July 1, 1993

LCMR Final Status Report - Summary - Research

LCMR WORK PROGRAM 1991

I. **Land and Water Resource Management for the Lower St. Croix National Scenic Riverway** - Recreation 26.

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Boundary Area Commission
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A. M.L.91 Ch. 254, Art.1, Sec.14, Subd:3(e) Appropriation:$360,000
Balance: $0

Land and Water Resource Management, Lower St. Croix Riverway: This appropriation is from the Minnesota environment and natural resources trust fund to the commissioner of natural resources for a grant to the Minnesota-Wisconsin Boundary Area Commission to develop a management strategy, improved technical capability, and sustained local government and landowner stewardship on the jointly managed lower St. Croix.

B. During the biennium ending June 30, 1993, the data collected by the projects funded under this section that have common value for natural resource planning and management must conform to information architecture as defined in guidelines and standards adopted by the information policy office. In addition, the data must be provided to and integrated with the Minnesota land management information center's geographic data bases with the integration costs borne by the activity receiving funding under this section.

C. Status of Match requirement - not applicable

II. Narrative

The natural, recreational and scenic resources which make up the Lower St. Croix National Scenic Riverway are threatened by dramatic increases in recreational use and land use changes occurring in and adjacent to the Riverway. Preservation and protection of the Riverway's resources, consistent with the goals and objectives of the 1976 Master Plan, is becoming increasingly difficult, using management strategies devised nearly three decades ago. Growing recreational boating use, increased land development pressures, and a decline in Riverway landowner and local government support for Riverway preservation and protection programs call for new management strategies and renewed contact with local stakeholders.

This project will organize and analyze updated information about the ecological and visual impacts of growing use, assess existing management strategies to determine their effectiveness toward meeting the policy goals of the Riverway's Master Plan, and determine long-term monitoring, research, and public policy needs. Coordination and communication with local units of government and private groups will be increased in order to rebuild local ownership and stewardship in the Riverway preservation and protection effort.

III. Objectives

III.A. **To identify and map land and water surface use changes occurring in the Lower St. Croix National Scenic Riverway (LSCNSR) between 1976 and 1991.**

A.1. Narrative: The following five components will be addressed: 1) documentation of the land and water surface use changes occurring in the LSCNSR and its watershed between 1976 and 1991; 2) identification of land use and water surface use changes in the Riverway that were proposed between 1976 and 1991 but never realized; 3) identification of land use and water surface use changes that are likely to occur within the LSCNSR based on existing public policy; and 4) establishment of a Geographic Information System (GIS) approach to the management and analysis of spatial data in the LSCNSR; and 5) development of videotape summary material for Objective E. This will include the integration of existing aquatic and terrestrial databases into a common, accessible database.

A detailed Plan of Study (POS) has been written for this objective, and delivered to LCMR as Deliverable (A1) of Exhibit C (11/19/91) of the Grant Agreement for this project. Exhibit C of the Agreement references section III.A.4. of this Work Program, the Time-line for Products/Tasks. (Bracketed) references in section III.A.5. of this Work Program refer to Exhibit C (appended).

A.2. Procedures: Development of data to support Objective A will include incorporation of data from numerous existing sources as well as the generation of new spatial data from aerial photography and map interpretations. System development must also account for the access requirements of several researchers, each involved with one or more phases of this overall work-plan. In order to best accomplish establishment of a useful and robust system that will have long-term effectiveness and utility, a structured approach to system and data development will be taken.

This process is formally defined as a project life-cycle. The life-cycle consists of four phases; planning, design, implementation, and maintenance. Each phase maintains a focus on the central, integrated GIS database which is to be used to address each of the project alternatives. The initial life-cycle phases are addressed

through a process called a User Requirements Analysis (URA). The aim of the URA is to systematically inventory the users and their objectives and data and analysis needs. Specific recommendations for system parameters (base maps, scale, land use classification schemes, statistical or process-related models, and change detection algorithms) will be predicted on results gained from the URA.

Much of the mapping activity within the LSCNSR, and in each of the bordering states, occurs at the scale of 1:24,000. State land use, topography, soils, and other databases commonly adhere to this standard. Issues of scale sensitivity, related in particular to the ecological work in Objective B, however, require that multiple scales be utilized in the study. Data used to estimate loadings of nutrients and sediments from watersheds contributing to the river will be aggregated to a smaller scale and/or resolution in order to develop correlative models to empirical water quality monitoring data currently and historically collected by various public agencies. Until the URA is completed, however, specific details as to scale and resolution cannot be determined.

Using maps of native vegetation and archival land survey records, pre-settlement land use/land cover maps for the Riverway will be digitized and stored in the GIS. Land use records, public policy documents and the print media will be examined to identify land and water surface use change proposals within the LSCNSR between 1976 and 1991 that never materialized as well as those that are pending or that have been scheduled as of the end of 1991. All three sets of land and water surface use data will be digitized as discrete layers within the GIS. Thus, analyses of change dynamics between 1976 and 1991 can be accomplished using GIS analysis tools, and an atlas of change will be produced as a deliverable.

Change dynamics will be developed by cross-tabulating land and water surface use figures for the years of the study. Additionally, map overlay and map comparison procedures will yield maps of locations showing specific locations of each type of change. Statistical summaries of the changes (i.e. area, type, patterns) in each nominal land and water surface use class will be produced. While patterns of change will be evident on the maps themselves, some quantitative estimates of pattern or patch dynamics will be generated. These techniques will include analyses of area/perimeter changes and of ownership and use fragmentation. Estimates of pareto size parameters and fractal dimensions will also be sued to numerically summarize the spatial and temporal frequency or texture of change. Specific output products will thus include both map and tabular summaries. These summaries will be provided according to the reporting rules stated throughout the work-plan; and deliverables will include interim as well as final reports and maps.

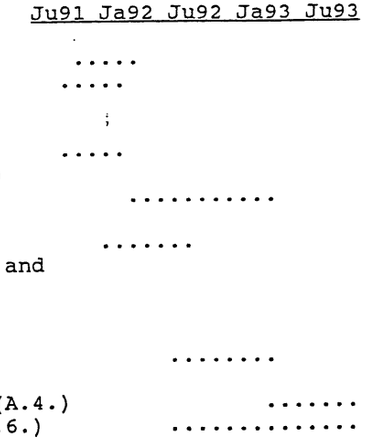
Geographic base files in digital format will also be provided as deliverables. By employing a structured, systematic URA at the outset of the project, it is anticipated that a GIS can be developed with sufficient flexibility to be useful to a wide range of users over a relatively long time frame. Design goals call for a system to be developed which will not be just a project-supporting effort; but a programmatic system that can support longer-term use for the assessment and quantification of land and water surface use dynamics within the LSCNSR

Appropriate summary material will be developed in videotape format for use in Objective E.

A.3. Budget

a. Amount budgeted: $53,860
b. Balance: $0

A.4. Time-line for Products/Tasks



A.5. Status:

Results:

The Study Plan (A1) and expanded 2-volume GIS Framework Description and Dictionary document (A2) including data files on disk, have been completed. All aerial photography and original mylar maps, used for the process of digitization have been organized and compiled for delivery to the MWBAC for storage in its archives as backup information (A3). A bound 81/2 x 11 inch atlas of land and water surface use change, (A4) consisting of a series of printed

color maps and descriptive tables and narrative, has been published. Deliverable (A5) was completed on June 23, 1993, considerably behind schedule. This has affected the completion of Deliverable (D5), which now will be submitted by July 30, 1993, rather than June 30, 1993.

A contractor, hired by the Minnesota-Wisconsin Boundary Area Commission, has produced a videotape documenting the products, findings and conclusions of the LCMR project and their relevance to Riverway management. Existing videotape source materials, anticipated from the University of Minnesota, demonstrating activities in objective A, of sufficient quality for use in a final video production, proved to be very limited. Therefore, most of the video materials therefore were recreated by the contractor through recent arranged shooting of activities associated with Objective A. Much of the work was done on-site at the remote sensing lab at the University of Minnesota.

Pre-settlement data compiled from the Public Land Survey (PLS) have been edited and compiled into database files and computer-generated maps of original vegetation for the watershed (A7).

Meaning of Results:

A state-of-the-art Geographic Information System (GIS) for the 1,469 square mile Lower St. Croix Watershed, and seven sub-watershed units within it, has been completed for use by resource managers to describe and analyze land use and land cover at pre-settlement and in 1973 and 1991 and to document changes over time. The GIS clearly presents land use change information showing the locations, general patterns, and overall magnitude of changes in land use within the watershed, particularly the extent of conversion of forest and farm lands to urban uses in this rapidly-changing watershed on the eastern and northeastern edge of the Twin Cities Metropolitan Area. While the system was developed for use principally by resource managers along the Lower St. Croix Riverway, its initial debut on June 10, 1993 has already generated requests from local and regional land use planners in five counties and both states which make up the watershed. Further, the Wisconsin Department of Natural Resources, in its June, 1993 draft St. Croix Basin Water Quality Management Plan, is recommending that the GIS be expanded to include the entire 7,760 square mile interstate watershed. The MWBAC and both the Minnesota and Wisconsin university systems are exploring ways to transfer the GIS system to entities that would serve as local and regional service centers and access points for the system and the data it contains.

The data and report provided as part of the (A5) Public Policy Analysis of land use change and cultural settlement patterns within the Riverway is being used by the member agencies of the Lower St. Croix Management Commission to evaluate potential modifications to land use rules and land use planning and regulatory programs along

the Riverway in each state. The data is being presented to the Minnesota DNR for their consideration in a land use rules upgrading process on July 15, 1993. The data will also be used by the MWBAC and the LSCMC as it develops specific recommendations for ongoing training and stewardship programs for landowners and local government officials within the Riverway.

Because of the amount of time required to complete the GIS construction, the level of analysis of the data is not as extensive as originally expected. As part of follow-up work by the MWBAC, funds are being sought to retain one or more project staff persons to assist in this effort over the next three months. This person will also assist the MWBAC in a technical assistance and outreach program to make the data and software programs available and usable to a wide audience of potential users who have or can obtain the hardware and ARC/INFO software necessary to operate the GIS.

A.6. Benefits:

A computerized map atlas of land and water surface use change in the LSCNSR will be produced. These data will exist for several time scales, including 1976 and 1991, and they will provide the ability to estimate the ecological effects of changing land and water surface use patterns in the LSCNSR (Objective B below), to assess the visual effects on scenic resources (Objective C), to analyze the effectiveness of existing policies and management strategies (Objective D), and to assist in stewardship-building (Objective E.)

III.B. To identify and assess the ecological impacts of land and water surface use changes occurring in the LSCNSR between 1976 and 1991 on the natural resource base.

B.1. Narrative: The ecological effects of land and water use change within the LSCNSR will be defined in three ways: 1) An evaluation of the relationships between changes in the land use within the Lower St. Croix watershed and land use and water surface use within the Riverway and changes in water quality and aquatic habitat within the Lower St. Croix River; 2) an evaluation of the effect of changes in Lower St. Croix River water quality and aquatic habitat on the abundance and distribution of selected aquatic invertebrate and fish species; and 3) a n evaluation of the effect of land use changes within the Lower St. Croix watershed and the Riverway on the abundance and distribution of selected terrestrial species.

A detailed Plan of Study (POS) has been written for this objective, and delivered to LCMR as Deliverable (B1) of Exhibit C (11/19/91) of the Grant Agreement for this project. Exhibit C of the Agreement references section III.B.4. of this Work Program, the Time-line for Products/Tasks. (Bracketed) references in section III.B.5. of this Work Program refer to Exhibit C (appended).

B.2. Procedures: This objective will be accomplished within five components:

a) Water Quality. Water quality characteristics of the LSCNSR at a number of locations will be assessed using existing monitoring data sets obtained from the published literature and agency reports. Loading of selected water quality constituents at a number of points on the LSCNSR will be estimated from these data (as data permits), and these data will be examined for temporal trends that are evident between 1976 and 1991. In addition, correlation analyses and regression models will be used to evaluate relationships between water quality characteristics of the LSCNSR and land use characteristics within the Riverway and the Lower St. Croix watershed. These analyses will incorporate land use information at the watershed-level using existing land use information and Minnesota and Wisconsin state records of point source dischargers along the LSCNSR.

Active data collection efforts will focus on: 1) paleoecological changes in sediment deposits within receiving basins; 2) historical changes in riverine habitat; and 3) population dynamics of a pollution-sensitive mussel population. Three sediment cores will be taken from the impoundment above Taylors Falls and Lake St. Croix and each core will be dated using ^{210}Pb techniques. Analyses will allow an indirect evaluation of sediment and nutrient loading to areas of the Riverway above and below the LSCNSR as documented through changes in deposition and trophic status of each impoundment. Deposition and trophic alterations of Lake St. Croix, as delineated with core analysis, will be examined in light of changes in land use practices within the watershed, land use management along the riparian corridor, changes in water surface use and sediment core characteristics of the upper impoundment.

b) Aquatic Habitat. Historic changes in the abundance and distribution of snag habitat (large woody debris) for aquatic invertebrates and fish will be examined along the Lower Riverway from existing aerial photographs. Recent biological surveys conducted by the Wisconsin and Minnesota DNRs along the Riverway suggest that invertebrate abundance and diversity and fish production are strongly related to the abundance and distribution of snags in the river (Gary Montz, Minnesota DNR, personal communication: Minnesota Department of Natural Resources 1990). Others have also found that snag habitat is important to invertebrate and fish production in river ecosystems. The Lower St. Croix Management Commission and Minnesota-Wisconsin Boundary Area Commission has aerial photography for the LSCNSR for 8 years between 1977 and 1989 and is scheduled to obtain photographs in 1991 as well. Preliminary analysis confirms that snags are easy to identify and enumerate on these photographs. These data will be

used to 1) quantify changes in snag habitat along four reaches of the Riverway since 1976; 2) incorporate snag habitat densities as attributes of the Riverway within the GIS: and 3) examine statistical relationships between the density of snags and land and water surface use practices along the LSCNSR.

c) Ecology. Mussel populations within the St. Croix River provide a sensitive biomonitor to changes in water quality and habitat within the Riverway. Because these organisms are long-lived, relatively sedentary, and sensitive to pollution, they represent excellent biomonitors of changes in water quality over space and time. Shell fragments from specimens of Amblema Plicata from a number of locations will be examined to evaluate temporal differences in; 1) rate of growth, and 2) accumulation of heavy elements. Existing survey information will be used to summarize spatial and temporal distribution patterns
Most of the analyses described above rely on existing monitoring data collected by state and federal agencies. Preliminary review of water quality data in STORET and contained within agency reports confirms that these data will support the procedures described above. A combination of active sampling efforts and passive data collection efforts, followed by careful integration of data from both, will be used to accomplish these objectives.

d) Terrestrial Habitat. The analysis of the effects of land use change on terrestrial species will involve the development of habitat requirement and habitat interrelationship models for selected avian species. Data for these models will be specified using mappable parameters that characterize the habitat needs and interrelationships of target species. These mappable parameters will be gathered from existing data sources and entered into the GIS developed in Objective A. The GIS will be used in estimating a spatial model of landscape structural diversity and habitat quality. These models will be applied to spatial data sets developed for conditions existent during pre-settlement, in 1976, and in 1991.

