1997 Project Abstract
For the Period Ending June 30, 1999
This project was supported by the Minnesota Legislature (ML 1997, Chapter 216, Section 15, Subd.17(c)) as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Future Resources Fund.

TITLE: Peatland Restoration
PROJECT MANAGER: Kurt Johnson
ORGANIZATION: Natural Resources Research Institute (NRRI), University of Minnesota
ADDRESS: 5013 Miller Trunk Highway, Duluth, Minnesota 55811-1442
LEGAL CITATION: ML 97, [Chap.216], Sec.[15], Subd. 17(c).
APPROPRIATION AMOUNT: $275,000

Statement of Objectives
The overall goal of this project is to promote reestablishment of diverse, sustainable peatland ecosystems on harvested peatland sites, through accelerated development of cost effective, reliable peatland restoration techniques consistent with state and federal regulatory requirements.

Overall Project Results
Work on this project over the two year funding period resulted in a number of significant contributions to the field of peatland restoration in Minnesota. A peatland restoration bibliography with over 200 references on all aspects of peatland restoration was compiled. Demonstration scale peatland restoration research studies were established at three locations, one at Michigan Peat Company (near Cromwell), and two at Aitkin Agri-Peat (near McGregor). Approximately 1200 linear feet of boardwalks were constructed in total for the three study locations and water table wells, rain gauges, and soil tensiometers were installed to monitor environmental conditions at each site. A total of six peatland restoration technical reports were produced based on research conducted during the funding period. An International Symposium "Peatland Restoration and Reclamation - Techniques and Regulatory Considerations," was held July 14-18, 1998, in Duluth, Minnesota. A 273 page proceedings was published and distributed at the Symposium containing a total of 60 papers and posters related to various aspects of peatland restoration and reclamation. A guided tour of the peatland restoration research sites and a Sphagnum moss peat harvesting operation was conducted on June 24, 1999. A draft peatland restoration concepts document was developed based on our research and other studies.

Project Results Use and Dissemination
The peatland restoration bibliography will be disseminated to interested parties through NRRI and the International Peat Society (IPS). The demonstration scale research sites were shown to numerous people during the peatland restoration symposium and field day. The technical reports produced will be published in scientific journals and/or presented at a symposium and included in the proceedings. Reprints will be available through NRRI or IPS. The peatland restoration symposium was attended by more than 90 scientists, regulators, and peat company representatives from 15 different countries. The peatland restoration field day was attended by 25 individuals from State and Federal regulatory agencies, peat companies, and State government. Copies of the draft peatland restoration concepts document will be disseminated by NRRI to State and Federal regulatory agencies, and peat companies for their review and input.

Date of Report: July 1, 1999

Date of Work Program Approval: June 23, 1997
Project Completion Date: June 30, 1999

LCMR Final Work Program Update Report

I. PROJECT TITLE: Peatland Restoration (M27)

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Total Biennial Project Budget:

$ LCMR:	$275,000
$ LCMR Amount Spent:	$275,000
$ LCMR Balance:	$0

A. Legal Citation: ML 97, [Chap.216], Sec.[15], Subd. 17(c).
PEATLAND RESTORATION
This appropriation is from the future resources fund to the University of Minnesota-Duluth, natural resources research institute, to promote reestablishment of diverse, sustainable peatland ecosystems on harvested peatland sites through accelerated development of cost effective, reliable peatland restoration techniques.

II. PROJECT SUMMARY AND RESULTS:

The goal of this project is to promote reestablishment of diverse, sustainable peatland ecosystems on harvested peatland sites, through accelerated development of cost effective, reliable peatland restoration techniques consistent with state and federal regulatory requirements.

The project began with a review of pertinent literature.

- Result 1: Review technical papers relevant to peatland restoration in Minnesota, to refine project design and produce a bibliography.

Based on the literature review, and team members experience, research sites were established.

- Result 2: Establish and maintain two demonstration scale restoration research sites (3-5 acres

each) on harvested peatlands (one formerly harvested for Sphagnum moss peat, and another harvested for reed-sedge peat), to determine suitable restoration practices for Minnesota conditions.

- Result 3: Compare peatland restoration establishment strategies for the funding period and present results and conclusions in a technical report.

Peat companies, regulatory agencies, and international restoration experts were solicited for their input.

- Result 4: Host a peatland restoration workshop, inviting restoration researchers from North America and Europe to present their research, resulting in published proceedings.

- Result 5: Conduct a peatland restoration field day for peat companies, state and federal regulators, and other interested parties, to demonstrate restoration techniques.

Based on the above tasks, a final document was produced.

- Result 6: Produce a locally reviewed, draft peatland restoration guidebook, ready for wider distribution and assessment, based on our research and other studies, specifically focused on Minnesota environmental conditions and regulatory requirements.

The information acquired through this research was disseminated to interested parties through the proposed publications, field day, and restoration workshop.

III. PROGRESS SUMMARY:

This report describes the achievements for the entire project period, July 1, 1997 through June 30, 1999. A progress summary for each individual project result is presented in the following paragraphs.

