RIPARIAN FORESTS IN MINNESOTA: A REPORT TO THE STATE LEGISLATURE

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Executive Summary

Charge

This analysis was written specifically for the Minnesota Legislature. Minnesota Statute 89A.05, *Monitoring riparian forests,* states that "information gathered on riparian forests and timber harvesting in riparian management zones and seasonal ponds as specified in this subdivision shall be presented to the legislature by February 2001."

Importance

Forest management activities within riparian areas have the potential to adversely affect their values and functions. Because of high stakeholder interest in these effects, the legislature has stipulated that riparian forested areas be monitored as to their extent and condition; the extent to which timber harvesting occurs within them; and the use and effectiveness of timber harvesting and forest management guidelines applied to protect their functions and values.

Challenges

Three primary reasons explain why riparian forests and their management are difficult to define, work with, and measure.

- An overwhelming supply of information on riparian forests makes it an intensive, time-consuming effort to prepare a study, report, or analysis.
- People are not always in agreement on the management practices required to sustain riparian areas and seasonal ponds.
- Time and funding are often lacking for research on riparian forest management issues.

Minnesota's Riparian Forests

There are 7,719,200 acres of riparian lands in Minnesota mostly occurring in agricultural, deciduous forest, lowland forest, and marsh areas (DNR Resource Assessment, 2000a). Most of the state's riparian lands, 81 percent, are privately owned.

Ongoing Research Affecting Riparian Area Management

Since 1996, the Minnesota Forest Resources Council (MFRC) has been supporting studies covering three areas:

- Forested riparian zones.
- Wildlife species and forest landscapes.
- Forest resource productivity and forest management.

Results from these studies are being used to review site-level timber harvesting and forest management guidelines.

Efforts Addressing Forested Riparian Areas

This analysis summarizes two projects undertaken to enhance the sustainability of Minnesota's forested riparian areas.

Forest management guidelines. A guidebook listing timber harvesting and forest

management guidelines was developed as a collaborative effort involving a broad spectrum of people who value forested lands in Minnesota (Minnesota Forest Resources Council, 1999). It offers recommendations for protecting wildlife habitat, riparian areas, historic/cultural resources, soil productivity, water quality, wetlands, and visual quality.

Peer review. The MFRC conducted a peer review of the guidelines recommended for protecting forest riparian areas and seasonal ponds from timber harvesting and forest management activities. A panel of eight scientists representing expertise in hydrology/soil science, terrestrial ecology, silviculture, and aquatic ecology provided the MFRC with formal written reviews and collective responses covering the consistency of the guidelines with available scientific understanding.

The Search for New Information

This analysis highlights three ongoing or proposed projects that address riparian area management.

What is the extent of harvesting in riparian areas? In 2001, DNR Forestry's Resource Assessment Unit acquired, rectified, calibrated, and differenced Landsat satellite scenes covering Carlton County to detect forest change. Under-flight photography was also acquired to interpret change areas and riparian harvest acreage adjustments. A map showing forest disturbance areas within riparian management zones in Carlton County was produced using this information (DNR Resource Assessment, 2001).

Are management guidelines used? A report presenting the findings of a first-year monitoring program that is gathering information on the application of the timber harvesting and forest management guidelines was completed (Phillips, 2001). This monitoring program included looking at how guidelines addressing site-level water quality, wetland, and riparian management issues were used on private, county, state, federal, forest industry, and other government lands across Minnesota.

Do forest management guidelines work? A proposal has been approved by the Legislative Commission on Minnesota Resources to study the effectiveness of the riparian guidelines contained within the timber harvesting and forest management guidelines. This project will evaluate site-based effects associated with applying various riparian management practices on terrestrial, wildlife, and aquatic variables.

Conclusion

This analysis recommends three major areas to pursue to learn more about Minnesota's riparian areas and how they are impacted by timber harvesting and other forest management activities.

- Current projects need to be extended and new projects implemented to monitor the extent to which timber harvesting and forest management guidelines are being used and if these guidelines are effective at minimizing impacts from timber harvesting and forest management activities.
- Additional funding is needed to extend ongoing projects and implement new ones.
- Education efforts to teach landowners, loggers, and resource managers how to use the timber harvesting and forest management guidelines need to be continued.

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Monitoring Riparian Forests: The Issue

Riparian forest management has long been an important and widely discussed issue in Minnesota. Because riparian areas can be adversely impacted by forest management activities, there is the need to monitor (Timber Harvesting and Forest Management Guidelines, 2000):

1. The extent and condition of Minnesota's riparian forests.
2. The extent to which timber harvesting occurs within riparian management zones and seasonal ponds.
3. The use and effectiveness of timber harvesting and forest management guidelines applied in riparian management zones and seasonal ponds.

The Search for Answers: Methodology

This analysis reviews reports on riparian forest management, highlights the guidelines produced to assist forest practitioners in managing riparian forests, and illustrates how satellite imagery and aerial photography are used to detect riparian forest harvesting. It also reviews initiatives undertaken or proposed that will help determine what management practices are being applied in forested riparian areas and whether these practices are effective.

Limitations

Three primary reasons explain why riparian forests and their management are difficult to define, work with, and measure.

Abundance of literature. An overwhelming supply of information on riparian forests and their management is available, making it a very intensive, time-consuming effort to

evaluate all the appropriate sources when preparing a study, report, or analysis. This is because riparian forests and their management touch so many social, political, and biological issues including wildlife numbers and frequency, timber harvesting, recreation, land ownership, and urban development. As an example, a conference was held in 1995 on riparian forestry. The conference proceedings (Minnesota Extension Service, 1996) contained 24 papers covering topics such as defining riparian forests, riparian forest structure, and the effects of forestry practices on riparian forest functions.

Polarization. The literature available on riparian forests represents a wide range of scientific perspectives. It is often difficult to get people to reach consensus because they are not always in agreement on the management practices required to sustain riparian areas and seasonal ponds. The principal disagreements are focused on how wide the riparian management zone should be and the amount of timber harvesting allowed within this zone.

Lack of resources. Time is often a commodity that is lacking. Many reports have short deadlines in which results must be produced. When dealing with the forest and its relationships, it can take years to see the effects from an activity like timber harvesting. Most reports on forests and their management are only a "snapshot" in time. These topics must be revisited throughout the years to really assess how the forest was impacted by a particular activity.

Another resource lacking when researching topics like riparian forests and their management is funding. For example, an initiative to study the effectiveness of riparian forest management guidelines (Blinn et al., 2001) was approved by the Legislative

Commission on Minnesota Resources and is now under review by the legislature. It was originally submitted for $800,000 but is now targeted for $200,000. A reduction in funding of this magnitude limits what the initiative can accomplish. Monitoring the effectiveness of a particular strategy to mitigate impacts from timber harvesting is a long-term research project that needs stability in funding if the project is to succeed in answering the questions being asked.