The general approach will be to describe and map past and present landscapes, select target species, prepare a landscape-habitat matrix for each species, and perform spatial analyses for relevant biogeographic and habitat quality factors.

e) Video Material. Appropriate summary material will be developed in videotape format for use in Objective E.

B.3. Budget

a. Amount budgeted:	$104,860
b. Balance:	$0

B.4. Time-line for Products/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Specify parameters and data needs for sediment\habitat models	.....				
b.	Develop digital database			.....		
c.	Complete aerial photo interp. of snag habitat and records (B.4.)			.....		
d.	Estimate sediment and nutrient flow loadings and habitat quality for 3 time frames (B.3-6.)			.....		
e.	Complete sediment core sampling	.....				
f.	Complete mussel sampling (B.5.)	.....				
g.	Analyze core and mussel samples (B.3&5.)		.....			
h.	Correlate indices of ecological disturbance with land and water surface use change data			.....		
i.	Identify continuing research and monitoring needs					.....
j.	Develop videotape material (B.8.)				.....	

B.5. Status:

Results:

The Study Plan for this Deliverable (B1) is complete. Sources of water quality data have been identified and compiled into a data dictionary and database which has been provided as Lotus database and worksheet files as well as in a printed report (B2). Data analysis has been completed at a level less extensive than originally anticipated due to the amount of data collected and lack of time to correlate this data with the recently-developed GIS system (see Objective A.) Data analysis completed for (B2) and (B6) have been combined into one document (combined B2 and B6.) The investigator has advised that the quality of this product may be upgraded during the course of the summer of 1993 as internal and external peer review is completed.

Deliverable (B3) Paleoecology of Sediment Cores, is complete. Loss on ignition, carbonate, dating and pigment analyses are complete for sampled cores. Midge analysis and analyses of stratigraphy have been completed. A final report (D3) has been submitted.

Interpretation of Snag Habitat (B4) is complete. Snag accumulations were tallied from 5 random locations in each stream reach in 1977, 1983 and 1989 using MN/WI BAC photography. All data have been entered onto our database and summary statistics have been generated for each reach and included in the final report (B4).

Mussel Shell Analysis (B5) is complete. A literature review of previous mussel work on the St. Croix River has been completed. Age, growth and shell chemistry measurements are complete for all 63 specimens. Data from these analyses have been entered onto a database, analyzed for spatial and temporal patterns as time has permitted, and a final report has been provided (B5).

Sources of biological data have been identified and obtained from local state and federal agencies to enable an Passive Invertebrate/Fish Analysis relating to the St. Croix River (B6). This report has been combined with B2 into one document.

A preliminary report describing work done to date on Terrestrial Habitat Analysis (B7) is complete. Subsequent reports useful to this effort, but being done by the US Forest Service as part of a long term project, will be provided as information becomes available. The relevant flora and fauna data which has been gathered and tabulated into a database for the Lower St. Croix (B7), has been developed further into a habitat matrix which describes the habitat attributes and interrelationships necessary to describe the presence and/or absence of terrestrial species in the watershed. This habitat matrix will eventually be used to evaluate, interpret and predict the presence and absence of species as well as the direction of population change for species and species groups sensitive to landscape change in the Lower St. Croix. Additionally, literature reviews determining the spatial habitat parameters which describe metapopulation dynamics for forest interior neotropical migratory species has been completed and a spatial habitat model has been developed for this species group. The spatial habitat model identifies the spatial parameters which will characterize and describe how changes in landscape pattern affects this select group of forest interior avian species. Currently, algorithms are being written to incorporate the spatial habitat model into the Geographical Information System.

A contractor was hired by the Minnesota-Wisconsin Boundary Area Commission to produce a videotape documenting the products, findings and conclusions of the LCMR project and their relevance to Riverway management. Available and suitable videotape source materials documenting work done as part of objective B proved limited. The contractor therefore completed additional videotape footage through on-site taping at the water quality lab at the University of Minnesota (B8).

Meaning of Results:

Since all of the deliverables (except B1) for this objective were submitted only within the last 24 hours, an adequate description of the meaning of this work cannot be assessed at this time. As part of the final project report, a separate document (beyond the required deliverables for this project) to be completed by the MWBAC, there will be more elaboration on the results and the

implications and subsequent recommendations to managing agencies. At this point we can state that a cursory review of the reports, in process, indicate that the results will have significant usefulness in correlating land use and water surface use data to water quality data for seven stream reaches and seven sub-watershed in the Lower St. Croix River and its watershed which will enable resource managers to develop some important recommendations for future resource management. The amount and quality of data and care taken in its presentation is excellent and worthwhile, acknowledging that such care has somewhat precluded completion of the level of analysis and interpretation originally anticipated.

B.6. Benefits: Empirical relationships will be established between the biophysical characteristics of the St. Croix watershed and the ecological characteristics of the Riverway and added to the GIS to simulate the effects of alternative management scenarios. These models will permit projections of ecological disturbances that will likely emanate from future land and water surface use changes within the Riverway.

The GIS and statistical models will provide a framework for public policy decision making, continued research and monitoring efforts, and will provide support for fostering stewardship efforts among users, landowners, local governments, within the Riverway, and, to a limited extent, within the larger Lower St. Croix watershed.

III.C. To identify and illustrate the visual impacts of land use change occurring in the LSCNSR between 1976 and 1991 on the Riverway's scenic and recreational resources.

C.1. Narrative: Secondary source material will be used to develop a narrative record of historical changes in the LSCNSR watershed. Photo documentation of archival images of the watershed during the early settlement period, in 1976, and 1991, will reveal changes in the watershed's visual character due to changing patterns in land use. The consequences of these changes on visual quality in the watershed will be estimated and fluctuations in visual quality will be correlated with land use changes. Visual quality evaluations will be spatially analyzed and mapped using the GIS developed in Objective A.

Computer-assisted video image capture technology will be used to generate video simulations of the watershed's visual character under various historical scenarios. The results will these studies of changing visual quality in LSCNSR and its watershed will be presented in videotape format.

A detailed Plan of Study (POS) has been written for this objective, and delivered to LCMR as Deliverable (C1) of Exhibit C (11/19/91) of the Grant Agreement for this project. Exhibit C of the Agreement references section III.C.4. of this Work Program, the Time-line for

Products/Tasks. (Bracketed) references in section III.C.5. of this Work Program refer to Exhibit C (appended).

C.2. Procedures: This objective will be accomplished in seven components:

a) Visual Documentation of Historic Landscape Change. A narrative historical record of landscape change in the LSCNSR watershed will be compiled from existing secondary source materials. Visual images will be obtained which show the character of the watershed (drawings, photographs, paintings, lithographs, etc.) during various historic periods. Special efforts will be made to represent the pre-settlement, early settlement and 1976 time periods. Selected images will be converted to 35mm slide format to depict specific locations. For those specific locations a slide of the contemporary (1991) landscape will be recorded. Videotape summary material will be produced in which the historic and contemporary slide images will be used to illustrate a narrative history of the changes in the visual character of the LSCNSR and its watershed.

b) Identification of Visual Character Types. A system to define discrete types of visual character found in the contemporary LSCNSR and it watershed will be developed. The visual character classification system will be based upon landform, existing land cover, and the historically significant elements of visual character identified in the visual documentation of the historic landscape.

Visual character types existing in the LSCNSR and its watershed during the early settlement period, 1976 and 1991 will be identified and mapped using the GIS. Changes in spatial pattern of visual character will be examined. Relationships between changes in the pattern of visual character types and changes in the pattern of land use will be examined for each of the three study periods.

c) Expert System Evaluation of Watershed Visual Quality. An expert system model will be developed to evaluate the visual quality of the visual character types found in the watershed during the three study time periods. Parameters of the expert system model will be identified and specified from existing visual quality evaluation models now in use by several federal and state agencies. Additional expert system models for visual quality assessment will also be evaluated for their applicability.

d) Perceptual Calibration of the Expert System Model. A series of slides will be developed to depict selected examples of the visual character types found in the LSCNSR and its watershed in 1991. These slides will be shown to selected groups of stakeholders identified in Objective E. Subjects will be asked to assess the visual attractiveness of the landscapes depicted. The perceptual evaluations of attractiveness as rated by the stakeholders will be correlated with the predicted visual attractiveness ratings which

emerge from the application of the expert system model. Differences between perceived and predicted attractiveness ratings will be used to calibrate the expert systems model.

e) Mapping and Spatial Analysis of Visual Quality. The calibrated expert systems model will be used to evaluate visual quality in the LSCNSR and its watershed for the three study time periods. The spatial patterns of visual quality will be mapped using the GIS. Changes in spatial patterns of visual quality between the three study time periods will be examined and correlated with changes in land use.

f) Simulation and Evaluation of the Visual Quality Due to Land Use Change. The visual quality effects of selected proposals for land use change in the LSCNSR will be illustrated and simulated using computer assisted video image-capture technology. The expert systems model of visual quality assessment will be used to evaluate the impacts of these scenarios on visual quality. This procedure will demonstrate the application of this technology as a tool for evaluation of the effects and impacts of future possible or potential land use changes, land protection strategies, or zoning decisions.

g) Videotape Materials. Appropriate summary material will be developed in videotape format for use in Objective E.

C.3. Budget

a. Amount budgeted: $94,280
b. Balance: $0

C.4. Time-line for Product/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Develop narrative historical record of landscape change in watershed (C.2.)	.....				
b.	Archival search for historic images (C.2.)	.....	.....			
c.	Locate historic images and create compatible contemporary views (C.2.)		.....	.....		
d.	Develop visual character classification system (C.3.)	.....	.....			
e.	Map and analyze visual change (C.4.)		.....	.....		
f.	Develop expert systems evaluation of visual quality in watershed (C.4)		.....	.....		
g.	Calibrate expert systems model (C.5)		.....	.....		
h.	Map and spatially analyze visuals (C.4)			.....	.....	
i.	Simulate and evaluate visual quality consequences of selected scenarios (C.6)			.....	.....	
j.	Identify continuing research needs				.....	.....
k	Develop videotape summary material (C.7)				.....	.....

C.5. Status:

Results

The Study Plan (C1) for this objective is complete. As part of the narrative and pictorial documentation of historic landscape change (C2), a literature review and development of a definition of the picturesque has been completed. A computer database of 261 sources of picturesque elements relevant to the St. Croix has been created. Acquisition of 19th century iconography of the Riverway landscape has been completed with 178 images collected, cataloged, and rated on a scale of -5 to 5 for their picturesque qualities. Location of picturesque landscapes and elements on USGS topographic maps has been completed for the Riverway. A picturesque rating system applicable to Riverway landscape has been created and integrated with Deliverables (C3), (C4), and (C5). Identification of changes occurring in Riverway landscape by comparing 19th century iconography with circa 1976 photography and 1991 photography has been completed. Precise locations of existing historical images proved difficult to identify and availability of historic images in the Riverway focused therefore, in detail, on three landscape types: the Dalles, the braided channels in the Osceola - Stillwater reach, and Lake St. Croix. Finding and re-photographing images that are now on private property has caused delay, and the number of 1976 images compared with the 19th century and 1991 images was therefore reduced.

A landscape character assessment framework has been developed and was applied to three setting units within the Riverway landscape (C3). Visual character types of the Riverway have been mapped and spatial locations of the character types, as well as the bio-physical and cultural data used to identify and map the visual character types have been hand-drawn for the final deliverable and are intended to be digitized to enable the creation of computer-generated mapping and analysis in the future.

A literature review of other models developed to explain landscape attractiveness has been completed. From this review, a series of criteria have been developed to evaluate attractiveness of the Riverway landscape (C4). Procedures for applying these criteria to the Riverway landscape have been developed and the early stages of a Riverway attractiveness model has been documented as part of this report.

The survey (C5) administered to participants in the Spring of 1992 town meetings (E3) was also administered to 85 boaters on the St.Croix River during the summer of 1992. This effort was undertaken in an effort to broaden knowledge of the base of beliefs and values held by subjects participating in the calibration effort. The survey was administered to boaters using public and private launch ramps, located throughout the Riverway, boaters

using marinas, and boaters beached at various locations in the Riverway. These data have been added to the survey data obtained from the Spring, 1992 town meetings. These data were then analyzed as a means of describing perceptual response to the landscape of each setting unit.

Half of the setting units contained in each landscape unit (resulting from Deliverable (C3)) were randomly selected to be included in the perceptual calibration effort (C5). The downstream and upstream images of 45 setting units were shown to approximately 100 participants in the series of five fall town meetings held in conjunction with this project. Participants recorded five perceptual judgments for each of the 45 setting units. Data gathered from these meetings was then compiled in preparation for analysis. The number of participants attending the Fall town meetings (E4) was substantially lower than the number attending the Spring meetings (E3). The low turnout at these meetings, coupled with the fact that the Study Plan envisioned the town meetings as a major source of subjects to participate in the calibration effort, raised the issue of the validity of this effort. Therefore, additional participants in the survey process were sought and obtained. The issue has become somewhat moot, however, as a result of very recent events which have called for a significant modification of the work plan for completion of this deliverable due to unavailability of staff resources beyond our control. The deliverable for (C5) is now limited to survey results that could be used at some later time to aid in the calibration of an expert evaluation system.

Based on the results of Deliverable (A5), the following information has been compiled: a) location and nature of structural changes occurring between 1974 and 1991; b) location and nature of proposed but unrealized land use changes between 1974 and 1991; c) location and nature of major land subdivision proposals pending at time of Riverway Plan adoption; d) location and nature of subdivision lots that have been platted but contain no structure as of 1991; e) location and nature of development that is likely to occur in Riverway if existing policy is extended into future. These five information sources serve as the population of Riverway land use changes. The locations of these changes (both existing and potential changes) have been photographed from the River. Video simulations of selected examples of these changes (C6) were subsequently created.

