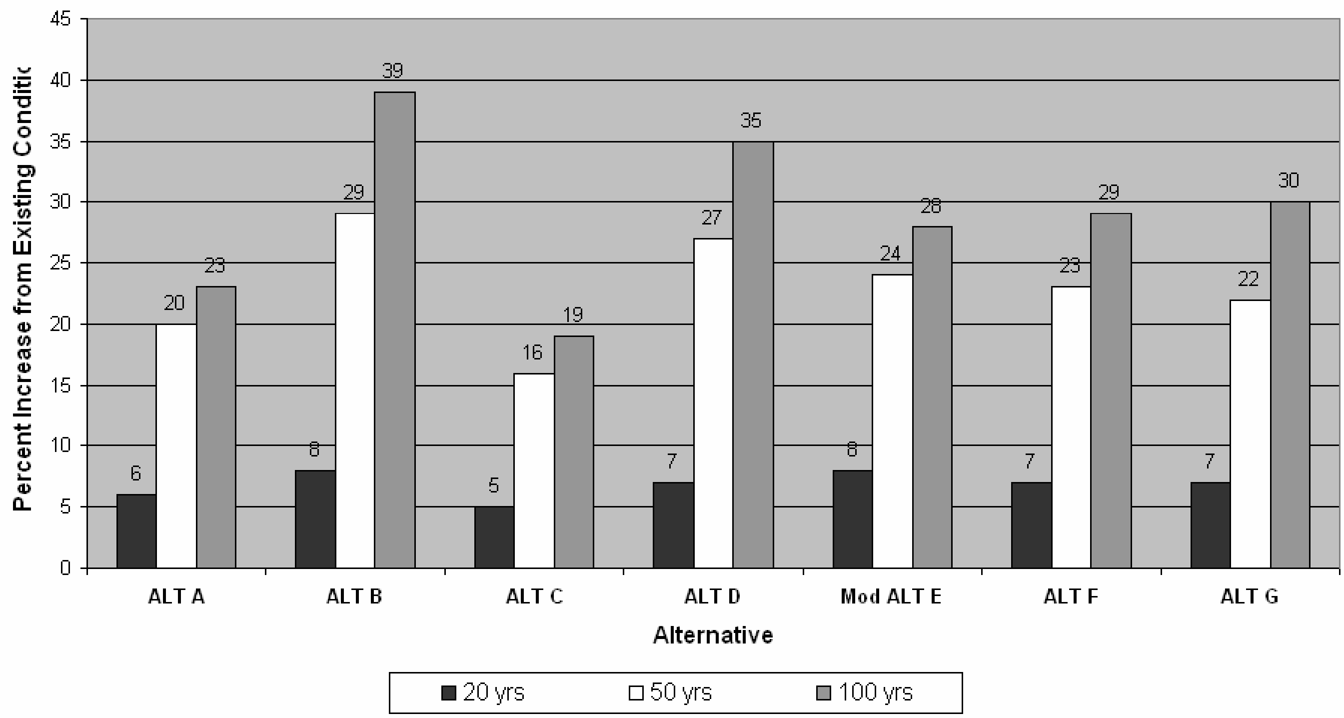


Figure RFM-4. Long-Lived Species in the Outer (100-200') Riparian Zone - Percent Increase from Existing Condition--SUPERIOR NATIONAL FOREST



Indicator 2 – Vegetation Community Age in Riparian Areas

Based on analysis of this indicator, the alternatives are listed below in order of most to least contribution toward achieving riparian objectives providing aquatic and riparian habitat features beneficial to watershed health.

Chippewa NF - Alternative: B, D, G, Modified E, F, C, A.
Superior NF - Alternative: B, Modified E, D, G, F, A, C.

The measure used for this indicator is based upon Dualplan model assigned treatments in the 200-foot riparian management (combined inner and outer) zone along mapped waters. Percentages shown in Figure RFM-5 represent the makeup of riparian forest vegetation in each of three vegetative age groupings averaged for three decades (decades 2, 5 and 10) for the Chippewa National Forest. Figure RFM-6 presents the equivalent information for the Superior National Forest.