What Are Riparian Forests? Terms and Definitions

To better understand riparian forests and their management, some terms and definitions used throughout this analysis are presented here. This section also includes information on riparian land ownership in Minnesota.

So What Is a Riparian Area?

A riparian area is the area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes, and open water wetlands (Minnesota Forest Resources Council, 1999). These areas are among the most important and diverse parts of forest ecosystems. They support high soil moisture and a diversity of associated vegetation and wildlife. They perform important ecological functions that link aquatic and terrestrial ecosystems. These areas also contain a significant amount of valuable timber resources.

Riparian Management Zones

Riparian management zones (RMZs) are areas of special concern along streams, lakes, and open water wetlands (Minnesota Forest Resources Council, 1999). They are intended to retain relatively continuous forest cover for the protection and maintenance of

aquatic and wildlife habitat, aesthetics, recreation, and forest products. Within the RMZ, management activities should be modified through the use of appropriate guidelines to protect riparian functions and values.

Seasonal Ponds

Seasonal ponds are depressions in the soil surface where water pools during wet periods of the year, typically in spring and fall (Minnesota Forest Resources Council, 1999). A pond will have an identifiable edge caused by annual flooding and local topography. The edge is best identified during dry periods by the lack of forest litter in the depression. Such depressions typically are fishless. They are important because they provide habitat for amphibians and they are a link between the amphibian population and the upland hardwood forest.

What Do Riparian Forests Look Like?

Minnesota's Sustainable Forest Resources Act requires monitoring the extent and condition of riparian forests in the state, together with timber harvesting practices on these forests (Timber Harvesting and Forest Management Guidelines, 2000). As a first step toward continuous monitoring, a detailed geographic information system (GIS) map was created depicting location, surface cover, and ownership category of all riparian lands in the state (DNR Resource Assessment, 2000a).

Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers, and Resource Managers (Minnesota Forest Resources Council, 1999) provides guidelines that establish RMZs extending 50 feet to 200 feet from the shoreline. The guidelines also recommend the amount of residual trees

to be retained in these RMZs. Width of these RMZs and the amounts of trees retained in them depend on the type and size of the water body, whether the water body is a trout water body, site conditions, and management objectives.

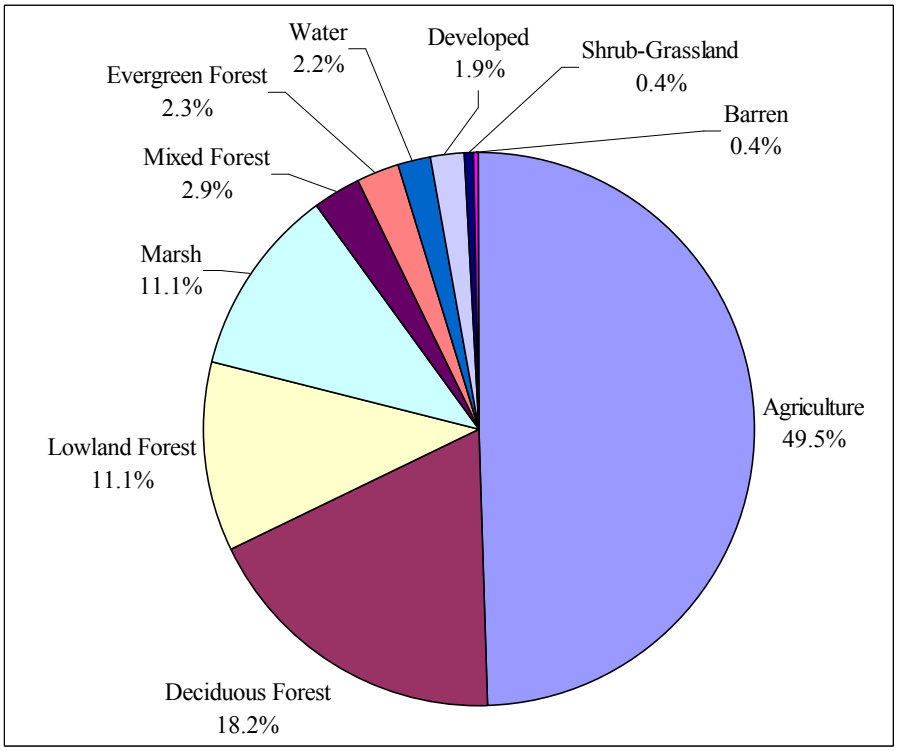
Table 1 shows the number of acres of riparian lands in Minnesota according to land-cover class. Figure 1 provides a display of the percentage of acres of riparian lands in each land-cover class shown in Table 1. Due to the limitations of satellite-derived land-cover data, acreages were tabulated using 200-foot RMZ widths—they do not include the actual area of the riparian feature (lake, stream, or wetland) enclosed by the RMZs (DNR Resource Assessment, 2000a). This information shows that 34.5 percent of riparian land is forested.

Table 1: Riparian Lands in Minnesota

Land-Cover Class	**Acres (% of riparian lands)**	
Agriculture	3,823,300	(49.5 %)
Deciduous Forest	1,401,500	(18.2 %)
Lowland Forest	860,100	(11.1 %)
Marsh	854,400	(11.1 %)
Mixed Forest	225,400	(2.9 %)
Evergreen Forest	181,200	(2.3 %)
Water	168,300	(2.2 %)
Developed	148,700	(1.9 %)
Shrub-Grassland	28,500	(0.4 %)
Barren	27,800	(0.4 %)
Total	7,719,200	(100 %)

Source: Minnesota's Riparian Lands Map, DNR Resource Assessment, 2000

Figure1: Riparian Lands in Minnesota



Source: Minnesota's Riparian Lands Map, DNR Resource Assessment, 2000

Who Owns Minnesota's Riparian Lands?