A simulation and evaluation of proposed land use changes (C6) has been completed at a reduced scope. The deliverable consists of a series of 35 mm slides of land use change depicting an array of computer-simulated alterations of the landscape on the Lower St. Croix River and a report summarizing the effect of various modifications on the visual quality as reflected in survey resulted described in (C5) above. The report provides the groundwork for future analysis and calibration of the expert system, but does not

provide a calibrated analytical tool at a usable stage of development without further work.

A contractor was hired by the Minnesota-Wisconsin Boundary Area Commission to produce a videotape documenting the products, findings and conclusions of the LCMR project and their relevance to Riverway management. Videotape source materials from objective C that could be used in the final video production (C7) proved to be limited in scope and nature. However, portions of the slide library were used to document efforts carried out as part of Objective C. as part of the final production (C7). Project reports as specified under this Objective (C8) are current to date.

Because output from work being done under objective C has been the subject of some media and public attention, the MWBAC has announced that it will provide additional public review opportunities for this material, as well as other project outputs, as part of a public review process it will carry out during its own final report development process. A project report in draft form will be developed during the summer of 1993, available for public review in early fall, and a final report to be produced in October, 1993.

Meaning of Results

Since the deliverables for this product have been provided only within recent days, their full meaning is yet to be assessed. Such information will be contained in the MWBAC's October, 1993 report.

C.6. Benefits: A computerized spatial data file and map atlas of visual quality in the LSCNSR and its watershed will be produced. The change in visual quality resulting from land and water surface use change within the LSCNSR and its watershed will be estimated. The results will enable residents, users and managers to see for themselves the incremental and cumulative visual impacts of land and water surface use changes on the visual character of the Riverway and watershed. Projections will be permitted of visual quality change that are likely to emanate from future land and water use changes in the LSCNSR and its watershed, enabling policy-makers to better estimate scenic resource value effects of management and regulatory decisions. An agenda of continuing research and monitoring needs relative to scenic resource value and public policy decisions will be identified.

III.D. To assess the effectiveness of existing legislative intent, public policy, legal, regulatory and administrative strategies for land and water resource management for the LSCNSR, and to identify critical current management issues and needs.

D.1. Narrative: The land and water resources of the LSCNSR are managed through the collaborative efforts of federal, state, county and municipal government agencies, quasi-public institutions, local and regional groups of stakeholders, and individual landowners. In many instances public policy goals, as reflected in the 1976 LSCNSR Master Plan, are not understood, not pursued, nor enforced as comprehensively or as vigorously as possible. Thus, there is a need to examine the public policy environment within which LSCNSR resource management exists, to define the range of stakeholders involved in LSCNSR management and to identify successful and unsuccessful strategies for managing the land and water resources of the Riverway.

A detailed Plan of Study (POS) has been written for this objective, and delivered to LCMR as Deliverable (D1) of Exhibit C (11/19/91) of the Grant Agreement for this project. Exhibit C of the Agreement references section III.D.4. of this Work Program, the Time-line for Products/Tasks. (Bracketed) references in section III.D.5. of this Work Program refer to Exhibit C (appended).

D.2. Procedures: The historical, legislative, and current intent and current implementation procedures for existing public policies and legal, regulatory and administrative strategies for managing the land and water resources of the LSCNSR will be inventoried at the local, state, and federal levels.

Riverway management strategies in use elsewhere will be collected, inventoried and assessed to determine their applicability to the LSCNSR. Through a process of identification of, and interaction with, stakeholders (see Objective E.) current policy objectives and implementation procedures will be described and further assessed.

Deliverables will include narrative and video material summarizing current policies and procedures, their perceived and real effectiveness, options for change, and implications for land use, water surface use, public policy, regulations, interagency management strategies, stakeholder participation programs, and agency resource commitments.

D.3. Budget:

a. Amount budgeted: $22,000
b. Balance: $0

D.4. Time-line for Products/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Inventory other places/tools (D.2)	.....				
b.	Inventory LSCNSR policy objectives and implementation procedures (D.3)	.....				
c.	Identify stakeholders involved in management (D.4., E.2.)	.....				
d.	Assess effectiveness of past and current policy and procedures (D.5.)		.....			
e.	Share findings with stakeholders via tasks in objective E. (D.6.)			.....		
f.	Prepare video/narrative summary info. (D.7.)				.....	

D.5. Status:

Results

Study Plan (D1) and Identification and Description of Stakeholders (D4) for this objective are complete. Stakeholder identification has resulted in a data base of 3,539 dedicated names and addresses with additional contacts as available and appropriate.

Final reports describing management strategies on other river systems (D2), and an inventory of policy objectives for the Lower St Croix (D3) have been submitted. The completion of Deliverable (D5) is subject to receipt of Deliverables from the U of M (from Objectives A-C), which were received on June 30, 1993. It will be complete and submitted for review on or before July 30, 1993. Further, much of the information contained in (D5) will also be included in a special final project report, to be prepared in the summer of 1993, available for public review in September, 1993, and presented to the Minnesota-Wisconsin Boundary Area Commission for formal adoption in October, 1993, after which time it will be available for general public distribution.

Materials for Workshop Series 1-4 were prepared and distributed (D6) prior to and at a series of public meetings during the project. Those materials included a special project brochure and three quarterly issues of a special newsletter called the **St. Croix Riverkeepers Journal.** The MWBAC has submitted a formal request to the Legislature of the State of Wisconsin (as a special appropriation added to our normal operating budget) to fund four future quarterly issues in FY 1994. A decision on that request is currently pending in the Wisconsin Legislature.

A contract has been signed with Cascade Communications, Inc. to complete the video work required for the Phase II video for the project (D7). A draft video has been produced and reviewed and a final video will be available in July, 1993.

Meaning of Results

The results of work completed to date have enabled the resource managers to communicate directly to the most comprehensive stakeholder list ever. The subsequent communications, via the **Riverkeepers Journal**, video presentations, reports, brochures, and through the town meeting and workshop series, has reached an audience that is estimated to be at least 60% "new" contacts (i.e. not a Riverway landowner, official, or other stakeholder at the time of Riverway designation.)

The early efforts to inventory river management strategies used elsewhere and to assess the effectiveness of our own strategies has have been reviewed by the public and the member agencies of the Lower St. Croix Management Commission; with strong expressions of concurrence from both the public sector as well as during agency review. The broad-based recommendations for improved stewardship across the continuum (from watershed-wide in scope to those that focus on the responsibilities of a specific landowner or visitor) has provided a prescription for integrated resource management that goes beyond the Riverway. This has been determined to be essential as we have increasingly learned about the direct relationships between actions carried out at the watershed level with impacts on the Riverway itself. A detailed discussion of recommendations for improvements to our current management strategy is contained in the May 7, 1993 Preliminary Project Report. A public review version of the report, as presented by mail and at a series of two public hearings in May, 1993, brought a strong positive response from the light audience of attendees and as reflected in subsequent written comments and testimony.

D.6. Benefits: This objective will document successes and failures of existing public policies and management strategies by comparing the legislative and agency intent for management policy, objectives and outcomes with the actual effectiveness of current practices and resultant patterns of use as perceived by managers themselves as well as local government, landowners and resources users (i.e. recreationists, etc.) Managers and stakeholders will obtain a more definitive statement of critical issues and needs in the policy environment of LSCNSR management, and will obtain input about the degree to which other stakeholders support or object to existing management strategies and would support or object to possible future options for change.

III.E. To rebuild and maintain landowner, organizational, institutional, government and agency stewardship for the LSCNSR through communications, information, education, and practical technical assistance efforts.

E.1. Narrative: Current grassroots stewardship-building efforts of the Boundary Area Commission (BAC) will be greatly expanded to include a regular and sustained communications effort with stakeholders, periodic public forums, publications, training workshops, and an ongoing technical assistance strategy for local units of government, landowners, business and tourist enterprises, recreationists, etc. A high-quality video and tabloid summary of information gathered in Objectives A through E will be produced as a training and stewardship-building tool.

A detailed Plan of Study (POS) has been written for this objective, and delivered to LCMR as Deliverable (E1) of Exhibit C (11/19/91) of the Grant Agreement for this project. Exhibit C of the Agreement references section III.E.4. of this Work Program, the Time-line for Products/Tasks. (Bracketed) references in section III.E.5. of this Work Program refer to Exhibit C (appended).

E.2. Procedures: A directory and atlas of stakeholders will be developed by updating the BAC computerized mailing lists, by incorporating National Park Service Riverway land ownership maps and by conducting deed searches to identify riparian landowners. Stakeholders will then be segmented according to the manner by which they influence and are affected by Riverway management strategy.

A series of workshops will be held to educate stakeholders about the Wild and Scenic River program purposes, the goals and objectives of Riverway managers as they currently exist, to explore changes that have taken place in the Riverway, and to explore how each stakeholder segment can modify existing or create new strategies to protect and preserve the ecological scenic and recreational values of the Riverway.

A strategy for continuing local government and riparian and Riverway District landowner technical assistance and stewardship-building will be developed that provides positive encouragement for stewardship to complement and support other regulatory devices for Riverway protection. Videotape and narrative materials from Objectives A-E will be edited to produce a final high-quality video tape and tabloid available to agencies, groups and landowners.

E.3. Budget

a. Amount Budgeted:	$85,000
b. Balance:	$0

E.4. Time-line for Products/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Develop stakeholder directory (E.2.)	.....				
b.	Segment and contact stakeholders (E.2.)		.....			
c.	Workshop #1: Introduction and project purpose sessions (E.3.)		.....			
d.	Workshop #2: Review/respond to data from Obj. A -D (E.4.)			.....		
e.	Workshop #3: Review/respond to draft results Obj. A-D (E.5.)				.....	
f.	Develop stewardship-building strategy and materials (E.6.)			.....		
g.	Develop video, booklet and tabloid info./tech. assistance (E.7.)			.....		
h.	Workshop #4: Present Steward-ship strategy and information about Technical Assistance (E.8)				.....	

E.5. Status:

Results

The Study Plan (E1) for this objective is complete. Initial Stakeholder/Stewardship brochure and contacts (E2) completed. Stewardship brochure has been reprinted twice, for a total of 5,500 contact pieces. The activities and reports for four workshop or public meeting series (E3) (E4) (E5) and (E8) have been completed, documenting the events and the results. In addition, project staff and researchers presented information about the project at the annual St. Croix Research Rendezvous sponsored by the National Park Service and Science Museum of Minnesota and the St. Croix River Heritage Coalition annual conference and numerous other civic, local government, and agency groups during the last two years.

A final project report, over and above the requirements of this project reporting requirements, will be prepared by the Minnesota-Wisconsin Boundary Area Commission for review by the public in September, 1993, with a formally adopted final report completed in October, 1993.

Final text and graphic materials for three Riverway Stewardship Guides for landowners, local governmental units, and visitors, (E6) have been completed in final draft form and are currently being reviewed by the managing agencies. Final versions will be published in July, 1993 and submitted as part of a special report describing an overall recommended stewardship strategy (E6) no later than July 30, 1993. Public distribution will occur during FY 1994 at a level dependent upon availability of funds per a special request to the Wisconsin Legislature for one time funding.

Cascade Communications, Inc. has completed the video work required for the Phase II video for the project (E7) and will publish the video in July, 1993 and submitted no later than July 30, 1993 (estimated length - 15 minutes) as the requested video version of a project summary as well.

Meaning of Results

The work completed under this objective has provided the first-ever comprehensive bi-state prescription for ongoing stewardship of the Lower St. Croix watershed and specific bi-state technical assistance materials designed for direct use of landowners and local government officials as well as others who have an interest in resource management and watershed stewardship. Already, there is renewed interest at the local government level in using the results of this project for local planning efforts; expressed interest by a consortium of nonprofit citizen groups to establish a watershed-wide network of supporters of managed growth concepts; and an expressed interest in establishing a funded full time nonprofit-based "riverkeeper" patrol on the St. Croix. The University of Wisconsin, Rivers Falls, has expressed an interest in serving as a technical center and access point for resource data, such as is contained in the GIS and other products from this project. The MWBAC has initiated meetings with the member agencies of the Lower St. Croix Management Commission to discuss and consider a variety of changes in management policy and procedures for the Riverway. This process will be ongoing for some time, as the MWBAC and the LSCMC review the overall results of this entire project. The final project report for this effort will elaborate further on these efforts and their status as of late summer, 1993.

E.6. Benefits: This objective will build stronger ties among various stakeholders into a community of effective and supportive stewards, committed in various ways to management and care of the Riverway resources. Through the transfer of information and through training of landowners, local government officials, and others, stakeholders will work more harmoniously and effectively to implement public policy strategies and private stewardship practices to the benefit of the stakeholders and the resource.

IV. Evaluation:

For the FY92-93 biennium, the program will be evaluated at no-less-than six month intervals by an advisory committee made up of representatives from the Minnesota DNR, the University of Minnesota, and the Minnesota-Wisconsin Boundary Area Commission. The committee will include or invite outside participation to assist in evaluation of scientific methodology, computer technology, strategic planning, and policy formulation advice.

Over the longer term, the program may be evaluated by stakeholders to the extent that: 1) tools and technologies developed in this effort are adopted

by LSCNSR planners and managers; 2) conflicts among stakeholders are reduced as they individually and mutually carry out management and stewardship strategies, 3) the program makes significant improvements in the natural and scenic resource values of the Riverway; and 4) the program becomes a model of managing changes in patterns of land and water use for other Riverway settings.

V. Context:

A. Previous work on the LSCNSR has not been supported by LCMR. Much of this work has been focused on single issues such as natural, recreational and or scenic resources, there are few studies that work comprehensively with multiple sets of resource values. There have been few attempts to correlate findings of these single issue studies with existent changes in the patterns of land use and water surface use in the Riverway.

B. This project is the outcome of two major River Managers/Local Government Forums and subsequent public meetings of the Lower St. Croix Management Commission during the last three years. The steady increase in recreational use of the Riverway, growing development pressures along the shoreline, and the need to rebuild a grassroots support for the Riverway protection and management were all identified as key issues that need to be addressed as the Riverway enters its third decade of existence.

C. The project will provide agencies and stakeholders with more complete information concerning the effects of changes on the natural, scenic and recreational resources of the Riverway and will enable them to develop a network of managers and stakeholders who are more committed and better equipped, with technical assistance, to manage Riverway change in an active rather than a reactive manner. It will focus the expertise of several units of the University of Minnesota and the USDA-Forest Service North Central Forest Experiment Station.

