Minnesota Timber Harvesting GEIS:

An Assessment of the First 10 Years

by
Michael A. Kilgore
Alan R. Ek
Karen A. Buhr
Lee E. Frelich
JoAnn M. Hanowski
Calder M. Hibbard
Andrew O. Finley
Leah C. Rathbun
Nicholas P. Danz
James W. Lind
Gerald J. Niemi

August 2005

Staff Paper Series No. 182

Department of Forest Resources

College of Natural Resources
University of Minnesota
St. Paul, Minnesota

Prepared for the
Minnesota Department of Natural Resources
500 Lafayette Road
St. Paul, Minnesota 55155

For more information about the Department of Forest Resources and its teaching, research, and outreach programs, contact the department at:
Department of Forest Resources
University of Minnesota
115 Green Hall
1530 Cleveland Avenue North
St. Paul, MN 55108-6112
Ph: 612-624-3400
Fax: 612-625-5212
Email: forest.resources@umn.edu
http://www.cnr.umn.edu/FR/publications/staffpapers/

The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, veteran status, or sexual orientation.

ACKNOWLEDGEMENTS

Report chapters with corresponding authors and affiliations are as follows:

1. Actual and Projected Harvest and Forest Change 1990-2000

Alan R. Ek[1]
Andrew O. Finley[1]
Leah C. Rathbun[1]

2. Wildlife/habitat Changes 1990-2000

Birds

JoAnn M. Hanowski[2]
Nicholas P. Danz[2]
James W. Lind[2]
Gerald J. Niemi[2]

Mammals, Reptiles, and Amphibians

Lee E. Frelich[1]

3. Old and Old-growth Forest and Biodiversity Assessments

Lee E. Frelich[1]

4. GEIS Mitigation Assessment

Michael A. Kilgore[1]
Karen A. Buhr[1]
Calder Hibbard[1]

[1]Department of Forest Resources, College of Natural Resources, University of Minnesota, St. Paul, MN.
[2]Natural Resources Research Institute, University of Minnesota, Duluth, MN.

EXECUTIVE SUMMARY

GEIS Accuracy and Implementation Assessment

In response to concerns about the potential impacts of increasing timber harvest levels, a Generic Environmental Impact Statement (GEIS) on timber harvesting and forest management in Minnesota was initiated in 1989.[1] Released in 1994, the GEIS assessed the environmental and related impacts of three levels of statewide timber harvesting intensity. In addition to the assessment, recommendations were developed to mitigate the adverse impacts identified in the assessment. These recommendations included site-level responses, landscape-level responses, and forest resources research.

This study, initiated 11 years after the release of the GEIS findings and recommendations (2005), serves to assess the accuracy of the original GEIS projections for statewide timber harvesting intensity and its associated impacts, as well as the level of implementation of the various mitigation strategies. The purpose is to assess the ability to predict future forest resource conditions and to describe the status of mitigations in the form of forest management practices relative to the GEIS recommendations. A summary of the results of this study is reported below in four parts.

1. Actual and Projected Harvest and Forest Change 1990-2000

Timber Harvest. Actual timber harvests were compared with the GEIS projected harvest statewide for 1990 to 2000. The GEIS was not intended to predict harvest levels. Rather, it projected scenarios considered plausible and instructive with respect to describing and mitigating potential environmental impacts. Ultimately, the GEIS 4 million-cord level was the scenario closest to the actual harvest over this time period. The most important results were:

- **The actual harvest fell slightly short of the GEIS base scenario (4 million-cord level) (varying between 99% in 1994 and 89% in 2000).** From 1990-2001, the cumulative harvest was approximately 3.3 million cords less than projected over this period in the GEIS base scenario—an amount equivalent to nearly one year's harvest.

- **The GEIS projections of harvest proportions by species group were comparable to actual harvests except that the assumed strong substitution of hardwoods for aspen had not taken place by the year 2000.** Instead, aspen harvests remained strong and imports (largely from Canada) added to that supply.

- **Annual variation in harvest levels were attributed to catastrophic events including: extensive blowdowns in 1995 and 1999, extensive spruce-budworm damage, faltering economic conditions beginning in 2000, global consolidation within the forest products industry, level of imports, and Canadian timber trade issues.** Such factors are not

[1] Jaakko Pöyry Consulting, Inc. 1994. Final Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. Prepared for the Minnesota Environmental Quality Board. Tarrytown, NY: Jaakko Pöyry Consulting, Inc. 549 p. plus 6 appendices.

uncommon in the span of a decade, but they are almost impossible to predict as to when, where, and what extent they might arise. Consequently, predictions of harvest levels and trends over a decade and beyond are very difficult to project precisely and accurately, especially by species.

- **Importantly, the changing technology for species utilization and demand has a major effect on when and to what extent species substitution (for example hardwoods for aspen) may occur.** In particular, the projected increase in utilization of hardwoods other than aspen simply did not occur as quickly as anticipated. However, such substitution has grown rapidly since 2001.

Forest Change. Change in a forest is due largely to tree growth and mortality, natural succession, harvest, and regeneration as well as changes in forest area and area by forest type. Major findings were:

- **GEIS projected forest area for timberland appears close (after definitional and other adjustments) to the latest (2001) statewide forest inventory results.**[2] Reserved Forest and Other Forest area projections differ largely due to procedural and definitional changes in the 2001 inventory.

- **The GEIS projected forest age class distributions across all forest types are similar to FIA inventory estimates, but show the effects of the differences in harvest projections noted above, catastrophic events, faltering economic conditions, and imports.** For the 16 forest types, the 1994 projections are close for some and quite different for others. For aspen, the supply was harvest augmented by or substituted for with imports of aspen from Canada. For balsam fir, extensive spruce budworm damage and preferential partial harvesting of mixed species stands converted several hundred thousand acres to northern hardwood and birch forest types.

- **Sample size and associated sampling error is an important factor in comparisons of forest conditions.** The 2001 FIA inventory employed 6,250 field sample plots in forest categories; the 1990 inventory utilized 12,118 field sample plot locations in timberland alone. Of the 2001 sample plots, 65% were plots measured in the 1990 inventory. The effect of sampling error is small for statewide figures such as timberland area, but becomes larger and more important within breakdowns of forest type, especially by stand age or stand size class by forest type within an ecoregion.

- **Procedural and definitional change in the FIA methods between 1990 and 2001 surveys complicate comparisons and limit precision in assessing differences.** However, detailed expert inspection can identify, and in some cases account for, the differences. Differences between actual and projected stand age class by forest type acreages are in part due to simplification of the GEIS forest type classification algorithm that were necessary for

[2] The 2001 inventory was conducted over the period 1999-2003 and reported here as the midpoint of that effort, i.e., dated as 2001. However, the USDA Forest Service Forest Inventory and Analysis (FIA) program designates this as the 2003 inventory.

projections and changes in that algorithm made for the 2001 inventory. A similar problem exists with respect to stand size class x forest type acreages, which is especially important to wildlife habitat estimates.

2. Wildlife/habitat Changes 1990-2000

Forest Birds

Differences between the predicted population and observed population can be attributed to changes in the estimated density of birds within certain forest types, and/or to differences in projected area of forest types between the GEIS predictions and 2001 FIA data.

- **For 59 (43%) of 136 forest bird species, the population predictions made by the GEIS for the year 2000 were in agreement with estimated 2001 populations.** For two species, a significant increase or decrease in population was predicted, but the opposite change was observed. For three species, the GEIS predicted significant increases in population and a nonsignificant change was observed. Forty-one species have current populations at least 25% lower than they were in 1990 and were predicted to have nonsignificant changes, and 31 species increased in population by $\geq$25% from 1990 to 2000 and were projected to have nonsignificant population trends.

- **Two species of forest grouse (ruffed grouse and spruce grouse) were analyzed separately from the other forest birds.** The GEIS predicted negative but nonsignificant changes in habitat suitability for both species, which was in agreement with habitat suitability estimated from the 2001 FIA data.

- **The precision of forest bird (and mammal) estimates are likely highest for those with widespread habitat, e.g., state- or forest-wide, and less so for species found in only one or two ecoregions or counties.** The reason for such interpretation is that the FIA habitat estimates, notably those based on stand size class by forest type acreage, are increasingly imprecise as the area considered declines in size. For example, the 2001 FIA inventory noted 202 plots in the balsam fir forest type statewide. But when broken down further to the acreage within one of three stand-size classes and one of seven ecoregions, habitat estimates can be very imprecise and fluctuate from one inventory to the next. It is possible that such habitat estimates may produce artificially high fluctuations in population estimates for some species.

Mammals, Reptiles, and Amphibians

Habitat suitability predictions of the GEIS for 2000 were close to those of the actual 2001 FIA data for a large majority of species. The substantive differences that occurred for seven species can be explained by differences in forest type and age class predictions from the GEIS as compared to the FIA data for 2001.

- **For 24 of the 31 species analyzed, the GEIS predicted and the 2001 FIA-based habitat suitability indexes were within 10% of each other.** Least chipmunk, timber rattlesnake, boreal ringneck snake, eastern hognose snake, and pickerel frog each had positive changes

based on the 2001 FIA that were more than 10% above those predicted by the GEIS for 2001. Meadow vole and marten had negative changes in habitat suitability more than 10% greater in magnitude than predicted by the GEIS.

- **Except for red fox, independent population survey data for mammals from 1992 to 2002 showed a different direction and magnitude of trends than the habitat suitability index.** Actual populations for black bear, bobcat, fisher, marten, and snowshoe hare were much more positive than predicted using the habitat suitability index. These differences can be attributed to the cyclic nature of many of these species, changing availability of plants and/or prey species, hunting patterns, habitat management, and climate change.

3. Old and Old-growth Forest and Biodiversity Assessments

These characterizations are largely a function of forest area in various conditions and/or exogenous factors including windstorms and deer density.

- **The area of old forest on timberlands increased from 1.2 to 1.3 million acres between 1990 and 2001, whereas the GEIS predicted 1.75 million acres of old forest for 2000.** The majority of the 500,000 acre difference is accounted for by changes in balsam fir, paper birch and aspen, and can be explained by three factors: (1) the GEIS growth model allowed stands to continue growing older when in reality many such stands would break up or succeed to other forest types; (2) extensive spruce budworm infestation in balsam fir; and (3) major blowdown events of 1995 and 1999, which were not accounted for in the GEIS.

- **The GEIS harvesting models assumed that 50,000 acres of old growth would be found and reserved, and, therefore, did not project any specific impacts on old growth.** Since the GEIS, The Minnesota Department of Natural Resources (MN DNR) has inventoried and set aside 44,800 acres of old growth and future old growth forest on state-owned lands. Invasive species of plants and animals (especially European earthworms), diseases, and pests have become a major issue for maintenance of biodiversity and forest productivity. The GEIS did not predict the degree to which invasive species are now disrupting native forest plant communities, including tree reproduction.

- **The GEIS did not predict the degree to which deer grazing became a significant negative factor in maintenance of biodiversity and forest productivity over the last decade**. There is now a widespread consensus that high deer populations are causing damage to tree regeneration and causing extirpation of native plants over large landscapes.

- **Invasive species and deer grazing have more direct impact on biodiversity than harvesting**. Harvesting impacts are mostly indirect by creating a mosaic of forest types and ages across the landscape.

- **The MN DNR has recently developed a new classification system and ranking of rarity for plant communities.** The list of rare communities differs substantially from that available at the time the GEIS was written.

4. GEIS Mitigation Assessment

Two surveys were developed to assess the implementation of the GEIS mitigation strategies. One was sent to the state's largest forest land managers to gather information regarding the level of knowledge and implementation of the site-level mitigation recommendations. The survey also asked these managers to rate their participation and the perceived usefulness of the landscape-level mitigation strategies implemented by the Minnesota Forest Resource Council (MFRC). The second survey was sent to the MFRC to assess its efforts in implementing the GEIS site-level mitigations, landscape-level mitigations, and the research recommendations. All organizations with active forest management and timber harvesting programs (16 public organizations, seven private companies, and one tribal council which collectively manage nearly 10 million acres of forest land) returned completed surveys, as did the MFRC.

A comparison of the survey results to state guideline implementation monitoring data was attempted to assess the consistency between self-reported and empirical data. This assessment concluded few comparisons were possible due to a lack of consistency between the two data sets with respect to site-level practice information collected and reporting results by ownership group. The survey did not include nonindustrial private forest (NIPF) owners, who collectively manage nearly 40% of the state's forest land. The results of the survey are summarized in the following
tables.

Important findings from the mitigation assessment include:

Guideline Implementation

- **In 1994, timber harvesting practices were reported to be largely consistent with the guidelines.** Organizations representing 71% of the forest land area indicated that in 1994 their timber harvesting practices were consistent with or exceeded the practices recommended in the guidelines.

- **Current timber harvesting practices are reported to be consistent with or exceed the guidelines.** Today, all surveyed organizations indicate their timber harvesting practices are equal to or exceed those recommended in the guidelines.

- **Guidelines have impacted an organization's timber harvesting practices.** All of the responding organizations stated at least a few changes in practices had been made as a result of the guidelines, with a majority indicating the guidelines have resulted in a moderate level of change in their organization's practices. All organizations that characterized their practices as often being less than consistent with the guidelines in 1994 now describe them as either consistent with or often exceeding the guidelines.

Table I. Timber harvesting and forest management practices reported by 26 of Minnesota's largest public and corporate forest management organizations, 1994 and 2005.

	Commitment to guidelines through formal policy	**Forest land subject to practices consistent with MFRC guidelines: 1994**	**Forest land subject to practices consistent with MFRC guidelines: today**
	- - - - - Percentage of affected acres - - - - -		
Timber harvesting /forest management practices in general	96	71	100
Specific practices Management of riparian zones	94	71	100
Retention of snags and cavity trees	91	74	100
Retention of leave trees	93	74	100
Visual management	95	68	100
Retention of slash	93	61	93
		Forest land subject to practice: 1994	**Forest land subject to practice: current**
Harvesting on frozen soils	75	64	64
Uneven-aged management	34	7	12
Site regeneration	94	84	87
Species-site matching	42	92	95
Reduction of pest damage	50	23	24
Utilization standards	87		11*
Protection of sensitive wildlife sites	93	86	92

***** Number of organizations that have increased utilization standards for at least one product group and/or size class since 1994

Table II. Organizational involvement and perceptions of usefulness: MFRC landscape planning process.

	----------Program elements----------					**Program effectiveness**	**Program influence**
	Assessment of conditions	**Desired future conditions**	**Strategies to achieve future conditions**	**Coordination of land management activities**	**Evaluation of implementation strategies**	**Identify / address landscape forest resource issues**	**Program has changed how forests are managed**
Number of respondents	17	17	16	14	12	18	21
Level of involvement*	3.1	3.5	3.7	3.4	3.2	NA	NA
Level of usefulness / effectiveness / change	2.9**	2.7**	2.8**	2.6**	2.6**	2.7***	2.8****

***** Number represents the mean of responses using the following scale (5=extensive involvement, 4=moderate involvement, 3=modest involvement, 2=minimal involvement, and 1= no involvement).

** Number represents the mean of responses using the following scale (4=extremely useful, 3=moderately useful, 2=minimally useful, and 1=not useful).

*** Number represents the mean of responses using the following scale (4=extremely effective, 3=moderately effective, 2=minimally effective, and 1=not effective).

****Number represents the mean of responses using the following scale (5=extensive change, 4=considerable change, 3=some change, 2=few changes, and 1=no change).

- **Organizations routinely require the guidelines.** Ninety-six percent of the responding organizations representing 97% of the forest land area surveyed stated they require the guidelines when conducting timber harvesting and forest management activities on their land.

- **The MFRC guidelines are only one factor affecting changes in forest management in Minnesota.** New technology, third-party certification, national policies, federal and state laws, and court settlements were cited as important drivers of change in an organization's timber harvesting and forest management practices.

Guideline Policy

- **The majority of organizations have a formal policy governing use of the guidelines.** Seventeen of the 26 responding organizations representing more than 9.2 million acres (98% of the forest land area surveyed) indicated their organization has adopted a formal policy for incorporating guidelines.

- **Policies and practices vary between public and private organizations.** Public organizations are more likely to have an official policy regarding the use of specific practices recommended in the guidelines. These organizations were also more likely to have applied practices that were minimally consistent with the guideline recommendations in 1994. Private organizations are more likely to have changed their policy since 1994 and currently more likely to apply practices that exceed guideline recommendations.

- **Most organizations reference the guidelines in their timber sale contracts.** Fifteen organizations (65% of all responding organizations representing 92% of the forest land) indicated the guidelines are currently referenced in all of the organization's timber sales.

Guideline Knowledge and Training

- **Most organizations consider their staff to be knowledgeable of the guidelines.** The majority of organizations characterized their staff's knowledge of the guidelines to be considerable—59% of the organizations representing 82% of the forest land indicated so. All felt their staff has at least a moderate level of familiarity with and understanding of the guidelines.

- **The majority of organizations have had staff participate in formal guideline training sessions.** Sixty-three percent of the organizations surveyed have sent all of their staff to guideline training sessions, and an additional 30% have had many of their staff attend guideline training.

MFRC Landscape Planning/Coordination Program

- **Organizational involvement in the MFRC landscape planning program has varied.** Organizations were modestly to moderately involved in the MFRC's landscape planning process. The greatest level of organizational involvement was in the planning of strategies to achieve future forest conditions, while involvement was the least in the assessment of regional conditions.

- **Perceptions of the MFRC's landscape program effectiveness vary.** While 32% of the forest land is managed by organizations that perceive the program to be extremely effective in identifying and addressing landscape-level forest resource issues and coordinating forest management activities across large landscapes and multiple ownerships, 38% is managed by organizations that believe the program to be minimally or not effective in addressing landscape-level issues and facilitating coordination. Public organizations generally find the program to be more effective than do private organizations. It is important to note that the surveyed participants represent the largest public and private organizations but do not include NIPF or community participants.

- **The MFRC landscape program has modestly influenced forest management activities.** Thirteen of the 21 responding organizations (62%) indicated they have made some to extensive change in their management practices as a result of the landscape program, while eight (38%) stated the program has resulted in few to no changes.

- **Landscape plans have been completed and approved by the MFRC in the following landscapes: East Central, Northeast, North Central, West Central, Northern, and Southeast.** Development of a plan for the Metro landscape has been deferred for the time being. The MFRC has decided not to develop a landscape plan for the Prairie landscape.

- **The North, Northeast, North Central, Southeast, East Central and West Central landscapes all have coordination groups meeting on a regular basis to discuss and plan coordination activities.**

MFRC Research Initiatives

- **MFRC's research program has addressed a portion of the information needs identified in the GEIS.** While several important information needs identified in the GEIS have been addressed through the MFRC and its Research Advisory Committee, several remain. One example is a need to understand better the linkages and interactions between forest management and forest-based tourism industries.

Table of Contents

List of Figures

List of Tables

1. Actual and Projected Harvest and Forest Change 1990-2000

1.1. Timber Harvest

1.1.1. Introduction

Timber harvesting activity in Minnesota was a fundamental projection of the GEIS. The intent of this study is a comparison of actual and GEIS projected harvest.

The GEIS developed three harvesting scenarios or harvest levels and projected the implications of their implementation from 1990 to 2040. The lowest or base scenario level of harvesting was approximately 4 million cords per year. The other scenario levels were 5 and 7 million cords per year, with the latter limited to 5.5 million cords to satisfy mitigation concerns. Each of these scenario projections involved various assumptions as outlined in sections 4.5.1-4 and 4.10.1-2 of Jaakko Pöyry Consulting, Inc. (1992). In effect, each scenario was an assumption about the degree of industry expansion and wood use. Each scenario identified an increase of harvest to the specified level, a time period in which that would occur, and various directions or constraints including projected changes in timberland area, forest growth and change—including silvicultural decision trees, rotation ages, natural succession, regeneration after harvest, timberland availability for harvesting (by ownership), and implication of mitigations in the form of constraints on harvest from certain areas, notably riparian zones. These predictions also included various relative product values, harvest and transport costs, and consumption estimates, so as to enable realistic projections. Since then industry expansion has slowed and annual harvest now hovers at or below the 4 million-cord level. Consequently, only the base scenario is analyzed here.

1.1.2. Methods

The collection of actual timber harvest data is led by the USDA Forest Service North Central Research Station's Forest Inventory and Analysis project (FIA). This work is part of what is called timber product output (TPO) studies and has been assisted by the Minnesota Department of Natural Resources' Division of Forestry, notably by its Marketing and Utilization staff (see Piva 2005, Minnesota Department of Natural Resources [MN DNR] 2004a). This effort conducts an annual consumer survey of wood utilization by species for all of the major mills in the state. Importantly, this survey involves a complete census of wood products consumption by the major wood users. Additionally, estimates for some of the small mills, and for firewood and imports are developed by survey methods on a three- to four-year cycle. Procedures are described by Piva (2005) and earlier such reports and MN DNR (2005b). The TPO study results provide an annual harvest by species that is considered among the most precise and accurate of records used in the GEIS and in this report. The error in actual harvest estimates is likely small in percent of the total and major species volumes.

The GEIS projected harvest volumes were the realization of the 4 million-cord scenario projection. This projection was drawn from table 4.19 in section 4 of Jaakko Pöyry Consulting, Inc. (1992) and includes assumed harvest by year from 1990 to 2000+ by species group and market area.

In developing the approach for this study, it was considered important to preface the comparison between actual and GEIS-projected harvest levels with an identification of the major factors that might contribute to these. This first step involved a careful consideration of the entire estimation process. Below the differences between the actual and the GEIS-projected harvest are reviewed and described in terms of the major contributing factors.

1.1.3. Findings

The major contributing factors to differences in actual versus the GEIS projections for the 4 million-cord scenario were identified as:

1. FIA 1990 data sampling error and bias
2. Error in the assumptions in the GEIS projection methods, notably in terms of species utilization.
3. TPO survey error, including sampling error, completeness and bias
4. Differences between actual and realized harvest levels due to exogenous factors affecting the forest products economy from global to local including weather, transportation, prices and comparative price structure and demand by species group, and final product demand.
5. Technological changes and improvements in wood utilization.

The actual and GEIS 4 million-cord scenario harvest figures are shown in Table 1.1 by major species group. The full set of actual and projected harvest data is shown in Appendix Tables 1.1 and 1.2. It is important to note that the six major species groups are those assumed in the GEIS. Table 1.2 shows the percentage differences in actual and projected harvest.

Table 1.1. Actual versus the GEIS projected timber harvest volume by species group and year, Minnesota, 1990-2001 base scenario (thousand cords).

	Actual						GEIS Projected						
Year	Total	Aspen	Northern Hardwoods	Oak	Pine	Spruce /Fir	Total	Aspen	Northern hardwoods	Oak S. MN	Other S. MN	Pine	Spruce/ Fir
1990	3,449	1,992	439	282	318	418	3,491	1,954	475	50	250	365	397
1991	3,527	2,048	431	282	393	374	3,727	2,124	481	50	250	429	393
1992	3,851	2,351	440	282	405	372	4,037	2,389	516	50	250	419	413
1993	4,102	2,527	460	298	423	395	4,132	2,489	516	50	250	419	408
1994	4,106	2,528	504	298	387	389	4,132	2,489	516	50	250	419	408
1995	3,723	2,424	347	184	377	390	4,177	2,524	531	50	250	414	408
1996	3,810	2,413	339	184	373	500	4,177	2,524	531	50	250	414	408
1997	3,735	2,402	366	192	361	414	4,172	2,469	556	50	250	439	408
1998	3,661	2,362	387	192	332	389	4,172	2,469	556	50	250	439	408
1999	3,816	2,519	377	188	343	389	4,172	2,469	556	50	250	439	408
2000	3,724	2,356	397	173	379	419	4,172	2,469	556	50	250	439	408
2001	3,563	2,144	395	173	401	450	4,172	2,469	556	50	250	439	408

First, it is important to note that the GEIS projected harvest level was actually 4.177 million cords rather than the commonly referred to 4.0 million. For the period 1990 to 2000, the percentage differences for overall harvests indicate the actual harvest has roughly followed the GEIS projections but has varied from 99.4% to 89.1%, the former being the peak harvest year in 1994 and the latter being the year 1995. For this same period the aspen harvest has stayed close to the projections while the hardwood harvest has declined in absolute and percentage terms. The pine harvest has fluctuated between 75.5% and 101.0% of the projections. Likewise the

spruce/fir harvest has fluctuated between 90.1% and 122.6% of the projections. The following section assesses the identified sources of error.

Table 1.2. Percentage differences between actual and the GEIS projected timber harvest volume by species group and year, Minnesota, 1990-2001 base scenario (thousand cords).

	Actual as % of projected				
Year	Total	Aspen	All other hardwoods	Pine	Spruce/ Fir
1990	98.8	101.9	93.1	87.1	105.2
1991	94.6	96.4	91.3	91.5	95.2
1992	95.4	98.4	88.5	96.7	90.1
1993	99.3	101.5	92.8	101.0	96.8
1994	99.4	101.6	98.3	92.4	95.2
1995	89.1	96.1	64.0	90.9	95.6
1996	91.2	95.6	62.9	90.1	122.6
1997	89.5	97.3	65.1	82.3	101.5
1998	87.8	95.7	67.6	75.5	95.4
1999	91.5	102.0	66.1	78.1	95.3
2000	89.3	95.4	66.6	86.3	102.6
2001	85.4	86.8	66.4	91.4	110.2

1. FIA 1990 data sampling error and bias. The baseline data used in the GEIS projections was the statewide forest survey. This survey is described in detail including estimates of precision by Miles et al. (1995). Documentation in the appendix of that report suggests the estimated sampling error of this survey was less than 1% for growing stock volume (0.71%) and timberland acreage statewide (0.36%) and also less than 1% for the area of aspen timberland statewide (0.61%). The standard FIA inventory is designed to provide sampling errors no more than 3% per million acres and the above meets that test. Additionally, the state of Minnesota augmented the survey to reduce the sampling error further. The overall goal was to provide sampling errors less than 10% for timberland area by county (see table 79 of Miles et al. [1995]) for county-level sampling errors. Surveys like the FIA are also subject to bias due to procedure such as classification into forest categories (nonforest, forest, timberland, unproductive, and forest types), and measurement procedures and volume tables used. However, the FIA devotes considerable attention to procedure testing, monitoring, and training. Consequently, a large bias seems unlikely for statewide figures. Further, given that the harvest in any decade is small compared to the total growing stock, any bias in volume estimation would be subject to compensation in actual utilization, either in greater or lesser utilization of given trees or slightly more or less acreage being harvested. Thus, overall, the FIA as a basis for projections seems an unlikely source of major error.

2. Error in the assumptions in the GEIS projection methods, notably in terms of forest growth, change, and catastrophic events. These would seem to be an important source in differences, especially in year-to-year variation. Perhaps the most important difference that the model failed to incorporate was large and devastating windstorms in 1995 (217,800 acres of blowdown of largely timberland) in north central Minnesota, and in 1999 (465,882 acres of blowdown in northeastern Minnesota, including approximately 370,000 acres of reserved forest inside the Boundary Waters Canoe Area Wilderness

[BWCAW]). Additionally, more than 250,000 acres of spruce fir in northeastern Minnesota was heavily damaged by the spruce budworm over the last decade. Given that the annual harvest acreage in the last decade has been approximately 150,000-200,000 acres, it is clear that these catastrophic events can dramatically shape other harvesting efforts for one to several years. Details of these events are given in reports by the Forest Health Monitoring Program (2000).

3. TPO survey error, including sampling error and bias. Like the FIA, the magnitude of this survey suggests it is not a major source of error in actual harvest versus the GEIS projections. However, there is fluctuation from year to year due to weather (access, harvest, and transport conditions), and within year market demand. For example, since harvesting in recent years is increasingly concentrated in winter months, the harvest in any calendar year can be subject to weather factors affecting both access and/or operations.

4. Differences between actual and realized harvest levels due to exogenous factors affecting the forest products economy from global to local including weather, transportation, prices, comparative price structure and demand by species group, and final product demand. The year 2000 downturn in the national economy, overcapacity in certain areas of the industry—particularly pulp and paper, and increasing industry consolidation were major factors in the actual harvest falling short of the GEIS projections. Other contributing factors were the gradual reduction in harvest on national forests, high timber prices, and imports from Canada and nearby states, i.e., Wisconsin and to a lesser extent Michigan. It should be noted the imports from Canada rose considerably in 1999 and 2000 as reported by MNDNR (2004). Overall, the harvest fell from its high in 1993 and 1994 to 89.2% of the GEIS projection in 2000 and 85.4% in 2001. However, the aspen harvest continued fairly strong with augmentation by imports, largely from Canada.

5. Technological changes and improvements in wood utilization. Importantly, the changing technology for species utilization has an effect on when and to what extent species substitution, for example, hardwoods for aspen, may occur. In particular, the projected increase in utilization of hardwoods other than aspen simply did not occur through 2001. However, such utilization has increased rapidly since then (MN DNR 2004).

A conclusion from this comparison is that future timber harvest levels are dependent on many factors in any decade. Year-to-year variation, especially for subsets of the total harvest, can be considerable. Clearly, overall primary forest products mill capacity is an important factor, but not the only one. In this respect, the GEIS projections were detailed enough to assess the major sources of error. In this case, the major error was the assumption in projections that hardwood utilization would increase substantially.

1.2. Forest Change

1.2.1. Introduction

Change in a forest is due largely to tree growth and mortality, natural succession, harvest and regeneration as well as changes in forest area and area by forest type. However, many factors may influence these components of change. The purpose of this section is to identify and explain, where possible, the differences between actual and the GEIS projected change, statewide, and notably in terms of present and future forest conditions that are of major economic and ecological significance.

The GEIS projections were developed from a simulation model with numerous components, each encapsulated in software and run together. These parts and key components are described in sections 4.5.1-4 and 4.10.1-2 of Jaakko Pöyry Consulting, Inc. (1992) and included:

- FIA data—14,256 field sample plots collectively describing forest conditions statewide, including the plot expansion factor (acres it represents) plot tree lists, ownership, county, UTM coordinates, forest type, age, site index, approximate stand size (acres), distance to water, distance to nearest road (see Miles et al. [1995] for a description of these data and procedures).
- GROW—an individual tree-based forest growth model. Actually GROW is the essential element of the larger Stand and Tree Evaluation and Modeling System (STEMS) developed by the FIA. GROW produces estimates of tree growth and mortality. For the GEIS, the GROW model was augmented by explicit submodels for consideration of forest regeneration, forest type change, species-product volumes, etc.
- RXWRITE—a silviculture prescription writer to code and generate alternative stand treatments, notably harvest and silvicultural practices according to stand age, site index, and type of harvest. For example, harvests might be clearcut or thinned and also lead to specification of the type of regeneration following harvest, either natural or planted. The number of alternatives generated for each plot was dependent on forest type and age.
- DTRAN—a model for simulating the flow of products, goods, and services from forest stands (represented by the FIA plots), such flows then accumulated by six different market locations in the state. This model was guided by economic considerations so as to distribute the harvest realistically across the state. This model also used GISTRAN, a basic GIS that generates transportation related information and portrays model results in terms of wood procurement for each market.

These projections were a technically complex undertaking with numerous assumptions built into the component models and the GEIS second run harvest specifications.

Additionally, the data providing the actual forest conditions with which the projections are compared differs in some key respects, i.e., the latest FIA data is somewhat different from the FIA data of 1990. Actually, the 1990 data was collected over the period 1987-1990. The latest FIA survey was conducted over a five-year period, 1999-2003, and its midpoint (2001) was chosen as the best basis for comparison.[3] Importantly, while the FIA continues much of its

[3] Note the FIA describes the 1999-2003 survey cycle as the 2003 results; here we call it the 2001 data.

historic procedure, there have been important changes in plot design, forest and type classification and related procedures that complicate comparisons.

Sample size and associated sampling error is another important factor in comparisons of forest conditions. The 2001 the FIA inventory employed 6,250 field sample plots in forest categories; the 1990 inventory utilized 12,118 field sample plot locations in timberland alone. Of the 2001 sample plots, 65% were plots measured in the 1990 inventory (Hansen 2005). Further details of the 2001 FIA inventory are described by Alerich et al. (2004) and USDA Forest Service (2003).

1.2.2. Methods

The comparison of actual versus the GEIS projected harvest may differ due to a number of factors. The first step in comparisons was thus an inspection of the methodology behind the actual and projected forest conditions, including the assumptions employed in the projections.

Given likely sources of error, actual and projected results in the summary formats most useful for describing present and future forest conditions from an economic and ecological standpoint were then examined. These summary formats included (1) total forest acreage, acreage by timberland, reserved and other forest categories, (2) forest age class by forest type acreages, and (3) forest stand size class by forest type. The last of these is most important to wildlife habitat and population estimates discussed in the next section. In making these comparisons the GEIS base scenario projections out to 2040 were also tabulated in order to clarify long-term trends per the modeling methodology. This detailed projection data was obtained from the author's (Alan Ek) GEIS project files as they were not actually published with the GEIS.

1.2.3. Findings

The actual versus the GEIS projected forest conditions differ largely due to the following factors:

1. <u>FIA 1990 data sampling error and bias in combination with the FIA 2001 data sampling error, new survey procedures including plot design, changes in definitions, and classification procedures</u>. For both the 1990 and 2001 FIA inventories the sampling error is small for statewide figures such as timberland area, but becomes larger and more important with breakdowns by forest type, especially by stand age or stand size class. The sample size is further limiting when projections are examined within an ecoregion. In addition, new procedures are more likely sources of differences. The changes for the 2001 inventory include a new plot layout across the state and a corresponding change in sampling intensity; extensive use of satellite imagery and associated classification as compared to the use of aerial photos in 1990; a new field sample plot design consisting of a cluster of 4 fixed radius subplots on an acre rather than the cluster of 10 points used earlier; corresponding new algorithms for sorting trees on plots to establish the forest type classification; and changes in how some of the variables associated with field plots were recognized, e.g., water as noncensus and census water. For census water, the new inventory design dropped observations of distance to water and stand size (acreage) that proved useful in the GEIS for characterizing wildlife habitat and riparian areas. The effect of most of these changes is increased difficulty in making highly precise comparisons of 1990 and 2001 results. However, in some cases major differences can be

accounted for by closer examination of the data. In other cases differences are small and fall within the sampling error of the estimates.

2. Error in the assumptions in the GEIS projection methods, notably in terms of forest growth, catastrophic events, silvicultural and harvesting practices, and species and utilization. Among these errors, the failure to account for catastrophic events (blowdown, spruce-budworm damage, etc.) appears most important. However, gradual shifts in harvesting practices consistent with more thinning, clear cutting with residuals, and less clear-cutting is also important in terms of affecting forest type acreages, age class distributions, and forest productivity. In terms of silviculture and harvesting practices, the report by Puettmann et al (1998) suggests the importance of increasing the use of alternatives to clear-cutting, e.g., thinning and clear-cutting with residuals.

3. Differences between actual and realized harvest levels due to exogenous local to global factors affecting the forest products economy including weather, transportation, prices and comparative price structure and demand by species group, and final product demand. Among these, the 2000 downturn in the national economy, and associated economic competition, industry consolidation, etc. affected demand in ways that were difficult to predict. Additionally, the gradual decline in timber harvesting on federal lands was an important factor that was difficult to predict precisely.

4. Technological changes and improvements in wood utilization. While technological improvements in harvesting methods and utilization of species continue, the actual implementation of these in terms of species substitution (e.g., for aspen) was difficult to predict. Increasing utilization of individual harvested trees (e.g., more of the tree top) will also result in greater yields per acre and thus reduce acreage of harvest, but there is no data on this possibility in general or for any specific tree species.

These factors are addressed in more detail in the discussions of findings. Additionally, since there are no standards for accuracy, the GEIS projections are judged to be accurate if after clear adjustments for procedure and classification, they are within the FIA suggested sampling errors. However, a discussion of the practical implications of observed differences follows.

Total forest area, timberland, reserved forest and other forest classification estimates

The total forest area as reported by the FIA in 1990 was 16.7 million acres. For 2001, the total forest area was 16.2 million acres, an apparent difference of 500,000 acres. Details by class of forest land are shown in Table 1.3 and the larger Appendix Tables 1.4 and 1.5.

Importantly, the apparent difference in total forest area largely disappears when adjustments are made for changes in procedure that affected 2001 estimates of reserved and other forest class estimates. In fact, the 1990 reserved forest description was not a field plot-based estimate.

Table 1.3. Actual and the GEIS projected timberland, reserved, and other forest age class distribution acreages by forest type, Minnesota, 1990-2000.

Forest Type*	Age	Timberland			Reserved forest			Other forest		
		FIA		GEIS	FIA		GEIS	FIA		GEIS
		1990	2001	2000	1990	2001	2000	1990	2001	2000
All forest types	5	1,397,200	1,380,649	1,646,602	27,200	40,173	0	31,800	58,684	0
	15	1,250,500	1,025,439	1,378,443	40,100	19,605	28,374	196,800	17,447	32,368
	25	1,025,500	1,077,629	1,253,108	34,100	14,723	40,280	17,600	9,900	197,050
	35	967,100	1,207,727	1,027,262	25,400	38,813	34,203	22,300	30,001	17,669
	45	1,768,100	1,635,444	929,777	93,800	131,758	28,917	27,000	50,089	22,313
	55	2,440,900	2,066,525	1,513,078	233,200	144,708	91,412	41,800	53,236	27,000
	65	2,305,800	2,230,143	1,992,362	310,200	154,487	239,892	44,900	51,985	41,841
	75	1,251,200	1,596,971	1,847,224	112,200	166,173	315,148	76,100	50,237	45,074
	85	832,100	1,033,004	1,050,698	55,600	105,773	110,678	41,500	32,062	76,162
	95	573,300	543,777	718,997	76,500	50,935	66,717	59,300	48,634	41,781
	105	370,400	347,934	518,587	41,400	53,247	73,300	75,100	46,854	59,383
	115	165,400	237,587	340,001	21,000	0	33,455	44,400	43,722	75,141
	125	213,900	166,212	158,251	16,100	0	22,500	49,100	15,738	44,483
	135	56,500	98,371	207,693	16,100	4,843	10,900	25,900	16790	49,218
	145	88,900	19,603	53,852	5,000	4,691	16,100	25,000	2,676	25,900
	155	30,800	42,738	85,202	5,200	4,601	6,600	47,500	0	25,000
	165	14,500	18,611	27,821	0	0	0	1,000	0	47,500
	175	9,000	9,826	14,478	0	3,588	0	1,200	0	1,000
	185	5,100	7,693	9,000	0	0	0	0	0	0
	195	7,200	13,946	12,281	0	3,055	0	0	0	1,200
Total		14,773,400	14,759,829	14,784,717	1,113,100	941,173	1,118,476	828,300	528,055	830,083

Rather, it was an estimate based on aerial photo interpretation plots and imputation methods (see section 4.21 of Jaakko Pöyry Consulting, Inc. [1992] for a description of this methodology for reserved forest). Beginning in 2000 (post blowdown) the BWCAW and other reserved forest became a regular part of the FIA survey. Thus the decline of 171,173 acres in reserved forest area from 1990 to 2001 was not real—it was actually the result of moving from an assumed forest area in 1990 to one based on actual field data for 2001.

Additionally, upon inspection of the "Other forest" columns in Table 1.3, it appears that a large portion of the 1990 age class 15 and other acres were reclassified in 2001 to nonforest, i.e., a marsh or wetland with trees class. From Appendix Table 2.4, it appears that acreage came largely from the very slow growing lowland black spruce forest type, and to a lesser extent from the lowland tamarack type. Thus, much if not all of the loss in other forest acreage came from reclassification rather than actual forest change.

Statewide, the GEIS projected a 0.2% increase in total forest area by 2040. Given the FIA sampling error and other inconsistencies in estimating the above components, (i.e., timberland, especially reserved, and other forest), these GEIS projections, with adjustments for reserved and

other forest, are consistent with or within the margin of sampling error for the first decade. Importantly, with most of the harvested acreage being regenerated and staying within the same timberland classification, harvesting itself has little impact on total forest and timberland acreage estimates. But, forest land dynamics are actually more complicated when involving:

1. Nonforest land converted to forest by planting or natural colonization of old fields by tree species, including abandoned pasture land with trees
2. Forest land converted to nonforest land by clearing for agriculture, residential, or urban development.

This dynamic involves thousands of acres a year and some acres have transitioned multiple times over many decades with factors such as the economics of agriculture.

Table 1.4 provides more detail about actual and projected forest area change by FIA unit. Adjusting for the 1990-2001 changes in reserved and other forest due to classification procedures in the FIA, the actual change for the two northern units would appear slightly negative or unchanged. Given the sampling error, this appears accurate. However, the projected increases in the two southern FIA units do not appear to be materializing, thus those results appear inaccurate.

Table 1.4. Actual (unadjusted for reserved and other forest classification changes) versus the GEIS projected forest acreage.

FIA Unit	FIA 1990	FIA 2001	Actual change percent	Projected 1990-2040 percent
Aspen-Birch	7,362,000	7,109,853	-3.4	-5.7
Northern Pine	6,336,400	6,165,020	-2.7	-10.7
Central Hardwoods	2,357,200	2,357,511	0.0	34.9
Prairie	660,400	597,949	-9.5	46.0
All units	16714800	16,230,334	-2.9	0.2

Adding to complications in interpretation, the 1990 FIA acreage for timberland used in the GEIS was 14,773,400 acres, as reported by the FIA in its four separate unit reports (see Table 2.4 in Jaakko Pöyry Consulting, Inc. [1992]). The 1990 FIA acreage reported by the FIA by Miles et al. (1995) was 14,723,200 acres, suggesting some adjustment (approximately 50,000 acres or 0.34%).

Finally, while little real net change in total forest acreage occurred, the FIA procedure and classification changes do complicate comparisons of wildlife habitat for reserved and other forest areas and, therefore, total forest area.

Age class by forest type estimates

Given difficulties in interpreting the apparent change in classification of reserved and other forest classes, this section will focus on timberland. Further inspection of Table 1.3 indicates substantially larger estimates of acreage in the age classes 5-35, but similar estimated acreages in the typically harvestable 45-75 year classes, and similar acreages in age classes 85 and higher. Table 1.5 illustrates the distribution of acreage by age class group and percentage.

The actual and the GEIS projected forest age class distributions across all forest types in Table 1.3 are roughly similar but show the combined effects of the differences in the previously noted harvest projections, catastrophic events, and imports. For the 14 forest types shown in Appendix Table 1.4, projections are close for some and quite different for others. A more detailed review of results by forest type follows, but first, it is appropriate to elaborate on procedural and definitional changes in the FIA methods between 1990 and 2001.

Table 1.5. Actual and the GEIS projected timberland, reserved, and other forest age class distributions by acreage and percent of total acreage, Minnesota 1990-2000.

Forest Type*	Age class	Timberland			Reserved forest			Other forest		
		FIA		GEIS	FIA		GEIS	FIA		GEIS
		1990	2001	2000	1990	2001	2000	1990	2001	2000
All forest types (acres)	5-35	4,640,300	4,691,444	5,305,415	126,800	113,314	102,857	268,500	116,032	247,087
	45-75	7,766,000	7,529,083	6,282,441	749,400	597,126	675,369	189,800	205,547	136,228
	85+	2,367,100	2,539,302	3,196,861	236,900	230,733	340,250	370,000	206,476	446,768
	Total	14,773,400	14,759,829	14,784,717	1,113,100	941,173	1,118,476	828,300	528,055	830,083
All forest types (percent)	5-35	31.4	31.8	35.9	11.4	12.0	9.2	32.4	22.0	29.8
	45-75	52.6	51.0	42.5	67.3	63.4	60.4	22.9	38.9	16.4
	85+	16.0	17.2	21.6	21.3	24.5	30.4	44.7	39.1	53.8

The 1990 FIA used a forest type classification algorithm unique to the plot design and one that made projection of type change problematic in the GEIS projections. The GEIS methodology required simplifications in the algorithm to allow projections of type change by decade, e.g., consistent with ecological succession of tree species. The methodology involved projecting tree growth and mortality on a plot and then reclassifying the projected list of trees together with their new sizes to identify the future forest type. This simplification adds complication to comparisons of the GEIS projections of forest type with the FIA values in 2001. For example, differences between actual and projected stand age class by forest type acreages are in part due to simplifications of the GEIS forest type classification algorithm. Importantly, the age class by forest type acreages shown in Appendix Table 1.4 for 1990 is from the FIA forest type algorithm. However, the actual projections were made from the 1990 plot data as classified by the simplified GEIS algorithm. A comparison of the two algorithms and resulting classification results is summarized in section 4.10.1 of Jaakko Pöyry Consulting, Inc. (1992). Consequently the 2000 and subsequent decade projections have two differences in procedure from the 1990 FIA classification: application of the forest scenario model for growth, mortality, harvest, and regeneration and the GEIS forest type algorithm. Additionally, the FIA 2001 algorithm is not exactly the same as that used for 1990, due in part to a change in field plot design. The FIA algorithms are described by Hansen and Hahn (1992) and Arner et al. (2003). Detailed inspection can identify and account for some of the differences. A similar problem exists in interpreting stand size class by forest type acreages, which are especially important to wildlife habitat estimates.

The following forest type specific findings draw from the GEIS projections, the FIA results for 1990 and 2001, and the FIA TPO reports provided by the FIA and DNR and referenced in MNDNR (2004) and earlier such reports. The emphasis is on timberland, GEIS accuracy and explanation.

Jack pine - The 2001 FIA shows a 13% decline in the timberland acreage of this type. The GEIS predicts similar direction but a greater (19%) decline. If not harvested or subjected to fire or other disturbance to regenerate it, acreage of this pioneer species is expected to continue to decline.

Red pine - The 2001 FIA shows a 6% increase in timberland acreage. The GEIS predicts similar direction but a greater (17%) increase. Red pine is the most highly planted and managed species in the state, but not to the extent projected.

White pine - The 2001 FIA shows a 9% increase in timberland acreage. However, this species is limited in extent and is often found in patches and/or mixed species stands. It was among the most difficult for the GEIS forest type algorithm to predict. The GEIS forest type algorithm produced double the FIA acreage for this type in 1990. Projections maintained the degree of difference in projections and thus predictions for 2000 showed an increase of 81%.

Black spruce - The 2001 FIA shows a slight (less than 1%) increase in timberland acreage. The GEIS projection shows a 21% decline for 2000 and a gradual decline each decade until 2040.

Balsam fir - The 2001 FIA shows a dramatic decline of 54% in timberland acreage. Extensive spruce budworm damage and preferential partial harvesting of mixed species stands converted several hundred thousand acres of balsam fir to northern hardwood and birch forest types. Additionally, as shown by the changing age class distributions of the latter species, these acres moved largely into the middle (45-75 year) age classes of the hardwood and birch distributions. The GEIS projected an 8% decline in acreage and clearly did not capture the insect and disease and preferential harvesting impacts.

Northern white cedar - The 2001 FIA shows a 12% decline in the extent of timberland for this type. However, this type typically occurs as mixed species stands. Like white pine, it was among the most difficult for the GEIS forest type algorithm to predict. The GEIS forest type algorithm produced only 50% of the FIA acreage for this type in 1990. Projections roughly maintained that degree of difference in projections and thus predictions for 2000 showed this type at 52% of its 1990 timberland acreage.

Tamarack - The 2001 FIA shows a 14% increase in the timberland acreage. The GEIS projections showed a decline of 6%. However, the GEIS forest type algorithm determined 97% of the FIA acreage for this type in 1990. Projections roughly maintained that degree of difference in projections and thus predictions for 2000 showed this type at 94% of its 1990 timberland acreage.

White spruce - The 2001 FIA shows a 1% increase in the timberland acreage. The GEIS projections showed more than a doubling of acreage. However, like white pine, it is a small forest type in terms of acreage and it was one of the most difficult for the GEIS forest type algorithm to predict. The GEIS forest type algorithm determined a 49% increase in acreage for this type in 1990. Projections increased that by 71% by 2000.

Oak/hickory - The 2001 FIA shows an 18% increase in timberland acreage. The GEIS projections showed an increase of 10%.

Elm/ash/cottonwood - The 2001 FIA shows a 5% increase in timberland acreage. The GEIS projections showed an increase of 44%.

Maple/beech/birch - The 2001 FIA shows a 15% increase in timberland area. The GEIS projections showed a decrease of 5%. The increase was in part from the above noted balsam fir type and occurred largely in the 45-75 age classes.

Aspen - The 2001 FIA shows a decrease of 8% in timberland area. The GEIS projections showed an increase of less than 1% or essentially no change. Importantly, this is the most frequently harvested forest type. Clear-cutting of aspen nearly always results in a new aspen stand. This fact plus continued strong demand and the nonmaterialization of the substitution of hardwoods for aspen kept this acreage at substantial levels. However, inspection of the age class distribution suggests that the GEIS overestimated clear-cutting of aspen or mixtures that would tend to produce new aspen stands which resulted in the overestimate of young stand acreage.

Paper birch - The 2001 FIA shows a 24% increase in timberland area. The GEIS projections showed an increase of 9%. This increase is likely due to preferential harvesting of associated species (e.g., aspen and balsam fir) in mixed stands, thus resulting in a covertype change to birch.

Balsam poplar - The 2001 FIA shows a 12% decrease in timberland area. The GEIS projections showed a decrease of 17%.

The net of these changes in terms of direction are shown in Table 1.6. This table and the actual acreage changes by forest type shown in Appendix Table 1.4 clearly indicate that cover type change can be substantial in a decade, even when overall acreage of timberland changes very little. In terms of direction, Table 1.6 indicates agreement in direction between actual and projected results for 10 of 14 forest types. Yet the GEIS projections are sometimes far different from the actual distribution, even when the direction is the same, especially for the smaller and typically mixed species types. Results suggest the GEIS forest type classification algorithm was a major source of error. Additionally, the forest growth component of the GEIS projections underestimated tree mortality and allowed older stands to continue as such. This is evidenced by accumulation of acreage beyond the usual life span for pioneer forest types as shown in Appendix Table 1.4, e.g., balsam fir. However, actual forest type dynamics due to insect and/or disease issues, windstorms, and subtle shifts in harvesting methods also caused major change in forest type acreage in the period 1990-2000.

Age class by forest stand size class estimates

Acreage by stand size class by forest type provides an alternative and simplified way of viewing age class structure. The FIA classifies stands into small, medium, and large stand size classes depending on the predominance of corresponding tree sizes. These 2001 FIA classes correspond to the 1990 FIA seedling/sapling, pole, and sawtimber size classes. Practically they approximate stand age categories. The actual class is determined by an algorithm in much the same way as

forest type (see Alerich et al. 2004). These classes are noted here and in Appendix Table 1.5 because of their use and importance in the wildlife habitat/wildlife population estimates. Importantly, Table 1.5 shows these class acreages can vary widely in a decade, thus increasing the error of any estimates based upon them.

Table 1.6. Direction of FIA and the GEIS projected forest type areas for timberland, Minnesota, 1990-2000.

	FIA		GEIS
Forest Type*	**1990 acres**	**2001 Direction**	**2000 Direction**
Jack Pine	446,600	−	−
Red Pine	354,700	+	+
White Pine	68,600	+	+
Black Spruce	1,349,900	+	−
Balsam Fir	809,200	−	−
Northern White Cedar	648,400	−	−
Tamarack	719,400	+	−
White Spruce	91,700	+	+
Oak/Hickory	1,124,700	+	+
Elm/Ash/Cottonwood	1,124,600	+	+
Maple/Beech/Birch	1,470,200	+	−
Aspen	5,242,200	−	+
Paper Birch	819,000	+	+
Balsam Poplar	504,200	−	−

Conclusions from the above comparisons are that future forest conditions are dependent on many factors in any decade (especially for subsets of the total such as breakdowns by forest type, age, or stand size class). Aggregated or statewide numbers are predictable over a decade, including total forest and timberland acreage. However, further analysis typically requires classification by species, stand age, etc., and therein lies great difficulty in methodology and associated precision in estimation.

As an example, many people have an appreciation of what is obviously an aspen stand (75% aspen by most computations). But even experts find it difficult to agree on *all* stand classifications in the field especially with only 14 FIA forest type classes. In fact, the FIA algorithm can label stands with as little as 30% aspen as aspen, if it is the largest component. In addition, most forested acres in Minnesota have at least several tree species present. This makes type classification algorithms quite sensitive to the species mix in a plot tree list, changes in that list, and it is, therefore, a shaping factor in describing forest change. Further, note that cover type change for a field sample plot does not occur gradually. It occurs instantaneously when the forest type algorithm detects a different forest type than previously detected. Thus, the point in time of application of the algorithm also adds variation to any comparison. Finally, nature is simply not very predictable in terms of year-to-year catastrophic events. These factors sum to make a classification of aspen stands difficult.

