Appendix H

Executive Summary on Final Generic Environmental Impact Statement

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Final Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota

Prepared for:

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EXECUTIVE SUMMARY

Overview

Indicative of a growing concern about the impact of increased timber harvesting on Minnesota's environment, a citizens' petition was brought before the Minnesota Environmental Quality Board (EQB) in July 1989. The petition requested the EQB to prepare a Generic Environmental Impact Statement (GEIS) on the cumulative impacts associated with timber harvesting and forest management in Minnesota. In December 1989, the EQB unanimously passed a resolution authorizing the preparation of such a GEIS and designated itself the responsible governmental unit for the study's preparation.

The EQB's resolution also established a ten-person citizen's Advisory Committee to help provide a direction and oversight through recommendations to the EQB. Specifically, the Advisory Committee was asked to assist in the preparation of the Final Scoping Decision (FSD), advise on selection of a project consultant, review and comment on all project work products, and make mitigation strategy recommendations.

The FSD was prepared during 1990 and issued in December 1990. The objectives called for in the FSD were to:

- develop a basic understanding of the status of timber harvesting and related forest management activities in Minnesota, and how this level of statewide activity relates to long-term sustainable levels of timber removals;
- identify and assess the environmental and related (i.e., economic and social) impacts associated with current and potential elevated levels of statewide timber harvesting and forest management activity; and
- develop strategies to mitigate potential significant adverse impacts that are identified.

A number of EQB-specified assumptions were used to prepare the GEIS. Key among these were:

Geographic Coverage and Forest Lands Under Consideration. The GEIS examines the impacts of timber harvesting and forest management on Minnesota's environment and on relevant sectors of the state and regional economies. The study was charged to consider all forest lands and resources within the state's boundaries to determine statewide cumulative impacts. This included commercial forest lands (timberlands), reserved, and unproductive forests. Emphasis was on the examination of cumulative impacts of timber harvesting and forest management activities occurring on all timberlands in Minnesota. This includes, to the extent possible, all public forest lands owned and/or managed by federal, state, county, or municipal governments as well as forest land owned by industrial and nonindustrial private interests.

Relationship to Timber Harvesting and Forest Management. The GEIS analyzes only those impacts resulting from timber harvesting and associated forest management activities in Minnesota. These include a broad range of human-induced activities such as logging, site preparation, reforestation, and forest road construction. In addition, changes due to ecological processes are also examined. Examples of these changes include aging of forest stands and the incidence of pests and diseases.

The GEIS assessed three levels of statewide timber harvesting activity that were prescribed by the EQB. These levels were the basis for incremental analyses of the potential impacts of timber harvesting and forest management:

- **4.0 million cords**. This was the level of statewide timber harvesting activity that occurred in 1990, the most recent year for which data were available at the time the study was undertaken;

- **4.9 million cords**. This is the level of statewide timber harvesting activity estimated to occur by 1995 if all announced or considered forest products industry expansions fully materialize; and

- **7 million cords**. This is the estimated maximum sustainable annual volume of timber growth available for harvest statewide for all tree species in the year 2000.

These three pre-established levels are referred to as the *base, medium,* and *high* scenarios, respectively. *Note that these are not recommended levels of harvest nor should their development and analysis be considered a plan. Rather, they are levels the study was asked to analyze to determine what the impacts would be if these harvests were to occur.*

All three scenarios project the spatial and temporal distribution of timber harvesting activity that might occur across the state over a 50-year planning horizon. This included projecting what tree species might be harvested as well as when and where that occurred. The USDA Forest Service's Forest Inventory and Analysis (FIA) database served as the primary data input for modelling these three scenarios. The FIA data (13,536 forest plots and other information) provided a statistical sample of existing forest conditions including estimates for location, types and extent of tree species and covertypes present, timber volume, growth, and mortality and various site, stand, and surrounding area descriptors. These data were assumed to represent Minnesota's forest resources.

Modelling and Assumptions

The FIA plots provided a spatial approximation of the total resource and were used as the basic *units* for allocating timber harvesting activity. Computer models were then used to generate realistic harvesting scenarios by incorporating the most recent available data covering the following:

- the volume (by size and species), location, and ownership of wood potentially available;
- existing, planned, or potential wood-based industries and their locations;
- costs associated with timber harvesting, transport, and forest management activities;
- the regional transport network to link the wood supplies with the processing facilities;
- forest management practices and the implications of these on the structure and species composition of the forests and yields of timber in the short- and long-term;
- criteria used by industries to select stands when making purchases of timber; and
- existing land management policies that influence the availability of timber for harvest.

The forest growth model used is an individual tree-based model that projects individual tree growth and mortality on each FIA plot. That model output was also analyzed each decade to assess covertype change via growth and stand dynamics. As the forest was projected, harvesting and associated forest management activities were scheduled by models that addressed individual stands in a way that made the most economic sense, given the mitigations and constraints on the various locations and ownerships. Resulting data from the scenarios formed the basis for most of the subsequent impact analysis undertaken by the study groups. Examples of harvest and management options for stands included: clearcutting, thinning, selective harvesting, or no harvesting. After harvest, the choices included natural regeneration or planting. The most appropriate option for each stand at each decision point was selected by a scheduling model that matched demand for a product with the stand or forest area best able to supply that product and in consideration of mitigations and other constraints. Forest and timberland area change from 1990 to 2040 was also implemented gradually throughout the 50-year period using estimates of annual change rates.

Outputs from the model runs included plots harvested by ten-year planning period; the type of harvesting; the products harvested and their cost; and assumed management activities. FIA plot expansion factors were then used to convert this to stand, ecoregion and state level descriptions of the forest and outputs. The study groups used various parts of this output, depending on their specific requirements for conducting environmental impact assessments. For example, the forest soils study group required information on the amount of timber removed by covertype and the frequency of harvests; whereas the wildlife group required data including the presence or absence of certain key tree species, the age and size class structure of stands, and any changes in covertype. Additional assumptions in those study areas are described in the following sections on those subjects.

Importantly, the model runs included ownership constraints and mitigations that reflect current and prospective management procedures and policies applied by the major forest land managers. Examples include:

- extended rotation forests (ERF), i.e., lengthened (usually by 50 percent) minimum rotation ages for approximately 20 percent of the timberland on state and USDA Forest Service ownerships (note that the Superior National Forest does not currently have an ERF program);
- greater use of uneven-aged management;
- designation and reservation of old growth and old growth replacement acreage;
- best management practices (BMPs), i.e., thinning or ERF within 100 feet of water; and
- wildlife buffers (thinning only within 200 feet of water) on the national forests and in the southeastern part of the state.

In addition, estimates of the actual availability of timberlands for harvest or management, developed separately by ownership, were used to set aside a portion of the timberland as *not available* for various economic, environmental and social concerns.

Note that if these ownership constraints and mitigations are not routinely applied to all timber harvesting and forest management activities during the next 50 years, the number and severity of significant impacts identified (see Base Scenario Review below for examples) will increase for all three harvest levels.

The percent of timberland assumed available for harvest ranged from 98 percent for forest industry lands to 53 percent for the Superior National Forest. State and county timberlands were assumed to be 95 percent available. These model runs also incorporated the USDA Forest Service allowable cut limits for yields from their timberlands for the base and medium scenarios, i.e., the lower two levels of harvest. The USDA Forest Service constraints were then relaxed for the high scenario model run, even though the actual constraints on USDA Forest Service lands have the potential to become more stringent in the future.

Inclusion of the above constraints and mitigations suggests that the base and medium scenarios were reasonable depictions of current and future timber availability and predominant land management practices.

Issues Addressed

By utilizing these three levels of timber harvesting and their related forest management activities the GEIS examines how current and increased levels of timber harvesting and forest management affect a number of important issues identified in the study's FSD. These FSD issues identify important attributes and characteristics of Minnesota's forests which are collectively defined in the study as *forest resources*. The issues identified were:

- *maintaining productivity of forests for timber production*: examining primarily sustainable harvest levels, all ownership classes, geographic regions, and forest types today and in the future;
- *forest resource base*: conducting a historical assessment of the state's forest land base including current condition and its evolution;
- *forest soils*: examining impacts on nutrient cycling, erosion, compaction, and overall site productivity;
- *forest health*: examining insect and disease infestation risks across all landowners, geographic regions, tree species, and forest types;
- *plant and animal diversity in forest ecosystems*: examining forests' biological diversity at genetic, species, and ecosystem levels, as well as covertype spacial patterns; species of special concern, threatened, or endangered species; and old growth and old forests;
- *forest wildlife and fish*: examining forest dependent species and their specific habitat requirements;
- *water quality*: examining changes in sedimentation and nutrient loading levels and runoff in lakes, rivers, streams, and wetlands, including impacts of fertilizers, compost, sludge, and pesticides on water quality;
- *forest recreation*: examining quantitative and qualitative recreation opportunity impacts covering various consumptive and nonconsumptive recreation activity types;
- *economics and management*: examining regional and state direct economic relationships, the tourism and recreation industry statewide, habitats of game species and economic relationships, and timber stumpage distributions among various uses; and
- *aesthetics and unique historic and cultural resources*: examining visual quality and unique heritage resources found in forested areas.