D. Not applicable.

E. Biennial Budget System Program Title and Budget:
Not available at this time.

VI. Qualifications:

1. Program Manager:

Daniel W. McGuiness
Associate Executive Director
Minnesota-Wisconsin Boundary Area Commission
B.A. Sociology, Winona State University, 1970

Mr. McGuiness is the study manager for biennial inter-agency recreational use aerial surveys on the Lower St. Croix and

Mississippi Rivers, Chairman of the Lower St. Croix Management Commission Technical Committee and staff for the St. Croix Regional Committee of the Boundary Area Commission. Current work also includes liaison services to local government and landowners on the Lower St. Croix National Scenic Riverway.

2. Major Cooperators:

A. David G. Pitt, Ph.D.
Professor of Landscape Architecture
University of Minnesota
Ph.D. Renewable Natural Resources, University of Arizona, 1986.
MLA Landscape Architecture, University of Massachusetts, 1974.

Dr. Pitt's publications focus on the perception of scenic resource value in the rural landscape and the policy environment of natural resource decision-making. His current work focuses on the use of video image capture technology in landscape perception research.

B. Lance Neckar
Assistant Professor of Landscape Architecture
University of Minnesota
M.S. Landscape Architecture, University of Wisconsin, 1982.
MLA Landscape Architecture, Harvard University, 1981.

Professor Neckar's work focuses on landscape history, particularly the history of the late 19th, early 20th Century landscape of the Upper Midwest.

C. James Perry, Ph.D.
Associate Professor of Forest Resources
University of Minnesota
Ph.D. Biology Idaho State University

Dr. Perry has authored more than 70 technical and lay publications on water quality, aquatic biology, and environmental monitoring. His lecture-topics include water quality assessment and management, aquatic biology, monitoring system design, watershed management, and the effects of stresses on aquatic ecosystems.

D. Nels Troelstrup
Post Doctoral Fellow in Forest Resources
University of Minnesota
Ph.D. Candidate Forest Resources, University of MN
M.S. Forestry, University of Nebraska

Mr. Troelstrup is presently a Ph.D. candidate in the Department of Forest Resources, focusing on the effects of land-use practices on water quality and aquatic ecology of southeastern Minnesota trout streams. He has participated in interdisciplinary research efforts on large river systems, temporary ponds, lakes and trout streams.

E. Lloyd Queen, Ph.D.
Research Associate
Laboratory for Remote Sensing
University of Minnesota
Ph.D. Geography, University of Nebraska

Dr. Queen is responsible for working on research involving quantitative approaches to natural resources inventory and management utilizing remote sensing and GIS; including the design, development and integration of digital image analysis and geographic information systems with emphasis on programming and data analysis. His areas of expertise are remote sensing, digital image processing, GIS, automated cartography, and computer graphics.

F. Thomas R. Crow, Ph.D.
Research Ecologist and Project Leader
Principles of Landscape Ecology for
Managing Temperate Forests.
USDA - Forest Service North Central
Forest Experiment Station

Ph.D. Plant Ecology, University of Minnesota

As a plant ecologist, Dr. Crow has been involved in studying the ecology of tropical forests and the silviculture of northern forest species. He currently directs a USDA project designed to integrate principles of landscape ecology into the management of regional landscapes.

G. John R. Probst, Ph.D.
Research Ecologist
USDA - Forest Service - North Central
Forest Experiment Station

Ph.D. Ecology, Princeton University
M.S. Zoology, Pennsylvania State University
Dr. Probst's current research focuses on the landscape ecology and biodiversity of managed ecosystems. This work involves research with avian populations in the St. Croix Valley as well a complex of turtle species.

VII. Reporting Requirements:

Semiannual status report submitted January 1, 1992, and July 1, 1992. Additional reports to be submitted not later than January 1, 1993 and a final status report by June 30, 1993.

APPENDIX
EXHIBIT of Grant Agreement between State of Minn. and MWBAC

LIST OF WORK PROGRAM ELEMENTS
LCMR RECREATION #26
11/19/91 Version

Ref. #	Description	Who	When	Amount
Objective A. Products (From A.4. Timeline)				
A.1.	Study Plan	Queen	9/91	$ 850.00
A.2.	GIS Framework Description (b.d.f.)	Queen	12/91	6,250.25
A.3.	Photo Interpretation '76-'79 and Digitized Data	Queen Pitt	6/93	17,910.00
A.4.	Atlas of Land and Water Surface Use Change (g)	Queen	6/93	15,250.75
A.5.	Public Policy Analysis/Report (e)	Pitt	6/92	13,599.00
A.6.	Video Tape Materials (h)	Pitt	6/93	- 0 -
A.7.	Digitized Pre-Settlement Data and Maps (c)	Crow	6/92	- 0 -
	TOTAL, OBJECTIVE A:			$ 53,860.00
Objective B. Products (From Table 2 - Sub-Objectives)				
B.1.	Study Plan	Pitt	9/91	$ - 0 -
B.2.	Passive Water Quality Data (Data and Analysis in Report Form)	Troelstrup	3/93	8,200.00
B.3.	Paleoecology of Sediment Cores (Data and Analysis in Report Form)	Troelstrup	6/93	30,500.00
B.4.	Snag Habitat Analysis (Data and Analysis in Report Form)	Troelstrup	6/93	7,600.00
B.5.	Mussel Shell Analysis (Data and Analysis in Report Form)	Troelstrup	6/93	20,500.00
B.6.	Passive Invertebrate/Fish Analysis (Data and Analysis in Report Form)	Troelstrup	3/93	8,200.00
B.7.	Terrestrial Habitat Analysis (Data and Analysis in Report Form)	Crow/Probs	6/93	29,860.00
B.8.	Video Tape Materials	Pitt/ McGuiness	6/93	- 0 -
	TOTAL, OBJECTIVE B:			$104,860.00

Ref. #	Description	Who	When	Amount
Objective C. Products (From Table 3 - Sub-Objectives)				
C.1.	Study Plan	Pitt	9/91	$ - 0 -
C.2.	Narrative and Pictorial Documentation of Historic Landscape Change	Pitt	6/93	18,516.50
C.3.	Identification of Visual Character Types (Data, Maps, Report)	Pitt	6/92	17,020.50
C.4.	Expert Evaluation System (Data, Maps, and Report)	Pitt	6/93	10.922.50
C.5.	Perceptual Calibration of Evaluation System (Reports)	Pitt	6/93	10,922.50
C.6.	Simulation and Evaluation (A Series of Slides and Report)	Pitt	6/93	17,020.50
C.7.	Video Tape Materials	Pitt	6/93	7,887.50
C.8.	Semi-annual Status Reports on Project Research Progress and Coordination	McGuiness	6/93	12,000.00
	TOTAL, OBJECTIVE C:			$ 94,280.00

Ref. #	Description	Who	When	Amount
Objective D. Products (From D.4. Timeline)				
D.1.	Study Plan	McGuiness	9/91	$ 500.00
D.2.	Inventory of Management Strategy (Other Places/ Tools) (a)	McGuiness	6/92	2,000.00
D.3.	Inventory LSCNSR Policy Objectives and Implementation Procedures (b)	McGuiness	6/92	2,000.00
D.4.	Identify Stakeholders Involved In Management (report and lists) (c)	McGuiness	6/92	5,000.00
D.5.	Policy and Procedure Assessment (Report) (d)	McGuiness	6/93	8,000.00
D.6.	Reports/Workshops to Stakeholders (Activity Summaries) (e)	McGuiness	6/93	2,500.00
D.7.	Video Tape Materials (f)	McGuiness	6/93	2,000.00
	TOTAL, OBJECTIVE D:			$ 22,000.00
Objective E. Products (From E.4. Timeline)				
E.1.	Study Plan	McGuiness	9/91	$ 1,000.00
E.2.	Segment and Contact Stakeholders (Brochure series and Report)(b)	McGuiness	6/92	5,000.00
E.3.	Workshops with Stakeholders Series I (Report on Results)(c)	McGuiness	6/92	8,000.00
E.4.	Workshops with Stakeholders Series II (Report on Results)(d)	McGuiness	12/92	8,000.00
E.5.	Workshops with Stakeholders Series III (Report on Results)(e)	McGuiness	3/93	8,000.00
E.6.	Stewardship Building Strategy and Materials (Printed Materials)(f)	McGuiness	6/93	25,000.00
E.7.	Develop Video, Booklets, Tabloid (Video and Tabloid) (g)	McGuiness	6/93	20,000.00
E.8.	Workshops with Stakeholders Series IV (Report on Results)(h)	McGuiness	6/93	10,000.00
	TOTAL, OBJECTIVE E:			$ 85,000.00
	TOTAL, MN-WI BOUNDARY AREA COMMISSION PRODUCTS			$119,000.00
	TOTAL, UNIVERSITY OF MINNESOTA PRODUCTS			241,000.00
	TOTAL ESTIMATED COST OF THE PROJECT			$360,000.00

July 1, 1993

LCMR Final Status Report - Detailed for Peer Review - Research

LCMR WORK PROGRAM 1991

I. Land and Water Resource Management for the Lower St. Croix National Scenic Riverway - Recreation 26.

Program Manager: Daniel McGuiness
The Minnesota-Wisconsin
Boundary Area Commission
619 Second Street
Hudson, Wisconsin 54016-1576
612-436-7131

A. M.L.91 Ch 254, Art.1, Sec.14, Subd.:3(e) Appropriation:$360,000
Balance: $0

Land and Water Resource Management, Lower St. Croix Riverway: This appropriation is from the Minnesota environment and natural resources trust fund to the commissioner of natural resources for a grant to the Minnesota-Wisconsin Boundary Area Commission to develop a management strategy, improved technical capability, and sustained local government and landowner stewardship on the jointly managed lower St. Croix.

B. During the biennium ending June 30, 1993, the data collected by the projects funded under this section that have common value for natural resource planning and management must conform to information architecture as defined in guidelines and standards adopted by the information policy office. In addition, the data must be provided to and integrated with the Minnesota land management information center's geographic data bases with the integration costs borne by the activity receiving funding under this section.

C. Status of Match requirement - not applicable

II. Narrative

The natural, recreational and scenic resources which make up the Lower St. Croix National Scenic Riverway are threatened by dramatic increases in recreational use and land use changes occurring in and adjacent to the Riverway. Preservation and protection of the Riverway's resources, consistent with the goals and objectives of the 1976 Master Plan, is becoming increasingly difficult, using management strategies devised nearly three decades ago. Growing recreational boating use, increased land development pressures, and a decline in Riverway landowner and local government support for Riverway preservation and protection programs call for new management strategies and renewed contact with local stakeholders.

This project will organize and analyze updated information about the ecological and visual impacts of growing use, assess existing management strategies to determine their effectiveness toward meeting the policy goals of the Riverway's Master Plan, and determine long-term monitoring, research, and public policy needs. Coordination and communication with local units of government and private groups will be increased in order to rebuild local ownership and stewardship in the Riverway preservation and protection effort.

III. Objectives

III.A. To identify and map land and water surface use changes occurring in the Lower St. Croix National Scenic Riverway (LSCNSR) between 1976 and 1991.

A.1. Narrative: The following five components will be addressed: 1) documentation of the land and water surface use changes occurring in the LSCNSR and its watershed between 1976 and 1991; 2) identification of land use and water surface use changes in the Riverway that were proposed between 1976 and 1991 but never realized; 3) identification of land and water surface use changes that are likely to occur within the LSCNSR based on existing public policy; and 4) establishment of a Geographic Information System (GIS) approach to the management and analysis of spatial data in the LSCNSR; and 5) development of videotape summary material for Objective E. This will include
the integration of existing aquatic and terrestrial databases into a common, accessible database.

A.2. Procedures: Development of data to support Objective A will include incorporation of data from numerous existing sources as well as the generation of new spatial data from aerial photography and map interpretations. System development must also account for the access requirements of several researchers, each involved with one or more phases of this overall workplan. In order to best accomplish establishment of a useful and robust system that will have long-term effectiveness and utility, a structured approach to system and data development will be taken.

This process is formally defined as a project lifecycle (Somers 1989). The lifecycle consists of four phases; planning, design, implementation, and maintenance. Each phase maintains a focus on the central, integrated GIS database which is to be used to address each of the project alternatives. The initial lifecycle phases are addressed through a process called a User Requirements Analysis (URA) (see example, USGS 1988; De Man and Erick 1988) The aim of the URA is to systematically inventory the users and their objectives and data and analysis needs. Specific recommendations for system parameters (base maps, scale, land use classification schemes, statistical or process-related models, and change detection algorithms) will be predicted on results gained from the URA.

A typical URA exercise consists of four steps: 1) an inventory of existing databases and users; 2) focus group interviews and discussions that evaluate user data, analysis and output requirements; 3) compilation of user interview information and establishment of system design parameters; and 4) implementation of the GIS. Results gained from the URA, including system design specifications, will be provided as a deliverable product.

Data inventories have been conducted by individual researchers, and databases from the Minnesota State Planning Agency, the National Park Service, the U.S. Department of Agriculture Wisconsin and Minnesota Departments of Natural Resources, the Minnesota-Wisconsin Boundary Area Commission and the Metropolitan Council will be compiled and modified to form part of the basis for the GIS database. (See for example, the data defined in Table 1, Objective B.) Round table discussions with project researchers will take place within the first few weeks of the project to formalize system specifications. Within this framework, several guidelines are apparent.

Much of the mapping activity within the LSCNSR, and in each of the bordering states, occurs at the scale of 1:24,000. State land use, topography, soils, and other databases commonly adhere to this standard. Issues of scale sensitivity, related in particular to the ecological work in Objective B, however, require that multiple scales be utilized in the study. Data used to estimate loadings of nutrients and sediments from watersheds contributing to the river will be aggregated to a smaller scale and/or resolution in order to develop correlative models to empirical water quality monitoring data currently and historically collected by various public agencies. Until the URA is completed, however, specific details as to scale and resolution cannot be determined.

Additionally, modeling and analysis functions may necessarily require use of both raster and vector-based GIS software. It is likely that data development will occur in a vector-based system using a layered data model that separates themes into specific map coverages. Database management systems will be used to maintain and integrate spatial and attribute data records. Metrics are also expected to be developed using raster-based processing. Thus, a hybrid, multi-system solution will be established.

Aerial photography over the entire period of the study (1976-1991) provides an essential record of land and water surface use patterns and river snag habitat (see, again, Table 1, Objective B). Specific classes to be interpreted from the photography will follow a hierarchical classification scheme, beginning with a Level I land use classification scheme as is currently being utilized in the Minnesota land use update effort. In specific cases, researchers may identify, during the URA, more specific lower-tiered classes to interpret and enter into the GIS.