Acknowledgements

Assistance from Mark H. Hansen, Keith H. Jacobsen, and Howard M. Hoganson is gratefully acknowledged.

2. Wildlife/habitat Changes 1990-2000

2.1. Introduction

The GEIS wildlife Technical paper (Jaakko Pöyry Consulting, Inc. 1992) projected 50-year (1990-2040) statewide habitat-based population indexes (for those species where population density data were available) or habitat suitability indexes for a large number of forest-dependent wildlife species. For many species, projections were made on a decadal basis including the year 2000. This section examines the accuracy of the GEIS predictions for the year 2000 including 136 species of forest birds, 2 species of forest game birds (ruffed grouse and spruce grouse), 22 species of small and medium sized mammals, eight species of reptiles and amphibians, and one large mammal, the black bear. The GEIS did not make projections for the timber wolf, and although it did analyze deer and moose habitat, it only did so for the year 2040, so that there is no year 2000 prediction with which to compare current data.

2.2. Birds

2.2.1. Introduction

A total of 138 species of birds are covered in this section. The two species of forest grouse were analyzed separately by Frelich using habitat suitability indexes. The other 136 species were analyzed using density data for different forest types and size classes from the Natural Resources Research Institute (NRRI) forest bird initiative, enabling construction of population indexes.

2.2.2. Methods

2.2.2.1. Methods for forest grouse

For forest grouse, the same methods were used as in the original GEIS (Jaakko Pöyry Consulting, Inc. 1992, pp. 72-73). For ruffed grouse the acreage of aspen forest in the state was adjusted by the evenness of aspen forest distributed among seed-sapling, pole and sawtimber size classes. An even distribution among these three size classes would lead to an adjustment factor of 1.0. For spruce grouse, change in population index was proportional to the acreage in black spruce plus jack pine plus half of the acreage of balsam fir statewide. The GEIS predicted habitat suitability for 2001 is compared to the baseline habitat suitability from 1990 (the year from which the original GEIS predictions were made), and to the same habitat suitability models using the 2001 FIA data. For ruffed grouse, independent population data were available from the spring drumming survey (Dexter 2004).

2.2.2.2. Methods for all other forest birds

The underlying algorithm for computing statewide estimates of breeding bird population sizes is to multiply estimates of bird density per acre of forest by the total acres of each forest covertype in Minnesota, and then sum across all covertypes in all ecoregions statewide. Each forest covertype has an estimate of the amount of acres in each ecoregion; similarly, each bird species has a separate density estimate for each forest covertype in each ecoregion. By computing density estimates for 1990, under the predicted base harvest scenario for 2001, and using observed FIA data from 2001, the degree to which the GEIS correctly predicted changes in bird populations can be gauged.

New Bird Density Estimates

The original bird density values for the GEIS came from three sources: (1) calculated from NRRI monitoring program point counts, (2) estimated from expert opinion, and (3) estimated from the literature. To reflect density changes in current bird populations from 1990, bird density estimates were updated using the following criteria. Density estimates from NRRI's (1999-2001) forest bird monitoring program for forest covertypes were used in ecoregions 2, 3, 4, and 6. When NRRI data were unavailable, USGS Breeding Bird Survey (BBS) trends (% annual change from 1991-2001) from Minnesota BBS routes were used to adjust original density values (Sauer et al. 2004). US Fish and Wildlife Mourning Dove survey data (1994-2003) were used to calculate new density values for the Mourning Dove (Dolton and Rau 2004). When data were not available from either of these sources, densities in the original bird/habitat matrix were retained. Therefore, a species can have a combination of NRRI-updated density values, BBS-adjusted values, and original GEIS values.

Criteria used for calculating new bird densities

NRRI bird data were **not** used for calculating density values in the updated matrix in the following cases: (1) Point counts were an inappropriate sampling method for a given species (e.g., waterfowl, herons, raptors) and (2) NRRI sampled three or fewer points in a given ecoregion/forest covertype (small sample size). BBS trends (i.e., percent annual changes) were **not** used for calculating density values in the updated matrix in the following cases: (1) Appropriate updated density values were available from NRRI survey points; (2) point counts were an inappropriate sampling method for a given species (e.g., waterfowl, herons, raptors); and (3) less than 14 BBS routes were sampled from 1991–2000 (small sample size). Exceptions were made to this criterion for 10 passerine species that were represented by 9-13 BBS routes, and had a Minnesota trend similar in direction and magnitude to their continent-wide BBS trend. This exception was made because the trend was based on a larger sample representative of the trend found on Minnesota BBS routes.

Criteria used for new forest covertype acreages. The area of timberland (acres) was determined for stand-size class by forest type breakdowns using the 2001 FIA plot data. Approximate plot coordinates were intersected with a digital map of ecoregion boundaries to compute acres per ecoregion. Although the FIA provides information for a larger number of forest types, the types were reduced to ten classes. In the original GEIS, acres were estimated from the FIA data in 1990 and predicted for 2000 using the STEMS model.

Many bird species reach their range limits in Minnesota, so distributions were delineated along ecoregion boundaries. Within ecoregions 4 and 9, the two largest ecoregions, county boundaries were used to delineate range limits and calculate forest type acreages.

Comparing the GEIS predictions to current population

Differences in the way the FIA now provides data caused estimates of some bird population sizes to be calculated in a slightly different manner to allow for comparison to the 1990 data. The FIA no longer identifies distance to water or stand size, making it difficult to account for riparian-dependent or area-sensitive bird species. To ensure comparability, the original GEIS analyses were reproduced for riparian-dependent and area-sensitive species by omitting special criteria for these species. The original SAS source code was modified and the population estimates for these

species were reproduced for 1990 and the GEIS predictions. Predictions for nonriparian or nonarea-sensitive species remained identical to the original GEIS.

The original GEIS predictions were made for the baseline year (1990) and the first decade (2000) using the bird density values from 1990 and the FIA acreages from 1990 and 2000. The observed population sizes in 2001 were made with the FIA acreages for 2000 (1999-2003) and updated bird density estimates (1999-2001). The predictions of the GEIS were assessed by comparing the predicted population change from 1990 to 2000 to the observed change from 1990 to 2001. For both predicted and observed values, population change was defined as [100%]*[2001 Population Size–1990 Population Size]/[1990 Population Size]. Before new population sizes for species were calculated, the FIA data summaries were verified against the statewide timberland acreages provided from the FIA to make sure these data were correctly summarized.

Comparing current populations to range of natural variation (RNV) populations

The GEIS predicted short-term population trends for bird species (10 years out) and used 1990 population status as a benchmark for determining "significant" population changes. With this approach it was assumed that the 1990 population for a species represented a "better condition" than what was predicted to occur with increasing harvest levels. This may be an acceptable approach when no other baseline population data exists. However, in work completed at NRRI for other projects, species RNV have been calculated for two ecological sections in northern Minnesota, Northern Superior Uplands and Drift and Lake Plains. The basic premise of RNV is that species populations vary naturally in response to changes in forest ecosystems due to natural disturbance in these regions. It is assumed that a species population is sustainable if the population is within the RNV population. RNV populations were previously calculated for 71 species in the Chippewa and Superior National Forests. RNV population estimates for species were combined and recalculated for these two forests. Although populations do not represent statewide populations for these species, it is reasonable to compare RNV populations to the trend in current populations for these species. The rationale is that most of their populations are in northern Minnesota forests and are representative of forests in this region.

Factors that could affect bird population calculations between 1990 and 2000

- The FIA data were collected differently in 2001 than in 1990. Fewer FIA points were sampled in 2001 and not all variables used to calculate bird populations in 1990 were collected in 2001. It is uncertain how the difference in number and location of the FIA points sampled affected the determination of the amounts of the different forest types and stand age. It would be helpful if the FIA reported the potential bias by forest cover type between the two sampling periods.

- Distance to water was quantified in the 1990 FIA data and not in the 2001 FIA data. This made it impossible to determine the amounts of riparian habitat that would be available for riparian dependent bird species with the 2001 FIA data. In order to make relevant comparisons for populations of riparian dependent bird species among 1990, predicted 2000, and current 2001 values, the riparian area restriction was not used in any models. For example, in the 1990 model, riparian habitat was restricted to forests within 200 feet of a stream, river or lake. The riparian classification significantly reduced the amount of

suitable habitat for these species in the 1990 model and without the restriction, all statewide densities are higher than what was predicted in 1990. One species affected was the Wood Duck. With the riparian habitat restriction, it was estimated that the population of Wood Ducks in 1990 was about 22,000 males. Without riparian habitat restrictions, the population was estimated to be 257,220 males. In order to make relevant comparisons, the 1990 population, the projected 10-year population, and the current population models were recalculated without the distance to water restriction.

- Patch or stand size was not quantified in the 2001 FIA data. Thus it was not possible to implement patch size restrictions for a select group of "interior forest birds" in the current bird population calculations. Because this variable was not available in the 2001 FIA, the 1990 population, projected 10-year population, and current 2001 bird populations were recalculated without this restriction. Similar to the change that occurred for the riparian dependent species, this change increased the amount of suitable habitat for "interior forest" birds that primarily occupy the central and southern forests of the state. For example, with the patch size restriction in place, the Acadian Flycatcher population was estimated to be 1,450 males in 1990. Without the patch size restriction, suitable habitat increased and thus the population estimate increased to about 4,900 males in 1990. This change in method affected primarily those species that have either restricted ranges in the central and southern areas of the state or those with statewide distributions (e.g., 1990 Ovenbird numbers increased by approximately 5% statewide when the patch size restriction was removed).

- Additional density estimates for more bird species are available. Point count data collected in the east central and southeast portions of the state since 1994 provided current density/habitat information for many species in these regions. In the 1990 model, estimated densities were used for several species in this region. In the retrospective analysis, density values for many species used in the 1990 bird/habitat matrix were found to be conservative. For example, Blue-winged Warbler population was underestimated in 1990 by more than 8,000%. The difference in population estimates for these species were controlled by using the current bird/abundance data with the 1990 FIA data. The 1990 population and the predicted 10-year population were recalculated.

2.2.3. Findings

2.2.3.1. Forest grouse

Negative but insignificant changes in the Habitat Suitability Index were predicted by the GEIS for ruffed grouse and spruce grouse, and this was in agreement with HSI for the 2001 FIA data (-2 predicted versus -10 2001 FIA for ruffed grouse, and -16 predicted versus -10 2001 FIA for spruce grouse). Independent population survey data for ruffed grouse showed no trend from 1992 to 2001 (Dexter 2004).

2.2.3.2. Forest birds

Because the bird population estimates are arithmetic products of bird density and amount of habitat, disagreements between predictions and observations for year 2000 can be attributed primarily to changes in the amount of habitat or to changes in the bird density values. Changes in the FIA data along with changes made in bird density affect population calculations of individual bird species differently. For this reason, making direct comparisons for species populations between 1990, projected 2000, and current 2001 population are easier for some species and more problematic for others (see discussion of factors above). With this in mind, results are reported for groups of birds based on the degree of confidence in the comparisons. Four groups of birds were identified: (1) riparian dependent; (2) species that have central and southern distributions; (3) species for which expert opinion or literature were used for densities in 1990 and 2000 and their population trends are unknown; and (4) species with up-to-date densities (from NRRI point count data) and good population trends (either from NRRI or BBS). Species that are within group four also are more abundant and would be less affected by changes in number of the FIA points sampled between the two decades. Note that some species occur in one or more groups and therefore the total species within all groups do not add up to 136 species.

Overall results (136 species)

Report Card: 59 correct predictions: 4 false positives: 1 false negative: 31 false nonsignificant positives: 41 false nonsignificant negatives

Overall, only 43% of all predicted 2000 populations and current 2001 populations were in agreement. The Mourning Dove was the only species where the GEIS predicted a significant increase in population and where a significant increase was observed (Table 2.1). For two species, the Lincoln's Sparrow and Eastern Towhee, the opposite significant difference from what the GEIS predicted was observed (i.e., the Towhee is now declining and the Sparrow is now increasing). For three species (American Black Duck, American kestrel, and Golden-winged Warbler), the GEIS predicted significant increases in population and a nonsignificant change was observed. More species (41 total) have current populations that are $\geq$25% lower than they were in 1990 and were predicted to have nonsignificant changes. In addition, 31 species increased in population by $\geq$25% from 1990 to 2000 and were projected to have nonsignificant population trends.

Riparian dependent species (20 species)

Report Card: 14 correct predictions: 1 false positive: 3 false nonsignificant positives; 2 false nonsignificant negatives.

Twenty species were classified as "riparian dependent" based on their known association with waterbodies (lakes, rivers, or streams). The GEIS correctly predicted nonsignificant population trends for 14 species (Table 2.1). For one species, the American Black Duck, the GEIS projected a false positive increase. In addition, for the Eastern Phoebe, Prothonotary Warbler, and Louisiana Waterthrush the GEIS projected no significant difference while a significant increase was observed. For two species, Northern Waterthrush and Rusty Blackbird, the GEIS predicted no significant change in population and a significant decrease was found.

Most of the differences observed for the Prothonotary Warbler, Louisiana Waterthrush, Eastern Phoebe, and Northern Waterthrush populations between 1990 and 2000 were due to changes made in their density estimates. In contrast, difference in Rusty Blackbird populations between 1990 and 2000 could be attributed to changes in the amount of suitable habitat (Appendix 2.1).

Species with southern distributions (11 species)

Report Card: 1 correct prediction: 9 false nonsignificant positives; 1 false nonsignificant negative

Only one species, the Yellow-billed Cuckoo was correctly predicted to have no significant population change between 1990 and 2000 (Table 2.1). For most species in this region, changes made in densities contributed most to the change from a predicted nonsignificant population change by the GEIS to either a significant negative (Red-headed Woodpecker) or significant positive (all other species). Changes in densities for most species occurred because current point count data from this region of the state was available. The decrease in Red-headed Woodpecker populations was due primarily to its dramatic decline based on BBS data. Overall, habitat availability decreased for all species in this region, but not enough to change the status category for the species (Appendix 2.1).

Species with limited information (41 species)

Report Card: 33 correct; 1 false positive; 6 false nonsignificant negatives; 1 false nonsignificant positive

For 41 species, density estimates were used to construct the bird/habitat matrix in 1990 and no new information was available to update those estimates. In addition, because most of these species have low populations or are not surveyed adequately by BBS, no population trend data are available. Therefore, changes in densities were not made for these species in the bird/habitat database. Changes in populations between 1990 and predicted 2000 and 1990 and current 2001 reflect only changes in available habitat for individual species. It is important to note that most of these species have low populations in the state and, therefore, small changes in numbers can result in a large percent change.

For species with limited information, 33 were correctly predicted as having nonsignificant population changes (Table 2.1). For the American Black Duck, the GEIS falsely predicted a significant increase and for the Wilson ’s warbler the GEIS did not predict a significant positive increase (Table 2.1). For six species, American Three-toed Woodpecker, Black-backed Woodpecker, Loggerhead Shrike, Bell’s Vireo, Yellow-breasted Chat, and Rusty Blackbird, the GEIS failed to predict significant decreases in current populations (Table 2.1). A decrease in suitable habitat for these species resulted in population declines from 1990 to 2001.

Table 2.1. Comparison of the GEIS predicted population change category and observed population category for 136 forest-dependent bird species. Italicized species are riparian dependent, underlined species have southern distributions in the state, and species in bold have good density estimates and population trend data.

Predicted	Observed 25%+	Observed 25-	Observed NS
25%+	**Mourning Dove**	**Eastern Towhee**	*American Black Duck* American Kestrel **Golden-winged Warbler**
25%-	**Lincoln's Sparrow**		
NS	**Red-bellied Woodpecker** **Yellow-bellied Sapsucker** **Yellow-bellied Flycatcher** **Acadian Flycatcher** ***Eastern Phoebe*** **White-breasted Nuthatch** **Blue-gray Gnatcatcher** **House Wren** **Eastern Bluebird** **Wood Thrush** **Tree Swallow** **Black-billed Magpie** **American Crow** **Black-capped Chickadee** **Tufted Titmouse** **Gray Catbird** **Cedar Waxwing** **Red-eyed Vireo** **Blue-winged Warbler** **Black-throated Blue Warbler** **Yellow-rumped Warbler** **American Redstart** ***Lousiana Waterthrush*** Wilson's Warbler **Bay-breasted Warbler** **Cerulean Warbler** ***Prothonotary Warbler*** **Common Yellowthroat** **Northern Cardinal** **Red Crossbill** **White-winged Crossbill**	**Chimney Swift** **Red-headed Woodpecker** **Downy Woodpecker** Black-backed Woodpecker 3-toed Woodpecker **Pileated Woodpecker** **Boreal Chickadee** **Winter Wren** **Golden-crowned Kinglet** **Ruby-crowned Kinglet** **Swainson's Thrush** **Olive-sided Flycatcher** **Eastern Wood Pewee** **Great Crested Flycatcher** **Gray Jay** **Blue Jay** **Brown Creeper** **Brown Thrasher** Loggerhead Shrike Bell's Vireo **Blue-headed Vireo** **Tennessee Warbler** **Magnolia Warbler** **Cape May Warbler** **Black-and-white Warbler** **Connecticut Warbler** **Canada Warbler** Yellow-breasted Chat **Black-throated Green Warbler** **Blackburnian Warbler** **Pine Warbler** ***Northern Waterthrush*** **Mourning Warbler** **Chipping Sparrow** **White-throated Sparrow** **Baltimore Oriole** *Rusty Blackbird* **Brown-headed Cowbird** **Pine Siskin** **Purple Finch** **Evening Grosbeak**	*Double-crested Cormorant* *Great Blue Heron* *Great Egret* *Green Heron* *Black-cr Night Heron* *Yellow-cr Night Heron* *Wood Duck* *Common Goldeneye* *Bufflehead* *Hooded Merganser* *Common Merganser* Turkey Vulture *Osprey* *Bald Eagle* Sharp-shinned Hawk Cooper's Hawk Northern Goshawk Red-shouldered Hawk Broad-winged Hawk Red-tailed Hawk Merlin **Black-billed Cuckoo** **Yellow-billed Cuckoo** Eastern Screech Owl Great Horned Owl Barred Owl Great Gray Owl Long-eared Owl Boreal Owl Northern Saw-whet Owl Whip-poor-will **Ruby-thr Hummingbird** **Hairy Woodpecker** **Northern Flicker** **Least Flycatcher** **Common Raven** **Red-breasted Nuthatch** **Veery** **Hermit Thrush** **American Robin** **Yellow-throated Vireo** ***Warbling Vireo*** Philadelphia Vireo **Nashville Warbler** **Northern Parula** **Yellow Warbler** **Chestnut-sided Warbler** **Palm Warbler** Hooded Warbler **Ovenbird** **Scarlet Tanager** **Rose-breasted Grosbeak** **Indigo Bunting** **Song Sparrow** **Dark-eyed Junco** **Common Grackle** Orchard Oriole **American Goldfinch**

Species with good information (95 species)
Report card: 27 correct; 2 false positives; 1 false negative; 35 false nonsignificant negatives; 30 false nonsignificant positives

Twenty-seven of the 95 predictions made by the GEIS for bird species with good density/habitat data and population trend data were correct (Table 2.1). For two species, the Golden-winged Warbler and Eastern Towhee, a significant increase was falsely predicted. In contrast, the Lincoln's Sparrow was predicted to significantly decline and instead a significant increase in population was found (Table 2.1). For 35 species, nonsignificant population changes were predicted and instead they were found to be decreasing significantly. Whereas, for 30 species, a nonsignificant change was projected, while a significant increase in population was found (Table 2.1).

Differences in populations projected by the GEIS and current populations can be attributed to two factors, one is observed change in the amount of habitat versus the predicted amount and the second is a change in density. The comparisons between 1990 to predicted 2000 population value reflected only one factor (a change in amount of habitat) because the same bird density values were used for both time periods. Thus, the original GEIS made the assumption that although changes in the amount of habitat would occur, changes in density (the number of birds per acre of habitat) would not. Population comparisons between 1990 and current 2001 populations reflect changes in either or both factors.

Individual species were affected differently by either increasing or decreasing densities or by increases or decreases in suitable habitat. For some species incorrectly predicted, the majority of the difference can be attributed to changes in their densities between 1990 and 2000. (Note that the intent of this report is not to investigate or propose reasons for species density changes from 1990 to 2000.) For other species, the reason for their significant increase or decrease was due primarily to the difference in the projected 2000 and 2001 FIA data (suitable habitat change). In addition, there are species that had decreases in amount of habitat and increases in densities (or vice versa) and their populations in 2000 were affected by both factors.

Bird Guild Summaries

Species trend information for predicted 2000 and current 2001 populations was summarized for 95 species by major habitat, nest and migration guilds. These guilds were chosen because they are a good way to consolidate species with similar life history strategies to determine patterns of species response. For example, the majority of species that are declining on the 14-year monitoring of the National Forests are ground nesting birds (Lind et al. 2005). Conversely, many permanent resident species have been increasing in density over this time period. A similar pattern is likely to be found for species populations between 1990 and 2000 if the major factor affecting their population status is density. On the other hand, if amounts of habitat within a major cover type (e.g., upland conifer) decreased or increased among 1990 base populations, 2000 projected populations, and current 2001 populations, it would be expected that species occurring in those habitats would have similar population trends. Note that totals for species with changes due to habitat and abundance do not always equal the total number of significant

changes. For example, an increase in habitat for a species could be offset by a decrease in density resulting in a nonsignificant increase or decrease in population.

Nesting Guilds (note: 2 species do not fit these categories and were not included, Brown-headed Cowbird and Eastern Phoebe)

Cavity nesters (19 species)
No population changes were predicted to occur for species that nest in cavities between 1990 and 2000 in the GEIS (Figure 2.1). However, almost all cavity nesters were found to have significant increases (9) or decreases (7) in abundance from 1990 to 2001. None of the changes in predicted versus observed were due to changes in habitat availability. Instead, changes in populations from 1990 to 2000 were due to either an increase (9 species) or decrease (6 species) in density (Figure 2.1).

Canopy nesters (26 species)
For the canopy nesting species, the GEIS predicted that one of 26 species would increase from 1990 to 2000. However, results indicated that 7 species increased and 13 species decreased (Figure 2.1). All of the species that increased did so because their densities increased. In contrast, almost half of the declining species (6) decreased because their habitat decreased. Seven canopy nesting species decreased between 1990 and 2001 because their density decreased during this time period (Figure 2.1).

Shrub/subcanopy nesters (26 species)
Although no population changes were predicted for shrub/subcanopy nesting birds in the GEIS, 10 increased and 6 decreased in abundance from 1990 to 2000 (Figure 2.1). One of the decreases was due to a decrease in habitat and all of the increases in populations were due to an increase in density from 1990 to 2001. Three shrub nesting birds decreased because their densities decreased over the ten year period (Figure 2.1).

Ground nesters (22 species)
For ground nesting birds, the GEIS predicted that 1 species would decline and 2 would increase in population from 1990 to 2000 (Figure 2.1). Instead 9 species decreased and 5 species increased in abundance from 1990 to 2001. For the species that increased, 2 did so because their habitat increased and 3 increased because their densities were higher in 2001 than in 1990. Almost all of the species that decreased in abundance did so because their densities decreased from 1990 to 2001 (8 species) (Figure 2.1).

Migration Guilds

Permanent residents (19 species)
No changes in population were projected for permanent resident species from 1990 to 2000, but almost all (16 of 19) species either increased (8) or decreased (8) in abundance during this time period (Figure 2.2). Three permanent resident species declined because their habitat declined and 4 decreased primarily because their densities were lower in 2000. All increases in permanent resident populations from 1990 to 2000 could be attributed to increases in densities for these species (9 total).

Short-distant migrants (27 species)
Two species in the short-distance migration guild were predicted to increase from 1990 to 2000, instead 8 species increased (Figure 2.2). No species were projected to decrease and 12 species decreased in abundance from 1990 to 2001. Most of the increase or decrease was due to changes in density between 1990 and 2001. Two species decreased because habitat availability was lower in 2000 and 1 species increased in population due to an increase in available habitat (Figure 2.2).

Long-distant migrants (49 species)
Although the GEIS predicted that 1 long-distance migrant species would increase and 1 would decrease, about one-third (16 species) increased and one-third decreased in population from 1990 to 2001 (Figure 2.2). The majority of the differences in predicted versus observed populations were again due to changes in density from 1990 to 2001. Only 2 increases and 1 decrease in species abundance from 1990 to 2001 were attributed to changes in habitat availability.

Habitat Guilds

Upland Conifer Forests (20 species)
None of the bird species that prefer upland conifer forest habitats were projected to change in abundance from 1990 to 2000 in the GEIS (Figure 2.3). The new analyses indicated that 13 of 20 species decreased and 4 of 20 species increased in abundance from 1990 to 2001. The decrease in abundance of 7 species was due primarily to a decrease in habitat and no species that increased was in response to an increase in habitat. Almost an equal number of species increased (5) or decreased (7) in abundance from 1990 to 2001 because their densities changed (Figure 2.3).

Lowland Conifer Forests (13 species)
One lowland conifer bird species was projected to decrease in abundance from 1990 to 2000 (Figure 2.3), but the new analysis indicated that 7 species declined and 2 species increased in population from 1990 to 2001. Only 1 species increased in abundance because of a change in available habitat. Four species declined in abundance because their densities were lower in 2001 than in 1990.

Deciduous Forests (35 species)
None of the bird species in the deciduous forest habitat guild were projected to change in abundance from 1990 to 2000 (Figure 2.3). However, 25 of 35 species in this guild either increased (15) or decreased (10) in population from 1990 to 2001. The reason for the difference in predicted versus observed was due to changes in bird densities. All of the species that increased had significant increases in abundance from 1990 to 2001.

Early-successional Forests (27 species)
Three early-successional bird species were projected to increase from 1990 to 2000, but 11 species increased and 6 species decreased (Figure 2.3). One of the species increased because of an increase in available habitat, but most of the changes were due to changes in bird density from

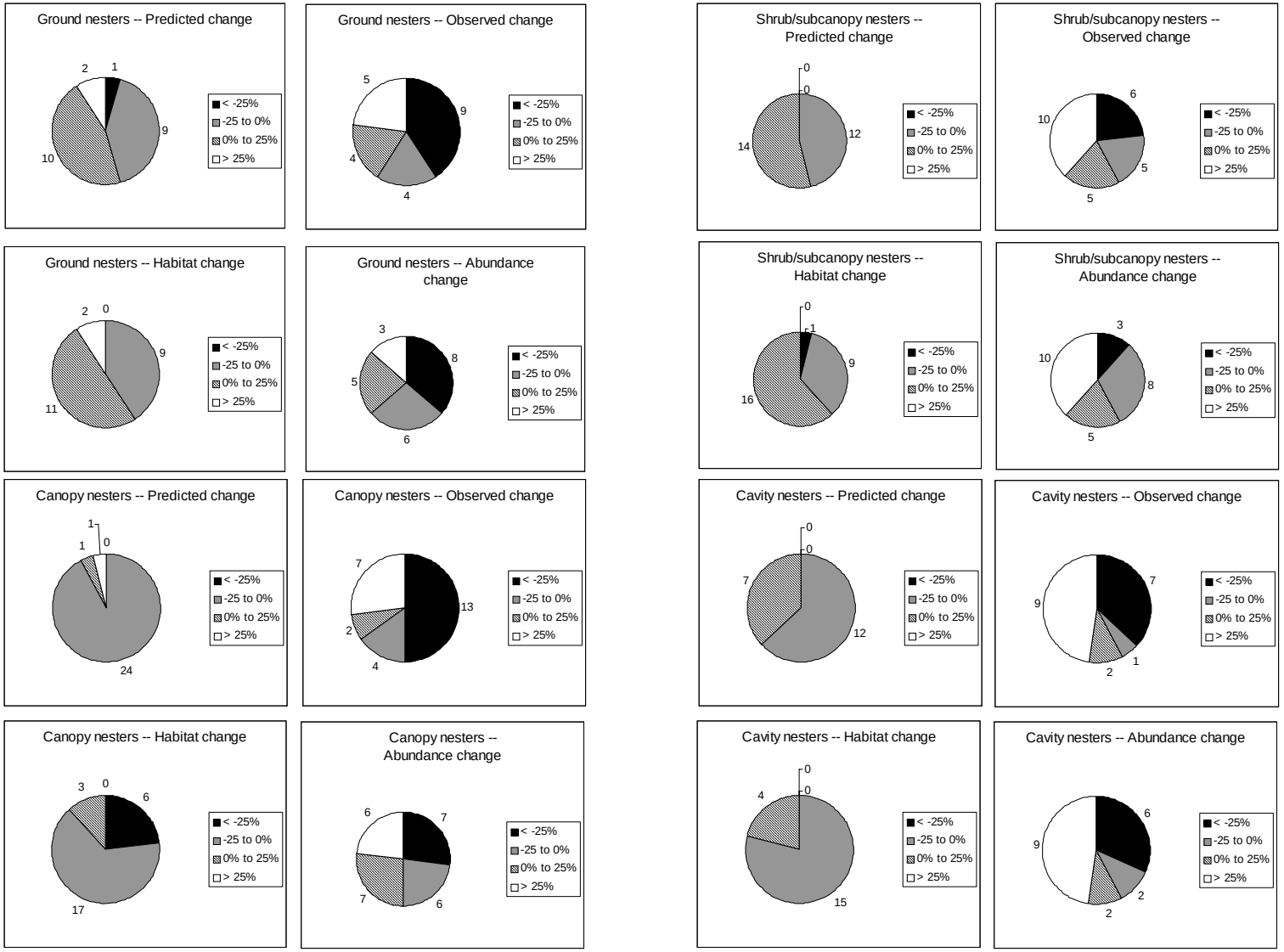

Figure 2.1. Number of species within four nesting guilds whose populations were projected to increase or decrease by the GEIS (predicted change), observed change (from 1990 to 2001), observed change due to habitat change in the FIA data, and observed change due to density change from 1990 to 2001. Data are for 95 species where density and population trends were available.

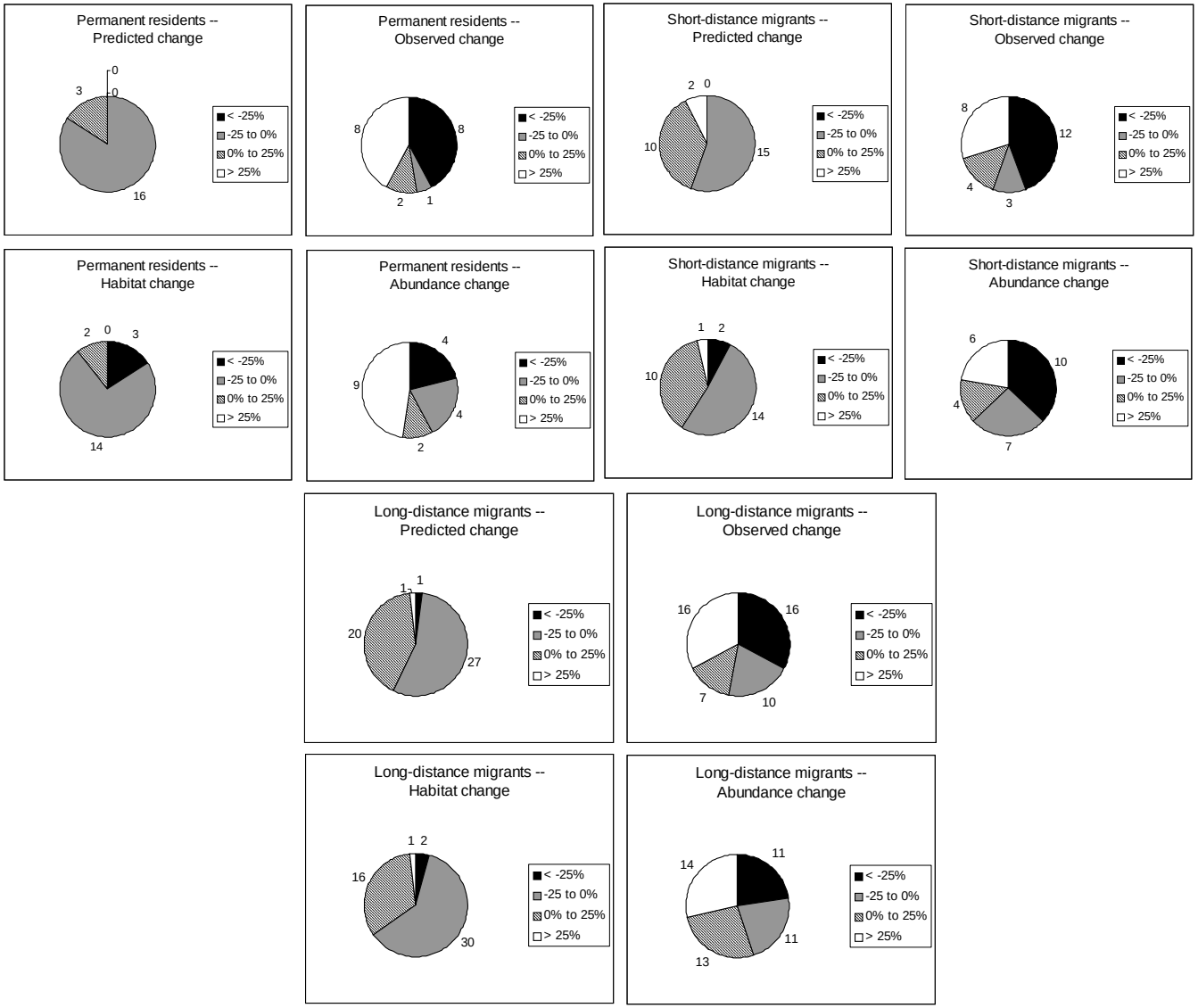

Figure 2.2. Number of species within three migration guilds whose populations were projected to increase or decrease by the GEIS (predicted change), observed change (from 1990 to 2001), observed change due to habitat change in FIA data, and observed change due to density change from 1990 to 2001. Data are for 95 species where density and population trends were available.

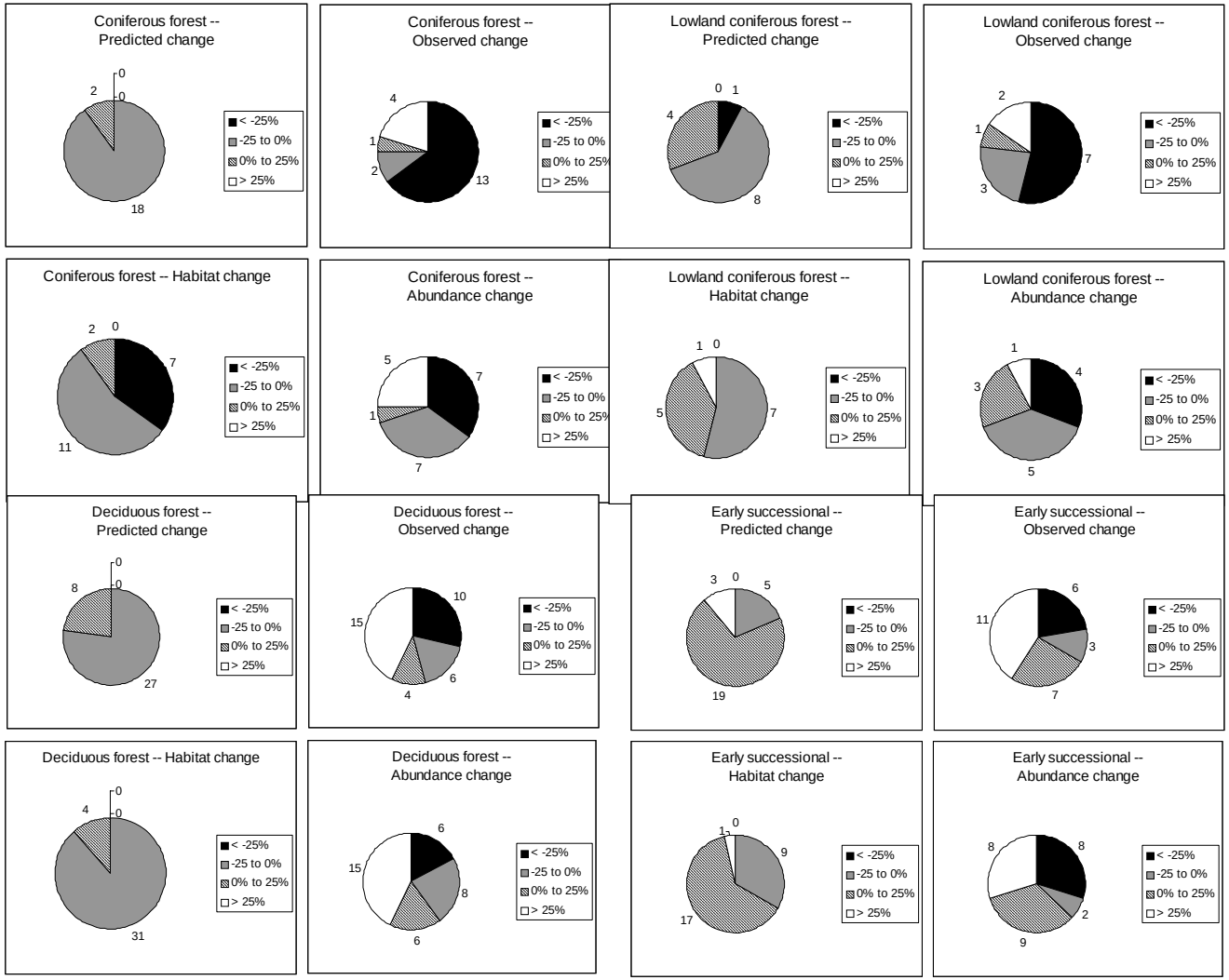

Figure 2.3. Number of species within four habitat guilds whose populations were projected to increase or decrease by the GEIS (predicted change), observed change (from 1990 to 2001), observed change due to habitat change in the FIA data, and observed change due to density change from 1990 to 2001. Data are for 95 species where density and population trends were available.

1990 to 2001. Eight species decreases were attributed to a decline in density and 8 species densities increased from 1990 to 2001 leading to a significant population increase (Figure 2.3).

RNV population comparisons

Forty of 71 species current populations are below their minimum RNV population, 26 species have current populations within their RNV population and 5 species have current populations that are above their maximum RNV population (Table 2.2). Of the species that have populations below their minimum RNV population, 21 have decreased significantly in population from 1990 to 2001 (Table 2.2). The Gray Catbird which has a current population above its maximum RNV increased in abundance from 1990 to 2001. Almost 75% of the species that are declining in population and that are below minimum RNV prefer conifer forests, either upland (10 species) or lowland (5 species) (Table 2.2).

It was predicted that four different factors could potentially contribute to differences in current and the GEIS projected 2000 populations for the 136 forest dependent bird species modeled. The potential affect that two factors (distance to water and patch size) could have on current populations were controlled by recalculating 1990, 2000, and current populations data for species without these restrictions applied to habitat availability (see methods section). Therefore, differences in predicted and observed populations in the models can be attributed to changes in bird density, to habitat availability, or to a combination of these two factors.

Differences due to habitat availability based on the FIA

As predicted, changes in habitat availability from 1990, 2000, and 2001 impacted groups of species differently depending on direction and relative amount of change in acres among habitat types. On average, 65 of 95 species populations (good data criteria) that were modeled decreased in abundance by 11.6% due to a change in available habitat. In contrast, 30 species populations increased an average of 7.6% because their preferred habitat increased. Amount of early-successional habitat increased by 13% from 1990 to 2001, but the 2001 amount was almost equal to the 2000 predicted acreage. Only one of 17 early-successional species that showed a significant population increase or decrease could be attributed to change in amount of early-successional habitat. Amount of suitable habitat for the Eastern Towhee increased significantly from 1990 to 2001, but a much larger decrease in population was due to declines in abundance resulting in an overall significant decrease for this species.

A similar result was found for birds that prefer lowland conifer and upland deciduous forests. A slight increase in acres of lowland conifer forest was found over the 1990 (6%) and 2000 (5%) prediction. One species, the Lincoln's Sparrow increased in abundance because of an increase in lowland conifer habitat. The amount of upland deciduous habitat in 2001 increased by 3% over the 2000 predicted acres and was slightly lower (3%) than it was in 1990. No birds that prefer upland deciduous forest had significant changes in abundance attributed to a change in habitat availability.

Table 2.2. Nesting, migration and habitat guild designation for 95 bird species. Predicted change (percent) is from the GEIS for years 1990-2000, observed change is from 1990 to 2001, abundance change indicates the percent population change that was due to change in species density, and habitat change indicates percent of population change due to change in FIA habitat. Percent RNV (range of natural variability) is for species populations in the Superior and Chippewa National Forests in northern Minnesota. Values below 100 indicate the percent that the species current population that is below its minimum RNV population. Values of 100 indicate that the current population is within the species historic range and values above 100 are percents above the species maximum RNV population. Species in bold are those that are declining in population and have a current population that is below its minimum RNV population.

Species	Nest type	Migration strategy	Habitat	Predicted change	Observed change	Abundance change	Habitat change	% RNV
Mourning Dove	Canopy	Short-distance	Early-successional	29.00	25.10	20.50	4.60	
Black-billed Cuckoo	Shrub	Long-distance	Deciduous forest	5.90	-24.60	-22.00	-2.60	58
Yellow-billed Cuckoo	Shrub	Long-distance	Deciduous forest	2.90	7.40	15.20	-7.80	
Chimney Swift	Cavity	Long-distance	Deciduous forest	21.00	-26.60	-27.20	0.60	
Ruby-throated Hummingbird	Canopy	Long-distance	Early-successional	-0.80	19.60	19.60	0.00	100
Red-headed Woodpecker	Cavity	Permanent	Deciduous forest	-6.50	-53.70	-48.60	-5.10	
Red-bellied Woodpecker	Cavity	Permanent	Deciduous forest	-4.30	108.10	111.80	-3.70	
Yellow-bellied Sapsucker	Cavity	Short-distance	Deciduous forest	-7.90	109.90	115.90	-6.00	100
Downy Woodpecker	Cavity	Permanent	Deciduous forest	2.00	-30.60	-26.60	-4.00	101
Hairy Woodpecker	Cavity	Permanent	Deciduous forest	6.40	2.60	2.60	0.00	72
Northern Flicker	Cavity	Short-distance	Early-successional	9.10	-21.20	-26.90	5.70	100
Pileated Woodpecker	Cavity	Permanent	Deciduous forest	-6.30	-28.70	-22.60	-6.10	100
Olive-sided Flycatcher	Canopy	Long-distance	Early-successional	8.40	-54.20	-65.80	11.60	75
Eastern Wood-Pewee	Canopy	Long-distance	Deciduous forest	-8.80	-43.50	-29.70	-13.80	100
Yellow-bellied Flycatcher	Ground	Long-distance	Lowland conifer	1.30	25.80	25.10	0.70	99
Acadian Flycatcher	Shrub	Long-distance	Deciduous forest	-1.00	234.60	235.70	-1.10	
Least Flycatcher	Shrub	Long-distance	Deciduous forest	-4.30	-12.70	-8.60	-4.10	100
Eastern Phoebe	Platform	Short-distance	Early-successional	-6.90	25.70	28.00	-2.30	55
Great Crested Flycatcher	Cavity	Long-distance	Deciduous forest	-2.40	-35.20	-33.80	-1.40	100
Yellow-throated Vireo	Canopy	Long-distance	Deciduous forest	-8.80	-1.60	1.30	-2.90	110
Blue-headed Vireo	Shrub	Short-distance	Coniferous forest	-8.90	-32.00	-1.00	-31.00	56
Warbling Vireo	Canopy	Long-distance	Deciduous forest	-3.30	2.50	6.10	-3.60	
Red-eyed Vireo	Shrub	Long-distance	Deciduous forest	3.40	28.50	33.40	-4.90	100
Gray Jay	Shrub	Permanent	Lowland conifer	-4.20	-40.90	-25.70	-15.20	69
Blue Jay	Canopy	Permanent	Deciduous forest	-10.70	-25.90	-14.10	-11.80	70
Black-billed Magpie	Shrub	Permanent	Early-successional	22.90	40.00	27.10	12.90	
American Crow	Canopy	Short-distance	Deciduous forest	-7.10	30.00	43.00	-13.00	83
Common Raven	Canopy	Permanent	Coniferous forest	-8.40	-10.50	16.00	-26.50	100
Tree Swallow	Cavity	Short-distance	Early-successional	19.60	82.70	84.30	-1.60	

Species	Nest type	Migration strategy	Habitat	Predicted change	Observed change	Abundance change	Habitat change	% RNV
Black-capped Chickadee	Cavity	Permanent	Deciduous forest	-5.50	44.90	55.70	-10.80	78
Boreal Chickadee	Cavity	Permanent	Lowland conifer	-7.00	-28.60	-9.50	-19.10	27
Tufted Titmouse	Cavity	Permanent	Deciduous forest	-4.10	104.20	107.80	-3.60	
Red-breasted Nuthatch	Cavity	Permanent	Coniferous forest	-0.80	18.70	39.80	-21.10	66
White-breasted Nuthatch	Cavity	Permanent	Deciduous forest	-7.80	88.40	94.60	-6.20	100
Brown Creeper	Cavity	Short-distance	Deciduous forest	-6.40	-44.40	-30.80	-13.60	81
House Wren	Cavity	Long-distance	Early-successional	0.10	25.10	28.60	-3.50	
Winter Wren	Ground	Short-distance	Lowland conifer	6.70	-36.50	-29.60	-6.90	80
Golden-crowned Kinglet	Canopy	Short-distance	Coniferous forest	-7.80	-68.50	-48.40	-20.10	82
Ruby-crowned Kinglet	Canopy	Short-distance	Coniferous forest	-1.80	-47.70	-32.30	-15.40	96
Blue-gray Gnatcatcher	Shrub	Long-distance	Deciduous forest	-6.40	14448.20	14452.60	-4.40	
Eastern Bluebird	Cavity	Short-distance	Early-successional	18.00	31.80	17.90	13.90	
Veery	Ground	Long-distance	Deciduous forest	6.60	5.40	0.90	4.50	100
Swainson's Thrush	Shrub	Long-distance	Lowland conifer	-6.20	-28.10	-11.40	-16.70	94
Hermit Thrush	Ground	Short-distance	Coniferous forest	-7.40	-16.30	-4.40	-11.90	69
Wood Thrush	Shrub	Long-distance	Deciduous forest	-9.90	72.60	79.50	-6.90	
American Robin	Shrub	Short-distance	Early-successional	5.90	7.50	3.80	3.70	87
Gray Catbird	Shrub	Long-distance	Early-successional	17.40	63.00	55.60	7.40	244
Brown Thrasher	Shrub	Short-distance	Early-successional	14.40	-48.60	-59.10	10.50	86
Cedar Waxwing	Shrub	Short-distance	Early-successional	-6.90	67.30	70.80	-3.50	87
Blue-winged Warbler	Ground	Long-distance	Early-successional	-0.40	8185.50	8193.60	-8.10	
Golden-winged Warbler	Ground	Long-distance	Early-successional	25.50	17.20	18.70	-1.50	112
Tennessee Warbler	Ground	Long-distance	Lowland conifer	-5.90	-34.60	-23.00	-11.60	100
Nashville Warbler	Ground	Long-distance	Lowland conifer	-3.30	-5.90	-8.30	2.40	75
Northern Parula	Canopy	Long-distance	Lowland conifer	-5.00	-4.40	13.60	-18.00	60
Yellow Warbler	Shrub	Long-distance	Early-successional	9.00	8.00	10.20	-2.20	
Chestnut-sided Warbler	Shrub	Long-distance	Early-successional	7.80	-1.10	3.40	-4.50	100
Magnolia Warbler	Shrub	Long-distance	Coniferous forest	-12.00	-33.10	-16.90	-16.20	100
Cape May Warbler	Canopy	Long-distance	Coniferous forest	-6.20	-32.10	-3.80	-28.30	100
Black-throated Blue Warbler	Shrub	Long-distance	Deciduous forest	-1.70	72.50	76.10	-3.60	96
Yellow-rumped Warbler	Canopy	Short-distance	Coniferous forest	-8.20	51.40	74.30	-22.90	58
Black-throated Green Warbler	Shrub	Long-distance	Deciduous forest	-7.60	-26.70	-14.40	-12.30	78
Blackburnian Warbler	Canopy	Long-distance	Coniferous forest	-7.30	-53.80	-35.90	-17.90	84
Pine Warbler	Canopy	Short-distance	Coniferous forest	-5.70	-54.30	-15.80	-38.50	60

Species	Nest type	Migration strategy	Habitat	Predicted change	Observed change	Abundance change	Habitat change	% RNV
Palm Warbler	Ground	Long-distance	Lowland conifer	2.20	11.70	8.60	3.10	28
Bay-breasted Warbler	Canopy	Long-distance	Coniferous forest	-10.00	161.00	194.90	-33.90	100
Cerulean Warbler	Canopy	Long-distance	Deciduous forest	-3.80	30.80	34.30	-3.50	
Black-and-white Warbler	Ground	Long-distance	Coniferous forest	5.60	-62.10	-63.20	1.10	88
American Redstart	Shrub	Long-distance	Early-successional	7.20	42.00	40.70	1.30	100
Prothonotary Warbler	Cavity	Long-distance	Deciduous forest	-8.80	91.80	101.70	-9.90	
Ovenbird	Ground	Long-distance	Deciduous forest	-6.80	-14.40	-4.30	-10.10	95
Northern Waterthrush	Ground	Long-distance	Lowland conifer	-2.00	-36.90	-27.10	-9.80	62
Louisiana Waterthrush	Ground	Long-distance	Deciduous forest	-9.10	100.10	108.30	-8.20	
Connecticut Warbler	Ground	Long-distance	Lowland conifer	2.10	-48.40	-49.80	1.40	100
Mourning Warbler	Ground	Long-distance	Early-successional	10.60	-29.80	-33.80	4.00	100
Common Yellowthroat	Ground	Long-distance	Early-successional	10.00	30.00	11.80	18.20	
Canada Warbler	Ground	Long-distance	Coniferous forest	0.50	-54.20	-56.70	2.50	100
Scarlet Tanager	Canopy	Long-distance	Deciduous forest	-8.30	-11.00	2.70	-13.70	97
Eastern Towhee	Ground	Short-distance	Early-successional	79.00	-30.20	-70.80	40.60	122
Chipping Sparrow	Canopy	Short-distance	Coniferous forest	-1.90	-26.90	-15.90	-11.00	84
Song Sparrow	Ground	Short-distance	Early-successional	12.10	0.90	-8.20	9.10	100
Lincoln's Sparrow	Ground	Long-distance	Lowland conifer	-30.00	53.20	24.60	28.60	100
White-throated Sparrow	Ground	Short-distance	Early-successional	-4.40	-38.60	-35.20	-3.40	76
Dark-eyed Junco	Ground	Short-distance	Lowland conifer	-14.00	-4.30	-5.20	0.90	47
Northern Cardinal	Shrub	Permanent	Deciduous forest	-8.40	35.60	45.00	-9.40	
Rose-breasted Grosbeak	Shrub	Long-distance	Deciduous forest	6.30	-11.40	-14.30	2.90	100
Indigo Bunting	Shrub	Long-distance	Early-successional	7.50	-24.50	-28.30	3.80	100
Common Grackle	Shrub	Short-distance	Early-successional	11.60	9.20	-7.20	16.40	
Brown-headed Cowbird	Parasite	Short-distance	Early-successional	6.40	-25.10	-30.00	4.90	100
Baltimore Oriole	Canopy	Long-distance	Deciduous forest	-13.20	-28.90	-24.50	-4.40	100
Purple Finch	Canopy	Short-distance	Coniferous forest	-9.60	-43.00	-28.10	-14.90	49
Red Crossbill	Canopy	Permanent	Coniferous forest	-7.50	579.40	597.90	-18.50	
White-winged Crossbill	Canopy	Permanent	Coniferous forest	-8.10	2806.60	2827.50	-20.90	80
Pine Siskin	Canopy	Permanent	Coniferous forest	-10.40	-57.00	-24.20	-32.80	57
American Goldfinch	Shrub	Short-distance	Early-successional	17.80	16.40	7.10	9.30	
Evening Grosbeak	Canopy	Permanent	Coniferous forest	-1.10	-68.70	-34.80	-33.90	79

Acres of upland conifer forest decreased by 41% in 2001 compared to 1990 and by 39% over the 2000 predicted amount. This habitat type had the biggest change and resulted in the most difference in species changes in the upland conifer habitat guild. Of the 13 species that decreased from 1990 to 2001, seven decreases were due primarily to change in habitat availability.

