Yellow River Watershed
Landscape Stewardship Plan

Prepared for the Yellow River Watershed Partnership

August 2014

Wisconsin Department of Natural Resources (WI DNR)
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Cover photo by Jeff Reinhart, Minnesota Forest Resources Council.

Please cite this document as: Wisconsin Department of Natural Resources. 2014. *Yellow River Watershed Landscape Stewardship Plan.* PUB-FR-542-2014. Wisconsin Department of Natural Resources, Madison, Wisconsin.

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Executive Summary

Forests play an important role in keeping water clean. Clean water is vital to the ecological, economic and social health of the St. Croix River Basin. While links between healthy forests and clean water are generally well known, there have been few efforts that both document the significance of the relationship between forest land cover and water quality and quantity in the St. Croix River Basin and then develop collaborative ways to bring partners and stakeholders together in sustained ways to achieve shared goals within key basin communities. In response, a small group of resource professionals working in the Basin pursued federal funding to support this project. As a part of the project, this Plan was created to bring together natural resource practitioners in the Yellow River Watershed in their efforts to protect and improve forests and water resources with a focus on the connection between forest land cover and water quality and quantity.

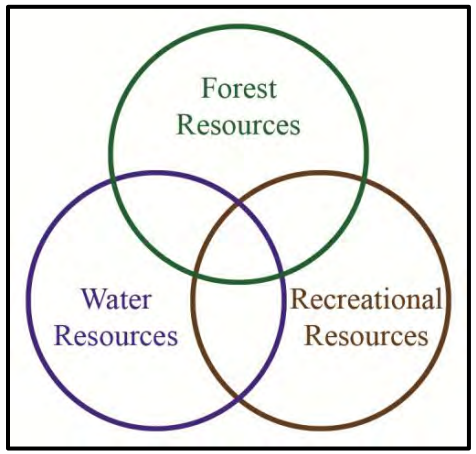
While the federal grant requires this project to be completed over a three-year timeframe (2012-2014), the broader intent of this landscape stewardship effort is to encourage long term collaboration across the Yellow River Major Watershed and ultimately the St. Croix River Basin that fosters sustainable forest management that protects and improves water quality. Healthy forests and clean waters will lead to benefits for wildlife, recreational opportunities, and forest based economic activities that will help to improve the quality of life of people living, working, and recreating in the Yellow River Major Watershed for years to come. Given that there is no one entity responsible for managing both forest and water resources in the Watershed and that land is mainly held by private landowners, partnering agencies and organizations will need to find more effective ways to work together on an ongoing basis to support the implementation of this plan throughout the watershed and ultimately support similar efforts across all lands throughout the St. Croix River Basin.

The Basin has been changed by human activities in significant ways since European settlers began to call it home. Our collective management of the land has had a noticeable impact on natural resources in many ways, particularly with respect to water quality. Along with point sources, changes to the landscape have resulted in enough additional nutrients (phosphorus) reaching Lake St. Croix at the mouth of the Basin to cause the Lake to become eutrophic and to warrant a designation of “impaired” from the Wisconsin Department of Natural Resources and the Minnesota Pollution Control Agency. Section 2 of the plan provides an overview of the physical setting of the Basin and the Watershed.

The loss of low phosphorus export land cover types such as forest (1.1 million acres lost) to high phosphorus export cover types such as agriculture and urban (0.73 million acres converted) is most pronounced at the southern and downstream portion of the Basin. The Yellow River Major Watershed sits at a transition point where this upstream movement of converted cover types slows. Protecting the remaining forests (as well as shrublands, grasslands, and lowland vegetation) in the Yellow River Major Watershed and other watersheds in the St. Croix River Basin will be critical for maintaining the water quality that the Upper St. Croix River Basin enjoys and to keeping the water quality in Lake St. Croix from declining further.

Watersheds for tributaries in the St. Croix River Basin each differ in the makeup of natural and cultural factors that drive the relationship between forests and water quality. This is also true for sub-watersheds in the Yellow River Watershed. To guide the project implementation portion of this plan, key drivers for the forest and water quality relationship were analyzed for each sub-watershed. Based on the results of that analysis, sub-watersheds were evaluated for the risk of water quality decline if strategic forest management activities are not employed. Section 3 summarizes this analysis.

While the primary focus of a landscape stewardship plan is forest resources, the strategic framework of this plan recognizes not only the critical connection of management of forest resources with the management of water resources but also with recreational resources. The intent of Sections 4 and 5 is to provide an overall vision as well as a detailed and integrated framework that defines how natural resource professionals and landowners can work together to better manage forest, water, and recreational resources in the watershed over the next ten to twenty years.



To guide strategic forest management activities, natural resource provider coordination, and outreach and education efforts, a set of working principles and desired future conditions were developed by the Yellow River Watershed Landscape Stewardship Planning Committee to frame up an overall vision of what needs to be done across the Watershed. Working principles cover planning, coordination, implementation, and monitoring. Desired future conditions (DFCs) include protected and improved water quality, protected and improved forest resources, and attractive and engaging recreational resources. These DFCs are then broken down into goals, objectives, and action items to further define how they will be achieved. Combined, the working principles, desired future conditions (DFCs), and goals and objectives make up a strategic policy framework that is the heart of this plan.

Successful implementation starts with a small group of committed people and requires timely and purposeful coordination. Coordination, before implementation, is one of the most overlooked and underestimated cost-saving management efforts in resource management. In an age of complex environmental and socio-economic issues and declining budgets for public and private conservation agencies, sharing resources and leveraging successes has never been more important. Services to private landowners must meet the needs of both the landowner and the needs of the community if we are going to address the forest and water quality issues of the watershed with increasing effectiveness.

Coordinating resources brings multiple benefits including making grant funding more likely due to multi-agency approaches, removal of duplication of services, and delivering consistent services and information to the people who live, work, and recreate in the watershed. Targeted outreach to landowners and targeted conservation efforts result in messages that resonate with individuals and communities alike and in actions that get the most bang for the buck.

There are four areas of coordination that resource managers and their landscape partners should address before diving into the implementation of a landscape stewardship plan: Partners and Partnerships, Implementation Programs and Priorities, Training and Funding, and Engaging Communities and Landowners. Moving from a paradigm of preparing and implementing single forest stewardship plans and projects for individual landowners to a landscape approach involving hundreds, perhaps thousands of landowners and their communities will require new ways of thinking and working together. Section 6 provides natural resource professionals responsible for the implementation of this plan with a suggested series of coordination strategies to follow.

Implementation of landscape stewardship plans will be as successful as the imagination, creativity, and commitment that partners and stakeholders bring to the overall process. To guide the process, a framework is provided for guiding the implementation of the Plan over the next 10 – 20 years (Section 7). Seven overall implementation strategies are provided as well as potential demonstration projects that were suggested by the Planning

Committee. Sub-watershed Action Plans are then outlined as a start for guiding targeted implementation activities at the sub-watershed level that, when further developed, can ultimately guide work down to a specific parcel of land. Recommendations to resource agencies are also provided to intentionally increase communications on how we can better integrate efforts by the various conservation agencies and organizations to help find ways to more effectively use limited technical and financial resources.

This Plan is just the beginning to bringing together natural resource practitioners in the Yellow River Watershed in their efforts to protect and improve forests and water quality and quantity. Successful planning also involves monitoring and evaluation that provides feedback to the implementation process for what course corrections are necessary to ensure the continued success of pursuit of the desired future conditions. Monitoring and evaluation will also provide the backbone for the narrative of how this Plan was successfully implemented. Through sound planning, cumulative coordination, strategic implementation, and meaningful monitoring and evaluation, we can more effectively ensure that forests and water quality are protected and improved to improve the quality of life of people living, working, and recreating in the Yellow River Major Watershed and the St. Croix River Basin.

Part 1.
Section 1 – Introduction

The purpose of this section of the Plan is to provide background information on how this project got started and funded, the landscape stewardship planning process, and how partners can use this plan to concurrently promote sustainable forest management and improve water quality and quantity.

A. Project Background

Forests play an important role in keeping water clean, which is vital to the ecological, economic and social health of the St. Croix River Basin. While links between healthy forests and clean water are generally well known, there have been few efforts that both document the significance of the relationship between forest land cover and water quality and quantity in the St. Croix River Basin and then develop collaborative ways to bring partners and stakeholders together in sustained ways to achieve shared goals within key basin communities.

In response, a small group of resource professionals working in the Basin pursued federal funding to support this project. The *Linking Forestry & Clean Water Quality, Upper St. Croix Project* was established on December 19, 2011with initial funding from the USDA Forest Service Northeastern Area State and Private Forestry (S&PF) Competitive Allocation program.

Scope of the USDA Forest Service Grant:

- Objective 1 – State of the Forest Report: Appendix D.
- Objective 2 – Landscape Stewardship Plan: This document.
- Objective 3 – Outreach & Education: Outlined in Part 3 – Section 7.
- Objective 4 – Demonstration Projects: Outlined in Part 3 – Section 7.

Specific involved organizations include:

- Minnesota and Wisconsin Departments of Natural Resources (DNR)
- Minnesota Forest Resource Council (MFRC)
- St. Croix River Association (SCRA)
- Minnesota Soil and Water Conservation Districts (SWCDs)
- Wisconsin Land and Water Conservation Departments (LWCDs)
- Natural Resource Conservation Service (NRCS)
- The Nature Conservancy (TNC)
- Universities in both states
- Minnesota Forestry Association (MFA) and Wisconsin Woodland Owners Association (WWOA)
- Private landowners

This landscape stewardship project seeks to implement USDA Forest Service priorities: 1) conserve and manage working forest landscapes for multiple uses; 2) protect forests from threats; and, 3) enhance public benefits from trees and forests by linking forestry with water quality and quantity in the St Croix River Basin through the application of landscape stewardship principles and practices. The "Linking Sustainable Forestry with Water Quality in the Upper St. Croix Basin Project" and this Plan document represent a pilot effort by project partners with the WI DNR and Minnesota Forest Resources Council (MFRC) through its Landscape Program to develop and implement a model landscape stewardship plan for the state and the nation.

While the federal grant requires this project to be completed over a three-year timeframe (2012-2014), the broader intent of this landscape stewardship effort is to encourage long term collaboration across the Yellow River Major Watershed and ultimately the St. Croix River Basin that fosters sustainable forest management that protects and improves water quality. Healthy forests and clean waters will lead to benefits for wildlife, recreational opportunities, and forest based economic activities that will help to improve the quality of life of people living, working and recreating in the Yellow River Major Watershed for years to come. Given that there is no one entity responsible for managing both forest and water resources in the Yellow River Major Watershed and that land is mainly held by private landowners, partnering agencies and organizations will need to find effective ways to work together on an ongoing basis to support the implementation of this plan throughout the watershed and ultimately support similar efforts across all lands throughout the St. Croix Basin.

B. Landscape Stewardship: Collaboration that Works

The "***landscape approach to forest stewardship***" focuses on the needs and objectives of communities of place and communities of interest, which define a "landscape" as much as any geographical boundary. Landscape stewardship plans are developed to take into account a broader or "all lands" perspective that includes both shared community objectives and individual management activities. To be successful, landscape stewardship must be strategic and collaborative, it must appeal to stakeholder motivations and needs, it must manage for results, and it must encourage flexibility in all activities. Successful landscape stewardship builds agency, organizational, and community capacity through collaboration, increases landowner trust of agencies and organizations through streamlined management and communications, motivates landowners using messages and activities that resonate with their needs, and supports the application of science and knowledge through well informed policies and practices. Taken together, these activities work to make service delivery to private landowners more effective and efficient.

C. The Landscape Stewardship Planning Process

The general process used to develop this plan included:

- Assemble a planning team – Yellow River Watershed Landscape Stewardship Planning Team.
- Inventory and assess the resources in the watershed in technical support documents.
- Gathering of input from planning team members through a series of meetings.
- Building a strategic policy framework based on resource knowledge assembled and input from the planning team.
- Identify potential priority areas within the 230,000 acre tributary watershed and prioritize potential conservation projects to improve forest and water resources.

- Identify ways to enhance the effective delivery of conservation services on both private and public lands.
- Develop a 10-year project list that will implement the goals and objectives in the Plan.
- Establish a procedure to monitor, evaluate and report progress made in implementing the Plan.

A team of resource professionals was assembled in 2012 to guide the development of this Plan. Members of the planning team are listed in Appendix A. Their mission was to review data and scientific information gathered for the planning process and to provide input into the content of the Plan. The Planning Committee also reviewed and commented on various draft plan documents.

The Yellow River Watershed Landscape Stewardship Plan (LSP) was developed utilizing technical support documents created for the Yellow River Watershed Landscape Stewardship Planning Team by WI DNR and MFRC Staff. The complete documents can be found in the Appendix section of this Plan. The detailed resource information compiled and the analysis of that data helped facilitate the development of this Plan and formed the basis for informed decisions on what directions to take, what goals to pursue, and the rationale for implementing this Plan. Technical support documents used in the development of this plan included:

- **St. Croix River Basin – State of the Forest Report (Appendix D)**. Reviews the relationship between forests and water quality and analyzes the historical change in land cover across the St. Croix River Basin.
- **Yellow River Watershed – Resource Inventory and Assessment (Appendix E)**. Outlines the geography of the Yellow River Watershed and the state of the watershed in terms of land cover and water quality.
- **Yellow River Watershed – Sub-watersheds Resource Inventory and Assessment (Appendix F)**. Analyzes key geographic factors in the Watershed by six sub-watersheds.

D. Organization and Uses of the Yellow River Watershed Landscape Stewardship Plan

Strategic planning asks three fundamental questions: 1) *Where have we been?*, 2) *Where do we want to go?*, and 3) *How do we get there?*

The *Yellow River Watershed Landscape Stewardship Plan* has been organized into a three-part format to address these basic questions and compliment the strategic nature of the landscape stewardship planning process. This format complies with the framework established by the USDA Forest Service in the document entitled, "*Landscape Stewardship Guide*." The three parts of this Plan are:

- **Part 1 – Plan Background**: addresses the fundamental questions of "where are we?" as presented in the context of "where have we been?"
- **Part 2 – Strategic Policy Framework**: outlines the vision in a written framework to help answer the question of "where do we want to go?
- **Part 3 – Plan into Action**: focuses on "how will we get there?" and is the portion of this Plan that establishes how the Yellow River Watershed Partnership, along with partners and other interested parties, will implement the strategic policy framework developed in Part 2.

This landscape stewardship plan can be used to inform:

- Forest Stewardship Plans and Implementation
- Water Resource Management Plans and Implementation
- Fish & Wildlife Management Plans
- Community Land Use Planning and Implementation
- Collaborative Project and Funding Development
- Connections to the Forest and Water Resource Policy Decision Makers

These are just a few of the Plan's applications and uses. This Plan is not intended to incorporate other planning efforts; it is meant to supplement and inform those efforts in a manner that promotes increased and improved collaboration among current and future partners and stakeholders to achieve the many public benefits of sustained forest health and improved water quality and quantity.

E. Coordination with Other Conservation Efforts

The Yellow River Watershed Landscape Stewardship Plan provides an overview of the role of healthy forests for water quality and quantity in this major watershed. Below are some examples of other planning and implementation efforts that may benefit from this Plan, especially the concepts outlined in Section 6 relating to coordination strategies:

- Local Water Resources Management Plans in Yellow River Watershed Counties
- Lower & Middle St. Croix River Conservation Action Plan (TNC)
- Wisconsin State Forest Action Plan (WDNR Forestry)
  - Wisconsin Statewide Forest Assessment
  - Wisconsin Statewide Forest Strategy
- WDNR Division of Forestry Strategic Direction
- Lake St. Croix Nutrient Total Maximum Daily Load (WDNR, MPCA)
- St. Croix River Watershed Conservation Priorities Report (SCCC)
- Northwest Sands Habitat Corridor Plan (WDNR, UW-Madison)
- Glacial Lake Grantsburg Master Plan (in progress)
- NW Sands Master Plan (soon to be in development)
- Other existing or forthcoming planning efforts

Part 1.
Section 2 – Physical Setting

Section 2 provides a description of the geography of watersheds and the relationship between forest land cover and water resources, and introduces the six sub-watersheds within the Yellow River Watershed that this Plan uses as the first geographic screening tool or delineator in developing a strategic course of action for collaborative forest and water resource management.

A. The Geography of Watersheds

To better establish the "language" of watersheds in this Plan, a brief overview is warranted. Please note that hydrology is a complex science and delineating watersheds is a complex task. The descriptions below are generic and are intended to provide a starting point for better understanding of the terminology of watersheds and how terms are being used in this Plan. So what is a watershed? A watershed is the area of land that drains into a surface water feature such as a stream, river, or lake and contributes to the recharge of groundwater. Further, a watershed is a geographic area of land, water, and biota within the confines of a drainage area. Both the quality and quantity of the water resources within a watershed can be greatly influenced by the land that the water flows through.

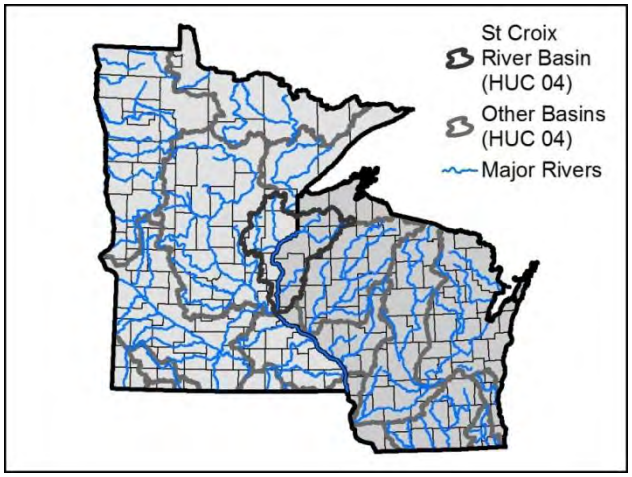
Watersheds come in different shapes and sizes. The term "watershed" is used to describe different scales or levels of hydrologic areas. In Wisconsin, there are four general levels of watersheds: 1) basins, 2) subbasins, 3) watersheds and 4) subwatersheds. There are 11 basins that stretch across the State of Wisconsin within which there are 52 subbasins. And within the 52 subbasins, there are approximately 1,800 subwatersheds across the state. The St. Croix River Basin is located along the border of Wisconsin and Minnesota. The Yellow River Watershed (which is delineated as 2 WI DNR "watersheds") lies entirely within the St. Croix River Basin and the State of Wisconsin.

For the purpose of this Plan, the levels of watershed being described are:

- Basin = St. Croix River Basin (HUC 04)
- Major Watershed = Upper St. Croix Major Watershed (HUC 08) in the St. Croix River Basin
- Tributary Watershed = Yellow River Tributary Watershed (combination of HUC 10 watersheds or WI DNR "watersheds") in the Upper St. Croix Major Watershed
- Sub-watersheds = 6 Sub-watersheds* (collection of HUC 12 watersheds or WI DNR "subwatersheds") in the Yellow River Tributary Watershed
- Minor watersheds = 11 minor watersheds** (HUC 12 watersheds or WI DNR "subwatersheds") in the Yellow River Tributary Watershed

*Note: The sub-watershed level is being used for this Plan because the major watershed level is too large to effectively focus planning and implementation efforts and the minor watershed level includes too many units to manage effectively.

** Note: Minor watersheds are analogous to WI DNR subwatersheds (no hyphen). Sub-watersheds (with hyphen), however, are a collection of HUC 12 watersheds or WI DNR "subwatersheds".