Result 1: Review technical papers relevant to peatland restoration in Minnesota, to refine project design and produce a bibliography.

A review of pertinent United States and foreign peatland restoration literature had been completed and a detailed project experimental design was developed entitled, "Peatland Restoration Research Site Establishment and Experimental Design". This document has served as the template for all subsequent research studies. A copy is included with this final report package.

A peatland restoration bibliography also resulted from the literature review. Over the two year funding period over 200 references on all aspects of peatland restoration were compiled. Due to the increasing number of new articles being published on the subject, plans are to keep the bibliography as a work in progress, and continue adding references as they become available. A copy of the peatland restoration bibliography as of June 1999 is included with this final report package.

Result 2: Establish and maintain demonstration scale restoration research sites on harvested peatlands, to determine suitable restoration practices for Minnesota conditions.

Research conducted to date on the restoration of *Sphagnum* dominated peatlands has demonstrated the potential for re-establishing native vegetation on harvested or disturbed sites by spreading moss and other plant fragments, collected from natural, undisturbed, "donor" sites, on bare peatland surfaces. This encourages the primarily vegetative reproduction of *Sphagnum*, and allows associated peatland plant establishment from seeds, rhizomes, and other plant structures, included with the donor vegetation. This concept forms the basis for all studies conducted as part of this project.

Much of the research follows the Canadian experience, utilizing methods similar to those developed at Laval University in Quebec and at the University of Manitoba. The overall goal of our research is to adapt or develop restoration techniques suitable for Minnesota conditions which are reliable, cost effective, and compatible with state and federal regulatory requirements. Achieving this goal will allow for the sustainable use of peatlands in Minnesota.

Demonstration scale peatland restoration research studies were established at three locations, one at Michigan Peat Company (near Cromwell), and two at Aitkin Agri-Peat (near McGregor). Approximately 1200 linear feet of boardwalks were constructed in total for the three study locations to allow access to research plots with minimal disturbance. Water table wells, rain gauges, and soil tensiometers were installed to monitor environmental conditions at each site. Specific research studies conducted at the sites include a mulch and companion species study, moisture gradient study, and a large-scale peatland restoration study. Additional greenhouse studies were conducted to determine the viability of certain companion species. Several field tours featuring the study sites were conducted over the two year period (see Results 4 and 5). Plans are to secure funding from other sources to continue monitoring the established field studies in the coming years to determine long-term restoration success. Summaries of the results for each specific project are presented under Result 3.

Result 3: Compare peatland restoration establishment strategies for the funding period and present results and conclusions in a technical report.

A total of six peatland restoration technical reports were produced based on research conducted during the funding period. Conclusions from this research applicable to peatland restoration in Minnesota include:

1) Mulch applications, fall planting, and *Carex* as a companion species significantly increased peatland plant percent cover.
2) Field contouring and the resulting V-shaped topography significantly increased the water table level, peat moisture content, and peat moisture tension, however, mulch is still required to establish peatland plants.
3) Estimated costs for large-scale peatland restoration using Laval University methods are in the range of $700 to $800 per acre. These sites require continued monitoring to determine long-term success.
4) Peatland companion plant species in general exhibit complex seed dormancies and most likely require very specific conditions for germination.
5) *Eriophorum spissum* and *Polytrichum* species are appear to be the first and most aggressive

colonizers of recently abandoned (10-12 years) unmanaged post-harvested sites.

6) Older harvested sites abandoned over 20 years ago have complete vegetation cover corresponding to natural bog vegetation, but lower abundance of larger woody species and a larger abundance of graminoids and *Vaccinium oxycoccus* than natural areas.

To disseminate this information, plans are to present the findings at U.S. and international peat and soil producers meetings and symposiums over the next two years. Summaries for each report are presented in the following sections. Copies of each complete report are also included with this final report package.

The Effect of Mulch Applications, Companion Species, and Planting Time on Restoration of Post-Harvested Peatlands in Minnesota

A study to determine the effect of mulch applications, companion species, and planting time on the establishment of *Sphagnum* moss and other peatland plant species was established in fall 1997 and spring 1998 at three post-harvested horticultural peat sites in north central Minnesota. The experimental treatments for this study consisted of two mulch treatments (straw mulch, no mulch) x two companion species treatments (*Carex oligosperma*, no companion species) x two planting time treatments (fall, spring) for a total of eight treatment combinations. The study was established in a randomized block design, with six replications of each treatment combination resulting in a total of 48 plots at each study site. Donor plant material, consisting of the top 10 cm of vegetation collected from adjacent natural sites, was spread in equal amounts on each plot to serve as a source of regenerative material. Mean percent cover for all treatments at each study site were determined in October 1998 using the visual cover estimate method. Mean percent cover for individual treatments ranged from 1.0 to 7.3 percent at Michigan Peat, 0.7 to 3.5 percent at Aitkin Agri-Peat North, and 1.4 to 5.5 percent at Aitkin Agri-Peat South. The predominant cover component varied between sites as well, with vegetative cover dominated by *Sphagnum* at Michigan Peat, other mosses at Aitkin Agri-Peat North, and vascular plants at Aitkin Agri-Peat South. Survival of transplanted *Carex* was 34 percent at the Michigan Peat site, 9 percent at the Aitkin Agri-Peat North site, and 15 percent at the Aitkin Agri-Peat South site. Statistical analysis of the data indicated that mulch applications significantly increased percent cover for all plant categories (with the exception of vascular plants at the Michigan Peat site). Fall planting also proved to be significantly beneficial. *Carex* as a companion species also significantly increased percent cover.