Differences due to density change

Changes made in species densities in the model from 1990 to 2000 also contributed to differences found between 1990 and 2000 predictions and 1990 and 2001 observed populations. Because density change was not modeled in the original GEIS projections, it is not surprising that differences were found between the predicted and observed population trends. What is somewhat surprising is the magnitude of population change that has occurred in the past decade that can be attributed to decreasing or increasing densities. If species that had population changes greater than 500% are excluded, 47 species had density decreases (averaging 27%) and 44 species had increases (averaging 48%). These large changes in density between 1990 and 2001 accounted for many of the differences between the predicted and current 2000 populations. These species have either increasing or decreasing trends from NRRI's monitoring program or from BBS (Lind et al. 2005; Sauer et al. 2004).

Species trends in the context of RNV

The degree to which forest covertypes in two northern Minnesota ecological sections are within, below, or above RNV also varies by forest ecosystem type. In general, current forests are younger in age, have a smaller amount of conifer tree basal area, and have fewer acres of conifer forest than were present on the landscape 3,000-5,000 years ago (see Brown et al. 2005). It is not surprising that many of the bird species with current populations below their RNV minimum are associated with upland conifer forest types. Based on the comparison of the FIA data between 1990 and 2000, the trend of decreasing conifers in Minnesota continues at an alarming rate. Acres of upland conifer forest decreased by 41% in 2000 compared to 1990 and by 39% over the 2000 predicted amount. Almost half (10 of 21 species) of bird species that have populations below their minimum RNV and that declined in population from 1990 to 2000 are associated with upland conifer forests.

2.3. Mammals, reptiles and amphibians

2.3.1. Methods

Twenty-two species of small and medium-sized mammals, one species of large mammal (black bear) and eight species of herps are covered in this section. For all species the general methodology was to form a matrix of habitat based on forest type (jack pine, white pine, etc.) and size class (seedling-sapling, pole, and sawtimber) and then assign a weighting factor that reflects habitat value for each forest type/size class combination for each wildlife species. The habitat weighting factors were multiplied by the statewide acreages, based on the 1990 FIA data, for a simple product sum that is a statewide habitat-suitability index (HSI) for each species.

In all cases, the GEIS predicted habitat suitability for 2000 is compared to the baseline habitat suitability from 1990, and to the same habitat suitability models using the 2001 FIA data. In several cases independent wildlife population data from 1990 to circa 2001 were available from MN DNR Division of Fish and Wildlife or Division of Ecological Services reports, and

comparisons are also made to this independent data for these species, including six species of small- and medium-sized mammals, black bear, and two species of frogs (Dexter 2001, 2004; Garshelis and Noyce 2004; Monstad 2004). For comparison of 1990 and 2001 populations the following were used: snowshoe hare the winter track index (Dexter 2004); Beaver, the survey of live colonies per route mile, 1990 and 2000 from Dexter (2001); Bobcat, Fisher and Marten, estimated spring population size (Dexter 2004); red fox scent station index, forest zone (Dexter 2004); black bear, average of upper and lower confidence intervals for population change from 1991 to 2001 (Gershelis and Noyce 2004); spring peeper and pickerel frog, from frog and toad calling survey, forest zone (Monstad 2004).

For small- and medium-sized mammals values assigned for 1990 were: absent (0), low (2), medium (5) and high (10), for a given forest type and size-class combination and there were separate matrices for timberland and recent clearcuts. These same values were used for the current analyses and are available in Appendix 6, Tables A and C in Jaakko Pöyry Consulting, Inc. (1992). These values were modified to reflect the impact of certain other factors, such as recent clearcuts, availability of mast (oak trees or white spruce trees) for squirrels, nearness to agricultural fields for red fox, and moist versus dry forest condition for snowshoe hare, beaver, bobcat, and lynx. In addition, the value changed based on whether the forest was a plantation or naturally regenerated, which was of importance to fisher and marten. Due to the unavailability of some of these features in the FIA data at both times (1990 and 2001), and the limited amount of time and funding available, the presence of mast trees and nearness to agricultural fields were dropped in these analyses. Therefore, all analyses were recalculated so that data were comparable between 1990 and 2001. In addition, it was necessary to recalculate some of the models because for several species the 1992 models were run for all forest only in 1992 (Jaakko Pöyry Consulting, Inc. 1992), whereas this study is analyzing timberland only.

Analyses for 1990 and today were run for eight species of herps using the same habitat relationships specified in the GEIS (Jaakko Pöyry Consulting, Inc. 1992, p. 74). For a given species an index of habitat suitability was estimated from the acreage of the preferred forest types >20 years old.

Projections for large mammals were not done in the GEIS for timber wolves, and projections were not done for the year 2000 for three other large mammals; white-tailed deer, moose, and black bear. Deer and moose projections in the GEIS for the year 2040 were based on township level analyses, and it is not possible to create similar analyses for the year 2001 given the lack of the FIA plot locations for 2001. However, HSI for black bear was based on a statewide analysis of oak habitat (Jaakko Pöyry Consulting, Inc. 1992, p. 60), and it was possible to create new analyses for the 1990, GEIS 2001, and FIA 2001.

For all species the simplifying assumptions are made that new clearcuts, moist sites, size classes of trees, plantations, and the mixture of conifer and deciduous stand types are randomly distributed within the range of each animal species, and/or within each forest type. Without these assumptions, it would be impossible to model habitat-based population indexes for wildlife species without a major effort lasting over a year and costing several times the amount of money allocated for this study.

2.2.2. Findings

For small mammals and herps, the GEIS did not predict any significant changes in HSI from 1990 to 2001 and only one species (the least chipmunk) had a significant positive increase in HSI using the 2001 FIA data (Table 2.3). Twenty-four of the 31 species had GEIS predicted HSI and FIA-based HSI for 2001 within 10% of each other. Least chipmunk, timber rattlesnake, boreal ringneck snake, eastern hognose snake, and pickerel frog each had positive changes based on the 2001 FIA more than 10% above those predicted by the GEIS for 2000. Meadow vole and marten had negative changes in HSI more than 10% greater in magnitude than predicted by the GEIS.

Table 2.3. Summary of HSI change and population change data for mammals and herps, 1990-2001.

Species	1990 GEIS	% HSI change 2000 GEIS	% HSI change 2001 FIA	% population change, independent data 1990-2001
Small mammals				
Snowshoe hare	100	-8	-7	+170
Eastern chipmunk	100	-2	+1	
Least chipmunk	100	+12	+27	
Red squirrel	100	-5	+2	
Gray squirrel	100	+3	+10	
Fox squirrel	100	+10	+4	
S. flying squirrel	100	+2	0	
N. flying squirrel	100	-10	-2	
Beaver	100	+16	+8	-48
Woodland deer mouse	100	-7	-2	
White-footed mouse	100	-1	+1	
S. red-backed vole	100	-1	-2	
Meadow vole	100	-4	-18	
Meadow jumping mouse	100	+7	+9	
Woodland jumping mouse	100	-3	+3	
Porcupine	100	+2	+2	
Bobcat	100	-9	-9	+25
Lynx	100	-14	-11	
Fisher	100	-3	-11	+72
Marten	100	0	-19	+36
Red fox	100	+3	+6	0
Gray fox	100	+7	-2	
Large mammal				
Black bear	100	+2	+4	+44
Herps				
Timber rattlesnake	100	+6	+18	
Boreal ringneck snake	100	+2	+24	
Eastern hognose snake	100	+5	+23	
Eastern newt	100	-3	+2	
Red-backed salamander	100	-3	+2	
Wood frog	100	-3	+3	
Spring peeper	100	0	+7	0
Pickerel frog	100	+2	+24	0

Except for red fox, independent population survey data for mammals from 1990 to 2001 showed different direction and magnitude of trends than HSI (Table 2.3). Actual populations for black bear, bobcat, fisher, marten, and snowshoe hare were much more positive than predicted using

HSI. The two frog species were stable in the forest zone although a small increase in habitat quality was predicted (Table 2.3).

Habitat suitability predictions from the GEIS for 2000 were close to those based on actual 2001 FIA data for a large majority of species. The substantive differences that occurred for seven species can be explained by differences in forest type and age class predictions from the GEIS as compared to the FIA data for 2001.

Note that unlike for bird species other than forest grouse, which have population density estimates for each forest type enabling a habitat-based population index to be calculated, there are no such habitat-specific population density estimates for mammal and herp species, and therefore, the GEIS predictions were strictly habitat suitability indexes. The large differences between predicted HSI and independent population survey data are due to several factors. These include the cyclic nature of many mammal populations, especially small mammals (Olson 2005), but also include some medium-sized mammals such as showshoe hare, bobcat, and the forest grouse (Dexter 2004). Suitable habitat is used to varying degrees over time by animals with cyclic populations, and the population cycles may or may not be consistent with the 1990-2000 period modeled for this study. Another factor that allows divergence between habitat suitability and actual populations are short-term climatic trends that may have impacted 1990 and 2000 populations, trends in prey species for predators, special protection for species of concern, patterns of hunting, and habitat changes not strictly related to forest type and age or size class (e.g., availability of berries and other food plants, ephemeral wetlands). The availability of suitable habitat does not ensure that it will be fully used by a given animal species, especially when similar habitat is shared by more than one species.

Acknowledgements

Assistance from Rich Baker, Margaret Dexter, John Erb, Andrew Finley, Carol Hall, Gerda Nordquist, and Carlye Olson is gratefully acknowledged.

3. Old and Old-growth Forest and Biodiversity Assessments

3.1. Old and Old-growth Forest

3.1.1. Introduction

Area of old forest within timberland and old-growth forest were identified as important issues in the GEIS Biodiversity Technical Paper and the final GEIS (Jaakko Pöyry Consulting, Inc. 1992, 1994), because it is important to maintain older forests for habitat diversity. Old forest is an umbrella term that includes forests beyond traditional rotation ages within commercial forest, and this does include early successional forest types such as jack pine, aspen, paper birch, and balsam poplar forest >70 years old. The GEIS projected acreage of old forest for the year 2000.

Old growth is defined as forest that has had minimal human disturbance, in essence was never logged, and was regenerated by natural processes such as wind, fire, and gap formation. The MN DNR has used 120 years as an age threshold (one exception was made for white spruce >90 years), in forest types dominated by late-successional species (such as black spruce, maple-basswood) or early successional species that are long lived (such as red pine and white pine, but not aspen or paper birch). Given the relatively recent settlement history of the forested part of Minnesota, this definition essentially restricts old growth to primary forests. Old-growth forests serve important roles as blueprints for restoration of second growth, as references for harvesting techniques that mimic natural disturbance, as sources of biological resources, and as a benchmark for comparison to harvested stands over time to see if the same levels of productivity are maintained under harvesting regimes as under the influence of natural disturbances (Frelich et al. 2005a).

3.1.2. Methods

For old forest within timberland, area of stands of the appropriate ages were calculated from the 1990 and 2001 FIA, and then compared to the area predicted by the GEIS (see section 2.1.2 for details). Acreage of newly reserved (since the GEIS) old growth on MN DNR lands is presented here.

3.1.3. Findings

The area of old forest on timberlands increased from 1.2 to 1.3 million acres between 1990 and 2001, whereas the GEIS predicted 1.75 million acres of old forest for 2000 (Table 3.1). Significant overprediction of old forest area by the GEIS occurred for jack pine, balsam fir, white spruce, oak hickory, elm-ash-cottonwood, maple basswood, aspen, and paper birch. The majority of the 500,000 acre difference is accounted for by balsam fir, paper birch, and aspen, and can be explained by three factors:

1. The GEIS growth model allowed stands to continue growing older when in reality many such stands would break up or succeed to other forest types. Although maple-basswood and white pine forests may very well continue to grow older, aspen and paper birch would break up and succeed to other forest types.
2. Balsam fir stands are likely be infested with spruce budworm prior to reaching older ages, and usually younger fir trees replace the older ones that die, hence the overprediction for area of old fir forest.

3. Two major blowdowns occurred (July of 1995 and 1999) that affected several hundred thousand acres of forest, especially aspen and paper birch in north central and northeastern Minnesota. Although the main damage swath from the 1999 storm was in the BWCAW, widespread damage also occurred throughout timberlands on Chippewa and Superior National Forests.

Table 3.1. Acreage of old forest on timberland, the 1990 FIA, 2001 FIA, and predicted for 2000 by the GEIS. Old is defined as >120 years for forest types dominated by long-lived tree species, >90 years for white spruce, and >70 years for forest types dominated by short-lived tree species.

Forest type (age)	**1990 FIA**	**2001 FIA**	**2000 GEIS**
Jack pine (>70)	51,200	50,457	85,471
Red pine (>120)	3,500	235	5,252
White pine (>120)	8,700	6,752	18,574
Black spruce (>120)	53,400	64,385	56,613
Balsam fir (>120)	2,600	4,211	51,243
White cedar (>120)	168,400	142,007	66,082
Tamarack (>120)	49,000	79,337	61,964
White spruce (>90)	5,200	1,357	22,841
Oak-hickory (>120)	51,400	16,416	58,499
Elm-ash-cottonwood (>120)	37,300	33,837	96,673
Maple-basswood (>120)	31,500	19,958	48,618
Aspen (>70)	465,700	423,850	687,426
Paper birch (>70)	202,700	310,413	455,883
Balsam poplar (>70)	48,800	67,986	32,408
Total	**1,179,400**	**1,221,201**	**1,747,547**

The GEIS growth model could have done a better job of capturing the routine transitional dynamics of aging forests of short-lived species such as aspen, paper birch, and balsam fir, but there is no way that rare large events such as the 1995 and 1999 storms could have been incorporated in the GEIS predictions.

Area of old white cedar, tamarack, and balsam poplar forest were underpredicted compared to the 2001 FIA, with the majority of the underprediction being in white cedar. Less harvesting of these species occurred than was predicted over the last 10 years and these forest types were less impacted by blowdowns than other upland forest types.

Although any harvest of old growth was deemed a significant impact in the GEIS, and one of the GEIS mitigations was to undertake a survey of all old growth on all ownerships, the final predictions of the GEIS models simply assumed that 50,000 acres of old growth would be found and reserved, and, therefore, did not project any specific impacts on old growth. Since the GEIS, the MN DNR has inventoried, identified, and designated for protection 44,800 acres of old growth and potential future old growth on state-administered lands. This designation includes 21,250 acres previously reserved in state parks, SNAs, and forestry lands within the BWCAW, and 23,550 acres of MN DNR timberlands.

3.2 Biodiversity

3.2.1 Introduction

Forest-dependent threatened and endangered species, rare plant communities, and invasive species were identified as forest management issues in the GEIS Biodiversity Technical Paper and the final GEIS. Due to lack of detailed data, projections of harvesting impact on these resources were not attempted. However, there are some updates for plant community classification and impacts from invasive species presented here. Regarding threatened and endangered species, there is an updated list available at the following website: http://www.dnr.state.mn.us/ets/index.html. The MN DNR staff is working on a table of habitat requirements for these species. Synthesis of the literature was used for invasive species and deer grazing impacts. The key references are cited here.

3.2.2 Findings

3.2.2.1 Invasive species and deer grazing

Invasive species, diseases, and pests have become a major issue for maintenance of biodiversity and forest productivity. The GEIS failed to predict the degree to which invasive species are now disrupting native forest plant communities, including tree reproduction. Spotted knapweed (*Centaurea maculosa*) now invades summer clearcuts in northern Minnesota, making it difficult to establish tree regeneration in some cases. Garlic mustard (*Alliaria petiolata*), European honeysuckles (*Lonicera tartarica, L. morrowii, L. x bella*), Japanese barberry (*Berberis thunbergii*), and European buckthorn (*Rhamnus cathartica* and *Frangula alnus*), are spreading rapidly in the state and have recently begun to appear in forests around Duluth, which proves that they can tolerate the cold climate and that the limiting factor in the north has been seed dispersal (Frelich, personal observation). It is now apparent that these species will become major obstacles to the maintenance of biodiversity and forest management in Minnesota. Norway maple (*Acer platanoides*) and Amur maple (*Acer ginnala*) are additional potential invasive species in Minnesota forests.

European earthworms ([*Lumbricidae*], including the nightcrawler [*Lumbricus terrestris*], the leaf worm [*L. rubellus*]) and angleworms (*Apporectodea* ssp.) fundamentally alter forest ecosystems as they invade forests such as those in Minnesota that were previously earthworm free. Earthworms change the seedbed conditions by consuming the duff, changing the structure of the soil (increased bulk density, altered water flow), and by changing the nutrient cycling system of the forest. All of these changes can favor different suites of species than those that historically lived in Minnesota forests (Frelich et al. 2005b). European earthworms are having major negative impacts in some hardwood, aspen, and birch forests, and almost all of these forests types will be impacted to some extent over the next century.

Invasive insect pests and diseases have already affected Minnesota forests through Dutch elm disease, white pine blister rust, and Gypsy moth. Emerald ash borer (now in Upper Michigan) and sudden oak death (currently in California) have the potential to cause widespread loss of native forests in Minnesota should they reach the state. Hemlock wooley adelgid may someday reach Minnesota and will not cause disruption of forest management like the other invasive species mentioned, but it could still cause the loss of eastern hemlock, a state-listed species of special concern with only a few groves of the tree known in the state.

The GEIS failed to predict the degree to which deer grazing became a significant negative factor in the maintenance of biodiversity and forest productivity. There is now a widespread consensus that high deer populations are causing damage to tree regeneration and causing extirpation of native plants over large landscapes (Cotè et al. 2004).

Invasive species and deer grazing likely have much more impact on biodiversity than harvesting. The impact of harvesting on biodiversity is indirect through change in forest type and age distribution, which feeds back in terms of the habitat availability for various forest-dependent species, facilitation of invasives in disturbed areas, and deer population. European earthworms and deer grazing, however, directly and fundamentally alter the forest. The GEIS did not anticipate these major alterations of Minnesota forest ecosystems.

3.2.2.2. Rare plant communities

Rare plant communities serve similar roles as old growth discussed above, especially as a reservoir of rare species and biological resources. Therefore, the GEIS identified rare communities as an issue, since forest managers are the most likely people to encounter previously unknown examples of rare forest communities. TNC reserves, USDA Forest Service Research Natural Areas, and State Scientific and Natural Areas can fulfill much of the role of maintenance of natural communities. Nevertheless, timber harvesting is compatible with some rare communities, and it is important for forest managers to be aware of rare plant communities that may occur in their area and to be able to identify them.

Since the GEIS was written, the MN DNR has developed a new classification system for plant communities based on scientific principles of ecosystem classification, and objective statistical analyses of a broad new data set collected under several programs: Minnesota County Biological Survey, Division of Forestry Ecological Land Classification Program, and Natural Heritage and Nongame Research Program (MN DNR 2003). This comprehensive new classification has rankings for rarity of each community and those forest communities identified as critically imperiled or imperiled are shown in Table 3.2. Unfortunately, the new classification system precludes a direct comparison with the GEIS plant community list.

Table 3.2. Critically imperiled (1) and imperiled forest and savanna plant communities in Minnesota. State rank 1=critically imperiled, and 2=imperiled.

Type Code	Subtype Code	Type Name	Subtype Name	State Rank
FDc12a		Jack Pine - (Bearberry) Woodland		2
FDc23a	*FDc23a1*	Jack Pine - (Yarrow) Woodland	*Ericaceous Shrub Subtype*	2
FDc23a	*FDc23a2*	Jack Pine - (Yarrow) Woodland	*Bur Oak - Aspen Subtype*	2
FDc25a		Jack Pine - Oak Woodland		2
FDc25b		Oak - Aspen Woodland		2
FDc34a		Red Pine - White Pine Forest		2
FDn12a		Jack Pine Woodland (Sand)		2
FDn12b		Red Pine Woodland (Sand)		2
FDn22d		Red Pine - White Pine Woodland (East Central Bedrock)		2
FDn32b		Red Pine - White Pine Woodland (Minnesota Point)		1
FDn32c	*FDn32c1*	Black Spruce - Jack Pine Woodland	*Jack Pine - Balsam Fir Subtype*	2
FDn32d		Jack Pine - Black Spruce Woodland (Sand)		2
FDn32e		Spruce - Fir Woodland (North Shore)		1
FDn33c		Black Spruce Woodland		2
FDn43a		White Pine - Red Pine Forest		2
FDs27a		Jack Pine - Oak Woodland (Sand)		1
FDs27b		White Pine - Oak Woodland (Sand)		1
FDs27c		Black Oak - White Oak Woodland (Sand)		2
FDs38b		Oak - Shagbark Hickory Woodland		2
FDw24a		Bur Oak - (Prairie Herb) Woodland		2
FFs59b		Swamp White Oak Terrace Forest		1
FFs59c		Elm - Ash - Basswood Terrace Forest		2
MHc38a		White Pine - Sugar Maple - Basswood Forest (Cold Slope)		1
MHn44b		White Pine - White Spruce - Paper Birch Forest		2
MHn45b		White Cedar - Yellow Birch Forest		2
MHs38a		White Pine - Oak - Sugar Maple Forest		2
MHs38c		Red Oak – Sugar Maple - Basswood - (Bitternut Hickory) Forest		2
MHs39b		Sugar Maple - Basswood - Red Oak - (Blue Beech) Forest		2
MHs49b		Elm - Basswood - Black Ash - (Blue Beech) Forest		2
MHw36a		Green Ash - Bur Oak - Elm Forest		2
WFs57a		Black Ash - (Red Maple) Seepage Swamp		2
WFs57b		Black Ash - Sugar Maple - Basswood - (Blue Beech) Seepage Swamp		2
UPn13a		Dry Barrens Jack Pine Savanna (Northern)		1
UPn13b		Dry Barrens Oak Savanna (Northern)		2
UPn13c		Dry Sand - Gravel Oak Savanna (Northern)		1
UPn13d		Dry Hill Oak Savanna (Northern)		1
UPn24a		Mesic Oak Savanna (Northern)		1
UPs14a	*UPs14a1*	Dry Barrens Oak Savanna (Southern)	*Jack Pine Subtype*	1
UPs14a	*UPs14a2*	Dry Barrens Oak Savanna (Southern)	*Oak Subtype*	2
UPs14b		Dry Sand - Gravel Oak Savanna (Southern)		2
UPs14c		Dry Hill Oak Savanna (Southern)		1
UPs24a		Mesic Oak Savanna (Southern)		1

4. GEIS Mitigation Assessment

4.1. Site-level Guidelines

4.1.1. Introduction

This section of the report describes the degree to which the mitigation strategies recommended in the Timber Harvesting GEIS (GEIS) have been implemented since the study was completed a decade ago. The focus of this assessment is on the GEIS's "strategic program recommendations," namely the development of a forest resource practice program to address site-level mitigation needs, a sustainable forest resources program to address landscape-level impacts, and a forest resources research program to address research and related information needs. To the degree site-specific mitigation practices were recommended in the GEIS (e.g., methods for the disposal/redistribution of slash and other woody biomass), an evaluation of the application of these practices was included in the assessment.

4.1.2. Methods

Two surveys were developed to obtain the information needed to address the study's objectives relative to the implementation of the GEIS strategic program recommendations (copies of the surveys are included in the appendices). Landowners with the largest amount of land, and thus the largest impact on change, were selected to respond to the survey in order to provide an accurate picture of change in forestry practices in the state of Minnesota. One survey was sent to the state's largest forest landowners, consisting of 14 county land commissioners in the state's forested region, the supervisors of the state's two national forests, the Minnesota Department of Natural Resources (MN DNR), eight corporate forest owners, and eight tribal governments. The survey was designed to gather information about the organization's knowledge, use, and understanding of the guidelines. Respondents were also asked to indicate their organization's use of and staff training on specific practices recommended in the guidelines and how these practices have changed over the past decade. In addition, the survey addressed the landscape-level initiatives by requesting information on the organization's participation with the Minnesota Forest Resource Council's (MFRC) regional meetings and their perception of the overall usefulness and influence of the MFRC landscape planning and coordination program on the organization's forest land management activities. Table 4.1 indicates the number of respondents and the corresponding acreage managed by the organizations that responded. It should be noted that these acres represent timberland not forest land, as defined by the USDA Forest Service.

While nonindustrial private forest (NIPF) landowners are a substantial segment of forest landownership in the state, they were not surveyed. Surveying a representative sample from the roughly 150,000 NIPF landowners was outside the scope of this study. Further, landowner groups or associations were not surveyed as no single organization can represent the diverse attitudes and actions of these landowners with respect to the application of guidelines or landscape-level planning and coordination activities.

The second survey was sent to the MFRC to gather information about its site-level, landscape-level, and research initiatives. The MFRC was asked to identify how the GEIS recommendations were specifically addressed by responding to questions clarifying the framework, process, and

overall strategy for implementing the recommendations. Finally, the MFRC was asked to comment on the coordination of research initiatives.

Both surveys were mailed in early February, with follow-up calls to organizations that had not returned their surveys during the second week of March. One corporate landowner and one county land commissioner sent letters stating that no significant timber harvesting is occurring on their land making the survey not applicable. In addition to the completed MFRC survey, 24 surveys from forest land management organizations were returned (Table 4.1). The returned surveys represent 100% of the public and corporate private forest landowners surveyed (seven private companies and 16 public organizations). In addition, a completed survey was received from one tribal council. All returned surveys were deemed usable for the study. The results of the study are self-reported and thus represent the perceptions of the organizations surveyed. No physical or biological surveys were done to verify the information.

Table 4.1. Number of survey respondents and corresponding timberland acreage.

	Number of respondents	**Timberland acreage represented by respondents**
Private	8	928,875
Public	16	8,733,757
Total	24	9,662,632

Other sources of information consulted in the development of this assessment included the Minnesota Sustainable Forest Resources Act (MS § 89A), MN DNR, and MFRC reports and related documents, and reports describing the results of state guideline implementation monitoring efforts.

4.1.3. Findings

4.1.3.1. Site-level Timber Harvesting and Forest Management Practices

GEIS Recommendations

To help mitigate the site-specific environmental impacts associated with timber harvesting and forest management practices and promote the health of Minnesota's forests, the GEIS recommended the development of a Forest Resources Practice Program. The goal of this program was to "adopt a comprehensive forest resources practices program that advances acceptable practices for maintaining and enhancing these values" (Jaakko Pöyry Consulting, Inc., 1994). To do so, the GEIS identified the following six components deemed crucial to the implementation of site-level policies.

- Incorporate all site-level mitigation strategies recommended in the final GEIS.
- Apply statewide to all ownerships to the extent legally and practically possible.
- Ensure that the issue of cost effectiveness is given key consideration.
- Consider the need to maintain the integrity of private property ownership rights
- Inform all property owners of their statewide responsibilities for resource protection.
- Provide for ongoing research and special interest groups' input and, as appropriate, develop processes for subsequent clarification and/ or modification of these practice standards (Jaakko Pöyry Consulting, Inc., 1994).

Sustainable Forest Resources Act Provisions

The GEIS provided considerable technical analysis and perspective on the ecological impacts associated with timber harvesting. To develop further details on the implementation of the major recommendations contained in the GEIS, a roundtable of state forest resource interests was convened. The recommendations of the roundtable for implementing the site-level and landscape-based recommendations contained in the GEIS became the basis for the implementation actions specified in the Minnesota Sustainable Forest Resources Act (SFRA) (MN § 89A) which was enacted in 1995 (Minnesota Statutes 2004).

The SFRA articulated the following four main goals for the sustainable management and use of Minnesota's resources.

1. Pursue the sustainable management, use, and protection of the state's forest resources to achieve the state's economic, environmental, and social goals.
2. Encourage cooperation and collaboration between public and private sectors in the management of the state's forest resources.
3. Recognize and consider forest resource issues, concerns, and impacts at the site and landscape levels.
4. Recognize the broad array of perspectives regarding the management, use, and protection of the state's forest resources, and establish processes and mechanisms that seek and incorporate these perspectives in the planning and management of the state's forest resources (Minnesota Statutes 2004).

The SFRA established and defined the institution responsible for coordinating implementation of the GEIS recommendations: the MFRC. The act encouraged the council to form partnerships with appropriate stakeholders whenever possible.

The SFRA (89A.05) directed the MFRC to coordinate the development of comprehensive timber harvesting and forest management site-level guidelines. The guidelines were to be presented in a format that could be easily understood and implemented by public and private forest landowners. The act specified deadlines and timelines for their initial development as well as subsequent revisions. As part of the guideline development process, the SFRA mandated that an economic impact study be completed prior to the implementation of the guidelines. It also required the MFRC to establish goals for guideline implementation, and specified the development of programs to monitor the use and effectiveness of guidelines.

MFRC Process to Develop Site-level Guidelines

The MFRC was given the broad goals listed above in the SFRA and was charged with creating specific guidelines for on-the-ground practices. The MFRC-led process was initiated by the formation of four teams of stakeholder groups to address the issues for which guidelines were to be developed: riparian zone management, forest soils, wildlife habitat, and historical and cultural resources. Once developed, each team's guidelines were integrated with existing water quality and visual management guidelines. Concurrently, the MFRC conducted an economic evaluation of the guidelines. The guidelines were adopted by the MFRC in 1998.

Substance of Site-level Guidelines

The following section is information provided by the MFRC describing the extent to which the guidelines address the specific strategies recommended in the GEIS for mitigating adverse timber harvesting and forest management impacts.

Timber sale design and layout to incorporate nontimber concerns

A critical component of timber harvesting explicitly addressed within the timber harvesting and forest management site-level guidelines is the recommendation to protect nontimber forest values during timber sale design and layout. The site-level guidelines (the guidelines) specifically recommend:

- Reviewing the appropriate information with which to make informed decisions that protect the resources (e.g., aerial photographs, topographic maps, soil surveys, visual quality sensitivity maps).
- Consulting the appropriate organizations and inventories to determine if known cultural resources are present on the proposed management area.
- Determining the visual sensitivity of the proposed harvest area.
- Checking existing databases and consulting with the appropriate DNR staff to determine if endangered, threatened, and species of special concern are present on or near the harvest area.
- Obtaining the appropriate water crossing permits as needed.
- Conducting on-the-ground site evaluations to identify the resources and special features that require special attention.
- Establishing the appropriate riparian management zones (RMZ) based on the type and size of waterbody and the long-term objectives for management.
- Specifying harvesting restrictions that provide for post-harvest wildlife habitat needs.
- Communicating with the logger/contractor to ensure common understanding of resource protection requirements.

Managing slash and other woody debris

Recommendations for the management of slash and other woody debris are explicitly addressed in the guidelines. These guidelines recognize that slash and other woody debris are important components of the nutrient cycling process and, as such, need to be retained on the site to a practicable extent. There is also recognition in the guidelines that inappropriately placed slash and other woody debris can cause impairments to waterbodies and wetlands. Specific recommendations include:

- Favoring practices that encourage dispersal of the slash over the site rather than piling, and using practices to disperse the slash that minimizes soil disturbance.
- How to manage slash in a manner that reduces the visual impacts to the public.
- Avoiding placement of slash in streams, lakes, and open water wetlands.

Establishing and managing riparian corridors

The most detailed guideline recommendations are for the management of riparian forests and the establishment of RMZ. The guidelines specify the types of waterbodies for which RMZ are recommended (i.e., perennial streams, lakes, open water wetlands, intermittent streams ≥3 feet

wide, and intermittent streams <3 feet wide that are tributaries to trout waterbodies). Timber harvesting is permissible within the RMZ but the intrusion of harvesting equipment is reduced or minimized. RMZ are defined based on waterbody type and size, on the management objective (i.e., even-aged vs. uneven-aged), and whether it is a trout waterbody. Within the established RMZ, guidelines provide recommendations ensuring that management will be conducted in a manner that minimizes adverse impacts to resource functions and values. These guidelines include recommendations on:

- Amounts of residual basal area and its distribution within the RMZ.
- Managing for longer-lived, uneven-aged, mixed species stands.
- Retaining the intact forest floor to prevent erosion and sedimentation of waterbodies and to maintain the infiltration capacity of the soil.
- Restricting the placement of site infrastructure within the RMZ to reduce soil disturbance.
- Restricting the placement of fueling and maintenance areas within the RMZ.
- Retention of super canopy trees within the RMZ.
- Retention of coarse woody debris to provide wildlife habitat in the riparian corridor.
- Protection of cultural resources within the RMZ.

Defining best management practices (BMPs) for water quality

As part of the process of developing comprehensive guidelines, the water quality and wetlands best management practices, adopted in 1995 with the support and approval of the Minnesota Pollution Control Organization, were incorporated into the MFRC's timber harvesting and forest management guidebook. These guidelines were developed specifically to protect water quality and wetland hydrology and include:

- Establishing filter strips that border and parallel the edge of perennial streams, intermittent streams, lakes, open-water wetlands, seasonal ponds, seeps, and springs. Filter strips vary in width based on percent slope. The minimum width is 50 feet and increases to a maximum recommended width of 150 feet. Filter strips protect surface water by providing a zone of infiltration to remove pollutants and trap sediments. They work when the integrity of the forest floor remains relatively undisturbed (i.e., < 5 soil exposure well distributed over the filter strip).
- Minimizing the percentage of the harvest site in infrastructure (i.e., skid trails, roads, and landings) responsible for the majority of sediment generated during and following forest management activities. The recommendation is to keep the percentage of primary infrastructure (i.e., roads, landings) to less than 3% of the harvest area.
- Minimizing the number of approaches to and crossings of waterbodies and installing and maintaining appropriate water diversion structures on the approaches to prevent or minimize sediment flows.
- Recommendations on a variety of techniques for selecting and installing appropriate water diversion structures (e.g., water bars, broad-based dips, scattered slash) to control the volume, velocity, and direction of surface water flows.
- Avoiding disturbances such as ruts, soil compaction, and addition of fill that can interrupt and redirect hydrologic flows through wetlands.

- Rehabilitation of landings and skid trails following harvest and proper sale closure to mitigate soil compaction and rutting and prevent erosion and sedimentation to waterbodies.
- Restrictions on the use of soil mobile pesticides in the RMZ and filter strips.

Retaining biomass in harvested sites

The timber harvesting and forest management guidelines provide specific recommendations on the retention of leave trees, snags, and coarse woody debris to provide adequate wildlife habitat benefits on even-aged management sites. These guidelines specify:

- Species, conditions, numbers, and sizes of leave trees favored for retention for wildlife benefits.
- Options for the distribution of the leave trees on the harvest site (i.e., scattered, clumped).
- Need to retain appropriate mast species (e.g., oak) on or adjacent to the harvest site.
- Retention of all snags possible.
- Creating or retaining large down logs or coarse woody debris in the general harvest area and RMZ. Recommendations are provided on the species, conditions, numbers, and sizes of down logs.

Defining postharvest reforestation practices

The timber harvesting and forest management guidebook contains a specific chapter of guideline recommendations on reforestation. The recommendations to protect resource functions and values identified for timber harvesting and roads are applicable to reforestation except where modified to accomplish reforestation objectives. These guidelines specify:

- Need to select a suitable species for the site.
- Need to promote a mixture of species to maintain or improve visual quality.
- Favor longer-lived species where appropriate

Constructing roads for timber harvesting and forest management

The guidelines provide sound and practical recommendations on designing, planning, constructing, maintaining, and closing roads so that resource functions and values are protected while providing access for conducting forest management activities. These guidelines discuss:

- Limiting the area disturbed by roads to no more than 1-2% of the management area.
- Adequately planning access to the site to minimize the area exposed.
- Techniques for constructing and maintaining winter access roads across wetlands.
- Proper installation and maintenance of water diversion devices and the types, sizes, and spacings for culverts.
- Proper road closure.
- Maintenance of road surfaces to prevent erosion and sedimentation.
- Differences between permanent and temporary roads, wetland and upland roads, and all-season and seasonal roads and protection strategies for each.
- Rutting, alignment, ditching, and other issues that impact efficient operations on the site.

Managing for visual and aesthetic objectives

The forestry community and the resort and tourism industry collaborated from 1992 to 1994 on the development of visual quality BMPs. A guidebook, *Visual Quality Best Management Practices for Forest Management in Minnesot*a, published in 1994, contained the guidelines to minimize specific impacts of forest management practices to visual quality. Following publication of these guidelines, county visual quality committees classified all roads, designated recreation trails, and lakes and rivers into one of three visual sensitivity classifications (i.e., most sensitive, moderately sensitive, less sensitive) and these classifications were published in county visual sensitivity classification maps. The visual quality guidelines were integrated as written and inserted as appropriate throughout the chapters of the timber harvesting and forest management guidebook. These guidelines recommend:

- Timing activities to reduce noise and visibility during peak recreational use depending on visual sensitivity classification.
- Limiting apparent harvest size dependent on visual sensitivity classification using such techniques as creating narrow openings into the harvest area from viewscapes, utilizing natural terrain to limit views of harvest area, and adjust contiguous linear feet of harvest frontage along travel routes relative to travel speed.
- Restricting visibility of landings within travel routes dependent on visual sensitivity classification.
- Limiting the visibility of slash piles dependent on visual sensitivity classification.

Protecting unique historic and cultural resources

Cultural resource guidelines were developed to increase awareness of cultural resources and to provide the recommendations to landowners, loggers, and resource managers that protect cultural resources during forest management activities. These guidelines include:

- Emphasizing the need to check inventories to identify potential cultural resources on or near the harvest site.
- Communicating to loggers and resource managers protection strategies to employ during harvesting.
- Avoiding forest management activities within the cultural resource area when practical and feasible.
- Prohibiting location of landings, roads, and skid trails in cultural resource areas.
- Delineating cultural resource areas with flagging or other appropriate methods.
- Reducing soil disturbance within a cultural resource area.

Minimizing soil compaction

Forest soil productivity guidelines were developed to minimize the amount of soil disturbance (e.g., compaction, rutting, and puddling) that occurs during forest management activities. To ensure that soil compaction is minimized, the guideline recommendations include:

- Limiting the percentage of the harvest area in roads and landings.
- Limiting the area in skid trails.
- Restricting the extent of rutting in uplands and within wetlands on roads, skid trails, landings, and the general harvest area.
- Utilizing techniques to mitigate compaction on roads and skid trails (e.g., grading, ripping, disking).
- Stabilizing bare soil areas from surface erosion and ensuring that soil erosion measures are properly maintained and functioning.
- Restricting operations on steep slopes.
- Using slash on skid trails to reduce compaction.

1.1.3.2. Guideline Implementation: Public and Corporate Private Forest Landowners

The extent to which the guidelines are applied by the state's various forest management organizations were measured in two different methods: the organization's commitment to implementing the guidelines, and the organization's use of specific forest management and timber harvesting practices. Together, the data indicates the organization's demonstrated interest in implementing the guidelines as well as how guideline use has changed timber harvesting and forest management activities.

Overall Adoption, Understanding, and Use of Guidelines

The following section describes the adoption, understanding, and use of the guidelines as reported by the organizations who manage much of Minnesota's forests. This information provides an important perspective as to how these organizations perceive the guidelines, their intent to use them, and how they believe guidelines have impacted their timber harvesting and forest management practices. The general statements in this section regarding organizational commitment to the guidelines are detailed on a practice-by-practice basis later in the report.

Organization Commitment to Guidelines

Ninety-six percent of the responding organizations, representing 97% of the forest land area surveyed, stated they require the application of the guidelines in conducting timber harvesting and forest management activities on their land (Table 4.2). The application of guidelines is high among both public and private forest land management organizations, with 97% and 100% of the forest land area, respectively, managed by organizations that adopted the guidelines. Only one public organization, representing approximately 300,000 acres, indicated that guidelines are not required on their lands.

Seventeen of the 26 responding organizations representing more than 9.2 million acres (98% of the forest land area surveyed) indicated their organization has adopted a formal policy incorporating the guidelines (Table 4.2). The adoption of guidelines by a formal policy is slightly

more prevalent with public organizations than private organizations, with more than three-fourths of all responding public organizations representing 98% of surveyed public forest land. In contrast, only five of the eight private organizations (representing 92% of its land area) indicated adoption of guidelines by formal policy.

Table 4.2. Organizations, and associated acreage, that require the application of guidelines in conducting timber harvest and those with a formal policy regarding the use of guidelines.*

	Require the guidelines	**Adoption of a formal policy regarding the guidelines**
Private organizations		
Acres	923,875 (100)	853,875 (92)
Respondents	7 (100)	5 (63)
Public organizations		
Acres	8,433,390 (97)	8,372,316 (98)
Respondents	15 (94)	12 (80)
Total		
Acres	**9,357,265 (97)**	**9,226,191 (98)**
Respondents	**22 (96)**	**17 (74)**

* Numbers in parentheses represent corresponding percentages of total response.

Table 4.3 summarizes the various mechanisms by which organizations have formally incorporated the guidelines into their land management and planning activities. The most common methods are creating an official policy and incorporating them into their land management planning activities—six organizations indicated the use of each of these methods. Other methods include a governing board action (i.e., resolution) endorsing the use of guidelines by the organization, incorporating guidelines into an organization's timber sale contracts, agreements about future guideline application by the organization resulting from court settlements, use of guidelines as a requirement of forest land certification processes, and adoption of national policies at or above the practices called for in the guidelines.

Table 4.3. Methods by which organizations have formally adopted the guidelines.*

	Number of respondents
Incorporation into management plan	6
Official policy of organization	6
Governing board action	3
Incorporation into timber sale contract	1

*One respondent did not provide information on the methods of the adoption of their policy

Extent of guideline incorporation in timber sales. Organizations were asked about the extent to which guidelines are specifically referenced in their timber sale documents. Fifteen organizations (65% of all responding organizations representing 92% of the forest land) indicated that guidelines are currently referenced in all of the organization's timber sales (Table 4.4). When including all organizations that reference the guidelines in at least three-fourths of all timber sales, the total amount of forest land represented increases to almost 9.3 million acres or 96% of the forest land area surveyed. Only two organizations (representing 375,000 acres or 4% of all forest land surveyed) indicated guidelines are not specifically referenced in any timber sale documents. Both of these are public forest land management organizations.

Table 4.4. Extent to which organizations specifically reference the guidelines in their timber sales.*

	Timber sales which reference the guidelines (percentages)					
	All (100)	**Most** (99-75)	**Many** (74-50)	**Some** (49-25)	**Few** (24-1)	**None** (0)
Private organizations						
Acres	809,183 (88)	84,692(9)	30,000(3)	0	0	0
Respondents	4 (57)	2 (29)	1 (14)	0	0	0
Public organizations						
Acres	8,047,807 (92)	310,643 (4)	0	0	0	375,307 (4)
Respondents	11 (69)	3 (19)	0	0	0	2 (13)
Total						
Acres	**8,856,990 (92)**	**395,335 (4)**	**30,000 (<1)**	**0**	**0**	**375,307 (4)**
Respondents	**15 (65)**	**5 (22)**	**1 (4)**	**0**	**0**	**2 (9)**

* Numbers in parentheses represent corresponding percentages of total response.

Staff familiarity with guidelines. Another measure of an organization's commitment to the guidelines is the effort to ensure staff is adequately trained in the proper application of the guidelines. When asked about their staff's familiarity with and understanding of the guidelines, all felt their staff has at least moderate familiarity and understanding (Table 4.5). The majority of organizations characterized their staff's knowledge of the guidelines as considerable—59% of the organizations representing 82% of the forest land indicated so. Five organizations (representing 1.5 million acres) felt their staff have extensive knowledge of the guidelines. Of these organizations, a larger portion of private organizations (57% of responding organizations representing 57% of private forest land surveyed) perceived their staff to have extensive knowledge of the guidelines than do public organizations (only one public organization managing slightly less than 1 million acres).

Table 4.5. Overall familiarity and understanding of the guidelines by individuals within the organization that are responsible for their implementation.*

	Amount of knowledge				
	Extensive	**Considerable**	**Moderate**	**Minimal**	**None**
Private organizations					
Acres	524,183 (57)	359,692 (39)	40,000 (4)	0	0
Respondents	4 (57)	2 (29)	1 (14)	0	0
Public organizations					
Acres	960,573 (11)	7,275,935 (86)	196,882 (2)	0	0
Respondents	1 (7)	11 (73)	3 (20)	0	0
Total					
Acres	**1,484,756 (16)**	**7,635,627 (82)**	**236,882 (3)**	**0**	**0**
Respondents	**5 (23)**	**13 (59)**	**4 (18)**	**0**	**0**

* Numbers in parentheses represent corresponding percentages of total response.

Staff participation in guideline training. Sixty-three percent of organizations have sent all of their staff to formal guideline training sessions and 93% have sent many to nearly all of their staff to training (Table 4.6). The most common response by acreage was that most staff had attended formal guideline training sessions—four organizations accounting for 5.3 million acres (55%) responded in this manner. Only two organizations (collectively accounting for less than 400,000 acres of forest land) indicated few to none of their employees have attended guideline training. One organization indicated its response (many had attended guideline training) would have been higher but the organization recently hired additional staff that as of yet had no opportunity to

attend any training sessions. This data suggests Minnesota's forest land managers have a strong commitment to the guidelines as expressed by their interest in having employees attend guideline training programs. A significant number of staff trained in guideline use increases the likelihood that the guidelines will be correctly applied.

Table 4.6. The extent to which individuals responsible for implementing the guidelines, within organizations, have participated in formal guideline training.*

	Percentage of staff with formal training					
	All (100)	**Most (99-75)**	**Many (74-50)**	**Some (49-25)**	**Few (24-1)**	**None**
Private organizations						
Acres	506,183 (54)	338,000 (36)	44,692 (5)	0	0	40,000 (4)
Respondents	4 (50)	2 (25)	1 (13)	0	0	1 (13)
Public organizations						
Acres	2,267,608(26)	4,981,209 (57)	1,184,573 (14)	0	300,367 (3)	
Respondents	11 (69)	2 (13)	2 (13)	0	1 (6)	
Total						
Acres	**2,773,791 (29)**	**5,319,209 (55)**	**1,229,265 (13)**	**0**	**300,367 (3)**	**40,000 (<1)**
Respondents	**15 (63)**	**4 (17)**	**3 (13)**	**0**	**1 (4)**	**1 (4)**

* Numbers in parentheses represent corresponding percentages of total response.

Change in an Organization's Timber Harvesting and Forest Management Practices

Organizations were asked how timber harvesting and forest management activities on their land compare to those practices recommended in the guidelines at two points in time: 1994 (the year the GEIS was completed) and today. Organizations representing 71% of the forest land area indicated that, in 1994, their timber harvesting and forest management practices were consistent with or exceeded the practices recommended in the guidelines (Table 4.7). Organizations collectively managing just less than 2.8 million acres (29%) indicated their 1994 practices were often less than those recommended in the guidelines. No organization indicated its harvesting and management practices rarely or never met the standards suggested in the guidelines.

Table 4.7. Extent to which an organization's timber harvesting and forest management practices in 1994 were consistent with the guidelines.*

1994	**Extent to which practices were consistent with guidelines**				
	Always exceeded guidelines	**Often exceeded guidelines**	**Consistent with guidelines**	**Often less than guidelines**	**Rarely or never met guidelines**
Private organizations					
Acres	30,000 (3)	348,000 (39)	0	506,183(57)	0
Respondents	1 (17)	2 (33)	0	3 (50)	0
Public organizations					
Acres	300,367 (3)	2,941,782 (34)	3,243,298 (37)	2,248,310 (26)	0
Respondents**	1 (6)	2.33 (15)	6.33 (40)	6.33 (40)	0
Total					0
Acres	**330,367 (3)**	**3,289,782 (34)**	**3,243,298 (34)**	**2,754,493 (29)**	**0**
Respondents**	**2 (9)**	**4.33(20)**	**6.33 (29)**	**9.33(42)**	**0**

* Numbers in parentheses represent corresponding percentages of total response.

**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Today, all organizations indicate their practices are equal to or exceed those recommended in the guidelines (Table 4.8a). Slightly less than half of the acres surveyed are managed under timber harvesting and forest management practices that are consistent with the guidelines. Fifty-five percent of the organizations and 52% of forest land area are associated with practices that often exceed those recommended by the guidelines.

Table 4.8a. Extent to which an organization's current timber harvesting and forest management practices are consistent with the guidelines.*

2005	Extent to which practices are consistent with guidelines				
	Always exceed guidelines	**Often exceed guidelines**	**Consistent with guidelines**	**Often less than guidelines**	**Rarely or never meet guidelines**
Private organizations					
Acres	30,000 (3)	534,183 (60)	320,000 (36)	0	0
Respondents	1 (14)	4 (57)	2 (29)	0	0
Public organizations					
Acres	300,367 (3)	4,212,622 (48)	4,220,768 (48)	0	0
Respondents**	1 (6)	6.5 (41)	8.5 (53)	0	0
Total					
Acres	**330,367 (3)**	**4,746,805 (49)**	**4,540,768 (47)**	**0**	**0**
Respondents**	**2 (9)**	**10.5 (46)**	**10.5 (46)**	**0**	**0**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Contrasting the change in an organization's timber harvesting and forest management practices over the past decade is instructive. All of the organizations that characterized their practices as often being less than consistent with the guidelines in 1994 (2.75 million acres) are now characterized as either consistent with (4.5 million acres) or often exceed (5.1 million acres) the guidelines. For public forest land, this amounts to 1.3 million acres of additional forest land now managed using the guidelines, and 1.5 million acres managed with practices that regularly exceed the guidelines (Table 4.8b). For private forest land, an additional 320,000 acres are managed with practices consistent with the guidelines while an additional 186,183 acres are managed under practices that exceed the guidelines.

Table 4.8b. Change in timber harvesting and forest management practices relative to the guidelines: 1994 - present.*

	Always exceed guidelines	**Often exceed guidelines**	**Consistent with guidelines**	**Often less than guidelines**	**Rarely or never meet guidelines**
Private organizations					
Acres	0	186,183	320,000	-506,183	0
Respondents	0	2	2	-3	0
Public organizations					
Acres	0	1,270,840	977,470	-2,248,310	0
Respondents	0	4.17	2.17	-6.33	0
Total					
Acres	**0**	**1,457,023**	**1,297,470**	**-2,754,493**	**0**
Respondents	**0**	**6.17**	**4.17**	**-9.33**	**0**

*Numbers do not sum to zero because there are nonresponses in either the 1994 or 2005 data

Influence of Guidelines on Organization's Timber Harvesting and Forest Management Practices

In order to assess the causality of the changes in forestry practices, respondents were asked to characterize the extent of change in management practices that can be attributed to the guidelines. While a majority of organizations stated that some to considerable changes had been made as a result of the guidelines, all of the responding organizations stated that at least a few changes had been made (Table 4.9). Although no organization indicated the guidelines have resulted in extensive changes in timber harvesting and forest management practices, more than half of the acreage represented by survey respondents has been subject to considerable change in the manner in which timber harvesting and forest management practices are carried out. Approximately one-third of the forest area was subject to some change in forestry practices. When contrasting how guidelines have influenced the practices of private versus public organizations, changes in practices have been greater on public than private lands. For private lands, 37% of the area has been subject to considerable change in forestry practices and 60% experienced some change. In contrast, 54 and 31% of public forest land experienced considerable versus some change, respectively.

Table 4.9. The extent to which the guidelines have changed the way organizations conduct their timber harvesting and forest management activities.*

	Extensive changes	**Considerable changes**	**Some changes**	**Few changes**	**No changes**
Private organizations					
Acres	0	345,000 (37)	553,875 (60)	30,000 (3)	0
Respondents	0	2 (25)	5 (63)	1 (13)	0
Public organizations					
Acres	0	4,721,900 (54)	2,750,917 (31)	1,260,940 (14)	0
Respondents	0	3 (19)	11 (69)	2 (13)	0
Total					
Acres	0	**5,066,900 (52)**	**3,304,792 (34)**	**1,290,940 (13)**	0
Respondents	0	**5 (21)**	**16 (67)**	**3 (13)**	0

* Numbers in parentheses represent corresponding percentages of total response.