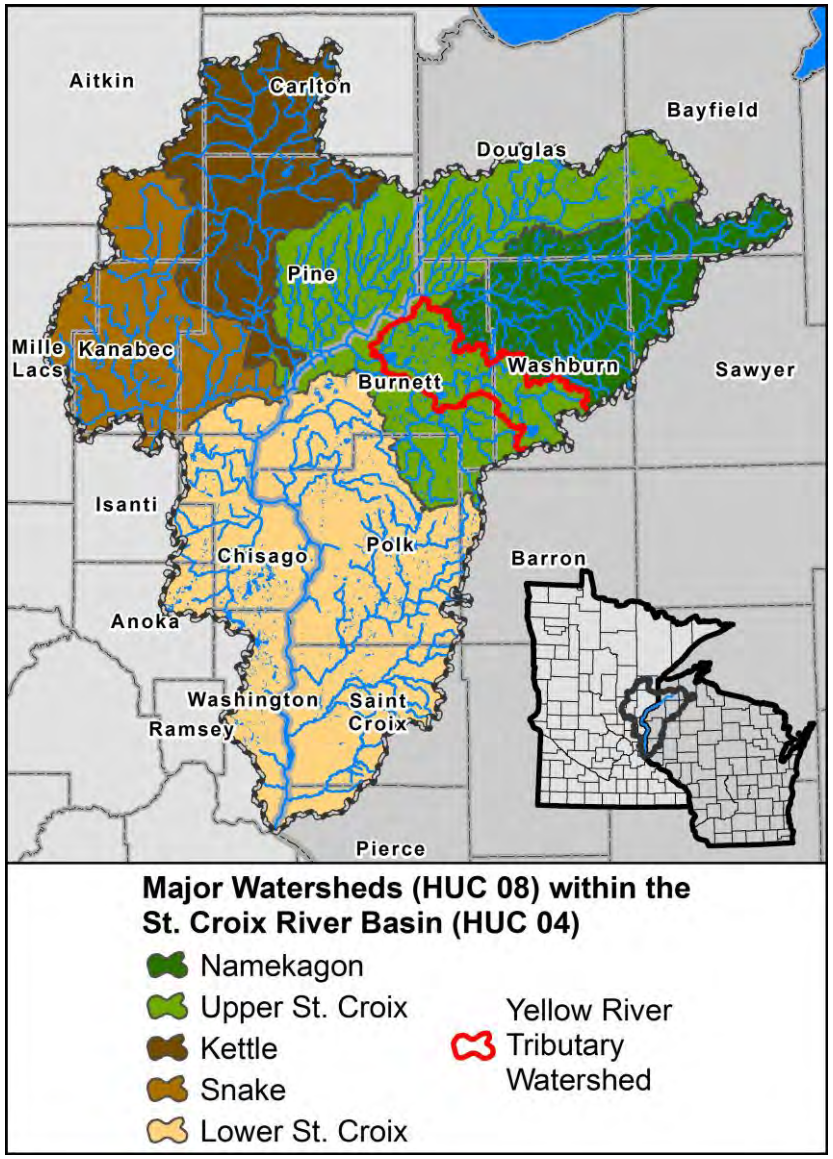
B. The St. Croix River Basin and the Yellow River Tributary Watershed

St. Croix River Basin (HUC 04)

The St. Croix River Basin reaches across ten counties in Minnesota and nine counties in Wisconsin. It covers approximately 7,700 square miles or 4,928,000 acres. Approximately 54 percent of the basin is in Wisconsin. Within the St. Croix River Basin, there are five major (HUC 08) watersheds including the Namekagon in Wisconsin; the Yellow and Snake in Minnesota; and the Lower and Upper St. Croix Majors which intersect both Minnesota and Wisconsin.

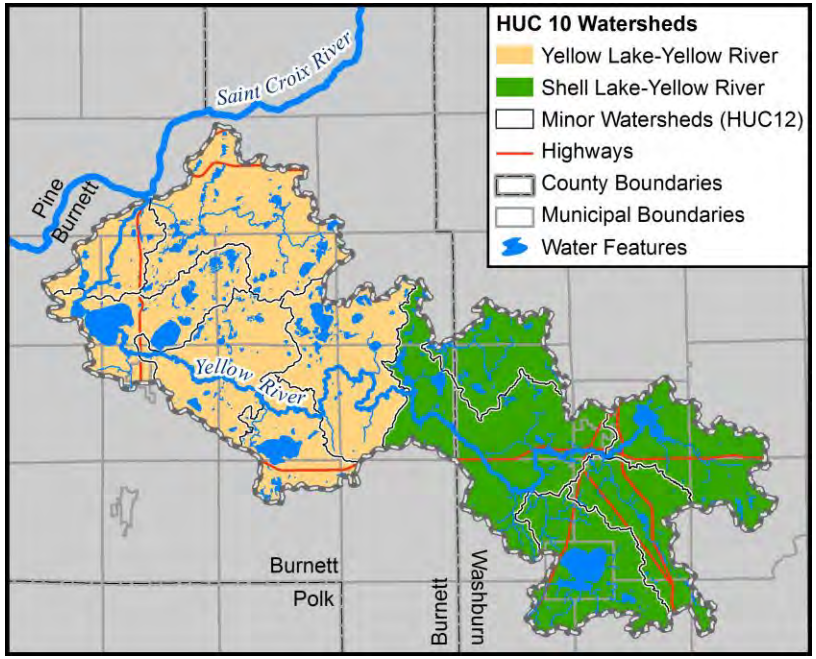
The St. Croix River is a national treasure. It provides clean water to the Mississippi River, high quality natural ecosystems, beautiful scenery, striking geologic features, unique cultural resources, and abundant recreational opportunities. Over 1 million people per year use the river for recreation. Yet there is mounting evidence that the river's health is at a tipping point. Lake St. Croix was recently designated as "impaired" for phosphorous pollution. Because the St. Croix's Wild and Scenic designation applies to only a thin ribbon of land along portions of the river, much of the river and its 7,700 square mile basin are vulnerable to actions that compromise the health of the River. The sheer size and complexities of the St. Croix River Basin are beyond any one organization's capacity to address all of the issues in the Basin in a comprehensive and effective manner.

While forested land cover is one of the most beneficial land uses to water resources, the forestry community has not been actively involved in these efforts in a coordinated or sustained way. Protecting, improving, and restoring forests throughout the Basin are keys to not only protecting and improving water quality and quantity, but to maintaining the ecological and socio-economic health of the Basin.



Yellow River Tributary Watershed of the St. Croix River Basin (HUC 04)

The Yellow River Tributary Watershed is part of the Upper St. Croix Major Watershed and contains two HUC 10 watersheds and 11 minor watersheds (HUC 12). When compared to other tributary watershed areas as described in the State of the Forest Report (Appendix D), the Yellow River is a medium-sized watershed.



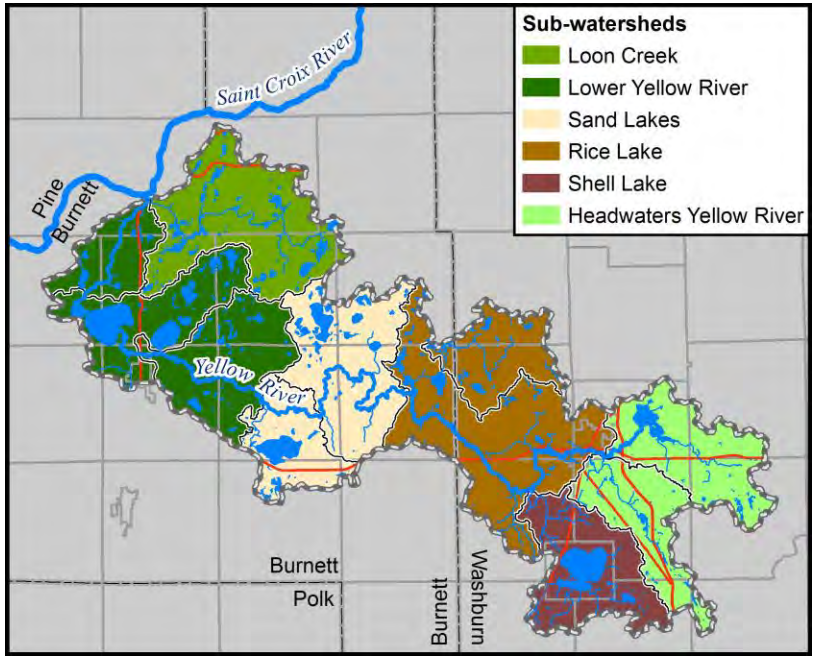
Of the 234,344 acres in the Yellow River Major Watershed, 39,488 acres (17%) are under public, private conservancy, or tribal ownership, most of which (33,057 acres) is forest cover or lowland shrub (Appendix E). Of the 194,856 acres under private ownership (83% of the watershed), it is estimated that only small amounts have a current forest stewardship plan that supports active forest management.

Appendix E is the ***Yellow River Tributary Watershed Resource Inventory and Assessment***. The Resource Inventory provides a comprehensive outline of the geography of the Yellow River Tributary Watershed in terms of land cover and water quality. Within this outline is general information to orient the reader within the political, ecological and hydrological geographies followed by discussions and illustrations of the data concerning landforms, soils, and land cover framed against ownership and population. Following the Resource Inventory several Resource Assessment tools are discussed and illustrated.

One of the primary purposes of this landscape stewardship project is to significantly increase the amount of private land under active forest management for the purpose of increasing long-term private and public benefits, including water quality and quantity.

Six Sub-Watersheds of the Yellow River Tributary Watershed

Planning specific site level implementation activities at the tributary watershed level can be complicated and ineffective because the tributary watershed is too large. Conversely, the minor watershed level includes too many units (11 minor watersheds) to manage. Therefore, this section of the Plan focuses on six sub-watersheds.



The sub-watersheds were defined first by the USGS HUC 10 watersheds with three sub-watersheds in each HUC 10 being made up of one, two, or three minor (HUC 12) watersheds. The Yellow Lake – Yellow River HUC 10 includes the Loon Creek Sub-watershed (one minor watershed), the Lower Yellow River Sub-watershed (three minor watersheds), and the Sand Lakes Sub-watershed (two minor watersheds). The Shell Lake – Yellow River HUC 10 includes the Rice Lake Sub-watershed (two minor watersheds), the Shell Lake Sub-watershed (one minor watershed), and the Headwaters Yellow River Sub-watershed (two minor watersheds).

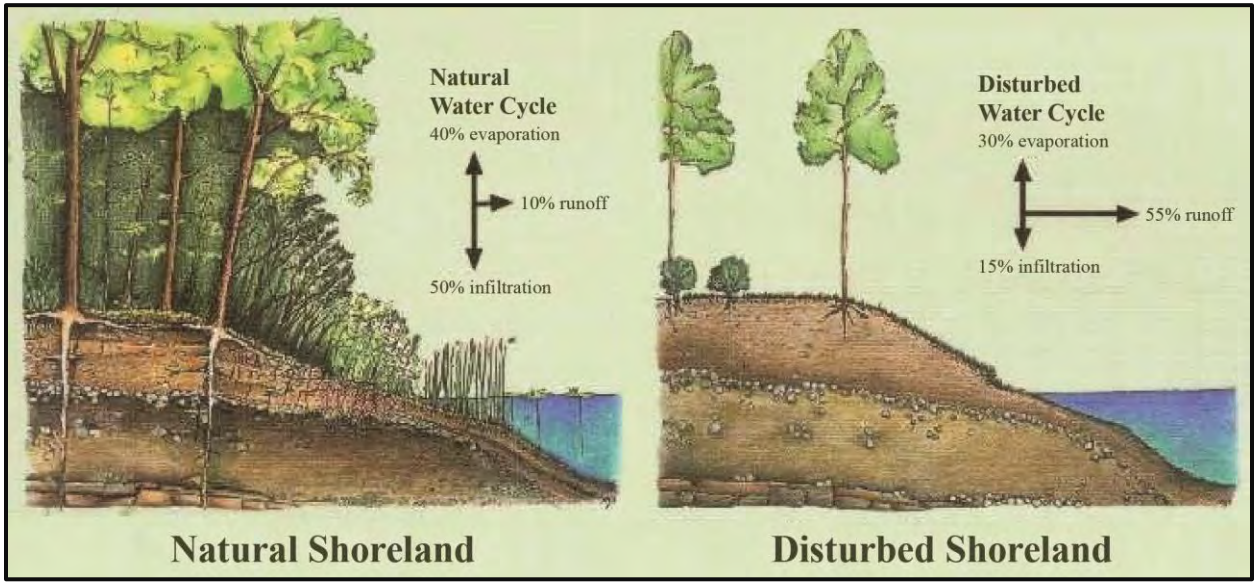
Each of the six sub-watersheds has its own blend of characteristics that affect how they contribute to the production of clean water to the Yellow River, the St Croix River and beyond. Some of these characteristics include position in the watershed, land cover, public and private landownership, slope, soils, and water conveyance and storage. Understanding how the sub-watersheds function in terms of water quality and quantity is critical. Forested land cover plays a key role in the production of clean water.

To support the development of targeted implementation projects across the 230,000 acre Yellow River Tributary Watershed, the planning team developed a detailed resource inventory and assessment at the sub-watershed scale Please refer to Appendix F, the ***Yellow River Tributary Watershed Sub-watershed Inventory and Assessment***, for detailed characteristics, narrative, figures, and analysis for each sub-watershed.

C. A Primer on the Land Cover/Water Quality Connection

Changes to land cover are important factors to examine when assessing the quality of water resources. Because of the extensive capacity that forest land cover has on both slowing down and filtering runoff, its removal has been a primary factor in the historical decline of water quality in most water resources in Minnesota. Removing forest land cover as well as other permanent vegetative covers (brushlands, grasslands) tends to increase the volume of runoff into water bodies.

Land use and development certainly can have a profound impact on the quality of water in lakes, rivers and streams, as well as to our drinking water. Impervious and cultivated surfaces such as fields, lawns, roads, driveways, and buildings increase the rate and volume of surface water flows that can carry phosphorus (when attached to soil particles), sediment, other excess nutrients, bacteria and other pathogens (animal waste/septic systems), and debris (natural or man-made) into a lake or stream. A primary impact from land use is the increased contribution of phosphorus through surface water runoff.



Phosphorus is a nutrient that can cause severe algal blooms and oxygen depletion when in excess in a water feature leading to degradation of water quality and diminished aesthetic and recreational enjoyment. The greater the phosphorus content in runoff water, the more the water quality in the receiving water is threatened. To get a general understanding of the impact of land cover on phosphorus loading, a measure called the Total Phosphorus Export Coefficient (TPEC) is used. The TPEC is measured as the mass of phosphorus export per area per year. Different land cover types have different values for TPEC. If the amount of area of a type of land cover is known, the TPEC can be applied to estimate the amount of phosphorus runoff.

Rates for TPEC can vary for a land cover type based on a variety of characteristics such as climate, soils, slope, proximity to water bodies, and in stream processes. To account for this variability, the models used to determine TPEC rates are typically calibrated by site measurements of actual phosphorus export. In the St. Croix River Basin, monitoring records are too sparse to calibrate TPEC models beyond a basin-wide accuracy. The table at right lists TPEC values used in the Lake St. Croix Nutrient TMDL report which were calibrated based on phosphorus loading to Lake St. Croix. The change in predicted phosphorus export is striking as land use changes from a natural setting – forest, shrubland, or grassland – to converted land uses such as agriculture or urban. Phosphorus export rates from agriculture and urban are 6 times greater than that of forest or shrubland.

Cover Type	TPEC (lbs/ac/yr)
Water	0.006
Forest	0.088
Shrubland	0.088
Grassland	0.197
Agriculture	0.561
Urban	0.561

Water quality can also be significantly affected by the quantity of runoff in a watershed. Cover from mature upland forests slows spring snow melts, thus mitigating peak flows that, when increased, can cause in-channel erosion during peak flow events. Areas of lowland vegetation and open water are also important; they act as a storage area for water during spring snow melts. Watersheds that have greater than 40% of their area covered by mature upland forests, lowland vegetation, and open water have enough shade (mature upland forests) and storage (lowland vegetation and open water) to keep peak flows from spring snow melts at levels that will not cause in-channel erosion in streams (Verry 2000).

When the land cover in the watershed drops below 40% of mature upland forests, lowland vegetation, and open water, that watershed will begin to see peak flows from spring snow melts increase in intensity. This increased peak flow will then cause in-channel erosion, which causes the streams to change. The changes in the streams result in sedimentation and aquatic habitat fragmentation. In watersheds where there is not enough storage (over 40% of the watershed) to manage spring snow melts, managing mature upland forests is important to ensure that there is enough shade to keep the watershed covered during spring snow melts.

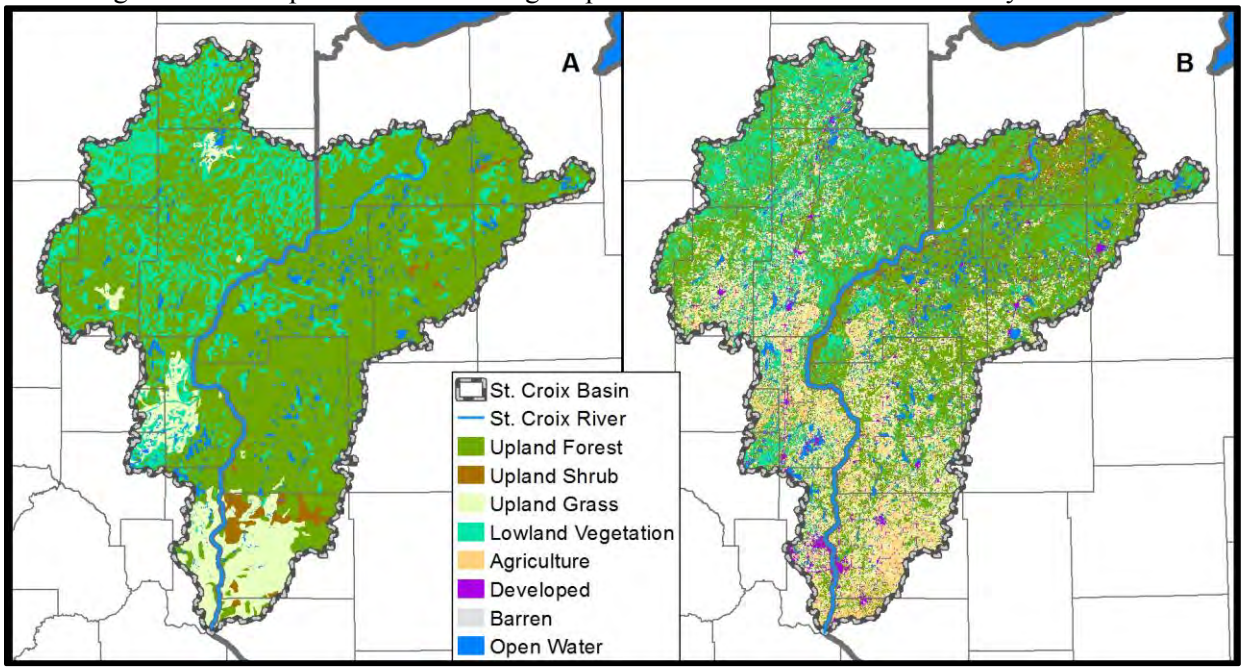
D. Historical Land Cover Analyses

St. Croix River Basin Historical Land Cover Change

The landscapes of the St. Croix River Basin (SCRB) in the mid-late 1800s (presettlement) were covered by upland forest and lowland vegetation in the north to grassland, prairie, and shrublands in the south and southwest (as can be seen in panel A in the map bottom right). Since then, much of the southern half of the basin has been converted to agriculture or developed lands, with pockets of non-cultivated lowland and upland vegetation remaining. The northern half has retained much of its presettlement land cover characteristics of upland forests and lowland vegetation, although the composition of large portions of the upland forests has been heavily altered by logging. In the northern portion of the watershed, only pockets of agriculture and developed cover types are present (panel B, map bottom right).