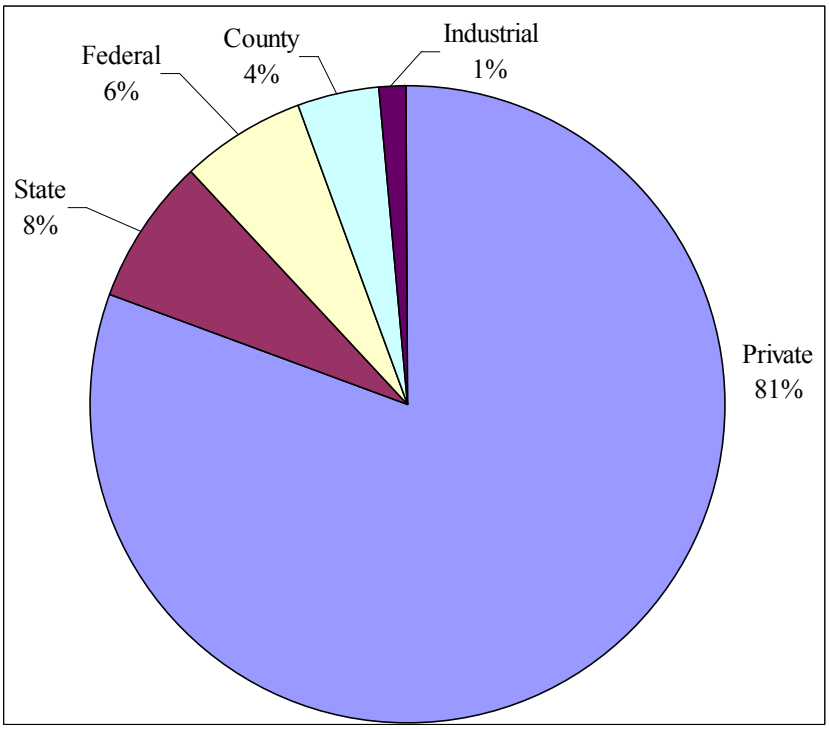
Information gathered shows that there are 7,719,200 acres of riparian lands in Minnesota and that most of these lands occur in agricultural and deciduous forest areas (Table 1). But who owns Minnesota's riparian lands? Table 2 shows riparian land ownership in Minnesota. Figure 2 provides a display of the percentage of acres of riparian lands under each ownership shown in Table 2. From this analysis, it is clear that the vast majority of riparian area in Minnesota is held in private ownership. Table 3 shows riparian land ownership in Minnesota by land-cover class.

Table 2: Riparian Land Ownership in Minnesota

Owner	Acres (% of riparian lands)	
Private	6,214,700	(81 %)
State	582,300	(8 %)
Federal	492,000	(6 %)
County	322,300	(4 %)
Industrial	107,900	(1 %)
Total	7,719,200	(100.0 %)

Source: Minnesota's Riparian Lands Map, DNR Resource Assessment, 2000

Figure 2: Riparian Land Ownership in Minnesota



Source: Minnesota's Riparian Lands Map, DNR Resource Assessment, 2000

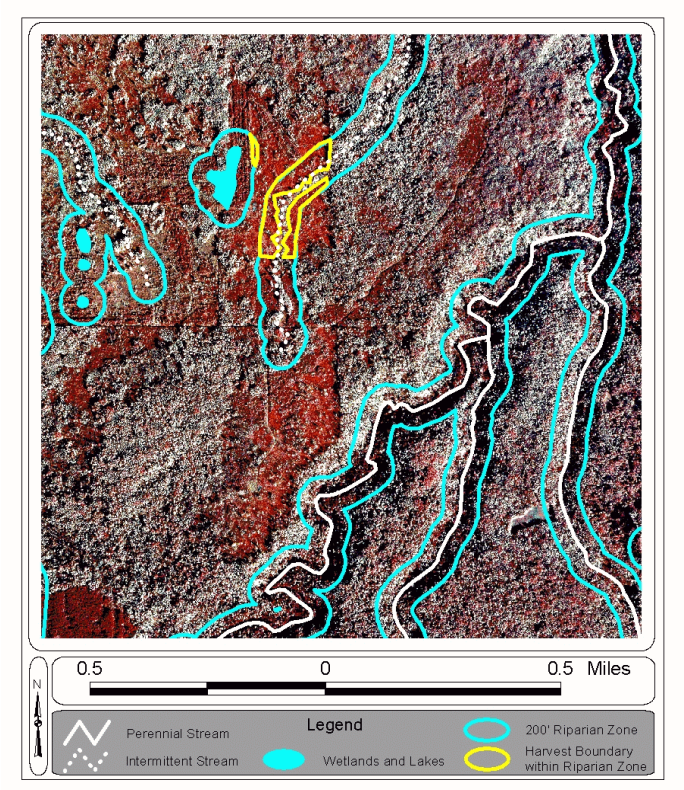
Table 3: Riparian Land Ownership in Minnesota by Land-Cover Class

Land-Cover Class	Owner					
	Private	Industrial	State	Federal	County	*Total*
Agriculture	3,679,800	30,700	64,500	38,600	9,700	3,823,300
Forest	1,589,500	58,200	394,100	370,600	255,800	2,668,200
Water/Marsh	777,000	14,900	107,600	74,500	48,700	1,022,700
Developed	141,700	500	4,000	1,500	1,000	148,700
Shrub-Grass/Barren	26,700	3,600	12,100	6,800	7,100	56,300
Total	6,214,700	107,900	582,300	492,000	322,300	7,719,200

Source: Minnesota's Riparian Lands Map, DNR Resource Assessment, 2000

Figure 3 shows riparian features (streams, wetlands, and lakes), RMZs, and harvest boundaries marked on an aerial photo.

Figure 3: Aerial Photo Showing Riparian Features, RMZs, and Harvest Boundaries



Source: Riparian Forest Harvest Monitoring Map: Carlton County 1997 - 1999, DNR Resource Assessment, 2001

Ongoing Research: A Background Analysis

Since 1996, the research advisory committee established by the Minnesota Forest Resources Council (MFRC) has been supporting a series of studies (Minnesota Forest Resources Council, 2000). These studies cover three areas:

1. Forested riparian zones.
2. Wildlife species and forest landscapes.
3. Forest resource productivity and forest management.

Results from these studies (Perry et al., 1998; Hanowski et al., 2001; Puettmann et al., 1999) will be used to identify additions, modifications, and improvements in the voluntary site-level timber harvesting and forest management guidelines (Minnesota Forest Resources Council, 1999). These studies will be finalized in June 2001 and the results and conclusions related to riparian management and forest soil productivity will be available at that time.

Forested Riparian Zones

Evaluating Riparian Area Dynamics, Management Alternatives, and Impacts of Harvesting Practices (Perry et al., 1998) considered both pre- and post-harvest conditions of aquatic insects and their habitat, fish populations and their habitat, riparian vegetation composition and development, blow down of residual trees, soil in riparian and upland areas, model archaeological artifacts, leaf-litter inputs to streams, and the amount and size of coarse woody debris in and around the streams.

Preliminary findings (Minnesota Forest Resources Council, 2000) indicated that overstory retention of up to 35 square feet of basal area (the summed, cross-sectional area

of the main stem of all trees on an acre of land at 4.5 feet above the ground) per acre does not greatly inhibit early aspen regeneration in the partially harvested riparian buffer. Over time, a decline in average sucker (sprouting) density and vigor may occur relative to the adjacent clear-cuts where all of the stems were removed. Significant reductions in leaf-litter input to the stream occurred with upland clear-cutting and thinning of forests in riparian zones, but also (to a lesser extent) with upland clear-cuts and no harvests in riparian areas within 100 feet of the stream.