Future plans for modifying practices. Thirteen organizations responded to an open-ended question about future plans for modifying their timber harvesting and forest management policies and practices. Although individual responses varied considerably, they can be classified into three major directions (Table 4.10). Five organizations suggested their future direction would be influenced through ongoing periodic internal assessments of their policies and practices through a process of continual improvement. Four organizations indicated they are in the process of seeking third party certification of their forest lands, which will likely improve documentation of practice standards and their application across the forest lands they manage. An equal number stated they were in various stages of adopting new policies and/or plans that included modifications to their timber harvesting and forest management practices. Overall, more public organizations indicated plans for modifying their timber harvesting and forest management policies and practices than did the private forest managers.

Table 4.10. Number of organizations indicating type of future plans for modifying timber harvest and forest management policies and practices.

Types of organizations	Method of modification		
	Continual improvement	**Third party certification**	**New policies and/ or management plans**
Private organizations	3	0	0
Public organizations	2	4	4
Total	**5**	**4**	**4**

Site-specific Mitigation Strategies

Management of riparian zones

The proper management of riparian zones is critical to the ecological function and other values of riparian areas. RMZ provide critical habitat for both aquatic and terrestrial organisms. In addition, the quality of riparian habitat in upstream locations has a significant impact on downstream environmental conditions. The benefits of applying appropriate practices in harvesting areas adjacent to water include: increased water quality, decreased sediment, consistent water temperatures, increased habitat, lower peak water flows, and overall stream health (MFRC 1999b). The guidelines recommend leaving filter strips surrounding waterbodies in which the harvesting is less intensive, and minimizing the exposure of mineral soils. These practices have associated costs for organizations both in the time and money spent to assess and prescribe harvest treatments for the RMZ and in the economic loss of timber left behind.

Policy governing practice. Ninety-four percent of the acres surveyed (63% of responding organizations) are managed with an official policy regarding timber harvesting in a RMZ (Table 4.11a). Private land is more likely to be managed under a RMZ policy than public land, as 92% of the private forest land is managed by organizations with such a policy versus 84% for public organizations. However, private organizations are as likely as public organizations to have an official RMZ policy (both equal approximately 63%). When asked to describe the nature of their policy, five organizations described their policy as general statements regarding the management of riparian areas, while an equal number described their "policy" as a number of site-specific prescriptions. Four of those organizations cited the use of the MFRC guidebook. Organizations responded that the emphasis on standards which reflect site-specific conditions allows for flexibility in protecting sensitive areas.

Four point three million acres (45%) are managed with an RMZ policy that has changed since 1994 (Table 4.11a). Private acres are much more likely than public acres to be managed under a policy changed since 1994. Fifty percent of public organizations representing 40% of acres have had a policy change while 88% of private organizations representing 96% of acres have had a policy change. Further, on public lands, the smaller organizations are more likely to have had a policy change as demonstrated by the large percent of respondents versus the smaller percentage of acres (50% of the organizations represent 40% of the acres) while on the private lands larger organizations have seen a policy change (88% of the organizations representing 96% of acres).

In addition to an increase in the number of organizations whose policies are consistent with the guidelines, many respondents reported qualitative changes to their policy. Eleven respondents mentioned giving more sensitivity now to riparian zone management, three of which cited the

guidelines specifically. In addition, two respondents cited the main difference between their 1994 policy and current policy is that the latter was more formalized within the context of their organization's operation. To quote one respondent, "An official policy was established, although our on-the-ground practices protected riparian areas in 1994."

Table 4.11a. Existence and change in policy governing the management of riparian zones**.***

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	853,875 (92)	888,875 (96)
Respondents	5 (62)	7 (88)
Public organizations		
Acres	7,375,549 (84)	3,434,449 (40)
Respondents	10 (63)	8 (50)
Total		
Acres	**8,229,424 (85)**	**4,323,324 (45)**
Respondents	**15 (63)**	**15 (63)**

* Numbers in parentheses represent corresponding percentages of total response.

1994 practices. In 1994, the management within RMZs relative to the guidelines varied considerably among the state's forest land managers. A number of respondents, representing nearly half of the surveyed forest land, indicated their 1994 RMZ practices were consistent with the guidelines (Table 4.11b). In 1994, 42% of the organizations (29% of forest land) were applying RMZ practices that were often less protective than those currently recommended in the guidelines. In contrast, one-fifth of the forested land managed by organizations applied 1994 RMZ practices that often exceeded those recommended in the current guidelines, while 3% of this forest land was subject to RMZ practices that always exceeded the guidelines.

Table 4.11b. Comparison of organization's 1994 practices regarding the management of riparian zones to those practices recommended in the guidelines.*

1994	**Practices always exceeded guidelines**	**Practices often exceeded guidelines**	**Practices consistent with guidelines**	**Practices often less than guidelines**	**Practices rarely or never met guidelines**
Private organizations					
Acres	0	378,000 (43)	0	506,183 (57)	0
Respondents	0	3 (50)	0	3 (50)	0
Public organizations					
Acres	300,367 (3)	1,500,000 (17)	4,615,622 (53)	2,317,768 (27)	0
Respondents**	1 (6)	.33 (2)	8.33 (52)	6.33 (40)	0
Total					
Acres	**300,367 (3)**	**1,878,000 (20)**	**4,615,622 (48)**	**2,823,951 (29)**	**0**
Respondents**	**1 (5)**	**3.33 (15)**	**8.33 (38)**	**9.33 (42)**	**0**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Overall, public organizations were more likely to apply RMZ practices consistent with the current guidelines in 1994 than private organizations. Sixty percent of public respondents representing 73% of public acres said their practices were at least consistent with the guidelines while half of the responding private organizations (43% of the private forest land) were reported

to be at least consistent with the guidelines (Table 4.11b). The private organizations whose RMZ practices in 1994 were considered to be less than those recommended in the guidelines were generally larger organizations. While representing half of the private respondents, three organizations indicated their practices were often less than the guidelines which accounted for 57% of the forest land area. By contrast, 40% of the public respondents whose riparian management practices were less than consistent with the guidelines represented only 27% of the forested acres, suggesting that the smaller public organizations tended to have practices that were less restrictive than those recommended in the guidelines.

Current practices. Currently, all public and private organizations responding to the survey indicate their RMZ practices are at least consistent with the guidelines (Table 4.11c). Nearly six out of ten organizations (86% of forest land) reported the utilization of RMZ practices consistent with the guidelines. Just more than 1 million acres are managed by organizations who indicate their RMZ practices often exceed the guidelines, and one public organization managing more than 300,000 acres stated its riparian areas are managed using practices that always exceed those recommended in the guidelines. The differences between how RMZs are managed by public and private organizations is noteworthy. While 31% of the responding public organizations (9% of acreage) indicate that RMZs are managed in a manner that exceeds the guidelines (either often or always), two-thirds of the private organizations (accounting for 60% of private forests surveyed) apply practices that often exceed the RMZ practices recommended in the guidelines.

Table 4.11c. Comparison of organization's 2005 practices regarding the management of riparian zones to those practices recommended in the guidelines**.***

2005	Practices always exceed guidelines	Practices often exceed guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	534,183 (60)	359,692 (40)	0	0
Respondents	0	4 (66)	2 (33)	0	0
Public organizations					
Acres	300,367 (3)	518,982 (6)	7,914,408 (91)	0	0
Respondents	1 (6)	4 (25)	11 (69)	0	0
Total					
Acres	**300,367 (3)**	**1,053,165 (11)**	**8,274,100 (86)**	**0**	**0**
Respondents	**1 (5)**	**8 (36)**	**13 (59)**	**0**	**0**

* Numbers in parentheses represent corresponding percentages of total response**.**

Change in practices between 1994 and 2005. Change in riparian practices since 1994 among the organizations surveyed is indicated in Table 4.11d. The change has been toward stricter harvest practices in some cases and less strict harvest practices in others. More than 2.8 million acres of forest land managed using practices less than those recommended in the guidelines in 1994 are now subject to RMZ practices considered to be consistent with those suggested in the guidelines. Consequently, all surveyed organizations now indicate their riparian practices are at least minimally consistent with the guidelines. However, more than 800,000 acres managed under practices that often exceeded the guidelines in 1994 now are managed under practices consistent with the guidelines. This is a result of one large organization that characterized its 1994 riparian practices as a mixture of practices ranging from less than to exceeding the

practices recommended in the guidelines, while describing all of its current riparian zone management practices as consistent with the guidelines.

Table 4.11d. Change in management of riparian zones relative to the guidelines: 1994–2005**.***

	Practices always exceed guidelines	**Practices often exceed guidelines**	**Practices consistent with guidelines**	**Practices often less than guidelines**	**Practices rarely or never met guidelines**
Private organizations					
Acres	0	156,183	359,692	-506,183	0
Respondents	0	1	2	-3	0
Public organizations					
Acres	0	-981,018	3,298,786	-2,317,768	0
Respondents**	0	3.67	2.67	-6.33	0
Total					
Acres	**0**	**-824,835**	**3,658,478**	**-2,823,951**	**0**
Respondents**	**0**	**4.67**	**4.67**	**-9.33**	**0**

***** Numbers do not sum to zero due to nonresponses in either the 1994 or 2005 data.
Fractions indicate that at least one respondent indicated acreages in multiple categories.**

Summary of practices. Most organizations representing nearly all forested acres have a policy governing RMZ. Large organizations are more likely to have a policy than smaller ones, and public and private lands are about equally as likely to have such a policy. Since 1994, policies have changed in more private organizations than public organizations and large private organizations are more likely to have changed their policy than smaller public organizations. All organizations are now using RMZ practices that are at least consistent with the guidelines and private organizations are more likely to apply practices exceeding guideline recommendations.

Retention of snags and cavity trees

The guidelines recommend that any naturally occurring snags and cavity trees be left intact, as the retention of snags and cavity trees on a harvested site provides habitat for animals (MFRC 1999b). If none occur onsite naturally, the guidelines specify a number of downed logs or live trees to be left when the logging operations are completed. Leaving trees behind on a harvest site can be expensive for the harvesting agent. Since defective pieces of wood are common to harvests and have minimal economic value, it is recommended that hollow sections and defective trees be left behind as habitat. In addition, the guidelines recommend that a variety of tree species be left to provide homes for a diversity of animal species (MFRC 1999b).

Policy governing practice. Almost all the acres surveyed are managed under an official policy regarding the retention of snags and cavity trees (Table 4.12a). By acreage, public and private land is are equally as likely to be managed under an official policy regarding the retention of snags and cavity trees. However, public organizations are more likely to have such a policy than private organizations. Fifty percent of the private organizations and 67% of public organizations have adopted an official policy to retain snag and cavity trees, representing roughly 90% of the acreage.

Table 4.12a. Existence and change in policy governing the retention of snags and cavity trees.*

	Organizations with an official policy	Organizations with a change in policy since 1994
Private organizations		
Acres	809,183 (87)	888,875 (96)
Respondents	4 (50)	7 (88)
Public organizations		
Acres	7,978,182 (91)	7,879,656 (90)
Respondents	10 (67)	11 (69)
Total		
Acres	**8,787,365 (91)**	**8,768,531 (91)**
Respondents	**14 (61)**	**18 (75)**

* Numbers in parentheses represent corresponding percentages of total response.

When asked to describe their snag and cavity tree policy, eight organizations cited a specific policy that applies generally to all land, while three mentioned the assessment of site-specific needs to determine the appropriate practice. Three organizations specifically mentioned the adoption of the guidebook. When an organization does not have an official policy, it does not necessarily mean its practices do not meet the guideline recommendations. One organization without an official policy said, "It's implied in several places in our strategic plan but we do not have an official written policy specific to snags and cavity trees. Our policy is to retain whenever possible."

A majority of organizations have had a policy change since 1994 (75% of organizations representing 91% of acres) (Table 4.12a). Private organizations are more likely to have had a policy change than public organizations. Eighty-eight percent of private organizations have had a policy change while 69% of public organizations have had a policy change.

When asked to describe the nature of their change in snag and cavity tree policy, 12 respondents noted an increase in practice application or greater sensitivity to the retention of snags and cavity trees, three mentioned a more formal policy or the adoption of a policy, and one mentioned the guidelines specifically. One organization summed up their change in policy as "Before, rarely left. After, part of doing business."

1994 practices. In 1994, organizations representing 4 million acres of forest land applied practices for snags and cavity trees consistent with the current guidelines (Table 4.12b). Additionally, 3 million acres were managed using snag and cavity tree practices that exceeded the guidelines. Public organizations were more likely to have applied practices minimally consistent with the guidelines than private organizations. Sixty-six percent of public respondents (77% of public acres) reported being consistent with or exceeding the guidelines, while only 34% of private organizations (40% of private acres) were consistent with or exceeded the guidelines. Two and a half million acres (25%) were subject to practices not meeting the guidelines, roughly 2 million of which were managed by public organizations. Most organizations employing snag and cavity tree practices less stringent than the guideline recommendations managed small amounts of forest land.

Table 4.12b. Comparison of organization's 1994 practices regarding the retention of snags and cavity trees to those practices recommended in the guidelines.*

1994	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	308,000 (35)	40,000 (5)	186,183 (21)	350,000 (40)
Respondents	0	1 (17)	1 (17)	2 (33)	2 (33)
Public organizations					
Acres	300,367 (3)	2,460,573 (28)	4,023,810 (46)	1,875,965 (21)	73,042 (1)
Respondents**	1 (6)	1.33 (8)	8.33 (52)	4.33 (27)	1 (6)
Total					
Acres	**300,367 (3)**	**2,768,573 (29)**	**4,063,810 (42)**	**2,062,148 (21)**	**423,042 (4)**
Respondents**	**1 (5)**	**2.33 (11)**	**9.33 (42)**	**6.33 (29)**	**3 (14)**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Current practices. Today, nearly 100% of land is managed under practices that are at least consistent with the guideline recommendations (Table 4.12c). Only one private organization managing less than 50,000 acres of forest land indicated its snag and cavity tree practices are currently not meeting the guideline recommendations for such practices. Most organizations (representing 51% of the forest land) employ practices consistent with the guidelines. Private organizations are more likely to exceed guidelines. Forty-three percent of private organizations representing 53% of acres often or always exceed guidelines while 39% of public organizations representing 49% of acres often or always exceed guidelines.

Table 4.12c. Comparison of organization's 2005 practices regarding the retention of snags and cavity trees to those practices recommended in the guidelines.*

2005	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	494,183 (53)	385,000 (42)	44,692 (5)	0
Respondents	0	3 (43)	3 (43)	1 (14)	0
Public organizations					
Acres	300,367 (3)	3,913,722 (45)	4,519,668 (52)	0	0
Respondents**	1 (6)	4.5 (28)	10.5 (66)	0	0
Total					
Acres	**300,367 (3)**	**4,407,905 (46)**	**4,904,668 (51)**	**44,692 (<1)**	**0**
Respondents**	**1 (5)**	**7.5 (34)**	**12.5 (57)**	**1 (5)**	

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Change in practice. Snag and cavity tree practices have changed considerably among the organizations surveyed from 1994 to 2005 (Table 4.12d). While management on 2.5 million of the surveyed acres fell below guideline recommendations in 1994, all but roughly 45,000 acres (managed by one organization) are now at least minimally consistent with the guidelines. Of the private organizations surveyed, 500,000 fewer acres of forest land (52%) are managed using snag and cavity tree practices less than what is recommended in the guidelines. Public forest land

has also seen a change. Two million additional public acres (22% of timberland) managed in 1994 using practices less than the guidelines are now applying snag and cavity tree practices at least consistent with or exceeding the guidelines. Thus, while a larger percentage of public organizations were using practices consistent with the guideline recommendations in 1994, more private organizations have changed their practices over the past decade. In addition, 1.6 million more acres are managed with practices that often or always exceed the guidelines.

Table 4.12d. Change in the retention of snags and cavity trees relative to the guidelines: 1994–2005.*

	Practices always exceeded guidelines	**Practices often exceeded guidelines**	**Practices consistent with guidelines**	**Practices often less than guidelines**	**Practices rarely or never met guidelines**
Private organizations					
Acres	0	186,183	345,000	-141,491	-350,000
Respondents	0	2	2	-1	-2
Public organizations					
Acres	0	1,453,149	495,858	-1,875,965	-73,402
Respondents**	0	3.17	2.17	-4.33	-1
Total					
Acres	**0**	**1,639,332**	**840,858**	**-2,017,186**	**-423,402**
Respondents**	**0**	**5.17**	**4.17**	**-5.33**	**-3**

* Numbers do not sum to zero because there are nonresponses in either the 1994 or 2005 data.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Summary of practice. Public organizations are more likely to have a policy regarding the retention of snags and cavity trees while private organizations are more likely to have had a policy change since 1994. With the exception of 45,000 acres managed by one private organization, snag and cavity tree guidelines are currently being met or exceeded. While managers expressed an interest in leaving snags and cavity trees, worker safety is an important concern determining site-specific snag and cavity tree practices. This sentiment is expressed well by one respondent who noted, "Previous to 1998, most snags were knocked down. Between 1998 and October 2001, most snags were left for roosting or den trees, unless safety dictated their removal."

Retention of Leave (Live) Trees

The retention of leave trees is important to the vertical structure of the surrounding habitat. Birds and animals that nest in trees need the height to provide for their basic needs such as cover, perching, and food. Vertical structure also provides corridors for migrating and foraging animals. The guidelines recommend leaving small clumps of live trees scattered across the harvest area. It is recommended that the trees remaining on-site be composed of a variety of species to maintain a diversity of habitat (MFRC 1999b).

Policy governing practice. Ninety-three percent of surveyed acres are managed with an official policy for the retention of leave trees (Table 4.13a). A higher percentage of public organizations have official policies regarding leave trees than do private organizations (69% versus 50%). Organizations managing large forest areas (both public and private) are more likely to have official policies governing this practice, given that the 63% of organizations with a policy manage 93% of the acreage surveyed.

When asked to describe their policy, all 15 organizations that responded to the survey cited a specific policy that applies to all their acres. One respondent stated, "Department policy is to leave live trees with qualities favorable to long-term retention and value to wildlife not to exceed 20 BA/Acre." Of the respondents, three specifically referenced the adoption of the guidebook.

Less than half the surveyed acreage is managed under a leave tree retention policy that has changed since 1994 (Table 4.13a). Large private organizations and small public organizations are the most likely to have changed. Seventy-five percent of private organizations (representing 92% of private acres) have had a change in policy since 1994 in contrast to the 50% of public organizations (36% of acres) that have changed their policy. When asked to describe the change in policy, seven organizations cited the adoption of more stringent practices and four mentioned the adoption of an official policy. Two of the respondents that cited an adoption of an official policy referenced the adoption of the guidelines while the other two stated that the main difference between 1994 and 2005 is that they now have a policy.

Table 4.13a. Existence and change in policy governing the retention of leave trees.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	809,183 (87)	858,875 (92)
Respondents	4 (50)	6 (75)
Public organizations		
Acres	8,180,449 (94)	3,179,449 (36)
Respondents	11 (69)	8 (50)
Total		
Acres	**8,989,632 (93)**	**4,038,324 (42)**
Respondents	**15 (63)**	**14 (58)**

* Numbers in parentheses represent corresponding percentages of total response.

1994 practices. More than half of the surveyed acres were managed under practices consistent with the guidelines in 1994 (Table 4.13b). Public land was more likely to be managed under practices consistent with the guidelines than private land as 53% of public acres and 39% of private acres were consistent with the guidelines in 1994. Public land was also more likely to exceed the guideline recommendations than private land. A quarter of public acres often or always exceeded the guidelines while only 3% of private acres often or always exceeded the guidelines. Together, more than 7 million acres (74%) of the surveyed acreage reported having applied leave tree practices that equaled or exceeded those recommended in the guidelines. The 1994 practices on the remaining 2.5 million acres (25%) were reported to be below those recommended in the guidelines.

Current practices. With the exception of 22,000 acres (managed by one private organization and accounting for less than 1% of all surveyed acres), all organizations report using leave tree retention policies at least consistent with the guidelines (Table 4.13c). Sixty-one percent of public land is managed by practices consistent with the guidelines, while 7% of the private land is reported to be managed in accordance with leave tree guidelines. The practices of private organizations are more likely to exceed the guidelines—91% of private land is managed with practices that often or always exceed the guidelines while 39% of public land often or always exceeds the guidelines.

Table 4.13b. Comparison of organization's 1994 practices regarding the retention of leave trees to those practices recommended in the guidelines.*

1994	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	30,000 (3)		348,000 (39)	156,183 (18)	350,000 (40)
Respondents	1 (17)		2 (33)	1 (17)	2 (33)
Public organizations					
Acres	300,367 (3)	1,798,940 (21)	4,662,283 (53)	1,899,125 (22)	73,042 (1)
Respondents**	1 (6)	2.33 (15)	8.33 (52)	3.33 (21)	1 (6)
Total					
Acres	**330,367 (3)**	**1,798,940 (19)**	**5,010,283 (52)**	**2,055,308 (21)**	**423,042 (4)**
Respondents**	**2 (9)**	**2.33 (11)**	**10.33 (47)**	**4.33 (20)**	**3 (14)**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Table 4.13c. Comparison of organization's 2005 practices regarding the retention of leave trees to those practices recommended in the guidelines.*

2005	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	30,000 (3)	809,183 (88)	62,346 (7)	22,346 (2)	0
Respondents**	1 (14)	4 (57)	1.5 (21)	0.5 (7)	0
Public organizations					
Acres	2,550,367 (29)	883,416 (10)	5,299,974 (61)	0	0
Respondents**	1.5 (9)	4 (25)	10.5 (66)	0	0
Total					
Acres	**2,580,367 (27)**	**1,692,599 (18)**	**5,362,320 (56)**	**22,346 (<1)**	**0**
Respondents**	**2.5 (11)**	**8 (35)**	**12 (52)**	**0.5 (2)**	**0**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Change in practices. The most significant change in leave tree practices since 1994 has been with organizations that a decade ago indicated their practices were less restrictive than those recommended in the guidelines (Table 4.13d). Today 2.5 million more acres are managed at or above the guideline standards than were managed in 1994. Further, an additional 2.25 million acres of forest land are reported to be subject to leave tree practices that always retain more leave trees than is recommended by the guidelines. Despite the indication in Table 4.13d that 915,524 fewer public acres are managed under practices that often exceeded the guidelines, all of the changes have been toward more environmentally protective practices. These acres are now managed under practices that always exceed guidelines.

Table 4.13d. Change in leave tree retention practices relative to the guidelines: 1994–2005.*

	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	809,183	-285,654	-133,837	-350,000
Respondents**	0	4	-0.5	-0.5	-2
Public organizations					
Acres	2,250,000	-915,524	637,691	-1,899,125	-73,042
Respondents**	0.5	1.67	2.17	-3.33	-1
Total					
Acres	**2,250,000**	**-106,341**	**352,037**	**-2,032,962**	**-423,042**
Respondents**	**0.5**	**5.67**	**1.67**	**-3.83**	**-3**

* Numbers do not sum to zero due to nonresponses in either the 1994 or 2005 data.
Fractions indicate that at least one respondent indicated acreages in multiple categories.**

Summary of practice. Overall, forest land management practices are now more consistent with the leave tree guidelines than they were in 1994. Approximately half of the surveyed acreage is managed currently under practices that often or always exceed the guidelines. Nearly all acres surveyed are now managed by organizations with an official policy regarding leave tree management. About half of the acres are managed under a policy changed since 1994, and all but a few acres are managed under practices that are at least consistent with the guidelines. While a larger percent of public forest land was managed in 1994 in a manner consistent with current leave tree guidelines, a greater portion of private forest land surveyed is now more likely to apply leave tree practices that exceed current guideline recommendations.

Considerable discrepancy exists between the number of organizations with an official policy for leaving live trees and those that indicate using this practice. Although 99% of the responding organizations indicated the application of leave tree practices at or above what is called for in the guidelines, only about two-thirds of the organizations reported having an official policy. Some organizations incorporate the guidelines using other methods that alleviate the necessity of an official policy. Additionally, several respondents indicated the organization does not have an official policy in order to allow for site-specific decisions. Managers expressed a need to identify and leave trees on a site-by-site basis as determined by the needs of the specific harvested area. One organization without an official policy said its decision is "based on unique site conditions, species of concern and current pest populations." Another respondent thought the site-by-site assessment to be limited by the contracts with and needs of the landowners "we apply leave tree guidelines in most cases. In the case of trust-allotment lands, this can be different, due to the nature of ownership." Thus, for some organizations, no single policy is adhered to, but the harvesting practices are consistent with the guidelines. This accounts for at least some of the discrepancy between the consistency with the guidelines in practice and the adoption of an official policy.

Application of Visual Management Guidelines

It is important that forest managers are aware of the visual characteristics and sensitivities of a harvested site. This includes the visual impact of both the actual logging operations and the harvested area once the harvesting is complete. The guidelines recommend that efforts should be

made to enhance the visual quality of the land, reduce conflicts on multiple-use land, minimize visual and audible impacts of harvesting activities, minimize the visibility of the harvest area, minimize visual impact of slash, minimize the impact of landing operations, and minimize the visual contrast created by snags and broken or leaning trees. The guidelines recommend the classification of sites based on visual sensitivity as "most sensitive," "moderately sensitive," or "less sensitive." Harvesting modifications applied at the site to protect the site and surrounding area depend on the sensitivity classification and include: temporarily closing recreation facilities, redirecting trails, harvesting at times of low-usage, leaving small openings into the cut area, reducing the apparent cut size, patterning the cut after a natural distribution, reducing noise during the early morning and late evening, and educating the public about the operations (MFRC 1999b).

Relatively new visual management BMPs were already in place when the guidelines were published. Consequently, the existing visual management BMPs were incorporated into the guidelines. Thus, many managers may already have been using visual management BMPs in 1994.

Policy governing practice. Ninety-five percent of surveyed acres are managed under an official policy regarding visual management practices (Table 4.14a), with private organizations (as represented by number of organizations and size of forest land managed) are less likely to have an official policy than public organizations. The 30% of landowners without a visual management policy accounted for just 5% of the acreage, suggesting the organizations managing a relatively small amount of forest land are least likely to have such a policy.

When asked to comment on their policy, 11 organizations cited having a specific policy for visual management practices that applied to all of their acreage. Of the 11 organizations, three had adopted the visual management BMPs before they were incorporated into the guidelines and four have adopted the guidelines specifically. Two additional organizations have enacted site-specific policies and develop visual quality management prescriptions on a site-by site basis: "Department policy is to prescribe considerations for visual quality in the development of overall prescription."

While both public and private organizations report substantial change in visual management policy since 1994, forest land managed by public organizations has been subject to the greatest change (Table 4.14a). Ninety percent of public land is managed under a visual management policy reported to have changed since 1994, while only 59% of private land is managed under visual management policy that has changed. The private organizations that changed their policies are more likely to manage disproportionately smaller amounts of forest land, given that 63% of organizations with such a change collectively manage 59% of acres. Those public organizations experiencing change in visual management policies over the past decade tend to be larger (69% of organizations represent 90% of the affected acreage). Overall, large public organizations are more likely to have an official policy and more likely to have changed their policy since 1994.

When asked to describe their change in policy, public respondents described different aspects of the policy than did private respondents. All of the private organization responses were in reference to the practical aspects of harvesting. For example, one respondent said their change in

practices included “More edge and smaller clear cuts.” However, five of the qualitative responses from public organizations acknowledged the importance of the impact of their activities on the public around them. One respondent said that they now harvest with “more consciousness and outreach to adjacent landowners with an attempt to meet local, special needs.” While the policies and practices may have changed equally between private and public lands, public land managers express a greater concern about the interest of other parties.

Table 4.14a. Existence and change in policy governing the application of visual management guidelines.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	809,183 (87)	543,875 (59)
Respondents	4 (50)	5 (63)
Public organizations		
Acres	8,130,349 (96)	7,865,849 (90)
Respondents	12 (80)	11 (69)
Total		
Acres	**8,939,532 (95)**	**8,409,724 (87)**
Respondents	**16 (70)**	**16 (67)**

* Numbers in parentheses represent corresponding percentages of total response.

1994 practices. Sixty-two percent of respondents, representing approximately two-thirds of the forest land surveyed, managed in 1994 using visual management practices consistent with or exceeding those currently recommended in the guidelines (Table 4.14b). Ninety-six percent of private acres were managed under visual management practices that met or exceeded the visual management guidelines, compared to 65% of the forest land managed by responding public land managers. Only 4% of private acres were managed under visual management practices that were often less than the guidelines. In contrast, 34% of public acres were managed under practices that were often less than the guidelines.

Table 4.14b. Comparison of organization’s 1994 practices regarding the application of visual management guidelines to those practices recommended in the guidelines.*

1994	**Practices always exceeded guidelines**	**Practices often exceeded guidelines**	**Practices consistent with guidelines**	**Practices often less than guidelines**	**Practices rarely or never met guidelines**
Private organizations					
Acres	0	30,000 (3)	819,183 (93)	35,000 (4)	0
Respondents	0	1 (17)	4 (67)	1 (17)	0
Public organizations					
Acres	300,367 (3)	1,516,722 (17)	3,917,500 (45)	2,999,168 (34)	0
Respondents**	1 (6)	3 (19)	4.5 (28)	7.5 (47)	0
Total					
Acres	**300,367 (3)**	**1,546,722 (16)**	**4,736,683 (49)**	**3,034,168 (32)**	**0**
Respondents**	**1 (5)**	**4 (18)**	**8.5 (39)**	**8.5 (39)**	**0**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

2005 practices. Currently, no responding organization indicated having visual management practices below what is called for in the guidelines (Table 4.14c). Three-fourths of the acreage is

reported to be managed with practices consistent with the visual quality guidelines, with the remaining 2.3 million acres of forest land subject to practices that often or always exceed the guidelines' recommendations for visual quality. The percent of private and public organizations (and the acres they manage) consistent with or exceeding the guidelines are roughly equal.

Table 4.14c. Comparison of organization's 2005 practices regarding the application of visual management guidelines to those practices recommended in the guidelines.*

2005	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	216,183 (23)	707,692 (77)	0	0
Respondents	0	3 (43)	4 (57)	0	0
Public organizations					
Acres	300,367 (3)	1,813,764 (21)	6,619,626 (76)	0	0
Respondents	1 (6)	5 (31)	10 (63)	0	0
Total					
Acres	**300,367 (3)**	**2,029,947 (21)**	**7,327,318 (76)**	**0**	**0**
Respondents	**1 (4)**	**8 (35)**	**14 (61)**	**0**	**0**

* Numbers in parentheses represent corresponding percentages of total response**.**

Change in practices. Over the last decade, considerable progress has been reported in applying visual quality practices on lands managed by the organizations surveyed. In contrast to 1994 when 3 million acres were subject to visual quality practices considered to be less than those called for in the guidelines, no such acres are reported to exist today (Table 4.14d). Most of these forests (2.6 million acres) are now subject to visual management practices generally consistent with the guidelines, while the remaining acres are managed using practices exceeding the guidelines.

Table 4.14d. Change in application of visual management guidelines relative to the guidelines: 1994–2005.*

	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	186,183	-111,491	-35,000	0
Respondents	0	2	0	-1	0
Public organizations					
Acres	0	297,042	2,702,126	-2,999,168	0
Respondents**	0	2	5.5	-7.5	0
Total					
Acres	**0**	**483,225**	**2,590,635**	**-3,034,168**	**0**
Respondents**	**0**	**4**	**5.5**	**-8.5**	**0**

*Numbers do not sum to zero due to nonresponses in either the 1994 or 2005 data.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Summary of practice. Almost all of the surveyed acres are managed under an official policy regarding visual management and under a policy that has changed since 1994. Currently, all organizations report having practices at least consistent with the visual management guidelines,

and about a quarter of the affected acres are managed under visual quality practices that often or always exceed the guidelines.

Retention of Slash

Retention of slash on the harvest site is important to the habitat of many small mammals, amphibians, and microorganisms. Slash retained on-site also contributes to nutrient cycling important to soil health. The guidelines recommend that slash be distributed throughout the site rather than piled on landings and it is preferred that harvesters leave the slash near the area from which it was cut (MFRC 1999b). However, on some sites the retention of slash can cause pest management and worker safety problems. Thus, it is not always the best management option.

Policy governing practice. Ninety-three percent of the surveyed acreage is managed under an official policy regarding slash (Table 4.15a). This number is slightly higher in public than private organizations with 93% of public acres and 87% of private acres managed under an official policy. Larger organizations are more likely to have a policy than smaller organizations. When asked to describe their slash retention policy, six respondents referenced a specific policy that applied generally to all forest land. Six additional respondents referenced policies that allowed for retention of slash depending on the site-specific needs of the given harvest. For example, one landowner without an official policy said, "It varies by sale, but must be specified on site prescription." One respondent had adopted third party certification standards stricter than the guidelines yet did not reference the guidelines specifically.

In excess of 8.6 million acres (91%) is managed under a slash management policy that has changed since 1994 (Table 4.15a). The percentage of organizations that reported a change in policy regarding the retention of slash onsite is roughly the same between public and private organizations. Larger organizations were more likely to have changed their policy than smaller organizations. When asked to describe the nature of the policy change, five mentioned stricter practices regarding slash and four reported instituting a policy regarding retention of slash, two of which specifically mentioned the guidelines.

Table 4.15a. Existence and change in policy governing the retention of slash.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	809,183 (87)	828,875 (89)
Respondents	4 (50)	5 (63)
Public organizations		
Acres	8,131,549 (93)	7,816,949 (91)
Respondents	10 (63)	10 (67)
Total		
Acres	**8,940,732 (93)**	**8,645,824 (91)**
Respondents	**14 (58)**	**15 (65)**

* Numbers in parentheses represent corresponding percentages of total response**.**

1994 practices. More than one-third of the respondents reported employing slash management practices in 1994 that were often less than those currently recommended in the guidelines—approximately 3.3 million acres (Table 4.15b). Eight organizations that manage 2.3 million acres reported 1994 slash management practices roughly consistent with the guidelines, and 3.6

million acres were reported to be managed under practices that exceeded the guidelines. Public forest land was more likely to be subject to slash management practices that exceeded the guidelines (44% for public versus 3% for private), whereas private forest land was more likely to be subject to practices consistent with the guidelines.

Table 4.15b. Comparison of organization's 1994 practices regarding the retention of slash to those practices recommended in the **g**uidelines.*

1994	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	30,000 (3)	504,183 (57)	350,000 (40)	0
Respondents	0	1 (17)	3 (50)	2 (33)	0
Public organizations					
Acres	300,367(3)	3,612,573 (41)	1,835,250 (21)	2,985,567 (34)	0
Respondents**	1 (6)	3.5 (22)	5 (31)	6.5 (41)	0
Total					
Acres	**300,367 (3)**	**3,642,573 (38)**	**2,339,433 (24)**	**3,335,567 (35)**	**0**
Respondents**	**1 (5)**	**4.5 (20)**	**8 (36)**	**8.5 (39)**	**0**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Current practices. Ninety-nine percent of the forest land represented by the survey respondents is currently managed under practices at least consistent with the guidelines (Table 4.15c). Contrary to reported 1994 practices, the current slash management practices of private organizations are more likely to exceed those recommended in the guidelines than public forests. More than half of the private organizations (57% of private acreage) indicated often or always exceeding the guidelines, while only 31% of public organizations (23% of public acreage) indicated often or always exceeding the guidelines.

Change in practices. The change in slash management practices over the past decade followed an interesting pattern. Rather than trending toward increased use of practices overall relative to the guidelines, practices have become more consistent with the guidelines. As can be seen in Table 4.15d, 3.3 million fewer acres are managed with practices less than the guideline recommendations, yet nearly 1.4 million fewer acres are managed under practices that often exceed the guidelines. An additional 4.7 million acres are managed under practices consistent with the guidelines. Thus, some acres are managed under increased management practices in order to be consistent with the guidelines, while others are managed under practices that have diminished in order to be consistent with the guidelines.

Table 4.15c. Comparison of organization's 2005 practices regarding the retention of slash to those practices recommended in the guidelines.*

2005	Practices always exceed guidelines	Practices often exceed guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	524,183 (57)	377,346 (41)	22,346 (2)	0
Respondents**	0	4 (57)	2.5 (36)	.5 (7)	0
Public organizations					
Acres	300,367 (3)	1,769,824 (20)	6,614,666 (76)	48,900 (1)	0
Respondents	1 (6)	4 (25)	10 (63)	1 (6)	0
Total					
Acres	**300,367 (3)**	**2,294,007 (24)**	**6,992,012 (72)**	**71,246 (1)**	**0**
Respondents**	**1 (4)**	**8 (35)**	**12.5 (54)**	**1.5 (7)**	**0**

* Numbers in parentheses represent corresponding percentages of total response.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Table 4.15d. Change in retention of slash practices relative to the guidelines: 1994–2005.*

	Practices always exceeded guidelines	Practices often exceeded guidelines	Practices consistent with guidelines	Practices often less than guidelines	Practices rarely or never met guidelines
Private organizations					
Acres	0	494,183	-126,837	-327,654	0
Respondents**	0	3	-0.5	-1.5	0
Public organizations					
Acres	0	-1,842,749	4,779,416	-2,936,667	0
Respondents**	0	0.5	5	-5.5	0
Total					
Acres	**0**	**-1,348,566**	**4,652,579**	**-3,264,321**	**0**
Respondents**	**0**	**3.5**	**4.5**	**-7**	**0**

*Numbers do not sum to zero due to nonresponses in either the 1994 or 2005 data.
**Fractions indicate that at least one respondent indicated acreages in multiple categories.

Summary of practice. Almost all of the surveyed acreage is currently managed under an official policy regarding the retention of slash. While the proportions of private and public organizations with an official policy are about equal, large organizations are more likely to have a policy than small organizations. Additionally, almost all of the surveyed acreage is managed under a slash management policy changed since 1994. Large organizations were more likely to have a policy change than smaller ones. While almost half of the surveyed acres used slash management practices that were less than the guidelines in 1994, nearly all forest land is currently managed under slash management practices considered to be at least consistent with the guidelines.

Respondents reported two factors that influence the decision whether to remove slash from the site. First, the interest in leaving slash at the site is mitigated by a need to reduce fire risk associated with increased bio-accumulation. While most organizations wanted to retain slash on-site in order to "protect and maintain forest and soil productivity," they have other concerns that sometimes preempt that goal. One organization acknowledged an "emphasis on slash disposal as a fuel reduction treatment (wildland fire.)" In cases where fuel reduction is critical to

maintaining a healthy forest, the fuel is removed. This is also true for instances in which pest populations would be increased by the retention of slash.

A second factor that influences respondents' retention of slash on site is the advancement of technology. To quote one respondent, "All slash is now required to be returned … in 1994 there were not a lot of stroke delimbers around so most limbing was done by hand in the woods. Now most operations have stroke delimbers." Technology has aided operator's ability to be consistent with the guidelines.

Harvesting on Frozen Soils

Harvesting on frozen soil is recommended for two reasons. If the soil on the harvest site is sensitive, it may be damaged by the logging operation and the on-site use of heavy machinery. Additionally, access to many of the harvesting sites occurs across sensitive areas such as wetlands. Frozen soil is more resistant to damage (which may include soil compaction, rutting, and erosion). By harvesting on frozen soil, damage to sensitive soils is more likely to be reduced or avoided (MFRC 1999b).

Policy governing practice. While 75% of the surveyed land is managed under an official policy regarding harvesting on frozen soils, less than 50% of the organizations have an official policy (Table 4.16a). Thus, primarily larger organizations have adopted policies that govern timber harvesting activities on frozen soils. Public organizations are more likely to have an official policy than private organizations. While 44% of public organizations (77% of acreage) have an official policy, 38% of private organizations representing 54% of acres have an official policy.

When asked to describe their policy, nine organizations stated that their policy was site-specific in nature. One respondent stated, "(the) Professional can (decide to harvest on frozen soil) by site characteristics. Restrictions detailed in the contract are re-evaluated due to drought conditions, variability of freezing, changes in equipment." Thus, management decisions consider the soil characteristics and also seasonal and equipment impacts on a site-by-site basis. It should be noted that frozen soil is not necessary on every harvest site but rather is important on sensitive sites that may be adversely affected by harvesting. Thus, implementing a frozen soil policy does not mean that every harvest is completed on frozen soil.

Table 4.16a. Existence and change in policy governing harvesting on frozen soil.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	501,183 (54)	315,000 (36)
Respondents	3 (38)	1 (14)
Public organizations		
Acres	6,765,934 (77)	5,785,376 (66)
Respondents	7 (44)	7 (44)
Total		
Acres	**7,267,117 (75)**	**6,100,376 (63)**
Respondents	**10 (42)**	**8 (35)**

* Numbers in parentheses represent corresponding percentages of total response**.**

Nearly two-thirds of the land is managed under policies that have changed since 1994 (Table 4.16a), yet this land base represents only 35% of the responding organizations. As found with many other timber harvesting practices, the larger forest land management organizations are more likely to have changed their policy regarding harvesting on frozen soils. In addition, fewer private organizations have changed their policy than public organizations. Forty-four percent of public organizations have changed their policy (66% of public acres) while only 14% of private organizations (36% of acres) have changed their policy. Thus, large public organizations are more likely to have an official policy regarding harvesting on frozen soil and more likely to have changed that policy since 1994.

1994 and current practices. There has been very little change in the percentage of acres harvested on frozen soil between 1994 and 2005 (Table 4.16b). Organizations reported the percent of harvested acres on frozen soil have remained constant at 64% over the past decade. On private forest land, the proportion of harvesting on frozen soil increased slightly from 49% to 51%, whereas no change in frozen soil harvesting (as a percent of all harvest activity) was reported by public forest land managers. The change in frozen soil harvesting activity reported by individual organizations varied from a decrease of 15% to an increase of 25% over the past 10 years.

Table 4.16b. Comparison of percentage of acres harvested on frozen soils between 1994 and 2005.

	1994	**2005**	**Percentage change**
Private organizations	49	51	+2
Public organizations	65	65	0
Total	**64**	**64**	**0**

While the quantitative data suggests minimal change in the policies for harvesting on frozen soils, the qualitative data suggests there has been a change in the way managers assess sites for frozen ground restrictions. Five respondents cited an increased sensitivity to soil types in designating frozen ground harvests and three of those attributed their increased sensitivity to an increase in the availability of soil type information. “We have better soils info [sic] to determine compaction potential. Prior to that, we used field observation only.”

Summary of policy. Large public organizations are more likely than small private organizations to have a policy regarding harvesting on frozen soils and are more likely to have changed that policy since 1994. However, the change in both policy and practice has been relatively small. The respondents cited two reasons for the lack of change in policy and practice for harvesting on frozen soils. First, most of the sites that would be impacted by harvesting on unfrozen soil are largely inaccessible without frozen soils. “In most instances, harvesting during frozen ground conditions is the only and obvious alternative. Under certain conditions, we may now require operations to be held during frozen conditions.” Second, the data is not always collected or well maintained on frozen soil harvest. Two respondents replied “unknown” and most of the percentages of change reported were in round numbers suggesting that some managers are estimating their actual harvest numbers.

Uneven-aged Management

The goal of uneven-aged management is to create a more natural and diverse forest condition. Multiple aged trees foster a diverse array of natural habitat. Practicing uneven-aged management is more difficult for managers than clearcutting because more attention needs to be given to the pattern and distribution of cuts and multiple layers on one site (MFRC 1999b).

Policy governing practice. Just over one-third of the surveyed acres are managed under an official policy for uneven-aged management (Table 4.17a). Public organizations are more likely to have a policy for uneven-aged management than private organizations (44% and 13%, respectively). Smaller public organizations are more likely to have a policy, given that the 44% of respondents with an official policy only represent 36% of the acreage.

Table 4.17a. Existence and change in policy governing uneven-aged management.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	156,183 (17)	186,183 (21)
Respondents	1 (13)	2 (29)
Public organizations		
Acres	3,122,049 (36)	6,642,682 (77)
Respondents	7 (44)	7 (47)
Total		
Acres	**3,278,232 (34)**	**6,828,865 (72)**
Respondents	**8 (33)**	**9 (41)**

* Numbers in parentheses represent corresponding percentages of total response**.**

When asked to describe their policy, four organizations indicated having specific policies that apply to all of their acres. An additional four respondents said they have adopted a policy by setting landscape objectives for the distribution of forest stands then applying them on a site-by-site basis. Managers expressed that setting goals allow for site-specific flexibility for the needs and concerns of a healthy forest. One of the respondents summarized the large number of factors that influence site-by-site management objectives "Foresters use North Central guidelines but have flexibility due to site conditions, local genetics, and input from F+W and Ecoservices to promote adaptive siviliculture."

Nine organizations (41% of all respondents) representing 72% of the forest land changed their policy since 1994 (Table 4.17a). This suggests the larger organizations are more likely to have changed their policy. Overall, public organizations were more likely to change their policy than private organizations. Twenty-nine percent of the private organizations (21% of the private acreage) changed their policy, while nearly half of the public organizations (77% of public acres) have changed their policy regarding uneven-aged management during the past decade, suggesting the large, public organizations are the ones most likely to have changed their uneven-aged management policy.

When asked to describe their change in policy, nine organizations provided explanations. Eight of the nine respondents cited an increased intent to practice uneven-aged management. All but one suggested that the practice of uneven-aged management is in its infancy within their organization, but that attention to uneven-aged management is increasing. One respondent stated,

"We never had specific language regarding uneven-aged management until our Management Plan was updated in 2004. It remains only a small portion of our annual harvest."

1994 and current practices. In 1994, 7% of all harvested acres were subject to uneven-aged management practices (Table 4.17b). Today, responding organizations indicated uneven-aged management is being applied to approximately 12% of all harvested acres. Increases in uneven-aged management were more likely on private acres than public acres. The increase of private acres that are subject to uneven-aged management is twice the increase of public acres with a 10% increase on private land and a 5% increase on public lands. The amount of change within a given organization varied greatly. On public land, the change in the use of uneven-aged management ranged from a decrease of 3% to an increase of 14%. The use of uneven-aged management practices increased as much as 34% from 1994-2005 among individual private forest land managers.

Table 4.17b. Comparison of percentage of acres harvested which include uneven-age management between 1994 and 2005.

	1994	**2005**	**Percentage change**
Private organizations	11	21	+10
Public organizations	7	12	+5
Total	**7**	**12**	**+5**

Summary of practice. While only about one-third of the respondents have adopted a policy regarding uneven-aged management and a little more than one-third of the organizations have changed their policy since 1994, the data shows that the attention to uneven-aged management is growing. Large public organizations are most likely to have official policies and to have changed those policies since the GEIS was completed. Only about one-ninth of all harvested forest land under the jurisdiction of the organizations surveyed land is currently subject to uneven-aged management practices.

Seven respondents expressed an intention to practice more uneven-aged management, but were limited by two factors. First, it is difficult to find logging businesses willing to thin rather than clear-cut. "We are starting to thin our oak and hardwood stands to promote advanced regeneration and improve crop trees. The constraining factor is the small number of logging operations that can and will conduct stand thinnings." In addition to finding companies to harvest selectively, it takes time to switch practices and implement an uneven-aged management scheme. One respondent said, "10-15 percent is managed on an uneven aged basis today. This will increase with time as stands reach conditions that are conducive to uneven-aged management."

The respondents expressed some concern over the quality of the acreage held in uneven-aged management. One respondent stated that currently "there are more residual trees left, that technically still constitutes a 'clear cut.' There is retention of long lived, low volume species, but probably results in a 2-aged stand at best." In addition, it appears the biggest effort to promote uneven-aged management is in areas where it is economically beneficial. As stated by one respondent, "We focus it more on ecological systems where shade tolerant species (such as maple-basswood) has some commercial potential."

Site Regeneration

Site regeneration is an important ecological and economic component of forest management. The guidelines recommend that a harvested area is reestablished with tree species within five years. These practices may include seeding, leaving live trees, and planting new trees (MFRC 1999b).

Ninety-four percent of the surveyed acres are managed under a specific policy regarding site regeneration (Table 4.18a). However, this acreage is managed by 65% of the respondents, suggesting large organizations are more likely to have a policy than smaller organization. When asked to describe their policy, most of the respondents specifically mentioned regeneration occurring within five years. One said their regeneration occurred within three years.

Table 4.18a. Existence and change in policy governing site regeneration.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	839,183 (90)	359,692 (39)
Respondents	5 (63)	2 (25)
Public organizations		
Acres	8,131,549 (95)	476,900 (5)
Respondents	10 (67)	3 (20)
Total		
Acres	**8,970,732 (94)**	**836,592 (10)**
Respondents	**15 (65)**	**9 (39)**

* Numbers in parentheses represent corresponding percentages of total response.

One-tenth of the surveyed acreage is managed under a site-regeneration policy changed since 1994 (Table 4.18a). While public and private organizations are equally likely to have changed their policy, there is a difference in the size of the organizations that changed their policy. Smaller public and larger private organizations are more likely to have had a change in policy. The one-fifth of the public organizations that changed their policy manage only 5% of the public acreage, while the one-quarter of the private organizations that changed their policy represent 39% of the private acreage. When asked to describe the change in policy between 1994 and the present, two respondents cited the main difference as that they now have a formal policy, whereas one stated such a policy includes more closely matching species to sites and greater reliance on natural regeneration. One additional respondent commented that predation is increasing and is now a major obstacle to regeneration.

1994 and current practices. Respondents indicated 84% of the acres harvested in 1994 were fully stocked within five years (Table 4.18b). By 2005, this percent had increased slightly to 87%. Overall, private land managers indicated a higher proportion of their harvested acres as fully stocked than public land managers in both 1994 and 2005. Respondents provided the following comments on their organization's restocking practices: focus more on species types, allow multiple species types on one site, restock with uneven-aged management, and allow natural growth and seed-base to supplement their restocking program.

Table 4.18b. Comparison of percentage of acres harvested which were fully stocked within five years between 1994 and 2005.

	1994	2005	Percentage change
Private organizations	93	97	+4
Public organizations	84	87	+3
Total	**84**	**87**	**+3**

Summary of policy. Almost all acres surveyed have an official policy regarding restocking of harvested land. While consistency with the guideline to restock within five years was high, some respondents attributed their consistency to factors other than the guidelines. Two respondents stated their regeneration practices are determined by law. One respondent stated: "All regeneration harvest sites must be regenerated within 5 years, by law." Respondents seemed to take regeneration as a given. One spoke of their policy saying: "It outlines our policy on deciding on natural vs. regeneration. It's assumed that we want to regenerate areas harvested." Respondents expressed confusion about new definitions of restocking. Restocking can be straightforward on a clear-cut harvest, but not on sites with multiple-aged trees. Two respondents specifically mentioned struggling with this definition. One of these respondents said: "Working towards a definition of fully stocked in mixed wood situations."

Species Site Matching

Species site matching helps increase forest productivity and growth. By planting species that would naturally occur in a given area, both the ecological integrity of an area and the ecological integrity of the broader system are more likely to be enhanced. Wildlife habitat is also enriched by a diversity of plant species that closely matches the naturally occurring plant community (MFRC 1999b).

Policy governing practice. Almost half of the surveyed acres are managed under an official policy regarding species site matching (Table 4.19a). There is a large difference between the number of public and private organizations with official species site-matching regeneration policies. Only one-quarter of the private organizations (half of the private forest land surveyed) have a policy for species-site matching, while more than half of the public organizations representing 42% of the acres have an official policy. The larger private and smaller public organizations are more inclined to have official policies for matching tree species to specific sites. When asked to describe their policies, all ten organizations that responded expressed an intention to practice species-site matching. Of those, four cited formal classification systems used to match the species and sites, and four mentioned using native species on a site-by-site basis.

Only 23% of the surveyed acres are managed under a species site-matching policy that has changed since 1994 (Table 4.19a). While nearly half of all public organizations indicated such a change, the collective forest land they manage is less than 25%. Few private organizations have changed their species site-matching policy—only one organization (14% of owners) indicated such a change over the past decade.

Table 4.19a. Existence and change in policy governing species site matching.*

	Organizations with an official policy	Organizations with a change in policy since 1994
Private organizations		
Acres	464,183 (50)	156,183 (18)
Respondents	2 (25)	1 (14)
Public organizations		
Acres	3,631,549 (42)	2,050,240 (24)
Respondents	9 (56)	7 (47)
Total		
Acres	**4,095,732 (42)**	**2,206,423 (23)**
Respondents	**11 (46)**	**8 (36)**

* Numbers in parentheses represent corresponding percentages of total response.