Alternative A

Chippewa NF: This alternative, along with Alternative C, would contribute the least toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. In this alternative the combined seedling and sapling age classes would average 41 percent of forested land in the combined inner and outer riparian zones. An average of 23 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes average 36 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 23 percent in the second decade to 49 percent in the tenth decade.

Superior NF: Relative to other alternatives, Alternative A would contribute little, but slightly more than Alternative C, toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. In this alternative the combined seedling and sapling age classes would average 35 percent of forested land in the combined inner and outer riparian zones. An average of 21 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 43 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 41 percent in the second decade to 49 percent in the tenth decade.

Alternative B

Chippewa NF: Of all the alternatives, this alternative would achieve riparian objectives and contribute to aquatic and riparian habitat features that are beneficial to watershed health to the greatest degree. In this alternative the combined seedling and sapling age classes would average 13 percent of the forested land in the combined inner and outer riparian zones. An average of 36 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 51 percent. The portion of forest land in the older age classes (old growth and old growth multi-age) would increase from 33 percent in the second decade to 75 percent in the tenth decade.

Superior NF: Of all the alternatives, this alternative would achieve riparian objectives and contribute to aquatic and riparian habitat features that are beneficial to watershed health to the greatest degree. This alternative would be nearly the same as Alternative D in this regard. In this alternative the combined seedling and sapling age classes would average 17 percent of forested land in the combined inner and outer riparian zones. An average of 25 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 58 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 50 percent in the second decade to 69 percent in the tenth decade.

Alternative C

Chippewa NF: Relative to other alternatives. Alternative C would contribute little toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. Although this alternative would have more mature age class stages than Alternative A, most of it would be harvested upon maturity; therefore the end result at decade 10 would be similar to Alternative A. In this alternative the combined seedling and sapling age classes would average 41 percent of the forested land in the combined inner and outer riparian zones. An average of 23 percent of vegetation would be in mature age class and the combined old growth and old growth multi-age class would average 36 percent. The portion of forest land in the older age classes (old growth and old growth multi-age) would increase from 22 percent in the second decade to 51 percent in the tenth decade.

Superior NF: Relative to other alternatives, Alternative C would contribute the least toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. In this alternative the combined seedling and sapling age classes would average 39 percent of forested land in the combined inner and outer riparian zones. An average of 20 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 41 percent. The portion of forest land in the older age classes (old growth and old growth multi-age) would increase from 36 percent in the second decade to 48 percent in the tenth decade.

Alternative D

Chippewa NF: This alternative would be very effective in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. In this alternative the combined seedling and sapling age classes would average 15 percent of forested land in the combined inner and outer riparian zones. An average of 36 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 49 percent.

The portion of forest land in the older age classes (old growth and old growth multi-age) would increase from 32 percent in the second decade to 74 percent in the tenth decade.

Superior NF: This alternative would be very effective in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. It would be only slightly less effective than Alternative B, and about the same as Modified Alternative E in this regard. In this alternative the combined seedling and sapling age classes would average 18 percent of forested land in the combined inner and outer riparian zones. An average of 25 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 57 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 48 percent in the second decade to 70 percent in the tenth decade.

Modified Alternative E

Chippewa NF: This alternative would be moderately effective in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. Objectives would be met somewhat less than in Alternatives B, D, and G. In this alternative the combined seedling and sapling age classes would average 20 percent of the inner and outer riparian zones. An average of 32 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 48 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 29 percent in the second decade to 71 percent in the tenth decade.

Superior NF: This alternative would be very effective in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health, and is about the same as Alternatives B and D in this regard. In this alternative the combined seedling and sapling age classes would average 18 percent of forested land in the combined inner and outer riparian zones. An average of 20 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 61 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 54 percent in the second decade to 74 percent in the tenth decade.