Other areas requiring analysis were: (1) recycled fiber opportunities and their timber harvesting relationships; (2) possible impacts of global warming on Minnesota's forests; (3) Minnesota's public forestry organizations and policies; (4) harvesting systems; and (5) silvicultural systems.

Detailed analyses of these issues were carried out through development of nine technical and five background papers. Focus of the analysis in all papers was assessing cumulative impacts occurring across the state, by region, and for various ecoregions. Figure I.1 indicates the ecoregions used in these analyses.

Figure I.1. Ecoregions used in the GEIS study. (Source: Jaakko Pöyry Consulting, Inc. 1992a.)

Data availability limited the extent to which impacts could be quantitatively assessed for certain issues. The GEIS study does identify areas where future research is needed to collect data that are currently unavailable, but that are necessary to completely address all GEIS-scoped issues.

GEIS Study Components

The study components, as summarized here, were designed to address the requirements outlined in the previous section:

- *Feasibility Study*: established the study's structure;
- *Workplan*: outlined the study's methodology;
- *Statewide Timber Harvesting Scenarios*: initial analyses of the three harvesting levels used to help identify probable impacts for all FSD issues;
- *Study Criteria*: criteria developed to help assess significant impacts, mitigation alternatives, and mitigation strategies;
- *Technical papers*: nine stand alone studies addressing collectively the FSD technical issues of concern;
- *Background papers*: five support studies addressing the other identified areas of interest (e.g., global warming, recycled fiber, etc.);
- *Draft GEIS document*: initial report targeted to fully synthesize and integrate the materials from the nine technical and five background papers, clearly summarize all relevant impacts, and describe recommendations to address the identified impacts; and
- *Final GEIS document*: subsequent and final report to address the above contents as modified to reflect review, commentary, and inputs from the peer review process, the Advisory Committee, the EQB, and the public at large.

Given these eight study components, the study criteria require some elaboration to put the balance of the executive summary into perspective.

First, the GEIS employed a number of models and submodels singly and in combination to develop projections for the study period. The models used, particularly those describing changes, were developed and/or employed to approximate the processes under study, natural or otherwise. However, there are limitations to any such modelling. Second, the interested study reviewer would benefit from examining work products associated with all eight study components. The criteria were developed to specifically evaluate each issue of concern from the perspective of cumulative impacts geographically and over time. Eighteen *categories* of impacts were discussed, based on the ten issue areas identified in the FSD. For each significance criterion developed, background information was used to determine levels or thresholds when impacts are likely to be considered significant. Similarly, a criterion was developed to identify possible mitigation measures and to select preferred strategies.

Minnesota's Forest Resources

Forest lands currently occupy about 16.7 million acres in Minnesota, or about 33 percent of the state's 50.8 million acres of land. This is approximately half the area of forest prior to European settlement (about 1850). The loss of forest area has occurred as a consequence of expanding agriculture and urbanization. In addition to a loss of forest area, timberland area (now 14.8 million acres) also declined by 3.4 million acres or 19 percent over the last 50 years. This was a result of a 700,000 increase in reserved forest area during the 1970s when the Boundary Waters Canoe Area Wilderness (BWCAW) and Voyageurs National Park were legislatively established, and 2.7 million acres of conversion of timberland to other land uses. Recent trends and projections of land use suggest the forest area in the north will continue to decline, largely due to development for other uses. However, the forest area in the southern part of the state is increasing due to reversion from marginal agricultural lands and that is projected to continue. Overall, the forest area in Minnesota is expected to increase slightly over 1990–2040.

The volume of timber in Minnesota's forests has increased severalfold since the 1930s as once small trees have matured from seedling/sapling status to pole- and sawtimber size. This accumulation of volume is due to net growth exceeding harvest rates for a number of decades.

Currently, timberland, reserved, and unproductive forest comprise about 88, 7 and 5 percent, respectively, of all forest land.

Minnesota's forest land can be classified into fourteen *forest types* (sometimes called *covertypes*), which was done for the GEIS. Each forest type bears the name of one or more tree species that form a majority of wood volume in the stand. Most stands have a considerable mixture of species and typically contain five or six species of trees. This can complicate the process of classifying stands into forest types.

Currently, the aspen forest type occupies about one-third of the state's total forest area. However, many aspen stands contain a high proportion of other hardwoods or conifers, so there is more diversity than this figure suggests. Black spruce occupies the largest area of any conifer type, due to its ability to grow on Minnesota's extensive peatland soils. Other major forest types include maple-basswood, oak-hickory, and elm-ash-soft maple, each comprising 7 to 8 percent of the total forest land area. The current forest landscape comprises a lower proportion of jack, red, and white pine forests; swamp conifers; northern hardwoods; and more aspen than in presettlement times.

Much of Minnesota's forest land was harvested in the late nineteenth and early twentieth centuries. In addition, other areas were cleared for agricultural uses, only to be returned to forest following the failure of these enterprises. Forests have reestablished on many formerly cutover and cleared lands and, once established, timber volume growth has exceeded removals (harvesting) and mortality. Therefore, despite ongoing harvesting, an increasing proportion of stands have grown into the older, larger size classes. The acreages in many forest types are now comprised of stands that are much older, on average, than they were in 1953, especially forest types that are of low commercial value. Although the average age of stands has been increasing recently, and most stands are in a mature state, there is still nowhere near the amount of old growth (>120 years old) that there was prior to European settlement, either as a percentage of the forest or in absolute acreage. Currently, there are about 610,000 acres of forest greater than 120 years old in the state (3.9 percent of all forest lands), compared with an estimated 13.9 million acres (51 percent of all forest) prior to European settlement (Jaakko Pöyry 1992e). This large shift in age structure, reduced forest acreage, and the species composition changes mentioned above, have reduced the biological diversity of Minnesota forests.

Minnesota's forest resources provide a variety of nontimber values important to addressing environmental, economic, and amenity interests and objectives. Among these are the following:

Water Resource Protection. Forest cover functions to affect the quantity, quality, and timing of water resources for human use and for aquatic species. Forest cover and the biological systems it includes has important mitigating effects on various land use practices in terms of protecting water quality.

Outdoor Recreation. Forests provide the habitat for wildlife species and the setting for many outdoor recreation activities, as well as for the very substantial resort industry that has developed in northern Minnesota.

Aesthetic Values-Attractiveness of the Forest. Maintenance of these values is important to insure that the forests continue to provide attractive recreational settings.

Cultural and Historical Values of the Forest. Forests contain a variety of heritage resources including sites that provide the most complete record of pre-European land use history, and sites of significance to contemporary Native Americans.

Biological Values of the Forest. The biological diversity of forests is of immense ecological, social, and economic importance to all regions of the world, for many reasons. Ultimately, the sustainability of forest resources, measured in either economic or ecological terms, depends on maintaining biodiversity.

Timberland Ownership and Timber Usage

Private individuals and corporations, other than the forest industry, own the largest area of Minnesota timberland—about 6.4 million acres or 43 percent. The state is the largest public landowner with over 3 million acres or 21 percent of timberland, followed by counties with 2.5 million acres or 17 percent; the national forests with 1.8 million acres and 12.3 percent; and the forest industry, 750,000 acres or 5 percent of all timberland in the state.

The six major forest products industries in Minnesota include: pulp and paper, hardboard, waferboard (also known as flakeboard) and oriented strand board (OSB), sawmills, veneer, and wood preservation.

The Minnesota forest products industry is in the midst of a significant expansion of output and wood consumption. Total demand from industrial, fuelwood, and nonindustrial uses increased from just over 1 million cords in 1960 to 1.5 million cords in 1975. Today, approximately 4.0 million cords are harvested statewide each year on approximately 200,000 acres. This includes wood consumption for pulpwood, paper and paperboard, OSB, lumber, fuelwood, and other uses. The greatest expansion has taken place in pulpmills, waferboard, and OSB mills. Much of the increase in the demand for pulpwood has been met by increasing the level of harvesting in the aspen forest type.