The research also detected significant reductions in canopy cover and increases in blown-down trees in the riparian harvest sites and a related increase in woody debris at these sites; however, the increase in woody debris did not persist. There were minor changes in fish community structure attributable to riparian harvest, most notably an increase in mudminnows (a pollution-tolerant species) in the full-tree harvest (removal of the entire tree after it is felled) sites.

Wildlife Species and Forest Landscapes

Wildlife Species: Response to Forest Harvesting and Management in Riparian Stands and Landscapes (Hanowski et al., 2001) examined the relationship between harvest levels and harvest systems in riparian areas and breeding bird populations. Preliminary results (Minnesota Forest Resources Council, 2000) suggested that riparian buffers increase the amount of edge habitat. This is significant because many forest bird species have lower reproductive success along edges. Only two “riparian-dependent” species, the northern waterthrush and the common merganser, were observed; several “riparian-associated” species, which occur in many forest types in northern Minnesota, were also identified.

Bird community composition was found to change in response to harvest and harvest system in forests adjacent to small streams in northern Minnesota. As expected, bird communities where basal area was removed to 25 to 35 square feet per acre changed more relative to the control sites than sites where the riparian forest was left uncut.

Forest Resource Productivity and Forest Management

Impacts of Harvesting on Regeneration, Productivity, and Floristic Diversity of Quaking Aspen and Northern Hardwood Ecosystems (Puettmann et al., 1999) examined the impacts of harvest on soil properties, the ability of trees to regenerate, productivity of harvested sites, and the diversity of vegetation in quaking aspen and northern hardwood ecosystems. Preliminary results (Minnesota Forest Resources Council, 2000) indicated lower soil compaction on sites harvested in winter than on sites harvested in summer. Other seasonal differences seem to be independent of compaction. Residual overstory (trees left on the site after harvest) decreased the density and growth of tree regeneration, and the influence of a residual overstory was stronger in areas with higher compaction.

Preliminary analysis also suggested a shift in vegetation composition with the initial entry (lighter disturbance). Residual basal area was also related to vegetation composition. There seemed to be little difference in vegetation composition between areas with light disturbance and areas with heavy disturbance. Increased richness of understory species with disturbance level was due to an increase in pioneering species on both hardwood and aspen sites.

Possible Solutions: What Has Been Initiated

Sustainable forestry is a proactive form of management that provides for the multiple

uses of the forest by balancing a diversity of both present and future needs. This analysis summarizes two projects undertaken that include significant aspects intended to enhance the sustainability of Minnesota's forested riparian areas.

Forest Management Guidelines

Recognizing the challenges that sustainable forest management represents, a guidebook listing broad timber harvesting and forest management guidelines was developed. *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers, and Natural Resource Managers* was developed as a collaborative statewide effort involving a broad spectrum of people who value forested lands in Minnesota (Minnesota Forest Resources Council, 1999). The listed guidelines address projected site-level impacts on forest resources as identified in the 1994 Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. They offer recommendations for how landowners, loggers, and natural resource managers can protect wildlife habitat, historic/cultural resources, riparian areas, forest soil productivity, water quality, wetlands, and visual quality.

The chapter, "Rationale for Guidelines," includes a section on riparian areas. Here riparian areas are defined and their importance explained. Riparian management zones are introduced and defined, and it is explained how their use can minimize adverse impacts on riparian areas during forest management activities. This section also explains that there is a need to intensively monitor and carry out research to determine the effectiveness of riparian management zone guidelines and their ability to accomplish their intended objectives. Another chapter, "Integrated Guidelines," includes a section on

managing riparian areas that lists recommendations to use when forest management activities are conducted within a riparian management zone.

While these guidelines are based on the best available scientific information and are the result of a consensus-agreement process by the Minnesota Forest Resources Council (MFRC), most of the research studies that form the basis for discussion were conducted in other regions of the country. Considerable research in Minnesota is still needed on riparian areas due to the lack of data specific to landforms, water bodies, and forest cover types found within the state.

Peer Review of Riparian and Seasonal Pond Guidelines

The 1999 Minnesota Legislature directed the MFRC to conduct a science-based peer review of guidelines for protecting forest riparian areas and seasonal ponds contained within *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers, and Natural Resource Managers* (Minnesota Forest Resources Council, 1999). In response, the MFRC commissioned a panel of eight scientists representing expertise in hydrology/soil science, terrestrial ecology, silviculture, and aquatic ecology. The peer review panel provided input to the MFRC in two forms:

1. Formal written reviews prepared by scientists in each of the four disciplines discussing the consistency of the guidelines with available scientific understanding.
2. Collective responses from the eight scientists to various scientific aspects of riparian forest ecology, management, and protection.

Conclusions of the review. After considering the information contained in these

reviews, the MFRC concluded the following (Minnesota Forest Resources Council, 2000):

1. The peer reviews represented a range of scientific perspectives not always in agreement on the management practices required to sustain riparian areas and seasonal ponds.
2. The recommendations contained in *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines* (Minnesota Forest Resources Council, 1999) are a major advancement in promoting sustainable management of riparian areas and seasonal ponds in Minnesota's forests.
3. Recommendations for even-aged management (a planned sequence of treatments designed to maintain and regenerate a stand with one or two age classes [Minnesota Forest Resources Council, 1999]) may inhibit the ability of plants with low and intermediate shade tolerance to become established within riparian management.
4. Science cannot specify with certainty the riparian management zone (RMZ) width needed to protect riparian functions. RMZ width will vary according to the type of water body, site conditions, and specific riparian functions and values needing the most protection.
5. The types and intensity of land use (for example, the extent of harvest, conversion to nonforested status, and development) within a landscape will have a greater influence on aquatic ecosystems than specific RMZ parameters (for example, width, amount of residual vegetation). Therefore, management of forested

riparian areas needs to consider both site-specific and landscape perspectives.

6. MFRC programs that evaluate use and effectiveness of the guidelines, and the condition and management practices within forested riparian areas and around seasonal ponds, are critical to understanding how to sustain these resources.
7. Site conditions and patterns of harvest will greatly affect the future condition and functions of riparian forests.

How was the peer review used? In response to the input provided by the reviews, the MFRC developed a plan for education, research, and monitoring of riparian forests. Examples of the MFRC's recommended action included incorporating input from the peer review into training for loggers, natural resource managers, and private forest landowners; integrating peer review findings into planning processes used by the state's public forest management agencies; monitoring the extent of timber harvesting in riparian areas; and encouraging additional research on the effects of various timber harvesting methods on forested riparian areas and seasonal ponds (Minnesota Forest Resources Council, 2000).