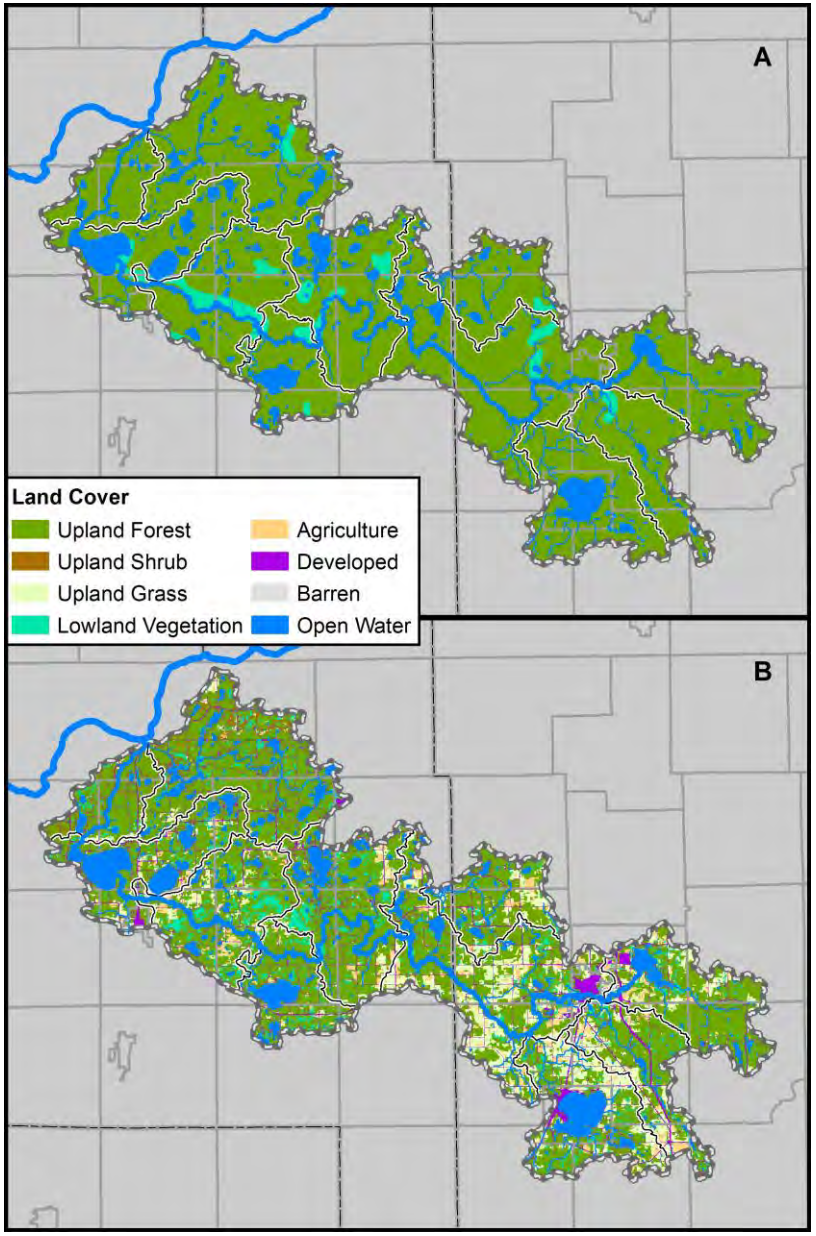
Analysis has shown that this land cover change has progressed upstream in the St. Croix River Basin. As human expansion has pushed upstream, change from low phosphorus export cover types such as forest, shrub, and grassland to high phosphorus export cover types such as cultivated crops and developed land has been the result. More recently (from 2001 to 2006), this downstream to upstream trend has become a change from cultivated crops to developed land. Upland forest continues to be lost.

The relationship of tributary watershed position within the watershed to change to converted land cover types is complex, but it exists and can be used to determine where to target particular types of water quality protection and improvement strategies. In the downstream portion of the basin, restoration and mitigation strategies will be important because a higher portion of the land cover has already been converted to higher phosphorus exporting land cover types. Mid-basin, protection strategies would be more appropriate to preserve some of the low-phosphorus export land cover types that still exist in abundance. Watersheds such as the Snake and the Yellow Rivers in Minnesota, and the Clam and the Yellow Rivers in Wisconsin are at the edge of this northeastward and upstream advance of converted lands. Failure to preserve low phosphorus export land cover types could mean failure to meet water quality goals in the SCRB (Appendix D. State of the Forest Report.).



Yellow River Tributary Watershed Historical Land Cover Change

From presettlement to 2006, land cover in the Yellow River Tributary Watershed shifted from upland forest cover types to upland shrub, upland grass, lowland vegetation, agriculture, and developed cover types (as can be seen in the map at right where panel A is presettlement cover and panel B is 2006 cover). Of the total area in the watershed, 26% has changed from upland forest to other cover types, which was slightly larger than the change in the percent cover in the St. Croix River Basin.



Historic vegetation was strongly dominated by jack pine forests of relatively small diameter trees. Density in this area was variable, with thick patches of forest interspersed with large openings. There were also areas of open savannas with large-diameter red pine and oak. Around 1860, red and white pine began to be logged to make way for farming that began shortly thereafter. Logging intensified after 1910, when jack pine began to be used for pulp. Most of the farms in the Northwest Sands were abandoned by 1930. Extensive areas reforested naturally or were planted, and fire suppression began. In the south and central portion of the Northwest Sands where the Yellow River Watershed is located, forest density increased, red pine and oak savannas disappeared, and other hardwood cover increased. In addition, jack pine abundance decreased, although a considerable amount of jack pine forest still exists today. Most of the barrens and savannas became forested (Kovach, 2005 – *unpublished*).

The generalized land use change is helpful to see the overall picture, but in the Yellow River Tributary Watershed the presence of jack pine barrens and logging activities occurring during times prior to settlement confuses the picture somewhat. There have been many important changes to the vegetation of the Yellow River watershed since presettlement times. Jack pine was the most extensive tree species throughout most of the watershed and the northwest sands prior to settlement. It is now very limited. Red and white pine species are no longer widespread and hardwood species, especially oak and aspen now occupy large areas that used to be pine systems. In general, forest cover decreased within the

watershed (a loss of over 62,000 acres), but the remaining forest has changed substantially from presettlement times. Forested area is more closed and a lot of the jack pine/barrens mosaic typical to this part of Wisconsin has been lost which has resulted in the decline of wildlife species adapted to open habitats (Radeloff, 1999).

While changes to the natural vegetation are less clear due to the patchwork of forest, shrub, and grassland areas that made up the jack pine barrens, anthropological changes to the landscape are clearly evident. An increase in agriculture, upland grassland (primarily pasture and hayfields), and developed land has resulted in the remaining forest being in a more fragmented condition. This is especially evident in the eastern and upstream half of the Yellow River Watershed where agriculture and pasture/hayfields are more prevalent and some of the watershed's larger towns are found. The State of the Forest Report for the St. Croix Basin describes how these changes can affect water quality. An analysis of land cover change between 2001 and 2006 shows continued small declines in all forest types including forested wetland. There have not been significant declines in riparian forest cover between 2001 and 2006 (Appendix E).

E. Important Ecological Resources

Water flow and resulting water quality are bound by topography, and the areas that water flows from are delineated by watershed boundaries. Unlike the overland flow of water, biotic and environmental features are distributed by multiple factors. The Wisconsin DNR Ecological Classification System describes the land using associations of biotic and environmental factors, including climate, geology, topography, soils, hydrology, and vegetation to guide ecological management activities. Most of the Yellow River watershed (74.7%) is within the **Northwest Sands Ecological Landscape**. This ecological landscape encompasses approximately the western ¾ of the watershed. Within the Northwest Sands the Yellow River Watersheds is part of the Bayfield Sand Plains Subsection. Two small sections of **Northwest Lowlands Ecological Landscape** extend into the far western edge of the Yellow River Watershed (1.3% of the watershed). Within the Northwest Lowlands the Yellow River Watersheds is part of the Mille Lacs Upland Subsection which extends across the St. Croix into eastern Minnesota. The eastern ¼ of the Yellow River Watershed (24.0%) is within the **Forest Transition Ecological Landscape (EL)**. Within the Forest Transition EL the Yellow River Watersheds is part of the St Croix Moraine Subsection.

Land Type Associations (LTAs) are the smallest ECS units currently mapped for the entire watershed. There are 7 LTAs mapped within the Yellow River Watershed. The Danbury-Trego Plains LTA is on the northwest end of the Yellow River Watershed. The Lower Namekagon Rolling Barrens LTA intersects with the Yellow River Watershed in a small area on the western end of the watershed. The Web Lake Collapsed Barrens LTA intersects with the Yellow River Watershed across the north-central watershed boundary into the western end of the watershed. The Siren Plains LTA intersects with the Yellow River Watershed in a band along the western half of the southern watershed boundary. The Spooner Plains LTA intersects with the south-central portion of Yellow River Watershed along the transition from the northwest sands EL to the Forest Transition EL. The St Croix Plains LTA extends into the Yellow River Watershed in two small separate sections on the western watershed boundary. The Late St Croix Moraines LTA encompasses the eastern ¼ of the Yellow River Watershed. Detailed descriptions of the LTAs can be found by Ecological Landscape on the WDNR Ecological Landscape webpage: http://dnr.wi.gov/topic/landscapes/index.asp?mode=Choose

As part of the Wisconsin Statewide Forest Strategy, the WI DNR created models to describe and rank potential areas for managing for ecosystem services such as water quality, air quality, carbon sequestration, and habitat for threatened or endangered species. The Yellow River Watershed is heavily forested, and rich in high quality water resources. As a result, 39.7% of the watershed is considered high priority for managing for ecosystem service such as water quality, air quality, carbon sequestration, and habitat for threatened or endangered species. Much of the high priority and medium priority (24.6%) area is concentrated in the western half of the watershed. Much of the eastern third of the watershed in not rated most likely because this area has a lot of cultivated crops and pasture/hay. This data set does not include marginally productive agricultural lands that have the potential to provide greater ecosystem services if they were planted with trees, because they do not currently provide such services. The watershed is located in a part of Wisconsin with a relatively high proportion of high priority areas as compared to the state as a whole.

Wisconsin Strategy for Species of Greatest Conservation Need, September, 2005 (also known as Wisconsin's the State Wildlife Action Plan (SWAP)) is a strategic plan focused on managing populations of "species in greatest conservation need." The plan offers some highlights for the Northwest Sands and Forest Transition Ecological Landscapes, which include:

Northwest Sands

- There is ample opportunity for increasing the extent of dry jack pine-northern pin oak forest and white and red pine restoration.
- Large-scale restoration of oak-pine barrens and wetlands (sedge meadows, marshes, and bogs) would benefit many rare birds, herptiles, plants, butterflies and moths, and many other invertebrates found in the Northwest Sands.
- Other species deserving special management in this Ecological Landscape include wolves and grassland/shrubland birds.
- Maintenance and restoration of St. Croix, Yellow lakes, wild rice lakes, streams, springs or spring creeks, and conifer swamps present additional ecological management opportunities.

Forest Transition

- Reforestation of marginal agricultural lands to reduce forest fragmentation, increase forested habitat, provide protection from erosion, and increase socioeconomic value.
- Preservation of Eastern hemlock on the western extent of its range, where it may have unusual genetic factors.
- Preservation and management of the St. Croix which run through this Ecological Landscape. Prevention of nonpoint pollution in the river system.

F. Conclusion

The St. Croix River Basin has been changed by human activities in significant ways since European settlers began to call it home. Our collective management of the land has had a noticeable impact on natural resources in many ways, particularly with respect to water quality. Along with point sources, changes to the landscape have resulted in enough additional nutrients (phosphorus) reaching Lake St. Croix at the mouth of the Basin to cause the Lake to become eutrophic and to warrant a designation of "impaired" from the MPCA and WI DNR.

The loss of low phosphorus export land cover types such as forest (1.1 million acres lost) to high phosphorus export cover types such as agriculture and urban (0.73 million acres converted) is most pronounced at the southern and downstream portion of the Basin. The Yellow River Tributary Watershed sits at a transition point where this upstream movement of converted cover types slows. Protecting the remaining forests (as well as shrublands, grasslands, and lowland vegetation) in the Yellow River Tributary Watershed and other watersheds in the St. Croix River Basin will be critical for maintaining the water quality that the Upper St. Croix River Basin enjoys and to keeping the water quality in Lake St. Croix from declining further.

The Yellow River Watershed lost approximately 62,000 acres (26% of the watershed) of upland forest from presettlment to 2006. Yellow Lake, a pool on the Yellow River flowage, is designated as impaired for Total Phosphorus. Some of that impairment may be due to an increase in high phosphorus export cover types upstream from the Lake. The loss of upland forest may have also had some effect on water quantity due to increased peak flows from spring snow melts. Throughout the Yellow River Watershed overall, there is not enough area of storage (lowland vegetation and open water, a total of 18% of the watershed) to maintain stable peak flows from spring snow melts. Streams in the watershed may be at risk for increased peak flows if too much upland forest is lost (see Section 3 for more).

The Lake St. Croix Nutrient TMDL recommends reaching phosphorus loading reduction goals by reducing phosphorus export per land cover type, not by converting land cover. However, converting land cover from high phosphorus export cover types to low export cover types would also reduce phosphorus loading. According to the TPEC used in the TMDL, converting agriculture and urban to forest and shrubland results in a reduction of 0.47 lb/ac-year. The TMDL report calls for reduction of 9,121 lb/yr (24%) of phosphorus export in the Yellow River Watershed. To achieve the TMDL phosphorus export reduction goal by that type of land cover conversion alone would require conversion of approximately 19,000 acres (from 1990 land cover amounts) from agriculture and urban to forest and shrubland.

In terms of reaching TMDL goals by land cover conversion, the Yellow River Tributary Watershed has made progress in comparison to 1990 land cover levels as reported in the TMDL. According to analysis in the TMDL, in 1992, 32,465 acres of the Yellow River Tributary Watershed was in agricultural land cover and 2,087 acres was in urban land cover for a total of 34,552 acres in higher phosphorus export land cover types. According to the 2006 land cover data (Appendix E), agricultural land cover has decreased by 23,401 acres to 9,064 acres and urban has increased by 13,093 acres to 15,180 acres. With a cumulative decrease of approximately 10,000 acres of land cover with high phosphorus export, it appears that some of the TMDL goals have already been met.

Meeting the remaining reduction by land cover change alone would mean that an additional 9,000 acres would need to return to lower phosphorus export cover types. Reduction of phosphorus export amounts from agriculture and urban lands will clearly need to be a part of the effort taken to reduce phosphorus loading. However, if agricultural land began to increase again along with urban lands, the gains made

since 1990 towards better water quality could be lost. Protection of lower phosphorus export land cover types will be necessary to ensure that a backwards slide away from reaching TMDL goals does not occur.

While total phosphorus export coefficients do a good job of calculating the distribution of phosphorus export loads across an area as large as the St. Croix Basin, they lose their effectiveness at finer scales. For example, phosphorus in runoff from a row crop has less chance of reaching a larger water body if it first runs through a naturally meandering stream rather than through a drainage ditch. Similarly, 100 acres of afforestation that is miles from the nearest perennial stream will not have the same effect on water quality as 100 acres of afforestation that is next to that stream. Planning and management at finer scales will require better tools. Section 3, the Sub-watershed Analysis, zooms in on the Major Watershed by analyzing key natural and cultural factors that are drivers for water quality at the sub-watershed scale and is a first step towards finer scale planning that can guide activities in the Yellow River Tributary Watershed.

Forests and water quality are important and phosphorus export is a focal point of that relationship, but that interaction is only a part of the larger ecological and socio-economic system. In the ecological system, wildlife habitat, forest composition, invasive species, and climate change are important. In the socio-economic system, recreational activities, landowner goals, and the forest products industry are important. This Plan does not attempt to cover all of these issues in depth, but it also does not claim that the forest and water quality solution exists as an independent system. On the contrary, actions taken to protect, improve, and restore forests throughout the watershed are keys to not only protecting and improving water quality and quantity, but to maintaining the ecological and socio-economic health of the Basin.

Protecting and improving forests and water quality is a complex issue that no single agency can handle on its own. Humans have altered the ecological systems in ways never seen before. The socio-economic system continues to become more complex as we grow as individuals and as communities. To address the issues involved with forests and water quality, we will need a shared vision on where we want to go. Part 2 of the plan outlines this shared vision.

Part 1.
Section 3 – Sub-watershed Analyses

The purpose of this section is to provide resource managers with a detailed analysis of conditions and forest land cover/water relationships that exist on a sub-watershed basis. Strategically analyzing watersheds for conservation opportunities is hard work. This analysis is intended to help managers identify and prioritize specific areas in the Yellow River Major Watershed so they can more effectively promote and implement forest management practices that are more likely to result in improving water quality and to achieve other public and private benefits.

A. Overview

Watersheds were not created equal, nor do they function equally in their "production" of clean water. As introduced in Section 2, each of the major watersheds of the St. Croix Basin has its own unique set of hydrologic and ecological conditions as well as its own mix of land use activities that define water quality conditions in lakes, streams and rivers. Correspondingly, each of the six sub-watersheds as well as the 11 minor watersheds within the sub-watersheds have their own distinct in characteristics; varying greatly in size, shape, and function which affect their ability to produce clean water. Informed with an understanding of these general watershed characteristics, resource managers can set logical, rational priorities to guide their use of public funds.

The following narrative provides a more detailed description and a list of key findings for each of the sub-watersheds that seeks to expose the "drivers" of water quality in relation to land cover. The narrative also provides an overall assessment of risk in terms of impacts on water quality if forest management activities are not strategically implemented. With this detailed information it becomes easier to better understand how these sub-watersheds currently function in their production of clean water. With this understanding, the assessment of the sub-watersheds becomes an excellent foundation for shaping resource management policy and priorities on a local level.

B. Sub-watershed Assessment Criteria

Throughout the landscape stewardship planning process, members of the planning committee reviewed and discussed a wide range of data, maps and reports detailing the land cover and water resource connections. Data on several key "natural" factors such as area of the sub-watershed, stream length, slope, and soils were assessed. Numerous "cultural" factors, manmade activities across the landscape, were also assessed. Cultural factors included items such as land ownership, disturbed lands, historic loss of upland forests, and impaired waters. For the purposes of this Plan the sub-watershed assessment was based on the following criteria:

Natural Factors

- Position in the major watershed: Sub-watersheds that are lower in the watershed receive waters from upstream, and so are at risk based on land cover in the sub-watershed as well as upstream.
- Total stream length: Total stream length is used to calculate stream density (which is miles of stream per square mile).

- Stream density: Greater stream density means a potential for more land area to drain to contributing waters.
- Average sub-watershed slope: Higher average slope means greater potential for runoff and for more land area to drain to contributing waters.
- Slope of main stream channel: The slope of the main stream channel affects in-stream processes such as the rate of flow.
- Soils: The soils in the watershed affect runoff.
- Area of storage (wetlands/open waters): Storage in the watershed slows peak flows from spring snow melts and significant rainfall events.

Cultural Factors

- Public land ownership: Public land in the watershed is generally protected from conversion to agriculture and developed cover types.
- Historic upland forest cover lost: Loss of upland forests contributes to declining water quality. Statistics below are given in percent of the sub-watershed that was converted from upland forest to other cover types.
- Converted lands: Converted lands include agriculture and urban areas that have high potential to negatively influence water quality. Statistics below are given in percent of the sub-watershed that has been converted to these cover types.
- Potential PFM (private upland and lowland forest and lowland shrub with unknown conservation): These areas have the potential for increased protection of forest and lowland shrub. Failure to protect these areas could result in declining water quality.
- Area of upland forest: The total area of upland forest indicates how much area is left that has high water quality and quantity protection potential. The total area of upland forest that is protected (not private ownership with unknown conservation status) is also included to compare with the amount of forest that should be protected to maintain stable peak flows from spring snow melt.
- Preserve forest to maintain stable spring snow melt: The amount of forest that should be protected to keep 40% of the sub-watershed area covered by upland forest and storage to maintain stable peak flows from spring snow melt.
- Impaired streams: Sub-watersheds with high disturbance and high upland forest loss generally are at higher risk for impaired streams.
- Impaired waters: Sub-watersheds with high disturbance and high upland forest loss generally are at higher risk for impaired waters.
- Designated trout streams: Trout streams represent additional water quality considerations such as stream temperature.

C. Yellow River Sub-watershed Historical Land Cover Change

As summarized in Section 2, land cover is one of the leading critical factors that can impact water quality. The following information was taken from the Yellow River Sub-watershed Resource Inventory and Assessment which provides detailed information about the six sub-watersheds. See Appendix F for the complete report including narrative, key findings, tables, and maps. The following two tables provide the detailed land cover information for presettlement and the current time frames for each sub-watershed in the Yellow River Major Watershed. Users of the Plan are reminded that the impacts of land cover change, over time, can be either negative or positive.

Presettlement Land Cover (mid-late 1800s).