Figure RFM-5. Forest Age Class Comparison (Average of Composition at the end of Decades 2, 5, and 10) in Combined Inner and Outer (0-200') Riparian Zone--CHIPPEWA NATIONAL FOREST

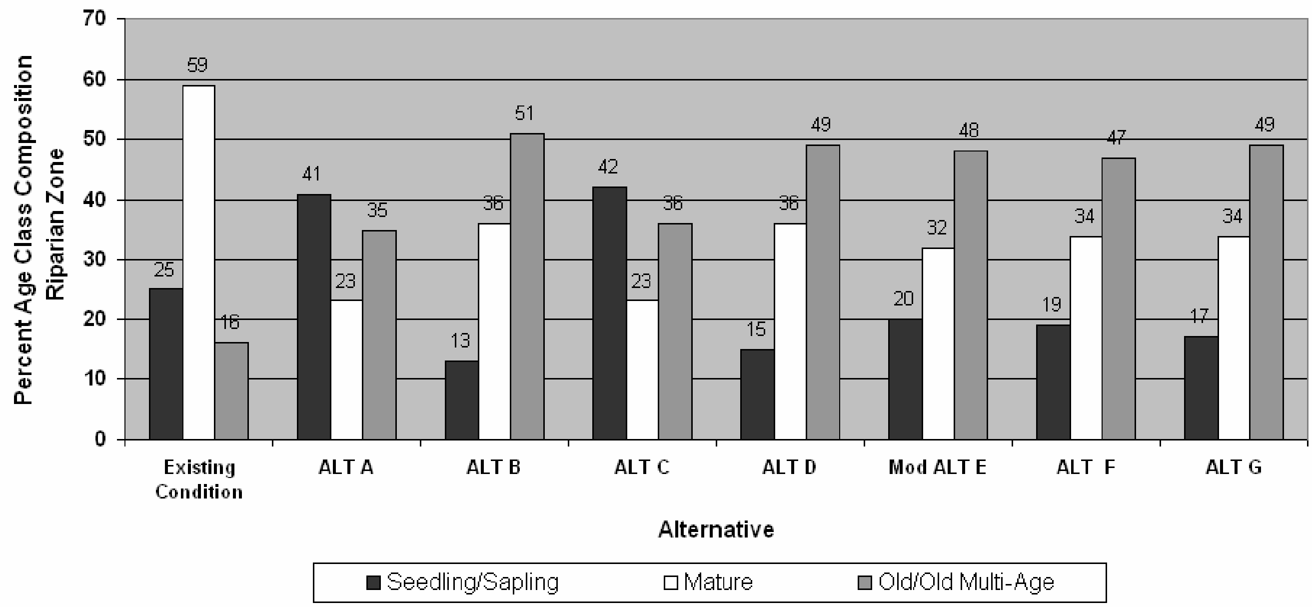
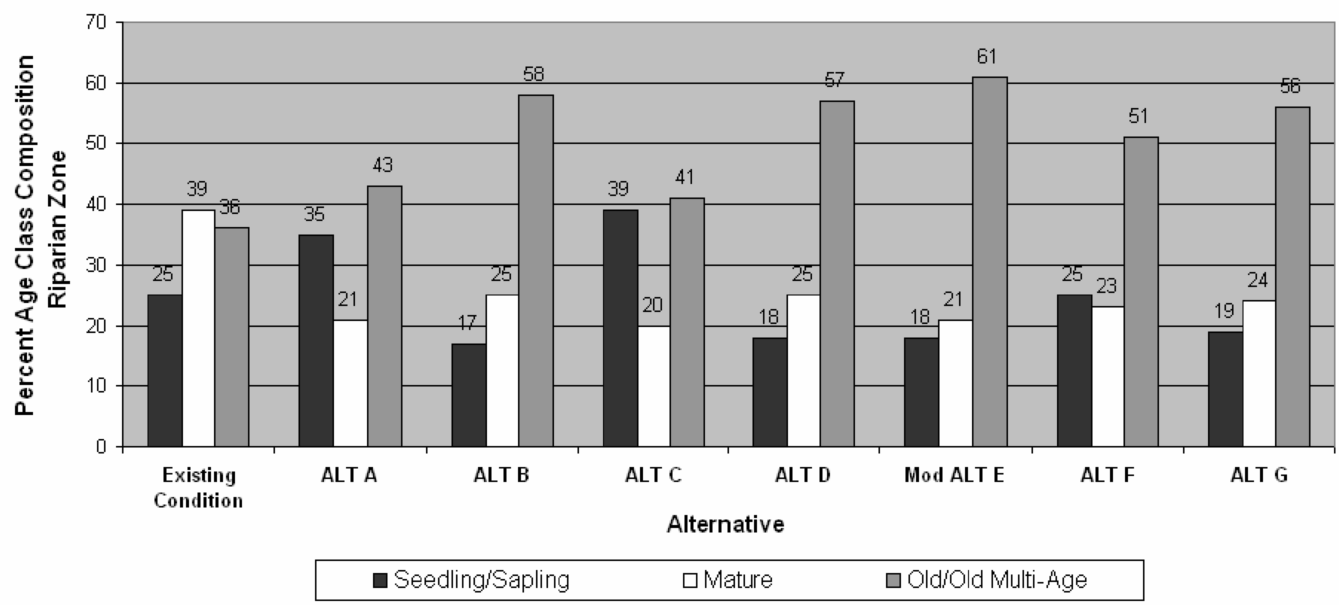