Using maps of native vegetation and archival land survey records, pre-settlement land use/land cover maps for the riverway will be digitized and stored in the GIS. Land use records, public policy documents and the print media will be examined to identify land and water surface use change proposals within the LSCNSR between 1976 and 1991 that never materialized as well as those that are pending or that have been scheduled as of the end of 1991. All three sets of land and water surface use data will be digitized as discrete layers within the GIS. Thus, analyses of change dynamics between 1976 and 1991 can be accomplished using GIS analysis tools, and an atlas of change will be produced as a deliverable.

Change dynamics will be developed by cross-tabulating land and water surface use figures for the years of the study. Additionally, map overlay and map comparison procedures will yield maps of locations showing specific locations of each type of change. Statistical summaries of the changes (i.e. area, type, patterns) in each nominal land and water [surface use] class will be produced. While patterns of change will be evident on the maps themselves, some quantitative estimates of pattern or patch dynamics will be generated. These techniques will include analyses of area/perimeter changes and of ownership and use fragmentation. Estimates of pareto size parameters and fractal dimensions will also be used to numerically summarize the spatial and temporal frequency or texture of change (Lam 1990; Roy et al. 1990). Specific output products will thus include both map and tabular summaries. These summaries will be provided according to the reporting rules stated throughout the workplan; and deliverables will include interim as well as final reports and maps.

Geographic base files in digital format will also be provided as deliverables. By employing a structured, systematic URA at the outset of the project, it is anticipated that a GIS can be developed with sufficient flexibility to be useful to a wide range of users over a relatively long time frame. Design goals call for a system to be developed which will not be just a project-supporting effort; but a programmatic system that can support longer-term use for the assessment and quantification of land and water surface use dynamics within the LSCNSR.

Appropriate summary material will be developed in videotape format for use in Objective E.

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A.3. Budget

a. Amount budgeted: $53,860
b. Balance: $0

A.4. Timeline for Products/Tasks

	Ju91	Ja92	Ju92	Ja93	Ju93
a. Develop GIS framework	.....				
b. Complete aerial photographic interpretation of use change, 1976-1991	.....				
c. Develop pre-settlement land use/land cover map	.....				
d. Digitize pre-settlement, 1976 and 1991 use data		.....	.....		
e. Complete land/water surface use record public policy document and media search for proposed but unachieved and pending land and water surface use changes		.....			
f. Digitize land/water surface use change data			.....	.....	
g. Prepare atlas of use changes				.....	.....
h. Prepare videotape material				.....	.....

A.5. Status:

Results:

The Study Plan (A1) and expanded 2-volume GIS Framework Description and Dictionary document (A2) including data files on disk, have

been completed. All aerial photography and original mylar maps, used for the process of digitization have been organized and compiled for delivery to the MWBAC for storage in its archives as backup information (A3). A bound 81/2 x 11 inch atlas of land and water surface use change, (A4) consisting of a series of printed color maps and descriptive tables and narrative, has been published. Deliverable (A5) was completed on June 23, 1993, considerably behind schedule. This has affected the completion of Deliverable (D5), which now will be submitted by July 30, 1993, rather than June 30, 1993.

A contractor, hired by the Minnesota-Wisconsin Boundary Area Commission, has produced a videotape documenting the products, findings and conclusions of the LCMR project and their relevance to Riverway management. Existing videotape source materials, anticipated from the University of Minnesota, demonstrating activities in objective A, of sufficient quality for use in a final video production, proved to be very limited. Therefore, most of the video materials therefore were recreated by the contractor through recent arranged shooting of activities associated with Objective A. Much of the work was done on-site at the remote sensing lab at the University of Minnesota.

Pre-settlement data compiled from the Public Land Survey (PLS) have been edited and compiled into database files and computer-generated maps of original vegetation for the watershed (A7).

Meaning of Results:

A state-of-the-art Geographic Information System (GIS) for the 1,469 square mile Lower St. Croix Watershed, and seven sub-watershed units within it, has been completed for use by resource managers to describe and analyze land use and land cover at pre-settlement and in 1973 and 1991 and to document changes over time. The GIS clearly presents land use change information showing the locations, general patterns, and overall magnitude of changes in land use within the watershed, particularly the extent of conversion of forest and farm lands to urban uses in this rapidly-changing watershed on the eastern and northeastern edge of the Twin Cities Metropolitan Area. While the system was developed for use principally by resource managers along the Lower St. Croix Riverway, its initial debut on June 10, 1993 has already generated requests from local and regional land use planners in five counties and both states which make up the watershed. Further, the Wisconsin Department of Natural Resources, in its June, 1993 draft St. Croix Basin Water Quality Management Plan, is recommending that the GIS be expanded to include the entire 7,760 square mile interstate watershed. The MWBAC and both the Minnesota and Wisconsin university systems are exploring ways to transfer the GIS system to entities that would serve as local and regional service centers and access points for the system and the data it contains.

The data and report provided as part of the (A5) Public Policy Analysis of land use change and cultural settlement patterns within the Riverway is being used by the member agencies of the Lower St. Croix Management Commission to evaluate potential modifications to land use rules and land use planning and regulatory programs along the Riverway in each state. The data is being presented to the Minnesota DNR for their consideration in a land use rules upgrading process on July 15, 1993. The data will also be used by the MWBAC and the LSCMC as it develops specific recommendations for ongoing training and stewardship programs for landowners and local government officials within the Riverway.

Because of the amount of time required to complete the GIS construction, the level of analysis of the data is not as extensive as originally expected. As part of follow-up work by the MWBAC, funds are being sought to retain one or more project staff persons to assist in this effort over the next three months. This person will also assist the MWBAC in a technical assistance and outreach program to make the data and software programs available and usable to a wide audience of potential users who have or can obtain the hardware and ARC/INFO software necessary to operate the GIS.

A.6. Benefits:

A computerized map atlas of land and water surface use change in the LSCNSR will be produced. These data will exist for several time scales, including 1976 and 1991, and they will provide the ability to estimate the ecological effects of changing land and water surface use patterns in the LSCNSR (Objective B below), to assess the visual effects on scenic resources (Objective C), to analyze the effectiveness of existing policies and management strategies (Objective D), and to assist in stewardship-building (Objective E.)

III.B. To identify and assess the ecological impacts of land and water surface use changes occurring in the LSCNSR between 1976 and 1991 on the natural resource base.

B.1. Narrative:
The ecological effects of land and water use change within the LSCNSR will be defined in three ways: 1) An evaluation of the relationships between changes in the land use within the Lower St. Croix watershed and land use and water surface use within the Riverway and changes in water quality and aquatic habitat within the Lower St. Croix River; 2) an evaluation of the effect of changes in Lower St. Croix River water quality and aquatic habitat on the abundance and distribution of selected aquatic invertebrate and fish species; and 3) an evaluation of the effect of land use changes within the Lower St. Croix watershed and the Riverway on the abundance and distribution of selected terrestrial species.

Statistical models (i.e., regression models) will be used to evaluate relationships between watershed and riparian biophysical characteristics and observed physical, chemical and biological parameters of water quality, aquatic habitat, aquatic ecology and terrestrial habitat.

These statistical techniques have been used successfully to evaluate land use effects on water quality in previous watershed-level investigations (Lystrom et al. 1978; Hirose and Kuramoto 1981; Smart et al. 1981, 1985; Fannin et al. 1985; Troelstrup and Perry 1990).

After careful consideration it has become apparent that current nonpoint source sediment and nutrient models lack the sophistication and accuracy to provide estimates of loading over large spatial areas such as the LSCNSR (Scott Needham, USDA, Morris, MN, personal communication). Established statistical relationships will be used to evaluate the ecological effects of alternative watershed and Riverway land and water surface use patterns.

B.2. Procedures: This objective will be accomplished within five components:

a) Water Quality. Water quality characteristics of the LSCNSR at a number of locations will be assessed using existing monitoring data sets obtained from the published literature and agency reports (see Table 1). Loading of selected water quality constituents at a number of points on the LSCNSR will be estimated from these data (as data permits), and these data will be examined for temporal trends that are evident between 1976 and 1991. In addition, correlation analyses and regression models will be used to evaluate relationships between water quality characteristics of the LSCNSR and land use characteristics within the Riverway and the Lower St. Croix watershed. These analyses will incorporate land use information at the watershed-level using existing land use information and Minnesota and Wisconsin state records of point source dischargers along the LSCNSR.

Active data collection efforts will focus on: 1) paleoecological changes in sediment deposits within receiving basins; 2) historical changes in riverine habitat; and 3) population dynamics of a pollution-sensitive mussel population. Three sediment cores will be taken from the impoundment above Taylor's Falls and Lake St. Croix and each core will be dated using ^{210}Pb techniques (Collaborator: Dr. Dan Engstrom, Department of Geology and Geophysics, University of Minnesota). Analyses conducted on each core will include an evaluation of sedimentation rates, photosynthetic pigments, changes in insect community composition (Diptera; Chironomidae), and relative amounts of inorganic and

organic material. These analyses will allow an indirect evaluation of sediment and nutrient loading to areas of the Riverway above and below the LSCNSR as documented through changes in deposition and trophic status of each impoundment (Haworth and Lund 1984: Engstrom et al. 1985; Smeltzer and Swain 1985). Deposition and trophic alterations of Lake St. Croix, as delineated with core analysis, will be examined in light of changes in land use practices within the watershed, land use management along the riparian corridor, changes in water surface use and sediment core characteristics of the upper impoundment.

b) Aquatic Habitat. Historic changes in the abundance and distribution of snag habitat (large woody debris) for aquatic invertebrates and fish will be examined along the Lower Riverway from existing aerial photographs (see Table 1). Recent biological surveys conducted by the Wisconsin and Minnesota DNRs along the Riverway suggest that invertebrate abundance and diversity and fish production are strongly related to the abundance and distribution of snags in the river (Gary Montz, Minnesota DNR, personal communication: Minnesota Department of Natural Resources 1990). Others have also found that snag habitat is important to invertebrate and fish production in river ecosystems (Angermeier and Kar 1984: Benke et al. 1985). The Lower St. Croix Management Commission and Minnesota-Wisconsin Boundary Area Commission has aerial photography for the LSCNSR for 8 years between 1977 and 1989 and is scheduled to obtain photographs in 1991 as well. Preliminary analysis confirms that snags are easy to identify and enumerate on these photographs. These data will be used to 1) quantify changes in snag habitat along four reaches since 1976; 2) incorporate snag habitat densities as attributes of the Riverway within the GIS: and 3) examine statistical relationships between the density of snags and land [and water surface] use practices along the LSCNSR (e.g., Hemstrom 1989; Malanson and Butler 1990).

c) Ecology. Mussel populations within the St. Croix River provide a sensitive biomonitor to changes in water quality and habitat within the Riverway. Because these organisms are long-lived, relatively sedentary, and sensitive to pollution, they represent excellent biomonitors of changes in water quality over space and time. Several investigators have examined the ecology and distribution of mussels within the Riverway (see Table 1). These studies provide information which reveals spatial changes in composition of mussel communities along the Riverway. However, these studies focus on population and community level analyses, providing information on distributions, reproductive biology, food habits and general ecology. Shell fragments from specimens of Amblema Plicata from a number of locations will be examined to evaluate temporal differences in; 1) rate of growth, and 2) accumulation of heavy elements. Existing survey information will be used to summarize spatial and temporal distribution patterns (see Table 1). All specimens examined for age, growth and element analysis will be obtained from sites near those of previous mussel

studies (total # of specimens = 30-50). All analyses will focus on shell characteristics. These studies will involve sampling and section mussel shells followed by a microscopic analysis of growth annuli to determine age and growth rate (Nielsen and Johnson 1983: Moyer 1984) and an x-ray microanalysis of shell material to quantify element concentrations (Carell et al. 1987: Perry et al. 1989). Changes in growth, accumulation of heavy elements within shells and distribution of these mollusks will be examined in light of corresponding changes in water quality, [water surface use] and land use within the watershed and along the riparian corridor (i.e. Riverway) since 1976

A considerable body of information for distribution and abundance of aquatic invertebrates and fish already exists within published literature and agency reports (see Table 1). This information presents a valuable body of data which will be collected and integrated to evaluate changes in invertebrate and fish communities along the Riverway since 1976. Metrics of community structure (i.e., species richness, relative abundance, trophic guild structure) will be derived from this extensive data base, summarized and examined in light of temporal changes in land use in the watershed and land use[and water surface use] within the Riverway using correlation and regression analysis techniques (e.g., see Troelstrup and Perry 1990).

Most of the analyses described above rely on existing monitoring data collected by state and federal agencies (see Table 1). Preliminary review of water quality data in STORET and contained within agency reports confirms that these data will support the procedures described above. A combination of active sampling efforts and passive data collection efforts, followed by careful integration of data from both, will be used to accomplish these objectives.

d) Terrestrial Habitat. The analysis of the effects of land use change on terrestrial species will involve the development of habitat requirement and habitat interrelationship models for selected avian species. Data for these models will be specified using mappable parameters that characterize the habitat needs and interrelationships of target species. These mappable parameters will be gathered from existing data sources and entered into the GIS developed in objective A. The GIS will be used in estimating a spatial model of landscape structural diversity and habitat quality. These models will be applied to spatial data sets developed for conditions existent during pre-settlement, in 1976, and in 1991.

The general approach will be to use existing literature to describe and map past and present landscapes, select target species, prepare a landscape-habitat matrix for each species, and perform spatial analyses for relevant biogeographic and habitat quality factors.

The specific tasks will include; 1) describe pre-settlement, 1976 and 1991 landscapes in the watershed and Riverway; 2) select bird species and groups with a variety of life history characteristics based on their sensitivity to land use change; 3) prepare matrices of landscape attributes (eg. forest age, upland versus lowland forest, coniferous versus deciduous forest, distribution of prairie, habitat size and connectivity, habitat fragmentation) that characterize species requirements; 4) develop spatial models of landscape pattern as it affects habitat quality and metapopulations; 5) inventory and map ecosystem types; 6) analyze spatial patterns for the study's three time periods; and, 7) generate hypotheses of change in interaction within and among metapopulations as a result of land use change. Tests of the hypotheses and calibration, verification and validation of the models will be done outside of the scope of this project by investigators under a separate USDA-North Central Forest Experiment Station project which is examining the landscape ecology of the St. Croix Valley.

e) Video Material. Appropriate summary material will be developed in videotape format for use in Objective E.