Presettlement Land Cover (mid-late 1800s)	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Jack pine, scrub (hills), oak forest and barrens	28,195.8	87.6	41,348.7	78.9	30,935.1	77.9	42,829.7	83.1	63.0	0.3	14,925.0	40.5
Oak -- white oak, black oak, bur oak	0.0	0.0	0.0	0.0	0.0	0.0	473.1	0.9	0.0	0.0	0.0	0.0
Sugar maple, basswood, red oak, white oak, black oak	0.0	0.0	0.0	0.0	0.0	0.0	1,268.4	2.5	490.2	2.3	4,049.6	11.0
Sugar maple, yellow birch, white pine, red pine	0.0	0.0	0.0	0.0	0.0	0.0	2,410.5	4.7	15,468.4	71.9	12,546.2	34.0
White pine, red pine	0.0	0.0	0.0	0.0	1,221.7	3.1	178.9	0.3	2,080.9	9.7	2,258.4	6.1
Subtotal (Upland Forest)	**28,195.8**	**87.6**	**41,348.7**	**78.9**	**32,156.8**	**81.0**	**47,160.7**	**91.5**	**18,102.6**	**84.1**	**33,779.2**	**91.6**
Lowland hardwoods -- willow, soft maple, box elder, ash, elm, cottonwood, river birch	0.0	0.0	3,231.4	6.2	1,554.9	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Swamp conifers -- white cedar, black spruce, tamarack, hemlock	703.3	2.2	851.7	1.6	1,253.6	3.2	1,425.6	2.8	0.0	0.0	578.5	1.6
Subtotal (Lowland Vegetation)	**703.3**	**2.2**	**4,083.1**	**7.8**	**2,808.5**	**7.1**	**1,425.6**	**2.8**	**0.0**	**0.0**	**578.5**	**1.6**
Lakes (open water, 1992 areas added)	3,287.1	10.2	6,998.2	13.3	4,730.0	11.9	2,980.3	5.8	3,417.4	15.9	2,533.7	6.9
Subtotal (Open Water)	**3,287.1**	**10.2**	**6,998.2**	**13.3**	**4,730.0**	**11.9**	**2,980.3**	**5.8**	**3,417.4**	**15.9**	**2,533.7**	**6.9**
Total Sub-watershed Area	**32,186.2**		**52,429.9**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

Current Land Cover (2006).

Current Land Cover (2006)	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Deciduous Forest	15,233.8	47.3	23,255.3	44.3	18,121.0	45.7	23,052.7	44.7	8,015.0	37.2	19,975.4	54.1
Evergreen Forest	1,916.5	6.0	1,992.4	3.8	1,940.4	4.9	1,217.8	2.4	243.1	1.1	469.1	1.3
Mixed Forest	5,017.7	15.6	5,633.4	10.7	5,157.9	13.0	4,630.2	9.0	909.8	4.2	1,336.8	3.6
Subtotal (Upland Forest)	**22,168.0**	**68.8**	**30,881.2**	**58.9**	**25,219.4**	**63.5**	**28,900.7**	**56.0**	**9,167.8**	**42.6**	**21,781.3**	**59.0**
Shrub/Scrub	1,550.2	4.8	801.1	1.5	255.9	0.6	176.6	0.3	31.1	0.1	41.5	0.1
Subtotal (Upland Shrub)	**1,550.2**	**4.8**	**801.1**	**1.5**	**255.9**	**0.6**	**176.6**	**0.3**	**31.1**	**0.1**	**41.5**	**0.1**
Grassland/Herbaceous	75.0	0.2	140.7	0.3	143.1	0.4	189.8	0.4	180.1	0.8	421.7	1.1
Pasture Hay	603.0	1.9	3,773.5	7.2	1,727.7	4.4	10,172.1	19.7	4,975.1	23.1	5,588.6	15.1
Subtotal (Upland Grass)	**678.0**	**2.1**	**3,914.2**	**7.5**	**1,870.8**	**4.7**	**10,362.0**	**20.1**	**5,155.2**	**24.0**	**6,010.4**	**16.3**
Woody Wetlands	1,680.5	5.2	2,786.0	5.3	2,245.0	5.7	1,854.8	3.6	1,106.7	5.1	2,088.3	5.7
Emergent Herbaceous Wetlands	536.3	1.7	1,832.6	3.5	1,947.1	4.9	1,007.5	2.0	59.0	0.3	106.1	0.3
Subtotal (Lowland Vegetation)	**2,216.9**	**6.9**	**4,618.6**	**8.8**	**4,192.0**	**10.6**	**2,862.3**	**5.6**	**1,165.7**	**5.4**	**2,194.4**	**5.9**
Cultivated Crops	170.7	0.5	1,849.1	3.5	1,197.1	3.0	2,978.9	5.8	974.9	4.5	1,893.2	5.1
Subtotal (Agriculture)	**170.7**	**0.5**	**1,849.1**	**3.5**	**1,197.1**	**3.0**	**2,978.9**	**5.8**	**974.9**	**4.5**	**1,893.2**	**5.1**
Developed, High Intensity	0.0	0.0	31.0	0.1	0.0	0.0	74.0	0.1	21.6	0.1	26.9	0.1
Developed, Medium Intensity	11.9	0.0	66.4	0.1	5.5	0.0	175.1	0.3	54.5	0.3	36.6	0.1
Developed, Low Intensity	98.5	0.3	243.0	0.5	64.0	0.2	510.2	1.0	378.7	1.8	536.5	1.5
Developed, Open Space	1,977.0	6.1	2,856.3	5.4	1,985.3	5.0	2,783.7	5.4	1,174.3	5.5	2,069.0	5.6
Subtotal (Developed)	**2,087.3**	**6.5**	**3,196.7**	**6.1**	**2,054.8**	**5.2**	**3,543.1**	**6.9**	**1,629.0**	**7.6**	**2,669.1**	**7.2**
Barren Land (Rock/Sand/Clay)	0.0	0.0	1.3	0.0	0.0	0.0	7.1	0.0	19.0	0.1	55.8	0.2
Subtotal (Barren)	**0.0**	**0.0**	**1.3**	**0.0**	**0.0**	**0.0**	**7.1**	**0.0**	**19.0**	**0.1**	**55.8**	**0.2**
Open Water	3,334.1	10.4	7,203.5	13.7	4,905.3	12.4	2,736.0	5.3	3,377.2	15.7	2,245.7	6.1
Subtotal (Open Water)	**3,334.1**	**10.4**	**7,203.5**	**13.7**	**4,905.3**	**12.4**	**2,736.0**	**5.3**	**3,377.2**	**15.7**	**2,245.7**	**6.1**
Total Sub-watershed Area	**32,205.2**		**52,465.6**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

Loon Creek:

From presettlement to 2006, forest cover in the Loon Creek sub-watershed decreased from 87.6% of land area within the sub-watershed to 68.8%. That represents a loss of approximately 6,000 acres of previously forested land. These acres have primarily been converted to shrub land, hay field/pasture, and development. However, it is important to note that although much of the Loon Creek sub-watershed remains forested, the presettlement cover type has been almost completely eliminated from the landscape. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 6% of the total land area in the Loon Creek sub-watershed is in a primarily evergreen cover type and there are virtually no barrens opening within the sub-watershed. This represents a significant loss of the native cover type.

Lower Yellow River:

From presettlement to 2006, forest cover in the Lower Yellow River sub-watershed decreased from 78.9% of land area within the sub-watershed to 58.9%. That represents a loss of approximately 10,000 acres of previously forested land. These acres have primarily been converted to shrub land, hay field/pasture, cultivated crops and development. This includes the conversion of thousands of acres of forest and forested wetland in proximity to the Yellow River and Devils Lake. It is also important to note that although much of the Lower Yellow River sub-watershed remains forested, the presettlement cover type has declined significantly on the landscape. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 3.8% of the total land area in the Lower Yellow River sub-watershed is in a primarily evergreen cover type and only around 140 acres of barrens openings remain. This represents a significant loss of a historically important cover type for this watershed.

Sand Lakes:

From presettlement to 2006, upland forest cover in the Sand Lakes sub-watershed decreased from 81.0% of land area within the sub-watershed to 63.5%. Lowland forest cover decreased from 7.1% to 5.7% of land area within the watershed. That represents a loss of approximately 7,500 acres of previously forested land. These acres have primarily been converted to shrub land, hay field/pasture, cultivated crops and development. It is also important to note that although much of the Sand Lakes sub-watershed remains forested, the presettlement cover type has declined significantly on the landscape. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 4.9% of the total land area in the Sand Lakes sub-watershed is in a primarily evergreen cover type and only 0.4% of the land area is in potential barrens openings. This represents a significant loss of a historically important cover type for this watershed.

Rice Lake:

From presettlement to 2006, upland forest cover in the Rice Lake sub-watershed decreased from 91.5% of land area within the sub-watershed to 56.0%. That represents a loss of approximately 18,000 acres of previously forested land – 35% of the watershed converted. These acres have primarily been converted to hay field/pasture, cultivated crops and development with much of this conversion in close proximity to the Yellow River and its tributaries within the sub-watershed. The Rice Lake sub-watershed has experienced a significant decrease in forested area since presettlement times, and the dominant presettlement cover type has virtually disappeared from the Rice Lake

sub-watershed. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 2.4% of the total land area in the Rice Lake sub-watershed is in a primarily evergreen cover type and only 0.4% of the land area is in potential barrens openings. This represents a significant loss of a historically important cover types for this sub-watershed.

Shell Lake:

From presettlement to 2006, upland forest cover in the Shell Lake sub-watershed decreased from 84.1% of land area within the sub-watershed to 42.6%. That represents a loss of approximately 9,000 acres of previously forested land – 41.5% of the watershed converted – the largest of any of the sub-watersheds within the Yellow River watershed. Much of that land was converted to pastures and hay fields, agriculture, and development. The Shell Lake sub-watershed has richer soils and higher amounts of prime and important farmland than other sub-watersheds within the Yellow River watershed, an important factor in the loss of forested lands here.

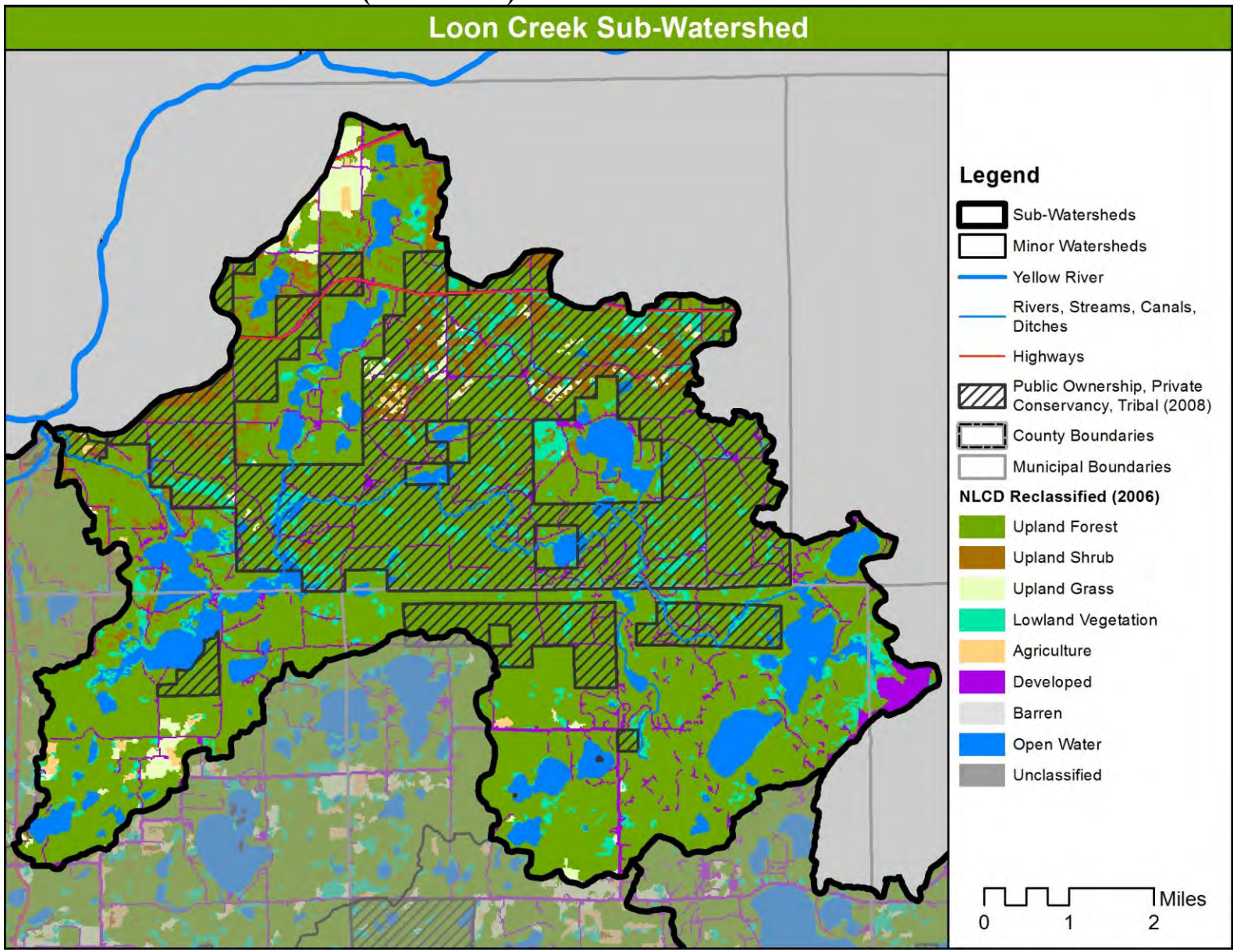
Headwaters Yellow River:

From presettlement to 2006, upland forest cover in the Headwaters sub-watershed decreased from 91.6% of land area within the sub-watershed to 59.0%. That represents a loss of approximately 12,000 acres of previously forested land – 32.5% of the watershed converted. Most of that area has been converted to pastures and hay fields, agriculture, and/or development. Like the Shell Lake sub-watershed, the Headwaters sub-watershed has some richer soils and higher amounts of prime and important farmland than many of the other sub-watersheds within the Yellow River watershed, an important factor in the loss of forested lands here. In addition, the northern half of this sub-watershed was dominated by jack pine and barrens. Today only around 1.3% of the total land area in the headwaters sub-watershed is in a primarily evergreen cover type – a loss of approximately 14,000 acres. This represents a significant loss of a historically important cover types for this sub-watershed.

D. Individual Sub-watershed Assessments

A map and more detailed information for each of the six sub-watersheds is provided next (pages 3-6 to 3-19). A series of key findings statements are listed for each sub-watershed followed by an overall sub-watershed risk assessment rating. This rating provides resource managers using this plan with an initial interpretation of the risks that the particular sub-watershed has in negatively affecting water quality if forest management activities are not strategically implemented. High risk translates to high priority for forest management activity.

Loon Creek Sub-Watershed (SubWD #1)

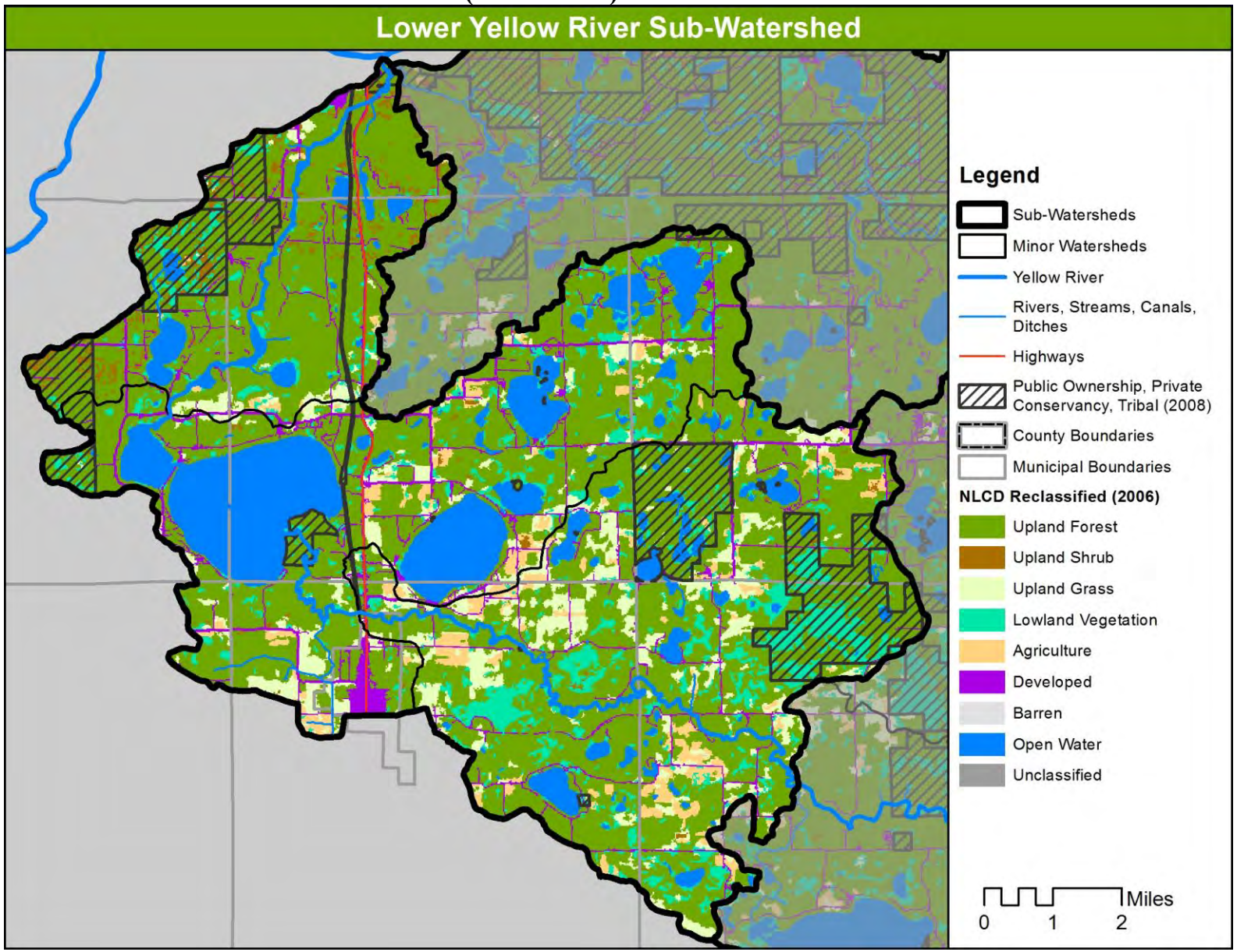


Loon Creek Sub-Watershed Description:
Area: 32,205 acres; 50.3 square miles
Position in watershed: Isolated tributary (low)
Total stream length: 27.4 miles
Stream density: 0.5 miles/square mile
Average sub-watershed slope: 3.9%
Lakes over 100 acres: Cadotte, Gull, Little Bear, Loon, Love, Minerva, Myre, Shoal, Tabor, Twentysix
Soils: Majority (90%) of rated soils are excessively to moderately well drained with high amount of excessively drained, not prime farmland.
Historic upland forest cover lost: approx. 6,000 acres; 19% of area converted from upland forest to other cover types
Converted lands: 2,258 acres; 7.0%
Public and private conservancy land ownership: 13,213 acres; 41.0 %
Private forest and lowland shrub (potential PFM): 13,174 acres; 55.2% of all forest/lowland shrub
Area of storage (wetlands/open waters): 5,551 acres; 17.2% of total sub-watershed area
Area of upland forest: 22,168 acres, 68.8% of total sub-watershed area, 9,784 acres (44.1%) protected
Preserve forest to maintain stable spring snow melt: 7,331 acres
Impaired streams: None
Impaired waters: None
Designated trout streams: None

Key Findings:
- Isolated from the rest of the Yellow River watershed. Confluence with Yellow River is less than one mile from Yellow/St. Croix confluence.
- Soils are well drained with high amount of excessively drained; very little prime farmland.
- High average slope.
- 10 lakes over 100 acres, 10.4% open water.
- High loss of barrens cover type (was 88% barrens presettlement).
- High amount of public and private conservancy ownership (41.0%), with high concentration along Loon Creek.
- Enough upland forest is protected to maintain stable peak flows from spring snow melts in Loon Creek.
- Townships of Jackson, Scott, and Webb Lake were heavily affected by a massive wind event and blowdown on July 1, 2011.

Overall Sub-watershed Risk Assessment:
- Low risk.