Continuing the Search for New Information

Additional research in Minnesota is still needed to determine the management practices required to sustain riparian areas and seasonal ponds. This analysis highlights three ongoing or proposed projects that address riparian area management.

What is the Extent of Harvesting in Riparian Areas?

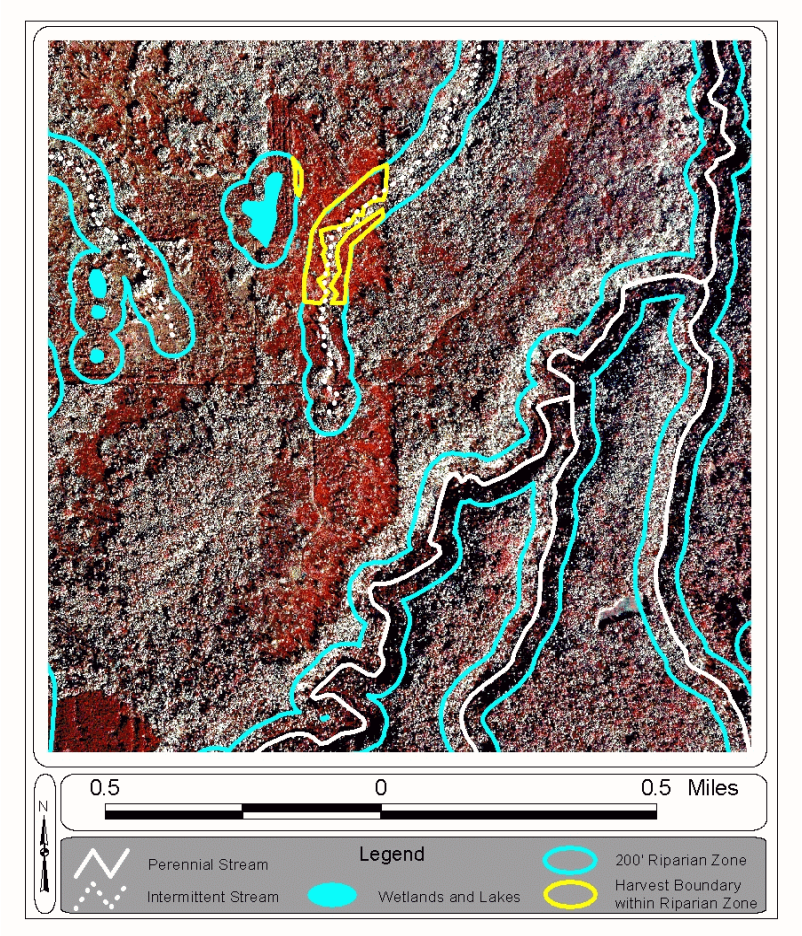
In 2000, a map depicting location, land-cover class, and ownership category of all riparian lands in the state was created from newly available digital data (DNR Resource

Assessment, 2000a). On this map, riparian zones were delineated 200 feet from all water bodies. These riparian zones, comprising almost one-seventh of the total area of the state, were overlaid on the forest land identified in new satellite-derived National Land-Cover Data maps.

Within these statewide forested riparian zones, the Division of Forestry, Minnesota Department of Natural Resources (DNR), is employing satellite imagery and aerial photography to detect and quantify impacts of timber harvesting. Detection is done by comparing the most recent available Landsat satellite images against similar images taken one or two growing seasons earlier (DNR Resource Assessment, 2001). Sharp differences from one date to another indicate vegetation disturbances, which are then investigated in greater detail by aerial photography.

Sampling the forest disturbances with aerial photos permits refinement of the satellite data. Analysts can precisely delineate the riparian portion of each harvest and can distinguish between disturbances caused by forestry practices and others caused, for example, by construction or beaver activity (DNR Resource Assessment, 2001). In Figure 4, an interpreter has delineated the riparian portions of a recent forest harvest. Acreages measured on such sample photographs are used to adjust the coarser estimates obtained from satellite disturbance detection.

Figure 4: Delineated Riparian Portions of a Recent Forest Harvest



Source: Riparian Forest Harvest Monitoring Map: Carlton County 1997 - 1999, DNR Resource Assessment, 2001

What's been done. In 2000, DNR Forestry's Resource Assessment Unit conducted a pilot test of what can become a permanent monitoring system. Landsat satellite scenes covering Carlton County were acquired, rectified, calibrated, and differenced to detect forest change, and appropriate under-flight photography was acquired for interpretation of change areas and riparian harvest acreage adjustments. A map showing forest disturbance areas within riparian management zones (RMZs) in Carlton County was produced using

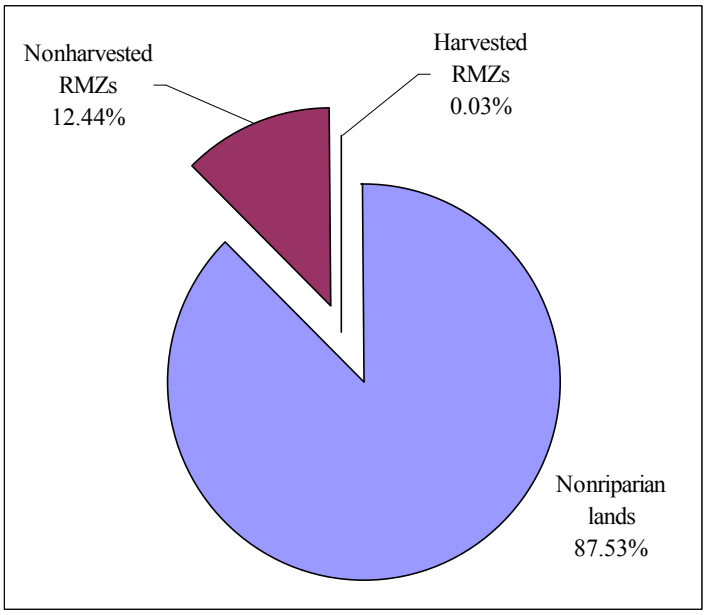
this information (DNR Resource Assessment, 2001). Table 4 uses data from this map to show the acres harvested in RMZs in Carlton County. Figure 5 provides a display of the information presented in Table 4. This information shows that 12.5 percent, 69,800 acres, of Carlton County is designated as RMZs and of this total RMZ area, 0.21 percent, 145 acres, was harvested.