The Effect of Field Topography Modifications on Hydrologic Parameters and Re-vegetation Success on Post-Harvested Peatlands In Minnesota

A study was conducted on two post-harvested peatland sites (Michigan Peat Company and Aitkin Agri-Peat, Inc.) in north central Minnesota to determine the effect of field topography on water table, peat moisture, peat moisture tension, and ultimately on the adaptability and growth of peatland plant species. Former horticultural peat production fields were contoured to a V-shaped topography using common field shaping equipment to create a moisture gradient. Donor vegetation collected from adjacent natural areas was spread in 1.0 m wide swaths across the moisture gradient. Black spruce (*Picea mariana*), tamarack (*Larix laricina*), and jack pine (*Pinus banksiana*) were also planted over the same range of hydrologic conditions. Hydrologic parameters (water table level, peat moisture content, and peat moisture tension), and establishment and survival of applied donor vegetation and tree seedlings were monitored across the moisture gradient during the 1998 growing season. Results indicated that field contouring and the resulting V-shaped topography significantly increased the

water table level, peat moisture content, and peat moisture tension at both Michigan Peat (with the exception of peat moisture tension) and Aitkin Agri-Peat research sites. However, even with field contouring, peat moisture tension still dropped below the level (-100 mb) required for satisfactory *Sphagnum* regeneration during certain dry periods. In general, plant establishment and survival within the one meter swath of donor vegetation along each boardwalk was quite limited. Regression analysis of the percent cover and hydrologic parameter data revealed very few statistically significant correlations. There was a significant positive effect of increased peat moisture tension on moss (mosses other than *Sphagnum*) percent cover at Michigan Peat and a significant negative effect of increased water table level on both total cover and *Sphagnum* cover at Aitkin Agri-Peat. There was no significant effect of field topography on survival of black spruce, jack pine, or tamarack seedlings. It is likely that mulching or some other method of moisture modification will be required in addition to field contouring in order to successfully re-establish peatland vegetation on post-harvested sites.

Plots along the moisture gradient at the Aitkin Agri-Peat site were re-established in June 1999 with a straw mulch and oat companion crop to try to improve peatland vegetation survival.

Large-Scale Restoration Studies of Post-Harvested Peatlands in Minnesota

Tests of Laval University methods on post-harvested peatland sites in Minnesota demonstrated that large-scale establishment of *Sphagnum* moss dominated vegetation can be achieved using readily available equipment commonly owned by peat companies. The timing of such operations is critical. The snow must be melted to allow donor vegetation harvesting, and the ground must remain frozen to support the weight of the equipment. Estimated costs for this restoration are in the range of $700 to $800 per acre. Economies of scale are not figured into this analysis and may reduce costs. After one growing season total percent cover for mulched plots at Michigan Peat ranged from 4.78 to 13.73 percent. Total cover on plots with no mulch ranged from 1.43 to 2.13 percent. Total percent cover for mulched plots at Aitkin Agri-Peat ranged from 4.48 to 39.78 percent. Total cover on plots with no mulch ranged from 0.40 to 4.90 percent. In general, mulched plots had higher percent cover than plots without mulch. The Michigan Peat site had higher *Sphagnum* percent cover than the Aitkin Agri-Peat site, while the Aitkin Agri-Peat site had higher percent cover by other mosses and vascular plants. The sites should continue to be monitored for several years to determine the long-term success of these restoration methods.

Factors Influencing Seed Dormancy and Germination in Five Peatland Species

The goal of the companion species greenhouse study was to determine seed dormancy and germination requirements for companion plant species, those plants found in association with *Sphagnum* moss in natural settings, through controlled greenhouse experiments. Tests were conducted with seed collected from five peatland plant species frequently found in association with *Sphagnum* moss: 1) *Carex lasiocarpa*, 2) *Carex oligosperma*, 3) *Eriophorum spissum*, 4) *Scheuchzeria palustris*, and 5) *Rhyncospora alba.* Greenhouse experiments were begun at the University of Minnesota Department of Horticultural Science, St. Paul in March 1998. A number of experimental treatments were applied to induce seed germination including hot water scarification and plant hormone applications. *Rhyncospora alba* was the only species which had any significant seed germination. This suggests that peatland plant species in general exhibit complex seed dormancies and most likely require very specific conditions for germination. Therefore, the study was re-established in December 1998 with a different seed stratification protocol.