Sawmill roundwood receipts have also increased significantly, rising by 80 percent from 1960 to 1988. In contrast, there was little overall change in the demand for roundwood from other forest industries over this period.

The expansion of the wood industry in Minnesota is projected to continue for at least the next five years. Current forest industry expansion plans are based on previously discussed and/or permitted projects and include $1.6 billion in investments in new plants and equipment. These new mills, if built, will consume an estimated 790,000 cords of pulpwood per year in addition to the 4.0 million cords currently consumed as pulpwood, sawtimber, fuelwood, and other products.

Given the configuration of the state's pulp and paper mills, it is unlikely that market deinked pulp will replace *existing* virgin pulp production in Minnesota. However, use of market deinked pulp produced from Minnesota could replace up to 400,000 cords of pulpwood otherwise harvested in the state annually, if recycled pulp were used as a substitute for projected increases in virgin chemical pulp capacity. In addition, market deinked pulp could be used to replace purchased kraft pulp, which is the more likely ultimate scenario for Minnesota. Key here is that accurate projections regarding future use of recycled fiber are very difficult to make due to constantly changing technology and government policy.

Resource Management Framework

Minnesota, like other states, is faced with a highly complex natural resources decisionmaking environment. Minnesota's resources management framework is built on a myriad of policies, planning, coordination, programs, laws, regulations, guidelines, practices, and public participation. It involves federal, state, and county agencies; departments; commissions; boards; committees; and individuals, whose interests often overlap.

Key observations on the current status of forest land management are as follows:

- Minnesota has a substantial forest resource base today, regardless of how the overall effectiveness of its existing natural resources decisionmaking is viewed or judged;
- the complexity of these decisionmaking mechanisms and their present overlapping nature, both organizationally and functionally, create the potential for significant problems with development and implementation of future policies and decisions; and
- the natural resources decisionmaking process has grown inherently more complex over the past decade, consequently, the state will be faced with increasing potentials for difficulties in managing Minnesota's forest resources.

Contrasts Among the Timber Harvesting Scenarios

Comparison of the impacts projected to occur at the three different timber harvesting scenarios (base, medium, and high) illustrate important changes in forest resource conditions and associated values in response to these degrees of timber harvesting and forest management activities. The following highlights some of these major differences identified.

Acres Harvested Overview

Table I.1 contrasts the 1990 acres harvested one or more times and that not harvested during 1990-2040 for the three scenarios. Under the base scenario, 7.2 million acres are harvested while 7.6 million acres of timberland and 1.9 million acres of reserved and unproductive forest are not disturbed by harvesting over the study period. Thus, for the base scenario, a total of 9.5 million acres, or 57 percent of the forest, is not disturbed by harvesting over the study period. Timberland acreage is unharvested because it is still too young or under rotation age, of low productivity, uneconomic, or simply unneeded to achieve the specified harvest level. Although succession and stand development are controlled to some degree by humans in some managed forests (e.g., aspen managed to regenerate as aspen after harvest), 57 percent of Minnesota's forest landscape will not be harvested under the base scenario over the 50-year study period, so that natural forces of succession and stand development will be the primary influence on the landscape with or without timber harvesting. The percentage of the forest harvested increases considerably under the medium and high scenarios, but natural forces still play an important role in forest change.

Table I.1. Original acres harvested one or more times and not harvested during 1990–2040.*

Forest land use and harvest status	Total (thousand acres)
Total forest land acres	16,714.8
Reserved/unproductive	1,941.4
Timberland	14,773.4
Base Scenario	
Acres not cut	7,600.0
Acres cut	7,173.4
Medium Scenario	
Acres not cut	6,156.4
Acres cut	8,617.0
High Scenario	
Acres not cut	4,308.2
Acres cut	10,465.2

*Table 7.6 provides a breakdown of this acreage and harvest by ecoregion. See also section 5.1.1 for a discussion of assumptions and interpretation.

Forest Covertype Changes

Table I.2 contrasts the forest covertype acreage for timberland and all forest plots, 1990 and projected 2040, statewide for the three scenarios. Note that the forest covertypes used, by definition, contain a number of different tree species (see section 2.3.1). Perhaps most important is that acreage in various covertypes *is* sensitive to the level of harvesting. The increase in aspen timberland acreage with increasing harvest is an example of change due in part to harvesting. The overall forest and timberland acreage is expected to increase slightly, but the combination of harvesting and natural succession lead to important changes in future acreages by forest type. These changes argue for mitigations to slow such changes or at least to develop and seek to achieve covertype goals statewide. Failure to do so jeopardizes the timber and nontimber benefits the various forest types provide.

Note especially changes to selected covertypes. Jack pine experiences a significant reduction across all three timber harvesting scenarios, as does balsam fir. However, paper birch, which also shows a marked decline, seems to be less affected by harvest level. The same is found for black spruce. These changes indicate that a number of forces are affecting such changes, not just timber harvesting.

Table I.2. Forest type acreage for timberland and all forest plots under the base, medium and high scenarios, 1990 and projected 2040, statewide (thousand acres). Based on GEIS covertype algorithm. Each forest type contains a number of tree species. The reader should consult appendix 2 for forest covertype determination, and table 5.11 of this document for projected changes in individual tree species.

	1990		2040					
			Timberland			All Forest Land		
Forest Type	Timberland	All Forest Land	Base Scenario	Medium Scenario	High Scenario	Base Scenario	Medium Scenario	High Scenario
Jack pine	487.1	614.2	329.6	307.4	272.6	387.0	365.8	330.0
Red pine	350.6	430.1	452.4	454.4	433.2	541.0	543.0	521.8
White pine	137.3	148.3	141.0	136.0	120.2	174.9	169.9	154.1
Black spruce	1,320.8	1,997.9	1,001.2	945.4	957.8	1,637.0	1,581.2	1,593.6
Balsam fir	1,012.5	1,151.4	657.4	598.4	589.6	748.8	689.8	681.0
Northern white cedar	322.4	367.9	360.9	370.4	370.6	410.1	419.6	419.8
Tamarack	696.2	822.2	678.7	704.4	701.7	803.8	829.5	826.8
White spruce	137.0	181.0	227.9	202.7	158.2	334.6	309.4	264.9
Oak-Hickory	1,288.0	1,315.6	1,370.2	1,322.3	1,354.1	1,407.6	1,359.8	1,391.5
Elm-Ash-Soft maple	1,564.2	1,662.5	1,744.0	1,714.8	1,721.5	1,874.6	1,845.5	1,852.1
Maple-Basswood	1,301.8	1,334.5	1,460.2	1,368.6	1,255.2	1,497.1	1,405.5	1,292.1
Aspen	4,496.0	4,888.0	5,238.7	5,496.5	5,730.0	5,669.0	5,926.8	6,160.3
Paper birch	1,179.3	1,295.1	803.4	806.2	741.7	933.5	936.4	871.8
Balsam poplar	480.1	506.1	413.7	451.8	473.0	437.7	475.8	497.0
Nonstocked	0	0						
Other	0	0						
Total	14,773.4	16,714.8	14,879.4	14,879.4	14,879.4	16,857.0	16,857.0	16,857.0

Source: Jaakko Pöyry Consulting, Inc. (1992a).

Stand Age Changes

Table I.3 compares the average stand age by covertype and scenario for timberland 1990-2040. Notable is the continued aging of the forest despite increased harvesting, which has important implications for aesthetics as older and larger trees are a positive component of such values. For most covertypes, the base and medium scenarios suggest the forest would be on average older and the largest trees larger in 2040 than at present. Notable exceptions to increasing average covertype age for these two scenarios are aspen and related forest types (e.g., balsam poplar) experiencing high demand. Under the high scenario, the mean age and size class of the forest would return to 1977–90 conditions (approximately) in the year 2040.

Table I.3. Average stand age by covertype and harvest scenario for timberland 1990-2040.

Forest Type	1990	2040		
		Base	Medium	High
Jack pine	48	77	69	42
Red pine	44	54	54	41
White pine	80	104	102	87
Black spruce	59	89	61	50
Balsam fir	46	82	71	58
Northern white cedar	97	116	106	94
Tamarack	57	99	85	55
White spruce	42	90	82	76
Oak-Hickory	69	78	71	63
Elm-Ash-Soft maple	56	86	75	60
Maple-Basswood	58	90	80	58
Aspen	41	34	33	28
Paper birch	58	92	81	61
Balsam poplar	41	33	31	31

Source: Jaakko Pöyry Consulting, Inc. (1992a). Projected ages for stands not clearcut were determined by adding 50 years to current age. See appendix 2 for more detail.