Lower Yellow River Sub-Watershed (SubWD #2)

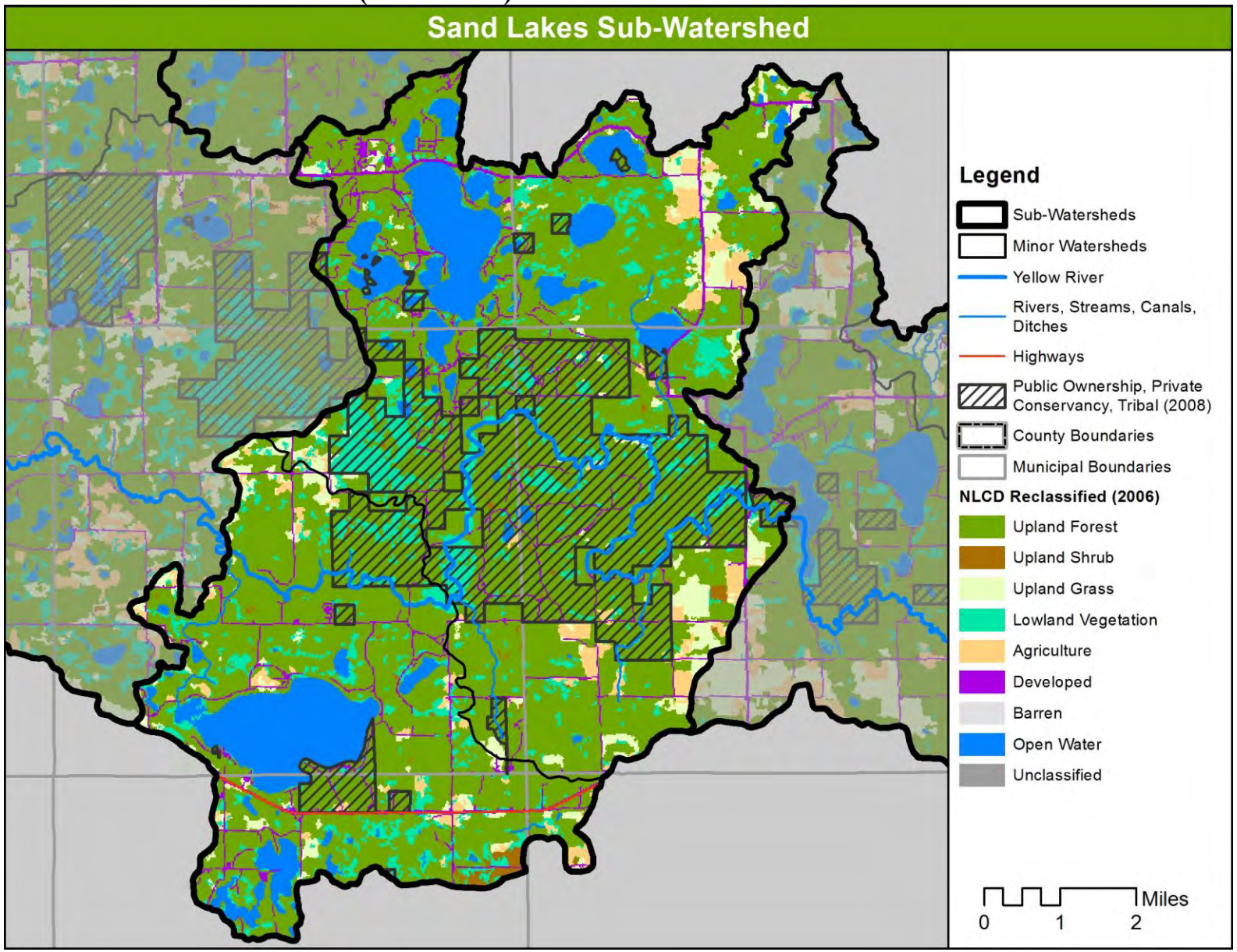


Lower Yellow River Sub-Watershed Description:
Area: 52,466 acres; 82.0 square miles
Position in watershed: Main stem flow through and watershed pour point (low)
Total stream length: 43.0 miles
Stream density: 0.5 miles/square mile
Average sub-watershed slope: 2.6%
Lakes over 100 acres: Bass (Union Township), Bass (Meenon Township), Conners, Crooked, Devils, Ham, Johnson, Little Yellow, Mud, Point, Yellow
Soils: Majority (75%) of rated soils are excessively to moderately well drained, highest percent area of poorly drained soils (25%), not prime farmland.
Historic upland forest cover lost: approx. 10,500 acres; 20% of area converted from upland forest to other cover types
Converted lands: 5,046 acres; 9.6%
Public and private conservancy land ownership: 6,612 acres; 12.6 %
Private forest and lowland shrub (potential PFM): 28,296 acres; 84.0% of all forest/lowland shrub
Area of storage (wetlands/open waters): 11,822 acres; 22.5% of total sub-watershed area
Area of upland forest: 30,881 acres, 58.9% of total sub-watershed area, 4,566 acres (14.8%) protected
Preserve forest to maintain stable spring snow melt: This measure does not apply to the Lower Yellow River Sub-watershed area given that there are areas upstream from the watershed that influence the stream channel characteristics of the main stem of the Yellow River. Additional analysis for watersheds smaller than minor watersheds would be necessary to evaluate the small streams that feed into the Yellow River within this sub-watershed. The reach of the Yellow River in this sub-watershed does not have enough storage in upstream areas (over 40%) to maintain stable spring snow melts, 45,354 acres of forest should be preserved throughout this sub-watershed and upstream areas.
Impaired streams: None
Impaired waters: 2680 acres: Johnson Lake for mercury (399 acres); Yellow Lake for total phosphorus and mercury (2,281 acres)
Designated trout streams: None

Key Findings:
- Pour point of Yellow River Tributary Watershed.
- 11 lakes over 100 acres, 13.7% open water.
- Yellow Lake is home to a population of over 2,000 Lake Sturgeon.
- Yellow Lake is designated as impaired for total phosphorus.
- Soils are well drained but also has highest percent area of poorly drained soils; very little prime farmland.
- High loss of barrens cover type (was 78.9% barrens presettlement).
- Low percent area of public lands and protected upland forest.
- High percent area of potential PFM.
- Villages of Webster and Danbury.

Overall Sub-watershed Risk Assessment:
High risk.

Sand Lakes Sub-Watershed (SubWD #3)

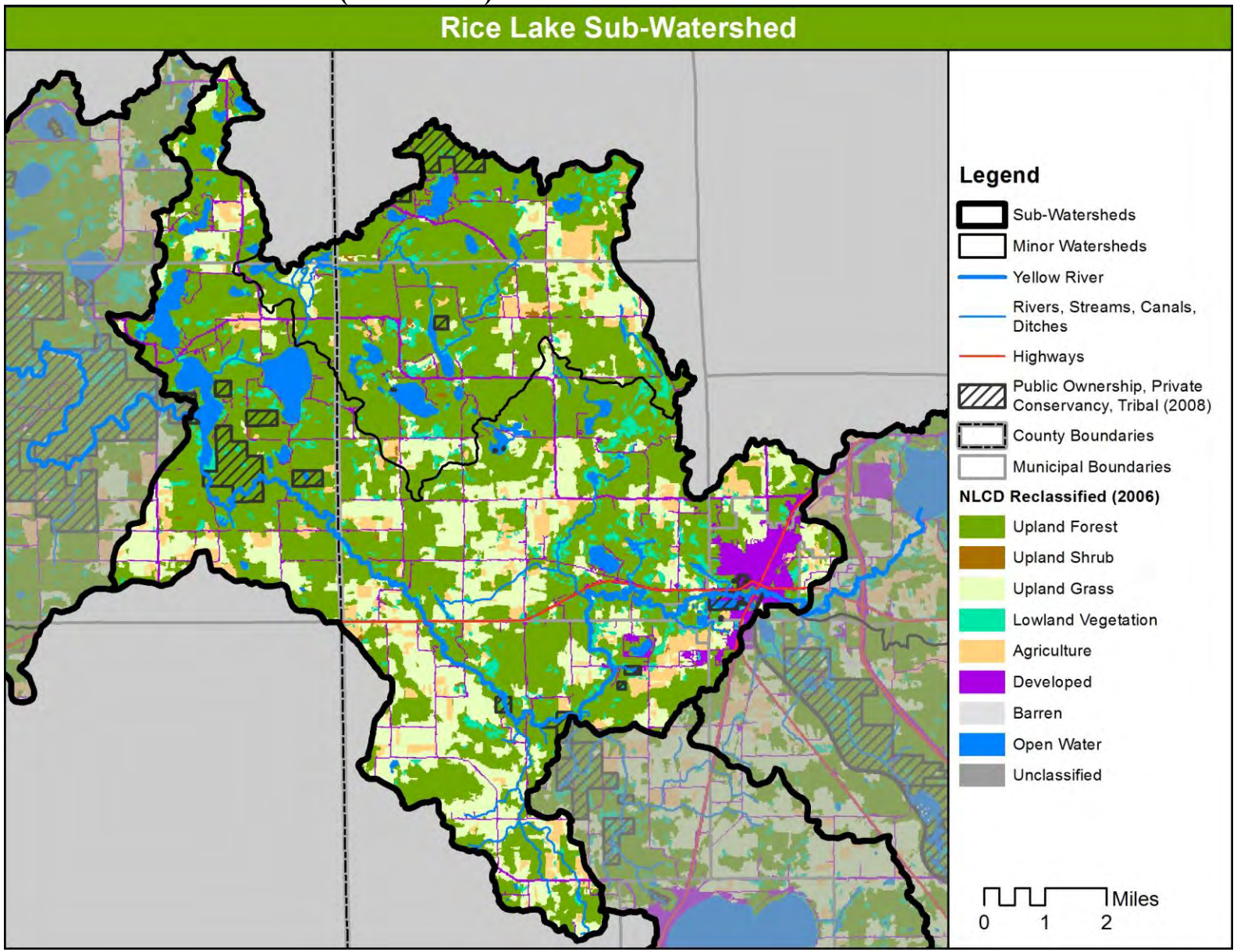


Sand Lakes Sub-Watershed Description:
Area: 39,695 acres; 62.0 square miles
Position in watershed: Main stem flow through (mid)
Total stream length: 33.5 miles
Stream density: 0.5 miles/square mile
Average sub-watershed slope: 2.6%
Lakes over 100 acres: Big Sand, Gaslyn, Green, Lower Twin, Mallard, Oak, Rice, Sand, Upper Twin, Warner Lake
Soils: Majority (76%) of rated soils are excessively to moderately well drained, second highest percent area of poorly drained soils (24%), not prime farmland.
Historic upland forest cover lost: approx. 6,900 acres; 18% of area converted from upland forest to other cover types
Converted lands: 3,252 acres; 8.2%
Public and private conservancy land ownership: 9,226 acres; 23.2%
Private forest and lowland shrub (potential PFM): 19,206 acres; 69.9% of all forest/lowland shrub
Area of storage (wetlands/open waters): 9,097 acres; 22.9% of total sub-watershed area
Area of upland forest: 25,219 acres, 63.5% of total sub-watershed area, 7,225 acres (28.6%) protected
Preserve forest to maintain stable spring snow melt: This measure does not apply to the Sand Lakes Sub-watershed area given that there are areas upstream from the watershed that influence the stream channel characteristics of the main stem of the Yellow River. Additional analysis for watersheds smaller than minor watersheds would be necessary to evaluate the small streams that feed into the Yellow River within this sub-watershed. The reach of the Yellow River in this sub-watershed does not have enough storage in upstream areas (over 40%) to maintain stable spring snow melts, therefore 36,191 acres of forest should be preserved throughout this sub-watershed and upstream areas.
Impaired streams: None
Impaired waters: Sand Lake for mercury (899.8 acres)
Designated trout streams: Spring Brook designated Class I (1.9 mi); Black Creek designated Class II (2.3 mi)

Key Findings:
- 10 lakes over 100 acres, 12.4% open water.
- Soils are well drained but with higher percent area of poorly drained soils than most other sub-watersheds; very little prime farmland.
- High loss of barrens cover type (was 77.9% barrens presettlement).
- Moderate percent area of public lands and protected upland forest, with high concentration along Yellow River.
- Moderate percent area of potential PFM.

Overall Sub-watershed Risk Assessment:
Low risk.

Rice Lake Sub-Watershed (SubWD #4)

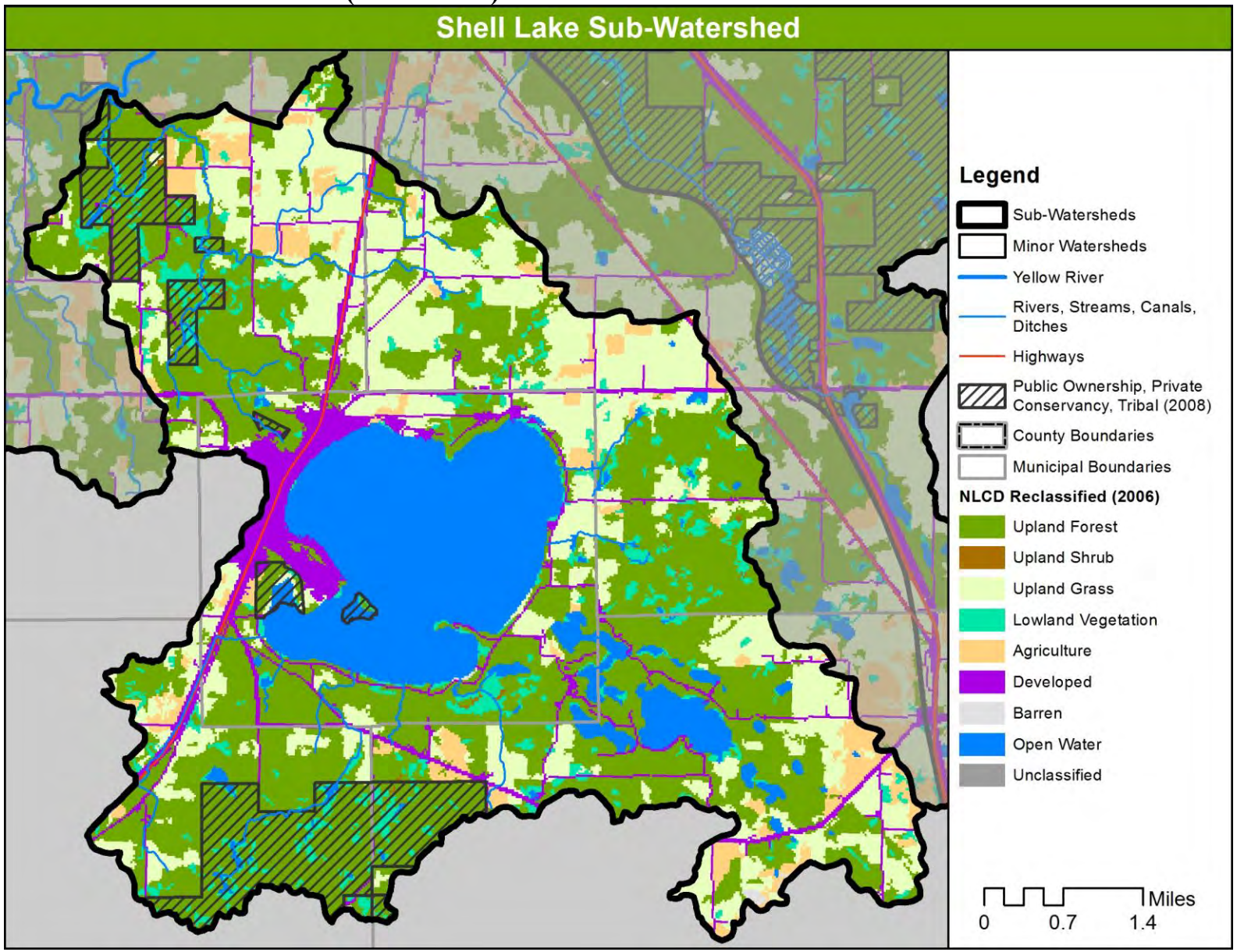


Rice Lake Sub-Watershed Description:
Area: 51,567 acres; 80.6 square miles
Position in watershed: Main stem flow through (mid) with an isolated tributary (Rocky Ridge Creek)
Total stream length: 67.9 miles
Stream density: 0.8 miles/square mile
Average sub-watershed slope: 3.4%
Lakes over 100 acres: Bass, Benoit, Ellsworth, Lipsett, Rice, Wilkerson
Soils: Majority (86%) of rated soils are excessively to moderately well drained, 4.3% prime farmland.
Historic upland forest cover lost: approx. 18,300 acres; 35% of area converted from upland forest to other cover types
Converted lands: 6,522 acres; 12.6%
Public and private conservancy land ownership: 1,325 acres; 2.6%
Private forest and lowland shrub (potential PFM): 29,511 acres; 96.0% of all forest/lowland shrub
Area of storage (wetlands/open waters): 5,598 acres; 10.9% of total sub-watershed area
Area of upland forest: 28,901 acres, 56.0% of total sub-watershed area, 1,179 acres (4.1%) protected
Preserve forest to maintain stable spring snow melt: This measure does not apply to the Rice Lake Sub-watershed area given that there are areas upstream from the watershed that influence the stream channel characteristics of the main stem of the Yellow River. The reach of the Yellow River in this sub-watershed does not have enough storage in upstream areas (over 40%) to maintain stable spring snow melts, therefore 29,410 acres of forest should be preserved throughout this sub-watershed and upstream areas. Rocky Ridge Creek would be at risk for increased peak flows if 3,907 acres of upland forest was lost in its drainage area.
Impaired streams: None
Impaired waters: None
Designated trout streams: Yellow River Trib (S4) designated Class I (0.4 mi), Dahlstrom Brook designated Class I (3.8 mi); Dago Creek designated Class I (1.2 mi); Yellow River Trib (S31) designated Class I (0.6 mi)

Key Findings:
- 6 lakes over 100 acres, 5.3% open water.
- High stream density.
- Soils are well drained; little prime farmland (4.3% of rated soils).
- High loss of barrens cover type (was 83.1% barrens presettlement).
- Highest percent area of converted lands.
- Low percent area of public lands and protected upland forest.
- High percent area of potential PFM.
- Not enough upland forest protected in Rocky Ridge Creek HUC12 to maintain stable peak flows from spring snow melts.
- Governor Tommy G. Thompson State Fish Hatchery, the state's largest cool water facility and the world's largest musky hatchery.
- City of Spooner.

Overall Sub-watershed Risk Assessment:
High risk.