Peatland Restoration Strategies: Effects of Water Depth on Re-establishment of Companion Plants
Controlled experiments were conducted to ascertain how depth to water table affects seedling establishment and growth of five common vascular peatland plants: *Carex oligosperma, Carex lasiocarpa, Eriophorum spissum, Scheuchzeria palustris*, and *Rhynchospora alba.* In one experiment, giberillic acid (GA) was used to break dormancy and in another, seeds were cold-stratified to break dormancy. Plants were grown under four different depths to water table in both experiments: 2, 10, 18 and 26 cm. *Carex oligosperma* did not establish under any environmental conditions during the study. *Carex lasiocarpa* and *Scheuchzeria palustris* established at low rates following (GA) but not cold-stratification. *E. spissum* established only after cold-stratification whereas *R. alba* established following both seed treatments. Seedling establishment was optimal at lower elevations (2 or 10 cm) for *S. palustris* and *R. alba* and at higher elevations (18 or 26 cm) for *C. lasiocarpa* and *E. spissum.*

Vegetation Analyses of Donor sites and of Harvested Peatlands, Northern Minnesota
Vegetation surveys were conducted on a total of five sites in northern Minnesota to determine natural (unmanaged) restoration success. Two donor sites were selected near experimental plots at the Aitkin Agri-Peat and Michigan Peat operations as source areas for plant propagules. These sites had no surficial peat removed but might have been influenced in the past by logging and/or drainage from the nearby peat operations. In addition, three sites were selected among northern Minnesota's earlier harvested peatlands, to analyze natural revegetation: (1) the Peterson Bog (Arlberg), abandoned in the mid 1970's, (2) the Wawina-Colby Bog, abandoned in 1986, and (3) the Power-O-Peat Bog (Central Lakes), abandoned in 1988. These sites had an unknown amount of surficial peat removed, but a significant depth of acidic peat was left. Drainage by nearby ditches was restricted or completely inhibited by natural overgrowth some time in the past after the harvesting was abandoned. All five sites can be classified as bogs. The most recently harvested sites, abandoned slightly more than 10 years ago (Wawina-Colby and Power-O-Peat), have still about half of the surface exposed as bare peat. Among the graminoids, *Eriophorum spissum* appears to be the first and most aggressive colonizer, and among the mosses the rare *Dicranella cerviculata* is unique to these sites. *Polytrichum* species are significant, too, but *Sphagnum* is nearly absent. The Peterson (Arlberg) site, abandoned more than twenty years ago, and the two donor sites, have complete vegetation cover corresponding to natural bog vegetation, without exotic species. However, this older harvested site still lags behind in the larger woody species compared with the donor sites, and has a larger abundance of graminoids and *Vaccinium oxycoccus*. Among the bryophytes all the typical bog species are present, and on the harvested site a few additional species, usually found in slightly more minerotrophic poor fens, occur, such as *Polytrichum longisetum* and *Sphagnum teres*, reflecting the recent disturbance

Result 4: Host an international peatland restoration workshop.

The NRRI Peat Group hosted the International Symposium "Peatland Restoration and Reclamation - Techniques and Regulatory Considerations," July 14-18, 1998, in Duluth, Minnesota. The goal of the Symposium was to bring together peat scientists, peat industry representatives, and government regulators to discuss options for the use of post-harvested peatlands. More than 90 scientists, regulators, and peat company representatives from 15 different countries attended. The Symposium was sponsored by NRRI, MDNR– Minerals Division, the U.S. National Committee and Commission V of the International Peat Society, and the Minnesota Peat Association. Field trips to Minnesota

peatland restoration and reclamation sites at Michigan Peat Company and Aitkin Agri-Peat, and the USDA Forest Service, Marcell Experimental Forest, were also conducted in conjunction with the Symposium.

A 273 page proceedings was published and distributed at the Symposium. It contains a total of 60 papers and posters related to various aspects of peatland restoration and reclamation. The proceedings are available through either the International Peat Society Headquarters in Finland (e-mail: ips@peatsociety.fi) or the U.S. National Committee of the International Peat Society (e-mail: tmaltere@sage.nrri.umn.edu).

A copy of the Symposium proceedings, the list of participants, Symposium field trip guides, and a copy of the *Peatlands International* newsletter containing an article about the Symposium, are included along with this final report package.

Result 5: Conduct a peatland restoration field day for peat companies, state and federal regulators, and other interested parties.

The NRRI Peat Group, together with the University of Minnesota Extension Service, Minnesota Peat Association, Minnesota Sphagnum, Inc. and Michigan Peat Company hosted the guided tour "Peatland Restoration and Sphagnum Moss Peat Harvesting Operation" on June 24, 1999. There were 25 attendees including Minnesota DNR, Minnesota Pollution Control Agency, and U.S. Army Corps of Engineers personnel, peat producers, private citizens and Senator Becky Lourey. Guest presentations were made by Julie Jordan (Minnesota DNR, Minerals Division), Tim Peterson (U.S. Army Corps of Engineers) and Dr. John Stewart (University of Manitoba, Winnipeg) regarding peatland restoration regulations and techniques. A copy of the field trip guide and the list of participants are included along with this final report package.