The changes in average age for aspen are due largely to harvesting, as demand is projected to be strong. At the same time, stands in reserved or otherwise unavailable status will continue to age. Consequently, aspen (and most other covertypes) will show a wider range of age classes than in the recent past.

Stand and tree age is also important as a major factor in determining tree size, quality, and value. For red oak, however, age may be deceptive as demand has been high for sometime and the quantity of high-quality timber is a concern. Locally, quality is problematic and depends heavily upon the history of stands with respect to grazing, logging, fire, etc.

Nominal rotation ages by covertype are shown in section 2.3.1 and range from 50 to 80+ years, but the actual age class distribution (many stands already older than the rotation age) and the need to schedule harvests over the entire study period precluded harvesting at rotation age for many stands.

Soil Resources Impacts

Soil resource impacts were developed by overlaying harvest locations on soil maps at a statewide scale. Harvest of merchantable bole did not remove either nitrogen or phosphorus beyond their rates of replenishment. Areas at risk for loss of calcium are most closely associated with harvest of aspen-birch and upland hardwoods on medium-textured soils and especially on coarse-textured soils (approximately 5 million acres are at risk for calcium loss). Loss of magnesium beyond rates of replenishment is especially associated with harvest on coarse-textured soils and organic soils. Under the base scenario, about 2.5 million acres are at risk for magnesium loss. Finally, potassium loss is primarily associated with harvest of aspen-birch on coarse-textured soils and the harvest of all deciduous types on organic soils. Under the base scenario, about 1.5 million acres are at risk for potassium loss.

For full tree harvesting, calcium losses increase slightly compared to merchantable bole harvest. In contrast, nutrient losses for magnesium and potassium are significantly increased.

The effect of nutrient losses on long-term site productivity are uncertain. Expectations are that nutrient losses, unless countered by inputs, will lead to diminished productivity in the long-term. Uncertainty remains over the levels of nutrients at which productivity may decrease.

Compaction and related disturbance would be most frequent on the well-drained medium-textured soils, which are the most common soils in the state, and the poorly-drained medium and poorly-drained fine soils which have the lowest strength.

Surface erosion rates were significant on less than 1 percent of the area harvested plus haul roads, and this significant impact was predominantly limited to well-drained soils which exist on steeper slopes in ecoregion 6.

Results for the medium and high scenarios are closely related to the acreage subject to harvesting and show a greater extent of impacts than under the base scenario.

Forest Health Impacts

All timber harvesting and forest management activities affect forest health; all have impacts. Those impacts range from nearly none (where the management activity is minimal) to very large (where major changes are brought about in the forest). Given changes, vulnerability to impacts is a function of the insect, disease, or health vector, the harvesting or management related disturbance that would hinder or favor its expansion or development, and the susceptibility of the forest as defined by vegetation patterns, forest age class structure, etc.

Certain assumptions were made as part of the analysis of significant impacts on forest health. In particular, it was assumed that the MNDNR pest management guidelines and other guidelines would be followed by all ownerships. If the guidelines are not followed, impacts of harvesting on the health of Minnesota's forests could be more severe. This is because the guidelines are intended to prevent pests and diseases from becoming established by avoiding the creation of conditions that are suitable for pests. The significant impacts projected to occur under the base level harvesting by forest type groups are developed for the major present and prospective pests and diseases. For most covertypes, insect and disease problems are closely related to the age class structure with older stands often, but not always, being the most susceptible. Thus harvesting, as it affects the age class structure, is an important factor in managing forest health. With the exception of unanticipated catastrophic outbreaks of pest or disease problems, forest health is manageable and can be improved.

Water Quality and Fisheries Impacts

Timber harvesting is, by nature, a disturbance to the forest and the landscape. As such, it could affect sedimentation, nutrient loading, changes to key aspects of the aquatic environment, and the amount, duration, and timing of runoff. The degree to which a given disturbance represents an *impact* is a matter of scale. For example, few if any landscape modifications associated with timber harvest will be detectable in large rivers such as the upper Mississippi. As one progresses further upstream, the probability of detecting impacts increases as changes outside of the identified standards and tolerances become more noticeable.

Application of the study significance criteria to the impacts identified indicates that the effects of timber harvest at the ecoregion level will not cause significant impacts. However, there will be a series of changes in the landscape and water resource. Most of those changes will be relatively local and short-term. Timber harvest which complies with Minnesota BMPs will have significantly fewer local water resource impacts than timber harvest carried out in the absence of such practices.

Projected Wildlife Species Impacts

Impacts on wildlife species were assessed by several criteria. Two of these are emphasized here. The first criteria was that an impact was significant if the available habitat of a species was projected to be changed by 25 percent or more *in any ecoregion.* Note that with this criterion, an impact occurred whenever a species in any ecoregion and decade met the criterion. The second criteria involved species federal or state listed as of special concern, threatened, or endangered or their habitat. With this criteria, an impact was significant if any timber harvest or forest management activity is projected to decrease the habitat and disturb a listed species by 5 percent or more *statewide.* In all of these analyses, area of available habitat for each species serves as an index of population. It is this index that is modelled, rather than actual numbers of animals. Additional criteria considered lowland habitat, food species, habitat fragmentation and genetic variability.

Projected adverse significant impacts of timber harvesting on forest wildlife are shown in Table I.4. For the 173 species examined, 27, 44 and 53 percent are projected to be negatively impacted by the base, medium, and high scenarios on an ecoregion basis. Among species groups, no large mammals would be adversely impacted by any of the three harvest scenarios. Six small mammal species would be adversely impacted by the base and medium scenarios and eight would be impacted under the high scenario. Herps (amphibians and reptiles) show a similar pattern with the same number of impacts for the base and medium scenarios, but more species were negatively impacted under the high scenario. Forest birds are projected to have a major increase in the number of species negatively impacted as harvesting moves from the base to the medium scenario level (from 28 percent to 50 percent impacted). The high scenario shows a further but less dramatic increase in the number of species negatively impacted compared to the medium scenario. Fifty-six percent of the bird species are negatively impacted in one or more ecoregions under the high scenario.

Table I.4. Number of species projected to be significantly and negatively impacted on all forest lands by harvest scenario. The first number in a cell is the number of species showing a 25 percent or more decline for a species *in any ecoregion* or a 5 percent or more decline *statewide* for a species listed as endangered, threatened or of special concern. Values in parentheses show number of species projected to decline *statewide* by 5 percent or more for species listed as endangered, threatened, or of special concern or 25 percent or more for all other species.

Species Group (Number of species)	Scenario		
	Base	Medium	High
Small Mammals (22)	6 (0)	6 (2)	8 (5)
Large Mammals (5)	0 (0)	0 (0)	0 (0)
Birds (138)	39 (5)	69 (8)	78 (44)
Herps (amphibians and reptiles) (8)	1 (0)	1 (1)	5 (1)
All (173)	46 (5)	76 (11)	91 (50)

Table I.5 illustrates the projected changes in habitat-based wildlife population indices on a statewide basis, but interpretation is important. The table shows the number of species by species group that increase, remain stable or decrease statewide. However, an increase in already common species does not in a biological sense balance a decline in a rare species. Further, harvesting tends to favor early successional species or, in some instances, those that are not obligatory forest inhabitants, i.e., species that do not necessarily require forest habitat.

Table I.5. Number of species of interest that are projected to decrease by 25 percent or more, remain stable, or increase by 25 percent or more, statewide on all forest lands by harvest scenario.*

Species Group (number of species)	Decreasing			Stable			Increasing		
	Base	Med.	High	Base	Med.	High	Base	Med.	High
Small Mammals (22)	0	2	4	21	19	16	1	1	2
Large Mammals (5)	0	0	0	5	4	4	0	1	1
Birds (138)	5	8	43	111	106	61	22	24	34
Herps (amphibians and reptiles)(8)	0	1	1	6	5	6	2	2	1
All (173)	5	11	48	143	134	87	25	28	38

* *Stable* is a change of less than 25 percent. No special consideration given to species listed as endangered, threatened, or of special concern.