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Table 1. Summary of Data Sources for Objective B.

Source	Content Information
Boundary Area Commission (ongoing)	Aerial photographs of LSCNSR
D. Hornbach (on-going)	Mussel Data
E.M. Stern (1983)	Mussel Distributions/Abundance
K. Fausch (1987)	Fish Data
M.E. Havlik (1980)	Mussel Data
Metropolitan Waste Control Commission (on-gong)	Point Source Water Quality Data
Minnesota Pollution Control Agency (on-going)	Water Quality/STORET Data
Minnesota/Wisconsin Boards of Health (1935)	Historic Water Quality Data
Minnesota Department of Nat. Resources (Draft)	Mussel, Insect, Fish Data
National Park Service (Draft)	Invertebrate Survey Data

National Park Service (1973)	Historic Water Quality Data
Northern States Power Co. (multiple dates)	Historic Water Quality Data
T.C.J. Doolittle (1988)	Mussel Data
U.S. Geological Survey (multiple dates)	Discharge and Water Quality Data
Wisconsin Department of Nat. Resources (on-going)	Water Quality/STORET Data
Wisconsin Department of Nat. Resources (on-going)	Mussel, Insect, Fish Data

B.3. Budget

a. Amount budgeted: $104,860
b. Balance: $0

B.4. Timeline for Products/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Specify parameters and data needs for sediment\habitat models	.....				
b.	Develop digital database			.....		
c.	Complete aerial photo interp. of snag habitat and records	.....	.....			
d.	Estimate sediment and nutrient flow loadings and habitat quality for 3 time frames			.....	.....	
e.	Complete sediment core sampling	.....				
f.	Complete mussel sampling	.....				
g.	Analyze core and mussel samples			.....	.....	
h.	Correlate indices of ecological disturbance with land and water surface use change data			.....	.....	.....
i.	Identify continuing research and monitoring needs					.....
j.	Develop videotape material				.....	.....

B.5. Status:

Results:

The Study Plan for this Deliverable (B1) is complete. Sources of water quality data have been identified and compiled into a data dictionary and database which has been provided as Lotus database and worksheet files as well as in a printed report (B2). Data analysis has been completed at a level less extensive than originally anticipated due to the amount of data collected and lack of time to correlate this data with the recently-developed GIS system (see Objective A.) Data analysis completed for (B2) and (B6) have been combined into one document (combined B2 and B6.) The investigator has advised that the quality of this product may be upgraded during the course of the summer of 1993 as internal and external peer review is completed.

Deliverable (B3) Paleoecology of Sediment Cores, is complete. Loss on ignition, carbonate, dating and pigment analyses are complete for sampled cores. Midge analysis and analyses of stratigraphy have been completed. A final report (D3) has been submitted.

Interpretation of Snag Habitat (B4) is complete. Snag accumulations were tallied from 5 random locations in each stream reach in 1977, 1983 and 1989 using MN/WI BAC photography. All data have been entered onto our database and summary statistics have been generated for each reach and included in the final report (B4).

Mussel Shell Analysis (B5) is complete. A literature review of previous mussel work on the St. Croix River has been completed. Age, growth and shell chemistry measurements are complete for all 63 specimens. Data from these analyses have been entered onto a database, analyzed for spatial and temporal patterns as time has permitted, and a final report has been provided (B5).

Sources of biological data have been identified and obtained from local state and federal agencies to enable an Passive Invertebrate/Fish Analysis relating to the St. Croix River (B6). This report has been combined with B2 into one document.

A preliminary report describing work done to date on Terrestrial Habitat Analysis (B7) is complete. Subsequent reports useful to this effort, but being done by the US Forest Service as part of a long term project, will be provided as information becomes available. The relevant flora and fauna data which has been gathered and tabulated into a database for the Lower St. Croix (B7), has been developed further into a habitat matrix which describes the habitat attributes and interrelationships necessary to describe the presence and/or absence of terrestrial species in the watershed. This habitat matrix will eventually be used to evaluate, interpret and predict the presence and absence of species as well as the direction of population change for species and

species groups sensitive to landscape change in the Lower St. Croix. Additionally, literature reviews determining the spatial habitat parameters which describe metapopulation dynamics for forest interior neotropical migratory species has been completed and a spatial habitat model has been developed for this species group. The spatial habitat model identifies the spatial parameters which will characterize and describe how changes in landscape pattern affects this select group of forest interior avian species. Currently, algorithms are being written to incorporate the spatial habitat model into the Geographical Information System.

A contractor was hired by the Minnesota-Wisconsin Boundary Area Commission to produce a videotape documenting the products, findings and conclusions of the LCMR project and their relevance to Riverway management. Available and suitable videotape source materials documenting work done as part of objective B proved limited. The contractor therefore completed additional videotape footage through on-site taping at the water quality lab at the University of Minnesota (B8).

Meaning of Results:

Since all of the deliverables (except B1) for this objective were submitted only within the last 24 hours, an adequate description of the meaning of this work cannot be assessed at this time. As part of the final project report, a separate document (beyond the required deliverables for this project) to be completed by the MWBAC, there will be more elaboration on the results and the implications and subsequent recommendations to managing agencies. At this point we can state that a cursory review of the reports, in process, indicate that the results will have significant usefulness in correlating land use and water surface use data to water quality data for seven stream reaches and seven sub-watershed in the Lower St. Croix River and its watershed which will enable resource managers to develop some important recommendations for future resource management. The amount and quality of data and care taken in its presentation is excellent and worthwhile, acknowledging that such care has somewhat precluded completion of the level of analysis and interpretation originally anticipated.

B.6. Benefits: Empirical relationships will be established between the biophysical characteristics of the St. Croix watershed and the ecological characteristics of the Riverway and added to the GIS to simulate the effects of alternative management scenarios. These models will permit projections of ecological disturbances that will likely emanate from future land and water surface use changes within the Riverway and provide a framework for public policy decision making and continuing research and monitoring efforts.

Specific deliverables from procedures under B.2. are shown in Table 2. below. In addition to these deliverables, all water quality, habitat and biological data will be spatially registered and

entered as a point and/or area attributes onto the GIS. This integrated system will provide support for additional queries and examinations of relationships between land use and water surface use and ecology of the Riverway. Statistical relationships between biophysical characteristics within the watershed and along the Riverway and ecological attributes within the Riverway will provide a means of examining the results of changes in land use and water surface use.

The GIS and statistical models will provide a framework for public policy decision making, continued research and monitoring efforts, and will provide support for fostering stewardship efforts among users, landowners, local governments, within the Riverway, and, to a limited extent, within the larger Lower St. Croix watershed.

Table 2. Summary of Specific Products from Objective B.

Sub-objective	Deliverables
Passive Water Quality Data	1. Statistical Summary of Water Quality trends since 1976. 2. Loading estimates for water quality parameters where historical data permits. 3. Regression models of water quality parameters versus watershed and riparian biophysical parameters.
Paleoecology of Sediment Cores	1. Estimates of deposition for Lake St. Croix and the impoundment above Taylor's Falls. 2 Historical changes in pigments, organic matter and Chironomidae in sediments of both impoundments. 3. Correlations and regression models of impoundment changes versus land use and riparian conditions along the LSCNSR.
Snag Habitat	1. Densities of snags per hectare of river channel at four reaches along the LSCNSR in 1977 and 1990. 2. Correlations and regression models of snag densities versus riparian conditions.
Mussel Shell Analyses	1. Temporal and longitudinal patterns in the distribution of Actinonaias ligamentina carinata (Barnes). 2. Age and growth rates of specimen collected from sites along the LSCNSR. 3. Heavy element concentrations of shell material collected from specimens from sites along the LSCNSR.
Passive Invertebrate/Fish	1. Summary of invertebrate and fish distributions, relative abundance and species richness along the LSCNSR. 2. Summary of EPA bioassessment metric values derived from analysis of published data. 3. Correlations and regression models of invertebrate and fish metrics versus land-use, water surface use and riparian conditions along the LSCNSR.
Terrestrial Habitat	1. Spatial Characteristics of habitat needs for selected avian species. avian ~~species~~ 2. Spatial models of habitat change for selected avian species between pre-settl., 1976, 1991 3. Hypotheses of interaction within and among metapopulations as a result of land use change across 3 study periods
Videotape Materials	1. Appropriate summary materials for use in Objective E.

III.C. To identify and illustrate the visual impacts of land use change occurring in the LSCNSR between 1976 and 1991 on the Riverway's scenic and recreational resources.

C.1. Narrative: Secondary source material will be used to develop a narrative record of historical changes in the LSCNSR watershed. Photo documentation of archival images of the watershed during the early settlement period,in 1976, and 1991, will reveal changes in the watershed's visual character due to changing patterns in land use. The consequences of these changes on visual quality in the watershed will be estimated and fluctuations in visual quality will be correlated with land use changes. Visual quality evaluations

will be spatially analyzed and mapped using the GIS developed in Objective A.

Computer-assisted video image capture technology will be used to generate video simulations of the watershed's visual character under various historical scenarios. The results of these studies of changing visual quality in LSCNSR and its watershed will be presented in videotape format.

C.2. Procedures: This objective will be accomplished in seven components:

a) Visual Documentation of Historic Landscape Change. A narrative historical record of landscape change in the LSCNSR watershed will be compiled from existing secondary source materials (e.g. Dunn,1979; Folsom, 1888; Warner and Foote, 1881; Easton, 1909) Archival searches will be conducted at the Minnesota Historical Society, the State Historical Society of Wisconsin, local historical societies, and among watershed residents' records to identify visual images of the watershed (drawings, photographs, paintings, lithographs, etc.) that illustrate the watershed's character during various periods. Special efforts will be made to represent the pre-settlement, early settlement and 1976 time periods. Selected images will be converted to 35mm slide format to depict specific locations. For those specific locations a slide of the contemporary (1991) landscape will be recorded. Videotape material will be produced in which the historic and contemporary slide images will be used to illustrate a narrative history of the changes in the visual character of the LSCNSR and its watershed.

b) Identification of Visual Character Types. A system to define discrete types of visual character found in the contemporary LSCNSR and it watershed will be developed. The visual character classification system will be based upon landform, existing land cover, and the historically significant elements of visual character identified in the visual documentation of the historic landscape.

Visual character types existing in the LSCNSR and its watershed during the early settlement period, 1976 and 1991 will be identified and mapped using the GIS. Changes in the spatial pattern of visual character will be examined. Relationships between changes in the pattern of visual character types and changes in the pattern of land use will be examined for each of the three study periods.

c) Expert System Evaluation of Watershed Visual Quality. An expert system model will be developed to evaluate the visual quality of the visual character types found in the watershed during the three study time periods. Parameters of the expert system model will be identified and specified from existing visual quality evaluation models now in use by the USDA-Forest Service, the USDI-Bureau of

Land Management, the USDI-National Park Service, the USDOT-Federal Highway Administration, the USDA-Soil Conservation Service, and the US Army Corps of Engineers. Additional expert system models (e.g. Litton, et al., 1974; Zube, 1970) and literature on visual quality assessment (Zube, et al., 1982; Zube, 1984; Smardon, et al., 1986; and Ribe, 1989) will also be evaluated for their applicability.

d) Perceptual Calibration of the Expert System Model. A series of slides will be developed to depict selected examples of the visual character types found in the LSCNSR and its watershed in 1991. These slides will be shown to selected groups of stakeholders identified in Objective E. Subjects will be asked to assess the visual attractiveness of the landscapes depicted. The perceptual evaluations of attractiveness as rated by the stakeholders will be correlated with the predicted visual attractiveness ratings which emerge from the application of the expert system model. Differences between perceived and predicted attractiveness ratings will be used to calibrate the expert systems model.

e) Mapping and Spatial Analysis of Visual Quality. The calibrated expert systems model will be used to evaluate visual quality in the LSCNSR and its watershed for the three study time periods. The spatial patterns of visual quality will be mapped using the GIS. Changes in spatial patterns of visual quality between the three study time periods will be examined and correlated with changes in land use.

f) Simulation and Evaluation of the Visual Quality Due to Land Use Change. The visual quality effects of selected proposals for land use change in the LSCNSR will be illustrated and simulated using computer assisted video image-capture technology. The expert system model of visual quality assessment will be used to evaluate the impacts of these scenarios on visual quality. This procedure will demonstrate the application of this technology as a tool for evaluation of the effects and impacts of future possible or potential land use changes, land protection strategies, or zoning decisions.

g) Videotape Materials. Appropriate summary material will be developed in videotape format for use in Objective E.

Literature Cited:

Dunn, J.T. 1979. The St. Croix River: Midwest Border River. Minnesota Historical Society, Minneapolis, MN.

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USDI-Bureau of Land Management. 1975. Visual Resource Management: BLM Manual. U.S. Government Printing Office. Washington, D.C.

USDA-Soil Conservation Service. 1978 Procedures to Establish Priorities in Landscape Architecture. Technical Release G5. U.S. Government Printing Office. Washington , D.C.

Litton, R.B., R.J. Tetlow, J. Sorensen and R. Beatty. 1974. Water and the Landscape. Water Information Center. Port Washington, N.Y.

Zube, E.H. 1970. Evaluation of the Visual and Cultural Environment. Journal of Soil and Water Conservation, 25(4): 137-141

Zube, E.H., J.L. Sell and J.G. Tayler. 1982. Landscape Perception: research, application and theory. Landscape Planning, 9(1): 1-33.

Zube, E.H. 1984. Themes in landscape assessment theory. Landscape Journal, 3(2): 104-110

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C.3. Budget

a. Amount budgeted: $94,280
b. Balance: $0

C.4. Timeline for Product/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Develop narrative historical record of landscape change in watershed	.....				
b.	Archival search for historic images		.....			
c.	Locate historic images and create compatible contemporary views			.....		
d.	Develop visual character classification system		.....			
e.	Map and analyze visual change			.....		
f.	Develop expert systems evaluation of visual quality in watershed		.....			
g.	Calibrate expert systems model			.....		
h.	Map and spatially analyze visual				.....	
i.	Simulate and evaluate visual quality consequences of selected scenarios				.....	
j.	Identify continuing research needs					.....
k	Develop videotape summary material			.....		