Shell Lake Sub-Watershed (SubWD #5)

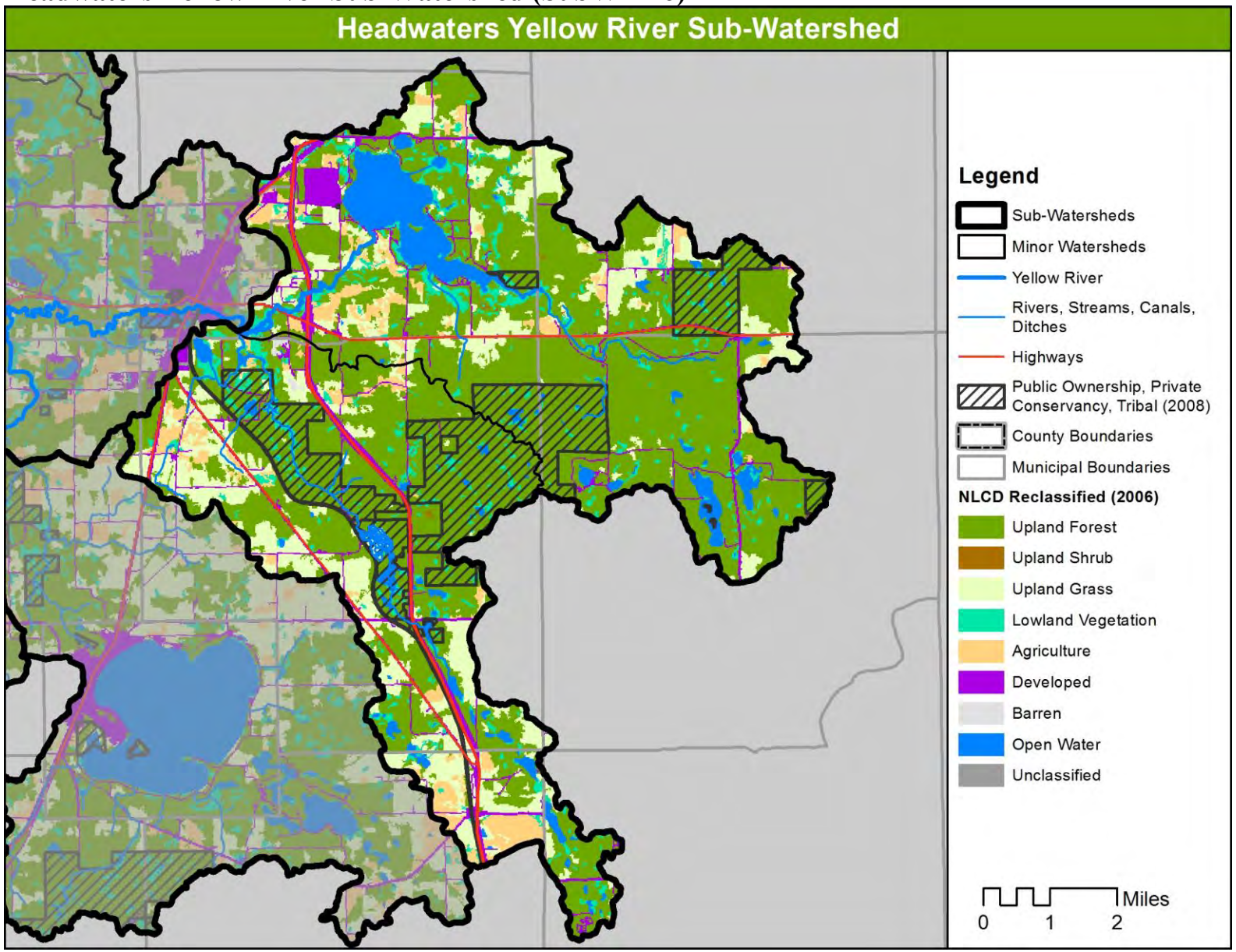


Shell Lake Sub-Watershed Description:
Area: 21,520 acres; 33.6 square miles
Position in watershed: Isolated tributary (high)
Total stream length: 35.0 miles
Stream density: 1.0 miles/square mile
Average sub-watershed slope: 3.0%
Lakes over 100 acres: Ripley, Shell
Soils: Majority (82%) of rated soils are excessively to moderately well drained, 23.3% prime farmland, 27.9% farmland of statewide importance.
Historic upland forest cover lost: approx. 8,900 acres; 42% of area converted from upland forest to other cover types
Converted lands: 2,604 acres; 12.1%
Public and private conservancy land ownership: 2,147 acres; 10.0 %
Private forest and lowland shrub (potential PFM): 8,307 acres; 80.9% of all forest/lowland shrub
Area of storage (wetlands/open waters): 4,543 acres; 21.1% of total sub-watershed area
Area of upland forest: 9,168 acres, 42.6% of total sub-watershed area, 1,684 acres (18.4%) protected
Preserve forest to maintain stable spring snow melt: Overall, analysis using this measure shows that 4,065 acres should be preserved in the Shell Lake Sub-Watershed to maintain stable peak flows from spring snow melts. However, the upper portion of the watershed has several pockets that are not connected by overland flow to the Yellow River (including Shell Lake). Additional analysis would be necessary to determine if loss of upland forest would affect small streams in the watershed.
Impaired streams: None
Impaired waters: None
Designated trout streams: Sawyer Creek designated Class I (2.8 mi); Sawyer Creek designated Class II (3.7 mi)

Key Findings:
- 2 lakes over 100 acres, 15.7% open water. Shell Lake, Wisconsin's largest land-locked, spring-fed lake at approximately 2,500 acres is the defining feature of the sub-watershed.
- Highest stream density. Sawyer Creek is a clear water spring fed trout stream, notable as home to a trout stocking and research program that goes back to 1933.
- Soils are well drained; highest percent area of prime farmland (23.3% of rated soils).
- Highest loss of upland forests (42%), differs from other sub-watersheds in that presettlement upland forest was primarily sugar maple, yellow birch, white pine, and red pine (not barrens).
- High percent area of converted lands.
- Low percent area of public lands, but moderate percent area of protected upland forest.
- Moderate percent area of potential PFM.
- City of Shell Lake.

Overall Sub-watershed Risk Assessment:
Moderate risk.

Headwaters Yellow River Sub-Watershed (SubWD #6)



Headwaters Yellow River Sub-Watershed Description:
Area: 36,891 acres; 57.6 square miles
Position in watershed: Headwaters and isolated tributary (high)
Total stream length: 38.2 miles
Stream density: 0.7 miles/square mile
Average sub-watershed slope: 4.0%
Lakes over 100 acres: Leesome, Spooner
Soils: Majority (90%) of rated soils are excessively to moderately well drained, 18.9% prime farmland. 24.0% farmland of statewide importance.
Historic upland forest cover lost: approx. 12,000 acres; 33% of area converted from upland forest to other cover types
Converted lands: 4,562 acres; 12.4%
Public and private conservancy land ownership: 6,004 acres; 16.3%
Private forest and lowland shrub (potential PFM): 18,328 acres; 76.8% of all forest/lowland shrub
Area of storage (wetlands/open waters): 4,440 acres; 12.0% of total sub-watershed area
Area of upland forest: 21,781 acres, 59.0% of total sub-watershed area, 5,059 acres (23.2%) protected (2,006 acres in Spooner Lake –Yellow River minor and 3,053 acres in Beaver Brook minor)
Preserve forest to maintain stable spring snow melt: While the Yellow River Headwaters Sub-watershed is grouped together, the Beaver Brook and Spooner Lake –Yellow River minor watersheds are essentially separate drainage areas. In the Beaver Brook minor watershed, maintain 4,926 acres of upland forest. In the Spooner Lake –Yellow River minor watershed, maintain 5,391 acres of upland forest.
Impaired streams: None
Impaired waters: None
Designated trout streams: Beaver Brook designated Class I (7.7 miles); Crystal Brook designated Class I (3.4 miles)

Key Findings:
- Headwaters of Yellow River Tributary Watershed.
- 2 lakes over 100 acres, 6.1% open water.
- Home to Beaver Brook Wildlife Area (BBWA), surrounding Beaver Brook and the many spring ponds and bank seeps that feed it.
- Highest average slope.
- Soils are well drained; higher amount of prime farmland (18.9% of rated soils) than most other sub-watersheds.
- High loss of upland forest, presettlement forest was a mix of barrens cover type and sugar maple, yellow birch, white pine, and red pine.
- High percent area of converted lands.
- Moderate percent area of public lands and protected upland forest.
- Moderate percent area of potential PFM.
- Not enough upland forest protected in Spooner Lake –Yellow River or Beaver Brook minor watersheds to maintain stable peak flows from spring snow melts.

Overall Sub-watershed Risk Assessment:
Moderate risk.

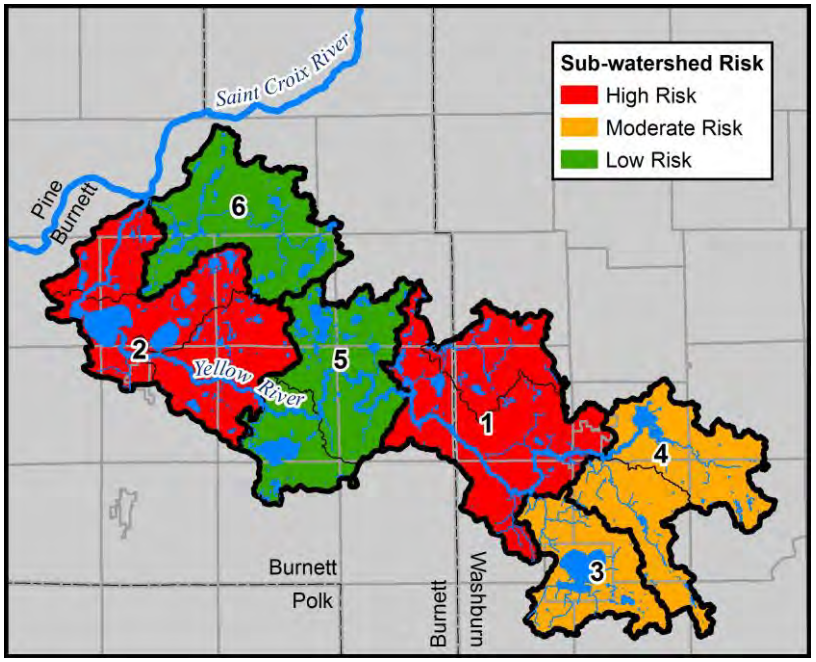
E. Assessment Criteria Summary Table

In order to draw some conclusions for management priorities and to help compare each sub-watershed with the others on each given resource issue, the resulting calculations of the key assessments were placed into a table format. The table below summarizes the results of the calculations made for each sub-watershed and for key natural and cultural factors developed through the sub-watershed assessment process. Rankings were assigned based on qualitative assessment of the range of values in the tributary watershed. Sub-watersheds were compared against each other, thus the priorities only apply within the context of the watershed.

Yellow River Sub-watershed Assessment Criteria Summary

	Loon Creek (SubWD # 1)	**Lower Yellow River (SubWD # 2)**	**Sand Lakes (SubWD # 3)**	**Rice Lake (SubWD # 4)**	**Shell Lake (SubWD # 5)**	**Headwaters Yellow River (SubWD # 6)**
Area	32,205 acres	52,466 acres	39,695 acres	51,567 acres	21,520 acres	36,891 acres
Natural Factors						
Position in watershed	**L** Trib, low	**H** Main stem, low	**M** Main stem, mid	**M** Main stem, mid	**L** Trib, hi	**L** Headwaters, hi
Stream density	**L** 0.5 miles/sqmi	**L** 0.5 miles/sqmi	**L** 0.5 miles/sqmi	**M** 0.8 miles/sqmi	**H** 1.0 miles/sqmi	**M** 0.7 miles/sqmi
Sub-wd Slope	**H** 3.9%	**L** 2.6%	**L** 2.6%	**M** 3.4%	**M** 3.0%	**H** 4.0%
Cultural Factors						
Upland forest loss	**L** 18.8%	**L** 20.0%	**L** 17.5%	**H** 35.4%	**H** 41.5%	**H** 32.5%
Converted lands	**L** 7.0%	**M** 9.6%	**L** 8.2%	**H** 12.6%	**H** 12.1%	**H** 12.4%
Public lands	**L** 41.0%	**H** 12.6%	**M** 23.2%	**H** 2.6%	**H** 10.0%	**M** 16.3%
Protected upland forest	**L** 44%, 9,784 ac	**H** 15%, 4,566 ac	**M** 29%, 7,225 ac	**H** 4%, 1,179 ac	**M** 18%, 1,684 ac	**M** 23%, 5,059 ac
Potential PFM	**L** 55%, 13,174 ac	**H** 84%, 28,296 ac	**M** 70%, 19,206 ac	**H** 96%, 29,511 ac	**M** 81%, 8,307 ac	**M** 77%, 18,328 ac
Impaired streams (other than mercury)	**L** 0.0 miles	**L** 0.0 miles	**L** 0.0 miles	**L** 0.0 miles	**L** 0.0 miles	**L** 0.0 miles
Impaired waters (other than mercury)	**L** 0 acres	**H** 2,281 acres	**L** 0 acres	**L** 0 acres	**L** 0 acres	**L** 0 acres
Notes: H = High Priority for forest management action, M = Medium Priority for forest management action, L = Low Priority for forest management action. The shaded box priorities represent the sub-watershed that had the highest ranking of all six for the given factor being assessed.						

F. Initial Screening of Sub-watersheds



Based on this analysis, the six sub-watersheds are ranked below in order of priority from the highest risk to impacts on water quality to the lowest.

1. *Rice Lake Sub-watershed – high risk.* Lowest percent area of public lands and protected upland forest, highest percent area potential PFM, highest percent area converted lands, moderate average slope.
2. *Lower Yellow River Sub-watershed – high risk.* Low percent area of public lands and protected upland forest, second highest potential PFM, Yellow Lake impaired for total phosphorus, low average slope.
3. *Shell Lake Sub-watershed – moderate risk.* Low percent area public land, moderate protected upland forest and potential PFM, highest upland forest loss, high percent area converted lands, moderate average slope.
4. *Headwaters Yellow River Sub-watershed – moderate risk.* Moderate percent area public lands and protected upland forest, moderate potential PFM, high upland forest loss, high percent area converted lands, steepest average slope.
5. *Sand Lakes Sub-watershed – low risk.* Moderate percent area public lands and protected upland forest, moderate potential PFM, low upland forest loss, low percent area converted lands, low average slope.
6. *Loon Creek Sub-watershed – low risk.* Highest percent area public lands and protected upland forest, low potential PFM, low upland forest loss, lowest percent area converted lands, steep average slope.

This initial ranking of sub-watersheds, while somewhat subjective, begins the process of interpeting the organized collection of data and the setting of priorities. The comments provided in the ranking above reflect the application of general knowledge about the six sub-watersheds. This risk assessment exercise using existing data and information may be basic, but it is low cost and relatively easy to develop. This analysis can help resource managers make more informed decisions as to where to prioritize efforts. Questions managers will likely be facing include:

- Where should I plant that tree to maximize the positive impacts on water quality?
- If we only had enough money to restore 1,000 acres of forestland, where should we spend the money?

Part 2 of this Plan will address the strategic planning question, “where do we want to go?” and establish and long range vision for managing forests in the Yellow River Tributary Watershed. Part 3 will address the “how will we get there question?” and explain in more detail what efforts should be done in the six sub-watersheds to efficiently and concurrently manage forests and improve water quality.

Part 2.
Section 4 – The Vision

In Section 4, the Plan begins to outline the vision and pathway for the future of the Yellow River Tributary Watershed as established by the Planning Committee through a series of working principles and desired future conditions.

A. Working Principles

At a series of meetings in 2012 and 2013, the Planning Committee formulated a series of working principles to summarize how they generally viewed the context of the forests and water quality in the Yellow River Tributary Watershed over time and how they would recommend interested partners and stakeholders pursue sustainable forest management that protects water quality in the future. The working principles were developed to provide an initial shared or agreed upon set of perspectives as they developed Part 2 of the Plan. This part of the Plan, the strategic policy framework, represents the heart of the Plan. Users of the Plan are encouraged to closely read through these principles to gain that shared perspective with the Planning Committee.

The following summarizes the Planning Team's working principles:

Planning Principles

- The Planning Committee recognizes that forest land cover is key to good water quality. The Committee members also believe that diverse, healthy forests are key to healthy aquatic and terrestrial wildlife populations.
- The Planning Committee recognizes that the presettlement forests and cover types in the Yellow River Tributary Watershed were a shifting mosaic, dependent on climate, topography, natural disturbance, and the activities of Native Americans. The Planning Committee recognizes that beginning in the mid-late 1800s, the condition and composition of the forests and major cover types in the Yellow River Major Watershed were significantly altered by a variety of more intensive land use activities from logging to agriculture to urban, shoreland, and rural residential land development. The dominant presettlement cover type, jack pine barrens, has declined significantly from presettlement times, and overall forest cover has declined in the major watershed but levels of decline vary on a sub-watershed basis.
- The Committee recognizes that there are significant portions of the Yellow River Tributary Watershed that are in good ecological condition. The watershed is heavily forested with high quality water resources abundant. Protecting and maintaining high quality forests will help to keep levels of phosphorus transported into the river from rising, protecting high quality water resources and improving impaired waters. Where forests are in a lower quality condition, the Committee encourages appropriate management to improve and restore these areas.
- The Planning Committee recognizes from a water quality perspective, one of the best strategies is to reestablish forests on lands that have been converted to other uses. Most of the Upland Forest lost since presettlement (-63,000 acres) is now in an open landscape setting and classified as Upland Grass (+28,000 acres), Urban Development (+15,000 acres), and Agriculture (+9,000 acres). Restoring

forest cover on these sites, including tree planting, forest stand improvement, and riparian buffer projects, can help improve water quality. In the Yellow River Watershed, changes to the natural vegetation are less clear due to the historic patchwork of forest, shrub, and grassland areas that made up the jack pine barrens – the predominant pre-settlement cover type which has largely disappeared from the watershed. An increase in agriculture, upland grassland (primarily pasture and hayfields), and developed land has resulted in the remaining forest being in a more fragmented condition.

- The Planning Committee recognizes that while reestablishing forests on lands that have been converted is the best strategy from a water quality perspective, planting forests in areas where wildlife habitat would be jeopardized as a result should be avoided if possible.
- The Planning Committee recognizes that forest management involves a range of conditions, practices, and approaches (old growth forests, successional forests, extended rotation, plantations, etc.), and that landowners may be motivated by an array of goals and objectives that influence the type and intensity of forest management they will implement.
- The Planning Committee recommends an ecological approach -- growing "the right kinds of trees on the right sites" -- to forest management in the watershed. The Planning Committee recommends the use of Wisconsin's Forest Management Guidelines, BMPs for Water Quality, Forestry BMPs for Invasive Species, Forestland Woody Biomass Harvesting Guidelines and the WI DNR Silviculture and Forest Aesthetics Handbook as a means to guide forest management activities across the watershed.

Coordination Principles

- The Planning Committee believes that sustained coordination between service providers in the Yellow River Tributary Watershed will lead to greater capacity from pooled resources and increased funding opportunities and to more targeted and effective landowner services and interactions.
- The Planning Committee believes that there is room for improvement towards sustained coordination in the Yellow River Tributary Watershed.
- The Planning Committee believes that analyzing the sub-watershed functions can help provide clues on how to target and deliver limited public resources to improve forests and water quality as well as provide other public benefits and that additional tools will be helpful to fine tune that prioritization.
- The Planning Committee will advocate stable and consistent funding for not only implementation dollars but for increased levels of coordination and staff capacity to get the job done.
- The Planning Committee believes that existing technologies and collaboration can greatly extend our reach to the thousands of private landowners in the Yellow River Major Watershed and strongly encourages all partners and stakeholders to pool and coordinate efforts and resources over the next ten years to implement this Plan.

Implementation Principles

- **Good forest management = good water quality = good wildlife resources = good recreation opportunities**.
- The Planning Committee encourages the sustainable management and use of forest resources to promote better water quality, improved wildlife habitat and ecological resources, and enriched recreational opportunities through **outreach and education**.
- The Planning Committee encourages the use and application of sound scientific approaches, technologies, and methods to address forest, water, wildlife, ecological, and recreation resource management issues through **coordinated private incentive programs**.

- The Planning Committee through their public agencies, agree to use and apply sound resource management approaches, technologies, and methods to address forest, water, wildlife, ecological, and recreation resource management issues by supporting **public improvement projects** that are implemented by partnering agencies in the watershed.
- The Planning Committee supports the prudent development and/or updating of **regulatory controls** and enforcement mechanisms when appropriate and necessary, to address and protect public health and safety in relation to forest, water, wildlife, ecological, and recreation management issues. The highest amount of investments should be made in education, followed by incentives, improvements, and regulations, respectively.

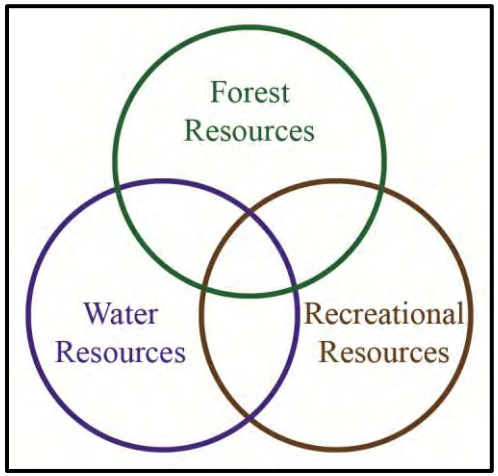
Monitoring/Evaluation Principles

- Through a shared vision and application of these principles, steady progress can be made towards the desired future conditions of forests in the Yellow River Tributary Watershed. The Planning Committee is committed to developing a practical and useful monitoring program for reviewing the implementation of this Plan.

B. Desired Future Conditions

The strategic policy framework for the Yellow River Watershed Landscape Stewardship Plan continues with the desired future conditions (DFCs). DFCs are statements that are long-range in nature. They are intended to provide an overall sense of direction or perspective in a relatively short concise format and are general in scope or content. A one hundred year horizon was used as the suggested timeframe. DFCs then filter down to Goals, Objectives, and Action Items in Section 5 of the Plan.

By achieving these desired future conditions, people living, working and recreating the Yellow River Tributary Watershed will enjoy a high quality of life more closely connected to the forests, water resources, and the overall watershed. People will have a greater awareness of the importance of healthy forests and high water quality from ecological, economic and social perspectives. This high quality of life could be considered an over-arching desired future condition.



In one hundred years, the Yellow River Watershed Partnership envisions a watershed that has:

- ***Protected and Improved Water Quality*** – landowners and local units of government will recognize together that healthy forests in this watershed are key to protecting good water quality and quantity. Forest land cover will be an integral component in water resource initiatives. In one hundred years, there will be no impaired waters in the Yellow River Tributary Watershed.
- ***Protected and Improved Forest Resources*** –will include:
  - Healthy and Sustained Forests and Ecological Resources – forests in the Yellow River Tributary Watershed will be healthy and sustained for the long term in an ecologically appropriate manner. The Yellow River Watershed Partnership envisions a forest that 1) is structurally, functionally, and compositionally diverse, 2) exhibits spatial

patterns consistent with the watershed's ecology, 3) supports natural communities of plant and animal species native to the watershed, and 4) provides diverse habitat that maintains natural communities and viable populations for the plant and animal species in the watershed.