1994 and current practices. Organizations indicated that 92% of all acres harvested in 1994 had species site matching incorporated in regeneration activities (Table 4.19b). The differences in the use of this practice were considerable between responding public and private organizations—96% of public organizations versus 53% of private organizations. By 2005, the overall percent of harvested acres subject to species site-matching activity upon regeneration was 95%. Nearly all public land incorporated such a practice, while 62% of private land was managed under this practice.

Table 4.19b. Comparison of percentage of acres harvested which included species site-matching activities for regeneration between 1994 and 2005.

	1994	2005	Percentage change
Private organizations	53	62	+9
Public organizations	96	98	+2
Total	**92**	**95**	**+3**

Particularly noteworthy in the change of species site-matching activities since 1994 is the considerable range in such practices among individual organizations. While only four organizations reported a change in the acres harvested that included species site matching between 1994-2005, the changes of those four organizations were large (up to 70%). Respondents also cited changes in methodology used to match tree species to the site. Nine respondents mentioned adopting site classification systems. “This NPC classification only became available to us in the last couple of years.” Previously, managers were using “Field observations.” Qualitative changes included a switch of species: “More emphasis on regenerating certain species such as white pine, tamarack, yellow birch—less emphasis on aspen regeneration.”

Summary of practice. Less than half of the surveyed acreage has an official policy dictating species site matching, and approximately one-quarter of those acres have experienced a change in policy since 1994. Species site-matching practices were largely consistent with the guidelines prior to being published in 1994 and still are today. Private organizations have experienced the greatest increase in this practice, though its use is still greater by public organizations. Many organizations have adopted official classification systems to provide guidance for selecting species.

While most managers make an attempt to be consistent with the guidelines, some land cannot be matched to the ideal species because of site-specific concerns. This thought is summarized well by one manager who stated, "We make every effort to match the right species to the site, however, we have been 'forced' to deviate from standard protocols, in some cases, due to severe browsing by deer. In some cases where we know the site should ideally be planted to pine we instead plant white spruce. We are now even seeing some browsing of white spruce." So, while species site matching is ideal, it is not effective or applicable to every situation.

Reduction of Pest Damage

The guidelines suggest using pesticides and pest control as part of an integrated pest management strategy including a combination of chemical, biological, and cultural activities to control unwanted species. The purpose of treatment should be to protect naturally occurring species from competition of invasive and unwanted natural species. Care should be taken to apply chemicals in spots and patches rather than via broadcast distribution to avoid unwanted affects of chemicals. If applied correctly, the natural heritage of an area can be protected. In addition, with proper use, controlling insect and disease damage can help protect cultural resources, minimize alteration of vegetation, increase visual quality, increase water quality, and protect wildlife habitat (MFRC 1999b).

Policy governing practice. Half of the organizations and the acreage they manage have an official policy for pest management (Table 4.20a). However, there is a difference between public and private organizations. Public organizations are more likely to have a policy than private organizations, but a larger percent of private acreage is managed under an official policy. The 56% of public organizations with an official policy manage 41% of the public acreage while the 34% of private organizations with an official policy manage 84% of the private acreage. This suggests that large private organizations are more likely to have official policies while small- to average-sized public organizations are more likely to have official policies. When asked to describe their policy, seven respondents referenced a policy that is incorporated into their management plans. Two respondents cited immediate harvesting as the option for pest management, with one stating: "Salvage harvest ASAP and harvest decadent stands. Do not treat w/ insecticide."

Table 4.20a. Existence and change in policy governing the reduction of pest damage.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	779,183 (84)	315,000 (36)
Respondents	3 (34)	1 (14)
Public organizations		
Acres	3,545,049 (41)	6,042,840 (73)
Respondents	9 (56)	5 (33)
Total		
Acres	**4,324,232 (50)**	**6,357,840 (69)**
Respondents	**12 (50)**	**6 (27)**

* Numbers in parentheses represent corresponding percentages of total response.

One-quarter of the respondents representing 69% of acres have had a change in policy since 1994 (Table 4.20a). Public organizations are more than twice as likely to have changed their

policy as private organizations. Thirty-three percent of public organizations representing 73% of public acres have had a change in policy while 14% of private organizations representing 36% of private acres have changed their policy. Large organizations account for a majority of the change given that the percentage of acreage changed is more than twice the percentage of the number of organizations that have changed. When asked to describe the change to their policy, three respondents cited the implementation of a written policy, eight cited specific treatments they have adopted, and seven cited the incorporation of national standards.

1994 and current practices. Respondents stated that in 1994, 23% of infested acres were treated or harvested to reduce forest pest damage (Table 4.20b). The percentage between public and private acres was very different. One-third of the infested private forest land was treated or harvested while only 19% of public acres which were infested were treated or harvested.

Organizations stated that the percent of infested acres treated to reduce forest pest damage has changed very little since 1994 (Table 4.20b). The increase on private forest land was modest (3% overall), although the practices of individual organizations varied considerably, ranging from a 100% decrease in the acreage treated to a 60% increase. Public organizations collectively indicated no change in the percent of acres treated between 1994 and 2005.

Table 4.20b. Comparison of percentage of infested acres harvested which were treated to reduce forest pest damage between 1994 and 2005.

	1994	**2005**	**Percentage change**
Private organizations	33	36	+3
Public organizations	19	19	0
Total	**23**	**24**	**+1**

Summary of policy. Half of the acreage corresponding to the survey respondents is governed under an official policy regarding pest management. Large private organizations and small- to mid-sized public organizations are most likely to have an official policy, while large public organizations are the most likely to have had a change in policy since 1994. Currently, approximately one-quarter of all infested acres are treated. This number is similar to the extent of treatment that occurred in 1994. Individual private organizations experienced a considerable range of change in the percentage of their infected acres treated, while public organizations experienced very little change.

The accuracy of the treatment data is not entirely clear, as respondents expressed confusion with the question and did not have accurate records on the extent of the practice. There were 11 nonresponses accounting for 44% of the survey respondents. The acres reported as managed in integrated pest management systems in 2005 represented only 7% of the total acres covered by the survey. In addition, the qualitative comments reflected the respondents' confusion with the question as demonstrated by the following two comments: "This question is strange because usually harvesting is the treatment" and "This question assumes that we have a significant infestation, which we do not. Acres thinned each year is insignificant compared to the total harvest." Finally, managers did not keep close records of infestation treatments as summarized by the following comments "No clear documentation" and "Unknown with spruce budworm, hard to say how many acres were affected and or treated."

From the above information it would appear managers are beginning to incorporate a more comprehensive pest management plan and are more sensitive to invasive species, but are having trouble documenting the change in a quantifiable way.

Utilization Standards

Changes in technology have impacted wood utilization by increasing the amount of wood utilized from each harvest. The guidelines call for increased utilization in order to maximize wood use in harvest areas and to reduce associated waste (MFRC 1999b). Greater harvest productivity requires fewer harvested acres to produce a given volume of wood fiber and, thus, less habitat is impacted.

Policy governing practice. Approximately half of the responding organizations (representing 8.4 million or 87% of acres) have an official policy regarding utilization standards (Table 4.21a). Private organizations are more likely to have a policy regarding wood utilization than public organizations (63% versus 50%), with these policies more common among larger forest land managers. When asked to describe their policy, seven respondents gave specific utilization requirements while two said their policy is applied on a site-by-site basis, and two said they allow the harvester or the mill to make that decision.

Table 4.21a. Existence and change in policy governing utilization standards.*

	Organizations with an official policy	**Organizations with a change in policy since 1994**
Private organizations		
Acres	853,875 (92)	784,183 (87)
Respondents	5 (63)	4 (57)
Public organizations		
Acres	7,534,774 (86)	4,934,358 (58)
Respondents	8 (50)	3 (20)
Total		
Acres	**8,388,649 (87)**	**5,718,541 (60)**
Respondents	**13 (54)**	**7 (32)**

* Numbers in parentheses represent corresponding percentages of total response.

Sixty percent of the surveyed acres are managed under a wood utilization policy that changed since 1994, reflecting a policy change among approximately one-third of the survey respondents (Table 4.21a). Modified utilization standards are more likely on private than public organizations, with only one of five public organizations and more than half of the responding private organizations indicating such a policy change.

Increased utilization standards since 1994

Pulpwood. Many organizations have increased their utilization standards over the past decade for pine, spruce/fir, aspen, and other hardwoods (Table 4.21b). The most common increase is in hardwoods other than aspen—ten organizations indicated changing utilization standards since 1994, while the least common increase is in pine utilization. In each product category, more private land managers have increased their utilization standards than have public organizations. While private organizations have increased their utilization almost equally across the different product types (with five or six organizations increasing utilization in each category), public

organizations have increased utilization of aspen and other hardwoods while only one and two organizations have increased pine and spruce/fir utilization, respectively.

Table 4.21b. Organizations, and associated acreage, indicating increased pulpwood utilization standards since 1994.

	Pine	Spruce/fir	Aspen	Other hardwoods
Private organizations				
Acres	853,875	858,875	853,875	858,875
Respondents	5	6	5	6
Public organizations				
Acres	147,000	434,358	4,981,400	483,258
Respondents	1	2	4	4
Total				
Acres	**1,000,875**	**1,293,233**	**5,835,275**	**1,342,133**
Respondents	**6**	**8**	**9**	**10**

Sawtimber. Fewer organizations indicated an increase in sawtimber utilization standards compared to the number of organizations with changes in pulpwood utilization standards since 1994 (Table 1.21c). As with pulpwood, the greatest number of organizations with increased sawtimber utilization standards are associated with nonaspen hardwood standards—six organizations indicated such a change (three public and three private). The other three categories (pine, spruce/fir, and aspen) have about equal increases in utilization with either three or four organizations having increased their utilization standards in these categories. However, public and private increases are very different. While three and four private organizations increased their utilization on pine and spruce/fir respectively, no public organizations increased their utilization of either of these species.

Table 4.21c. Organizations, and associated acreage, indicating increased sawtimber utilization standards since 1994.

	Pine	Spruce/fir	Aspen	Other hardwoods
Private organizations				
Acres	501,183	506,183	35,000	191,183
Respondents	3	4	2	3
Public organizations				
Acres	0	0	4,500,000	4,697,758
Respondents	0	0	1	3
Total				
Acres	**501,183**	**506,183**	**4,535,500**	**4,888,941**
Respondents	**3**	**4**	**3**	**6**

Summary of policy. Almost all forest land subject to management by the organizations surveyed are managed under an official policy for utilization standards, and more than half are managed under a policy changed since 1994. Large private organizations are more likely to have an official policy for utilization standards and to have changed their policy since 1994. Pulpwood and sawtimber utilization standards have increased in all categories.

While private organizations increased their utilization more than public organizations, the data did not indicate the degree to which the standards changed. It is possible that public lands had a higher standard of utilization in 1994 and, thus, while their policy and utilization standards have

not changed as significantly, their standards are now similar to those used by private forest land managers.

This assessment of changes in utilization standards is not conclusive due to the high level of nonresponses to these questions. Twelve public organizations and two private organizations—more than half of all organizations surveyed—did not respond to utilization questions. What is not clear is whether the nonresponse was due to no increase in utilization standards or a lack of available information on the utilization increases. A possible explanation for the lack of response is that utilization standards are not always set by the organizations. Three organizations mentioned the utilization standards were set by outside factors, but that economics gave incentive for maximum utilization as summarized by the following two comments: "We sell all timber area estimate. It is to the loggers benefit to utilize everything" and "Technology has greatly affected utilization standards. As mills are able to use smaller and smaller pieces of the harvest and as harvesting equipment improves, greater utilization follows."

Protection of Sensitive Wildlife Sites

Disturbing rare species may be illegal, contribute to the loss of biological diversity, and lead to the destruction of potentially viable commercial products. The guidelines recommend that before harvesting occurs, harvest planners should consult with the DNR County Biological Survey (if available) and local natural resource managers to determine if there are any known sensitive species on the site. Care should be taken to protect those species. Protecting sensitive areas may prove costly, but failure to do so may prove even more costly. Should harvesters knowingly jeopardize endangered species, the breach of state and federal law would be expensive (MFRC 1999b).

Policy governing practice. Nearly all of the acres represented by survey respondents have an official policy for the protection of wildlife sites (Table 4.22a). Public organizations are more likely to have a policy than private organizations. Nearly seven of ten public organizations representing almost all of the corresponding forest land have an official policy, while only half of the private organizations representing 87% of private acres report an official policy. When asked to describe their policy, 13 respondents gave specific policy references that applied to their acreage. Three of those specifically mentioned the guidelines and one mentioned the federal Endangered Species Act. Two of the 13 respondents mentioned site-specific practices.

Almost half of the organizations representing nearly three-quarters of the acres have changed their policy for protecting sensitive wildlife sites since 1994 (Table 4.22a). Private organizations are more likely to change their policy with 57% of the responding private organizations (92% of private forest land) reporting policy changes, while about 38% public organizations (68% of forest land) have done so. Organizations managing large forest acreage are more likely to have experienced a change in policy over the past decade than organizations managing proportionally small acreage. When asked to describe their change in policy, five cited being more sensitive to habitat: "Sensitive wildlife sites meaning things like deer yarding areas, grouse management areas, waterfowl nesting areas, etc." Five additional respondents mentioned increased information available to managers when making their decisions: "More detailed information available to field foresters in automated format." Thus, qualitative changes to the protection of sensitive wildlife sites have occurred in addition to the quantitative changes.

Table 4.22a. Existence and change in policy governing protection of sensitive wildlife sites.*

	Organizations with an official policy	Organizations with a change in policy since 1994
Private organizations		
Acres	809,183 (87)	809,183 (92)
Respondents	4 (50)	4 (57)
Public organizations		
Acres	8,192,049 (94)	5,906,473 (68)
Respondents	11 (69)	6 (38)
Total		
Acres	**9,001,232 (93)**	**6,715,656 (70)**
Respondents	**15 (63)**	**10 (44)**

* Numbers in parentheses represent corresponding percentages of total response.

1994 and current practices. In 1994, 86% of sensitive wildlife sites were protected during harvesting operations, according to survey respondents (Table 4.22b). While the percent of public land harvest areas that protected sensitive wildlife habitat were indicated to be 88% in 1994, less than one-third of the sensitive wildlife habitat in private land harvest was protected. By 2005, the percent of protected sensitive sites increased to 92% overall. Ninety-three percent of the forest land managed by public organizations is protected during harvest, while slightly less than half of all such sites are protected on private forest land. The 6% increase in protected acreage reported between 1994 and 2005 is due to changes reported by three organizations: two public and one private. The increase was greater on private land than on public land as the private organization that increased its practices accounted for a 16% increase in the private land acreage while the changes in the two public organizations accounted for just 5% of the total public acreage.

Table 4.22b. Comparison of percentage of harvested acres in which sensitive sites were protected between 1994 and 2005.

	1994	2005	Percentage change
Private organizations	31	47	+16
Public organizations	88	93	+5
Total	**86**	**92**	**+6**

Summary of practice. A majority of sensitive sites on the land surveyed are protected under an official policy. Public land is more likely to have a policy than private land. Private and large organizations are more likely to have changed their policy than small or public organizations. In practice, protection on public land changed 6% of the acreage while protected acreage on private lands increased by 16%.

This section of the survey had a large nonresponse rate. Seven respondents (29%) representing 1,844,632 acres (19%) did not respond to the acreage estimates of protection of sensitive sites. It seemed that data was not easily gathered and the definition of sensitive wildlife sites was not clear. One respondent replied “No criteria to make judgment” and another replied “Too vague! Many levels. Unaltered? Untouched? Improved?”

Another factor that may have made it difficult for managers to articulate their changes is the large number of outside policies, laws, and guidelines that guide managers in making their

decisions. Eight respondents mentioned national policy or court settlements including the federal Endangered Species Act and four respondents specifically mentioned the adoption of the guidelines. Thus, many factors guide managers on the protection of sensitive wildlife sites, and it is not easy to determine what precise acreage is directly attributed to the GEIS recommendations.

Final Comment

Organizations were asked for their final comments on the overall use of guidelines. Two organizations stated the guidelines did not dramatically impact their practices because they were accountable to other national policies, which were more stringent than the guidelines. Two additional respondents indicated the guidelines were incorporated into their management plans: "Recommendations of the guidelines were embraced in numerous references in our updated management plan." Two organizations found the guidelines to be a useful tool, but one of those cited a need for greater education. "They are a great tool—more education on how and when to use them would benefit the industry greatly." The other organization cited a need for better field auditing of practices. "Guidelines have been a positive tool, they have caused more time requirements which is ok. Guideline audit process has been poor—we have only been included in the process during the past year. We see the audit sheets, but don't know the bigger picture results. We question the future audit necessity with forest certification pending compliance."

One organization expressed concern that the guidelines undermined the work of managers. By setting guidelines the fine-tuning and "art" of forestry is lost. "All landscape level planning and coordination is done within the county under the land-use authority of the county board and the cooperation of public and private landowners. The MFRC program appears to be designed to challenge this authority."

4.1.3.3. Guideline Training

When the MFRC established the site-level program in 1996, it recognized the importance of training for loggers, landowners, and resource managers as the fundamental component for ensuring implementation of the guidelines on public and private forest land. The MFRC encouraged early collaboration with the Minnesota Logger Education Program (MLEP) to establish guideline training as a continuing element of logger education. The MFRC also provided seed money to establish the Center for Continuing Education (CCE) at the University of Minnesota with the stated objective of promoting excellence in natural resource management through educational opportunities. The CCE organized or sponsored many of the annual educational workshops training resource managers and landowners in the use of the guidelines.

The following statistics were drawn from the MFRC annual reports (MFRC 1999a, 2000, 2001, 2002) and demonstrate how extensive the training effort has been. It does not include the continuing and common internal industry and agency training sessions. For example, the DNR has held full day workshops in most of its Division of Forestry administrative areas for foresters and wildlife and fisheries managers with a focus on guideline implementation strategies.

- In 1999 and 2000, loggers and resource managers attended 38 day-long guideline training workshops.

- In 2001, there were 907 attendees at the MLEP workshops—778 loggers, 129 resource managers. More than 850 resource professionals attended CCE workshops in 2001.
- In 2002, the MLEP workshops focused on deficiencies in guideline application (i.e., use of water diversion and water and wetland crossing structures) identified through the compliance monitoring program. Attendance was 703 loggers and 249 resource managers.
- In 2003, attendance at specific guideline training workshops included 68 loggers and 7 resource managers.
- In 2004, joint MLEP-CCE workshops drew 982 loggers and resource managers.

4.1.3.4. Guideline Implementation Monitoring Program Development

The Sustainable Forest Resources Act of 1995 mandated the establishment of a process to assess the extent to which the guidelines are applied on public and private forest land in Minnesota. The MFRC convened a Guideline Implementation Monitoring Committee to oversee the development of the procedures and protocols for monitoring the application of the guidelines on public and private forest land. It was decided to monitor only guidelines that could be measured (e.g., RMZ width, residual basal area, size of leave tree clumps). Timber harvests were randomly selected from those identified through satellite imagery and/or aerial photography as the monitoring sites (MFRC 1997b).

The development of the on-site monitoring procedures was assigned to a Guideline Implementation Monitoring Technical Committee (GIMTC) made up of staff from public agencies and private industry. The GIMTC recommended the use of independent contractors to conduct the field monitoring. The successful contractors and their subcontractors were required to attend a three- to five-day calibration workshop to obtain the required training on the field assessment methods. It was also decided that quality assurance field reviews would be done on 10% of all sites monitored.

The data collected on the field data sheets was entered into a relational database and analyzed. The results were written up in reports provided to the MFRC, the legislature, and all interested parties. Individual reports were published describing field monitoring results in 2000 and 2001. A summary report, published in 2004, analyzed all of the data for the first three years of monitoring. The data came from harvested sites or sites contracted for harvesting prior to publication of the guidelines. They established the baseline from which annual monitoring would be compared after 2002 (Dahlman and Phillips 2004).

Monitoring Results

A total of 334 harvest sites was monitored from 2000-2002: 108 in 2000, 118 in 2001, and 108 in 2002. Nineteen of the sites from 2002 were sold or contracted following publication of the guidelines and added to the pool of sites that will be evaluated with the sites in the next round of post-baseline field reviews. In 2004, 88 sites were evaluated and there are 90 sites to be completed in 2005. The forest landowner categories monitored are USDA Forest Service (National Forest), state forest land, county forest land, private industrial land, American Indian tribal forest land, and NIPF land. Because timber harvesting on the sites evaluated during these three years was assumed to be governed by timber sale contracts established prior to the MRFC's release of the guidelines in 1998, the field monitoring results can be expected to reflect

best the 1994 practices self-reported by survey respondents in the current survey (Dahlman and Phillips 2004).

The following findings are summarized in the three-year guideline implementation monitoring report summary, *Baseline Monitoring for Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest land in Minnesota: Combined Report for 2000, 2001, and 2002* (Dahlman and Phillips 2004):

- 53% of the monitored sites were harvested exclusively in the winter.
- 92% of the sites were managed as even-age. Ninety-three percent of these were clear-cut, and two-thirds of the clear-cuts retained some reserve trees.
- 25% of the monitored sites were visually sensitive.
- Filter strip compliance with the guideline recommendation (< 5% mineral soil exposure, dispersed over the filter strip) was 73%.
- RMZ guideline recommendations for width and residual basal area were met 52% of the time.
- Appropriate water diversion and erosion control practices were installed on 7.4% (three-year data) of skid trail and road approaches to wetlands and streams. However, more detailed information gathered in 2002 found evidence of erosion on only 5.8% of the approaches, and sediment was reaching a waterbody on 59% of those with erosion evident.
- 37% of the skid trail and road segments with a grade of 2% or more had the appropriate water diversion and erosion control practices installed. Detailed information gathered in 2002 found that erosion was visually evident on 22% of the segments, and sediment was reaching a waterbody on 20% of the segments where erosion was observed.
- Only 6% of more than 2,000 locations on the 89 sites monitored in 2002 had rutting 6 inches deep or deeper. Most rutted locations (78%) had less than 5% of their surface area in ruts, and 47% of the rutting was confined to roads, skid trails, and landings.
- The guidelines recommend that site infrastructure (i.e., roads, landings) occupy no more than 3% of the harvest area. The statewide average was 3% for all three years.
- Landings were located outside of filter strips and RMZs 77% and 98% of the time, respectively, and outside of wetlands 79% of the time.
- Coarse woody debris guidelines were met in 79% of the general harvest areas and in 69% of the RMZs.
- Slash was retained at the stump or redistributed back on the site for 75% of the sites monitored.
- 53% of the clearcut sites met the leave tree guideline recommendations.

Guideline Implementation Goals

In 1998, the MFRC developed four goals for the implementation of the guidelines as mandated in the Sustainable Forest Resources Act of 1995. These were: (1) developing organizational support for the guidelines, (2) ensuring user awareness and understanding of the guidelines, (3) obtaining user commitment to apply the guidelines, and (4) measuring the actual application of specific practices set forth in the guidelines (MFRC 1998). Goal #1 was to be achieved by obtaining a statement of support from public and private organizations with an interest in the wise management of the state's forest resources.

The success in accomplishing goal #2 was to be measured by the numbers of timber harvesters and resource managers attending guideline education and training programs, and by the numbers of forest landowners who were made aware of the guidelines. For this goal, percentages of wood harvested by timber harvesters who had received guideline training were established. Specific percentages of the state's resource managers involved in administering timber sales were required to attend these training sessions. Percentages of NIPF landowners with holdings exceeding 20 acres to receive information regarding the guidelines were established. For each of these measures of guideline awareness, targets were established for 2000 and 2002.

The measure for goal #3 was the percentage of harvest sites where the timber harvester and landowner explicitly discussed and considered the application of the guidelines prior to the start of on-the-ground operations. As with goal #2, the percentage of timber sales where this goal was achieved was to be determined for public and private sales and over time (2000 and 2002).

The measure for goal #4 was the level of compliance with specific practices identified through the field monitoring program and the improvement in the application of these practices over time. The MFRC required the establishment of a baseline comparison of the approved guideline recommendations with current practices. The goal was to measure continuous improvement in the application of the guidelines.

The MFRC has assessed the progress in implementing the goals once. The results of this analysis are published in the report titled *The Timber Harvesting and Forest Management Guideline Implementation Goals for 2000: A Progress Report* (MFRC 1998). For goal #1, by 2000, 18 organizations had provided written support for implementing the guidelines.

By 2000, approximately 74% of the timber harvesting statewide was done by loggers who had received guideline training (target was 75%), 63% of resource managers in Minnesota received guideline training (target was 75%), and approximately 48,000 NIPF landowners owning greater than 20 contiguous acres were provided with information about the application of the guidelines. By 2004, more than 90% of the timber harvesting statewide was done by loggers who had received guideline training. No explicit target had been set for 2004. Updated information for the other data parameters has not been collected.

The goal for commitment to apply the guidelines was 75% for public land, private industrial land, and for NIPF and tribal land where professional forestry assistance is provided. This is not a goal reliably measured in the baseline analysis as these sites were harvested or contracted for

harvesting prior to publication of the guidelines. The measure of guideline application is evaluated through the implementation monitoring program.

Once revised guidelines are published in summer 2005, another major effort to train loggers and natural resource managers will be initiated by the MFRC, MLEP, and CCE. After this training is underway, updated goals comparable to those developed in 1998 above are likely to be established.

4.1.3.5. Comparing DNR Monitoring Results and GEIS Assessment Survey Findings

It was anticipated that the three-year summary of guideline implementation monitoring data would serve as a powerful complement to the survey of major forest landowners. This data would serve as a check, substantiating or refuting the self-reported landowner survey data. Further, the survey was sent only to the state's public and large corporate forest landowners. As such, it did not capture the attitudes and intentions from the state's NIPF landowners about their actions to implement site-specific practices recommended in the guidelines or their participation in the MFRC's landscape planning program. Consequently, the monitoring data has the potential to describe timber harvesting practices on these lands.

The assessment concluded that comparisons of guideline implementation monitoring data and the results of the survey of GEIS mitigation implementation progress were very limited, as the two evaluations were greatly different in scope, purpose, and specificity. Minimal data presented in the three-year baseline monitoring report was directly comparable to the survey results due to different reporting of practices by ownership (not all guideline implementation monitoring results are broken down by ownership category, especially NIPF where survey data is missing), metrics used (guideline implementation monitoring data is summarized by harvest site whereas survey results are reported by owner and corresponding forested acres managed), and practices evaluated (the monitoring results reported are not always consistent with the practices evaluated in the survey).

For example, comparable data from the two studies addressing the recommendation to harvest on frozen soils is not presently available. The monitoring report presents data on the season of harvest, the season of harvest associated with rutting on soils and the damage found on approaches and skid trails, but not whether the soil was frozen when harvesting occurred, which was evaluated in the GEIS mitigation survey. Similar limitations existed in comparing monitoring and survey data on the retention of snag trees. The three-year summary of guideline implementation monitoring results indicates the number of sites that retained snags, but does not report this information by ownership. Since the monitoring data includes NIPF data and the survey does not, comparisons could not be made for retention of snags.

Despite these limitations, two comparisons were made between the data contained in the three-year monitoring report and the GEIS mitigation survey data. Because timber harvesting on the sites evaluated during these three years was assumed to be governed by timber sale contracts established prior to the MRFC's release of the guidelines in 1998, the field monitoring results can be expected to reflect best the 1994 practices self-reported by survey respondents

Guideline implementation monitoring data for 2000-2002 indicates that 52% of the sites with RMZ had RMZ width and basal areas that met the guideline requirements for that type of waterbody (Table 4.36). In contrast, survey respondents managing 71% of the surveyed forest land indicated their 1994 RMZ practices met or exceeded the guidelines. Monitoring data was not summarized and reported by ownership to facilitate comparisons of monitoring results and self-reporting of riparian management practices for the state's public and corporate private forest landowners.

Similarly, half of the sites evaluated through guideline implementation monitoring efforts from 2000-2002 were found to properly apply the leave tree guidelines (Table 4.23). In contrast, public and corporate organizations report nearly three-fourths of the forest land was managed in 1994 using leave tree practices consistent with or exceeding the leave tree recommendations contained in the guidelines. Monitored and self-reported leave tree results were very close for corporate lands (45 and 42%, respectively), but considerably different for public ownership (54% were found to meet guidelines based on monitoring results versus 74% of acres in this survey reported using leave tree practices consistent with guidelines in 1994).

Table 4.23. Comparison of DNR guideline monitoring results and GEIS assessment survey data on RMZ and leave trees.

	Riparian Management Zones		**Leave trees**	
	Monitoring report* **	**GEIS Mitigation Survey: 1994 practices****	**Monitoring report***	**GEIS Mitigation Survey: 1994 practices****
	percent			
Public land	NA	73	54	77
Corporate private	NA	43	45	42
NIPF	NA	NA	63	NA
Total	**52**	**71**	**50**	**74**

* Number of sites with ≥6 scattered leave trees and ≥5% total site in leave tree clumps
** Percent of acres managed by organizations indicating 1994 practices were consistent with or exceeded guidelines.
*** Number of sites with RMZs that met guidelines for width and basal area.

It should be noted that surveyed managers in the GEIS report card survey repeatedly mentioned the need to tailor site-specific prescriptions (including the use of guidelines) to the conditions and management objectives associated with a site. For example, retention of snags varies on a site-by-site basis based on safety concerns, visual quality concerns, and other management objectives. In the survey, managers were not asked to distinguish management objectives or mitigating circumstances in developing information on historical or current use of guidelines. In contrast, the monitoring data provided specific information on a site-by-site basis and only sometimes separated the applicability of standards by identifying the number of sites to which the guidelines applied. Several survey respondents expressed confusion on how to report information on guideline use, recognizing not all guidelines may be applicable due to site-specific conditions.

4.2. Landscape-level Planning and Coordination

An important and unique aspect of the GEIS is its focus on cumulative impacts associated with timber harvesting and forest management activities in Minnesota. This focus facilitated an assessment of the repeated impact of various site-specific timber harvesting activities across

large forest landscapes. To address this level of environmental impact, the GEIS recommended citizens of the state come together to create a vision for the future of Minnesota's forests and develop a strategy for achieving that vision. Specifically, the GEIS stated, "to successfully mitigate, in advance, unacceptable landscape level impacts from timber harvesting and forest management activities, a statewide SFRP should be adopted as the basis for a common statewide foundation" (Jaakko Pöyry Consulting, Inc., 1994).

4.2.1. GEIS Recommendations

After assessing the potential for landscape impacts, the GEIS recommended the development of landscape-level responses to address potential problems that may occur on a statewide level across landowner types. The GEIS defined landscape level responses as "broad-based solutions to address the cumulative effects of individual site-level practices which require extensive planning and cross-ownership coordination to achieve intended regional or statewide objectives" (Jaakko Pöyry Consulting, Inc., 1994). Identified were seven goals that should be incorporated into all landscape level responses:

- Incorporate all landscape-level mitigation strategies recommended in the GEIS,
- Apply statewide across all ownerships to the extent legally and practically possible,
- Be simple, straightforward and cost-effective,
- Consider the conflicting nature of diverse forest lands and forest landowners,
- Involve all landowner groups to the maximum extent possible,
- Be responsive to new data and information to ensure flexibility for change when needed, and
- Create the environment to develop a common foundation (not necessarily uniform) for statewide resource management and planning objectives to the maximum degree possible.

The administrative mechanism recommended for addressing landscape-level responses was the establishment of a sustainable forest resources program. The objective of this program would be to facilitate a statewide structure for: identifying existing forest resource conditions, evaluating these conditions in light of forest trends, determining the desired future forest conditions, identifying and developing specific strategies necessary to achieve those desired future forest resource conditions, and providing feedback to assess the success in achieving those objectives (Jaakko Pöyry Consulting, Inc., 1994).

4.2.2. Sustainable Forest Resources Act Provisions

The SFRA codified the landscape-level goals and objectives recommended in the GEIS, and directed the establishment of regional committees. The overarching landscape-level goal of the MFRC as established by the SFRA is to "establish a framework that enables long-term strategic planning and landscape coordination to occur." Once the framework was established, the MFRC was to separate the state into landscape regions to more effectively coordinate efforts, state the principles and goals for landscape planning, and identify a general process for the various regions to follow in addressing landscape goals (Minnesota Statutes 2004).

The SFRA provided direction on the composition and activities of regional committees. Regional committees were to be inclusive of the interests of the community, serve as a forum for stakeholders, and allow for an open public process. Their work was to be integrated with other planning efforts, facilitate coordination of forest planning and management, facilitate public participation, set goals and strategies to achieve the goals, and communicate regional interests to the MFRC (Minnesota Statutes 2004).

4.2.3. MFRC Implementation

The following information was provided by the MFRC detailing their efforts in response to the landscape-level directives given to them by the GEIS and SFRA.

Establish a Framework

In July 1997, the MFRC established four components of the landscape-level framework. The framework was developed and implemented as follows:

Define forested landscapes. Landscapes are the areas within which long-range planning of the state's forest resources will occur. These landscapes are based on broadly defined ecological units and existing classification systems, yet recognize existing political and administrative boundaries and planning processes.

Principles and goals. The goals and principles are sufficiently well defined to provide structure to committee actions and outcomes, yet broad enough to allow them an opportunity to exercise their own creativity and to accommodate the diverse environmental, economic and community conditions that occur with the regions for which they are responsible.

General planning process. The general planning process must give considerable latitude to allow the design of planning processes that fit the unique needs, resources and conditions of each landscape. The planning process must also reflect an integrated consideration of the economic, social and environmental factors influencing the condition of each landscape**.**

Among many hoped for outcomes of the *general planning process* are better communication and coordination among forest land managers within a landscape region. Specifically, the voluntary coordination encouraged by the process should:

- Enable forest land managers to gain a better understanding of land management activities occurring on other forest properties within a region;
- Enable regional forest resource committees to be better informed about planned forest management and related activities within their region;
- Enable forest landowners generally to better understand the implications of various land management activities on ecological, economic and social conditions within a region;
- Develop and provide better information on forest land management;
- Provide an opportunity for land managers/owners to voluntarily adjust their management to help achieve the vision for the landscape; and
- Promote a better climate for public education about forest land management.

Regional forest resource committees. Regional forest resource committees are the mechanism by which landscape-based forest resource planning occurs. Committees have been established in each of the six landscapes identified by the MFRC as major forested landscapes. These committees:

- Include representative interests in each region that are committed to and involved in landscape planning and coordination activities;
- Serve as a forum for landowners, managers and representative interests to discuss landscape forest resource issues;
- Identify and implement an open and public process whereby landscape-based strategic planning of forest resources can occur;
- Identify sustainable forest resource goals for the landscape and strategies to achieve those goals; and
- Provide a regional perspective to the MFRC with respect to MFRC activities.

Landscape regions. The state is delineated into six forested landscapes, plus the Metro and Prairie landscapes. Delineation is based on a close match between county lines and the section/subsection lines of the Ecological Classification System (ECS), with county lines being the final determinant (Figure 4.1).

Ecological assessments in each of the six landscape regions are based on ECS sections and/or combinations of subsections within the delineated landscapes. Regional committees for each landscape have taken responsibility for ecological assessments that cross over county boundaries, as follows:

Northeast Landscape:	Superior Uplands Section Southern Superior Uplands Section
Northern Landscape:	Northern Minnesota and Ontario Peatlands Section Lake Agassiz, Aspen Parklands Section
West Central Landscape:	Hardwood Hills Subsection
North Central Landscape:	Minnesota Drift and Lake Plains Section
East Central Landscape:	Western Superior Uplands Section Anoka Sand Plain Subsection
Southeast Landscape:	Big Woods, Oak Savannah, Rochester Plateau, Blufflands Subsections
Metro:	St. Croix Moraines and Outwash Plains Subsection
Prairie:	North Central Glaciated Plains Section Red River Valley Section

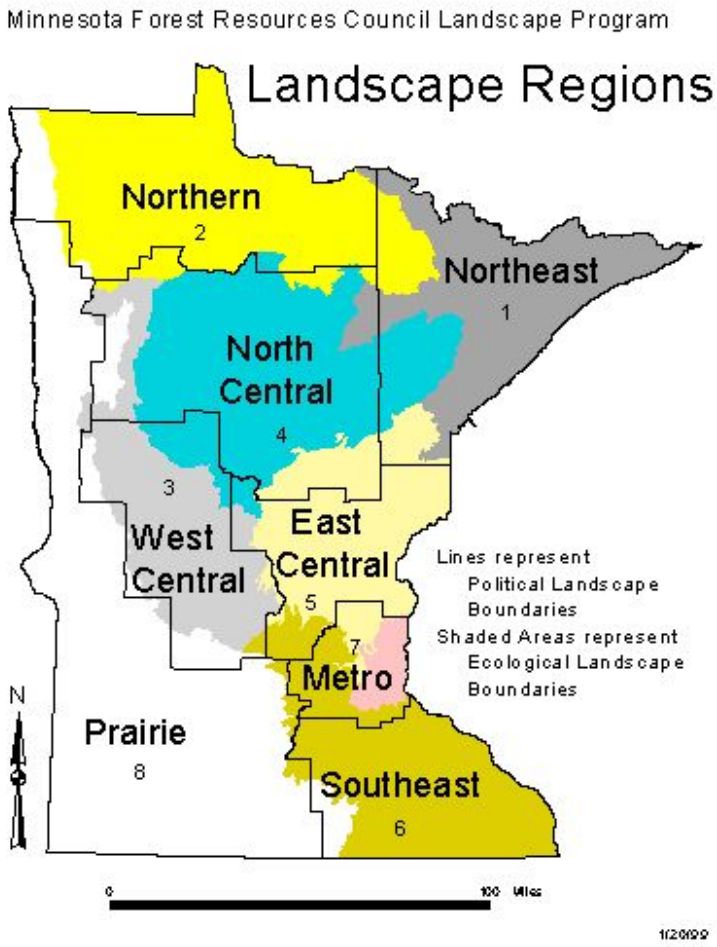

Figure 4.1. Minnesota landscape regions.

Principles and Goals for Landscape-based Forest Resource Planning

Goals

The MFRC has established the following broad goals for use by regional committees as they carry out their landscape-level planning and coordination responsibilities (MFRC 1997a):

- Land area covered by forests within a region's landscape will be the same or larger.
- Forests within a region's landscape will be in a variety of ownerships, serving both public and private interests.
- Within forested landscapes, healthy, resilient, and functioning ecosystems will be maintained within appropriate mixes of forest cover types and age classes to promote timber production, biological diversity and viable forest-dependent fish and wildlife habitats.
- Forests within a region's landscape will be providing a full range of products, services, and values, including timber products, wildlife, and tourism, that are major contributors to economic stability, environmental quality, social satisfaction and community well being.

- Forests within a region's landscape will be viewed by citizens as integral contributors to the quality of life enjoyed by current as well as future generations. The citizenry will be knowledgeable about forest conditions and opportunities within the region and actively engaged in their stewardship.
- Forest conditions and issues within the region's landscape will be better understood by the MFRC through its regional committee.

Principles

The MFRC has established the following principles for use by regional committees as they carry out their landscape-level planning and coordination responsibilities (MFRC 1997a):

Principles Guiding the Selection of Strategies

Landscape coordinating actions should:

- Effectively address the major forest resource issues identified in the region to achieve the goals established by the regional committees.
- Respect differences in goals and objectives of public and private forest owners within a forested landscape, as well as the rights and responsibilities of forest land ownership.
- Reflect a regional landscape's broad diversity of interests and perspectives in the use, management and protection of forest resources.
- Be selected after thoughtful deliberation and careful review of a variety of potential actions (policies/programs) that might be voluntarily undertaken by landowners.
- Be guided by the most currently available, science-based information about the condition of the region's forests, economies and communities.
- Reflect adaptive management processes that involve opportunity for continuous learning experiences.
- Be capable of being fully implemented with existing (or forthcoming) financial and professional resources.
- Promote forest practices that improve forest ecosystem health, resiliency and productivity within forested landscapes which, when aggregated, will achieve statewide goals.

Principles Guiding the Landscape Coordination Process

Landscape coordinating actions should:

- Result from cooperation and coordination among and between landowners, agencies and organizations responsible for forested landscapes.
- Result from open and continuous communication and dialogue among all parties interested in sustaining regional forested landscapes.
- Result from an engaged public that supports and has confidence in the effectiveness of the landscape-level planning and coordination process being implemented by the MFRC through its regional committees.

General Process: Landscape Planning and Coordination

Assessment

The purpose of assessments has been to provide each committee with accurate baseline information on existing and potential ecological, social and economic conditions in the landscape region. Assessments have compiled information across ownerships to give a broad

perspective that helps people accept and understand the data used in the assessments. Developing assessments has been an ongoing and interactive process as the committees addressed issues and requested more specific information.

Key elements of ecological assessments, which evaluate ecosystem integrity, have included:

- A system for collecting and evaluating ecological information;
- An understanding of historical vegetation and disturbance patterns; and
- A characterization of existing and potential vegetation patterns and ecological conditions.

Social and economic assessments appraise the region's social and economic conditions as they relate to regional economic activity, income and employment and general community health. In each of the six major forested landscape regions, efforts have been made to assemble the best information available that describes current and potential conditions of a landscape region. This assessment process was done using people skilled in data analysis, geographic information systems, and natural resource management.

Vision, Goals, and Issues

Using information provided by the assessment, regional committees have identified a common vision and goals for addressing existing and potential conditions considered desirable for each region. The vision and goals have addressed regional ecological, economic and social concerns and generally have been consistent with the broader statewide vision and goals developed by the MFRC. As part of the process, some regional committees have defined issues that prevent their regional vision and goals from being achieved.

Potential Strategies

Regional committees have identified and evaluated alternative strategies based on their ability to achieve desired ecological, economic and social conditions as identified by each region's vision or goals. Perspectives and information provided by land managers responsible for implementing plans and programs have been important to the identification and evaluation of alternative strategies.

Agreed-to Strategies

Identify desired strategies for a landscape region. Selection of strategies has almost always been consensus-based. Committee member agreement has been entirely voluntary. Agreed-to strategies have respected the rights, responsibilities and objectives of both private landowners and public land managers.

Strategy Implementation

In four of the landscape regions (Northeast, North Central, Southeast and West Central), regional forest resource committees have sought voluntary implementation of their agreed-to strategies, with a special focus on coordination of land management plans and programs being implemented by public and private landowners. Similar efforts will soon be underway in two other landscape regions (Northern and East Central). Plan implementation involves extensive communication, discussion and sharing of information between private landowners and public land managers within the landscape region**.**

Evaluation

In the future, regional forest resource committees will periodically evaluate the ability of the agreed-to strategies to accomplish the vision and goals set forth for their region. The evaluation will be used to make adjustments in the strategies or the manner in which they are implemented. Monitoring information developed by the MFRC monitoring program will be used to update assessments in each landscape region.

4.2.4. Landscape Planning and Coordination Accomplishments to Date

4.2.4.1. Regional Forest Resource Committee Representation

Northeast Landscape: USDA Forest Service; DNR Forestry, Wildlife and Ecological Services; The Nature Conservancy; Sierra Club; Potlatch Corporation; Boise Paper Company; Lake, St. Louis, and Carlton County Land Departments; MN Center for Environmental Advocacy; interested citizens; consulting foresters; MN Forest Industries; MN Forestry Association; University of MN College of Natural Resources; Cook County Commissioner.

North Central Landscape: USDA Forest Service; DNR Forestry and Ecological Services; Sierra Club; Potlatch Corporation; Boise Paper Company; Blandin Paper Company; Beltrami, Cass, Itasca, Clearwater and Becker County Land Departments; MN Center for Environmental Advocacy; interested citizens; consulting foresters; MN Forestry Association; Pine River Watershed; BIA Forestry; Ruffed Grouse Society; Itasca Community Collage; North Country Snowmobile Club; MN Trappers Association; Leech Lake Reservation; Leech Lake Watershed Project.

Northern Landscape: DNR Forestry; Boise Paper Company; Tree Farmer; Sierra Club; MN Forest Resources Partnership; Koochiching and Beltrami County Land Departments; Red Lake Band; MN Center for Environmental Advocacy; Koochiching County SWCD; Koochiching County Commissioner; sawmill operator; interested citizen.

West Central Landscape: MN Lakes Association; Building Trades; consultant; MN Deer Hunters Association; MN Farm Bureau; The Nature Conservancy; St. John's University; DNR Wildlife and Forestry; interested citizens; Land Trust; Audubon Society; International Paper Company; USDI Fish and Wildlife Service; Theodore Roosevelt Group (a conservation organization).

East Central Landscape: Isanti, Kanabec, Morrison, and Pine County Planning and Zoning Departments; Pine County Land Department; DNR Forestry, Wildlife and Ecological Services (Nongame Wildlife Program); MN Forestry Association; Pine County Commissioners; St. Croix Scenic Coalition; County Parks; sawmill owners; USDI Fish and Wildlife Service; Tree Farmer; East Central Landowners Association; Woodlands Cooperative; United County Real Estate; logging company; Audubon Society; SWCD; MN Center for Environmental Advocacy; MN Deer Hunters Association.

Southeast Landscape: DNR Forestry, Fisheries and Ecological Services; SWCD; Woodland Council; land trust; interested citizens; logging company; Izaak Walton League; Sportsman Club; Audubon Society; wood cooperative; sawmill owner.

Committee Progress to Date: Planning

Landscape plans have been completed and approved by the MFRC in the following landscapes: East Central, Northeast, North Central, West Central, Northern, and Southeast.

Development of a plan for the Metro landscape has been deferred for the time being. The MFRC has decided not to do a landscape plan for the Prairie landscape.

Committee Progress to Date: Coordination

The North, Northeast, North Central, Southeast East Central and West Central landscapes all have coordination groups meeting on a regular basis to discuss and plan coordination activities.

Committee Work Products

Description of Work	*Date Prepared*	*How it is being used*
Northeast Landscape		
1. Range of Natural Variability in Forest Structure for the Northern Superior Uplands. Lee E. Frelich.	September 1999	Foundation document to determine recommendations on balancing age-class and cover-type using the RNV concept.
2. Northeast Landscape Range of Natural Variation Analysis: Methods, Data and Analysis. Mark A. White, George E. Host and Terry Brown.	January 2001	Defined the RNV for each plant community, which was used to determine recommendations on age-class and cover-type for landscape.
3. Mapping Range of Natural Variation Ecosystem Classes for the Northern Superior Uplands: Draft Map and Analytical Methods. Mark A. White and George E. Host.	August 2000	Produced the base map for plant communities in the NE, which was used to determine acreage of age-class and cover types (growth stages) in each plant community. Is the ecological map currently being used for coordination activities.
4. Northern Superior Uplands: A Comparison of Range of Natural Variation and Current Conditions. Terry Brown and Mark White. (Introduction, Methods and one plant community)	February 2002	Provided a comparison of current conditions to RNV, which gave the extent of change needed to meet desired conditions.
5. Northern Minnesota Forestry Analysis. Richard Lichty, et al. UMD Bureau of Business and Economic Research	July 2001	Provided an analysis of economic activity in the landscape related to wood products.
6. Forestry Bottleneck Analysis. UMD Bureau of Business and Economic Research	September 2002	Provided an economic impact analysis for five different scenarios for moving toward RNV. Used in final decision making process on recommendations to balance age-class and cover-type
7. Atlas of Background Information for NE Landscape	July 1998	Provided a summary of existing information for the NE Regional Committee to use.
8. Northeast Regional Landscape Current Conditions and Trends Assessment	July 1999	Provided an assessment of current conditions and trends using existing social, economic and ecological information.
9. Recommended Desired Outcomes, Goals and Strategies Northeast Landscape	March 2003	Final report of NE Committee approved by the Council. Is the working document that coordination activities are based on in the landscape.

NC Landscape		
1. Natural Range of Variability Estimates for Forest Vegetation Growth Stages of Minnesota's Drift and Lake Plains.	April 2000	Foundation document to determine recommendations on balancing age-class and cover-type using the RNV concept.
2. Vegetation Comparisons of Current Conditions to RNV and Historical Conditions on Public and Selected Private Land in Drift and Lake Plains. A combination of forest inventory data compiled by MFRC and UPM Kymmene - Blandin Paper Company.	February 2000	Compared current age-class and cover-type data and was used to make recommendations on age-class recommendations.
3. Plant Community map	October 2000	Produced the base map for plant communities in the NE, which was used to determine acreage of age-class and cover types (growth stages) in each plant community. Is the ecological map currently being used for coordination activities.
4. Drift and Lake Plains: A Comparison of Range of Natural Variation and Current Conditions. Terry Brown and Mark White, NRRI	July 2001	Provided a comparison of current conditions to RNV, which gave the extent of change needed to meet desired conditions.
5. Northern Minnesota Forestry Analysis. Richard Lichty et al. UMD Bureau of Business and Economic Research	September 2002	Provided an analysis of economic activity in the landscape related to wood products.
6. Forestry Bottleneck Analysis. UMD Bureau of Business and Economic Research	July 2000	Provided an economic impact analysis for five different scenarios of moving toward RNV. Used in final decision-making process on recommendations to balance age-class and cover-type.
7. MN North Central Landscape Current Conditions and Trends Assessment	May 2000	Provided an assessment of current conditions and trends using existing social, economic and ecological information.
8. Recommended Desired Outcomes, Goals and Strategies: North Central Landscape	March 2003	Final report of NC Committee approved by the Council. Is the working document on which coordination activities in the landscape are based.

Northern Landscape 1. Forest Resource Management in Northern Minnesota: A Landscape Perspective	November 2002	Summarized existing plans in Northern Landscape; used by Committee to make recommendations
2. Recommended Desired Outcomes, Goals and Strategies Northern Landscape Region	May 2004	Final report of Northern Committee approved by the Council. Is the working document on which coordination activities in the landscape are based.
West Central Landscape 1. Minnesota West Central Landscape Current Conditions and Trends Assessment: Draft. Minnesota Forest Resources Council Landscape Program	March 2001	Provided an assessment of current conditions and trends using existing social, economic and ecological information
2. Forest Resource Management in West Central Landscape: A Landscape Perspective	May 2002	Summarized existing plans in West Central Landscape; used by committee to make recommendations
3. Forests in the West Central Landscape: Desired Outcomes, Goals and Strategies	March 2004	Final report of the West Central Committee approved by the MFRC. Is the working document on which coordination activities in the landscape are based.
Southeast Landscape 1. Minnesota Southeast Landscape Current Conditions and Trends Assessment: Draft, Minnesota Forest Resources Council Landscape Program	March 2000	Provided an assessment of current conditions and trends using existing social, economic and ecological information
2. Forest Resource Management in Southeast Minnesota, A Landscape Perspective	May 2001	Summarized existing plans in Southeast Landscape; used by committee to make recommendations
3. Recommended Vision, Goals and Strategies: Southeast Landscape	June 2003	Final report of the Southeast Committee approved by the MFRC. Is the working document on which coordination activities in the landscape are based.
East Central Landscape 1. Minnesota East Central Landscape Current Conditions and Trends Assessment: Draft, Minnesota Forest Resources Council Landscape Program	March 2001	Provided an assessment of current conditions and trends using existing social, economic and ecological information
2. Forest Resource Management in East Central Minnesota, A Landscape Perspective	June 2004	Summarized existing plans in East Central Landscape; used by Committee to make recommendations
3. East Central Minnesota: Social and Economic Trends and Implications, Forestry Analysis, UMD School of Business and Economic Research	March 2004	Provided social and economic information and analysis of implications on forest resources in the landscape. Used by committee to make recommendations.

Attention to Specific Landscape-level Mitigation Strategies Identified in the GEIS

The following identifies the work of the MFRC and its regional landscape committees in addressing specific landscape-level strategies for mitigating impacts identified in the GEIS.

Discourage Forest Land From Being Converted To Other Uses. The West Central, East Central, North Central and Southeast landscape plans all have specific goals and strategies designed to discourage forest land from being converted to other uses. The Northeast and Northern landscape plans do not have specific goals and strategies to deal with conversion, primarily because of the large percentage of public forest ownership and lower levels of development pressure. Refer to landscape plans for goals and strategies.

Balance Forest Age-Class and Cover-Type Structure. All the landscape plans except the Northern Landscape made recommendations on how to balance the forest age-class and cover-type structure:

Northeast: approximates/moves toward the range of variability (the spectrum of conditions possible in ecosystem composition, structure and function, considering both temporal and spatial factors) for plant communities naturally living and reproducing in northeastern Minnesota.