C.5. Status:

Results

The Study Plan (C1) for this objective is complete. As part of the narrative and pictorial documentation of historic landscape change (C2), a literature review and development of a definition of the picturesque has been completed. A computer database of 261 sources of picturesque elements relevant to the St. Croix has been created. Acquisition of 19th century iconography of the Riverway landscape has been completed with 178 images collected, cataloged, and rated on a scale of -5 to 5 for their picturesque qualities. Location of picturesque landscapes and elements on USGS topographic maps has been completed for the Riverway. A picturesque rating system applicable to Riverway landscape has been created and integrated with Deliverables (C3), (C4), and (C5). Identification of changes occurring in Riverway landscape by comparing 19th century iconography with circa 1976 photography and 1991 photography has been completed. Precise locations of existing historical images proved difficult to identify and availability of historic images in the Riverway focused therefore, in detail, on three landscape types: the Dalles, the braided channels in the Osceola - Stillwater reach, and Lake St. Croix. Finding and re-photographing images that are now on private property has caused delay, and the number of 1976 images compared with the 19th century and 1991 images was therefore reduced.

A landscape character assessment framework has been developed and was applied to three setting units within the Riverway landscape (C3). Visual character types of the Riverway have been mapped and spatial locations of the character types, as well as the bio-physical and cultural data used to identify and map the visual character types have been hand-drawn for the final deliverable and are intended to be digitized to enable the creation of computer-generated mapping and analysis in the future.

A literature review of other models developed to explain landscape attractiveness has been completed. From this review, a series of criteria have been developed to evaluate attractiveness of the Riverway landscape (C4). Procedures for applying these criteria to the Riverway landscape have been developed and the early stages of a Riverway attractiveness model has been documented as part of this report.

The survey (C5) administered to participants in the Spring of 1992 town meetings (E3) was also administered to 85 boaters on the St.Croix River during the summer of 1992. This effort was undertaken in an effort to broaden knowledge of the base of beliefs and values held by subjects participating in the calibration effort. The survey was administered to boaters using public and private launch ramps, located throughout the Riverway, boaters

using marinas, and boaters beached at various locations in the Riverway. These data have been added to the survey data obtained from the Spring, 1992 town meetings. These data were then analyzed as a means of describing perceptual response to the landscape of each setting unit.

Half of the setting units contained in each landscape unit (resulting from Deliverable (C3)) were randomly selected to be included in the perceptual calibration effort (C5). The downstream and upstream images of 45 setting units were shown to approximately 100 participants in the series of five fall town meetings held in conjunction with this project. Participants recorded five perceptual judgments for each of the 45 setting units. Data gathered from these meetings was then compiled in preparation for analysis. The number of participants attending the Fall town meetings (E4) was substantially lower than the number attending the Spring meetings (E3). The low turnout at these meetings, coupled with the fact that the Study Plan envisioned the town meetings as a major source of subjects to participate in the calibration effort, raised the issue of the validity of this effort. Therefore, additional participants in the survey process were sought and obtained. The issue has become somewhat moot, however, as a result of very recent events which have called for a significant modification of the work plan for completion of this deliverable due to unavailability of staff resources beyond our control. The deliverable for (C5) is now limited to survey results that could be used at some later time to aid in the calibration of an expert evaluation system.

Based on the results of Deliverable (A5), the following information has been compiled: a) location and nature of structural changes occurring between 1974 and 1991; b) location and nature of proposed but unrealized land use changes between 1974 and 1991; c) location and nature of major land subdivision proposals pending at time of Riverway Plan adoption; d) location and nature of subdivision lots that have been platted but contain no structure as of 1991; e) location and nature of development that is likely to occur in Riverway if existing policy is extended into future. These five information sources serve as the population of Riverway land use changes. The locations of these changes (both existing and potential changes) have been photographed from the River. Video simulations of selected examples of these changes (C6) were subsequently created.

A simulation and evaluation of proposed land use changes (C6) has been completed at a reduced scope. The deliverable consists of a series of 35 mm slides of land use change depicting an array of computer-simulated alterations of the landscape on the Lower St. Croix River and a report summarizing the effect of various modifications on the visual quality as reflected in survey resulted described in (C5) above. The report provides the groundwork for future analysis and calibration of the expert system, but does not

provide a calibrated analytical tool at a usable stage of development without further work.

A contractor was hired by the Minnesota-Wisconsin Boundary Area Commission to produce a videotape documenting the products, findings and conclusions of the LCMR project and their relevance to Riverway management. Videotape source materials from objective C that could be used in the final video production (C7) proved to be limited in scope and nature. However, portions of the slide library were used to document efforts carried out as part of Objective C. as part of the final production (C7). Project reports as specified under this Objective (C8) are current to date.

Because output from work being done under objective C has been the subject of some media and public attention, the MWBAC has announced that it will provide additional public review opportunities for this material, as well as other project outputs, as part of a public review process it will carry out during its own final report development process. A project report in draft form will be developed during the summer of 1993, available for public review in early fall, and a final report to be produced in October, 1993.

Meaning of Results

Since the deliverables for this product have been provided only within recent days, their full meaning is yet to be assessed. Such information will be contained in the MWBAC's October, 1993 report.

C.6. Benefits: A computerized spatial data file and map atlas of visual quality in the LSCNSR and its watershed will be produced. The change in visual quality resulting from land and water surface use change within the LSCNSR and its watershed will be estimated. The results will enable residents, users and managers to see for themselves the incremental and cumulative visual impacts of land and water use changes on the scenic character of the Riverway and watershed. Projections will be permitted of visual quality change that are likely to emanate from future land and water surface use changes in the LSCNSR and its watershed, enabling policy-makers to better estimate visual resource value effects of management and regulatory decisions. Finally, an agenda of continuing visual resource research and monitoring needs will be identified.

Table 3. Summary of Specific Products for Objective C.

Sub-Objective		Deliverables
Narrative and Pictoral Documentation of Historic Landscape Change	1.	Narrative record of landscape change
	2.	Slides of selected archival visual images
	3.	Slides of contemporary scene related to archival images
Identification of Visual Character Types	1.	A system to classify visual character types at 3 study periods
	2.	Spatial data to map types at 3 study periods
	3.	Maps and spatial analyses of visual character types at 3 study periods
Expert Evaluation System	1.	A system to evaluate visual quality
	2.	Calibration of system based upon perceptual judgement
	3.	Spatial data to map and analyze visual quality using GIS
	4.	Maps and spatial analyses of visual quality at 3 study periods
Perceptual Calibration of Evaluation System	1.	A report summarizing procedures and findings re: perceptual judgement of stakeholders
	2.	A report summarizing procedures used to calibrate system
Simulation and Evaluation	1.	A series of 35 mm slides of Land Use Change depicting visual character effects of selected land use change proposals
	2.	A report summarizing the effect of proposals on visual quality
Videotape Materials	1.	Appropriate summary materials for use in Objective E.

III.D. To assess the effectiveness of existing legislative intent, public policy, legal, regulatory and administrative strategies for land and water resource management for the LSCNSR, and to identify critical current management issues and needs.

D.1. Narrative: The land and water resources of the LSCNSR are managed through the collaborative efforts of federal, state, county and municipal government agencies, quasi-public institutions, local and regional groups of stakeholders, and individual landowners. Little is understood about the interdependence among these entities and how their interaction affects management of LSCNSR resources. In many instances public policy goals, as reflected in the 1976 LSCNSR Master Plan, are not being pursued or enforced as comprehensively or as vigorously as possible. Thus, there is a need to examine the public policy environment within which LSCNSR resource management exists, to define the range of stakeholders involved in LSCNSR management and to identify successful and unsuccessful strategies for managing the land and water resources of the Riverway.

D.2. Procedures: The historical, legislative, and current intent and current implementation procedures for existing public policies and legal, regulatory and administrative strategies for managing the land and water resources of the LSCNSR will be inventoried at the local, state, and federal levels. The inventory will include a description of policy objectives and an assessment of the effectiveness of current implementation procedures for each agency or institution, including a description of the environment explicitly or implicitly envisioned by each policy.

Riverway management strategies in use elsewhere will be collected, inventoried and assessed to determine their applicability to the LSCNSR. Through a process of identification of, and interaction with, stakeholders (see Objective E.) current policy objectives and implementation procedures will be described and further assessed.

Deliverables will include narrative and video material summarizing current policies and procedures, their perceived and real effectiveness, options for change, and implications for land use, water surface use, public policy, regulations, interagency management strategies, stakeholder participation programs, and agency resource commitments.

D.3. Budget:

a. Amount budgeted: $22,000
b. Balance: $0

D.4. Timeline for Products/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Inventory other places/tools	.....				
b.	Inventory LSCNSR policy objectives and implementation procedures	.....				
c.	Identify stakeholders (see E) involved in management	.....				
d.	Assess effectiveness of past and current policy and procedures		.....			
e.	Share findings with stakeholders via tasks in objective E.			.....		
f.	Prepare video/narrative summary info.			.....		

D.5. Status:

Results

Study Plan (D1) and Identification and Description of Stakeholders (D4) for this objective are complete. Stakeholder identification has resulted in a data base of 3,539 dedicated names and addresses with additional contacts as available and appropriate.

Final reports describing management strategies on other river systems (D2), and an inventory of policy objectives for the Lower St Croix (D3) have been submitted. The completion of Deliverable (D5) is subject to receipt of Deliverables from the U of M (from Objectives A-C), which were received on June 30, 1993. It will be complete and submitted for review on or before July 30, 1993. Further, much of the information contained in (D5) will also be included in a special final project report, to be prepared in the summer of 1993, available for public review in September, 1993, and presented to the Minnesota-Wisconsin Boundary Area Commission for formal adoption in October, 1993, after which time it will be available for general public distribution.

Materials for Workshop Series 1-4 were prepared and distributed (D6) prior to and at a series of public meetings during the project. Those materials included a special project brochure and three quarterly issues of a special newsletter called the **St. Croix Riverkeepers Journal.** The MWBAC has submitted a formal request to the Legislature of the State of Wisconsin (as a special appropriation added to our normal operating budget) to fund four future quarterly issues in FY 1994. A decision on that request is currently pending in the Wisconsin Legislature.

A contract has been signed with Cascade Communications, Inc. to complete the video work required for the Phase II video for the project (D7). A draft video has been produced and reviewed and a final video will be available in July, 1993.

Meaning of Results

The results of work completed to date have enabled the resource managers to communicate directly to the most comprehensive stakeholder list ever. The subsequent communications, via the **Riverkeepers Journal**, video presentations, reports, brochures, and through the town meeting and workshop series, has reached an audience that is estimated to be at least 60% "new" contacts (i.e. not a Riverway landowner, official, or other stakeholder at the time of Riverway designation.)

The early efforts to inventory river management strategies used elsewhere and to assess the effectiveness of our own strategies has have been reviewed by the public and the member agencies of the Lower St. Croix Management Commission; with strong expressions of concurrence from both the public sector as well as during agency review. The broad-based recommendations for improved stewardship across the continuum (from watershed-wide in scope to those that focus on the responsibilities of a specific landowner or visitor) has provided a prescription for integrated resource management that goes beyond the Riverway. This has been determined to be essential as we have increasingly learned about the direct relationships between actions carried out at the watershed level with impacts on the Riverway itself. A detailed discussion of recommendations for improvements to our current management strategy is contained in the May 7, 1993 Preliminary Project Report. A public review version of the report, as presented by mail and at a series of two public hearings in May, 1993, brought a strong positive response from the light audience of attendees and as reflected in subsequent written comments and testimony.

D.6. Benefits: This objective will document successes and failures of existing public policies and management strategies by comparing the legislative and agency intent for management policy, objectives and outcomes with the actual effectiveness of current practices and resultant patterns of use as perceived by managers themselves as well as local government, landowners and resources users (i.e. recreationists, etc.) Managers and stakeholders will obtain a more definitive statement of critical issues and needs in the policy environment of LSCNSR management, and will obtain input about the degree to which other stakeholders support or object to existing management strategies and would support or object to possible future options for change.

III.E. To rebuild and maintain landowner, organizational, institutional, government and agency stewardship for the LSCNSR through communications, information, education, and practical technical assistance efforts.

E.1. Narrative: Current grassroots stewardship-building efforts of the Boundary Area Commission (BAC) will be greatly expanded to include a regular and sustained communications effort with stakeholders, periodic public forums, publications, training workshops, and an ongoing technical assistance strategy for local units of government, landowners, business and tourist enterprises, recreationists, etc. A high-quality video and tabloid summary of information gathered in objectives A through E will be produced as a training and stewardship-building tool.

E.2. Procedures: A directory and atlas of stakeholders will be developed by updating the BAC computerized mailing lists, by incorporating National Park Service Riverway land ownership maps and by conducting deed searches to identify riparian landowners. Stakeholders will then be segmented according to the manner by which they influence and are affected by Riverway management strategy.
A series of workshops will be held to educate stakeholders about the Wild and Scenic River program purposes, the goals and objectives of Riverway managers as they currently exist, to explore changes that have taken place in the Riverway, and to explore how each stakeholder segment can modify existing or create new strategies to protect and preserve the ecological scenic and recreational values of the Riverway.

A strategy for continuing local government and riparian and Riverway District landowner technical assistance and stewardship-building will be developed that provides positive encouragement for stewardship to complement and support other regulatory devices for Riverway protection. Videotape and narrative materials from Objectives A-E will be edited to produce a final high-quality video tape and tabloid available to agencies, groups and landowners.

E.3. Budget

a. Amount Budgeted:	$85,000
b. Balance:	$0

E.4. Timeline for Products/Tasks

		Ju91	Ja92	Ju92	Ja93	Ju93
a.	Develop stakeholder directory.	.....				
b.	Segment and contact stakeholders		.....			
c.	Workshop #1: Introduction and project purpose sessions.		.....			
d.	Workshop #2: Review/respond to data from Obj. A -D.			....		
e.	Workshop #3: Review/respond to draft results Obj. A-D				.....	
f.	Develop stewardship-building strategy and materials.			.....		
g.	Develop video, booklet and tabloid info./tech. assist.			.....		
h.	Workshop #4: Present Steward-ship strategy and info. about Technical Assistance				.....	

E.5. Status

Results

The Study Plan (E1) for this objective is complete. Initial Stakeholder/Stewardship brochure and contacts (E2) completed. Stewardship brochure has been reprinted twice, for a total of 5,500 contact pieces. The activities and reports for four workshop or public meeting series (E3) (E4) (E5) and (E8) have been completed, documenting the events and the results. In addition, project staff and researchers presented information about the project at the annual St. Croix Research Rendezvous sponsored by the National Park Service and Science Museum of Minnesota and the St. Croix River Heritage Coalition annual conference and numerous other civic, local government, and agency groups during the last two years.

