"Minnesota's Forest Resources at a Crossroads" is a series of 15 briefs that summarize the draft version of a Generic Environmental Impact Statement (GEIS). The GEIS identifies and assesses the environmental, economic, and social impacts of potential increases in timber harvesting and forest management activities in Minnesota. The GEIS also develops mitigation strategies for these impacts and offers strategic policy recommendations. The study was commissioned by the Minnesota Environmental Quality Board. This information forms the basis for discussion about the future protection and management of Minnesota's forest resources.

How to obtain copies:
The draft GEIS document is lengthy and is based on information contained in five background papers and nine technical papers. These briefs parallel the GEIS document and the background and technical papers. Copies of the GEIS documents can be obtained by contacting Dr. Michael A. Kilgore, Environmental Quality Board, 300 Centennial Office Building, 659 Cedar Street, St. Paul, MN 55155 (Phone: 612/297-2607). Additional copies of the briefs can be obtained by writing the Minnesota Extension Service Distribution Center, Room 20 Coffey Hall, 1420 Eckles Avenue, St. Paul, MN 55108. OR fax in your order at 612/625-2207. Request item number NR-MI-6199-S, entitled "Minnesota's Forest Resources at a Crossroads."

This brief summarizes the impact of timber harvesting and forest management on biodiversity. The following issues are addressed: 1) biological diversity in forests at genetic, species, and ecosystem levels; 2) forest-dependent species and habitats that are federally or state listed as threatened, endangered, or of special concern; and 3) old growth (forests dominated by long-lived species that have escaped catastrophic disturbance for at least 120 years) and old forests (forests that are managed with the goal of having them develop into older forests).

The GEIS Biodiversity Technical Paper complements the Forest Wildlife Technical Paper that analyzes the impacts timber harvesting and forest management activities have on Minnesota's wildlife species.

The Biodiversity Issue

Biological diversity or biodiversity is a complex concept that combines genetic diversity of individual plant and animal species and the variety and abundance of those species in a community. The interactions among species and between the organisms and the environment is a component of biodiversity as well. Biodiversity can be assessed in a community, an ecosystem, a landscape (a section of natural inland scenery such as a prairie or woodland), or even globally.

A community is often defined as a complex or group of species that occurs in a particular setting. The term ecosystem relates more to the interactions among plants, animals, and their environment. Ecosystem emphasizes the properties and processes that occur in an area while community describes the inhabitants of an area. An ecosystem and a community may often describe the same area.

The two major issues affecting biodiversity are: 1) maintenance of rare species and habitats and 2) maintenance of genetic and species diversity. Two specific issues are addressed by an analysis of biodiversity in Minnesota. First, forest management activities impact major species at the edge of their range. Minnesota has an unusual number of these due to its location at the junction of the conifer forest, deciduous forest, and prairie. Second, many land management activities can affect rare communities. Conversion to agriculture, overharvesting, wildfire suppression, and replacement of old forest by younger forest all deplete rare communities.

Through careful management, some level of forest harvest can be sustained even while protecting the original biological diversity. In general, the strategy requires first identifying all of the elements to be protected, then scheduling harvesting and other management actions so that adequate areas and variations of all the identified forest communities are maintained. These management practices also involve the use of harvest systems that minimize the disruption of fundamental biogeochemical.
processes including flow and filtration of water, recycling of nutrients by decomposition, protection of the soil surface layer, and retention of many microhabitats such as dead and decaying trees that provide habitat for a host of plants and animals.

Some might argue that protecting biodiversity can be handled far more easily by simply identifying individual species that appear to be in jeopardy, then mitigating through narrowly directed actions to prevent the species demise. This strategy does not always work for several reasons. First, when a species reaches a state of jeopardy, much of its genetic diversity may have already been lost; also, it may be too late and expensive by then to save the species regardless of the recovery strategy used. Second, many species can disappear before their status is discovered. And finally, and perhaps most importantly, the species is not the proper unit around which biological conservation should be organized. The proper unit for such activity is a region’s array of natural biotic communities, each self-sufficient with its set of species and its set of ecosystem processes.

**Taking the Community Approach**

Biodiversity is best preserved by using the community approach. There are four major reasons for this assumption:

1. There are too many species in Minnesota (over 2,000 vascular plant species, about 380 moss species, 550 lichen species, 23 forest-dependent mammals, 148 birds, 12 herps (amphibians and reptiles), and numerous insects) to produce management guidelines to maintain each species individually.

2. The knowledge of the habitat and response to logging of most plant species is very limited, and there is not enough information to relate plant populations to forest covertypes (indicates the most common tree species) and age.

3. Biodiversity was maintained for thousands of years under natural disturbance regimes that created a pattern of plant communities on the landscape.

4. Managing of forests to maintain all natural covertypes in reasonable proportions on the landscape should eliminate the need to implement recovery plans for a growing number of endangered species.

Mimicking natural spatial patterns and natural disturbances on the landscape is the best way to implement the community approach to saving biodiversity. Adjusting harvesting methods and spatial patterns of harvests is necessary to prevent loss of biodiversity. Fragmentation of forest areas and reductions in covertype may cause loss of biodiversity over long time periods. Problems caused by inbreeding or lack of regeneration of long-lived species become evident only after long periods.