  - Multiple Uses of Forest Resources – a full range of forest products will be produced in the watershed in a sustainable manner that protects and improves existing ecological resources and allows for a balance between economic and recreational interests.

- ***Attractive and Engaging Recreational Resources*** – a broad range of recreational opportunities in the watershed will be available to the public consistent with the respect for private property rights, the high quality of life enjoyed by residents, and the protection of the natural resource base. Forests and waters will be attractive for recreational activities to residents, tourists and outdoor enthusiasts and will provide educational opportunities that engage the people who recreate in the watershed to understand the importance that forests and water quality play in protecting recreational resources, the natural resource base, and a high quality of life.

Achieving these desired future conditions will require the following management conditions, which will be applied to each of the DFCs:

- ***Balanced and Managed Land Development*** – land use and development across the landscape will be managed in both urban and rural areas so as to respect and sustain healthy forests and water quality. Forest management policies and practices will be integrated into local land-use planning processes.
- ***Coordinated Collaborative Management*** – the 10-year landscape stewardship process for the Yellow River Major Watershed will have entered into its tenth generation. Coordinated and collaborative management of the forest and water resources will be thoroughly established. All partners and stakeholders including landowners, local officials, and agency staff will work collaboratively both on the planning and management of the forest and water resources to achieve the goals set forth in this Plan.

Part 2.
Section 5 – Goals and Objectives

A. Overview

One common complaint about resource management plans is that they do not provide enough direction or depth. Many plans lack enough specifics to be useful for the people who are supposed to implement them. As a result, plans too often end up sitting on a shelf. This problem is partially caused by inconsistent use of planning terms and how the "policy level" statements are written. A good planning process should work to thoroughly incorporate suggestions made by the people who are affected and/or benefit from the plan's implementation. Good plans should also be well organized and written in a consistent fashion.

To help in the development of a useful plan that can be more successfully implemented, the Planning Committee adopted a series of "nested" terms to clearly define and better organize the multitude of ideas and concepts suggested by all the people involved in the planning process. The planning process terms used in this Plan are defined as follows:

Desired Future Conditions. Desired Future Conditions (DFC), which were outlined in Section 4 of the Plan are broad overarching statements that describe preferred or desired conditions that a given geographic area or region will be like at the end of a given timeframe. DFC statements are very general and long range in nature. They are intended to provide an initial starting point for agreement on what forests in the landscape should be like in the future. DFCs are comparable in content to vision statements found in local government plans such as comprehensive plans. The DFC statements for the previously approved MFRC landscape plans have typically used a one hundred (100) year horizon when describing the desired future conditions of forests.

Goals. Goal statements outline the general directions that an organization intends to be attained at some point in the future. Goals are intended to provide general direction for a given resource initiative (water resources, forest management, recreation). Words such as ***encourage, protect, promote***, ***preserve***, and ***restore*** are commonly found in goal statements. The goals in the landscape stewardship plans represent what the Planning Committee thought needed to be pursued over the next ten to twenty (10 – 20) years to promote sustainable forest resources in the watershed.

Objectives. Statements that provide more specific direction on the efforts or strategies that are needed to implement each goal. Goals usually have more than one objective. Words like ***construct, plant, remove,*** and ***monitor*** are used to describe more specific direction in implementing the goals. Often, objectives will include quantifiable targets, as means to provide more specific and measurable parameters for monitoring progress towards the goals. The initial description of programs and projects are usually found in objective statements.

Action Items. These statements outline in more detail what the partners anticipate will be the major tasks in completing the objectives. Objectives should contain several action item statements to help further clarify efforts needed to complete the objectives.

In general, goals, objectives, and action items are intended to provide a detailed outline of what an organization proposes to implement over the planning horizon, typically ten to twenty years. Collectively, the objectives and action statements define the methods needed to achieve the goals.

A simple illustration can help clarify these fundamental planning policy definitions. The diagram at right illustrates how the different types or levels of policy statements (goals, objectives and action items) should relate to each other.

As illustrated, several action item statements are "nested" into a corresponding objective or the next level up in the outline. Next, objectives nest into or describe how a given goal is to be implemented. And finally, the goals nest into the one desired future condition addressing the major emphasis areas of the resource initiatives of this project (water, forests, recreation). This structure or hierarchy helps to provide a stronger sense of purpose and a more detailed or specific course of action. This organizational format is also intended to help readers more quickly locate the specific topics that they are interested in.

Users of this Plan are encouraged to first briefly review the headings of goals and objectives to develop a general sense of direction that the partners of the Yellow River Watershed Partnership have chosen. With the hundreds, if not thousands of ideas and recommendations made in a good planning process, it is imperative to have a simple yet useful structure to help record, sort, and organize the various policy statements.

Nesting of Policy Statements

Desired Future Condition… in one hundred years, the watershed will have…

Goal 1:

Objective 1:
Action Item 1.
Action Item 2.

Objective 2:
Action Item 1.
Action Item 2.

Goal 2:

Objective 1:
Action Item 1.
Action Item 2.

Objective 2:
Action Item 1.
Action Item 2.

and so on…

The strategic policy framework described in this section of the Plan is like an aviation flight plan. It lays out the intended path or trajectory for the management of forest resources in the watershed. It is meant to guide not only the efforts of the members of the Yellow River Watershed Partnership, but also the thousands of landowners as well as local officials, natural resources professionals and service providers working in the watershed. Only through the combined and coordinated efforts of these people will more successful sustainable management of the forests that protect and improve water quality and quantity in the Yellow River Tributary Watershed occur.

While the focus of the federal grant for this project is to link water and forest resource management, the wealth of public recreation lands in the Yellow River Tributary Watershed coupled with strong interest by landowners for their own private recreation activities on their own

lands, recreation opportunities should be addressed concurrently. This section includes an initial outline of recreation goals and objectives to encourage increased opportunities and synergy which can provide for mutual gains by landowners and the public alike.

The goals, objectives, and action items for this Plan have been organized into the following three categories to address the DFCs:

- Water Resources – DFC: Protected and Improved Water Quality
- Forest Resources – DFC: Protected and Improved Forest Resources
- Recreational Resources – DFC: Attractive and Engaging Recreational Resources

B. Water Resources

Desired Future Condition: Protected and Improved Water Quality

Goal 1 – Protect Healthy Water Systems and Features. *Protect existing high quality water systems and features that are at medium risk and are moderately threatened from further decline.*

Rationale:

- The Federal Clean Water Act requires states to adopt water quality standards to protect lakes, rivers, streams and wetlands from pollution.
- Protecting healthy water resources before further land development occurs is essential to maintaining and improving water quality, biological diversity and high quality habitats.
- Riparian forest cover declined by more than 5% between 2001 and 2006.
- Continued demand for shoreland/riparian development and threats of land parcelization and forest fragmentation.

Potential Monitoring Indicators:

- Wisconsin DNR Impaired Waters List http://dnr.wi.gov/topic/impairedwaters/.
- Wisconsin's Natural Heritage Inventory database http://dnr.wi.gov/topic/nhi/.
- Wisconsin's Forestry Best Management for Water Quality Monitoring Program
- Protection of Sites of Biodiversity Significance not already protected by public land.
- Restoration of critical riparian corridors.

Objective A: **Protect Forested Riparian Corridors and Undeveloped Shorelands.** The Yellow River Major Watershed has several high quality forested water resources. Support the protection and maintenance of existing forested riparian corridors and undeveloped shorelands.

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to assess and prioritize riparian corridor and shoreland protection projects.
2. Support active protection and maintenance of forested riparian corridors and undeveloped shorelands through fee title (purchase) or conservation easements, County Forest acquisitions, and other protection tools and strategies.
3. Develop a list of federal, state and local shoreland protection/restoration incentive programs available in the Yellow River Watershed. Information about these programs will be helpful in engaging riparian landowners.
4. Inventory all riparian corridors and shorelands in the targeted landscape area (watershed, sub-watershed).
3. Identify and assess the quality of the riparian corridors and shorelands along the Yellow River Waterhsed.
4. Identify priority riparian areas and shorelands, in coordination with key partners and stakeholders including SWCDs, where protection, maintenance and forest management would be beneficial to water quality, fisheries, wildlife, etc.

5. Provide encouragement, information and technical assistance to landowners and local units of government to protect existing healthy forest resources in riparian areas and shorelands.
6. Identify key stakeholder groups, such as Lake and River Associations, and collaborate with them in outreach and education efforts to landowners to promote the protection and maintenance of healthy forest resources in riparian areas and shorelands.
7. Encourage and assist lake and river organizations in pursuing management plans and protection projects.

Objective B: BMPs. Advocate and support the implementation of Best Management Practices (BMPs) that guide the protection and maintenance of existing forested riparian corridors and shoreland areas.

Action Items:
1. Utilize Wisconsin's Forest Management Guidelines, Forestry BMPs for Water Quality, Forestry BMPs for Invasive Species, Forestland Biomass Harvesting Guidelines, and other resource tools when preparing stewardship plans or otherwise guiding the implementation of forest management practices in forested riparian corridors and undeveloped and native shoreland areas.
2. Support the distribution of forest best management practices to interested landowners, organizations, local officials or other partners and stakeholders.
3. Convene a workshop(s) for resource managers, community leaders, landowners and others that provides information on the guidelines and other management practices to improve applied knowledge when planning and implementing forest stewardship and other natural resources plans.
4. Implement current programs such as Low Impact Development (LID) and TMDL compliance as applicable.

Goal 2: **Improve Impaired Water Resources.** *Restore and improve impaired water resources that are at high or extreme risk and are highly or extremely threatened to higher quality water systems and features.*

Rationale:
- Yellow Lake is designated as impaired for total phosphorus.
- Forest harvest, agriculture, and other development activities over the past one hundred years have significantly altered, disrupted, removed and/or destroyed many plant and animal species and have contributed to the impairment of lakes, rivers and streams.

Potential Monitoring Indicators:
- Sustainable forest management policies in county water plans.
- Change in impaired water features in the Yellow River Major Watershed (WI DNR Impaired Waters Database).
- Effective use of Forestry Best Management Practices for Water Quality (BMPs) and site-level guidelines by landowners.

Objective A: Native Vegetation. Implement projects that restore and improve native vegetation in riparian corridors.

Action Items:
1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to assess and prioritize riparian corridor restoration projects.
2. Support active restoration and management of forested riparian corridors.
3. Support active protection and maintenance of restored and managed forested riparian corridors through fee title (purchase) or conservation easements and other protection tools and strategies.
4. Inventory all riparian corridors in the targeted landscape area (watershed, sub-watershed).
5. Assess the quality of the riparian corridors.
6. Identify priority riparian areas, in coordination with key partners and stakeholders including SWCDs, where restoration, protection and forest management would be beneficial to water quality, fisheries, wildlife, etc.
7. Look for opportunities to support habitat corridors and linkages.
8. Provide encouragement, information and technical assistance to landowners and local units of government to restore, manage and protect forest resources in riparian areas to improve impaired water resources.
9. Identify key stakeholder groups, such as Lake and River Associations, and collaborate with them in outreach and education efforts to landowners to promote the restoration, protection and management of forest resources in riparian areas to improve impaired water resources.
10. Look for opportunities to support barrens community protection and restoration. Including the incorporation of permanent or temporary barrens habitat in forest management plans.

Objective B: Shoreland Restoration Projects. Work with partners and stakeholders to support the implementation of shoreland restoration projects on lakes in the watershed, especially erosion control projects.

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to prioritize shoreland restoration projects.
2. Support active restoration and management of shoreland vegetation.
3. Support active protection and maintenance of restored and managed shoreland vegetation through fee title (purchase) or conservation easements and other protection tools and strategies.
4. Inventory all shorelands in the targeted landscape area (watershed, sub-watershed).
5. Assess the quality of the shoreland vegetation.
6. Identify priority shoreland areas, in coordination with key partners and stakeholders including SWCDs, where restoration, protection and vegetation management would be beneficial to water quality, fisheries, wildlife, etc.
7. Provide encouragement, information and technical assistance to landowners and local units of government to restore, manage and protect forest resources and native vegetation in shoreland areas to improve impaired water resources.
8. Identify key stakeholder groups, such as Lake and River Associations, and collaborate with them in outreach and education efforts to landowners to promote the restoration, protection and management of forest resources and native vegetation in shoreland areas to improve impaired water resources.
9. Support implementation of the Burnett County Shoreline incentive program. Washburn County also provides cost sharing for some best management practices.

Objective C: Local Projects. Coordinate collaborative projects that restore and improve riparian corridors and shoreland areas.

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to assess and prioritize riparian and shoreland projects in collaboration with other partners and stakeholders restoration projects.
2. Facilitate and support integration of forest management into water resource management integration on a sub-watershed basis.
3. Assist counties in integrating sustainable forest management concepts and principles into their water management plans and/or implement forest management strategies outlined in county water plans.
4. Support water quality and other watershed-based projects that promote sustainable forest management practices in riparian corridors and riparian areas.
5. Develop a storm water management plan that establishes the maximum hydrologic flows for each sub-watershed.
6. Assist in the development of urban forestry projects in shoreline communities of Spooner and Shell Lake.

Goal 3: **Advance Water Resources Knowledge.** *Build coordination and share knowledge relating to water resources and forest resources management to protect and restore water quality and quantity.*

Rationale:

- The federal Clean Water Act requires states to adopt water quality standards to protect lakes, rivers, streams and wetlands from pollution.
- Tree canopies are one of the best filters for slowing stormwater runoff over large-scale areas. Removal of trees from a landscape (including both urban and rural forests) tends to increase the volume of runoff which can result in degraded water quality.
- Yellow Lake is designated as impaired for total phosphorus.

Potential Monitoring Indicators:

- Sustainable forest management policies in county water plans.
- Change in impaired water features in the Yellow River Major Watershed in the WDNR Impaired Waters Database.
- WDNR Water Quality BMP monitoring and Training program.

Objective A: County Water Plans. Work with counties and other partners and stakeholders in the development and implementation of county water plans to include forest management practices.

Action Items:

1. Determine the timeline for the development and revision of county water plans within the targeted landscape (watershed, sub-watershed).
   a. Washburn County Land and Water Resource Management Plan: http://www.co.washburn.wi.us/departments/landwatercons/info/WashburnCountyLandandWaterManagementPlan.pdf
2. Advocate the integration of this Plan with the county water plans during the planning process.
3. Support research and programs that seek to increase public understanding, acceptance and implementation of watershed stewardship practices and the relationship of forest management practices to watershed protection.
4. Encourage county staff to adopt and receive training on WDNR Forestry Water Quality BMPS

Objective B: Lake Management Plans. Work with counties, lake associations and other partners and stakeholders in the development and implementation of lake management plans to include forest management practices.

Action Items:

1. Determine the timeline for the development and revision of lake management plans within the targeted landscape (watershed, sub-watershed).
2. Advocate the integration of this Plan with the lake management plans during the planning process.
3. Support research and programs that seek to increase public understanding, acceptance and implementation of watershed stewardship practices and the relationship of forest management practices to watershed protection.

4. Outreach to all shoreland landowners: develop shoreland property owners guidebook, support neighbor to neighbor contacts, recognize good stewardship, compile and distribute information regarding shoreland restoration techniques and assistance that is available.
5. Shoreland habitat activities for schools and children; "Learn About Your Lake" workshops for shoreland property owners; Invasive species identification training and education.

Objective C: Monitor Water Quality. Support efforts by local and state agencies and other partners and stakeholders to monitor water quality changes in the watershed and distribute results to the public.

Action Items:

1. Support the monitoring of ground and surface water quality and quantity in the watershed through current agency programs (WI-DNR, USGS).
2. Support the development of a watershed monitoring program that compliments the agency ground and surface water monitoring efforts.
3. Develop an outreach and education plan to inform partners, stakeholders and the general public about the results of water quality changes and the relationship to forest and other land management practices.
4. Participate in the Forestry Best Management Practices for Water Quality monitoring program.
5. Support citizen science based water quality monitoring programs:
   a. Volunteer secchi disk monitoring to involve lake property owners and track progress.
   b. School sponsored water quality monitoring.
   c. Citizen Lake monitoring: http://dnr.wi.gov/lakes/contacts/contacts.aspx?role=clmn_start

C. Forest Resources

Desired Future Condition: Protected and Improved Forest Resources

Goal 1: **Protect Healthy Forest Ecosystems.** *Protect existing high quality forest ecosystems that are at medium risk and are moderately threatened from further decline.*

Rationale:

- Tree canopies are one of the best filters for slowing stormwater runoff over large-scale areas. Removal of trees from a landscape (including both urban and rural forests) tends to increase the volume of runoff which can result in degraded water quality.
- Forest harvest, agriculture, and other development activities over the past one hundred years have significantly altered, disrupted, removed and/or destroyed many plant and animal species in the watershed.
- Protecting remaining forest resources before further land development occurs is essential to maintaining biological diversity and high quality habitats. Biological diversity is essential to ecological and economic health and social well-being of the residents of the watershed.
- In the Yellow River Watershed about 50% of the land area is considered medium to high priority area for managing and reducing the threats from insects and disease.
- At least 60% of the watershed is considered to be at high to very high fire risk.
- Persistent and increasing forest health concerns such as Emerald ash borer, deer and climate change.

Potential Monitoring Indicators:

- Long-term changes in the health of critical natural resources, primarily forest resources.
- Increased knowledge of the public of the need to protect forest resources.
- Protection of critical forested land cover through conservation easements, fee title (purchase) and other protection measures.
- Forest Stewardship Plans or Comprehensive Plans created.
- Enrollment in property tax, cost-share and incentive programs such as MFL, WFLGP, EQIP, and WHIP.
- Forest protection provisions in local ordinances and plans.

Objective A: Public Forestlands. Support the protection and maintenance of public forestlands using priorities established in the sub-watershed analyses (Ref. Sections 2 and 3 of this Plan).

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to prioritize public forestland protection projects.
2. Support the development and implementation of sustainable forest management on all public lands.
3. Identify, assess, and document the specific locations of remaining high quality public forest resources within the Yellow River Tributary Watershed to prioritize projects.

4. Inventory and assess coniferous and deciduous plantations on public lands to prioritize projects.
5. Gather, organize, and map the results of biological surveys for appropriate geographic areas (i.e. Burnett and Washburn counties, NW Sands Ecological Landscape etc.).
6. Identify and map old growth forests in the watershed.
7. Utilize available information to identify critical project areas for forest management.
8. Ensure that site-level guidelines are followed on all public lands.
9. Support efforts by counties to develop, implement and/or maintain forest management plans that incorporate sustainable forest management practices and concepts consistent with this Plan.
10. Support the inventory of state school trust lands in each county and distribute information on state statutes regarding memorial forests to local officials and organizations.
11. Encourage cities and townships to manage their public forestlands in ways consistent with this Plan.
12. Support efforts to protect and enhance critical natural areas, fish and wildlife habitat, and game and non-game populations in forestland areas through public and private conservancy acquisition efforts through planning and coordination.
13. Work with landowners, local units of government, organizations and the WDNR to identify and acquire new wildlife management areas where forest resources are high priority. Implement recommendations from the Glacial Lake Grantsburg Master Plan (in progress), and the NW Sands Master Plan (future development).
14. Work with landowners, local units of government, organizations and the WDNR to identify and acquire new scientific and natural areas where forest resources are high priority.
15. Inventory and assess forest resources in order to target acquisition and conservation easements. Support efforts and projects by other agencies and organizations to protect forest resources.

Objective B: Private Forestlands. Implement projects that protect and maintain private forestlands using priorities established in the sub-watershed analyses (Ref. Sections 2 and 3 of this Plan).

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to prioritize private forestland protection projects.
2. Support the development and implementation of sustainable forest management programs and projects on **all** private lands.
3. Support active protection and maintenance of healthy forestlands through fee title (purchase) or conservation easements and other protection tools and strategies.
4. Support the coordination of existing private lands programs and encourage the development of new programs where gaps exist.
5. Support efforts to protect critical natural areas, fish and wildlife habitat, and game and non-game populations in forestland areas on private lands through planning and coordination.
6. Identify, inventory and assess privately-owned large forested tracts in the watershed to prioritize projects.
7. Inventory and assess coniferous and deciduous plantations on private lands to prioritize projects.
8. Work with partners and stakeholders to develop mailing lists of private forest landowners starting with those owning lands in critical forested areas.