North Central: There will be an increased component of red, white, and jack pine, cedar, tamarack, spruce, and fir. The forest will have a range of species, patch sizes, and age classes that more closely resemble natural patterns and functions within this landscape.

West Central: Historically this landscape was 36% (1,985,400 acres) forested in the following cover types: Pine, Tamarack, Oak, Lowland Hardwoods, Upland Hardwoods and Aspen/Birch. Restore these native forested types from the current 11% (579,300 acres) to 15% (825,000 acres) in the landscape.

Southeast: Increase forest land that is biologically diverse (appropriate species on appropriate sites) and is in contiguous areas. On mesic sites, promote a mix of maple, cottonwood, basswood, oak and other native species. On dry (oak savanna) and dry-mesic (hardwood) sites, promote regeneration and management of oak, walnut, shagbark hickory and other native species.

East Central: The East Central landscape has recently completed the recommendations on age-class and cover type structure.

Protect Riparian Corridors. The West Central Plan has the following goals concerning riparian corridors (refer to plan for strategies):

1. Maintain and increase riparian buffers along and around all public waters.
2. BMPs are used on at least 80% of the management activities in forest and forest riparian zones to protect water quality.

The North Central Plan has goals to protect shorelines around lakes (refer to plan for strategies):

1. Protect sensitive and/or undeveloped shoreline.
2. Increase the natural benefits of developed shorelines.
3. Minimize loss of publicly held shorelines.

The Northern, Northeast, and Southeast do not have specific goals and strategies for protection of riparian corridors.

Promote the Use of Extended Rotation Forestry. The Northeast and North Central Plans promote the use of extended rotation forestry since their desired conditions (refer to 2 above) would move the forest to an older age class distribution. The Northern Plan has no recommendations for age-class distribution. The West Central and Southeast Plans are more concerned with maintaining and reestablishing forest cover than with extended rotation forestry, because of major reductions in forest cover in those regions and the relatively small percentage of public forest land ownership.

Protect Sensitive Sites for Rare Plant Species. This is a site-level consideration, and therefore was not directly considered in any of the landscape plans.

Promote Development of a Landscape-based Road and Trail Plan. This has not been done. An inventory of all roads was completed for the Northeast and North Central Landscapes, but the inventory has not been used to develop a landscape-based road and trail plan.

Develop an Integrated Pest Management Strategy. None of the landscape plans dealt with developing an integrated pest management strategy.

Develop Visual Management Guidelines. Visual management guidelines were developed before landscape planning began, and were included in the site-level guidelines developed by the MFRC and many partners in the late 1990s. Visual management guidelines were deemed a site level rather than a landscape-level issue.

4.2.5. Landscape-level Planning and Coordination: Public and Corporate Private Forest Landowners

The framework by which to address landscape-level planning activities included the formation of regional committees. The MFRC and the regional committees have accomplished varying levels of progress toward assessing and completing their respective regional goals. One of the unique aspects of the response dictated by the GEIS is that landowners and stakeholders should be involved in the process of creating and implementing regional plans. Without the participation and perceived success of the landowners, the MFRC cannot successfully reach its goals. Thus, the landowners that participated in the MFRC landscape-level planning process were asked for their perspectives on the success and effectiveness of the process and associated products of the MFRC landscape level initiatives to date.

The following section describes information provided by public and corporate private forest landowners who participated in the MFRC's landscape planning and coordination activities. The

surveyed landowners provided information about their participation in and perceived effectiveness of the MFRC framework and regional efforts.

All of the landowners surveyed for the site-level initiatives were also surveyed regarding the landscape-level planning initiatives. The response rate to the landscape planning portion of the survey was lower than the response rate to the site-specific portion of the survey. Fifteen of the 16 public respondents that completed the site-specific survey also completed the landscape-level survey. Four of the eight private respondents that completed the site-specific survey also completed the landscape level survey. It should be noted that the participants surveyed were not an inclusive list of participants. NIPF and community participants were not surveyed about their perceptions of the MFRC program.

4.2.5.1. Participation and Contributions to the Landscape Planning and Coordination

Respondents were concentrated in the North Central and Northeast regions (Table 4.24). Public organizations had the largest number of respondents in the Northeast and North Central regions, while private organizations had the most participation in the Northern and Northeast Regions. Respondents were allowed to participate in multiple regions, and thus sometimes provided feedback on more than one region. One large landowner participated in and responded to questions regarding all of the regions. In the two regions with one response, it is the response of this one large organization.

Table 4.24. Organizational participation in MFRC Landscape-level Planning Initiatives.

	Landscape regions					
	Northeast	**Northern**	**North Central**	**Southeastern**	**East Central**	**West Central**
Private organizations						
Respondents	3	3	2	0	0	0
Public organizations						
Respondents	6	3	10	1	2	1
Total						
Respondents	**9**	**6**	**12**	**1**	**2**	**1**

Participation levels varied among organizations. The 18 organizations that participated contributed a total of 635 hours to the landscape planning program in 2004 (Table 4.25). The average organizational contribution was 35 hours. Organizations reported contributing as few as six and as many as 100 hours to the MFRC Landscape Planning Program in 2004. The range differed between private and public organizations. Based on the survey results, the public organizations contributed fewer average hours per organization (33 hours) than private organizations, but also had a much wider range of contributions (between 6 and 100 hours). Private organizations donated an average of 47 hours and all private organizations contributed between 40 and 60 hours.

Survey respondents were asked to provide information on their level of involvement in the landscape planning and coordination activities in 2004, although 2004 may not be representative of an organization's typical annual level of involvement. For instance, one respondent from the North Central region said that a majority of its work had been completed in 2003. The

organization estimated its level of contribution was three times greater in 2003 than in 2004, and suggested that its contribution will likely be higher next year as implementation of landscape-level strategies begins.

Table 4.25. Estimated staff contributions to the MFRC Landscape Planning Program in 2004.

	Responding organizations	Total staff hours	Mean staff hours	Range of staff hours
Private organizations	3	140	47	40-60
Public organizations	15	495	33	6-100
Total	**18**	**635**	**35**	**6-100**

Organizations made a variety of contributions to the MFRC's landscape-level planning efforts, one being staff time. In addition to the staff hours, organizations made other contributions such as data collection and analysis efforts, equipment purchases, contracts for professional services, and additional expenses related to landscape-level planning efforts. Beyond staff time, the greatest contribution was nonsalary staff cost which 12 organizations reported donating (Table 4.26). Nine organizations contributed data collection and analysis, four donated contracts for professional services, three bought equipment, and three made other contributions. The "other" contributions included money, projects, grant contributions, and administrative functions. Private organizations proportionally contributed more than public organizations with 100% of private organizations contributing both nonsalary costs and data collection and analysis and 50% of private respondents reporting equipment purchases, contracts for service, and other contributions. In contrast, just over 50% of public organizations contributed nonsalary costs, one-third contributed data collection and analysis, and less than 15% of public organizations contributed equipment purchases, contracts for services and other contributions.

Table 4.26. Number of organizations indicating additional (other than staff salary) contributions made by organizations to the MFRC Landscape Planning Program.

	Nonsalary staff costs	Data collection and analysis	Equipment purchases	Contracts for services	Other
Private organizations	4	4	2	2	2
Public organizations	8	5	1	2	1
Total	**12**	**9**	**3**	**4**	**3**

Perceptions of Program Effectiveness

In order to assess the framework established by the MFRC, organizations were asked to rate their perceived effectiveness of various aspects of the landscape-level planning initiatives. This included an evaluation of the MFRC landscape planning and coordination program, as well as region-specific landscape planning and coordination activities

Overall effectiveness in identifying and addressing landscape-level forest resources issues. When asked about the overall effectiveness of the MFRC in identifying and addressing landscape-level forest resource issues, two thirds of the organizations perceive the effectiveness of the landscape planning program to be moderately to extremely effective (Table 4.27). Public organizations found the program to be more effective than private organizations. Nearly three-quarters of the responding public organizations rated the program as moderately or extremely effective, while only two of the four responding private organizations did so. One respondent

that commented on the effectiveness said that the program would have been more effective except that politics among participants held up much of the progress of the group.

Table 4.27. Organizational perceptions of the overall effectiveness of the MFRC Landscape Planning Program in identifying and addressing landscape-level forest resource issues.*

	Extremely effective	**Moderately effective**	**Minimally effective**	**Not effective**
Private organizations				
Acres	0	359,692 (43)	308,000 (37)	156,183(19)
Respondents	0	2 (50)	1 (25)	1 (25)
Public organizations				
Acres	1,590,640 (38)	1,140,583 (27)	1,153,267 (28)	300,367 (7)
Respondents	3 (21)	7 (50)	3 (21)	1(7)
Total				
Acres	**1,590,640 (32)**	**1,500,275 (30)**	**1,461,267 (29)**	**456,550 (9)**
Respondents	**3 (17)**	**9 (50)**	**4 (22)**	**2 (11)**

* Numbers in parentheses represent corresponding percentages of total response

Nearly identical results were found regarding the perceived effectiveness of the MFRC landscape planning program at effectively coordinating forest management activities across a large landscape and with other landowners (Table 4.28). Overall, more respondents find the program to be effective than not effective, and public organizations perceive it as more effective than do private organizations. One respondent stated that the program "was a good tie to the SFRMP" and another noted that the planning program is still in its beginning stages**:** "the program is moderately effective, but the implementation is just beginning."

Table 4.28. Organizational perceptions of the overall effectiveness of the MFRC Landscape Planning Program in effectively coordinating forest management activities across large landscapes and multiple ownerships.

	Extremely effective	**Moderately effective**	**Minimally effective**	**Not effective**
Private organizations				
Acres	0	359,692 (54)	308,000 (46)	0
Respondents	0	2 (67)	1 (33)	0
Public organizations				
Acres	1,590,640 (38)	1,140,583 (27)	1,153,267 (28)	300,367 (7)
Respondents	3 (21)	7 (50)	3 (21)	1 (7)
Total				
Acres	**1,590,640 (32)**	**1,500,275 (30)**	**1,461,267 (29)**	**300,367 (9)**
Respondents	**3 (17)**	**9 (50)**	**4 (22)**	**1 (11)**

* Numbers in parentheses represent corresponding percentages of total response

The MFRC's landscape-level planning initiative has had variable influence on the manner in which an organization manages its forest resources. Eight of the 21 responding organizations indicated they have made some changes to their management practices as a result of the landscape planning program (Table 4.29). More respondents made few to no changes than made considerable to extensive changes. Four public organizations indicated the program has had no influence on their forest management activities, while two stated the MFRC's landscape planning program has resulted in substantial change in how they manage their forests.

Table 4.29. Organizations indicating that the MFRC Landscape Planning Program has changed the manner in which they manage their forest resources.

	Extensive changes	Considerable changes	Some changes	Few changes	No changes
Private organizations					
Acres	0	200,875 (23)	359,692 (41)	308,000 (35)	0
Respondents	0	2 (40)	2 (40)	1 (20)	0
Public organizations					
Acres	1,441,782 (17)	148,858 (2)	6,123,042 (70)	420,541 (5)	599,534 (7)
Respondents	2 (13)	1 (6)	6 (38)	3 (19)	4 (25)
Total					
Acres	**1,441,782 (15)**	**349,733 (4)**	**6,482,734 (68)**	**728,541 (8)**	**599,534 (6)**
Respondents	**2 (10)**	**3 (14)**	**8 (38)**	**4 (19)**	**4 (19)**

* Numbers in parentheses represent corresponding percentages of total response

Organizations were asked to describe specific examples of how the MFRC's landscape planning program has changed the way they manage forests. Seven organizations stated landscape-level objectives have been incorporated into their organization's management plans, while two said that outside influences were more influential to their management than the work done by the landscape planning program. Two additional organizations commented that this process is just beginning and thus the impacts on the organization's approach to forest management cannot yet be assessed. Finally, one organization said that while not incorporated into their management plan, landscape level planning initiated their "on-site thought process to protect the resource."

Additional Comments

Organizations were provided the opportunity to give additional feedback on their thoughts about the MFRC Landscape Level Planning Process. Six respondents provided information about the process. While the feedback was very different between the respondents, three gave generally positive feedback and three gave generally negative feedback.

Of the three positive comments, one talked about the ability of the process to provide "buy-in" from other stakeholders. While they used the products of the landscape-level planning program extensively in their new management plan, they felt that the actual outcome and process would have been similar for them regardless of whether the landscape-level planning had occurred. However, the ultimate benefit is that they received feedback from stakeholder groups in advance and had the opportunity to dispelled myths of how they manage their land. The educational aspect of the landscape-level management plan has led to a smooth adoption of their new management plan which they feel would not have been achieved without the planning program. The other two positive comments expressed their dedication to and satisfaction with the program. One of the two noted the program's unique qualities by saying that "this program is a model for other states especially since it's voluntary."

Of the three respondents that provided negative comments, one felt the timing should have been different and one was frustrated with the consensus style process and is looking for other options. "Future participation will be limited if done on a consensus format. We would look to conflict/ adversarial resolution through voting on issues, or some other valid process to positively work through issues where agreements cannot be reached." The final respondent felt that the landscape-level planning process took the power and authority away from the counties and voters and put it in the hands of centralized authority.

Region-specific Landscape Planning Processes

In addition to the overall assessment of the effectiveness of the MFRC's landscape planning and coordination activities, information was requested on the level of participation and perceived effectiveness of individual regional MFRC planning and coordination efforts. Respondents were asked to provide information on the regions in which they participated. It is important to note that the progress of each landscape region toward the creation and implementation of its landscape plan varies considerably. Consequently, not all aspects of the regional planning efforts have been undertaken by all regions. Respondents were asked to assess their participation and their perceived effectiveness of the process in the regions in which they participated to the extent these activities have, in fact, been undertaken.

A five-point Likert Scale rating was used to assess respondent's level of involvement in regional MFRC landscape planning and coordination initiatives. Response choices for identifying an organization's level of involvement in regional landscape planning activities were: 1=no involvement; 2=minimal involvement (the organization occasionally participated); 3=modest involvement (the organization regularly participated); 4=moderate involvement (the organization actively participated but was not a lead participant); and 5=extensive involvement (the organization was a lead participant).

Respondents were also asked a set of questions and to rate their perceived effectiveness of various aspects of the regional landscape programs in which they participated. Responses to these questions were organized on a four-point Likert Scale: 1=not useful (provided no new information or understanding); 2=minimally useful (provided minimal information or understanding that would not otherwise have been available to this organization); 3=moderately useful (provided some information or understanding that would not have otherwise been available to this organization); and 4=extremely useful (provided considerable information or understanding that would not otherwise have been available to this organization).

Northeast Region

Respondents in the Northeast region had an average response of being modestly to moderately involved in nearly all aspects of the landscape planning process (Table 4.30). The exception being the evaluation of implementation strategies in which respondents indicated moderate to extensive involvement. Respondents were least involved in the coordination of land management activities. When asked to assess the usefulness of the elements of the program, the respondents found all of the planning program elements to be moderately useful in that the process provided some information or understanding that would not have otherwise been available. The respondents found the assessment of conditions to be the most useful part of the region's landscape planning program, while the coordination of land management activities was perceived to be least useful. Respondents also indicated their level of involvement in land management coordination activities was the lowest of the various regional committee activities evaluated. It should be noted that the coordination of activities is just beginning and thus the responses may be influenced by the degree to which this activity has developed.

Table 4.30. Organizational involvement and perceptions of usefulness in elements of the landscape planning process in the Northeast Region.

	Assessment of conditions	Desired future	Strategies to achieve future	Coordination of land management	Evaluation of implementation

		conditions	conditions	activities	strategies
Number of respondents	7	7	7	7	5
Level of Involvement*	3.8	3.8	3.8	3.5	4.1
Level of Usefulness**	3.3	2.9	3.0	2.7	2.8

*****Number represents the mean of responses using the following scale (5=extensive involvement, 4=moderate involvement, 3=modest involvement, 2=minimal involvement, and 1= no involvement).
** Number represents the mean of responses using the following scale (4=extremely useful, 3=moderately useful, 2=minimally useful, and 1=not useful).

Northern Region

Respondents from the Northern region expressed varied participation levels in the different program elements (Table 4.31). Participation regarding most program elements ranged from moderate to extensive involvement. Two notable exceptions are land management coordination and evaluation of implementation strategy progress—respondents indicated only moderate to modest involvement. The data suggests that for most aspects of the northern regional landscape initiative, the average participant was actively involved with some serving as lead participants in certain activities. When asked to assess the usefulness of the program, responses ranged from minimally useful to moderately useful. This suggests that, on average, participants gained minimal to some information or understanding that would not otherwise have been available to them. Respondents found the coordination of land management activities to be the least useful and both the assessment of conditions and evaluation of implementation strategies to be the most useful. The element with the least involvement was also found to be the least useful.

Table 4.31. Organizational involvement and perceptions of usefulness in elements of the landscape planning process in the Northern Region.

	Assessment of conditions	Desired future conditions	Strategies to achieve future conditions	Coordination of land management activities	Evaluation of implementation strategies
Number of respondents	4	4	4	3	2
Level of Involvement*	4.1	4.6	4.6	3.8	3.8
Level of Usefulness**	3.0	2.5	2.8	2.0	3.0

*****Number represents the mean of responses using the following scale (5=extensive involvement, 4=moderate involvement, 3=modest involvement, 2=minimal involvement, and 1= no involvement).
** Number represents the mean of responses using the following scale (4=extremely useful, 3=moderately useful, 2=minimally useful, and 1=not useful).

North Central Region

The North Central landscape planning region had the largest number of participants who responded to this survey (Table 4.32). Respondents' levels of involvement ranged from modest to moderate, meaning that participants regularly or actively participated but were not lead participants. The highest level of organizational involvement indicated was during the development of strategies to achieve future conditions, while the lowest was in the assessment of conditions. When respondents were asked to assess the usefulness of the various elements, all the elements of the North Central's landscape planning program were considered to be minimally to moderately useful, suggesting that participants gained minimal to some information that would not otherwise have been available to them. Program activities that focused on developing strategies to achieve future forest conditions were perceived to be the most useful, while the coordination of land management activities was found to be the least useful. As found in other

landscape regions, the element found to be most useful also had the highest level of participation.

Table 4.32. Organizational involvement and perceptions of usefulness in elements of the landscape planning process in the North Central Region.

	Assessment of conditions	Desired future conditions	Strategies to achieve future conditions	Coordination of land management activities	Evaluation of implementation strategies
Number of respondents	11	11	10	10	8
Level of Involvement*	3.0	3.3	3.6	3.4	3.1
Level of Usefulness**	2.6	2.6***	2.8	2.4****	2.6

*****Number represents the mean of responses using the following scale (5=extensive involvement, 4=moderate involvement, 3=modest involvement, 2=minimal involvement, and 1= no involvement).
** Number represents the mean of responses using the following scale (4=extremely useful, 3=moderately useful, 2=minimally useful, and 1=not useful).
***Based on 10 responses.
****Based on 9 responses.

Southeastern Region

There was only one respondent in the Southeastern region (Table 4.33). This respondent indicated a moderate to extensive involvement in all elements of this region's program. Further, they found all of the elements to be extremely useful (meaning they gained considerable information that they would not otherwise have obtained) with the exception of the assessment of desired future conditions. This category was found to be moderately useful, they gained some information.

Table 4.33. Organizational involvement and perceptions of usefulness in elements of the landscape planning process in the Southeastern Region.

	Assessment of conditions	Desired future conditions	Strategies to achieve future conditions	Coordination of land management activities	Evaluation of implementation strategies
Number of respondents	1	1	1	1	1
Level of Involvement*	4.5	4.5	4.5	4.5	4.5
Level of Usefulness**	4.0	3.0	4.0	4.0	4.0

*****Number represents the mean of responses using the following scale (5=extensive involvement, 4=moderate involvement, 3=modest involvement, 2=minimal involvement, and 1= no involvement).
** Number represents the mean of responses using the following scale (4=extremely useful, 3=moderately useful, 2=minimally useful, and 1=not useful).

East Central Region

Two respondents participated in the East Central region's program (Table 4.34). One of the respondents participated moderately to extensively, while the other expressed no involvement in any of the region's landscape activities. The perceived level of usefulness was found to be extremely useful, with the exception of the creation of desired future conditions which was found to be moderately useful meaning that the respondents gained considerable to some information or understanding that would not otherwise have been available.

Table 4.34. Organizational involvement and perceptions of usefulness in elements of the landscape planning process in the East Central Region.

	Assessment of	Desired future	Strategies to achieve future	Coordination of land management	Evaluation of implementation

	conditions	conditions	conditions	activities	strategies
Number of respondents	2	2	2	1	2
Level of Involvement*	2.8	2.8	2.8	4.5	2.8
Level of Usefulness**	4.0	3.0	4.0	4.0	4.0

*****Number represents the mean of responses using the following scale (5=extensive involvement, 4=moderate involvement, 3=modest involvement, 2=minimal involvement, and 1= no involvement).
** Number represents the mean of responses using the following scale (4=extremely useful, 3=moderately useful, 2=minimally useful, and 1=not useful). Rating based on only one respondent.

West Central Region

There was only one respondent in the West Central region (Table 4.35). This respondent indicated a moderate to extensive involvement in all elements of this region's program. Further, it found all of the elements to be extremely useful with the exception of the assessment of desired future conditions which they found to be moderately useful, meaning they gained considerable information that they would not otherwise have obtained from most elements with the exception of desired future conditions from which they gained some information.

Table 4.35. Organizational involvement and perceptions of usefulness in elements of the landscape planning process in the West Central Region.

	Assessment of conditions	Desired future conditions	Strategies to achieve future conditions	Coordination of land management activities	Evaluation of implementation strategies
Number of respondents	1	1	1	1	1
Level of Involvement*	4.5	4.5	4.5	4.5	4.5
Level of Usefulness**	4.0	3.0	4.0	4.0	4.0

*****Number represents the mean of responses using the following scale (5=extensive involvement, 4=moderate involvement, 3=modest involvement, 2=minimal involvement, and 1= no involvement).
** Number represents the mean of responses using the following scale (4=extremely useful, 3=moderately useful, 2=minimally useful, and 1=not useful).

Other Landscape-level Planning Initiatives Completed Outside the MFRC

The MFRC's landscape-level planning initiative encourages participants to undertake forest planning and management practices consistent with the strategies identified through the regional planning process to achieve future forest resource conditions for the landscape region. One example would be the incorporation of regional landscape direction into agency-specific landscape planning processes. The incorporation of landscape-level planning into routine management is summarized well by one participant who commented: "It initiates the on-site thought process to protect the resource." In this way, one measure of success is the work managers do outside the landscape planning process that upholds the values and goals established in the landscape planning process.

Survey respondents were asked to describe additional landscape-level planning and management projects outside of the MFRC's landscape-level planning process that had been undertaken by their organization. Seven organizations described the following six landscape-based planning and coordination projects.

Nemadji River Basin—This project is a partnership of three organizations working on stopping the severe erosion of a basin composed of sensitive soils.

Bear River demonstration forest—Eight organizations partnered to create a model forest to

demonstrate innovative silviculture techniques including uneven-aged management. Due to funding constraints, this forest is no longer operating.

Minnesota Ecosystem Project—A four-year project that included field sampling for vegetative species, small mammals, birds, reptiles, and amphibians.

County Comprehensive Plan—Prior to the landscape process, one county involved all their landowners in various projects for the betterment of the landscape.

Cornish Hardwood Management Area—A partnership between one county and the State, the management area is a contiguous deciduous forest managed using uneven-aged management practices. It provides habitat that is otherwise declining in the state and provides a site to develop further the understanding of the potential for uneven-aged management—including its wildlife and product development potentials.

Dark River Trout Project—A partnership between five organizations that reestablished a trout stream to its natural functioning. This project included a workshop that educated 100 landowners on management issues of family owned land to enhance the success of the project.

4.3. Timber Harvesting and Forest Management in Minnesota: Assessment of Research Program Response to the MN GEIS

4.3.1. Background and Overview

The Minnesota Generic Environmental Impact Statement on Timber Harvesting and Forest Management (GEIS) recommended development of a Forest Resources Research Program for successful mitigation of unacceptable impacts from timber harvesting and forest management (Jaakko Pöyry Consulting, Inc., 1994). In response, the Sustainable Forest Resources Act (MS §89A) was enacted, part of which recommended the establishment of a forest resources research advisory committee (Minnesota Statutes 2004). This committee was established by the Minnesota Forest Resource Council (MFRC) in 1996, appointing representatives from the following organizations to serve on the committee: College of Natural Resources, University of Minnesota; Natural Resources Research Institute, University of Minnesota; Minnesota Department of Natural Resources (DNR); North Central Research Station, USDA Forest Service; Minnesota Forest Industries (via a representative of the National Council of the Paper Industry for Air and Stream Improvement); Minnesota Forest Action Network; and Minnesota Forest Resources Partnership.

The assessment which follows is derived from the survey responses provided by the MFRC regarding the MFRC's Research Advisory Committee (RAC) and related activities. It provides an assessment of the RAC and other MFRC activities in their function to identify research needs, support research, and foster coordination and collaboration between researchers, organizations, and practitioners.

4.3.2. Issue Identification

A primary activity of the RAC is to undertake an assessment periodically of strategic directions in forest resources research based on input from administrators, researchers, practitioners, and the public. Important components of this include an assessment of the current status of forest resources research in Minnesota; identification of priority forest resources research activities; and an assessment of the progress toward addressing these research needs. The purpose of this assessment is to provide direction to the state's research community on priority forest resources research.

During the summer of 1996, the RAC distributed a Research Status Survey to research institutions throughout the state. The RAC also distributed a Priority Research Needs Survey to a broad group of individuals interested or involved in forestry or forestry-related research in the state. The information gathered from these surveys provided the input needed to compile a draft *Strategic Research Assessment Document*. This document was intended to help identify priority forest resources research and help to direct future funding.

In 1997, the RAC finalized the *Strategic Research Assessment Document* based on input from various organizations, interest groups and the public gathered via written comments and two public meetings. This document was printed and made widely available to the research community, forest managers, forest users and the public.

In 1998, the RAC published an assessment of priority research directions in a report entitled *Forest Resources Research in Minnesota: Meeting the Information Needs of the Next Decade.* This was the first attempt in the state of Minnesota to evaluate forest resource research needs comprehensively. Information needs identified for sustainable forest management were categorized in four areas: (1) understanding forest ecosystem function and integrity; (2) assessing economic and social aspects of forest resources; (3) developing information and technology to support sustainable forest management and planning; and (4) designing effective policies and programs for forest use, management and protection. This report has been distributed to interested parties over the years since it was completed.

Following these extensive efforts at research issue identification, there has been minimal effort devoted to strategic issue identification. This may be attributed to a $300,000 reduction in the MFRC annual base budget beginning in FY 1998, virtually eliminating direct funding for research by the MFRC in subsequent years. This funding reduction resulted in fewer meetings of the RAC from 1999-2001 than had occurred from 1996-98. Sustained interest was difficult to maintain when funding to support direct research was not available and other pressing priorities needed attention. Although the RAC has not formally met from 2002-2004, the MFRC has decided to reconstitute it in the near future.

4.3.3. Support for Research Program Areas

The GEIS identified a number of areas where information was insufficient and suggested a number of initiatives to facilitate the implementation of the mitigation strategies. Listed below are these research subject areas with the MFRC response regarding the current status of associated initiatives.

Develops a better understanding of timber harvesting and forest management impacts on ecosystem functions and processes

In its first biennial budget, the MFRC committed $300,000 in seed money to develop and support interagency research projects to evaluate the effectiveness of proposed timber harvesting and forest management guidelines. Three relevant studies recommended by the RAC and funded by the MFRC from 1996 to 2001 are entitled:

- Evaluating Riparian Area Dynamics, Management Alternatives and Impacts of Harvest Practices;
- Wildlife Species: Response to Forest Harvesting and Management of Riparian Stands and Landscapes; and
- Impacts of Harvesting on Regeneration, Productivity, and Floristic Diversity of Quaking Aspen and Northern Hardwoods Ecosystems.

Each project leveraged significant additional funding from sources other than the MFRC to support the research. These studies, completed in 2001, are available via the MFRC website (www.frc.state.mn.us). Brief summaries of each study's major findings are included on pages 17-19 of the MFRC 2001 *Annual Report to the Governor and Legislature*, which is also available via the MFRC website.

Identifies the full role of forest soils and their various conditions in forest resource productivity in Minnesota

The first and third studies listed under the previous section included an identification of the role of forest soils in relation to riparian area dynamics and in relation to the impact of timber harvesting on soil productivity, respectively.

From 1999-2004, the MFRC sponsored a multiyear study of the impact of skid trails on soil compaction. This study was published as an M.S. thesis entitled *The Boone Project: A Case Study of the Impacts of Timber Harvesting Activities on Soil Compaction and Aspen Regeneration in North Central Minnesota*. The study identified the extent and pattern of soil compaction on and adjacent to skid trails by number of passes, and the regeneration response to soil compaction on and adjacent to skid trails. Study findings were used to revise site-level guideline recommendations regarding skid trails and how to mitigate impacts on forest soils and forest resource productivity.

Provides a scientific basis for defining desired age class and covertype goals to meet biological diversity objectives

The 1994 GEIS recommended that the State of Minnesota conduct a spatial assessment. The MFRC forest spatial analysis project was initiated in 2000 to improve understanding of past, present, and possible future forest spatial patterns. This project focused on spatial patterns of

vegetation types and age-classes, land uses, and natural and human-caused disturbances. The project focused on three areas of study: (1) How forest spatial patterns have changed over time; (2) How different management scenarios can affect spatial patterns; and (3) How plants and animals are affected by spatial patterns. The project, completed in 2003, developed tools, conducted analyses and assessed the value and limitations of using spatial pattern data in forest management. Seven reports were produced. Also, a major focus of the MFRC Landscape-Level Program has been providing a scientific basis for defining desired age class and covertype goals to meet biological diversity objectives.

Identifies potentially complimentary forest industries in Minnesota

Several MFRC members and staff played a major role in helping to develop the 2003 *Governor's Task Force Report on the Competitiveness of Minnesota's Primary Products Industry*. In the 20 months since the report was completed, several MFRC members and staff have played critical roles in helping implement key report recommendations via both legislative and administrative actions. University of Minnesota College of Natural Resources experts also assisted with this effort.

Several MFRC members and staff and University experts have also played important roles on the Advisory Board to the Blandin Foundation's *Vital Forests/Vital Communities* initiative. This initiative strives to strengthen and diversify Minnesota's forest-based economy, including the primary and secondary forest products industries as well as the special forest products industry.

Monitors broad trends and conditions in the state's forest resources

The Sustainable Forest Resources Act (SFRA) identifies monitoring broad trends and conditions in the state's forest resources as a DNR responsibility. The MFRC, however, has provided financial and staff support to the DNR to help fulfill this mandate.

As directed in the SFRA, the MFRC helped fund accelerated monitoring of timber harvests in riparian areas by the DNR from 2001-2003. Two-year monitoring results suggested that a very small portion of the state's riparian forests (0.4% per year) is affected by timber harvest.

In 2003, the DNR and MFRC concluded that land use decisions that result in the loss of productive forest land may have more enduring effects than timber harvesting in riparian areas. Therefore, the DNR Resource Assessment Unit began focusing its monitoring efforts on forest land use changes, using change detection methods and satellite imagery similar to those used in riparian monitoring. Land use change monitoring was done for 2004, after which it was decided that it would be more productive to compare methodologies for assessing land use change before further statewide evaluations are conducted.

Monitors silvicultural practices and application of the timber harvesting and forest management guidelines

In June 1998, the MFRC published a report entitled *Status of Minnesota Timber Harvesting and Silvicultural Practice in 1996.* A major focus of the MFRC site-level program has been monitoring application of the timber harvesting and forest management guidelines.

Evaluates the effectiveness of practices to mitigate impacts of timber harvesting and forest management activities on the state's forest resources

A study entitled *Effects of Timber Harvest on Archaeological Sites* was funded by the MFRC in 1996 and completed in 1998. This study evaluated effects of timber harvest activities on subsurface archaeological deposits and recommended ways to avoid or mitigate significant adverse impacts.

In 2001, a 10-year study was initiated that is evaluating how well the MFRC site-level guidelines protect forest resources, especially in forested riparian areas. This study, *Evaluating the Sustainability of Timber Harvesting and Forest Management Practices in Riparian Areas*, has been funded by the Minnesota Legislature as recommended by the Legislative Commission on Minnesota Resources. Supplemental funding has been provided by the MFRC. Researchers identified eight pairs of forested riparian sites in northern Minnesota and collected preharvest sampling for each research plot. Each pair of sites includes: (1) a riparian control site with an upland clearcut and no harvesting within the RMZ; and (2) a site where varying amounts of trees are harvested and retained within the riparian zone. This study will provide important insights into the effectiveness of the MFRC site-level guidelines in protecting riparian areas.
From 1999-2004, the MFRC sponsored a multi-year study of the impact of skid trails on soil compaction. See the description of *"The Boone Project: a Case Study of the impacts of Timber Harvesting Activities on Soil Compaction and Aspen Regeneration in North Central Minnesota"* in the previous section for a brief summary of this study.

As a follow-up to riparian research funded in 1999, in 2003 the MFRC initiated a study entitled *Assessing and Minimizing Wind Damage to Leave Trees*. Results from this study and subsequent analyses of field data by MFRC staff have provided valuable information for use in revising leave tree recommendations in the site-level guidelines.

The MFRC has sponsored several studies of the potential financial effects associated with implementing timber harvesting and forest management guidelines. A study entitled *Assessing the Financial Effects Associated with Implementing Minnesota's Timber Harvesting and Forest Management Guidelines* was initiated in 1999 and completed in 2000. Another research study, *An Assessment of the Extent to Which Forest Landowners Bear Additional Cost Resulting from Implementation of Minnesota Timber Harvesting Guidelines*, was initiated in 2002 and completed in 2003. This study's purpose was to assess who incurs any additional costs or benefits as a result of implementing Minnesota's timber harvesting and forest management guidelines. A closely related study, *Willingness to Pay for Stumpage Requiring Timber Harvesting Guidelines: An Evaluation of Bidder Characteristics, Strategies, and Perceptions*, involved surveying loggers who participated in the study conducted from 2002 to 2003. The goal was to obtain greater insight into each logging firm's business characteristics, perceptions and timber sale bidding behavior.

Evaluates the interaction between the level of timber harvesting and forest management and the state's tourism and outdoor recreation industry

Neither the MFRC nor the RAC has directly supported research on this topic.

Identifies management techniques and impact assessments with regard to forest pests

Neither the MFRC nor the RAC has directly supported research on this topic.

Identifies and evaluates low impact timber harvesting techniques and technology applicable to Minnesota

Neither the MFRC nor the RAC has directly supported research on this topic.

4.3.4. Coordination and Collaboration

The GEIS offered a number of recommendations emphasizing the coordination and collaboration of researchers, organizations, and practitioners. The following assessment of the implementation of these recommendations is provided by the MFRC regarding three topic areas: collaboration between organizations, collaboration between researchers, and interaction and communication between researchers and practitioners.

Collaboration between organizations

The GEIS, as an integral part of the research program, recommends collaboration between organizations with responsibilities for conducting forest resources research. The three research projects recommended for funding by the RAC and funded by the MFRC all involved at least two research organizations, because collaboration between organizations with responsibilities for conducting forest resources research was a basic requirement for a proposal to receive funding. All research projects funded by the MFRC have supported collaboration with other research and/or forest resource management organizations in conducting the research. These particular research projects involved, among others, the University of Minnesota's College of Natural Resources and the Natural Resources Research Institute, DNR, USDA Forest Service North Central Research Station, and UPM Kymmene. These organizations contributed to research project design, conduct of the research, in kind support, and/or funding.

Collaboration between researchers

The GEIS recommends collaboration between researchers in different disciplines in conducting forest resources research as an integral part of the suggested research program. The three research projects recommended for funding by the RAC and funded by the MFRC all involved researchers from at least two different disciplines, because collaboration between researchers in different disciplines was a basic requirement for a proposal to receive funding. Most research projects funded by the MFRC have been encouraged to collaborate with researchers in different disciplines in conducting the research. Disciplines involved in these projects included silviculture, soil science, wildlife biology, hydrology, and aquatic biology.

Interaction and communication between researchers and practitioners

The GEIS recommends interaction and communication between researchers and practitioners in the development and use of forest resources research as an integral part of the suggested research program. In each of the three research projects recommended for funding by the RAC and funded by the MFRC, researchers were strongly encouraged to interact and communicate with practitioners in developing their research design and methodology. Each research group was encouraged to develop outreach related to its project. Researchers from the riparian and wildlife

studies conducted educational workshops about riparian areas in fall 1997. Individuals from the productivity study helped organize a workshop on soils in summer 1998.

Researchers were also encouraged to present research results at professional conferences and meetings attended by forest resource practitioners as well as by researchers, and to publish research results in professional journals accessible to and widely read by practitioners. Even prior to completion of the research, researchers from the productivity, riparian and wildlife studies presented their research and preliminary results at numerous workshops and national meetings. Formal presentations of the results from each of these research projects were made to the MFRC. The riparian and wildlife research teams wrote fact sheets about their research for the Internet; developed a guided tour of the research sites near Grand Rapids, Minnesota; and held a workshop in 2001 where study results were presented to forest resource managers.

The results from these and other relevant research projects supported by the MFRC are periodically reviewed to confirm or support existing guideline recommendations and to suggest where modifications to guidelines are needed to ensure that these practices encourage sustainable forest management.

Since January 2002, the RAC and MFRC have helped sponsor three one-day research symposia titled *Forest and Wildlife Research Review*. The MFRC helped sponsor a fourth symposium in March 2005. The 2003 and 2004 symposia attracted more than 200 attendees, including many practitioners and researchers. The University of Minnesota's College of Natural Resources Center for Continuing Education develops and conducts these symposia.

Literature Cited

1. Actual and Projected Harvest and Forest Change 1990-2000

Alerich, C. L, L. Klevgard, C. Liff, and P. D. Miles. 2004. The Forest Inventory and Analysis Database: Database Description and Users. Guide Version 1.7. USDA Forest Service. See http://www.ncrs2.fs.fed.us/4801/fiadb/fiadb_documentation/FIADB_v17_122104.pdf

Arner, S. L., S. Woudenberg, S. Waters, J. Vissage, C. MacLean, M. Thompson, and M. Hansen. 2003. National algorithms for determining stocking class, stand size class, and forest type for forest inventory and analysis plots. February 13, 2001, modified May 21, 2003. 65p. USDA Forest Service, Forest Inventory and Analysis. See http://socrates.lv-hrc.nevada.edu/fia/imb/imbandindex.html#_Code_Documentation

Brand, G. J. 1981. GROW - A computer subroutine that projects the growth of trees in Lake States forests. Research Paper NC-207. St. Paul, MN: USDA Forest Service, North Central Forest Experiment Station.

Brand, G. J., M. R. Holdaway, and S. R. Shifley. 1988. A description of the Twigs and STEMS individual-tree based growth simulation models and their applications. In *Forest growth modeling and prediction*, eds., Ek, A. R., S. R. Shifley, and T. E. Burk, 950-60. Proceedings of the IUFRO conference, Minneapolis, MN, August 24-28, 1987. General Technical Report NC-120. St. Paul, MN: USDA Forest Service, North Central Forest Experiment Station.

Forest Health Monitoring Program. 2000 Forest health highlights, Minnesota. St. Paul, MN: USDA Forest Service, State and Private Forestry, Northeastern Area. See http://www.fhm.fs.fed.us/fhh/fhh-00/mn/mn 00.htm.

Hansen, M. H. 2005. Personal communication. USDA Forest Service, North Central Research Station. June 13, 2005.

Hansen, M., H., and J. T. Hahn. 1992. Determining stocking, forest type and stand-size class from Forest Inventory data. *Northern Journal of Applied Forestry* 9(3):82-89.

Hansen, M. H., T. Thomas, J. F. Glover, and J. F. Kelly. 1992. The Eastwide forest inventory data base: users manual. Gen. Tech. Rep. NC-151. St.Paul, MN: USDA Forest Service, North Central Forest Experiment Station. 48 p.

Heinselman, M. L. 1996. *The Boundary Waters Wilderness Ecosystem*. Minneapolis, MN: University of Minnesota Press.

Jaakko Pöyry Consulting, Inc. 1992. Maintaining Productivity and the Forest Resource Base. A Technical Paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. Prepared for the Minnesota Environmental Quality Board. Tarrytown, NY: Jaakko Pöyry Consulting, Inc. 305 p plus 16 appendices.

Miles, P. D., G. J. Brand, and M. E. Mielke. 2004. Minnesota's forest Resources in 2003. Review draft dated September 20, 2004. St. Paul, MN: USDA Forest Service, North Central Forest Experiment Station.

Miles, P. D., C. M. Chen, and E. C. Leatherberry. 1995. Minnesota Forest Statistics, 1990, Revised. Resource Bulletin NC-158. St. Paul, MN: USDA Forest Service, North Central Forest Experiment Station.

MN DNR. 2004. Minnesota's forest resources. St. Paul, MN: Department of Natural Resources,Wood Utilization & Marketing Program. Revised October 11, 2004. 72p.

MN DNR. Various reports on fuelwood surveys. See http://www.dnr.state.mn.us/forestry/um/index.html. St. Paul, MN: Department of Natural Resources, Wood Utilization & Marketing Program.

Phillips, M. J. 2001. Monitoring the implementation of the timber harvesting and forest management guidelines on the public and private forest land in Minnesota: Report 2000. DNR Document MP - 0201. Submitted to the Minnesota Forest Resources Council. St. Paul, MN: MN Department of Natural Resources. 45p.

Piva, R. J.2005. Pulpwood production in the North-Central Region, 2002. Resource. Bulletin NC-239. St. Paul, MN: USDA Forest Service, North Central Research Station. 56 p.

Puettmann, K. J., C. R. Blinn, H. W. McIver, and A. R. Ek. 1998. Status of Minnesota timber harvesting and silvicultural practice in 1996. Report # MP0698. St. Paul, MN: Minnesota Forest Resources Council. 49p.

USDA Forest Service. 2001. Final Environmental Impact Statement for the Boundary Waters Canoe Area Wilderness Fuel Treatment. Duluth, MN: Superior National Forest.

USDA Forest Service. 2003. Forest inventory and analysis national core field guide, volume 1: field data collection procedures for phase 2 plots, version 1.7. USDA Forest Service, Washington Office. Internal report. On file with: USDA Forest Service, Forest Inventory and Analysis, 201 14th St., Washington, D.C., 20250.

2. Wildlife/habitat Changes 1990-2000

Brown, T., J. Hanowski, G. Host, and M. White. 2005. SUSTAIN: Subsection unit sustainability analysis using indicators. http://www.nrri.umn.edu/sustain/

Dexter, M. H., ed. 2004. Status of wildlife populations, Fall 2004. St. Paul, MN: Minnesota Department of Natural Resources, Division of Fish and Wildlife, 176pp.

Dexter, M., ed. 2001. Status of wildlife populations, Fall 2001. St. Paul, MN: Minnesota Department of Natural Resources, Division of Fish and Wildlife, 180pp.

Dolton, D. D., and R. D. Rau. 2004. Mourning dove population status, 2004. Laurel, MD: US Fish and Wildlife Service.

Garshelis, D., and K. Noyce. 2004. Status of black bears, 2003. St. Paul, MN: Minnesota Department of Natural Resources.

Jaakko Pöyry Consulting, Inc. 1992. Forest Wildlife. A technical paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. Tarrytown NY: Jaakko Pöyry, Consulting, Inc.

Lind, J., N. Danz, J. M. Hanowski, and G. J. Niemi. 2005. 2004 annual update report. Breeding bird monitoring in Great Lakes National forests: 1991-2004. NRRI/TR-2005/04.

Monstad, Y. 2004. Minnesota frog and toad calling survey, 2004 results. St. Paul, MN: MN Department of Natural Resources, Division of Ecological Services, Nongame Wildlife Program. Web report: http://files.dnr.state.mn.us/volunteering/frogtoad_survey/mftcs_results2004.pdf

Olson, C. 2005. 2004 small mammal survey report. Technical Report #05-01. 1854 Authority. Duluth, MN: Biological Services Division.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966 - 2003. Version 2004.1. Laurel, MN: USGS Patuxent Wildlife Research Center.

3. Old and Old-growth Forest and Biodiversity Assessments

Cotè, S. D., T. P. Rooney, J-P. Tremblay, C. D. Dussault, and D. M. Waller. 2004. Ecological impacts of deer overabundance. *Annual Reviews in Ecology and Systematics* 35:113-147.

Frelich, L. E., M. W. Cornett, and M. A. White. 2005a. Controls and reference conditions in forestry: the role of old growth and retrospective studies. Journal of Forestry, in press.

Frelich, L. E., C. M. Hale, S. Scheu, A. R. Holdsworth, L. Heneghan, P. J. Bohlen, and P. B. Reich. 2005b. Earthworm invasion into previously earthworm-free temperate and boreal forests. Biological Invasions, in press.

Jaakko Pöyry Consulting, Inc. 1992. Biodiversity. A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown NY: Jaakko Pöyry Consulting, Inc.

MN DNR. 2003. Field guide to the native plant communities of Minnesota: The Laurentian Mixed Forest Province. Ecolgical Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. St. Paul, MN: Department of Natural Resources.

4. GEIS Mitigation Assessment

Dahlman, R, and M. J. Phillips. 2004. Baseline monitoring for implementation of the timber harvesting and forest management guidelines on public and private forest land in Minnesota: Combined Report for 2000, 2001, and 2002. DNR Document MP - 0904. Submitted to the Minnesota Forest Resources Council. St. Paul, MN: MN Department of Natural Resources.

Jaakko Pöyry Consulting, Inc. 1994. *Final generic environmental impact statement on timber harvesting and forest management in Minnesota*. Prepared for the Minnesota Environmental Quality Board. Tarrytown, NY: Jaakko Pöyry Consulting, Inc.

Minnesota Forest Resources Council. 1997a. Landscape-level planning and coordination process principles and goals. Report LP-0797. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 1997b. Sustainable forest resource act monitoring programs: Development procedures. Report MA-0697. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 1998. Implementation goals for timber harvest and forest management guidelines. SI-1298. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 1999a. Biennial report to the governor and legislature: sustainable forest resources act implementation, 1997-98. Report to Governor and Legislature. Report CP-0299. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 1999b. Sustaining Minnesota forest resources: Voluntary site-level forest management guidelines for landowners, loggers, and resource managers. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 2000. Sustainable forest resources act implementation in 1999: Minnesota Forest Resources Council Annual Report to the Governor and Legislature. Report CP-0200. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 2001. Sustainable forest resources act implementation in 2000: Minnesota Forest Resources Council Annual Report to the Governor and Legislature. Report CP-0201. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 2002. Sustainable Forest Resources Act implementation in 2001: Minnesota Forest Resources Council Annual Report to the governor and legislature. Report CP-0202. St. Paul, MN: Minnesota Forest Resources Council.

Minnesota Statutes. 2004. Office of the Revisor of Statutes. State of Minnesota. Chapter 89A. St. Paul, MN.

Appendix Table 1.1. Actual timber harvest volume by species, species group and year, Minnesota, 1990-2001 (thousand cords). Bold letters represent species group comparable to GEIS.

Year	**Total**	Aspen	Balm	**Aspen**	Ash	Birch	Elm	Bass-wood	Maple	Cotton-wood	Other Hardwoods	**Northern Hardwoods**	Oak	**Oak**	Red Pine	White Pine	Jack Pine	**Pine**	Spruce	Balsam	Tamarack	Cedar	Other Softwoods	**Spruce/ Fir**
1990	3,449	1,939	53	1,992	72	160	88	36	73	8	3	439	282	282	105	36	177	318	193	208	5	12	0	418
1991	3,527	1,978	70	2,048	71	151	88	36	74	8	3	431	282	282	122	33	238	393	155	207	5	8	0	374
1992	3,851	2,265	86	2,351	75	162	88	40	66	8	3	440	282	282	134	36	235	405	165	198	2	8	0	372
1993	4,102	2,433	93	2,527	70	175	87	34	77	11	6	460	298	298	133	28	262	423	175	210	3	7	0	395
1994	4,106	2,405	124	2,528	72	208	87	36	84	11	6	504	298	298	127	28	232	387	182	196	4	7	0	389
1995	3,723	2,327	98	2,424	28	208	14	34	41	11	12	347	184	184	128	25	224	377	166	206	13	6	0	390
1996	3,810	2,322	92	2,413	29	207	14	34	33	11	11	339	184	184	162	25	186	373	220	260	14	6	0	500
1997	3,735	2,288	114	2,402	29	214	10	38	45	12	20	366	192	192	145	17	199	361	179	205	22	8	0	414
1998	3,661	2,247	115	2,362	31	226	10	39	49	12	21	387	192	192	134	17	181	332	166	198	17	8	0	389
1999	3,816	2,413	106	2,519	25	231	0	40	45	10	27	377	188	188	157	15	172	343	166	197	17	8	0	389
2000	3,724	2,262	94	2,356	24	233	0	38	73	8	22	397	173	173	132	15	232	379	195	192	20	6	5	419
2001	3,563	2,045	99	2,144	23	227	0	37	78	8	22	395	173	173	144	15	242	401	213	178	48	6	5	450

Appendix Table 1.2 GEIS projected harvest volme by species group and year, base scenario, Minnesota, 1990-2000 (thousand cord

Year	Total	Aspen	Northern Hardwoods	Oak	Pine	Other	Spruce/ Fir
1990	3,491	1,954	475	50	365	250	397
1991	3,727	2,124	481	50	429	250	393
1992	4,037	2,389	516	50	419	250	413
1993	4,132	2,489	516	50	419	250	408
1994	4,132	2,489	516	50	419	250	408
1995	4,177	2,524	531	50	414	250	408
1996	4,177	2,524	531	50	414	250	408
1997	4,172	2,469	556	50	439	250	408
1998	4,172	2,469	556	50	439	250	408
1999	4,172	2,469	556	50	439	250	408
2000	4,172	2,469	556	50	439	250	408

Appendix Table 1.3 Actual versus GEIS projected timber harvest volume by species group and year, Minnesota, 1990-2001 base scenario (thousand cords).

	Actual						GEIS Projected							Actual as % of projected				
Year	**Total**	Aspen	Northern hardwoods	Oak	Pine	Spruce/ Fir	**Total**	Aspen	Northern hardwoods	Oak S. MN	Other S. MN	Pine	Spruce/ Fir	Total	Aspen	All other hardwoods	Pine	Spruce/ Fir
1990	3,449	1,992	439	282	318	418	3,491	1,954	475	50	250	365	397	98.8	101.9	93.1	87.1	105.2
1991	3,527	2,048	431	282	393	374	3,727	2,124	481	50	250	429	393	94.6	96.4	91.3	91.5	95.2
1992	3,851	2,351	440	282	405	372	4,037	2,389	516	50	250	419	413	95.4	98.4	88.5	96.7	90.1
1993	4,102	2,527	460	298	423	395	4,132	2,489	516	50	250	419	408	99.3	101.5	92.8	101.0	96.8
1994	4,106	2,528	504	298	387	389	4,132	2,489	516	50	250	419	408	99.4	101.6	98.3	92.4	95.2
1995	3,723	2,424	347	184	377	390	4,177	2,524	531	50	250	414	408	89.1	96.1	64.0	90.9	95.6
1996	3,810	2,413	339	184	373	500	4,177	2,524	531	50	250	414	408	91.2	95.6	62.9	90.1	122.6
1997	3,735	2,402	366	192	361	414	4,172	2,469	556	50	250	439	408	89.5	97.3	65.1	82.3	101.5
1998	3,661	2,362	387	192	332	389	4,172	2,469	556	50	250	439	408	87.8	95.7	67.6	75.5	95.4
1999	3,816	2,519	377	188	343	389	4,172	2,469	556	50	250	439	408	91.5	102.0	66.1	78.1	95.3
2000	3,724	2,356	397	173	379	419	4,172	2,469	556	50	250	439	408	89.2	95.4	66.6	86.3	102.6
2001	3,563	2,144	395	173	401	450	4,172	2,469	556	50	250	439	408	85.4	86.8	66.4	91.4	110.2

Appendix Table 1.4 Actual and GEIS projected timberland, reserved, and other forest age class distribution acreages by forest type, Minnesota 1990-2040.