Table 4: Forest Harvest in Riparian Areas, Carlton County

Cover Type	Acres	Percent of County	Percent of RMZs
Nonriparian lands	489,900	87.53%	----------
Nonharvested RMZs	69,655	12.44%	99.79%
Harvested RMZs	145	0.03%	0.21%
Total	559,700	100%	100%

Source: Riparian Forest Harvest Monitoring Map: Carlton County 1997 - 1999, DNR Resource Assessment, 2001

Figure 5: Forest Harvest in Riparian Areas, Carlton County



Source: Riparian Forest Harvest Monitoring Map: Carlton County 1997 - 1999, DNR Resource Assessment, 2001

Continuing the program. DNR Forestry's Resource Assessment Unit proposes to acquire and analyze Landsat satellite imagery for riparian forest change detection at a rate of 10 scenes per year. This rate of acquisition will cover 70 percent of Minnesota each year, and ensure biennial coverage of the entire state (DNR Resource Assessment, 2000b). The Resource Assessment Unit will also carry out a regular sampling program of under-flight photography and interpretation. Financial support for the continuation of this detection program is needed at a level of at least $72,600 per year. Table 5 shows a budget breakdown of how these funds will be allocated. The DNR is working with the Minnesota Forest Resources Council to develop a plan for funding this program in the next year. The level of effort will depend on available funding.

Table 5: Annual Cost Estimate for Monitoring the Extent of Timber Harvesting in RMZs

• Purchase of every other TM satellite imagery scene (10 scenes)	$6,500
• Rectify each scene and other preparation - labor	$8,000
• Change detection - labor	$32,000
• Ground "truthing" Use of aerial photography of 190 sites and stratify into two groups: disturbed and undisturbed	$16,500
• Photo interpretation - labor	$6,600
• Analysis - labor	$3,000
Total	**$72,600**

Source: DNR Resource Assessment Unit

Are Forest Management Guidelines Used?

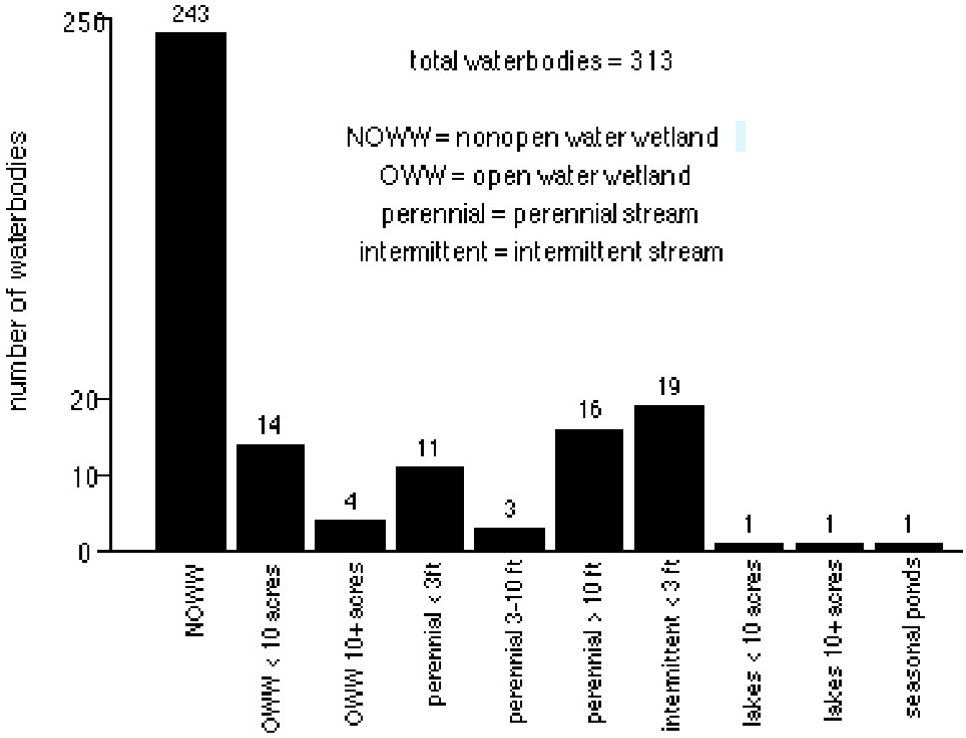
The report, *Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota* (Phillips, 2001), presents the findings of a first-year monitoring program that is gathering information on the application of the sustainable harvesting and management practices contained in *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines* (Minnesota Forest Resources Council, 1999). The application of timber harvesting and forest management guidelines was monitored on private, county, state, federal, forest industry, and other government land distributed broadly over the forested regions of the state. This monitoring program included looking at how guidelines addressing site-level water quality, wetland, and riparian management issues were used.

All sites monitored in 2000 were harvested and/or their stumpage sold under contract prior to publication of the MFRC's timber harvesting and forest management guidebook (Minnesota Forest Resources Council, 1999). Therefore, with the exception of water quality, wetland protection, and visual quality practices where guidelines have existed for several years, the monitoring program details baseline harvesting and management practices (those that existed prior to publication of Minnesota's comprehensive timber harvesting and forest management guidelines).

Management within an RMZ generally requires maintaining defined levels of forest cover, less intensive management, and reduced equipment intrusion into these areas (Phillips, 2001). The timber harvesting and forest management guidelines provide

recommendations for managing around a variety of water bodies and wetlands. The guidelines are based on modifying management near water and wetlands by providing specified widths where there is less intensive harvesting, where the forest floor is left relatively undisturbed, and where specified densities of residual trees are recommended. For purposes of monitoring, the types of water bodies and wetlands evaluated were nonopen water wetlands; open water wetlands; perennial and intermittent streams, lakes, and seasonal ponds; and seeps and springs. Types and numbers of water bodies or wetlands found on or adjacent to the monitoring sites are shown in Figure 6.