Result 6: Develop a guidebook of peatland restoration techniques.

One of the original objectives of the project was to produce a peatland restoration "guidebook". The restoration of post-harvested peatlands is a relatively new science with few long term examples of successful managed restoration to follow. Although the studies conducted at our research sites over the project two year period show significant potential for peatland restoration, more time is needed to insure success. The peatland restoration process is inherently slow and it is difficult to develop definitive recommendations within the time frame of this project. At the project outset we anticipated that a reasonable set of guidelines could be produced. However, due to the dynamic nature of this new research area, and rapidly changing regulatory thoughts, expectations, and requirements, it would be premature to produce definitive restoration guidelines. Rather, this document focuses on general peatland restoration concepts, with some specific examples resulting from our research. It can serve as a building block to direct future research and be expanded to create a truly comprehensive guide which will be applicable in a majority of situations. Plans are to continue refining the guidebook as our research progresses and as results from other ongoing research becomes available. A copy of the draft peatland restoration concepts document is included along with this final report package.

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Review technical papers relevant to peatland restoration in Minnesota, to refine project design and produce a bibliography.

- Pertinent peatland restoration literature has been gathered. A critical review of relevant restoration techniques and methodology was conducted, the project design was reviewed and refined, and a bibliography was completed.

- Dr. Elon (Sandy) Verry, et al, of the USDA Forest Service in Grand Rapids, Minnesota reviewed the project design and reported to the LCMR staff by August 29, 1997.

- This information was used to improve and refine research methods for this project and as a reference tool for researchers conducting further restoration studies in Minnesota.

LCMR Budget: $16,670 Balance: $0
Completion Date: The refined project design and review was completed by August 29, 1997. The bibliography was completed by June 30, 1999.

Result 2: Establish and maintain demonstration scale restoration research sites on harvested peatlands, to determine suitable restoration practices for Minnesota conditions.

- Demonstration scale restoration research sites, each approximately three to five acres in size, were established on two harvested peatlands characteristic of Minnesota horticultural peat operations.

- Research sites were located at Michigan Peat Company (near Cromwell), on a site formerly harvested for Sphagnum moss peat, and at Aitkin Agri-Peat (near McGregor), on a site formerly harvested for reed-sedge peat.

- Small scale replicated research plots were established at each demonstration site to examine the effects of various experimental treatments such as water table level, field topography, companion plants, fertilization, mulching, and spring vs. fall planting.

- Larger plots were also established to test techniques for full scale mechanized seeding and spreading of plant/moss fragments and to estimate restoration costs.

- Both sites were maintained and monitored throughout the funding period.

- Research sites established previously as part of preliminary projects also continued to be monitored.

- It is anticipated that all sites will continue to be monitored after June 1999 with funding from other sources.

LCMR Budget: $110,069 Balance: $0

Completion Date: Site establishment was completed by May 29, 1998. Maintenance and monitoring continued through June 30, 1999.

Result 3: Compare peatland restoration establishment strategies for the funding period and present results and conclusions in a technical report.

- Research plot data from each site was statistically analyzed to determine significant treatment effects.
- Establishment and maintenance cost data for each site was analyzed to determine the most cost effective restoration strategies.
- Results and conclusions were presented in a technical report which can be published in a scientific journal or symposium proceedings.

LCMR Budget: $68,839 Balance: $0
Completion Date: June 30, 1999

Result 4: Host an international peatland restoration workshop.

- The workshop consisted of scientific paper and poster presentations, and a field trip to restoration research sites and natural peatlands.
- Peatland restoration researchers and peat harvesting company representatives from the USA, Canada, United Kingdom, Ireland, France, Belgium, Germany, The Netherlands, Switzerland, Finland, Sweden, and other countries conducting peatland restoration research, presented their research findings.
- Proceedings of the research presented at the workshop was published and distributed.
- Additional copies of proceedings will be disseminated by NRRI and the International Peat Society (IPS).

LCMR Budget: $45,827 Balance: $0
Completion Date: July 31, 1998

Result 5: Conduct a peatland restoration field day for peat companies, state and federal regulators, and other interested parties.

- A one-day field tour of both research sites was conducted to demonstrate peatland restoration techniques and answer questions.
- Members of the Minnesota Peat Association (MPA), including representatives from five to eight of the major peat harvesting companies in Minnesota attended.

- Representatives from the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and other regulatory agencies attended.

- Interested persons in state and local government also attended.

LCMR Budget: $8,471 Balance: $0
Completion Date: June 30, 1999

Result 6: Develop a guidebook of peatland restoration techniques.

- A locally reviewed, draft peatland restoration guidebook, ready for wider distribution and assessment, detailing the most recent methods for restoring harvested Sphagnum moss and reed-sedge peatlands in Minnesota was produced.