		Timberland							Reserved forest							Other forest						
		FIA		GEIS Projections					FIA		GEIS Projections					FIA		GEIS Projections				
Forest Type	Age	1990	2001	2000	2010	2020	2030	2040	1990	2001	2000	2010	2020	2030	2040	1990	2001	2000	2010	2020	2030	2040
All	5	1,397,200	1,380,649	1,646,602	1,603,178	1,485,013	1,580,615	1,575,277	27,200	40,173	0	0	0	0	0	31,800	58,684	0	0	0	0	0
	15	1,250,500	1,025,439	1,378,443	1,639,490	1,591,539	1,479,439	1,568,894	40,100	19,605	28,374	0	0	0	0	196,800	17,447	32,368	0	0	0	0
	25	1,025,500	1,077,629	1,253,108	1,373,094	1,632,413	1,579,902	1,473,911	34,100	14,723	40,280	29,559	0	0	0	17,600	9,900	197,050	32,943	0	0	0
	35	967,100	1,207,727	1,027,262	1,258,307	1,367,741	1,625,325	1,568,263	25,400	38,813	34,203	40,461	30,754	0	0	22,300	30,001	17,669	197,302	33,519	0	0
	45	1,768,100	1,635,444	929,777	983,394	1,071,027	866,512	818,562	93,800	131,758	28,917	34,308	40,643	31,935	0	27,000	50,089	22,313	17,739	197,553	34,094	0
	55	2,440,900	2,066,525	1,513,078	740,365	738,588	784,026	749,378	233,200	144,708	91,412	25,636	34,413	40,823	33,129	41,800	53,236	27,000	22,327	17,809	197,805	34,670
	65	2,305,800	2,230,143	1,992,362	1,226,045	572,515	606,256	658,612	310,200	154,487	239,892	95,840	25,755	34,517	41,005	44,900	51,985	41,841	27,000	22,341	17,878	198,057
	75	1,251,200	1,596,971	1,847,224	1,581,028	957,153	488,900	544,744	112,200	166,173	315,148	236,006	96,869	25,873	34,621	76,100	50,237	45,074	41,883	27,000	22,355	17,948
	85	832,100	1,033,004	1,050,698	1,477,156	1,359,743	849,482	456,307	55,600	105,773	110,678	312,311	237,418	97,883	25,991	41,500	32,062	76,162	45,249	41,925	27,000	22,369
	95	573,300	543,777	718,997	894,807	1,299,920	1,229,306	776,939	76,500	50,935	66,717	112,560	313,374	238,812	98,912	59,300	48,634	41,781	76,225	45,424	41,967	27,000
	105	370,400	347,934	518,587	657,438	823,669	1,197,094	1,125,178	41,400	53,247	73,300	55,836	112,742	314,422	240,225	75,100	46,854	59,383	42,063	76,288	45,599	42,009
	115	165,400	237,587	340,001	483,384	603,743	761,721	1,110,022	21,000	0	33,455	76,500	55,955	112,922	315,486	44,400	43,722	75,141	59,467	42,346	76,350	45,774
	125	213,900	166,212	158,251	335,241	473,805	574,121	734,506	16,100	0	22,500	41,511	76,500	56,073	113,104	49,100	15,738	44,483	75,183	59,550	42,628	76,413
	135	56,500	98,371	207,693	155,763	324,016	438,654	530,688	16,100	4,843	10,900	21,000	41,567	76,500	56,191	25,900	16790	49,218	44,567	75,225	59,634	42,911
	145	88,900	19,603	53,852	199,682	157,969	276,955	422,216	5,000	4,691	16,100	17,800	42,200	41,622	78,400	25,000	2,676	25,900	49,336	44,650	75,267	59,718
	155	30,800	42,738	85,202	53,558	176,105	149,317	263,057	5,200	4,601	6,600	14,400	7,300	21,000	39,778	47,500	0	25,000	25,900	49,455	44,734	75,309
	165	14,500	18,611	27,821	83,196	52,145	173,047	146,959	0	0	0	5,000	12,500	16,100	21,000	1,000	0	47,500	25,000	25,900	49,573	44,818
	175	9,000	9,826	14,478	27,662	81,861	51,923	161,706	0	3,588	0	5,200	1,400	16,100	16,100	1,200	0	1,000	47,510	25,000	25,900	49,692
	185	5,100	7,693	9,000	14,434	27,503	80,153	51,700	0	0	0	0	0	5,000	16,100	0	0	0	1,000	47,500	25,000	25,900
	195	7,200	13,946	12,281	21,243	35,594	62,856	142,528	0	3,055	0	0	0	5,200	10,200	0	0	1,200	1,200	2,200	49,700	74,700
Total		14,773,400	14,759,829	14,784,717	14,808,465	14,832,062	14,855,604	14,879,447	1,113,100	941,173	1,118,476	1,123,928	1,129,390	1,134,782	1,140,242	828,300	528,055	830,083	831,894	833,685	835,484	837,288
Jack Pine	5	29,700	20,590	2,765	20,985	26,521	10,569	11,256	0	4,601	0	0	0	0	0	0	0	0	0	0	0	0
	15	38,600	32,456	38,811	2,694	20,843	25,970	10,560	0	0	0	0	0	0	0	0	848	0	0	0	0	0
	25	27,100	49,883	46,436	38,232	2,623	20,701	25,419	0	3,588	0	0	0	0	0	0	0	0	0	0	0	0
	35	37,200	69,838	20,241	46,311	37,652	2,552	20,557	0	4,601	0	0	0	0	0	0	0	0	0	0	0	0
	45	83,700	66,420	33,411	19,923	46,186	37,075	2,482	3,400	17,096	4,300	0	0	0	0	1,200	0	0	0	0	0	0
	55	92,900	53,557	74,723	30,817	18,916	43,342	30,220	14,200	9,507	3,400	4,300	0	0	0	0	0	1,200	0	0	0	0
	65	86,200	44,677	60,368	70,457	27,947	18,641	42,028	39,200	15,331	16,200	3,400	4,300	0	0	0	0	0	1,200	0	0	0
	75	28,500	28,053	53,729	55,189	62,870	26,036	18,070	40,800	4,601	21,400	16,200	3,400	4,300	0	0	0	0	0	1,200	0	0
	85	10,300	12,440	19,213	46,271	42,366	52,143	22,474	26,400	12,791	10,900	21,400	16,200	3,400	4,300	0	0	0	0	0	1,200	0
	95	3,800	5,024	6,956	16,922	40,272	39,854	44,720	7,500	9,278	0	10,900	21,400	16,200	3,400	0	0	0	0	0	0	1,200
	105	3,300	708	1,400	3,768	16,604	39,782	37,737	0	11,640	0	0	10,900	21,400	16,200	0	0	0	0	0	0	0
	115	0	4,232	973	1,400	3,681	16,285	39,291	0	0	0	0	0	10,900	21,400	0	0	0	0	0	0	0
	125	5,300	0	0	918	1,400	3,594	15,965	0		0	0	0	0	10,900	0	0	0	0	0	0	0
	135	0	0	3,200	0	864	1,400	3,506	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	145	0	0	0	3,200	3,200	810	1,400	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	155	0	0	0	0	0	0	755	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	165	0	0	0	0	0	3,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	175	0	0	0	0	0	0	3,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		446,600	387,878	362,226	357,087	351,945	341,954	329,640	131,500	93,034	56,200	56,200	56,200	56,200	56,200	1,200	848	1,200	1,200	1,200	1,200	1,200
Red Pine	5	50,400	33,485	51,590	37,471	38,456	53,792	47,696	0	0	0	0	0	0	0	0	1,021	0	0	0	0	0
	15	40,800	53,699	48,208	52,174	37,250	38,278	54,504	0	0	0	0	0	0	0	0	8,975	0	0	0	0	0
	25	59,900	61,523	51,837	47,625	52,759	37,029	38,098	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	32,200	60,739	68,729	51,912	47,041	53,339	36,809	0	0	0	0	0	0	0	0	3,617	0	0	0	0	0
	45	36,000	41,063	39,735	68,591	51,987	46,460	53,924	1,600	5,327	3,400	0	0	0	0	0	0	0	0	0	0	0
	55	21,900	37,790	34,989	40,011	68,453	52,059	45,876	0	1,151	0	0	0	0	0	0	0	0	0	0	0	0
	65	32,400	32,370	30,184	26,653	33,578	44,980	36,790	1,700	2,876	5,300	3,400	0	0	0	0	0	0	0	0	0	0
	75	21,600	21,019	38,600	26,020	14,138	25,593	39,396	9,200	2,096	9,200	0	3,400	0	0	900	0	0	0	0	0	0
	85	30,900	12,958	13,114	26,025	19,937	12,733	23,475	7,500	7,879	7,500	5,300	0	3,400	0	0	0	900	0	0	0	0
	95	12,000	9,499	17,923	11,143	16,000	19,832	12,627	16,600	0	18,500	9,200	5,300	0	3,400	0	0	0	900	0	0	0
	105	12,100	5,961	11,451	12,843	8,251	16,000	19,727	15,300	0	15,300	7,500	9,200	5,300	0	0	0	0	0	900	0	0
	115	1,000	6,611	2,700	7,972	12,805	8,152	16,000	7,300	0	7,300	18,500	7,500	9,200	5,300	0	0	0	0	0	900	0
	125	2,100	235	972	2,700	7,754	12,767	8,052	8,800	0	8,800	15,300	18,500	7,500	9,200	0	0	0	0	0	0	900
	135	1,400	0	4,280	0	1,300	7,533	9,629	3,600	0	3,600	7,300	15,300	18,500	7,500	0	0	0	0	0	0	0
	145	0	0	0	2,224	1,200	1,300	7,315	3,600	0	3,600	8,800	28,500	15,300	18,500	0	0	0	0	0	0	0
	155	0	0	0	0	0	0	1,300	5,200	0	5,200	3,600	0	7,300	15,300	0	0	0	0	0	0	0
	165	0	0	0	0	0	1,200	0	0	0	0	3,600	0	8,800	7,300	0	0	0	0	0	0	0
	175	0	0	0	0	0	0	1,200	0	0	0	5,200	0	3,600	8,800	0	0	0	0	0	0	0
	185	0	0	0	0	0	0	0	0	0	0	0	0	3,600	3,600	0	0	0	0	0	0	0
	195	0	0	0	0	0	0	0	0	0	0	0	0	5,200	8,800	0	0	0	0	0	0	0
Total		354,700	376,952	414,312	413,364	410,909	431,047	452,418	80,400	19,329	87,700	87,700	87,700	87,700	87,700	900	13,613	900	900	900	900	900
White Pine	5	1,900	695	15,893	6,217	6,568	7,552	2,400	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	0	1,607	5,417	15,678	6,162	6,436	7,140	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25	0	4,471	4,287	5,453	15,464	6,107	6,303	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	2,200	804	0	4,261	5,488	15,249	6,051	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	45	6,300	13,714	2,167	0	4,235	5,524	15,034	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	55	7,900	804	7,361	2,101	0	4,209	5,559	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	65	6,700	4,155	8,655	7,284	1,034	0	4,183	0	0	3,400	0	0	0	0	0	0	0	0	0	0	0
	75	10,700	16,218	14,971	8,769	7,207	0	0	0	18,100	4,100	3,400	0	0	0	0	0	0	0	0	0	0
	85	8,400	4,355	8,707	14,911	8,881	6,000	0	0	13,896	0	4,100	3,400	0	0	0	0	0	0	0	0	0
	95	5,000	5,295	23,637	7,422	14,850	8,187	6,000	2,000	0	21,300	0	4,100	3,400	0	0	804	0	0	0	0	0
	105	8,000	6,968	16,646	22,511	7,235	14,792	8,355	0	4,601	2,000	21,300	0	4,100	3,400	0	0	0	0	0	0	0
	115	2,800	9,183	6,799	16,341	21,484	6,159	14,732	0	0	0	2,000	21,300	0	4,100	0	0	0	0	0	0	0
	125	3,700	0	4,465	6,598	16,036	21,358	6,034	0	0	0	0	2,000	21,300	0	1,300	0	0	0	0	0	0
	135	1,300	3,392	6,267	4,394	6,397	15,729	21,233	1,800	0	0	0	0	2,000	21,300	0	0	1,300	0	0	0	0
	145	0	0	2,364	6,202	4,323	6,194	15,424	0	0	1,800	0	0	0	2,000	0	0	0	1,300	0	0	0
	155	2,900	0	3,400	2,292	6,137	4,252	5,994	0	0	0	1,800	0	0	0	0	0	0	0	1,300	0	0
	165	800	0	0	3,400	1,100	6,071	4,182	0	0	0	0	1,800	0	0	0	0	0	0	0	1,300	0
	175	0	0	2,078	0	3,400	1,100	6,006	0	3,588	0	0	0	1,800	0	0	0	0	0	0	0	1,300
	185	0	0	0	2,034	0	3,400	1,100	0	0	0	0	0	0	1,800	0	0	0	0	0	0	0
	195	0	3,360	0	0	1,989	1,945	5,301	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		68,600	75,021	133,114	135,868	137,990	140,264	141,031	3,800	40,276	32,600	32,600	32,600	32,600	32,600	1,300	804	1,300	1,300	1,300	1,300	1,300
Black Spruce	5	51,900	27,409	45,601	41,626	28,552	42,882	56,796	0	2,519	0	0	0	0	0	8,100	0	0	0	0	0	0

	15	104,900	44,539	37,978	45,406	41,443	28,171	42,337	8,600	3,451	0	0	0	0	0	153,100	0	8,100	0	0	0	0
	25	110,300	60,224	91,858	37,732	45,209	41,260	27,794	1,800	7,684	8,500	0	0	0	0	13,500	0	153,100	8,100	0	0	0
	35	91,100	80,757	97,487	91,974	37,488	45,013	41,080	12,700	0	0	8,500	0	0	0	7,300	3,360	13,500	153,100	8,100	0	0
	45	145,300	148,936	74,525	96,862	92,091	37,243	44,816	3,600	25,271	7,000	0	8,500	0	0	15,200	8,535	7,300	13,500	153,100	8,100	0
	55	206,900	184,695	119,287	74,380	96,235	92,206	36,998	13,500	29,748	3,600	7,000	0	8,500	0	21,200	15,625	15,200	7,300	13,500	153,100	8,100
	65	172,800	235,788	156,176	107,571	70,984	88,295	71,224	19,800	20,096	7,200	3,600	7,000	0	8,500	30,400	16,570	17,200	15,200	7,300	13,500	153,100
	75	135,000	180,769	112,447	145,025	99,212	62,615	73,440	21,800	13,878	8,500	7,200	3,600	7,000	0	50,500	15,042	30,400	17,200	15,200	7,300	13,500
	85	111,100	124,244	99,398	102,673	137,586	92,480	58,600	5,100	14,698	14,000	8,500	7,200	3,600	7,000	18,200	10,349	50,500	30,400	17,200	15,200	7,300
	95	82,200	82,068	76,856	93,840	99,978	128,551	84,735	25,700	11,747	1,700	14,000	8,500	7,200	3,600	37,800	13,826	18,200	50,500	30,400	17,200	15,200
	105	60,400	55,203	53,956	75,167	89,633	94,429	119,185	9,000	9,203	23,800	1,700	14,000	8,500	7,200	54,800	22,439	37,800	18,200	50,500	30,400	17,200
	115	24,600	66,093	43,545	50,368	72,828	78,451	86,159	5,000	0	9,000	23,800	1,700	14,000	8,500	33,200	13,534	54,800	37,800	18,200	50,500	30,400
	125	25,900	32,597	17,500	43,234	48,780	71,199	69,086	0	0	5,000	9,000	23,800	1,700	14,000	36,400	3,055	33,200	54,800	37,800	18,200	50,500
	135	10,700	11,927	18,773	17,500	40,210	43,790	63,573	0	848	0	5,000	9,000	23,800	1,700	17,200	0	36,400	33,200	54,800	37,800	18,200
	145	8,400	6,112	8,500	17,418	17,500	34,733	41,917	0	3,540	0	0	5,000	9,000	23,800	20,900	0	17,200	36,400	33,200	54,800	37,800
	155	3,500	10,174	6,070	8,500	17,364	17,500	33,257	0	0	0	0	0	5,000	9,000	32,700	0	20,900	17,200	36,400	33,200	54,800
	165	2,400	0	2,070	5,000	8,500	14,810	17,500	0	0	0	0	0	0	5,000	1,000	0	32,700	20,900	17,200	36,400	33,200
	175	1,300	3,576	2,400	2,010	5,000	8,500	13,655	0	0	0	0	0	0	0	0	0	1,000	32,700	20,900	17,200	36,400
	185	1,200	0	1,300	2,400	1,950	5,000	8,500	0	0	0	0	0	0	0	0	0	0	1,000	32,700	20,900	17,200
	195	0	0	0	1,300	3,700	5,590	10,531	0	0	0	0	0	0	0	0	0	0	0	1,000	33,700	54,600
Total		1,349,900	1,355,111	1,065,727	1,059,986	1,054,243	1,032,718	1,001,183	126,600	142,683	88,300	88,300	88,300	88,300	88,300	551,500	122,335	547,500	547,500	547,500	547,500	547,500
Balsam Fir	5	64,000	19,345	21,207	39,424	62,021	42,549	25,472	0	0	0					1,900	6,031	0	0	0	0	0
	15	85,900	38,617	77,038	21,018	39,039	61,471	41,592	3,600	4,601	3,500					5,500	2,463	1,900	0	0	0	0
	25	70,000	40,227	68,438	76,309	20,831	38,655	60,918	3,400	0	0	3,500				900	3,392	5,500	1,900	0	0	0
	35	48,600	33,088	61,170	67,712	75,583	20,642	38,271	0	0	5,200	0	3,500			2,200	4,332	900	5,500	1,900	0	0
	45	121,000	68,509	53,721	60,711	65,987	74,853	20,456	25,100	6,763	0	5,200	0	3,500		1,000	15,160	2,200	900	5,500	1,900	0
	55	194,200	68,618	99,861	49,539	49,932	46,796	58,238	29,900	9,344	10,600	0	5,200	0	3,500	2,400	12,312	1,000	2,200	900	5,500	1,900
	65	130,900	39,703	126,173	92,100	39,956	38,264	40,502	19,900	1,853	19,500	10,600	0	5,200	0	0	0	2,400	1,000	2,200	900	5,500
	75	50,900	26,902	82,529	111,813	82,966	38,379	32,988	1,900	0	14,700	19,500	10,600	0	5,200	0	0	0	2,400	1,000	2,200	900
	85	27,500	15,479	40,991	74,663	93,093	67,536	33,016	1,700	0	7,100	14,700	19,500	10,600	0	2,600	0	0	0	2,400	1,000	2,200
	95	5,300	11,035	43,426	37,974	61,067	70,994	52,549	1,900	0	5,100	7,100	14,700	19,500	10,600	900	0	2,600	0	0	2,400	1,000
	105	3,800	2,544	13,059	39,884	32,767	54,206	63,940	5,700	6,902	1,700	5,100	7,100	14,700	19,500	1,100	0	900	2,600	0	0	2,400
	115	4,500	6,269	10,073	12,978	36,407	31,414	52,149	0	0	1,900	1,700	5,100	7,100	14,700	0	0	1,100	900	2,600	0	0
	125	0	3,214	13,000	8,718	12,896	36,329	31,160	0	0	0	1,900	1,700	5,100	7,100	0	0	0	1,100	900	2,600	0
	135	0		13,362	13,000	8,664	12,814	36,252	0	0	0	0	1,900	1,700	5,100	0	0	0	0	1,100	900	2,600
	145	0		7,281	12,086	13,000	8,610	12,733	0	0	3,600	0	0	1,900	1,700	0	0	0	0	0	1,100	900
	155	2,600		5,100	7,243	12,010	13,000	8,555	0	0	0	3,600	0	0	1,900	0	0	0	0	0	0	1,100
	165	0	997	5,700	5,100	7,205	11,933	13,000	0	0	0	0	3,600	0	0	0	0	0	0	0	0	0
	175	0		1,500	5,700	4,100	7,167	11,857	0	0	0	0	0	3,600	0	0	0	0	0	0	0	0
	185	0	0	2,400	1,500	5,700	4,100	7,129	0	0	0	0	0	0	3,600	0	0	0	0	0	0	0
	195	0	0	2,900	5,300	6,800	12,500	16,600	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		809,200	374,547	748,929	742,772	730,024	692,212	657,377	93,100	29,463	72,900	72,900	72,900	72,900	72,900	18,500	43,690	18,500	18,500	18,500	18,500	18,500
Northern White Cedar	5	5,300	4,106	2,600	6,815	6,800	14,761	10,851	0	0	0	0	0	0	0	2,800	0	0	0	0	0	0
	15	12,600	3,567	6,273	2,600	6,624	6,800	14,523	2,100	0	0	0	0	0	0	10,000	0	2,800	0	0	0	0
	25	18,900	2,288	18,461	6,218	2,600	6,433	6,800	0	0	3,100	0	0	0	0	0	0	10,000	2,800	0	0	0
	35	9,800	12,599	22,300	18,384	6,164	2,600	6,244	0	4,601	0	3,100	0	0	0	0	3,278	0	10,000	2,800	0	0
	45	16,300	30,562	9,976	22,300	18,307	6,110	2,600	0	1,151	0	0	3,100	0	0	0	3,278	0	0	10,000	2,800	0
	55	28,400	58,311	17,040	9,927	22,300	18,229	6,055	0	2,301	0	0	0	3,100	0	1,000	0	0	0	0	10,000	2,800
	65	29,400	35,440	31,060	15,910	9,878	22,300	18,152	0	11,687	0	0	0	0	3,100	1,400	0	1,000	0	0	0	10,000
	75	57,100	49,879	27,067	27,676	15,850	9,829	22,300	1,800	1,151	1,800	0	0	0	0	3,400	2,834	1,400	1,000	0	0	0
	85	78,800	83,661	31,810	24,302	27,527	15,790	9,780	0	1,151	0	1,800	0	0	0	1,000	0	3,400	1,400	1,000	0	0
	95	100,700	52,989	20,100	31,628	24,237	27,378	15,731	0	4,355	0	0	1,800	0	0	5,000	0	1,000	3,400	1,400	1,000	0
	105	58,800	35,875	58,399	20,100	31,446	24,171	27,229	3,200	0	0	0	0	1,800	0	3,500	0	5,000	1,000	3,400	1,400	1,000
	115	63,900	62,224	26,400	58,196	20,100	31,264	24,106	2,300	0	1,900	0	0	0	1,800	4,100	6,750	3,500	5,000	1,000	3,400	1,400
	125	54,000	51,445	22,740	26,400	57,994	20,100	30,257	5,400	1,196	0	1,900	0	0	0	1,300	0	4,100	3,500	5,000	1,000	3,400
	135	28,700	30,637	19,572	22,620	26,400	56,983	20,100	8,900	0	0	0	1,900	0	0	1,600	0	1,300	4,100	3,500	5,000	1,000
	145	45,700	10,139	4,370	19,517	22,500	26,400	56,835	1,400	0	1,700	1,700	0	1,900	1,900	800	0	1,600	1,300	4,100	3,500	5,000
	155	15,600	21,429	12,300	4,309	19,462	20,090	26,400	0	4,601	0	0	0	0	0	3,600	0	800	1,600	1,300	4,100	3,500
	165	6,900	13,296	3,500	12,300	4,248	19,407	20,031	0	0	0	0	1,700	0	0	0	0	3,600	800	1,600	1,300	4,100
	175	6,400	3,195	1,300	3,500	12,300	4,187	19,351	0	0	0	0	0	1,700	0	1,200	0	0	3,600	800	1,600	1,300
	185	3,900	6,845	0	1,300	3,500	12,300	4,126	0	0	0	0	0	0	1,700	0	0	0	0	3,600	800	1,600
	195	7,200	5,020	2,300	2,300	3,600	7,100	19,400	0	3,055	0	0	0	0	0	0	0	1,200	1,200	1,200	4,800	5,600
Total		648,400	573,507	337,568	336,302	341,837	352,232	360,871	25,100	35,249	8,500	8,500	8,500	8,500	8,500	40,700	16,140	40,700	40,700	40,700	40,700	40,700
Tamarack	5	52,500	21,694	3,262	18,717	13,400	18,044	17,191	0	0	0					2,400	4,018	0	0	0	0	0
	15	58,700	19,157	59,729	3,186	18,860	13,119	17,570	3,100	0	0					18,300	0	2,420	0	0	0	0
	25	85,600	32,535	45,104	59,584	3,110	19,005	12,840	0	0	1,100					1,100	0	18,300	2,441	0	0	0
	35	68,500	81,073	68,906	45,114	59,441	3,033	19,150	0	0	0	1,100				3,200	6,753	1,100	18,300	2,462	0	0
	45	57,400	116,991	65,798	68,718	45,125	59,301	2,957	0	4,601	0	0	1,100			3,400	4,375	3,200	1,100	18,300	2,483	0
	55	73,200	72,087	57,233	64,799	68,529	45,133	59,154	0	0	0	0	0	1,100		5,800	3,214	3,400	3,200	1,100	18,300	2,504
	65	86,300	138,419	69,157	55,963	62,510	67,451	43,045	0	3,214	0	0	0	0	1,100	4,000	3,567	5,800	3,400	3,200	1,100	18,300
	75	49,800	85,499	75,907	64,734	54,695	57,286	66,273	0	0	0	0	0	0	0	16,500	0	4,000	5,800	3,400	3,200	1,100
	85	45,200	53,013	55,507	71,023	60,728	53,363	53,726	0	0	0	0	0	0	0	13,800	11,247	16,500	4,000	5,800	3,400	3,200
	95	45,300	62,181	48,678	49,390	67,239	58,556	50,529	3,900	7,159	0	0	0	0	0	7,800	6,781	13,800	16,500	4,000	5,800	3,400
	105	26,600	43,011	38,254	46,119	47,868	64,847	57,460	0	0	3,900	0	0	0	0	15,100	8,541	7,800	13,800	16,500	4,000	5,800
	115	21,300	16,827	28,467	36,662	44,808	46,716	64,119	0	0	0	3,900	0	0	0	4,800	0	15,100	7,800	13,800	16,500	4,000
	125	24,700	38,935	20,061	28,401	35,269	44,691	46,662	1,900	0	0	0	3,900	0	0	7,300	6,572	4,800	15,100	7,800	13,800	16,500
	135	3,700	23,516	21,500	19,984	28,334	34,977	44,575	0	0	1,900	0	0	3,900	0	4,500	0	7,300	4,800	15,100	7,800	13,800
	145	15,900	2,411	2,600	21,500	18,807	28,268	34,685	0	0	0	1,900	0	0	3,900	3,300	0	4,500	7,300	4,800	15,100	7,800
	155	1,400	7,103	13,103	2,600	21,500	18,729	28,202	0	0	0	0	1,900	0	0	6,800	0	3,300	4,500	7,300	4,800	15,100
	165	2,000	4,318	1,400	13,109	2,600	21,500	18,652	0	0	0	0	0	1,900	0	0	0	6,800	3,300	4,500	7,300	4,800
	175	1,300	3,055	2,000	1,400	13,116	2,600	21,500	0	0	0	0	0	0	1,900	0	0	0	6,800	3,300	4,500	7,300
	185	0	0	1,300	2,000	1,400	13,122	2,600	0	0	0	0	0	0	0	0	0	0	0	6,800	3,300	4,500
	195	0	0	0	1,300	3,300	4,700	17,828	0	0	0	0	0	0	0	0	0	0	0	0	6,800	10,100
Total		719,400	821,825	677,966	674,303	670,639	674,441	678,718	8,900	14,974	6,900	6,900	6,900	6,900	6,900	118,100	55,068	118,120	118,141	118,162	118,183	118,204
White Spruce	5	12,100	21,176	5,238	6,727	4,418	2,600	3,896	0	4,601	0	0	0	0	0	0	0	0	0	0	0	0
	15	4,700	17,897	17,573	5,315	6,412	4,386	2,600	0	0	0	0	0	0	0	0	1,841	0	0	0	0	0
	25	16,800	8,601	23,342	17,518	5,392	6,096	4,353	0	0	5,400	0	0	0	0	0	0	0	0	0	0	0
	35	11,100	21,267	38,483	23,227	17,464	5,468	5,780	0	0	5,400	5,400	0	0	0	0	0	0	0	0	0	0
	45	16,900	10,099	22,772	38,448	23,111	17,410	5,545	3,500	0	0	5,400	5,400	0	0	0	3,214	0	0	0	0	0
	55	13,000	6,358	23,822	18,842	38,413	22,993	17,355	1,700	0	8,800	0	5,400	5,400	0	0	0	0	0	0	0	0

	65	7,200	6,253	35,124	23,867	18,805	36,079	21,879	4,700	1,196	15,400	8,800	0	5,400	5,400	0	0	0	0	0	0	0	
	75	2,100	0	35,076	33,943	23,912	16,857	35,043	8,800	3,451	18,300	15,400	8,800	0	5,400	0	466	0	0	0	0	0	
	85	2,600	0	11,300	33,429	32,539	23,956	15,574	7,200	4,601	21,800	18,300	15,400	8,800	0	0	0	0	0	0	0	0	
	95	1,500	1,273	2,465	11,300	33,183	28,433	24,001	9,000	0	8,900	21,800	18,300	15,400	8,800	0	0	0	0	0	0	0	
	105	0	84	12,276	2,394	11,300	31,936	28,243	1,400	0	13,000	8,900	21,800	18,300	15,400	0	0	0	0	0	0	0	
	115	0	0	0	11,400	2,323	11,300	31,689	3,600	0	3,300	13,000	8,900	21,800	18,300	0	0	0	0	0	0	0	
	125	2,000	0	1,400	0	11,400	2,252	10,300	0	0	4,600	3,300	13,000	8,900	21,800	0	0	0	0	0	0	0	
	135	1,700	0	3,000	1,400	0	11,400	2,182	0	0	0	4,600	3,300	13,000	8,900	0	0	0	0	0	0	0	
	145	0	0	1,700	3,000	1,400	0	11,400	0	0	1,800	0	4,600	3,300	13,000	0	0	0	0	0	0	0	
	155	0	0	0	1,700	3,000	1,400	0	0	0	0	1,800	0	4,600	3,300	0	0	0	0	0	0	0	
	165	0	0	0	0	1,700	3,000	1,400	0	0	0	0	1,800	0	4,600	0	0	0	0	0	0	0	
	175	0	0	2,000	0	0	1,700	3,000	0	0	0	0	0	1,800	0	0	0	0	0	0	0	0	
	185	0	0	0	2,000	0	0	1,700	0	0	0	0	0	0	1,800	0	0	0	0	0	0	0	
	195	0	0	0	0	2,000	2,000	2,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total		91,700	93,008	235,571	234,510	236,772	229,266	227,940	39,900	13,849	106,700	106,700	106,700	106,700	106,700	0	5,521	0	0	0	0	0	
Oak/Hickory	5	29,000	56,664	38,373	69,215	124,254	143,658	111,392	3,100	0	0	0	0	0	0	1,400	3,270	0	0	0	0	0	
	15	19,100	29,477	41,185	40,721	71,694	127,268	146,988	0	0	3,313	0	0	0	0	0	0	1,495	0	0	0	0	
	25	26,400	41,853	22,525	42,554	43,073	74,172	130,295	0	0	0	3,530	0	0	0	1,000	3,334	0	1,593	0	0	0	
	35	15,500	64,640	35,320	23,370	43,924	45,422	76,648	0	0	0	0	3,747	0	0	200	0	1,069	0	1,691	0	0	
	45	96,300	120,996	31,514	37,165	23,115	45,291	47,770	2,600	0	0	0	0	3,962	0	0	2,488	213	1,139	0	1,789	0	
	55	183,100	184,331	115,394	32,743	37,288	23,960	46,664	0	17,214	2,780	0	0	0	4,177	600	4,170	0	227	1,209	0	1,887	
	65	226,400	223,470	223,201	117,684	33,967	37,498	22,878	4,100	4,601	855	2,961	0	0	0	1,900	4,131	641	0	241	1,278	0	
	75	154,100	227,197	242,972	223,676	114,656	32,063	38,117	700	17,671	4,384	911	3,143	0	0	1,100	9,447	2,074	683	0	255	1,348	
	85	142,200	183,176	156,022	229,232	212,998	105,311	33,280	700	13,546	1,816	4,670	967	3,323	0	3,100	7,564	1,100	2,249	725	0	269	
	95	99,600	109,001	119,732	139,781	201,563	186,254	94,747	0	4,601	748	1,935	4,956	1,022	3,505	1,200	9,709	3,340	1,100	2,424	767	0	
	105	65,700	63,352	85,488	109,142	125,749	169,798	155,354	800	2,301	0	797	2,054	5,240	1,078	600	5,817	1,283	3,580	1,100	2,599	809	
	115	15,900	15,446	69,437	88,723	91,569	109,808	139,493	0	0	855	0	846	2,172	5,527	1,200	13,881	641	1,367	3,821	1,100	2,774	
	125	46,900	9,453	15,668	72,982	86,728	81,268	106,258	0	0	0	911	0	895	2,291	1,700	2,544	1,283	683	1,450	4,061	1,100	
	135	1,000	6,022	42,831	16,810	72,147	73,469	67,319	0	3,995	0	0	967	0	943	0	0	1,818	1,367	725	1,534	4,302	
	145	3,500	941	0	44,055	17,948	43,808	77,408	0	0	0	0	0	1,022	0	0	0	0	1,936	1,450	767	1,618	
	155	0	0	0	0	35,362	16,599	38,072	0	0	0	0	0	0	1,078	0	0	0	0	2,055	1,534	809	
	165	0	0	0	0	0	34,489	14,184	0	0	0	0	0	0	0	0	0	0	0	0	2,173	1,618	
	175	0	0	0	0	0	0	23,330	0	0	0	0	0	0	0	0	0	0	0	0	0	2,292	
	185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total		1,124,700	1,336,019	1,239,662	1,287,853	1,336,035	1,350,136	1,370,197	12,000	63,929	14,751	15,715	16,680	17,636	18,599	14,000	66,355	14,957	15,924	16,891	17,857	18,826	
Elm/Ash/Cottonwood	5	108,500	64,182	22,919	48,685	115,062	119,444	119,376	8,400	1,998	0	0	0	0	0	6,400	13,963	0	0	0	0	0	
	15	106,600	18,710	120,678	22,955	47,944	114,371	117,176	0	2,350	10,800	0	0	0	0	3,100	2,428	6,440	0	0	0	0	
	25	51,700	53,152	139,627	121,240	22,993	47,202	113,674	700	0	5,600	11,506	0	0	0	0	3,174	3,100	6,482	0	0	0	
	35	63,200	86,111	74,351	142,095	121,796	23,028	46,461	0	1,898	2,448	5,600	12,219	0	0	1,100	0	0	3,100	6,524	0	0	
	45	91,700	89,601	88,794	75,137	137,754	122,359	23,065	4,500	3,588	0	2,497	5,600	12,924	0	0	3,214	1,100	0	3,100	6,566	0	
	55	130,200	176,478	155,339	89,069	72,130	140,212	122,915	7,000	0	12,664	0	2,546	5,600	13,638	1,800	2,462	0	1,100	0	3,100	6,608	
	65	200,300	217,109	219,469	153,491	78,747	69,068	119,525	3,400	680	12,983	13,035	0	2,595	5,600	5,400	12,593	1,800	0	1,100	0	3,100	
	75	126,800	183,481	249,543	210,507	137,545	75,699	61,568	4,200	0	22,168	13,473	13,406	0	2,643	3,700	9,532	5,400	1,800	0	1,100	0	
	85	80,100	100,048	180,681	238,349	196,726	129,331	72,174	1,900	4,601	3,600	22,644	13,961	13,772	0	1,800	1,339	3,762	5,400	1,800	0	1,100	
	95	67,800	61,161	118,223	173,626	214,530	194,156	129,506	7,300	4,592	3,600	3,600	23,120	14,446	14,143	4,200	13,353	1,841	3,825	5,400	1,800	0	
	105	47,900	65,884	92,942	116,146	163,515	203,674	181,485	4,100	3,179	7,300	3,600	3,600	23,588	14,935	0	6,532	4,200	1,883	3,888	5,400	1,800	
	115	12,500	32,496	64,337	89,659	105,233	157,515	192,327	1,800	0	4,100	7,300	3,600	3,600	24,064	0	804	0	4,200	1,925	3,950	5,400	
	125	18,600	12,849	18,740	63,412	88,282	93,208	155,766	0	0	1,800	4,100	7,300	3,600	3,600	1,100	3,567	0	0	4,200	1,967	4,013	
	135	4,100	17,906	34,016	17,619	59,870	83,051	86,049	1,800	0	0	1,800	4,100	7,300	3,600	2,600	6,142	1,100	0	0	4,200	2,009	
	145	8,400	0	9,745	31,447	16,634	52,053	72,998	0	1,151	0	0	1,800	4,100	7,300	0	2,676	2,600	1,100	0	0	4,200	
	155	3,800	0	21,672	9,635	26,282	16,568	47,443	0	0	0	0	0	1,800	4,100	3,300	0	0	2,600	1,100	0	0	
	165	2,400	0	9,700	21,616	9,526	23,115	16,502	0	0	0	0	0	0	1,800	0	0	3,300	0	2,600	1,100	0	
	175	0	0	1,100	9,700	21,560	9,417	22,750	0	0	0	0	0	0	0	0	0	0	3,300	0	2,600	1,100	
	185	0	0	0	1,100	9,700	21,504	9,306	0	0	0	0	0	0	0	0	0	0	0	3,300	0	2,600	
	195	0	3,082	1,700	1,700	2,800	12,500	33,949	0	0	0	0	0	0	0	0	0	0	0	0	3,300	3,300	
Total		1,124,600	1,182,250	1,623,576	1,637,188	1,648,629	1,707,475	1,744,015	45,100	24,037	87,063	89,155	91,252	93,325	95,423	34,500	81,779	34,643	34,790	34,937	35,083	35,230	
Maple/Beech/Birch	5	81,300	80,038	42,179	44,320	66,248	84,956	70,242	700	0	0	0	0	0	0	2,100	0	0	0	0	0	0	
	15	107,500	38,562	67,484	44,343	46,000	67,146	85,284	1,600	0	764	0	0	0	0	0	0	2,100	0	0	0	0	
	25	76,600	45,696	58,181	68,462	46,505	47,676	68,052	0	0	1,711	828	0	0	0	0	0	0	2,100	0	0	0	
	35	63,000	85,867	53,293	61,349	69,436	48,664	49,359	700	0	0	1,822	893	0	0	0	0	0	0	2,100	0	0	
	45	137,300	147,640	48,219	54,678	64,514	70,409	50,828	0	4,601	748	0	1,934	957	0	0	0	0	0	0	2,100	0	
	55	255,600	256,785	129,997	45,830	53,902	67,679	71,383	7,100	7,874	3,617	797	0	2,045	1,022	0	0	0	0	0	0	2,100	
	65	261,100	347,154	214,194	128,607	46,315	55,425	70,844	4,500	13,679	10,241	3,736	846	0	2,157	0	3,528	0	0	0	0	0	
	75	171,300	305,937	292,323	211,013	124,459	45,338	48,637	0	15,133	8,262	10,486	3,855	895	0	0	6,490	0	0	0	0	0	
	85	142,300	223,484	182,440	286,837	205,278	114,566	42,342	2,800	0	2,300	8,325	10,731	3,972	943	0	759	0	0	0	0	0	
	95	70,900	81,978	135,241	173,562	269,423	194,894	105,085	0	0	2,869	2,300	8,388	10,972	4,091	0	1,034	0	0	0	0	0	
	105	62,700	41,730	68,098	135,759	162,818	258,970	169,911	0	8,988	0	2,939	2,300	8,450	11,217	0	0	0	0	0	0	0	
	115	9,100	6,868	51,266	64,331	128,753	147,433	230,621	1,000	0	0	0	3,009	2,300	8,513	0	6,217	0	0	0	0	0	
	125	21,100	10,107	10,672	52,410	65,149	125,022	139,832	0	0	0	0	0	3,078	2,300	0	0	0	0	0	0	0	
	135	3,400	4,971	20,971	10,470	53,550	57,246	114,355	0	0	0	0	0	0	3,148	0	7,593	0	0	0	0	0	
	145	7,000	0	6,636	20,168	10,782	47,187	52,191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	155	0	4,032	6,539	6,710	16,550	11,093	46,975	0	0	1,400	0	0	0	0	0	0	0	0	0	0	0	
	165	0	0	2,300	6,417	6,784	16,969	11,409	0	0	0	1,400	0	0	0	0	0	0	0	0	0	0	
	175	0	0	1,500	2,300	6,294	6,857	17,389	0	0	0	0	1,400	0	0	0	0	0	0	0	0	0	
	185	0	848	0	1,500	2,300	4,801	6,930	0	0	0	0	0	1,400	0	0	0	0	0	0	0	0	
	195	0	0	0	0	1,500	3,800	8,573	0	0	0	0	0	0	1,400	0	0	0	0	0	0	0	
Total		1,470,200	1,681,697	1,391,533	1,419,066	1,446,560	1,476,131	1,460,242	18,400	50,275	31,912	32,633	33,356	34,069	34,791	2,100	25,621	2,100	2,100	2,100	2,100	2,100	
Aspen	5	799,400	736,380	1,285,185	1,161,587	861,407	910,463	946,143	12,500	10,353	0	0	0	0	0	6,700	15,018	0	0	0	0	0	
	15	587,200	642,141	722,483	1,275,033	1,148,551	856,158	901,143	15,800	9,203	7,497	0	0	0	0	4,800	892	7,113	0	0	0	0	
	25	417,000	585,833	592,967	718,417	1,264,910	1,135,528	850,937	24,600	0	8,600	7,695	0	0	0	1,100	0	4,974	7,527	0	0	0	
	35	461,900	498,053	416,639	593,074	714,351	1,254,797	1,122,492	12,000	18,510	19,355	8,600	7,895	0	0	6,000	3,343	1,100	5,149	7,942	0	0	
	45	761,900	622,538	404,597	375,593	423,936	251,318	528,134	42,400	34,419	12,069	19,411	8,600	8,092	0	3,200	9,825	6,000	1,100	5,324	8,356	0	
	55	957,900	694,756	532,978	233,944	166,804	181,206	173,682	128,700	37,833	36,951	12,139	19,467	8,600	8,292	6,900	6,390	3,200	6,000	1,100	5,499	8,771	
	65	791,200	626,399	610,691	314,103	113,850	94,171	132,292	166,800	46,384	123,513	37,308	12,209	19,522	8,600	1,800	8,382	6,900	3,200	6,000	1,100	5,674	
	75	297,000	272,903	434,128	286,204	133,569	68,002	76,727	17,700	48,676	143,834	124,136	37,665	12,278	19,578	0	0	1,800	6,900	3,200	6,000	1,100	
	85	110,000	108,920	150,987	161,405	168,212	99,692	62,580	2,300	12,613	22,562	144,072	124,759	38,016	12,348	1,000	0	0	1,800	6,900	3,200	6,000	
	95	40,900	21,903	55,493	54,461	114,984	158,365	99,917	900	9,203	4,000	22,625	144,310	125,372	38,373	2,400	3,127	1,000	0	1,800	6,900	3,200	
	105	8,800	10,317	24,133	25,535	41,056	112,660	157,772	1,900	6,433	2,700	4,000	22,688	144,544	125,995	0	3,525	2,400	1,000	0	1,800	6,900	

	115	3,400	7,323	13,548	6,600	20,022	39,499	111,537	0	0	1,900	2,700	4,000	22,750	144,782	0	0	0	2,400	1,000	0	1,800
	125	4,600	0	4,323	7,100	5,900	20,031	39,043	0	0	500	1,900	2,700	4,000	22,813	0	0	0	0	2,400	1,000	0
	135	0	0	2,614	3,436	4,000	5,900	20,040	0	0	1,800	500	1,900	2,700	4,000	0	0	0	0	0	2,400	1,000
	145	0	0	900	1,542	3,325	4,000	5,900	0	0	1,800	1,800	500	1,900	2,700	0	0	0	0	0	0	2,400
	155	1,000	0	1,300	900	1,100	3,216	4,000	0	0	0	1,800	1,800	500	1,900	0	0	0	0	0	0	0
	165	0	0	0	1,300	900	1,100	3,106	0	0	0	0	1,800	1,800	500	0	0	0	0	0	0	0
	175	0	0	0	0	1,300	900	1,100	0	0	0	0	0	1,800	1,800	0	0	0	0	0	0	0
	185	0	0	0	0	0	1,300	900	0	0	0	0	0	0	1,800	0	0	0	0	0	0	0
	195	0	2,484	0	0	0	0	1,300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		5,242,200	4,829,950	5,252,966	5,220,234	5,188,177	5,198,306	5,238,745	425,600	233,627	387,081	388,686	390,293	391,874	393,481	33,900	50,502	34,487	35,076	35,666	36,255	36,845
Paper Birch	5	44,000	52,359	15,145	25,592	67,071	62,277	40,176	2,500	4,601	0	0	0	0	0	0	0	0	0	0	0	0
	15	22,400	45,013	69,472	15,033	25,721	66,137	61,530	1,800	0	2,500	0	0	0	0	1,100	0	0	0	0	0	0
	25	23,200	53,473	33,171	68,612	14,924	25,846	65,209	3,600	3,451	1,069	2,500	0	0	0	0	0	1,176	0	0	0	0
	35	22,600	51,811	33,100	33,109	67,751	14,811	25,973	0	9,203	1,800	1,139	2,500	0	0	1,000	2,798	0	1,253	0	0	0
	45	96,700	73,207	26,716	33,299	31,001	66,892	14,702	5,300	28,941	1,400	1,800	1,209	2,500	0	0	0	1,000	0	1,329	0	0
	55	200,000	195,906	85,044	26,949	31,205	26,591	57,068	29,300	29,736	7,200	1,400	1,800	1,278	2,500	0	8,179	0	1,000	0	1,406	0
	65	207,400	239,037	173,034	80,936	25,984	25,350	19,708	46,100	28,289	23,500	7,200	1,400	1,800	1,348	0	0	4,000	0	1,000	0	1,483
	75	115,200	164,232	170,767	160,350	62,323	22,947	23,098	5,300	41,416	52,800	23,500	7,200	1,400	1,800	0	3,214	0	4,000	0	1,000	0
	85	35,900	89,414	93,377	162,898	144,787	54,812	20,700	0	19,997	19,100	52,800	23,500	7,200	1,400	0	804	0	0	4,000	0	1,000
	95	27,900	32,356	49,439	90,306	139,143	104,574	34,606	1,700	0	0	19,100	52,800	23,500	7,200	0	0	0	0	0	4,000	0
	105	12,300	16,297	38,721	47,186	82,974	108,397	89,308	0	0	3,600	0	19,100	52,800	23,500	0	0	0	0	0	0	4,000
	115	6,400	4,015	22,456	35,961	43,730	75,171	104,387	0	0	3,200	3,600	0	19,100	52,800	0	2,536	0	0	0	0	0
	125	5,000	4,099	26,310	22,368	35,267	42,302	73,436	0	0	1,800	3,200	3,600	0	19,100	0	0	0	0	0	0	0
	135	0	0	16,207	26,130	22,280	33,472	41,875	0	0	3,600	1,800	3,200	3,600	0	0	3,055	0	0	0	0	0
	145	0	0	9,756	16,223	25,950	22,192	31,179	0	0	1,800	3,600	1,800	3,200	3,600	0	0	0	0	0	0	0
	155	0	0	15,718	9,669	16,238	25,770	22,104	0	0	0	1,800	3,600	1,800	3,200	0	0	0	0	0	0	0
	165	0	0	3,151	14,954	9,582	16,253	25,593	0	0	0	0	1,800	3,600	1,800	0	0	0	0	0	0	0
	175	0	0	600	3,052	14,791	9,495	16,268	0	0	0	0	0	1,800	3,600	0	0	0	0	0	0	0
	185	0	0	4,000	600	2,953	14,626	9,409	0	0	0	0	0	0	1,800	0	0	0	0	0	0	0
	195	0	0	5,381	9,343	9,905	12,721	27,046	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		819,000	1,021,219	891,565	882,570	873,580	830,636	803,375	95,600	165,634	123,369	123,439	123,509	123,578	123,648	2,100	20,586	6,176	6,253	6,329	6,406	6,483
Balsam Poplar	5	67,200	37,718	94,645	75,797	64,235	67,068	112,390	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	61,500	39,997	66,114	93,334	74,996	63,728	65,947	3,500	0	0	0	0	0	0	900	0	0	0	0	0	0
	25	42,000	37,870	56,874	65,138	92,020	74,192	63,219	0	0	5,200	0	0	0	0	0	0	900	0	0	0	0
	35	40,200	61,080	37,243	56,415	64,162	90,707	73,388	0	0	0	5,200	0	0	0	1,300	2,520	0	900	0	0	0
	45	101,300	85,168	27,832	31,969	43,678	26,267	6,249	1,800	0	0	0	5,200	0	0	3,000	0	1,300	0	900	0	0
	55	75,700	76,049	60,010	21,414	14,481	19,411	18,211	1,800	0	1,800	0	0	5,200	0	2,100	884	3,000	1,300	0	900	0
	65	67,500	40,169	34,876	31,419	8,960	8,734	15,562	0	4,601	1,800	1,800	0	0	5,200	0	3,214	2,100	3,000	1,300	0	900
	75	31,100	34,882	17,165	16,109	23,751	8,256	9,087	0	0	5,700	1,800	1,800	0	0	0	3,212	0	2,100	3,000	1,300	0
	85	6,800	21,812	7,151	5,138	9,085	21,769	8,586	0	0	0	5,700	1,800	1,800	0	0	0	0	0	2,100	3,000	1,300
	95	10,400	8,014	828	3,452	3,451	9,278	22,186	0	0	0	0	5,700	1,800	1,800	0	0	0	0	0	2,100	3,000
	105	0	0	3,764	884	2,453	3,432	9,472	0	0	0	0	0	5,700	1,800	0	0	0	0	0		2,100
	115	0	0	0	2,793	0	2,554	3,412	0	0	0	0	0	0	5,700	1,100	0	0	0	0	0	0
	125	0	3,278	2,400	0	950		2,655	0	0	0	0	0	0	0	0	0	1,100	0	0	0	0
	135	500	0	1,100	2,400	0	890	0	0	0	0	0	0	0	0	0	0	0	1,100	0	0	0
	145	0	0	0	1,100	1,400	1,400	831	0	0	0	0	0	0	0	0	0	0	0	1,100	0	0
	155	0	0	0	0	1,100	1,100	0	0	0	0	0	0	0	0	1,100	0	0	0	0	1,100	0
	165	0	0	0	0	0	0	1,400	0	0	0	0	0	0	0	0	0	1,100	0	0	0	1,100
	175	0	0	0	0	0	0	1,100	0	0	0	0	0	0	0	0	0	0	1,110	0	0	0
	185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,100	0	0
	195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,100	1,100
Total		504,200	446,037	410,002	407,362	404,722	398,786	413,695	7,100	4,601	14,500	14,500	14,500	14,500	14,500	9,500	9,830	9,500	9,510	9,500	9,500	9,500
Non-Stocked	5	0	204,808	0	0	0	0	0	0	11,500	0	0	0	0	0	0	15,363	0	0	0	0	0
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	135	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		0	204,808	0	0	0	0	0	0	11,500	0	0	0	0	0	0	15,363	0	0	0	0	0

Source: USDA Forest Service NCRS Forest Inventory and Analysis as analyzed and reported by the Minnesota Forest Resources Information Cooperative at http://www.cnr.umn.edu/FR/centers/MFRIC/index.html

Note FIA data columns labeled 1990 are those from GEIS records. Non-stockedplots (approximately 169,900 acres) were allocated to forest types and size classes to facilitate projections.

Note FIA data columns labeled 2001 represent the average of field data collected over the 5 year period 1999 - 2003.

Note FIA 2001 data rows 195 years contains acreage in that age class plus all older age classes.

The 1999-2003 FIA has identifed 4 new forest type groups; eastern red cedar, exotic softwoods, oak-pine, and exotic hardwoods. To maintain comparability with the 1990 FIA reporting, these new groups were combined with existing larger types as follows:

Eastern red cedar → Oak-hickory

Exotic softwoods → Red pine

Oak-pine → Oak hickory

Exotic hardwoods → Elm-ash-cottowood

Appendix Table 1.5 Actual and GEIS Projected stand size class acreage by forest type, Minnesota, 1990-2040.