A final project report, over and above the requirements of this project reporting requirements, will be prepared by the Minnesota-Wisconsin Boundary Area Commission for review by the public in September, 1993, with a formally adopted final report completed in October, 1993.

Final text and graphic materials for three Riverway Stewardship Guides for landowners, local governmental units, and visitors, (E6) have been completed in final draft form and are currently being reviewed by the managing agencies. Final versions will be published in July, 1993 and submitted as part of a special report describing an overall recommended stewardship strategy (E6) no later than July 30, 1993. Public distribution will occur during FY 1994 at a level dependent upon availability of funds per a special request to the Wisconsin Legislature for one time funding. Cascade Communications, Inc. has completed the video work required

for the Phase II video for the project (E7) and will publish the video in July, 1993 and submitted no later than July 30, 1993 (estimated length - 15 minutes) as the requested video version of a project summary as well.

Meaning of Results

The work completed under this objective has provided the first-ever comprehensive bi-state prescription for ongoing stewardship of the Lower St. Croix watershed and specific bi-state technical assistance materials designed for direct use of landowners and local government officials as well as others who have an interest in resource management and watershed stewardship. Already, there is renewed interest at the local government level in using the results of this project for local planning efforts; expressed interest by a consortium of nonprofit citizen groups to establish a watershed-wide network of supporters of managed growth concepts; and an expressed interest in establishing a funded full time nonprofit-based "riverkeeper" patrol on the St. Croix. The University of Wisconsin, Rivers Falls, has expressed an interest in serving as a technical center and access point for resource data, such as is contained in the GIS and other products from this project. The MWBAC has initiated meetings with the member agencies of the Lower St. Croix Management Commission to discuss and consider a variety of changes in management policy and procedures for the Riverway. This process will be ongoing for some time, as the MWBAC and the LSCMC review the overall results of this entire project. The final project report for this effort will elaborate further on these efforts and their status as of late summer, 1993.

E.6. Benefits: This objective will build stronger ties among various stakeholders into a community of effective and supportive stewards, committed in various ways to management and care of the Riverway resources. Through the transfer of information and through training of landowners, local government officials, and others, stakeholders will work more harmoniously and effectively to implement public policy strategies and private stewardship practices to the benefit of the stakeholders and the resource.

IV. Evaluation:

For the FY92-93 biennium, the program will be evaluated at no-less-than six month intervals by an advisory committee made up of representatives from the Minnesota DNR, the University of Minnesota, and the Minnesota-Wisconsin Boundary Area Commission. The committee will include or invite outside participation to assist in evaluation of scientific methodology, computer technology, strategic planning, and policy formulation advice. The advisory committee will use a critical path methodology to review both products and progress against the work plan objectives and time line and will offer, as part of periodic status reports, ongoing assessments and recommendations for "course corrections" or work plan amendments. The program manager will be

responsible for day to day project coordination and regular communications with LCMR, the advisory committee, and others.

The committee's assessments will include evaluations on the basis of progress being made in the following areas: 1) development of a comprehensive GIS that adequately describes actual and proposed land and water use change in the LSCNSR and provides a framework for estimating the ecological and visual impacts of land and water use change in the Riverway; 2) definition of long-term research and monitoring needs that will enable LSCNSR managers to better understand the relationships between changes in the pattern of land and water use and changes in environmental and scenic quality; 3) definition of problems inherent in the existing policy framework for managing change in the pattern of land and water use; 4) success in informing and involving a larger set of stakeholders in LSCNSR management; 5) success in providing new tools and technologies that enable LSCNSR landowners, local government officials, and agency resource managers to direct changes in the pattern of water and land use toward accomplishment of Master Plan goals and objectives.

Over the longer term, the program may be evaluated by stakeholders to the extent that: 1) tools and technologies developed in this effort are adopted by LSCNSR planners and managers; 2) conflicts among stakeholders are reduced as they individually and mutually carry out management and stewardship strategies, 3) the program makes significant improvements in the natural and scenic resource values of the Riverway; and 4) the program becomes a model of managing changes in patterns of land and water use for other Riverway settings.

V. Context:

A. Previous work on the LSCNSR has not been supported by LCMR. Much of this work has been focused on single issues such as natural, recreational and or scenic resources. There are few studies that work comprehensively with multiple sets of resource values. There have been few attempts to correlate findings of these single issue studies with existent changes in the patterns of land use and water surface use in the Riverway.

B. This project is the outcome of two major River Managers/Local Government Forums and subsequent public meetings of the Lower St. Croix Management Commission during the last three years. The steady increase in recreational use of the Riverway, growing development pressures along the shoreline, and the need to rebuild a grassroots support for the Riverway protection and management were all identified as key issues that need to be addressed.

C. The project will provide agencies and stakeholders with more complete information concerning the effects of changes on the natural, scenic and recreational resources of the Riverway and will enable them to develop a network of managers and stakeholders who are more committed and better equipped to manage Riverway change in an active rather than a reactive manner. It will focus the

expertise of several units of the University of Minnesota and the USDA-Forest Service North Central Forest Experiment Station. The project will provide a stewardship network whereby the benefits realized from this project can be disseminated in a usable form to the stakeholders actually responsible for Riverway management.

D. Not applicable.

E. Biennial Budget System Program Title and Budget:
Not available at this time.

VI. Qualifications:

1. Program Manager:

Daniel W. McGuiness
Associate Executive Director
Minnesota-Wisconsin Boundary Area Commission
B.A. Sociology, Winona State University, 1970

In his current position, the program manager is study manager for biennial inter-agency recreational use aerial surveys on the Lower St. Croix and Mississippi Rivers, Chairman of the Lower St. Croix Management Commission Technical Committee, and staff for the St. Croix Regional Committee of the Boundary Area Commission. Current work also includes liaison services to local government and landowners on the Lower St. Croix National Scenic Riverway. The primary role of Mr. McGuiness will be as overall program coordinator as well as principal and staff supervisor for work done under Objectives D. and E.

2. Major Cooperators:

A. David G. Pitt, Ph.D.
Professor of Landscape Architecture
University of Minnesota
Ph.D. Renewable Natural Resources, University of Arizona, 1986.
MLA Landscape Architecture, University of Massachusetts, 1974.

Dr. Pitt's publications focus on the perception of scenic resource value in the rural landscape and the policy environment of natural resource decision-making. His current work focuses on the use of video image capture technology in landscape perception research. Current or recent projects have been supported by the USDA-Forest Service, the US Fish and Wildlife Service, the National Park Service and the Minnesota Department of Natural Resources.

B. Lance Neckar
Assistant Professor of Landscape Architecture
University of Minnesota
M.S. Landscape Architecture, University of Wisconsin, 1982.
MLA Landscape Architecture, Harvard University, 1981.

Professor Neckar's work focuses on landscape history, particularly the history of the late 19th, early 20th Century landscape of the Upper Midwest.

C. James Perry, Ph.D.
Associate Professor of Forest Resources
University of Minnesota
Ph.D. Biology Idaho State University

Dr. Perry has authored more than 70 technical and lay publications on water quality, aquatic biology, and environmental monitoring. He presents lectures at numerous locations around the world; his lecture-topics include water quality assessment and management, aquatic biology, monitoring system design, watershed management, and the effects of acid deposition and other stresses on aquatic ecosystems.

D. Nels Troelstrup
Post Doctoral Fellow in Forest Resources
University of Minnesota

Ph.D. Candidate Forest Resources, University of MN
M.S. Forestry, University of Nebraska

Mr. Troelstrup is presently a Ph.D. candidate in the Department of Forest Resources, focusing on the effects of land-use practices on water quality and aquatic ecology of southeastern Minnesota trout streams. He has participated in interdisciplinary research efforts on large river systems, temporary ponds, lakes and trout streams and he has taught classes in Zoology. Limnology, Meteorology and Water Quality at three Universities. He is particularly interested in the effects of disturbance on the structure and function of aquatic communities.

E. Lloyd Queen, Ph.D.
Research Associate
Laboratory for Remote Sensing
University of Minnesota
Ph.D. Geography, University of Nebraska

Dr. Queen is responsible for working on research involving quantitative approaches to natural resources inventory and management utilizing remote sensing and GIS; including the design, development and integration of digital image analysis

and geographic information systems with emphasis on programming and data analysis. His areas of expertise are remote sensing, digital image processing, GIS, automated cartography, and computer graphics. Current primary research interests include terrain and spatial modeling, satellite data calibration, and hydrologic applications of GIS.

F. Thomas R. Crow, Ph.D.
Research Ecologist and Project Leader
Principles of Landscape Ecology for
Managing Temperate Forests.
USDA - Forest Service North Central
Forest Experiment Station

Ph.D. Plant Ecology, University of Minnesota

As a plant ecologist, Dr. Crow has been involved in studying the ecology of tropical forests and the silviculture of northern forest species. He currently directs a USDA project designed to integrate principles of landscape ecology into the management of regional landscapes.

G. John R. Probst, Ph.D.
Research Ecologist
USDA - Forest Service - North Central
Forest Experiment Station

Ph.D. Ecology, Princeton University
M.S. Zoology, Pennsylvania State University
Dr. Probst's current research focuses on the landscape ecology and biodiversity of managed ecosystems. This work involves research with avian populations in the St. Croix Valley as well a complex of turtle species.

VII. Reporting Requirements:

Semiannual status reports will be submitted not later than January 1, 1992, July 1, 1992, January 1, 1993 and a final status report by June 30, 1993.

APPENDIX
EXHIBIT of Grant Agreement between State of Minn. & MWBAC

LIST OF WORK PROGRAM ELEMENTS
LCMR RECREATION #26
11/19/91 Version

Ref. #	Description	Who	When	Amount
Objective A. Products (From A.4. Timeline)				
A.1.	Study Plan	Queen	9/91	$ 850.00
A.2.	GIS Framework Description (b.d.f.)	Queen	12/91	6,250.25
A.3.	Photo Interpretation '76-'79 and Digitized Data	Queen Pitt	6/93	17,910.00
A.4.	Atlas of Land and Water Surface Use Change (g)	Queen	6/93	15,250.75
A.5.	Public Policy Analysis/Report (e)	Pitt	6/92	13,599.00
A.6.	Video Tape Materials (h)	Pitt	6/93	- 0 -
A.7.	Digitized Pre-Settlement Data and Maps (c)	Crow	6/92	- 0 -
	TOTAL, OBJECTIVE A:			$ 53,860.00
Objective B. Products (From Table 2 - Sub-Objectives)				
B.1.	Study Plan	Pitt	9/91	$ - 0 -
B.2.	Passive Water Quality Data (Data and Analysis in Report Form)	Troelstrup	3/93	8,200.00
B.3.	Paleoecology of Sediment Cores (Data and Analysis in Report Form)	Troelstrup	6/93	30,500.00
B.4.	Snag Habitat Analysis (Data and Analysis in Report Form)	Troelstrup	6/93	7,600.00
B.5.	Mussel Shell Analysis (Data and Analysis in Report Form)	Troelstrup	6/93	20,500.00
B.6.	Passive Invertebrate/Fish Analysis (Data and Analysis in Report Form)	Troelstrup	3/93	8,200.00
B.7.	Terrestrial Habitat Analysis (Data and Analysis in Report Form)	Crow/Probs	6/93	29,860.00
B.8.	Video Tape Materials	Pitt/ McGuiness	6/93	- 0 -
	TOTAL, OBJECTIVE B:			$104,860.00

Ref. #	Description	Who	When	Amount
Objective C. Products (From Table 3 - Sub-Objectives)				
C.1.	Study Plan	Pitt	9/91	$ - 0 -
C.2.	Narrative and Pictorial Documentation of Historic Landscape Change	Pitt	6/93	18,516.50
C.3.	Identification of Visual Character Types (Data, Maps, Report)	Pitt	6/92	17,020.50
C.4.	Expert Evaluation System (Data, Maps, and Report)	Pitt	6/93	10.922.50
C.5.	Perceptual Calibration of Evaluation System (Reports)	Pitt	6/93	10,922.50
C.6.	Simulation and Evaluation (A Series of Slides and Report)	Pitt	6/93	17,020.50
C.7.	Video Tape Materials	Pitt	6/93	7,887.50
C.8.	Semi-annual Status Reports on Project Research Progress and Coordination	McGuiness	6/93	12,000.00
	TOTAL, OBJECTIVE C:			$ 94,280.00

Ref. #	Description	Who	When	Amount
Objective D. Products (From D.4. Timeline)				
D.1.	Study Plan	McGuiness	9/91	$ 500.00
D.2.	Inventory of Management Strategy (Other Places/ Tools) (a)	McGuiness	6/92	2,000.00
D.3.	Inventory LSCNSR Policy Objectives and Implementation Procedures (b)	McGuiness	6/92	2,000.00
D.4.	Identify Stakeholders Involved In Management (report and lists) (c)	McGuiness	6/92	5,000.00
D.5.	Policy and Procedure Assessment (Report) (d)	McGuiness	6/93	8,000.00
D.6.	Reports/Workshops to Stakeholders (Activity Summaries) (e)	McGuiness	6/93	2,500.00
D.7.	Video Tape Materials (f)	McGuiness	6/93	2,000.00
	TOTAL, OBJECTIVE D:			$ 22,000.00
Objective E. Products (From E.4. Timeline)				
E.1.	Study Plan	McGuiness	9/91	$ 1,000.00
E.2.	Segment and Contact Stakeholders (Brochure series and Report)(b)	McGuiness	6/92	5,000.00
E.3.	Workshops with Stakeholders Series I (Report on Results)(c)	McGuiness	6/92	8,000.00
E.4.	Workshops with Stakeholders Series II (Report on Results)(d)	McGuiness	12/92	8,000.00
E.5.	Workshops with Stakeholders Series III (Report on Results)(e)	McGuiness	3/93	8,000.00
E.6.	Stewardship Building Strategy and Materials (Printed Materials)(f)	McGuiness	6/93	25,000.00
E.7.	Develop Video, Booklets, Tabloid (Video and Tabloid) (g)	McGuiness	6/93	20,000.00
E.8.	Workshops with Stakeholders Series IV (Report on Results)(h)	McGuiness	6/93	10,000.00
	TOTAL, OBJECTIVE E:			$ 85,000.00
	TOTAL, MN-WI BOUNDARY AREA COMMISSION PRODUCTS			$119,000.00
	TOTAL, UNIVERSITY OF MINNESOTA PRODUCTS			241,000.00
	TOTAL ESTIMATED COST OF THE PROJECT			$360,000.00