Figure RFM-6. Forest Age Class Composition (Average of Composition at the End of Decades 2, 5, and 10) in Combined Inner and Outer (0-200') Riparian Zone--SUPERIOR NATIONAL FOREST



Alternative F

Chippewa NF: This alternative would contribute a moderate amount toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. This alternative would be similar to Modified Alternative E. In this alternative the combined seedling and sapling age classes would average 19 percent of the inner and outer riparian zones. An average of 34 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 47 percent. The portion of forest land in the older age classes (old growth and old growth multi-age) would increase from 32 percent in the second decade to 68 percent in the tenth decade.

Superior NF: This alternative would contribute a moderate amount toward achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. In this alternative the combined seedling and sapling age classes would average 25 percent of forested land in the combined inner and outer riparian zones. An average of 23 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 51 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 46 percent in the second decade to 59 percent in the tenth decade.

Alternative G

Chippewa NF: This alternative would be effective in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. This alternative would be similar to Alternative D. In this alternative the combined seedling and sapling age classes would average 17 percent of the inner and outer riparian zones. An average of 34 percent of vegetation would be in the mature age class and the combined and old growth and old growth multi-age class would average 49 percent. The portion of forest land in the older age classes (old growth and old growth multi-age) would increase from 32 percent in the second decade to 71 percent in the tenth decade.

Superior NF: This alternative would be effective in achieving riparian objectives and contributing to aquatic and riparian habitat features that are beneficial to watershed health. It would be only slightly less beneficial than Alternatives B and D in this regard. In this alternative the combined seedling and sapling age classes would average 19 percent of forested land in the combined inner and outer riparian zones. An average of 24 percent of vegetation would be in the mature age class, and the combined old growth and old growth multi-age classes would average 56 percent. The portion of forestland in the older age classes (old growth and old growth multi-age) would increase from 49 percent in the second decade to 67 percent in the tenth decade.

Indicator 3 – Amount of Riparian Areas Subject to Vegetation Treatment Activities

Based on analysis of this indicator, the alternatives are listed below in order of the least to the most total (decades 1 and 2) amount of modeled vegetation treatment activity in the 200 foot modeled riparian management zone (thus least to most potential detrimental effects to watershed health).

Chippewa NF - Alternative: D, B, G, Modified E, F, A, C.
Superior NF - Alternative: B, D, G, Modified E, F, A, C.