Recreation and Aesthetic Impacts

Harvesting and the development of roads needed to access timber from forests within unroaded areas (primitive or semiprimitive categories of land) is indicative of an increased level of disturbance. The total forest area in primitive and semiprimitive categories is 3.1 and 9.6 percent, respectively. Of these, 0.4 and 7.2 percent, respectively, occur on timberlands. Improved access provides opportunities for additional use by people who depend on motorized access. However, this will likely displace a proportion of existing users and will impact animals that are adversely affected when the level of human contact increases. Based on study criteria, the significantly impacted areas under the base scenario correspond to approximately 32 and 26 percent of the timberland area in the primitive and semiprimitive nonmotorized categories, respectively. Under the medium scenario these impacts would rise to 34 and 29 percent. Under the high scenario the impacts would be 43 and 35 percent, respectively, for primitive and semiprimitive categories.

The study also considered the use of visual management guidelines (VMGs), which are planning tools used by the federal and state ownerships to reduce visual impacts. Significant impacts can be avoided where visual planning is used to identify *where* and *how* harvesting and associated forest operations should take place, i.e., road location and design, use of buffers, size and shape of cut, and slash and debris disposal practices. Harvesting can reduce the aesthetic experience for subsequent users, therefore limiting the recreation value of harvested areas and the adjacent unharvested areas. However, harvest operations and associated roading can also create additional recreation opportunities of a more developed type.

Based on study criterion, significant visual impacts occur when timber harvesting and forest management activities do not follow VMGs. Only the USDA Forest Service and the MNDNR are assumed to use VMGs. Analysis of all other ownerships found that 58.7 percent of these timberland areas harvested under the base scenario would not be treated according to VMGs and these are therefore judged to be significantly impacted. As determined by the higher acreage harvested, the medium and high scenarios showed higher levels of impacts on the other ownerships, 67.1 percent and 74.1 percent, respectively.

Impacts on Unique Cultural and Historic Resources

Heritage resources include cultural landscapes, structural remains, archaeological remains, Native American traditional use sites, and cemeteries. These were considered significantly impacted if destroyed or, in the case of cemeteries, disturbed. However, use of this significance criterion requires that the term *destroyed* be defined. The term destroyed has been interpreted as damage to a site such that its scientific, cultural, or spiritual values are diminished in whole or in part. This interpretation results in a *conservative* assessment of impact by including those sites with a partial loss of values; however, this is appropriate for the purpose of a GEIS.

Given these definitions and interpretation the significant impacts are predicted for each type of heritage resource. There is insufficient data to assess, even qualitatively, the extent that sites will be impacted. However, the number of impacts will increase as the level of harvesting increases.

Economic Impacts Overview

Development of precise conclusions on the overall state economy impacts from increased timber harvesting were not possible. The available data and the modelling tools used did indicate that employment in certain sectors of the economy would increase. However, due to limited data availability, conclusions on economic changes in the tourism and recreation industries and related costs of possible mitigation efforts were not possible. These limitations prevented the study from assessing detailed impacts to Minnesota's overall economy associated with increased timber harvesting.

Additionally, the study did not seek to analyze potential costs and benefits of increased timber harvesting or alternative management scenarios except in the limited area related to the timber industry's increased employment and financial flows. Because of the necessitated narrow scope of this economic analyses, they should be viewed as suggestive of trends or directions only.

With the limitations noted, table I.6 summarizes economic impacts in terms of employment, additional employee compensation and total industrial output for the three harvesting scenarios. The medium scenario represents expansion of existing capacity while the high scenario would represent the development of new mills. The impacts are presented in terms of direct, indirect, induced, and total effects as determined from an input-output model. Direct impacts are the increased employment, income, and output attributable to the expansion of activity. Indirect impacts are due to increases in purchase of raw materials and other goods and services required for the expansion. Induced effects are those due to the consumer purchases that result from the increased employment generated by the original expansion.

The medium and high scenarios would also require substantial staffing and funding increases to handle the increase in workload for planning and administration of timber sales.

Table I.6. Summary of statewide changes: direct, indirect, and total effect of increase in employment, additional employee compensation, and increase in total industrial output by harvest scenario.*

	Medium Scenario			High Scenario		
Impact	Direct Effect	Indirect Effect	Total Effect	Direct Effect	Indirect Effect	Total Effect
Employment (jobs)	352	3,788	6,752	3,059	18,424	35,094
Additional employee compensation (millions of $)	16.9	84.4	146.4	133.2	418.9	790.4
Total industrial output (millions of $)	611.2	297.0	1,059.5	3,084.0	1.451.2	5,324.1

Note: Induced effects may be estimated by subtracting direct and indirect effects from total effect.

Impacts on the Tourism and Travel-based Industries

A lack of information on relationships between the level of harvest and its consequences for the tourism and travel industry precluded the quantification of impacts. However, some general observations are possible. Resorts and other tourism-based facilities depend on the visual amenity of the surrounding forest for their setting. It is thus likely that individual resort operations will be adversely impacted by visually obtrusive harvesting operations within their viewshed or along access routes. The consequences for the use levels of the facility or the recreational experience of the users would depend on the expectations of the clientele attracted to the resort. The overall result is complicated by the fact that increased access to forest areas provided by harvesting often increases the level of recreational activity, however, the type of activity (primitive versus motorized) may change. Use of VMGs can reduce the area adversely impacted and the duration of impacts.

Base Scenario Review

The base scenario was modelled using the existing levels of roundwood consumption as the basis for demand over the modelled period of 50 years. This assumes that no further forest-based industrial developments take place within this period.

The base level of harvesting is well below the level of tree and forest growth potential if timber production was the only objective. It also appears sustainable from a biological standpoint as it would allow retention of other forest characteristics and values of concern in this study. As with any modelling effort, this conclusion is valid within a range of error and to the degree that the assumptions employed are representative of actual conditions. In this context, based on long-term (modelled) sustained yield analyses, a timberland area of approximately 7.4 million acres could sustain close to a 4 million cord annual harvest level. This would leave over 7.5 million potentially harvestable acres of timberland unharvested over the long-term. This analysis suggests that large areas of timberland could potentially be shifted towards other nontimber management objectives, such as wildlife habitat, without severely impacting timber production at the 4 million cord level in the long-term.

This situation applies to aspen, but with an important caveat. Given significant increases of demand coupled with an unbalanced age class distribution, there will likely be constraints in the supplies of this species during the middle of the modelled period. In order to meet the prespecified statewide timber demand levels, the base, medium, and high scenario projections assumed that 25 percent of the demand for this species would be transferred to the northern hardwood species.

The projected harvesting patterns indicate that harvesting is projected to occur in virtually all forested regions of the state. This pattern reflects the well-developed road network in Minnesota and the decentralized nature of the timber industry. In essence, few stands in Minnesota are ruled out for harvesting because of their location.

Base Scenario Significant Impacts Summary

Analysis considered impacts statewide and by seven ecoregions. The base scenario identified the following significant impacts:

1. projected significant loss of forest area in ecoregions 1, 2, 3, and 4 due to land use change (also includes consideration of the loss of timberland in the north);
2. projected harvesting affecting patterns of forest cover in areas of mixed land use (considers amount, type, and fragmentation of cover important to wildlife habitat);

3. projected changes to tree species mix (important to maintaining biodiversity and wildlife habitat; four tree species show significant declines in stem number);
4. projected changes in the age class structure of paper birch (important to community replacement capability for this species; the young age classes appear deficient in acreage for replacing the older age classes);
5. projected harvesting affecting genetic variability of plant or animal species (important to maintaining biodiversity; critically endangered, endangered or threatened communities are identified);
6. projected harvesting affecting federal- or state-listed plant species of special concern, threatened, or endangered or their habitats (statewide 9, 7, and 37 species listed as endangered, threatened, or of special concern are projected to be adversely impacted by harvesting);
7. changes in the susceptibility and vulnerability of covertypes to forest health risks (important to community stability and productivity; largely dependent on age class structure and the amount and type of harvesting activity);
8. projected harvesting affecting site nutrient capital, i.e., nutrient supplies present and/or actually available (important to sustainability of forest growth and yield; results indicate nutrient losses with certain types of harvesting on various types of soils; approximately 5 million acres are at risk for calcium loss);
9. projected harvesting affecting soil physical structure (important to maintenance of forest growth; the actual area where significance criteria for compaction are exceeded is estimated at 330,000 acres plus haul road area);
10. projected harvesting causing accelerated erosion from forest roads (important to site productivity and water quality; about 25,000 acres plus haul roads are estimated to be impacted with major concern in ecoregion 6);
11. projected changes in the populations of forest dependent wildlife (by changes in amounts of habitat available; 46 species, about 25 percent of all wildlife species studied, were projected to be significantly impacted). Negative impacts are projected for the ringneck snake, beaver, northern flying squirrel, gray and fox squirrels, bobcat, lynx, as well as 39 bird species, for example, Cooper's Hawk, Great Gray Owl, Pileated Woodpecker, Eastern Bluebird, Ovenbird, Song Sparrow, Yellow Warbler and Hooded Warbler;
12. projected harvesting affecting populations of endangered, threatened, or special concern species of animals (two such species, Louisiana Waterthrush and Red-shouldered Hawk are projected to be negatively impacted);