		Timberland							Reserved forest							Other forest						
		FIA		GEIS Projections					FIA		GEIS Projections					FIA		GEIS Projections				
Forest Type*	Size class	1990	2001*	2000	2010	2020	2030	2040	1990	2001*	2000	2010	2020	2030	2040	1990	2001*	2000	2010	2020	2030	2040
All Types	Small	3,997,900	4,856,728	4,871,941	5,198,994	5,287,096	5,092,483	4,920,588	190,300	215,218	116,890	86,692	47,290	25,385	8,500	334,800	326,794	281,429	259,445	225,719	202,049	163,704
	Medium	6,217,300	5,714,888	4,657,899	3,966,852	3,861,203	3,932,025	3,968,016	645,100	410,133	540,278	362,771	255,919	201,369	178,533	450,900	93,836	490,453	501,574	520,603	529,183	563,971
	Large	4,558,200	3,983,404	5,254,877	5,642,620	5,683,763	5,831,096	5,990,845	277,700	305,605	461,308	674,465	826,181	908,028	953,209	46,600	92,058	58,348	70,865	87,363	104,252	109,613
	Nonstocked	0	204,808	0	0	0	0	0	0	11,500	0	0	0	0	0	0	15,363	0	0	0	0	0
	Total	14,773,400	14,759,828	14,784,717	14,808,466	14,832,062	14,855,604	14,879,449	1,113,100	942,456	1,118,476	1,123,928	1,129,390	1,134,782	1,140,242	832,300	528,050	830,230	831,884	833,685	835,484	837,288
Jack Pine	Small	87,300	69,204	80,180	57,235	49,987	51,695	38,558	0	12,790	0	0	0	0	0	0	848	0	0	0	0	0
	Medium	122,200	157,758	56,976	71,142	81,050	54,118	36,693	23200	46,159	7700	4300	0	0	0	1,200	0	1,200	0	0	0	0
	Large	237,100	160,917	224,863	228,489	220,673	235,892	254,126	108300	34,085	48500	51900	56200	56,200	56,200	0	0	0	1,200	1,200	1,200	1,200
	Total	446,600	387,878	362,019	356,866	351,710	341,705	329,377	131,500	93,034	56,200	56,200	56,200	56,200	56,200	1,200	848	1,200	1,200	1,200	1,200	1,200
Red Pine	Small	107,500	72,898	120,500	119,989	116,410	114,241	106,389	0	0	0	0	0	0	0	0	8,140	0	0	0	0	0
	Medium	98,800	138,313	128,731	97,582	110,981	116,769	123,317	1600	4,972	3400	0	0	0	0	0	3,832	0	0	0	0	0
	Large	148,400	165,741	169,831	200,844	188,869	201,434	219,087	78800	14,356	84300	87700	87700	87,700	87,700	900	1,641	900	900	900	900	900
	Total	354,700	376,951	419,062	418,415	416,260	432,444	448,793	80,400	19,329	87,700	87,700	87,700	87,700	87,700	900	13,614	900	900	900	900	900
White Pine	Small	1,900	6,984	25,080	26,431	24,408	16,088	12,366	0	4,601	0	0	0	0	0	0	0	0	0	0	0	0
	Medium	11,700	8,900	1,917	5,178	13,509	26,967	22,816	0	4,601	0	0	0	0	0	0	0	0	0	0	0	0
	Large	55,000	59,136	106,117	104,259	100,073	97,209	105,849	3800	31,073	32600	32600	32600	32,600	32,600	1,300	804	1,300	1,300	1,300	1,300	1,300
	Total	68,600	75,021	133,114	135,868	137,990	140,264	141,031	3,800	40,276	32,600	32,600	32,600	32,600	32,600	1,300	804	1,300	1,300	1,300	1,300	1,300
Black Spruce	Small	675,000	922,963	506,704	434,883	347,800	305,420	277,848	56800	76,846	26300	19100	15500	8500	8500	248,800	121,487	211700	194500	180700	174700	161200
	Medium	627,800	408,543	535,199	574,905	623,755	613,957	569,770	63700	56,453	62000	69200	72800	79800	79800	301,600	848	334700	351900	363500	369500	383000
	Large	47,100	23,602	23,824	50,198	82,688	113,341	153,565	6100	9,385	0	0	0	0	0	1,100	0	1100	1100	3300	3300	3300
	Total	1,349,900	1,355,109	1,065,727	1,059,986	1,054,243	1,032,718	1,001,183	126,600	142,684	88,300	88,300	88,300	88,300	88,300	551,500	122,335	547,500	547,500	547,500	547,500	547,500
Balsam Fir	Small	264,500	188,658	218,888	202,409	200,113	165,617	144,620	20900	18,630	8700	8700	3500	3500	0	0	31,431	0	0	0	0	0
	Medium	391,700	124,974	203,531	166,903	154,012	155,207	137,962	64800	6,231	44800	30100	15800	5200	8700	18,500	12,259	18500	18,500	18500	18,500	18,500
	Large	153,000	60,914	326,510	373,460	375,899	371,388	374,795	7400	4,601	19400	34100	53600	64200	64200	0	0	0	0	0	0	0
	Total	809,200	374,546	748,929	742,772	730,024	692,212	657,377	93,100	29,463	72,900	72,900	72,900	72,900	72,900	18,500	43,690	18,500	18,500	18,500	18,500	18,500
Northern White Cedar	Small	53,500	61,606	46,434	32,717	22,188	27,994	35,774	2100	1,151	3100	3100	0	0	0	12800	6,556	12800	12,800	2800	0	0
	Medium	168,800	260,002	79,823	75,139	76,335	63,658	51,231	1800	11,687	1800	1800	3100	3100	3100	6800	3,536	5800	2,400	11000	12,800	12,800
	Large	426,100	251,900	211,311	228,446	243,314	260,580	273,866	21200	22,410	3600	3600	5400	5400	5400	21100	6,048	22100	25,500	26900	27,900	27,900
	Total	648,400	573,509	337,568	336,302	341,837	352,232	360,871	25,100	35,247	8,500	8,500	8,500	8,500	8,500	40,700	16,140	40,700	40,700	40,700	40,700	40,700
Tamarack	Small	56,500	421,141	250,107	202,096	157,218	128,100	107,211	3100	10,373	1100	1100	1100	1100	0	34200	55,068	28420	25041	21862	20,783	2,504
	Medium	326,300	324,775	363,586	391,676	399,344	379,969	366,693	5800	4,601	5800	5800	5800	5800	6900	83900	0	89700	93100	96300	97,400	115,700
	Large	336,600	75,910	64,273	80,531	114,077	166,372	204,814	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	719,400	821,825	677,966	674,303	670,639	674,441	678,718	8,900	14,974	6,900	6,900	6,900	6,900	6,900	118,100	55,068	118,120	118,141	118,162	118,183	118,204
White Spruce	Small	35,100	47,255	54,306	37,226	17,322	14,182	13,869	0	4,601	10800	5400	0	0	0	0	5,055	0	0	0	0	0
	Medium	42,800	34,455	101,313	83,651	71,823	50,307	36,033	19600	4,647	42500	29600	19600	10800	10800	0	0	0	0	0	0	0
	Large	13,800	11,297	79,952	113,633	147,627	164,777	178,038	20300	4,601	53400	71700	87100	95900	95900	0	466	0	0	0	0	0
	Total	91,700	93,007	235,571	234,510	236,772	229,266	227,940	39,900	13,850	106,700	106,700	106,700	106,700	106,700	0	5,521	0	0	0	0	0
Oak/Hickory	Small	77,400	160,348	113,959	157,595	244,943	359,890	406,167	3100	8,346	3313	3530	2780	0	0	2600	11,041	2564	1593	1691	0	0
	Medium	325,900	407,511	209,390	104,458	77,285	94,806	131,743	7000	24,823	8019	2961	4110	3962	4177	3600	17,549	2928	2049	1450	3,322	3,235
	Large	721,400	768,162	915,929	1,025,653	1,013,895	901,635	843,344	1900	30,760	3419	9224	9790	13674	14422	7800	37,762	9465	12282	13750	14,535	15,591
	Total	1,124,700	1,336,020	1,239,278	1,287,706	1,336,123	1,356,331	1,381,254	12,000	63,929	14,751	15,715	16,680	17,636	18,599	14,000	66,352	14,957	15,924	16,891	17,857	18,826
Elm/Ash/Cottonwood	Small	322,600	322,926	311,457	208,718	238,937	308,758	332,391	13000	7,917	18100	18806	17215	12285	0	9500	34,991	9582	9582	9624	6,566	0
	Medium	535,300	550,269	676,667	609,888	466,701	385,308	342,158	24400	2,678	54801	48652	47351	34113	34137	16900	40,289	10925	10925	7100	6,000	10,808
	Large	266,700	309,056	624,478	806,855	930,511	1,004,781	1,058,787	7700	13,441	14162	21697	26686	46927	61286	7000	6,499	14283	14283	18213	22,517	24,422
	Total	1,124,600	1,182,251	1,612,602	1,625,461	1,636,149	1,698,847	1,733,336	45,100	24,036	87,063	89,155	91,252	93,325	95,423	33,400	81,779	34,790	34,790	34,937	35,083	35,230
Maple/Beech/Birch	Small	255,800	141,337	167,825	152,175	149,245	201,871	239,028	2300	0	2475	2650	893	0	0	2,100	0	2100	2100	2100	0	0
	Medium	502,400	678,356	250,299	139,896	140,416	127,271	131,543	14100	25,573	21906	12172	4580	3002	3179	0	1,034	0	0	0	2,100	2,100
	Large	712,000	862,005	981,339	1,135,390	1,165,756	1,150,089	1,098,666	2000	24,702	7531	17811	27883	31067	31612	0	24,587	0	0	0	0	0
	Total	1,470,200	1,681,698	1,399,463	1,427,461	1,455,417	1,479,231	1,469,237	18,400	50,275	31,912	32,633	33,356	34,069	34,791	2,100	25,620	2,100	2,100	2,100	2,100	2,100
Aspen	Small	1,784,700	2,117,200	2,626,941	3,197,191	3,341,868	3,018,043	2,782,344	77600	39,030	32433	15467	3802	0	0	15,400	37,309	12187	11676	6942	0	0
	Medium	2,246,700	1,768,242	1,421,149	1,182,315	1,291,399	1,573,688	1,782,209	329500	109,469	174252	69686	42469	36214	15492	13,300	7,855	15300	11300	11224	14,955	14,445
	Large	1,210,800	944,508	1,205,947	841,738	555,861	607,466	672,902	18500	85,127	180396	303533	344022	355660	377989	5,200	5,337	7000	12100	17500	21,300	22,400
	Total	5,242,200	4,829,950	5,254,037	5,221,244	5,189,128	5,199,197	5,237,455	425,600	233,625	387,081	388,686	390,293	391,874	393,481	33,900	50,501	34,487	35,076	35,666	36,255	36,845
Paper Birch	Small	96,100	181,545	127,558	126,218	133,119	163,957	171,934	7900	30,932	5369	3639	2500	0	0	6,100	9,135	1176	1253	0	0	0
	Medium	591,700	623,086	497,061	346,295	233,039	165,300	138,021	86000	103,638	104000	84900	33309	14178	7048	0	2,536	5000	5000	6,329	2,406	2,483
	Large	131,200	216,587	266,015	409,063	506,366	500,259	490,924	1700	31,064	14000	34900	87700	109400	116600	0	8,913	0	0	0	4,000	4,000
	Total	819,000	1,021,218	890,634	881,576	872,524	829,516	800,879	95,600	165,633	123,369	123,439	123,509	123,578	123,648	6,100	20,585	6,176	6,253	6,329	6,406	6,483
Balsam Poplar	Small	180,000	142,664	222,002	244,111	243,538	216,627	252,089	3500	0	5200	5200	0	0	0	3,300	5,732	900	900	0	0	0
	Medium	225,200	229,705	132,257	117,824	121,554	124,700	97,827	3600	4,601	9300	3600	7000	5200	5200	5,100	4,098	6400	6400	5200	2,200	900
	Large	99,000	73,669	54,488	44,061	38,154	55,873	62,082	0	0	0	5700	7500	9300	9300	2,200	0	2200	2200	4300	7,300	8,600
	Total	504,200	446,037	504,200	405,996	403,246	397,200	411,998	7,100	4,601	14,500	14,500	14,500	14,500	14,500	10,600	9,830	9,500	9,500	9,500	9,500	9,500
Non Stocked	Small	0	204,808	0	0	0	0	0	0	11,500	0	0	0	0	0	0	15,363	0	0	0	0	0
	Medium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Large	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	204,808	0	0	0	0	0	0	11,500	0	0	0	0	0	0	15,363	0	0	0	0	0

*Source: USDA Forest Service NCRS Forest Inventory and Analysis as analyzed and reported by the Minnesota Forest Resources Information Cooperative at http://www.cnr.umn.edu/FR/centers/MFRIC/index.html

Note FIA data columns labeled 1990 are those from GEIS records. Non-stocked plots (approximately 169,900 acres) were allocated to forest types and size classes to facilitate projections.

Note FIA data columns labeled 2001 represent the average of field data collected over the 5 year period 1999 - 2003.

The 2001 FIA has identifed 4 new forest type groups; eastern red cedar, exotic softwoods, oak-pine, and exotic hardwoods. To maintain comparability with the 1990 FIA reporting, these new groups were combined with existing larger types as follows:

Eastern red cedar → Oak-hickory

Exotic softwoods → Red pine

Oak-pine → Oak hickory

Exotic hardwoods → Elm-ash-cottowood

Appendix 2.1. Common name of 136 forest dependent bird species and their special designation (riparian, etc.). Predicted change (percent) is from the GEIS STEMS decade 10, observed change is from new NRRI density data and new 2000 FIA data. The amount of change from 1990 and observed population for each species is divided into percent due to change in available habitat as designated in the FIA data and change due density between 1990 and 2000. Estimated refers to species where density was estimated in both 1990 and 2000 and modified is designated for species where density and trend data were available.

Common Name	GEIS Predicted Change	Observed Change	% Change due to FIA Habitat	%Change due to density change	Riparian	SE MN	Estimated	Modified
Wood Duck	-8.20	-9.20	-9.20	0.00	x		x	
American Black Duck	36.60	4.80	4.80	0.00	x		x	
Bufflehead	-1.10	5.70	5.70	0.00	x		x	
Common Goldeneye	-0.60	-18.80	-18.80	0.00	x		x	
Hooded Merganser	1.60	-7.90	-7.90	0.00	x		x	
Common Merganser	0.90	-11.30	-11.30	0.00	x		x	
Double-crested Cormorant	-4.90	-15.10	-15.10	0.00	x		x	
Great Blue Heron	-8.20	-8.80	-8.80	0.00	x		x	
Great Egret	-9.00	-8.80	-8.80	0.00	x		x	
Green Heron	-7.00	-5.20	-5.20	0.00	x		x	
Black-crowned Night-Heron	-5.00	-7.30	-7.30	0.00	x		x	
Yellow-crowned Night-Heron	-5.80	-7.90	-7.90	0.00	x		x	
Turkey Vulture	2.90	-5.20	-5.20	0.00			x	
Osprey	23.60	-11.60	-11.60	0.00	x		x	
Bald Eagle	22.10	-16.10	-16.10	0.00	x		x	
Sharp-shinned Hawk	-3.70	-5.00	-5.00	0.00			x	
Cooper's Hawk	-7.50	-5.20	-5.20	0.00			x	
Northern Goshawk	-9.30	-9.10	-9.10	0.00			x	
Red-shouldered Hawk	-6.90	-7.20	-7.20	0.00			x	
Broad-winged Hawk	-8.40	-10.70	-10.70	0.00			x	
Red-tailed Hawk	2.50	-1.40	-1.40	0.00			x	
American Kestrel	27.30	11.50	11.50	0.00			x	
Merlin	-7.10	-7.40	-7.40	0.00			x	
Mourning Dove	29.00	25.10	4.60	20.50				x
Black-billed Cuckoo	5.90	-24.60	-2.60	-22.00				x
Yellow-billed Cuckoo	2.90	7.40	-7.80	15.20		x		x
Eastern Screech-Owl	-8.70	-9.60	-9.60	0.00			x	
Great Horned Owl	-4.60	-4.70	-4.70	0.00			x	
Barred Owl	4.40	-9.10	-9.10	0.00			x	

Common Name	GEIS Predicted Change	Observed Change	% Change due to FIA Habitat	%Change due to density change	Riparian	SE MN	Estimated	Modified
Great Gray Owl	-7.30	-19.30	-19.30	0.00			x	
Long-eared Owl	-5.70	-6.00	-6.00	0.00			x	
Boreal Owl	-6.70	-10.50	-10.50	0.00			x	
Northern Saw-whet Owl	-6.30	-16.30	-16.30	0.00			x	
Whip-poor-will	-3.90	-11.30	-11.30	0.00			x	
Chimney Swift	21.00	-26.60	0.60	-27.20				x
Ruby-throated Hummingbird	-0.80	19.60	0.00	19.60				x
Red-headed Woodpecker	-6.50	-53.70	-5.10	-48.60		x		x
Red-bellied Woodpecker	-4.30	108.10	-3.70	111.80		x		x
Yellow-bellied Sapsucker	-7.90	109.90	-6.00	115.90				x
Downy Woodpecker	2.00	-30.60	-4.00	-26.60				x
Hairy Woodpecker	6.40	2.60	0.00	2.60				x
American Three-toed Woodpecker	-5.60	-31.50	-31.50	0.00			x	
Black-backed Woodpecker	-9.40	-26.10	-26.10	0.00			x	
Northern Flicker	9.10	-21.20	5.70	-26.90				x
Pileated Woodpecker	-6.30	-28.70	-6.10	-22.60				x
Olive-sided Flycatcher	8.40	-54.20	11.60	-65.80				x
Eastern Wood-Pewee	-8.80	-43.50	-13.80	-29.70				x
Yellow-bellied Flycatcher	1.30	25.80	0.70	25.10				x
Acadian Flycatcher	-1.00	234.60	-1.10	235.70		x		x
Least Flycatcher	-4.30	-12.70	-4.10	-8.60				x
Eastern Phoebe	-6.90	25.70	-2.30	28.00	x			x
Great Crested Flycatcher	-2.40	-35.20	-1.40	-33.80				x
Loggerhead Shrike	22.20	-38.90	-38.90	0.00			x	
Bell's Vireo	-14.30	-28.60	-28.60	0.00			x	
Yellow-throated Vireo	-8.80	-1.60	-2.90	1.30				x
Blue-headed Vireo	-8.90	-32.00	-31.00	-1.00				x
Warbling Vireo	-3.30	2.50	-3.60	6.10	x			x
Philadelphia Vireo	2.50	14.90	14.90	0.00			x	
Red-eyed Vireo	3.40	28.50	-4.90	33.40				x
Gray Jay	-4.20	-40.90	-15.20	-25.70				x
Blue Jay	-10.70	-25.90	-11.80	-14.10				x
Black-billed Magpie	22.90	40.00	12.90	27.10				x

Common Name	GEIS Predicted Change	Observed Change	% Change due to FIA Habitat	%Change due to density change	Riparian	SE MN	Estimated	Modified
American Crow	-7.10	30.00	-13.00	43.00				x
Common Raven	-8.40	-10.50	-26.50	16.00				x
Tree Swallow	19.60	82.70	-1.60	84.30				x
Black-capped Chickadee	-5.50	44.90	-10.80	55.70				x
Boreal Chickadee	-7.00	-28.60	-19.10	-9.50				x
Tufted Titmouse	-4.10	104.20	-3.60	107.80		x		x
Red-breasted Nuthatch	-0.80	18.70	-21.10	39.80				x
White-breasted Nuthatch	-7.80	88.40	-6.20	94.60				x
Brown Creeper	-6.40	-44.40	-13.60	-30.80				x
House Wren	0.10	25.10	-3.50	28.60				x
Winter Wren	6.70	-36.50	-6.90	-29.60				x
Golden-crowned Kinglet	-7.80	-68.50	-20.10	-48.40				x
Ruby-crowned Kinglet	-1.80	-47.70	-15.40	-32.30				x
Blue-gray Gnatcatcher	-6.40	14448.20	-4.40	14452.60		x		x
Eastern Bluebird	18.00	31.80	13.90	17.90				x
Veery	6.60	5.40	4.50	0.90				x
Swainson's Thrush	-6.20	-28.10	-16.70	-11.40				x
Hermit Thrush	-7.40	-16.30	-11.90	-4.40				x
Wood Thrush	-9.90	72.60	-6.90	79.50				x
American Robin	5.90	7.50	3.70	3.80				x
Gray Catbird	17.40	63.00	7.40	55.60				x
Brown Thrasher	14.40	-48.60	10.50	-59.10				x
Cedar Waxwing	-6.90	67.30	-3.50	70.80				x
Blue-winged Warbler	-0.40	8185.50	-8.10	8193.60		x		x
Golden-winged Warbler	25.50	17.20	-1.50	18.70				x
Tennessee Warbler	-5.90	-34.60	-11.60	-23.00				x
Nashville Warbler	-3.30	-5.90	2.40	-8.30				x
Northern Parula	-5.00	-4.40	-18.00	13.60				x
Yellow Warbler	9.00	8.00	-2.20	10.20				x
Chestnut-sided Warbler	7.80	-1.10	-4.50	3.40				x
Magnolia Warbler	-12.00	-33.10	-16.20	-16.90				x
Cape May Warbler	-6.20	-32.10	-28.30	-3.80				x
Black-throated Blue Warbler	-1.70	72.50	-3.60	76.10				x

Common Name	GEIS Predicted Change	Observed Change	% Change due to FIA Habitat	%Change due to density change	Riparian	SE MN	Estimated	Modified
Yellow-rumped Warbler	-8.20	51.40	-22.90	74.30				x
Black-throated Green Warbler	-7.60	-26.70	-12.30	-14.40				x
Blackburnian Warbler	-7.30	-53.80	-17.90	-35.90				x
Pine Warbler	-5.70	-54.30	-38.50	-15.80				x
Palm Warbler	2.20	11.70	3.10	8.60				x
Bay-breasted Warbler	-10.00	161.00	-33.90	194.90				x
Cerulean Warbler	-3.80	30.80	-3.50	34.30		x		x
Black-and-white Warbler	5.60	-62.10	1.10	-63.20				x
American Redstart	7.20	42.00	1.30	40.70				x
Prothonotary Warbler	-8.80	91.80	-9.90	101.70	x	x		x
Ovenbird	-6.80	-14.40	-10.10	-4.30				x
Northern Waterthrush	-2.00	-36.90	-9.80	-27.10	x			x
Louisiana Waterthrush	-9.10	100.10	-8.20	108.30	x	x		x
Connecticut Warbler	2.10	-48.40	1.40	-49.80				x
Mourning Warbler	10.60	-29.80	4.00	-33.80				x
Common Yellowthroat	10.00	30.00	18.20	11.80				x
Hooded Warbler	-3.80	-4.70	-4.70	0.00			x	
Wilson's Warbler	13.00	42.60	42.60	0.00			x	
Canada Warbler	0.50	-54.20	2.50	-56.70				x
Yellow-breasted Chat	-11.10	-33.30	-33.30	0.00			x	
Scarlet Tanager	-8.30	-11.00	-13.70	2.70				x
Eastern Towhee	79.00	-30.20	40.60	-70.80				x
Chipping Sparrow	-1.90	-26.90	-11.00	-15.90				x
Song Sparrow	12.10	0.90	9.10	-8.20				x
Lincoln's Sparrow	-30.00	53.20	28.60	24.60				x
White-throated Sparrow	-4.40	-38.60	-3.40	-35.20				x
Dark-eyed Junco	-14.00	-4.30	0.90	-5.20				x
Northern Cardinal	-8.40	35.60	-9.40	45.00		x		x
Rose-breasted Grosbeak	6.30	-11.40	2.90	-14.30				x
Indigo Bunting	7.50	-24.50	3.80	-28.30				x
Rusty Blackbird	-5.60	-31.50	-31.50	0.00	x		x	
Common Grackle	11.60	9.20	16.40	-7.20				x
Brown-headed Cowbird	6.40	-25.10	4.90	-30.00				x

Common Name	GEIS Predicted Change	Observed Change	% Change due to FIA Habitat	%Change due to density change	Riparian	SE MN	Estimated	Modified
Orchard Oriole	-7.60	-10.00	-10.10	0.10			x	
Baltimore Oriole	-13.20	-28.90	-4.40	-24.50				x
Purple Finch	-9.60	-43.00	-14.90	-28.10				x
Red Crossbill	-7.50	579.40	-18.50	597.90				x
White-winged Crossbill	-8.10	2806.60	-20.90	2827.50				x
Pine Siskin	-10.40	-57.00	-32.80	-24.20				x
American Goldfinch	17.80	16.40	9.30	7.10				x
Evening Grosbeak	-1.10	-68.70	-33.90	-34.80				x

SITE-LEVEL TIMBER HARVESTING AND FOREST MANAGEMENT GUIDELINES AND LANDSCAPE-BASED PLANNING AND COORDINATION

A SURVEY OF USE AND PARTICIPATION BY MINNESOTA'S FOREST LAND MANAGEMENT ORGANIZATIONS

Name of Organization: _____

Organization Contact: _____

Phone Number: _____

PART I – TIMBER HARVESTING AND FOREST MANAGEMENT GUIDELINES

The Minnesota Generic Environmental Impact Statement on Timber Harvesting and Forest Management (GEIS) recommended that a Forest Resources Practices Program be developed to successfully mitigate impacts from timber harvesting and forest management activities. In response, the Sustainable Forest Resources Act (MS §89A) was enacted by the Minnesota Legislature in 1995 to address the recommendations of the GEIS. This law directed the Minnesota Forest Resources Council (MFRC) to develop timber harvesting and forest management guidelines (Guidelines). In 1998, the MFRC published the Guidelines for use by the state's loggers and forest land managers.

Please provide information to the following questions about your organization's use of the Guidelines and timber harvesting policies and practices in general. In answering the questions, please try to be as specific as possible. If you need additional space to complete your response, please provide this on a separate sheet of paper and attach it to your questionnaire. Also note in several instances the questionnaire asks for copies of official policies of your organization related to the Guidelines and timber harvesting practices. Where requested, please attach your organization's official policies.

1. **Does your organization require the application of the Minnesota Forest Resources Council's Timber Harvesting and Forest Management Guidelines (Guidelines) in conducting timber harvesting and forest management activities on your lands? (check one)**

   _____Yes _____No

2. **Has your organization adopted a formal policy regarding the use of Guidelines? (check one)**

   _____Yes _____No

   If yes, please describe the nature of this policy and attach a copy to this questionnaire.

3. To what extent does your organization specifically reference the Guidelines in its timber sales? (check one)

_____ All timber sales reference the Guidelines (100%)

_____ Most timber sales reference the Guidelines (75%-99%)

_____ Many timber sales reference the Guidelines (50%-74%)

_____ Some timber sales reference the Guidelines (25%-49%)

_____ Few timber sales reference the Guidelines (1%-24%)

_____ No timber sales reference the Guidelines

4. In 1994, how did timber harvesting and forest management activities on your lands compare to those recommended in the Guidelines? (check one)

_____ Practices always exceeded those specified in the Guidelines

_____ Practices often exceeded those specified in the Guidelines

_____ Practices were consistent with those specified in the Guidelines

_____ Practices were often less than those specified in the Guidelines

_____ Practices were rarely or never consistent with those specified in the Guidelines

5. Currently, how do timber harvesting and forest management activities on your lands compare to those recommended in the Guidelines? (check one)

_____ Practices always exceed those specified in the Guidelines

_____ Practices often exceed those specified in the Guidelines

_____ Practices are consistent with those specified in the Guidelines

_____ Practices are often less than those specified in the Guidelines

_____ Practices are rarely or never consistent with those specified in the Guidelines

6. Characterize the overall familiarity and understanding of the Guidelines among the individuals in your organization who are responsible for implementing the Guidelines. (check one)

_____ My organization has an extensive knowledge and understanding of the Guidelines

_____ My organization has considerable knowledge and understanding of the Guidelines

_____ My organization has a moderate knowledge and understanding of the Guidelines

_____ My organization has minimal knowledge and understanding of the Guidelines

_____ My organization has no knowledge and understanding of the Guidelines

7. Characterize the extent to which individuals in your organization who are responsible for implementing the Guidelines have participated in formal training on use of the Guidelines. (check one)

_____ All staff who use the Guidelines have participated in formal Guideline training programs

_____ Most staff who use the Guidelines have participated in formal Guideline training programs

_____ Some staff who use the Guidelines have participated in formal Guideline training programs

_____ Few staff who use the Guidelines have participated in formal Guideline training programs

_____ No staff who use the Guidelines have participated in formal Guideline training programs

8. Characterize the extent to which the Guidelines have changed the way your organization conducts its timber harvesting and forest management activities. (check one)

_____ The Guidelines have resulted in extensive changes to the way the organization conducts its timber harvesting and forest management practices

_____ The Guidelines have resulted in considerable changes to the way the organization conducts its timber harvesting and forest management practices

_____ The Guidelines have resulted in some changes to the way the organization conducts its timber harvesting and forest management practices

_____ The Guidelines have resulted in few changes to the way the organization conducts its timber harvesting and forest management practices

_____ The Guidelines have resulted in no changes to the way the organization conducts its timber harvesting and forest management practices

9. Describe any future plans your organization has for modifying its timber harvesting and forest management policies and practices.

Please provide information to the following questions about your organization's use of the specific forest management or timber harvesting policies or practices.

MANAGEMENT OF RIPARIAN ZONES

Does your organization have an official policy regarding timber harvesting in forested riparian zones? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to this questionnaire.

11. Has your organization's policy regarding timber harvesting in riparian zones changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed.

12. In 1994, how did the management of riparian areas compare to those recommended in the Guidelines? (check one)

_____ Practices always exceeded those specified in the Guidelines

_____ Practices often exceeded those specified in the Guidelines

_____ Practices were consistent with those specified in the Guidelines

_____ Practices were often less than those specified in the Guidelines

_____ Practices were rarely or never consistent with those specified in the Guidelines

13. Characterize how the current management of riparian zones on your agency's lands compares to management practices recommended in the Guidelines. (check one)

_____ Practices always exceed those specified in the Guidelines

_____ Practices often exceed those specified in the Guidelines

_____ Practices are consistent with those specified in the Guidelines

_____ Practices are often less than those specified in the Guidelines

_____ Practices are rarely or never consistent with those specified in the Guidelines

RETENTION OF SNAGS AND CAVITY TREES

14. Does your organization have an official policy regarding the retention of snags and cavity trees during timber harvesting activities? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to this questionnaire.

15. Has your organization's policy regarding the retention of snags and cavity trees during timber harvesting activities changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed.

16. In 1994, how did the retention of snags and cavity trees during timber harvesting compare to those recommended in the Guidelines? (check one)

_____ Practices always exceeded those specified in the Guidelines

_____ Practices often exceeded those specified in the Guidelines

_____ Practices were consistent with those specified in the Guidelines

_____ Practices were often less than those specified in the Guidelines

_____ Practices were rarely or never consistent with those specified in the Guidelines

17. Currently, characterize how the retention of snags and cavity trees during timber harvesting on your organization's lands compares to management practices recommended in the Guidelines. (check one)

_____ Practices always exceed those specified in the Guidelines

_____ Practices often exceed those specified in the Guidelines

_____ Practices are consistent with those specified in the Guidelines

_____ Practices are often less than those specified in the Guidelines

_____ Practices are rarely or never consistent with those specified in the Guidelines

RETENTION OF LEAVE (LIVE) TREES

18. Does your organization have an official policy regarding the retention of leave trees during timber harvesting activities? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to this questionnaire.

19. Has your organization's policy regarding the retention of leave trees during timber harvesting activities changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed.

20. In 1994, how did the retention of leave trees during timber harvesting compare to those recommended in the Guidelines? (check one)

_____ Practices always exceeded those specified in the Guidelines

_____ Practices often exceeded those specified in the Guidelines

_____ Practices were consistent with those specified in the Guidelines

_____ Practices were often less than those specified in the Guidelines

_____ Practices were rarely or never consistent with those specified in the Guidelines

21. Currently, characterize how the retention of leave trees during timber harvesting on your organization's lands compares to management practices recommended in the Guidelines. (check one)

_____ Practices always exceed those specified in the Guidelines

_____ Practices often exceed those specified in the Guidelines

_____ Practices are consistent with those specified in the Guidelines

_____ Practices are often less than those specified in the Guidelines

_____ Practices are rarely or never consistent with those specified in the Guidelines

APPLICATION OF VISUAL MANAGEMENT GUIDELINES

22. Does your organization have an official policy regarding the application of visual management Guidelines during timber harvesting activities? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to this questionnaire.

23. Has your organization's policy regarding the application of visual management Guidelines during timber harvesting activities changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed.

24. In 1994, how did the application of visual management Guidelines during timber harvesting compare to those recommended in the Guidelines? (check one)

_____ Practices always exceeded those specified in the Guidelines

_____ Practices often exceeded those specified in the Guidelines

_____ Practices were consistent with those specified in the Guidelines

_____ Practices were often less than those specified in the Guidelines

_____ Practices were rarely or never consistent with those specified in the Guidelines

25. Currently, characterize how the application of visual management Guidelines during timber harvesting on your organization's lands compares to management practices recommended in the Guidelines. (check one)

_____ Practices always exceed those specified in the Guidelines

_____ Practices often exceed those specified in the Guidelines

_____ Practices were consistent with those specified in the Guidelines

_____ Practices were often less than those specified in the Guidelines

_____ Practices were rarely or never consistent with those specified in the Guidelines

RETENTION OF SLASH

26. Does your organization have an official policy regarding the retention of slash during timber harvesting activities? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to this questionnaire.

27. Has your organization's policy regarding the retention of slash during timber harvesting activities changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed.

28. In 1994, how did the retention of slash during timber harvesting compare to those recommended in the Guidelines? (check one)

_____ Practices always exceeded those specified in the Guidelines

_____ Practices often exceeded those specified in the Guidelines

_____ Practices were consistent with those specified in the Guidelines

_____ Practices were often less than those specified in the Guidelines

_____ Practices were rarely or never consistent with those specified in the Guidelines

29. Currently, characterize how the retention of slash during timber harvesting on your organization's lands compares to management practices recommended in the Guidelines. (check one)

_____ Practices always exceed those specified in the Guidelines

_____ Practices often exceed those specified in the Guidelines

_____ Practices are consistent with those specified in the Guidelines

_____ Practices are often less than those specified in the Guidelines

_____ Practices are rarely or never consistent with those specified in the Guidelines

HARVESTING ON FROZEN SOILS

30. Does your organization have an official policy regarding timber harvesting on frozen soils? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to the questionnaire?

31. Has your organization's policy regarding timber harvesting on frozen soils changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed

32. On your organization's lands, what percent of acres harvested were conducted on frozen soils?

_____ % in 1994?

_____ % in 2005?

UNEVEN-AGED MANAGEMENT

33. Does your organization have an official policy regarding uneven-aged management? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to the questionnaire?

34. Has your organization's policy regarding uneven-aged management changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed

35. On your organization's lands, what percentage of acres harvested included uneven-aged management?

_____ % in 1994?

_____ % in 2005?

SITE REGENERATION

36. Does your organization have an official policy regarding site regeneration? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to the questionnaire?

37. Has your organization's policy regarding site regeneration changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed

38. On your organization's lands, what percentage of acres harvested were fully stocked within five years?

_____ % in 1994?

_____ % in 2005?

SPECIES SITE MATCHING

39. Does your organization have an official policy regarding species site matching? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to the questionnaire?

40. Has your organization's policy regarding species site matching changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed

41. On your organization's lands, what percentage of acres harvested included species site matching activities for regeneration?

_____ % in 1994?

_____ % in 2005?

REDUCTION OF PEST DAMAGE

42. Does your organization have an official policy regarding reduction of pest damage? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to the questionnaire?

43. Has your organization's policy regarding reduction of pest damage changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed

44. On your organization's lands, what percentage of infested acres harvested were treated to reduce forest pest damage?

_____ % in 1994?

_____ % in 2005?

UTILIZATION STANDARDS

45. Does your organization have an official policy regarding utilization standards? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to the questionnaire?

46. Has your organization's policy regarding utilization standards changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed

47. Indicate if any of your utilization standards have increased since 1994. (Check all species where utilization standards have increased.)

Pulpwood		Saw timber	
Pine	_____	Pine	_____
Spruce/Fir	_____	Spruce/Fir	_____
Aspen	_____	Aspen	_____
Other Hardwoods	_____	Other Hardwoods	_____

PROTECTION OF SENSITIVE WILDLIFE SITES

48. Does your organization have an official policy regarding protection of sensitive wildlife sites? (check one)

_____Yes _____No

If yes, please describe the nature of this policy and attach a copy to the questionnaire?

49. Has your organization's policy regarding protection of sensitive wildlife sites changed since 1994? (check one)

_____Yes _____No

If yes, please describe how your policy has changed

50. On your organization's lands, what percentage of sensitive sites (in harvesting areas) were protected?

_____ % in 1994?

_____ % in 2005?

OTHER COMMENTS

51. Please provide any additional comments you have about your organization's use of the Guidelines.

PART II – LANDSCAPE PLANNING AND COORDINATION ACTIVITIES

The Minnesota Generic Environmental Impact Statement on Timber Harvesting and Forest Management (GEIS) recommended that a Sustainable Forest Resources Program be developed to successfully mitigate landscape-level impacts associated with timber harvesting and forest management activities. In response, the Sustainable Forest Resources Act (MS §89A) was enacted by the Minnesota Legislature in 1995 to address the recommendations of the GEIS. This law directed the Minnesota Forest Resources Council (MFRC) to develop and implement a landscape planning and coordination program (Landscape Planning Program).

Please provide information to the following questions about your organization's participation in and perceived usefulness of the MFRC's Landscape Planning Program. In answering the questions, please try to be as specific as possible. If you need additional space to complete your response, please provide this on a separate sheet of paper and attach it to your questionnaire.

OVERALL PARTICIPATION IN MFRC'S LANDSCAPE PLANNING PROGRAM

1. Which of the following MFRC regional Landscape Planning initiatives have your organization participated in? (check all that apply)

_____ Northeast Region
_____ Northern Region
_____ North Central Region
_____ Southeastern Region
_____ East Central Region
_____ West Central Region
_____ Metro Region
_____ Prairie Region

If no regions were checked, please go to question 9 on page 21.

2. Estimate the total effort your organization's staff contributed to the MFRC's Landscape Planning Program during 2004.

_____ total staff hours

3. Indicate other contributions made by your organization to the MFRC's Landscape Planning Program during 2004 for each of the areas listed below. Note: Do not include staff time. (check all that apply)

_____ Non-salary staff costs (e.g., travel)
_____ Data collection and analysis
_____ Equipment purchases
_____ Contracts for professional or technical services
_____ Other contributions: _____

4. **Characterize your organization's perception of the overall effectiveness of the MFRC Landscape Planning Program in identifying and addressing landscape-level forest resource issues. (check one)**

_____ Extremely effective

_____ Moderately effective

_____ Minimally effective

_____ Not effective

5. **Characterize your organization's perception of the overall effectiveness of the MFRC Landscape Planning Program in effectively coordinating your forest management activities across large landscapes and with other owners of forest land (check one)**

_____ Extremely effective

_____ Moderately effective

_____ Minimally effective

_____ Not effective

6. **To what extent has the MFRC's Landscape Planning Program changed the way your organization manages its forest resources? (check one)**

_____ The Landscape Planning Program has resulted in extensive changes in the way the organization manages its forest resources.

_____ The Landscape Planning Program has resulted in considerable changes in the way the organization manages its forest resources.

_____ The Landscape Planning Program has resulted in some changes in the way the organization manages its forest resources.

_____ The Landscape Planning Program has resulted in few changes in the way the organization manages its forest resources.

_____ The Landscape Planning Program has resulted in no change in the way the organization manages its forest resources.

Give specific examples to support your response to this question.

PARTICIPATION IN REGION-SPECIFIC LANDSCAPE PLANNING PROCESSES

The following two pages ask questions about your involvement in specific **regional** MFRC Landscape Planning Programs, as well as perceptions about the effectiveness of these programs. For each MFRC Landscape Region your organization participated in (you identified these regions in Question 1 on page 16), characterize your organization's involvement in and perceived effectiveness of the region's landscape planning process.

Note: Make additional copies of this and the following page for each MFRC Landscape Region your organization has been a participant of.

MFRC Landscape Region: _____

7. Characterize your organization's involvement in the following Landscape Planning Program activities of this region.

A. Development of Regional Assessment of Ecological, Economic, and Social Conditions (check one)

_____ Extensive involvement (our organization was a lead participant in this activity)
_____ Moderate involvement (our organization actively participated, but was not a lead participant)
_____ Modest involvement (our organization regularly participated)
_____ Minimal involvement (our organization occasionally participated)
_____ No involvement (our organization did not participate)
_____ NA (this part of the process has not been undertaken)

B. Development of Desired Future Conditions for the Region (check one)

_____ Extensive involvement (our organization was a lead participant in this activity)
_____ Moderate involvement (our organization actively participated, but not a lead participant)
_____ Modest involvement (our organization regularly participated)
_____ Minimal involvement (our organization occasionally participated)
_____ No involvement (our organization did not participate)
_____ NA (this part of the process has not been undertaken)

C. Development of Strategies to Achieve Desired Future Conditions (check one)

_____ Extensive involvement (our organization was a lead participant in this activity)
_____ Moderate involvement (our organization actively participated, but not a lead participant)
_____ Modest involvement (our organization regularly participated)
_____ Minimal involvement (our organization occasionally participated)
_____ No involvement (our organization did not participate)
_____ NA (this part of the process has not been undertaken)

D. Coordination of land management activities (check one)

_____ Extensive involvement (our organization was a lead participant in this activity)

_____ Moderate involvement (our organization actively participated, but not a lead participant)

_____ Modest involvement (our organization regularly participated)

_____ Minimal involvement (our organization occasionally participated)

_____ No involvement (our organization did not participate)

_____ NA (this part of the process has not been undertaken)

E. Evaluation of Implementation Strategies (check one)

_____ Extensive involvement (our organization was a lead participant in this activity)

_____ Moderate involvement (our organization actively participated, but not a lead participant)

_____ Modest involvement (our organization regularly participated)

_____ Minimal involvement (our organization occasionally participated)

_____ No involvement (our organization did not participate)

_____ NA (this part of the process has not been undertaken)

8. Characterize your organization's perception of the usefulness of the following products produced through this region's Landscape Planning Program.

A. Development of Regional Assessment of Ecological, Economic, and Social Conditions (check one)

_____ Extremely useful (provided considerable information/understanding that would not have otherwise been available to my organization)

_____ Moderately useful (provided some information/understanding that would not have otherwise been available to my organization)

_____ Minimally useful (provided minimal information/understanding that would not have otherwise been available to my organization)

_____ Not useful (provided no new information/understanding)

_____ NA (this part of the process has not been undertaken)

B. Development of Desired Future Conditions for the Region (check one)

_____ Extremely useful (has a major influence on the management of my organization's lands)

_____ Moderately useful (has a modest influence on the management of my organization's lands)

_____ Minimally useful (has minimal influence on the management of my organization's lands)

_____ Not useful (does not influence the management of my organization's lands)

_____ NA (this part of the process has not been undertaken)

C. Development of Strategies to Achieve Desired Future Conditions (check one)

_____ Extremely useful (many strategies are being used by my organization for its lands)

_____ Moderately useful (some strategies are being used by my organization for its lands)

_____ Minimally useful (few strategies are being used by my organization for its lands)

_____ Not useful (no strategies are being used by my organization for its lands)

_____ NA (this part of the process has not been undertaken)

D. Coordination of land management activities (check one)

_____ Extremely useful (my organization's coordination of land management with other agencies has been substantially increased)

_____ Moderately useful (my organization's coordination of land management with other agencies has been moderately increased)

_____ Minimally useful (my organization's coordination of land management with other agencies has been only minimally increased)

_____ Not useful (my organization's coordination of land management with other agencies has not been increased)

_____ NA (this part of the process has not been undertaken)

E. Evaluation of Implementation Strategies (check one)

_____ Extremely useful (clear understanding of the extent to which landscape goals and strategies are being accomplished)

_____ Moderately useful (some uncertainty about the extent to which landscape goals and strategies are being accomplished)

_____ Minimally useful (considerable uncertainty about the extent to which landscape goals and strategies are being accomplished)

_____ Not useful (does not increase understanding of the extent to which goals and strategies are being accomplished)

_____ NA (this part of the process has not been undertaken)

ORGANIZATION-SPECIFIC LANDSCAPE-LEVEL INITIATIVES

9. Describe on a separate piece(s) of paper attached to this questionnaire any other landscape-level planning and coordination effort undertaken by your organization since 1994. Include only those landscape-level initiatives that were undertaken <u>outside</u> of the MFRC's Landscape Planning Program. In describing these initiatives, be sure to include the following information:

A. Description of the initiative's goals or objectives

B. Geographic area of coverage

C. Forest landowners involved

D. Progress to date

E. Initiative outcomes (be as specific as possible)

<u>Note</u>: Landscape level initiatives typically address large forested areas, involve forest land owned by multiple public and private interests, develop strategies that are long term in nature, and require coordination among forest land owners in order for the initiative to be effective. The following are examples of landscape level initiatives identified in the GEIS.

- Reducing the area of the forest converted to other land uses.
- Balancing forest age class and covertype structure.
- Developing riparian corridors.
- Managing forests on extended rotation.
- Protecting sensitive plant species.
- Developing a landscape-based road and trail plan.
- Developing visual management Guidelines.
- Developing integrated pest management strategies.

10. Please provide any additional comments or ideas you have about your organization's participation with the MFRC or other landscape-level initiatives.

Survey of GEIS Implementation Progress
Site-Level Program

Organization: Minnesota Forest Resources Council

Contact for Information Provided: _____

Title: _____

Date: _____

The Minnesota Generic Environmental Impact Statement on Timber Harvesting and Forest Management (GEIS) recommended that a Forest Resources Practices Program be developed to successfully mitigate unacceptable impacts from timber harvesting and forest management. In response, the Sustainable Forest Resources Act (MS §89A) was enacted which recommended the development of timber harvesting and forest management guidelines. Please provide information to the following questions about the Minnesota Forest Resource Council's (MFRC) Timber Harvesting and Forest Management Guidelines (Guidelines). Where needed, attach additional material. Please be as specific as possible in answering these questions.

Content and Format

1. **For each of the following topical areas associated with timber harvesting and forest management, indicate: 1) whether or not it is explicitly addressed in the Guidelines; and 2) if so, how the guidelines treat each topical area**.

    a. Timber sale design and layout to incorporate nontimber concerns.

    b. Method for the disposal and/or redistribution of slash and other woody biomass.

    c. Establishing and managing riparian corridors.

    d. Defining best management practices for water quality.

    e. Retaining biomass in harvested sites.

    f. Defining postharvest reforestation practices.

    g. Methods of road construction.

    h. Managing for visual and aesthetic objectives.

    i. Protecting unique historic and cultural resources.

    j. Minimizing soil compaction.

2. **Identify and describe other major topical areas associated with timber harvesting and forest management that are addressed in the Guidelines.**

Training, Use and Evaluation

3. **Describe efforts to inform and train forest landowners, resource managers, and timber harvesters on how to use the Guidelines.**

4. **Describe efforts that been put in place to monitor the use of Guidelines in Minnesota. In doing so, be sure to specifically describe:**

    a. The design and implementation of a program to monitor use of the Guidelines.

    b. The extent to which this monitoring has taken place.

    c. The major forest ownership categories that have been monitored.

    d. The major findings of Guideline implementation monitoring efforts.

5. **Describe the Guideline outreach and implementation goals established by the MFRC. In doing so, specify for each major forest land ownership category:**

    a. The goals that have been established.

    b. Progress to date toward achieving each goal and an indication whether or not the goal has been achieved.

    c. Any actions taken to increase the likelihood a goal will be achieved.

Survey of GEIS Implementation Progress
Landscape-Level Program

Organization: Minnesota Forest Resources Council

Contact for Information Provided: _____

Title: _____

Date: _____

The Minnesota Generic Environmental Impact Statement on Timber Harvesting and Forest Management (GEIS) recommended that a Sustainable Forest Resources Program be developed to successfully mitigate unacceptable impacts from timber harvesting and forest management. In response, the Sustainable Forest Resources Act (MS §89A) was enacted which recommended the development of a landscape-level forest resources planning and coordination framework. Please provide information to the following questions about the Minnesota Forest Resource Council's Landscape Program. Where needed, attach additional material. Please be as specific as possible in answering these questions.

1. **Describe the framework that has been established that will enable long-range strategic planning and landscape coordination to occur across ownerships.**

2. **Identify and describe the landscape regions that have been defined and the criteria by which they have been defined.**

3. **Describe the principles and goals for landscape-based forest resource planning.**

4. **Describe the general process by which landscape-based forest resource planning is undertaken.**

5. **For each landscape region listed in question #2 above, describe the following regarding the landscape planning and coordination activities that have been accomplished to date. Please provide separate responses for each landscape region and be as specific as possible.**

    a. Representation of the regional forest resource committee.

    b. Progress that has been made in implementing landscape-based forest resources planning for the region.

    c. Progress that has been made in facilitating landscape-based coordination of timber harvesting and forest management activities in the region.

    d. A summary paragraph of any work products prepared as part of this region's landscape-based planning and coordination activities. The summary should include: 1) a description of the work product; 2) when the product was prepared; and 3) how it is being used to further regional landscape planning and coordination goals.

6. **For each of the following mitigation strategies identified in the GEIS, indicate: 1) whether or not it been addressed through the MFRC's Landscape Program; and 2) if so, how it has been addressed. Please be as specific as possible.**

    a. Discourage forest land from being converted to other uses.

    b. Balance forest age-class and cover-type structure.

    c. Protect riparian corridors.

    d. Promote the use of extended rotation forestry.

    e. Protect sensitive sites for rare plant species.

    f. Promote development of a landscape-based road and trail plan.

    g. Develop an integrated pest management strategy.

    h. Develop visual management guidelines.

Survey of GEIS Implementation Progress
Forest Resources Research Program

Organization: Minnesota Forest Resources Council

Contact for Information Provided: _____

Title: _____

Date: _____

The Minnesota Generic Environmental Impact Statement on Timber Harvesting and Forest Management (GEIS) recommended that a Forest Resources Research Program be developed to successfully mitigate unacceptable impacts from timber harvesting and forest management. In response, the Sustainable Forest Resources Act (MS §89A) was enacted which recommended the establishment of a forest resources research advisory committee (Committee). Please provide information to the following questions about the Minnesota Forest Resource Council's Research Advisory Committee. Where needed, attach additional material. Please be as specific as possible in answering these questions.

1. **Describe the extent to which the Committee has fostered the identification of priority forest resources research.**

2. **Describe forest resources research supported by the Committee or its member organizations that:**

    a. Develops a better understanding of timber harvesting and forest management impacts on ecosystem functions and processes.

    b. Identifies the full role of forest soils and their various conditions in forest resource productivity in Minnesota.

    c. Provides a scientific basis for defining desired age class and covertype goals to meet biological diversity objectives.

    d. Evaluates the interaction between the level of timber harvesting and forest management and the state's tourism and outdoor recreation industry.

    e. Identifies management techniques and impacts assessments with regard to forest pests.

    f. Identifies and evaluates low impact timber harvesting techniques and technology applicable to Minnesota.

    g. Identifies potentially complimentary forest industries for Minnesota.

    h. Monitors broad trends and conditions in the state's forest resources.

i. Monitors silvicultural practices and application of the timber harvesting and forest management guidelines.

j. Evaluates the effectiveness of practices to mitigate impacts of timber harvesting and forest management activities on the state's forest resources.

3. Describe the Committee's efforts to increase:

a. Collaboration between organizations with responsibilities for conducting forest resources research.

b. Collaboration between researchers in different disciplines in conducting forest resources research.

c. Interaction and communication between researchers and practitioners in the development and use of forest resources research.