This measure is based upon Dualplan model projected treatments in the 200-foot riparian management (combined inner and outer) zone along mapped waters. Acreages shown in Table RFM-1 represent total combined acres of even and uneven-aged treatments in each of two decades (decades 1and 2). Even-aged treatments include clearcut, shelterwood, and partial harvest to a residual basal area of 30; uneven-aged treatments include thinning, multi-age treatments, and partial harvest to a residual basal area of 60.

Alternative A

For both Forests, from Table RFM-1 it can be seen that, relative to other alternatives, Alternative A would provide a high level of vegetation treatment activity in the 200-foot riparian management zone in each of decades 1and 2.

Table RFM-1: Total Acres Of Vegetation Treatment Activity In 200ft (Combined Inner And Outer) Modeled Riparian Management Zone

National Forest		Alt. A No Action	Alt. B	Alt. C	Alt. D	Mod Alt. E	Alt. F	Alt. G
		(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)
Chippewa	Decade 1	4,073	1,253	5,422	1,207	2,075	1,701	1,239
	Decade 2	3,438	1,124	4,301	885	1,721	2,098	1,800
Superior	Decade 1	7,418	2,412	10,673	2,869	3,452	5,319	2,679
	Decade 2	6,698	1,835	11,116	1,663	2,900	4,633	2,553

Source: Acres of activity are derived from Dualplan outputs
Definitions: Riparian Management Zones are as modeled in Dualplan, consisting of an inner zone (0-100' along mapped waters) plus an outer zone (100'-200') along mapped waters.

Alternative B

For both Forests, from Table RFM-1 it can be seen that, relative to other alternatives, Alternative B would provide a low to medium level of vegetation treatment activity in the 200-foot riparian management zone in each of decades 1and 2.

Alternative C

For both Forests, from Table RFM-1 it can be seen that, relative to other alternatives, Alternative C would provide the highest level of vegetation treatment activity in the 200-foot riparian management zone in each of decades 1 and 2.

Alternative D

For both Forests, from Table RFM-1 it can be seen that, relative to other alternatives, Alternative D would provide a low or the lowest level of vegetation treatment activity in the 200-foot riparian management zone in each of decades 1and 2.

Modified Alternative E

For both Forests, from Table RFM-1 it can be seen that, relative to other alternatives, Alternative E would provide a medium level of vegetation treatment activity in the 200-foot riparian management zone in each of decades 1and 2.

Alternative F

For both Forests, from Table RFM-1 it can be seen that, relative to other alternatives, Alternative F would provide a medium to high level of vegetation treatment activity in the 200-foot riparian management zone in each of decades 1and 2.

Alternative G

For both Forests, from Table RFM-1 it can be seen that, relative to other alternatives, Alternative G would provide a low to medium level of vegetation treatment activity in the 200-foot riparian management zone in each of decades 1and 2.

Indicator 4 – Amount of Planned Regeneration Harvest in the Recruitment Zone for Coarse Woody Debris

The magnitude of impacts associated with regeneration of stands within coarse woody debris recruitment zones varies by alternative, but the trend is similar between the Forests. Figures RFM-7 and RFM-8 display the total acres harvested in the coarse woody debris recruitment zones by alternative by Forest. Acres summarized include all regeneration harvests planned for the first two decades under each alternative.

The alternatives are listed below in order from the lowest acreage regenerated to the highest (least to most potential affects on recruitment of large woody debris).

Chippewa NF - Alternative: B, D, F, G, Modified E, A, C.
Superior NF - Alternative: B, D, F, G, Modified E, A, C.

Regeneration harvests summarized for this indicator represent clearcutting, shelterwood, and partial cut (to 30 ft^2/acre basal area) silvicultural treatments.

Alternatives B, D, Modified E, and G employ a proactive approach to managing riparian zones along lakes, streams, and open water wetlands. Because of this, the Dualplan model does not plan timber harvest within 100 feet of lakes, streams, and open water wetlands for these alternatives. Therefore, acres of regeneration harvest in the coarse woody debris recruitment zone and summarized here for Alternatives B, D, Modified E, and G, represent harvest within 100 feet of non-open water palustrine wetlands only.