13. projected harvesting affecting patterns of mature lowland conifer stands (important to wildlife habitat; many important patches of lowland conifer habitat may be lost with harvesting);
14. projected harvesting affecting the availability of food producing trees (important to wildlife; particularly oaks and other mast producing species);
15. projected harvesting in the absence of VMGs on visually sensitive areas (important to aesthetics and recreational use; visual aspects of landscapes and recreational settings are impaired);
16. projected development of permanent forest roads in primitive (undeveloped) and semiprimitive nonmotorized areas (important to maintaining primitive or undeveloped recreational opportunities; harvesting leads to a loss of such areas); and
17. projected harvesting affecting unique cultural and historical resources (important to the protection and integrity of these resources; disturbance from harvesting can effectively destroy these resources).

Base Scenario Recommended Strategies

Numerous strategies were identified to mitigate the significant impacts projected to occur at the base level of harvest. These recommended mitigations are presented under three categories which reflect their main focus:

1. site-level responses;
2. landscape-level responses; and
3. forest resources research.

Site-level Responses: Strategies in this category are intended to modify operational procedures used in the planning and execution of timber harvesting and forest management activities on an individual site or local scale. The responses considered are:

- ***Modifications to harvesting practices and equipment***. Modifications to the practices and equipment used in Minnesota can be used to mitigate significant impacts projected to occur as a consequence of timber harvesting and forest management activities. Such modifications include:
  - *Retain Slash* (including bark where appropriate). This strategy is intended to modify harvesting systems and techniques in order to reduce the loss of nutrients from harvested sites and to maximize habitat values for small animals in the resulting cutovers. This must also encompass logger safety considerations.
  - *Equipment and practices for use in multiple entry harvesting operations.* The projected increase in the use of multiple entry, i.e., thinning, or uneven-aged silviculture will require modifications to existing safe equipment and practices to avoid excessive damage to retained stems during harvesting operations.
  - *Modify season of equipment operation to minimize compaction.* This strategy is intended to reduce compaction by identifying susceptible

sites and limiting operations on those sites to periods when the risk of compaction is lowest.

- ***Modifications to silvicultural practices.*** These specify the circumstances where modifications to normal silvicultural practices are required to maintain wildlife habitat and aesthetic values. Typically, the modifications represent a shift from clearcutting to techniques that retain a proportion of the stand following harvesting.
  - *Patterns of forest cover in areas of mixed land use.* A strategy to mitigate the negative impacts of changing patterns of forest land in the southern parts of the state requires modifications to the silvicultural practices used and specification of the size of individual cuts. Thinning or uneven-aged management should be used where feasible.
  - *Retention of key habitat requirements in clearcut areas.* Certain key habitat can be retained within clearcuts by retaining snag trees, trees with cavities; and retention of conifer patches and isolated trees when harvesting in predominantly deciduous forests.
  - *Retention of cavity trees* or mature trees that are likely to produce cavities in stands that are clearcut, will provide nesting and hiding places for a wide range of birds as well as some mammals in postharvest forests.

- ***Protection of sensitive sites.*** Sensitive nest sites, habitats, and rookeries should be identified and protected by appropriate buffers.

- ***Increasing the wood fiber productivity of timberlands***. There are two elements to the strategy. The first provides short- to long-term benefits, and the second provides medium- to long-term benefits.
  - *Increasing Utilization.* This element is intended to increase utilization by making maximum use of the volume of wood available for harvest in any particular stand, as well as optimizing use at mills.
  - *Increasing Productivity*. Regeneration to full stocking levels and species-site matching are two of the most readily implemented and effective ways to increase the productivity of timberlands on a statewide scale. Thinning and management to reduce pest damage can also provide important gains.

Landscape-level Responses: These are typically long-term or broad-based solutions that require extensive analysis and/or planning to identify and achieve the intended objectives of developing regional or statewide responses. These responses also provide direction and coordination across ownerships. The strategic responses considered here are:

- ***Measures to reduce the area of forests converted to other land uses***. This strategy seeks to develop policy instruments to discourage conversion of forested land to other, nonforest, land uses.

- ***Balancing age class and covertype structure***. This strategy seeks to develop statewide objectives that cross ownership boundaries that addresses future age and/or size class and covertype structure goals.
- ***Riparian corridors***. This strategy identifies environmentally sensitive areas near waterbodies. Harvesting can be carried out within these buffers; however, uneven-aged management or thinning rather than clearcutting are the most appropriate silvicultural systems. Riparian corridors are a special case of a broader strategy referred to as *connected landscapes*, which are wide corridors of mature or selectively cut forest between core areas such as patches of old growth, research natural areas, and scientific and natural areas. Connected landscapes are considered a potentially important tool. However, more research is needed to determine its effectiveness and approaches for implementation.
- ***Extended Rotation Forests (ERF)***. This strategy provides one means to manipulate age class distributions. ERF can be described as any forest managed on a rotation length that is longer than that recommended for the covertype for timber production. Management as ERF does not preclude harvesting and therefore does not remove lands from the timberland base; yet it helps provide many of the biodiversity features of older forests over large areas.
- ***Protection of sensitive sites for plant species.*** This strategy would exclude or modify harvesting in the known locations of rare plant species and rare plant communities that are likely to be sensitive to harvesting impacts and should be excluded from harvesting.
- ***Landscape-based road and trail plan***. This strategy would involve planning and coordination between ownerships to develop landscape-based road and trail plans, and would cover the development of new roads (particularly in primitive and semiprimitive nonmotorized areas); long-term access needs; and closure policies.
- ***Develop VMGs***. This strategy requires development and widespread application of VMGs. VMGs, especially if used in conjunction with nonpermanent roads, give attention to the important social attributes and long-term benefits of primitive recreation opportunities and reduce the likelihood of adverse visual impacts.
- ***Integrated Pest Management (IPM) strategies***. The state should initiate and oversee development of IPM strategies for the major pests likely to increase as a consequence of timber harvesting.

Forest Resources Research: Strategies in this category are intended to: obtain the information needed to undertake strategic and operational planning; monitor changes at the landscape- and site-level; and provide the basis for developing management direction and planning tools. The responses considered here are:

- ***Monitor the age class and covertype structure of the state's forests and their pattern across the landscape***. This strategy would develop monitoring of the age class and covertype structure of the state's forests and information on landscape patterns. This information is important to planning and analysis in a wide range of subject areas.

- ***Undertake an inventory of the state's biodiversity features***. This strategy will speed up the identification of the occurrences of rare plant and animal species and communities, and key habitat features for wildlife species.
- ***Conduct an inventory of old growth forests across all ownerships***. This strategy, in conjunction with the above inventory of biodiversity features, will speed up the identification of important sites and ensure their protection.
- ***Develop and fund a research program to investigate the effects of timber harvesting and forest management activities on the tourism and travel industry in Minnesota.*** This strategy is intended to identify and quantify the relationship between changes in the forest resource and induced changes in recreational/tourism user patterns in forested areas in the northern part of the state.
- ***Upgrade and maintain a listing of known heritage resource use sites in the state*.** These resources include cultural landscapes, standing structures, archaeological sites, cemeteries, and traditional use sites. This strategy will upgrade the quality, extent and utility of the database on the state listing of known sites and their locations and aid their protection.

Base Scenario Cumulative Unmitigated Significant Impacts

The mitigation strategies described in the previous section will likely mitigate many of the significant impacts projected to occur under the base level of harvesting. However, some unmitigated impacts such as loss of forest area and timberland in the north, loss of soil nutrients on some sites, and disturbance of archaeological resources will remain, despite implementation of the mitigation strategies. These impacts will likely be concentrated on NIPF lands as a consequence of likely lower standards of planning and supervision of field operations, compared to large ownerships with professional staffing. However, the mitigations proposed would reduce the likelihood of significant impacts that might degrade the long-term sustainability of the state's forest resources. The only exception is the projected reductions in the nutrient capital of some low productivity sites. These reductions will need to be carefully monitored. The relationship between changes in nutrient capital and changes in site productivity also needs to be closely observed.