Figure 6: Water Bodies on or Adjacent to Monitored Harvest Sites



Source: Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2000

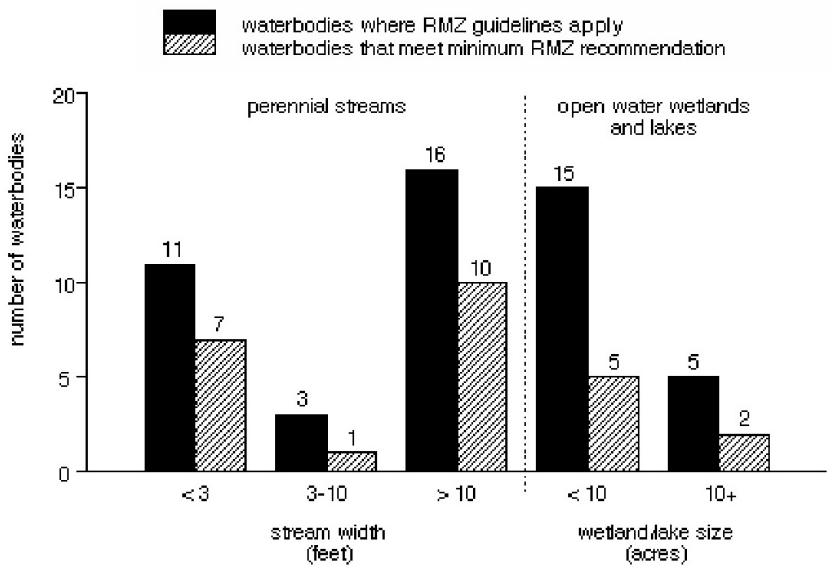
Filter strip application. One of the essential guideline protections for aquatic ecosystems during and following forest management activities is the use of filter strips (Phillips, 2001). Filter strips are recommended for perennial and intermittent streams, lakes, open water wetlands, nonopen water wetlands, seasonal ponds, and seeps and springs. The principle requirement for an effective filter strip is that the forest floor be retained essentially undisturbed to maintain its filtering capability to remove sediments, debris, nutrients, and pesticides and to promote continued soil infiltration of surface flows. The first year's monitoring found that filter strip compliance with the guideline recommendation (< 5 percent mineral soil exposure, dispersed over the filter strip) was 70 percent (Phillips, 2001).

Riparian management zones. The timber harvesting and forest management guidelines (Minnesota forest Resources Council, 1999) recommend RMZs for open water wetlands, lakes, perennial streams, and intermittent streams ? 3 feet wide. RMZs modify harvesting activity adjacent to water bodies and wetlands by requiring reduced equipment intrusion and retention of specified levels of residual tree species.

Fifty water bodies were found on or adjacent to 34 monitoring sites for which RMZs were recommended. Thirty of the water bodies were perennial streams, 18 were open water wetlands, and two were lakes. For these water bodies, 50 percent of RMZs met the guideline recommendations for width and residual basal area (Phillips, 2001). Figure 7 compares the number of water bodies statewide where RMZ guidelines apply to the number of water bodies meeting the minimum RMZ recommendation for width and basal

area.

Figure 7: Water Bodies Meeting Minimum RMZ Recommendations



Source: Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2000

Water body and wetland crossings. Crossing wetlands and open water bodies should be avoided whenever possible, but it is often necessary for hauling and harvesting equipment (Phillips, 2001). Skid-trail crossings for harvesting equipment are generally confined to the harvest area and are temporary in the majority of cases. Haul roads frequently must cross wetlands and open water bodies to access a site as well as reach an appropriate loading area on the site. The first year's monitoring (Phillips, 2001) found that:

1. A high percentage of skid-trail and road approaches to wetlands and streams did not have the appropriate water diversion devices installed to divert surface run off from directly entering these water bodies.

2. Landings were located outside of filter strips and RMZs 95 percent and 99 percent of the time, respectively.
3. Rutting was found on 33 percent of the sites monitored and was most prominent on skid trails, wetland inclusions, and roads. The use of slash and shifting operations until conditions improved accounted for 70 percent of all techniques used to minimize rutting.

Do Forest Management Guidelines Work?

A $200,000 proposal has been approved by the Legislative Commission on Minnesota Resources (LCMR) that will conduct long-term effectiveness monitoring of the riparian guidelines contained within *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines* (Minnesota Forest Resources Council, 1999). The project, *Evaluating Timber Harvesting and Forest Management Guidelines* (Blinn et al., 2001), will evaluate site-based effects associated with applying various riparian management practices on terrestrial, wildlife, and aquatic variables. Timber harvests will be implemented within five watersheds in northern Minnesota to establish the basis for conducting long-term effectiveness monitoring of the riparian guidelines. The proposed LCMR project will provide a preliminary, short-term (one-year, post-harvest) assessment of the effectiveness of the guidelines at mitigating impacts to regeneration, aquatic habitat, and forest birds.

What's next? While only one year of post-harvest data will be collected and analyzed under this current LCMR proposal, additional funding will be solicited from the LCMR and other sources to allow data collection and analysis for approximately 10 more years

following the application of treatments. These additional efforts will enable long-term effectiveness monitoring.

The importance of effectiveness monitoring. Many states, including Minnesota, are currently conducting compliance monitoring to assess the extent to which forest management guidelines are being used during timber harvesting activities. In contrast, these states do not routinely conduct effectiveness monitoring. As a result, they are unable to assess the extent to which guidelines actually mitigate timber harvesting impacts. While some graduate student theses have assessed impacts following timber harvests, those studies generally are not long-term in their approach (Blinn et al., 2001). As a result, those monitoring efforts provide little information about any long-term impacts from timber harvesting. Also, while riparian systems have been examined in some detail on the West Coast and in the Appalachians, the study areas and forest management guidelines are often not directly applicable to Minnesota. Work in Canada has focused on mountainous and boreal systems and less so in northern deciduous forests. Differences in topography and vegetation between those more mountainous areas and Minnesota are considerable.

Conclusion

As this analysis shows, there has been a good start to defining and measuring the impacts of timber harvesting and forest management in Minnesota, including that occurring in riparian areas. The compilation of management recommendations in a guidebook was an especially important endeavor, as it was a collaborative effort involving over 60 individuals committed to sustaining Minnesota's resources. However,

all of this is only a start. Much more needs to be accomplished.

Recommendations

This analysis recommends three major areas that should be pursued to improve knowledge and understanding of Minnesota's riparian areas and how they are impacted by timber harvesting and other forest management activities.

1. Current projects need to be extended and new projects implemented to monitor the extent to which timber harvesting and forest management guidelines (Minnesota Forest Resources Council, 1999) are being used and if these guidelines are effective at minimizing timber harvesting and forest management impacts.
2. Additional funding is needed to extend ongoing projects such as guideline implementation monitoring and acquiring and analyzing satellite imagery to define harvest disturbance. Funding is also needed to implement new projects such as the one just approved by the LCMR to evaluate the effectiveness of the timber harvesting and forest management guidelines.
3. Education efforts made by the Minnesota Forest Resources Council and the DNR to teach landowners, loggers, and resource managers how to use the timber harvesting and forest management guidelines and why, need to be continued.

For More Information

This analysis summarizes some of the completed and ongoing work being done on riparian land management. A complete listing of the references used in the text can be found in the annotated bibliography. The following web sites provide additional

information:

1. Minnesota Forest Resources Council at http://www.frc.state.mn.us. This site contains many pertinent documents about forests and their management including the full edition of *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines.*
2. DNR Forestry at http://www.dnr.state.mn.us/forestry/. This site contains information on state forest lands including current timber harvest plans and subsection forest resource management planning.