Alternatives A, C, and F do not apply a proactive riparian management approach; rather, they would rely on implementation of the Minnesota Forest Resource Council's Voluntary Site-Level Forest Management Guidelines. For these alternatives the Dualplan model accounted for these guidelines by allowing timber harvest to be planned within 100 feet of lakes, streams and open water wetlands, while restricting the choice of vegetation treatment type to those most compatible with the MFRC riparian guidelines. Thus, total acres of regeneration harvest in coarse woody debris recruitment zones under Alternatives A, C, or F represent harvest within 100 feet of lakes, streams, or wetlands (all palustrine types).

Potential effects from riparian timber harvest, especially regeneration treatments, can be found under *General Effects Common to All Alternatives – Management Activities Including Timber Harvest*.

Figure RFM-7 displays the acreage of regeneration harvest in coarse woody debris recruitment zones on the Chippewa NF in decades 1 and 2 for each alternative. Figure RFM-8 presents the equivalent information for the Superior NF.

Alternative A

Chippewa NF: This alternative would contribute less than all other alternatives, except for Alternative C, toward achieving the desired condition of maintaining a multi-layered riparian forest canopy, where suitable to the site, in order to provide shade, leaf-litter, and coarse woody debris to lakes, streams, and wetlands. Approximately 24,400 acres of harvest treatments for the coarse woody debris recruitment zone are projected for this alternative.

Superior NF: Except for Alternative C, this alternative would contribute less than other alternatives, toward achieving the desired condition of maintaining a multi-layered riparian forest canopy, where suitable to the site, in order to provide shade, leaf-litter, and coarse woody debris to lakes, streams, and wetlands. Approximately 78,000 acres of harvest treatments for the coarse woody debris recruitment zone are projected for this alternative.

Alternative B

Chippewa NF: This alternative would have the lowest level of planned regeneration harvest in coarse woody debris recruitment zones. Only Alternative D would plan fewer acres of harvest in this zone. Application of a proactive riparian management approach in Alternative B restricted planned timber harvest in the Dualplan model; therefore, disturbance in the "inner riparian zone" (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities.

Approximately 6,500 acres around palustrine wetlands would be planned for regeneration harvest. This Alternative is one of the best in terms of meeting the desired condition of continual recruitment of coarse woody debris to lakes, streams, and wetlands.

Superior NF: This alternative would have a lower amount of regeneration harvest in coarse woody debris recruitment zones than any other alternative. Application of a proactive riparian management approach in this alternative restricted planned timber harvest in the Dualplan model, and disturbance in the "inner riparian zone" (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities. Approximately 30,000 acres would be planned for regeneration harvest around palustrine wetlands. This Alternative best provides for coarse woody debris recruitment to lakes, streams, and wetlands.

Alternative C

Chippewa NF: This alternative would contribute the least toward achieving riparian desired conditions, such as continued recruitment of large woody debris. Nearly 29,000 acres would be harvested and regenerated in coarse woody debris recruitment zones under Alternative C. Less habitat created by large, old, fallen trees would be present in this zone than in other alternatives.

Superior NF: This alternative would contribute the least toward achieving riparian desired conditions, such as continued recruitment of large woody debris. Nearly 101,000 acres would be harvested and regenerated in coarse woody debris recruitment zones under Alternative C. Less habitat created by large, old, fallen trees would be present in this zone than in other alternatives.

Alternative D

Chippewa NF: This alternative would have a low level of regeneration harvest in coarse woody debris recruitment zones, with only slightly more harvest than Alternative B. Application of a proactive riparian management approach in this Alternative restricted planned timber harvest in the Dualplan model, and disturbance in the “inner riparian zone” (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities.