The harvesting projected to occur at the base level (4 million cords) will likely be sustainable in a broad sense. That means this timber harvest level can be continued indefinitely and other forest resource characteristics such as soil productivity, water quality, wildlife habitat, and aesthetic values can be maintained *providing recommended mitigation strategies are implemented within the next few years*. There will be changes to the forest; however, the most profound of these will be a consequence of the natural forest aging process.

Medium and High Scenarios Overview

The previous section describes the changes projected to occur under the base scenario and the associated significant impacts and mitigation strategies. The differences in identified impacts projected to occur at the medium and high scenarios, compared to the base scenario, lie in the *degree* of impacts rather than the *types* of impacts. Similarly, the unmitigated impacts of the medium and high scenarios are the same type as those for the base scenario, but they differ in degree. As an example, the medium scenario impacts certain wildlife habitat availability to a greater extent than the base scenario, but the type of impact (say habitat loss) is the same. For any significant impact criteria, there is also only one threshold for significance. Beyond that threshold, impacts can assume increased importance, but that does not change the type of impact as defined here or its significance. In particular, the high scenario suggests many impacts are large and would be left unmitigated.

For most covertypes, the differences between the three scenarios are related to the intensity of timber harvesting and related forest management activities at the landscape-level. The types of site-level impacts will remain the same under the medium and high scenarios, although would typically apply to more area than under the base scenario. For example, 900,000 acres were projected to be significantly affected by compaction under the base scenario; while 1,025,000 acres were projected to be affected under the medium scenario. Other area-based impacts include the remaining impacts on soils (nutrient loss and erosion), impacts on cultural and historic resources, and impacts on primitive and semiprimitive areas.

In addition, the number of animal species affected (increases and decreases in populations) increased from the base to the medium, and medium to the high levels of harvesting (see tables I.4 and I.5). These changes were a consequence of changes in areas of particular forest types affected, and the projected intensity of harvesting reflected in changes in the age class distributions. Similarly, the increased intensity at the higher levels of harvesting also affected other nontimber values including aesthetics and recreation values, covertype species composition, and rare plants and plant communities.

The level of economic benefits evaluated in this study as accruing from the medium and high scenarios increased relative to the base level scenario. Recall that these economic benefits were previously noted to be limited to only those for which data were available, primarily forest industry employment and financial flows. The studied increases in the forest industry sector were accompanied by flow on benefits to other sectors that service these industries or are otherwise likely to benefit from increased levels of economic activity. The increased levels of harvesting will increase direct and indirect employment.

The impacts of the increased levels of harvesting on the tourism and travel industry are unclear. These impacts are likely to be linked to the intensity of harvesting with increasing harvesting having an adverse impact, but in ways that are difficult to quantify.

The most important differences between the scenarios are those related to the long-term sustainability of the levels of harvesting. An analysis of long-term sustainability indicates that, with some modifications, the levels of demand specified under the base and medium scenarios are sustainable in the long-term. *However, harvest at these levels would need to implement the recommended mitigations relatively soon to avoid or mitigate the significant impacts described under these scenarios.* In contrast, the levels of harvesting specified under the high scenario could not be sustained for timber assuming the levels of productivity investments and net increments (forest growth) used in the GEIS analysis. Additionally, there is concern that some significant impacts to forest resources at that level of harvest could not be fully mitigated.

The results, as based on the modelling techniques and assumptions used, indicate that a level of approximately 5.5 million cords is the maximum that could be sustained. *However, these conclusions also assume the site-specific or other mitigations below the modelled level of resolution are implemented within the next few years and do mitigate otherwise significant impacts.* This assumption is critical since the 5.5 million cord harvest level was not explicitly examined for impacts as was done for the base, medium, and high scenarios. Also, at this level of harvesting there is little flexibility available to meet timber supply demands while making provision for nontimber values. Importantly, if some of the significant impacts cannot be effectively mitigated, then the 5.5 million cord level would not be sustainable as described for this study.

The high level of harvesting is still below the level of tree and forest growth potential if timber production was the only objective. However, harvest levels above 5.5 million cords appear sustainable only if, in addition to effective mitigation of significant impacts, the loss of forest land projected in the north was halted, and substantial investments in forest management are made to improve productivity. Clearly, such harvest levels would require long-term investment. Additionally, such harvest levels might require the USDA Forest Service allowable sale quantities on the two national forests in Minnesota to be increased.

The high level scenario was not analyzed with a view to examining it as a feasible goal for the statewide level of harvest. The level was specified as the estimated maximum level of harvesting that could be sustained from a timber production standpoint. As such, it served a useful analytical purpose. The analysis has shown that, with the assumptions and constraints applied, this level is not achievable on a sustainable basis.

Suggested Strategic Programmatic Responses

The GEIS presents a variety of mitigation recommendations at each of the three alternative levels of statewide timber harvest that are required of each level of harvesting to assure mitigation of the identified significant impacts. While such tactical mitigations are extremely important and useful study outcomes, the GEIS also serves the broader purpose of providing direction on the types of policy (programmatic) strategies the state should consider to help verify and effectively address and implement these recommended mitigations. The various mitigation options can be integrated into a comprehensive set of policy strategies that can serve as the focus for an implementation program. This will require a well-coordinated statewide policy formulation effort aimed at establishment of the following:

Forest Resources Practices Program

The GEIS study team recommends that the most coordinated way to collectively consider the site-level recommendations is through a *state comprehensive Forest Resources Practices Program* (FRPP). Such a program would serve as an umbrella structure for the implementation of a wide range of specific management prescriptions. These management prescriptions could include guidelines that address the following activities associated with timber harvesting, and that are recognized in the GEIS as desirable approaches to mitigating adverse impacts:

- timber sale design and layout to incorporate nontimber concerns (e.g., visual BMPs, wildlife habitat, protection of rare plant occurrences, and archeological sites);
- methods for the disposal/redistribution of slash and other woody biomass;
- establishment and management of riparian corridors;
- BMPs for water quality;
- biomass retention (e.g., inclusion of snags);
- postharvest reforestation practices;
- style and methods of road construction;
- managing for visual/aesthetic objectives;
- managing for protection of unique historical/cultural resources; and
- traffic control/site amelioration to minimize compaction.

The following implementation steps are associated with adoption of the new FRPP:

- The FRPP should initially be voluntary to help avoid costly public and private steps. However, the FRPP must also clearly define the following elements:
  - logger, forest operator, and forester certification or licensing programs;
  - statistically sound monitoring and evaluation of compliance activities, wherein if compliance falls below a specified threshold for two consecutive years, mandatory compliance rules become effective automatically for the area out of compliance, and stay mandatory until

three consecutive years of successful compliance are once again achieved;

- wood purchasing industries will be encouraged to adopt a forest operators/loggers code of practices (COP) that is congruent with forest practices guidelines. This COP would then be introduced into all forest operators/loggers contracts to ensure statewide standard compliance; and
- the state should work with its own agencies and departments, the counties and especially the USDA Forest Service to develop financial assistance and incentives programs for private landowners, operators, and loggers.

Sustainable Forest Resources Program

The GEIS study team recommends that to successfully mitigate, in advance, unacceptable *landscape-level* impacts from timber harvesting and forest management activities, a statewide *Sustainable Forest Resources Program* (SFRP) should be adopted. This initiative would provide a broad, landscape-level focus on managing Minnesota's forest resources for a variety of outputs and objectives. The basic objective of this SFRP would be to establish a statewide structure for: systematically identifying existing resource conditions; evaluating these conditions in light of past forest resource trends; determining desired future forest conditions; identifying and developing specific strategies necessary to achieve those desired future forest conditions; and providing feedback to assess the success in achieving those objectives.

In contrast to forest or land use planning efforts conducted by federal, state, and county agencies, the SFRP would identify and set goals for desired future forest conditions that *transcend ownership boundaries*. In addition, the temporal requirements associated with achieving these goals could be longer-term than existing individual planning efforts. Achieving desired statewide forest covertype and age class goals along with developing coordinated plans to protect especially sensitive plant and animal species are examples of mitigations that would be administered through a SFRP. The steps in developing and enhancing such goals are:

- identify present and past resource conditions;
- identify future forest condition goals;
- formulation of management alternatives to achieve these goals; and
- monitoring and evaluation (feedback).