**Impacts**

The base (4 million cords annually), medium (4.9 million cords annually), and high (7 million cords annually) harvest scenarios in the GEIS study have different projected effects on biodiversity. These effects are described by reductions in the area of specific forest covertypes or reductions in the abundance of species within forest covertypes. Covertype and age are used to approximate types of forest communities, so declines in covertype represent declines in certain communities. The only covertypes that are expected to decline in area due to harvesting activities are old white cedar forest and old-growth swamp conifer forest. Accidental harvest of rare plant communities and physical damage to rare plants are expected under all scenarios.

Declines in the abundance of major and minor tree species within covertypes affect biodiversity as well. A number of rare tree species are predicted to decline under all three harvest levels. Tree species near the edge of their range are also expected to decline. The conifer component of mixed-species stands will likely decline under all three harvest scenarios. There is also the possibility that some exotics and hybrids may replace native species.

The genetic characteristics of remaining plant and animal populations after a harvest operation are also important to biodiversity. Forest fragmentation isolates forest herbs with little ability to spread pollen or seed. Loss of genetic diversity due to fragmentation occurs under all harvesting scenarios affecting wildlife species populations such as those of white-tailed deer. Future climate change may also affect genetic diversity of trees and other plants.

Some animal and bird populations are significantly impacted by harvesting. The red-shouldered hawk, a state-listed special concern species, shows a declining population under all three harvesting scenarios. The
Table 1 - Effectiveness of mitigation strategies relevant to each significant impact, from 1 = high to 3 = low. Empty box = little or no effect.

<table>
<thead>
<tr>
<th>Significant Impact</th>
<th>Mitigation*</th>
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<tbody>
<tr>
<td>Decline of old-growth swamp conifer forest</td>
<td>1 2 2 1 1</td>
</tr>
<tr>
<td>Likely decline of uncommon tree species like hemlock,</td>
<td>1 1</td>
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<tr>
<td>yellow oak, honeylocust, sycamore, Kentucky coffeetree,</td>
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<tr>
<td>and rock elm</td>
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<tr>
<td>Potential loss of conifers in mixed-species stand</td>
<td>1 1 1 2 3 1</td>
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<tr>
<td>Decline of tree species near the range edge</td>
<td>1 2 1 1 3 2</td>
</tr>
<tr>
<td>Decline of rare communities</td>
<td></td>
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<tr>
<td>Effects of fragmentation on forest herbs</td>
<td>3 2 1 2 3</td>
</tr>
<tr>
<td>Effects of fragmentation during climate change</td>
<td>3 1</td>
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<tr>
<td>Deer browsing</td>
<td>3 1</td>
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<tr>
<td>Potential displacement of native species by hybrids</td>
<td>1 1</td>
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<tr>
<td>Decline of rare plant species</td>
<td>1 1 1 2 1 3</td>
</tr>
<tr>
<td>Decline of red-shouldered hawk</td>
<td>1 1 3</td>
</tr>
<tr>
<td>Decline of pine marten</td>
<td>1 1 1 1</td>
</tr>
</tbody>
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Key for Table 1:
- **A** Mitigation:
  - Do nothing
  - Inventory
  - Extended rotation

- **B** Mitigation:
  - Connect landscapes
  - Biodiversity maintenance areas
  - Prescribed burning
  - Return of red and white pines and upland white cedar
  - Favor tree species near the edge of their range
  - Careful use of exotics and hybrids
  - Retain conifers in mixed-species stands
  - Careful harvest near rare species and communities
  - Resolution of conflicting management goals

Pine marten, also a state-listed special concern species, has declining populations under only the high scenario.

**Mitigations**

A combination of strategies should be effective for mitigating harvesting impacts on biodiversity. These strategies include:

1. Comprehensively inventorying Minnesota's forest lands and biological features.
2. Developing harvesting methods to maintain rare species and communities identified in the inventory.
3. Distributing corridors of extended rotation forest across the landscape to connect major parks, wilderness areas, and old-growth areas. (Extended rotation refers to retaining a forest well beyond the age when it would be economical to harvest.)
4. Re-establishing red and white pine and upland white cedar covertypes.
5. Maintaining and/or enhancing the conifer component of mixed-species aspen and birch stands.

Table 1 shows that this combination of strategies helps to reduce nearly all of the significant negative impacts of harvesting on biodiversity. Also, it requires that very little additional forest be reserved. The extended rotation forest would not greatly impact the timber harvest since no forest would be permanently reserved from harvesting. The GElS harvesting scenarios show that 20 percent of state and federal forest lands can be managed under extended rotation guidelines and still meet the demand for timber. However, even with the use of extended rotation forests, it can be physically difficult to prevent fragmentation of forest areas.

Some additional mitigation alternatives may be useful in certain circumstances. First, maintenance of large blocks of mature conifer forest benefit
species and communities adapted to the forest interior. Second, prescribed burning restores rare communities such as oak or pine savannas. Third, modified harvesting methods will allow regeneration of uncommon tree species and maintain rare communities. Fourth, hybrids and exotics must be used carefully to ensure that native species are not displaced.

Many of the habitat requirements for one species may conflict with those of other species. The resolution of these conflicts in the formation of management plans can help avoid future problems.

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