Approximately 6,900 acres would be planned for regeneration harvest around palustrine wetlands. This Alternative best provides for coarse woody debris recruitment to lakes, streams, and wetlands.

Superior NF: This alternative would be similar to Alternative B in achieving a desired condition for coarse woody debris recruitment. Under Alternative D, there would be slightly more harvest around palustrine wetlands (approximately 30,000 acres). Application of a proactive riparian management approach in this Alternative restricted planned timber harvest in the Dualplan model, and disturbance in the “inner riparian zone” (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities.

Modified Alternative E

Chippewa NF: Modified Alternative E would have the third highest harvest in coarse woody debris recruitment zones, even though application of a proactive riparian management approach in this alternative restricted planned timber harvest in the Dualplan model. Disturbance in the “inner riparian zone” (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities. The majority of the coarse woody debris recruitment zone harvested under this Alternative would be around palustrine wetlands (approximately 12,800 acres harvested).

Superior NF: Modified Alternative E would have the third highest harvest in coarse woody debris recruitment zones, even though application of a proactive riparian management approach in this Alternative restricted planned timber harvest in the Dualplan model. Disturbance in the “inner riparian zone” (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities. The majority of the coarse woody debris recruitment zone harvested under this Alternative would be around palustrine wetlands (approximately 53,000 acres harvested).

Alternative F

Chippewa NF: This alternative would have a moderate amount of regeneration harvest in coarse woody debris recruitment zones (approximately 7,900 acres). As in Alternatives A and C, Alternative F would not have proactive riparian management.

Superior NF: This alternative would have a moderate amount of regeneration harvest in coarse woody debris recruitment zones (approximately 45,000 acres). As in Alternatives A and C, Alternative F would not have proactive riparian management.

Figure RFM-7. Acres of Planned Regeneration Harvest in Coarse Woody Debris Recruitment Areas (Total Acres for the First Two Decades)--CHIPPEWA NATIONAL FOREST