Forest Resources Research Considerations

In addition to recognizing specific gaps in the existing information relating to Minnesota's forest resources, the GEIS study process underscored the need to focus future forest resources research efforts to address the following information needs:

- multidisciplinary considerations;
- broadening spatial and temporal dimensions;
- linkages to resource management; and
- investment and response linkages.

As well as identifying information gaps, the GEIS study process also noted areas where additional research will be needed to fully mitigate projected timber harvesting and forest management significant impacts. Examples of research initiatives that could be included as foundation steps for this program are:

- to develop a better understanding of timber harvesting and forest management impacts on ecosystem functions and processes;
- to identify the full role of forest soils and their various conditions in forest resources productivity in Minnesota;
- to provide the scientific basis for setting and refining desired age class and covertype goals to meet biological diversity objectives;
- to determine the interaction between the level of timber harvesting and forest management activities and the tourism/outdoor recreation industry;
- to determine management techniques and impact assessments for forest pests;
- to identify and evaluate low impact timber harvesting techniques and technologies applicable to Minnesota;
- to identify potentially complementary forest industries for Minnesota; and
- to fulfill some of the monitoring functions identified under the harvesting practices and SFRP.

In order to meet previously identified research program goals and objectives, and effectively deal with the other issues raised here, the GEIS study team recommends the state assume the central role for the development of a comprehensive cross-landowner, statewide *Forest Resources Research Program* (FRRP). The statewide FRRP should also become the driving force for extension, technology transfer, and continuing education activities. This applies to current programs and those to be developed in cooperation with the Minnesota Extension Service (MES).

The GEIS study team recommends the establishment of a Minnesota Applied Forestry and Harvesting Program within the statewide FRRP and in coordination with the MES. The program would be jointly administered by the MNDNR and the MES and would:

- be the basis of certification/licensing for employment and subcontract work in forest areas for all landowners and agencies in Minnesota as required by the COP;
- integrate forest management, harvesting, and other forest multiresource subjects into a comprehensive extension education program; and

- be supportive of the needs of the FRPP and SFRP.

Minnesota Board of Forest Resources

The study considered a range of possible administrative and organizational structures to carry out the major strategic program recommendations (FRPP, SFRP, and FRRP). These included the identification of the advantages and disadvantages of the EQB, MNDNR, and the Minnesota Forestry Coordinating Committee (MFCC) and a forestry board in this role. Important attributes considered for the organization included the need to:

- provide opportunities for representative stakeholders of Minnesota's forest resources to provide input;
- provide an environment that fosters interagency coordination;
- have defined opportunities and procedures for providing public input to decision making;
- be recognized as the focal point that can provide input to legislative and executive branches on statewide forest resource policy matters;
- be recognized as the organizational entity with the authority to implement the strategic program recommendations;
- have adequate staff and financial resources to fully accomplish program objectives; and
- have the authority and responsibility without being in conflict with other existing agency policies or programs.

Implementation of the broad, strategic programmatic recommendations developed here will need to be carried out through means that involve executive and legislative branch participation. While the FRPP, SFRP, and FRRP efforts *could* be developed independently, the GEIS study team analysis concluded that a forest resources board is the most appropriate administrative structure for implementing these initiatives. As such, the team views the creation of a forest resources board as crucial to effectively develop these three major policy initiatives. Functional responsibilities of the board should include the following:

- to coordinate all forest resource issues, policies, plans, and programs;
- to serve as the primary advisory body on forest resource issues to the executive and legislative branches of the Minnesota state government;
- to design, implement, administer, and assume responsibility for the FRPP, SFRP and FRRP; and
- to work with both the executive and legislative branches of government to secure funding, and to implement the organizational structures required to meet its mission.

As a means of implementing the strategic policy responses presented in this section, the GEIS study team recommends the initial focus should be on *establishing* a state board of forest resources. As the recommended umbrella structure under which the site- and landscape-level strategic policy and forest research initiatives are largely carried out, it is essential that this organizational structure be created in advance of the other policy initiatives. Only after a forest resources board is created can these other strategic policy responses be fully implemented. As an initial step in the development of this board, the GEIS study team suggests the creation of an ad hoc task force with broad representation that includes both legislative and executive branches. This task force could decide upon the key mission, authority, functions, and structure of such a board. The intended outcome of this task force would be draft legislation to create a Minnesota Board of Forest Resources.

Conclusions

Two broad issues are paramount: biodiversity and the social and economic health of our society. Analyses in this study indicate that few aspects of either issue are in peril at this time in Minnesota. However, the actions taken now can do much to minimize resource problems and provide opportunities for society in the long-term.

Follow-up efforts need to ensure that, to the extent desirable and practical, the recommendations put forward in this assessment are fully implemented. The model runs used to project future forest conditions for the three harvest scenarios employed mitigation strategies, such as for 20 percent ERF on state and federal lands, reservation of old growth, and buffer strips along certain waterways for wildlife. The model runs necessitated employment of these strategies to reduce the cumulative negative impacts of harvesting during the 1990-2040 timeframe. Therefore, actions are also necessary to implement these and other recommendations of the GEIS in the field as soon as possible. The GEIS study team also suggests that efforts should be undertaken to disseminate the information and findings of the GEIS to the state's land management organizations. In addition, educational efforts should be directed at disseminating the findings and recommendations of the GEIS to the 130,000 NIPF owners, as they are collectively responsible for managing nearly one-half of the state's forest land base. Workshops, seminars, and other similar forums are suggested as appropriate ways to disseminate the GEIS findings and recommendations.

The GEIS study team strongly recommends that processes to implement these recommendations should begin immediately. Public interest in the management and protection of Minnesota's forest resources has grown tremendously in the last few years. The GEIS study process has characterized many of the important forestry issues, providing a focus for the debate about the extent of problems or concerns, as well as how to effectively deal with them. Given this momentum, the study team believes successful implementation of the study's recommendations will be enhanced by their prompt consideration by the appropriate policymakers.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

Page

Page

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

Page

LIST OF FIGURES

LIST OF FIGURES (continued)

Page

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

Page

LIST OF TABLES (continued)

LIST OF TABLES (continued)

Page

LIST OF TABLES (continued)

Page

LIST OF TABLES (continued)

LIST OF TABLES (continued)

Page

LIST OF PREPARERS

Contractor
The contractor hired by the Minnesota Environmental Quality Board (EQB) to prepare a Generic Environmental Impact Statement (GEIS) on timber harvesting and forest management in Minnesota is Jaakko Pöyry Consulting Inc. of Tarrytown, New York.

Qualifications
Jaakko Pöyry Consulting, Inc. is a member of the Jaakko Pöyry Group, the world's leading independent consulting and engineering organization specializing in forestry and forest industry development. Jaakko Pöyry was established in 1958, and has its world headquarters in Helsinki, Finland. It employs nearly 6,000 people in over twenty countries.

Since the 1960s, the Jaakko Pöyry Group has focused on the environmentally sound development and sustainable management of forest resources, based on progressive forestry practices. The Group has a worldwide reputation as advisor to forest industries, national governments, and international agencies. Jaakko Pöyry companies have carried out forest resource management and utilization planning assignments in more than 100 countries, acquiring extensive expertise in all aspects of natural resource and ecosystem management. Much of this experience is related to the forest sector Master Plans and forest industry projects, and the Group has carried out approximately 60 forest-based/related projects over the last five years. In particular, the Jaakko Pöyry Group has considerable experience in conducting environmental impact assessments and environmentally-based development plans for a region, based on an objective, analytical, and comprehensive approach that includes estimating the economic impact of the recommendations.

Personnel
For the Minnesota GEIS project, Jaakko Pöyry has created a multidisciplinary team led by senior consultants from the USA, Australia, Canada and the United Kingdom. Jaakko Pöyry personnel were provided through the Jaakko Pöyry consulting network, and directed by the Jaakko Pöyry Consulting, Inc. office in Tarrytown, New York.

Because a detailed local perspective was an essential element of the project, Jaakko Pöyry subcontracted with a select group of scientists drawn largely from the University of Minnesota (UofM). In addition to their technical abilities, these experts were hired because of their thorough understanding of the practices and issues associated with managing, using, and protecting Minnesota's forest resources. Collectively, these scientists contributed expertise in: forest growth modelling, forest ecology, biometrics, forest economics, timber supply analysis, water quality, fisheries, entomology, watershed management, wildlife, soils, forest health, remote sensing, aesthetics, landscape architecture, forest recreation, cultural resources, forest policy, wood utilization and harvesting, and database management. A complete listing of all GEIS study participants is provided in section 2.1 of the main report.