Glossary

Basal area: The cross-sectional area of a live tree at 4.5 feet above ground. Basal area may be measured in square feet per tree or square feet per acre.

Clear-cut: A timber harvesting method that removes essentially all trees in a stand in one operation.

Full-tree harvest: A timber harvesting method where the entire tree is skidded to the landing.

Intermittent stream: A stream with well-defined channels, banks, and beds that flows only certain times of the year when it receives water primarily from runoff or snow melt. During dry years, this stream may cease to flow entirely or may be reduced to a series of separate pools.

Nonopen water wetland: A wetland that generally does not have observable surface water.

Overstory: The portion of the trees in a forest forming the upper canopy.

Open water wetland: A wetland with shallow to deep open water generally having readily observable surface water. Water depth varies from a few inches to less than 10 feet.

Perennial stream: A stream with well-defined channels, banks, and beds that exhibits essentially continuous flow. This stream flows year-round, but surface water may not be visible during extreme drought.

Residual trees: Trees retained on a site after a timber harvest as single scattered trees or aggregated in clumps, strips, or islands.

Riparian area: The area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes, and open water wetlands.

Riparian management zone: The portion of the riparian area where site conditions and landowner objectives are used to determine management activities that address riparian resource needs and where riparian guidelines are applied.

Seasonal pond: Depressions in the soil surface where water pools during wet periods of the year, typically in spring and fall. A pond will have an identifiable edge caused by annual flooding and local topography. The edge is best identified during dry periods by

the lack of forest litter in the depression. Such depressions typically are fishless.

Stumpage: The value of timber as it stands uncut in terms of an amount per unit area.

Sustainable forest management: The development, protection, and use of forest resources for achievement of economic and social well-being without damaging the forest resource base or compromising the ability of future generations to meet their own needs.

Annotated Bibliography

Blinn, C. R., B. J. Palik, R. M. Newman, & J. M. Hanowski. 2001. Evaluating timber harvesting and forest management guidelines: A project proposal to the Legislative Commission on Minnesota Resources. St. Paul, Minnesota: University of Minnesota, Department of Forest Resources. This proposal was submitted to the Legislative Commission on Minnesota Resources for $200,000 and covered the evaluation of site-based effects associated with applying various riparian management practices on terrestrial, wildlife, and aquatic variables.

DNR Resource Assessment. 2001. Riparian forest harvest monitoring map: Carlton County 1997 - 1999. Grand Rapids, Minnesota: Minnesota Department of Natural Resources. This map showed forest disturbance areas within riparian zones in Carlton County.

DNR Resource Assessment. 2000a. Minnesota's riparian lands map. Grand Rapids, Minnesota: Minnesota Department of Natural Resources. This map showed the number of acres of riparian lands in Minnesota broken down by region, land-cover class, and ownership.

DNR Resource Assessment. 2000b. Riparian forest monitoring project: First-year progress report. Grand Rapids, Minnesota: Minnesota Department of Natural Resources. This report summarized how the Minnesota Department of Natural Resources, Resource Assessment Unit answered a legislative mandate to map riparian lands, monitor riparian forests, and evaluate forest management guideline compliance through satellite imagery and geographic information system data.

Hanowski, J. M., N. Danz, J. Lind, G. J. Niemi, & P. T. Wolter. 2001. Wildlife species: Response to forest harvesting and management in riparian stands and landscapes: Report to the Minnesota Forest Resources Council. (Natural Resources Research Institute Technical Report No. NRRI/TR-2001/02). Duluth, Minnesota: Natural Resources Research Institute. This study looked at landscape effects of various harvest practice systems on riparian bird communities.

Minnesota Extension Service. 1996. At the water's edge: The science of riparian forestry. (Minnesota Extension Service Publication BU-6637-S). St. Paul, Minnesota: University of Minnesota. This report was a collection of the papers presented at a 1995 conference that explored the science of riparian forest management as a knowledge base for developing guidelines for forest management practices in riparian areas.

Minnesota Forest Resources Council. 2000. Sustainable forest resources act implementation in 2000: Minnesota Forest Resources Council annual report to the governor and legislature. St. Paul, Minnesota: Minnesota Forest Resources Council. This report highlighted the work and accomplishments of the Minnesota Forest Resources Council and its many partners during 2000 to implement the Sustainable Forest Resources Act. One accomplishment was a completion of a peer review of riparian and seasonal pond forest management guidelines.

Minnesota Forest Resources Council. 1999. Sustaining Minnesota forest resources: Voluntary site-level forest management guidelines for landowners, loggers, and resource managers. St. Paul, Minnesota: Minnesota Forest Resources Council. The Minnesota Forest Resources Council, as directed by the Sustainable Forest Resources Act of 1995, coordinated the development of an integrated set of voluntary, site-level timber harvesting and forest management guidelines. These guidelines included a section on managing riparian areas.

Perry, J., C. Blinn, M. K. Fox, B. Palik, J. Mattson, M. Thompson, S. Verry, L. Johnson, C. Richards, R. Newman, E. Merten, R. Dahlman, & P. Emerson. 1998. Evaluating riparian area dynamics, management alternatives, and impacts of harvest practices: Report to the Minnesota Forest Resources Council. St. Paul, Minnesota: University of Minnesota, Department of Forest Resources. This report summarized six projects that studied the effects of harvest activities on water quality and stream organisms and their habitat; fish and in-stream habitat; woody debris and coarse particulate organic matter; riparian vegetation; archeology and cultural artifacts; and harvesting system efficiency and damage to residual trees.

Phillips, M. J. 2001. Monitoring the implementation of the timber harvesting and forest management guidelines on public and private forest land in Minnesota: Report to the Minnesota Forest Resources Council. (DNR Document MP-0201). St. Paul, Minnesota: Minnesota Department of Natural Resources. This report discussed the findings from the first year of field monitoring timber harvesting and forest management practices on public and private forest land in Minnesota. One section of the report dealt specifically with the use of filter strips and riparian management zones.

Puettmann, K., G. Host, J. Zasada, D. Grigal, B. Berguson, & C. Blinn. 1999. Impacts of harvesting on regeneration, productivity, and floristic diversity of quaking aspen and northern hardwood ecosystems: Report to the Minnesota Forest Resources Council. St. Paul, Minnesota: University of Minnesota, Department of Forest Resources. This study assessed the impacts of clear-cutting and selective harvesting on soil properties controlling regeneration, productivity, and floristic diversity in quaking aspen and northern hardwood ecosystems.

Timber Harvesting and Forest Management Guidelines, 3 Minn. Stat. §89A.05. 2000. This statute covered the development, economic considerations, review, and application of timber harvesting and forest management guidelines. It also accelerated the monitoring of the extent and condition of riparian forests, especially as it pertained to the effects of timber harvesting.