- The guidebook is based on our research and other studies, and specifically focus on Minnesota environmental conditions and regulatory requirements.

- Copies of the draft guidebook will be disseminated by NRRI to peat companies, regulatory agencies, environmental consultants, and state, county, and local governments for their review and input.

LCMR Budget: $25,124 Balance: $0
Completion Date: June 30, 1999

V. DISSEMINATION:

Result 1: The peatland restoration bibliography was disseminated to interested parties through NRRI and the International Peat Society (IPS). Selected references were also included in the literature cited for the technical reports and guidebook.

Result 2: The demonstration scale research sites were shown to numerous people during the peatland restoration field day and restoration workshop. Other visits to the sites by interested parties can be arranged through NRRI.

Result 3: Portions of the technical report will be published in a scientific journal and/or presented at a symposium and included in the proceedings. Reprints will be available through NRRI or IPS.

Result 4: The peatland restoration workshop was attended by:

- peatland restoration researchers and peat harvesting company representatives from the USA, Canada, United Kingdom, Ireland, France, Belgium, Germany, The Netherlands, Switzerland, Finland, Sweden, and other countries conducting peatland restoration research.

- members of the Minnesota Peat Association (MPA) including representatives from five to

eight of the major peat harvesting companies in Minnesota.

- representatives from the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and other regulatory agencies.

- Interested persons in state and local government.

A proceedings of the research presented at the workshop was published and distributed.

Additional copies of proceedings will be disseminated by NRRI and IPS.

Result 5: The peatland restoration field day was attended by:

- members of the Minnesota Peat Association (MPA) including representatives from five to eight of the major peat harvesting companies in Minnesota.

- representatives from the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and other regulatory agencies.

- Interested persons in state and local government.

Result 6: Copies of the draft guidebook will be disseminated by NRRI to peat companies, regulatory agencies, environmental consultants, and state, county, and local governments for their review and input.

VI. CONTEXT:

A. Significance: Minnesota is one of the leading states in both the conservation of wetlands and the harvesting of horticultural peat. Peatland restoration is essential if we wish to preserve this beneficial dichotomy of economic and environmental interests. However, there is no demonstrated restoration of *Sphagnum* moss or reed-sedge dominated ecosystems, characteristic of boreal peatlands, on sites harvested for horticultural peat in Minnesota.

Although reclamation research conducted in the early 1980s by the Minnesota Department of Natural Resources and the University of Minnesota, included forestry and agriculture, very little research was done on "peatland restoration" - the managed restoration of harvested peatlands to their original vegetation and functional wetland status. Preliminary research has been conducted in Europe and Canada, with some promising results, although restoration techniques have yet to be tested on Minnesota sites.

Approximately 2,000 acres of Minnesota peatland are currently managed for the harvesting of horticultural peat. Most of these peat harvesting operations are located on peatlands known as "raised bogs." A raised bog is so called because of the dome-shaped accumulation of Sphagnum moss peat that has evolved at these sites over time. It is this Sphagnum moss

peat which is desirable for most horticultural applications and has considerable economic value.

Minnesota's horticultural peat industry employs about 200 people and adds approximately $10 million to the rural economy annually. Of Minnesota's 6.2 million acres of peatland, only 130,000 acres, or approximately 2 percent, are considered raised bogs. Many of these bogs are designated as ecologically significant Scientific and Natural Areas (SNA's) and are not available for development. All things considered (SNA's, location, accessibility, and resource quality and extent), a conservative estimate of the peatlands available for Sphagnum moss peat development is about 30,000 acres. Therefore, it is important that these environmentally and economically significant peatlands are carefully managed and after harvesting has ceased, restored to their original state whenever possible. Reed-sedge peatlands are also harvested for horticultural purposes and should similarly be restored.

According to the MDNR, Peatland Reclamation Rules (Chapter 6131), a peat company generally has two options in reclaiming a harvested site. The first option is to reclaim it to a specific end use such as forestry, agriculture, or biomass production. The second option is to stabilize the surface with wetland or typical peatland vegetation and meet a 5-year cover standard, which is essentially the same as peatland restoration. The second option is preferred by peat producers, and state and federal regulatory agencies. Peatland restoration also creates a "sustainability loop," where harvested peatlands are renewed over time for use by future generations.

The proposed demonstration projects established on harvested horticultural peatland sites in Minnesota will help to accelerate the establishment of reliable, cost effective, peatland restoration techniques compatible with state and federal regulatory requirements. This information will be disseminated to interested parties through the proposed publications, field day, and restoration workshop.