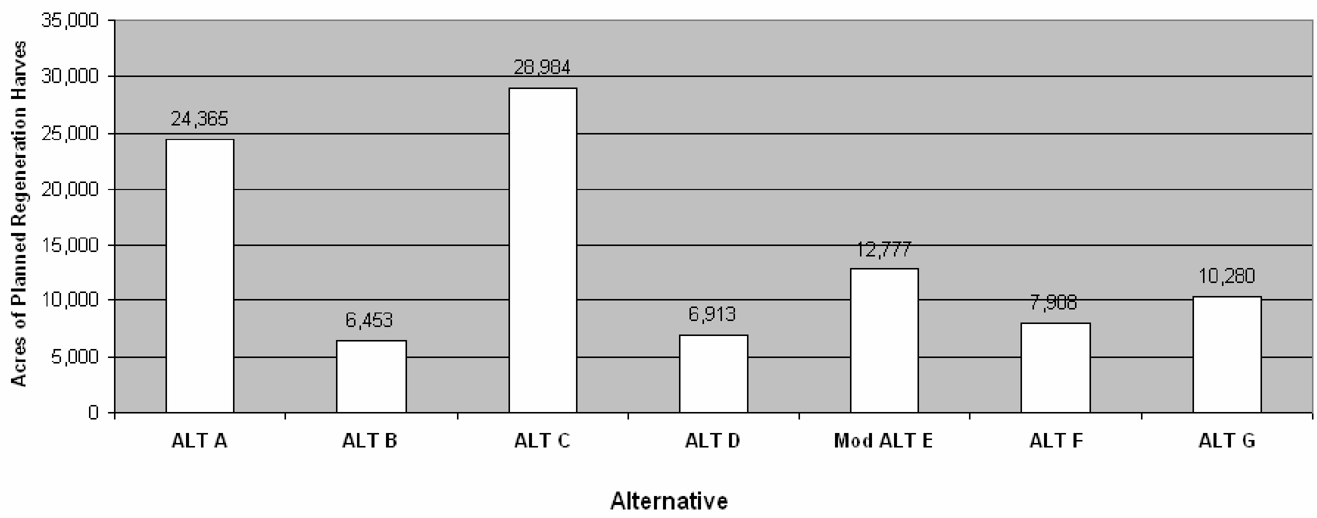
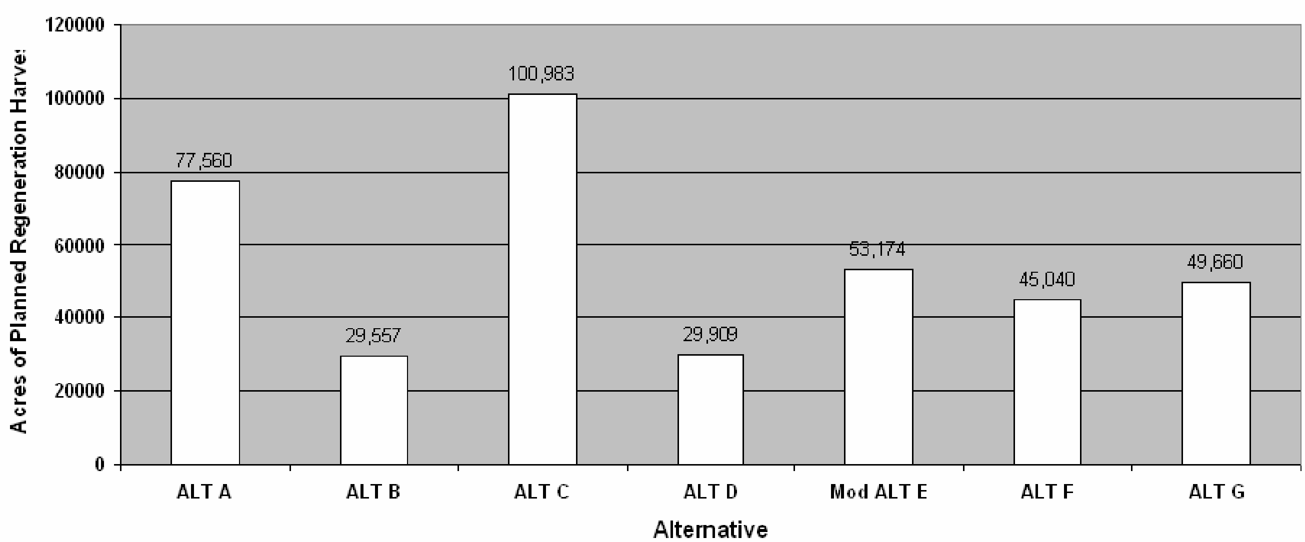


Figure RFM-8. Acres of Planned Regeneration Harvest in Coarse Woody Debris Recruitment Areas Within Ecological Land Types Considered Good to Excellent for Growth of Large Trees (Total Acres for the First Two Decades)--SUPERIOR NATIONAL FOREST



Alternative G

Chippewa NF: This alternative would have a moderate amount of regeneration harvest in coarse woody debris recruitment zones. Application of a proactive riparian management approach in Alternative G restricted planned timber harvest in the Dualplan model; therefore, disturbance in the "inner riparian zone" (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities. Approximately 10,300 acres around palustrine wetlands would be planned for regeneration harvest.

Superior NF: This alternative would have a moderate amount of regeneration harvest in coarse woody debris recruitment zones. Application of a proactive riparian management approach in Alternative G restricted planned timber harvest in the Dualplan model; therefore, disturbance in the "inner riparian zone" (of lakes, streams, and open water wetlands) would primarily occur though natural processes or planned restoration activities. Approximately 50,000 acres around palustrine wetlands would be planned for regeneration harvest.

Cumulative Effects

See discussion of cumulative effects in Section 3.6.1. (Watershed Management) of this EIS. Cumulative effects relevant to riparian area and fish management are an integral part of overall effects to watershed health, and for that reason are discussed in that section of the EIS.