B. Time: The project was completed within the two-year time frame.

C. Budget Context:

	July 1995-June 1997 Prior expenditure's on this project:	July 1997-June 1999 Project period:	July 1999-June 2001 Future expenditures on this project:
LCMR	$0	$275,000	$0
Other State	$60,242[1]	$0	$40,000[1]
Non-State	$0	$0	$0
In kind	$16,000[2]	$48,000[3] + $9,000[4]	$15,000[3]

[1] Minnesota Technology, Inc.
[2] Michigan Peat Company
[3] Michigan Peat Company, Aitkin Agri-Peat, and the Minnesota Peat Association
[4] MDNR Mineland Reclamation Specialist and U of M Assistant Professor

BUDGET:

Acquisition	$0
Development	$0
Personnel	$228,880
Equipment	
Monitoring equipment	$5,000
Boardwalks	$2,500
Computer/software	$1,545
Field equipment rental	$1,000
Other	
Lab analyses	$5,000
Printing	$2,975
Phone	$750
Mail	$300
Travel	$15,300
Workshop	$10,750
Field day	$1,000
Total	$275,000

VII. COOPERATION: The project team consists of the following individuals:

Natural Resources Research Institute	Kurt Johnson	83% time	$80,840
Natural Resources Research Institute	Tom Malterer	35% time	$55,330
Natural Resources Research Institute	Sr. Technician	83% time	$53,000
Natural Resources Research Institute	Asst. Scientist	18% time	$12,600
Natural Resources Research Institute	Senior Secretary	5% time	$3,275
MN Department of Natural Resources	Julie Jordan	10% time	no costs
Private Consultant	Jan Janssens	2% time	$4,000
Private Consultant	John Stewart	3% time	$6,200
Private Consultant	Francois Quinty	4% time	$8,700
University of MN, Horticulture Dept.	Susan Galatowitsch	5% time	no costs
University of MN, Horticulture Dept.	Technician	10% time	$4,935
Aitkin Agri-Peat	Mark Duitsman	5% time	no costs
Michigan Peat Company	Harry Fraser	5% time	no costs

VIII. LOCATION: The following maps show the project location and extent.

Figure 1. Peatland distribution in Minnesota and proposed restoration research sites.
Figure 2. The extent of Sphagnum raised bogs in relation to total peatlands in Minnesota.

IX. REPORTING REQUIREMENTS: Periodic work program progress reports were submitted not later than January 31, 1998 and January 31, 1999. A final work program report and associated products were submitted by June 30, 1999, or by the completion date as set in the appropriation.

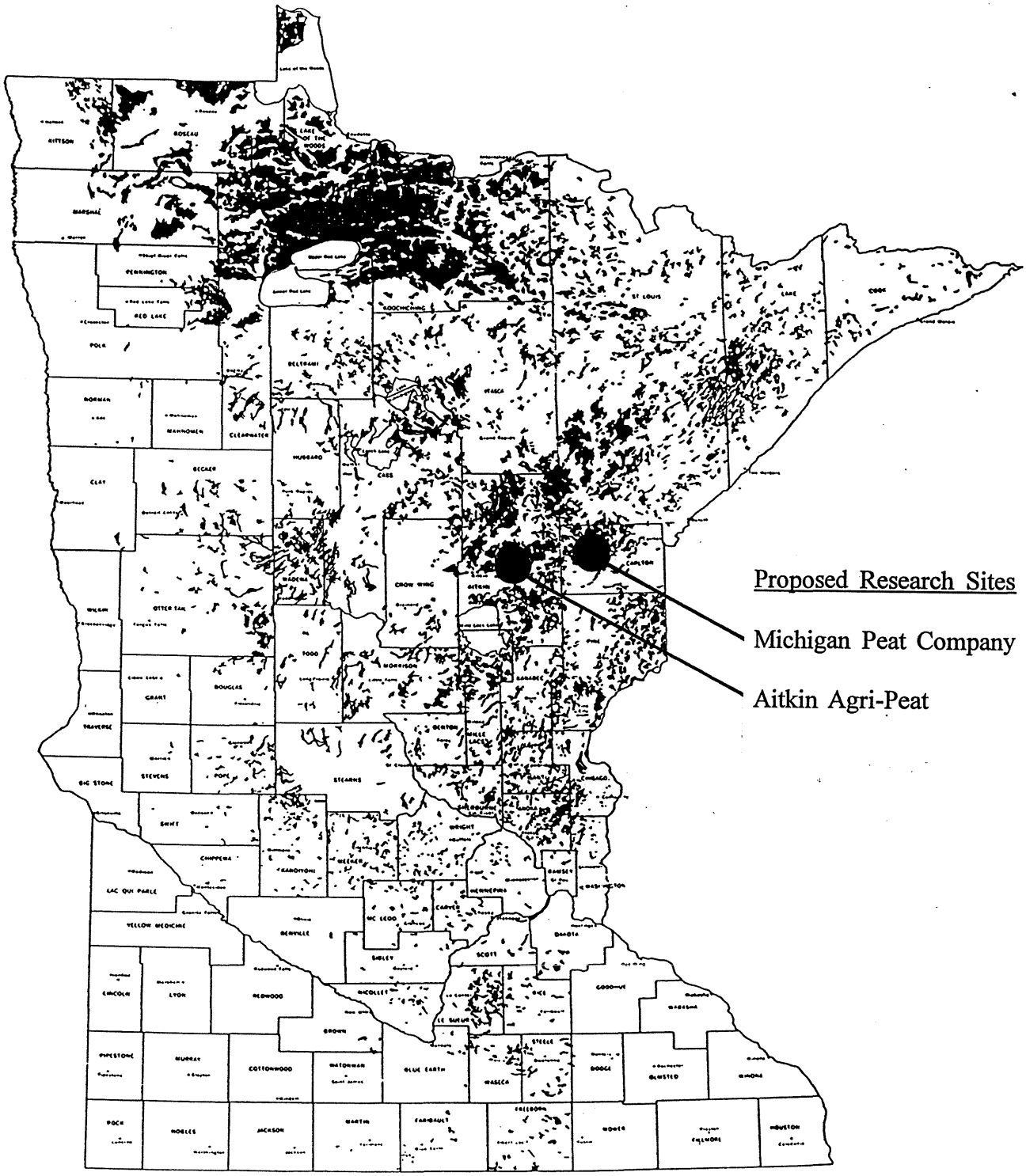

Figure 1. Peatland Distribution in Minnesota.

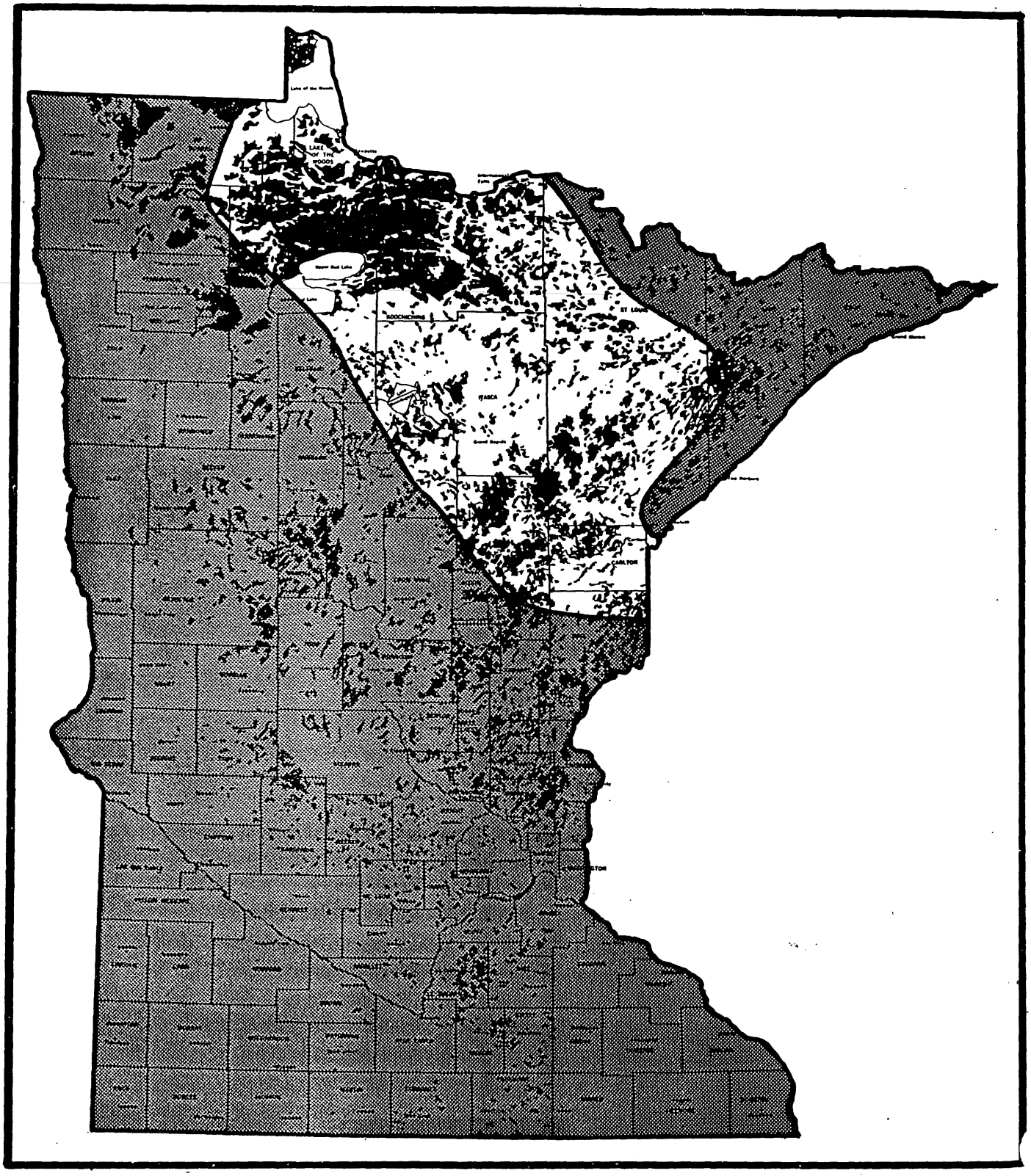

Figure 2. The extent of Sphagnum raised bogs in relation to total peatlands in Minnesota.