9. Work with the DNR Division of Forestry on an ongoing basis to encourage private forest landowners (owning 20 to 1,000 acres) to participate in the Forest Stewardship Program.
10. Create and/or implement a program to support landowners owning up to 20 acres of land on sustainable forest management.
11. Support efforts to distribute information about new technical assistance services and financial resources for sustainable forest management to current stewardship plan holders.
12. Circulate the WDNR – Division of Forestry "Forestry Assistance Locator" that includes local agency, private consultants and conservation organizations who can provide technical assistance and prepare stewardship plans for private forest landowners (http://dnr.wi.gov/topic/ForestLandowners/assist.html).
13. Support efforts to promote forest certification on private forestlands.
14. Provide technical assistance to all partners and stakeholders, in particular private landowners, working on biological diversity projects.
15. Support efforts to inform private landowners about Forest Legacy Program (FLP) and other conservation easement programs. Encourage their participation in these programs.
16. Provide the latest information on property tax, cost-share and incentive programs that promote long-term land conservation to eligible landowners (i.e. MFL, WFLGP, EQIP, and WHIP).

Objective C: Forest Health. Support and participate in programs and projects that promote proactive forest health practices as a form of prevention.

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to assess and prioritize areas of potential or increased forest health risk or threat from fire, insect and disease, development, wild land and urban interface, and invasive species.
2. Identify and assess current and future threats to forests in the watershed by non-native invasive species that may alter forest cover, particularly the Emerald ash borer.
3. Identify and assess potential impacts by native species (such as deer) that may alter forest cover.
4. Support and promote forest health programs administered by the DNR and other resource agencies to prevent the spread of harmful invasive species (native and non-native).
5. Support efforts to inform landowners in the watershed of invasive non-native aquatic and terrestrial species that negatively impact water and forest resources and ways to prevent their spread and mitigate their impact.
6. Obtain and analyze FS FIA and DNR GIS data for ash species (Fraxinus sp.) populations that will be impacted by Emerald ash borer. Include management prescriptions for ash in forest stewardship and other planning efforts.
7. Distribute information to local officials in the watershed that describe ways to prevent the introduction and/or spread of non-native invasive plant and animal species that negatively impact forest resources.
8. Partner with sporting groups to educate the public on the relationship between deer management and forest management including improving deer habitat and managing the population in an ecological manner.
9. Protect and manage the resources of the forest from preventable losses resulting from fire, insects, diseases and other destructive elements including those caused by people.
10. Protective methods shall include proper silvicultural methods.

Goal 2: **Increase and Restore Native Cover Types.** *Restore and improve forest resources that are at high or extreme risk and are highly or extremely threatened to a higher quality forested ecosystem.*

Rationale:

- Historically, the Yellow River Major Watershed was nearly 86% forested (200,744 acres); Most of this area, 68% of the watershed, was jack pine, scrub oak barrens.
- Per 2006 data, the forested lands covered nearly 60% (27% of the watershed converted from forest cover to other cover types).
- Evergreen forest types account for just 3.3% of the watershed.
- The loss of forestland varies by sub-watershed with the greatest loss in the Shell Lake Sub-watershed at nearly 42%.
- There are many organizations and programs available that can help increase the amount of sustainable forests in the region.

Potential Monitoring Indicators:

- Conservation easements and other protection measures.
- Forest cover types.
- WI DNR Natural Heritage Inventory Database.
- Tree plantings completed.
- Forestry elements in county and municipal comprehensive plans.
- Number of Forest Stewardship Plans completed, acres covered by plans and percent of recommendations implemented.

Objective A: Forest Restoration Projects. Support the implementation of forest restoration projects on priority sites in each sub-watershed.

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to prioritize forestland restoration projects.
2. Encourage the reforestation of historically forested lands within each sub-watershed.
3. Support barrens and the protection and restoration of barrens habitat. Look for opportunities to incorporate permanent or temporary barrens areas into forest management plans.
4. Encourage the long-term reversal of forestland fragmentation and the implementation of patch management practices to increase connectivity starting with public forestlands. Implement recommendations from the NW Sands Habitat Corridor Plan: http://dnr.wi.gov/topic/WildlifeHabitat/documents/nwsandsplan.pdf.
5. Support, co-sponsor and/or assist with workshops held on a periodic basis to inform landowners on techniques and methods for improving forest stands (e.g. UWEX - Learn About Your Land Workshops).
6. Support, co-sponsor and/or assist with workshops that inform landowners on regeneration/reforestation techniques and practices.
7. Support and promote regeneration/reforestation programs administered by the DNR and other resource agencies that are consistent with the goals in this Plan.

8. Support and promote forest stand improvement programs administered by the DNR and other resource agencies. Refer to strategies developed in the DNR subsection plans for forest stand improvement and timber productivity.

Objective B: Insects, Diseases and Invasive Species. Support efforts by local and state agencies, conservation groups, landowners and other partners and stakeholders to prevent and manage invasive species.

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to assess and prioritize areas of potential or increased forest health risk or threat from insects, diseases and invasive species.
2. Support, co-sponsor and/or assist in organizing workshops held on a periodic basis to inform landowners on the impacts and control of forest insects, diseases and invasive species.
3. Support efforts to inform landowners in the watershed of invasive non-native aquatic and terrestrial species that negatively impact water resources and ways to control or manage them.
4. Maintain current and historical GIS records of invasive species using DNR resources. Analyze for success/failure.
5. Track insects, diseases, and invasive species on private lands that have Forest Stewardship Plans.
6. Support the creation of Cooperative Weed Management Areas (CWMAs) and engagement with partner organizations such as IPAW and MIPN.
7. Distribute and support the implementation of Wisconsin's Best Management Practices for Invasive Species: http://www.wisconsinforestry.org/initiatives/other/invasive-species-bmps/overview

Objective C: Biomass/Forest Restoration Projects. Design and implement forest and other land-based restoration projects to maximize utilization of removed undesirable woody plant material.

Action Items:

1. Implement ***Sub-watershed Action Plans*** (Section 7) that provide additional resource inventory and analysis to assess and prioritize biomass/forest restoration projects in collaboration with other existing resource management goals.
2. Support the implementation of Wisconsin's Forestland Woody Biomass Harvesting Guidelines.
3. Identify and implement woody biomass removal projects where appropriate.
4. Support efforts to conduct habitat/forest restoration projects that include considerations for utilization of the woody biomass material for local markets and bioenergy.
5. Consider including creation of permanent and/or temporary barrens habitat in forest management plans.
6. Work with the WDNR Division of Forestry to communicate with partners in the forest products industry about new technologies and potential markets for under-utilized species.

Goal 3: **Advance Forest Resources Knowledge**. *Build coordination and share knowledge relating to forest resources and forest resources management to protect and restore water quality and quantity.*

Rationale:

- Over the past 100 years, the Yellow River Watershed has been changed significantly, first from the timber harvests of the late 1800s and early 1900s, and second from the expansion of agriculture in much of the 20th century. More recently, the region is experiencing development pressure, particularly in shoreline areas, that continue to threaten forested landscapes.
- There are forest models and monitoring programs that can more thoroughly describe the context of past and present forest conditions. Better understanding on the part of private forest landowners, local officials and agency personnel will be needed in the future to properly promote sustainable forest management in the watershed.

Potential Monitoring Indicators:

- Engagement by private landowners in forest management education.
- Capacity to provide private forest management outreach and education.
- Adoption of county-level forest management plans.
- Adoption of forest management practices and policies.

Objective A: Watershed/Forest Land Cover Association. Actively educate partners and stakeholders in the watershed about the watershed/forest land cover connection and its role in promoting water quality and quantity.

Action Items:

1. Advocate the sharing of ecologically-based management concepts to ensure that persons providing technical assistance to landowners are knowledgeable about sustainable forest management concepts.
2. Participate in continuing education programs such as UW-Extension, SAF & FSC events, webinars, conferences and other technical/professional educational opportunities that provide sustainable forest management and water quality training.
3. Promote of use of best management practices (BMPs) relating to forest management and water quality for all land uses and activities in the watershed**.**
4. Present information at towns association meetings, county board committees, etc.

Objective B: Local Conservation Groups. Support the expansion and effectiveness of local conservation groups through their active involvement in private forest management (Wisconsin Woodland Owners Association, lake associations, Friends of Crex Meadows, Friends of the NW Sands etc.).

Action Items:

1. Work with the WI DNR Division of Forestry, Wisconsin Consulting Foresters, Wisconsin Professional Loggers Association, Great Lakes Timber Professionals Association (GLTPA) and other partner groups to assist in connecting private forest landowners and loggers operating in the watershed.

2. Identify groups that are currently operating within the watershed to understand where their area of focus is and how it applies to forest management and water quality improvement. Potential partners include Friends of Crex Meadows and the newly forming Fiends of the NW Sands.
3. Create and maintain a current list of operational service providers and their activities that apply to forestry and water quality. Include local municipalities, tribes, citizen action groups, agricultural groups, and wildlife groups.
4. Develop and implement a targeted communications program to effectively inform groups within the watershed about how the goals and objectives of this Plan are being carried out.
5. Create outreach materials that are tailored to the needs and concerns of each targeted audience utilizing Tools for Engaging Landowners Effectively (TELE).
6. Provide a forum for partners and stakeholders to share ideas and activities that concern forestry and water quality.
7. Document the preferred medium of communication for each group and whether they are interested in being involved in a social network concerning forestry and water quality.
8. Create a social network of identified targeted audience using the most comprehensive and available medium to facilitate discussion and information sharing.

Objective C: Land-use Planning. Advocate sound land-use planning and the recognition of forest resources in local planning and regulation processes.

Action Items:

1. Provide forestry technical support, data and maps to counties and communities for use in their comprehensive planning processes.
2. Encourage local units of government to work with the DNR Bureau of Natural Heritage Conservation to use and interpret data collected for the Natural Heritage Inventory Database.
3. Support the incorporation of forest fire management concepts developed for the Firewise program in local and county land use planning processes.
4. Distribute sample language relating to sustainable forestry for local governments to consider when developing their long range plans. Encourage policies that discourage forest fragmentation. See NW Sands Habitat Corridor Plan: http://dnr.wi.gov/topic/WildlifeHabitat/documents/nwsandsplan.pdf.
5. Advocate that counties and communities consider creating a forestland land use category in their policies and on their land use plans.
6. Encourage local units of government to discuss conservation easements in conjunction with their land use planning as an optional tool for guiding and managing land within their jurisdiction.

D. Recreational Resources

Desired Future Condition: Attractive and Engaging Recreational Resources

Goal 1: **Protect Forest-Related Public Recreation and Tourism.** *Identify, select, develop, manage and maintain forest-related recreation and tourism opportunities on public lands in order to provide quality outdoor experiences for the recreational user and tourist while protecting forest and water resources.*

Rationale:
- Statewide forest-based tourism and recreation generates approximately $5.5 billion annually.
- There are many and diverse recreational opportunities in the watershed.
- The Yellow River Major Watershed has a moderate to high outdoor recreational value.
- While recreation and tourism contribute substantially to the region's economy, they also place burdens on natural resources, including forests.
- Many people live in the watershed to be close to outdoor and recreational pursuits such as hiking, hunting, fishing, and/or bird watching.

Potential Monitoring Indicators:
- Annual revenues generated in the watershed from tourism and recreation.
- Use of public lands, such as state forests, state parks, and wildlife management areas; number of visitor days.
- Number and type of complaints and/or compliments generated by recreationists relating to forest management.

Objective A: Public Recreational Lands. Support programs and projects that protect, maintain and promote state-owned land (state forests, state parks, SNAs, etc.) and other public recreational resources.

Action Items:
1. Assist in the development of a comprehensive inventory of parklands in the watershed and the inventory of forest resources within these parks. Make the data and maps from the inventory available to local officials, resource agencies, conservation organizations, and the general public.
2. Assist in the development of an inventory of state school trust lands in the watershed. Document the inventory on a township or sub-watershed basis. Assist in evaluating forest and water resources on these lands.
3. Encourage counties to protect and manage state school trust lands for forestry and recreational uses.
4. Support master planning efforts that address recreational resources. Examples:
   a. Glacial Lake Grantsburg Master Plan (in progress)
   b. NW Sands Master Plan (development to begin soon)

Objective B: Scenic Roadways. Support programs and projects that protect and maintain scenic roadways and view corridors in the watershed.

Action Items:

1. Work with local communities and other partners and stakeholders to incorporate sustainable forest management principles and concepts into their programs and projects.
2. Work with WI DOT and other partners and stakeholders to incorporate sustainable forest management principles and concepts into their programs and projects.
3. Work with organizations to identify and assess feasibility of easements and/or purchase of priority forest-based recreational areas.
4. Distribute and support the implementation of Transportation and Utility Rights-of-way BMPs for Preventing the Introduction and Spread of Invasive Species.

Objective C: Water-based Recreation. Support programs and projects that protect, maintain and promote water recreational areas (Wild and Scenic Rivers, AMAs, etc.) that provide resources for the diverse water-based recreation activities in the watershed (boating, canoeing and kayaking, fishing, etc.).

Action Items:

1. Identify private industry partners and stakeholders and actively engage them in project identification, planning and implementation.
2. Work with local communities and other partners and stakeholders to incorporate sustainable forest management principles and concepts into their programs and projects.
3. Provide technical and financial assistance.

Goal 2: Encourage Forest-Related Private Land Recreation. *Encourage and support forest-related recreational opportunities on private lands to promote multiple uses of the land, generate income, and provide quality outdoor experiences for recreational users while protecting forest and water resources.*

Rationale:

- Many people live in the watershed to be close to outdoor and recreational pursuits such as hiking, hunting, fishing, and/or bird watching.
- There are many and diverse recreational opportunities in the watershed.
- The Yellow River Watershed has a moderate to high outdoor recreational value.
- While recreation and tourism provide contribute substantially to the region's economy, they also place burdens on natural resources, including forests.

Potential Monitoring Indicators:

- Annual revenues generated in the watershed from tourism and recreation.
- Number and type of complaints and/or comments generated by private landowners relating to recreational use of their land.
- Number and type of recreational businesses or opportunities provided by private landowners on their property.

Objective A: Wildlife Habitat. Support programs and projects that restore and improve wildlife habitat on private lands (WHIP, EQIP, etc) while providing access for recreational users.

Action Items:

1. Inventory and assess critical natural areas, threatened and endangered species (included in Appendix E, but check for updates in NHIS database), fish and wildlife habitat, and game and non-game populations to prioritize projects and funding for implementation.
2. Support efforts to restore and improve fish and wildlife habitat and game and non-game populations in forestland areas on private lands to encourage recreational use.
3. Keep current about and promote federal, state and other programs that provide financial and technical assistance to private landowners who wish to restore and improve wildlife habitat. Include information in stewardship and other land management plans.

Objective B: Technical and Financial Support. Support programs and projects that provide technical and financial assistance to private landowners to increase outdoor recreation on their properties (hunting, trails, amenities, etc.)

Action Items:

1. Identify and work with private and non-profit organizations that provide technical and financial support to private landowners to identify and prioritize projects.
2. Assist in outreach efforts to private landowners regarding technical and financial support that encourages participation in providing outdoor recreation on their land.

Objective C: Trail Networks. Support the development of new and the improvement of existing neighborhood trail networks.

Action Items:

1. Work with partners and stakeholders to identify and assess existing neighborhood trail networks at the sub-watershed level.
2. Determine priority projects to implement.
3. Increase development and implementation of Forest Stewardship Plans that include trail networks.
4. Promote the use of best management practices (BMPs) relating to forest recreation management and water quality for trail networks including, but not limited to: horse-back riding and hiking trails, and others. Identify projects and apply BMPs during development, construction and maintenance of these trail networks.

Goal 3: **Enhance the Awareness of the Natural Resource Base on Which Outdoor Recreation Depends.** *Build coordination and share information among partners and stakeholders that supports quality forest and water resources while promoting quality outdoor experiences for recreational users and tourists.*

Rationale:
- There are many and diverse recreational opportunities in the watershed.
- The Yellow River Major Watershed has a moderate to high outdoor recreational value.
- While recreation and tourism contribute substantially to the region's economy, they also place burdens on natural resources, including forests.
- Many people live in the watershed to be close to outdoor and recreational pursuits such as hiking, hunting, fishing, and/or bird watching.

Potential Monitoring Indicators:
- Annual revenues generated in the watershed from tourism and recreation.
- Number and type of complaints and/or comments generated by recreationists.
- Surveys of private industry such as campgrounds, resorts, guides/outfitters, and user groups such as sports clubs, scouts, kayak/canoe clubs, etc.

Objective A: Increase Public Awareness. Work with local outdoor recreation groups to increase the awareness of the public about the value of forests and high quality natural resources to outdoor recreation.

Action Items:
1. Support efforts to provide responsible public access to forestlands in the watershed.
2. Encourage the incorporation of sustainable forest management practices in the local, county, regional, and state park planning programs and project implementation.
3. Support the implementation of sustainable forest management practices on existing and future local, county, tribal, regional, state and federal public lands.

Objective B: Collaborate with Partners and Stakeholders. Work with partners and stakeholders to link citizens and businesses in the watershed to support organizations actively working to protect, restore and improve forest and water resources in the watershed.

Action Items:
1. Identify key citizens and businesses and other interest groups.
2. Develop working relationships with groups that serve as "friends of the parks and rivers" and/or support efforts to create such groups.
3. Engage partners and stakeholders in the development and implementation of projects that include a citizen volunteer component.

Objective C: Outreach and Education. Proactively educate visitors to the Yellow River Watershed about the high quality natural resources in the watershed and their role in protecting them.

Action Items:

1. Collect and distribute information that describes the potential major impacts that visitors and recreational activities can cause and tips for users to minimize their impacts on forest and water resources (e.g. Wisconsin's Best Management Practices for Preventing the Spread of Invasive Species by Outdoor Recreation Activities: http://www.wisconsinforestry.org/initiatives/other/invasive-species-bmps/recreation-bmps).
2. Identify key points of distribution for educational materials such as state and county park offices, tourism offices, recreation-based clubs and organizations, including landowner organizations, etc.
3. Support the installation of informational signage at specific sites managed by tourism and recreational service providers.
4. Develop an action plan for each outreach effort that includes:
   a. Specific actions
   b. Identify geographic location to be targeted
   c. Cost of effort
   d. Measures of success.

Part 3.
Section 6 – Coordination Framework

Successful implementation starts with a small group of committed people. Successful implementation requires timely and purposeful coordination. Coordination, before implementation, is one of the most overlooked and underestimated cost-saving management efforts in resource management. This section provides guidance on a range of coordinative and administrative topics that need close consideration by partners working in the watershed. Additional guidance can be found in the US Forest Service document, "Landscape Stewardship".

A. Organizing for Effective Implementation

One of the primary goals of landscape stewardship is to provide seamless service to a far greater number of private landowners while at the same time coordinating efforts with public land managers over large geographic areas to create more sustainable landscapes. In order to attain this goal, increased levels of coordination by multiple agencies and organizations working within a landscape are needed.

The narrative in this section provides guidance on four areas of coordination that resource managers and their landscape partners should address before diving into the implementation of a landscape stewardship plan:

- Partners and Partnerships
- Implementation Programs and Priorities
- Training and Funding
- Engaging Communities and Landowners

Moving from a paradigm of preparing and implementing single forest stewardship plans and projects for individual landowners to a landscape approach involving hundreds, perhaps thousands of landowners and their communities will require new ways of thinking and working together.

B. Partners and Partnerships

There is no one entity solely responsible for the management of forest and water resources in the Yellow River Tributary Watershed. Rather, there are numerous agencies and organizations with varying and sometimes overlapping roles and authorities. Identifying partners and clarifying roles is important to the successful implementation of this Plan especially since there is no one governing entity.

Partners in the Yellow River Tributary Watershed

Partner agencies listed below have been involved in the development of this Plan (see Appendix A for a list of participants). Agencies and organizations not involved in the planning process are welcomed and encouraged to get involved in implementing the Plan.

- St. Croix River Association (SCRA). Nonprofit organization of people and organizations advocating for conservation across the Basin.
- The Nature Conservancy (TNC). A non-governmental organization dedicated to the conserve Minnesota's most significant prairies, forests, lakes, rivers, streams and wetlands for nature and people since 1958.
- Wisconsin Department of Natural Resources (WDNR), Wildlife Management, Division of Forestry and Water Division. WDNR Forestry provides overall leadership and management of services to private woodland owners through its Private Forest program.
  - Governor Knowles State Forest
  - Private Forestry Team
  - Northwest District Forestry Team
  - DNR – Wildlife Management, St. Croix Area
- Burnett County Forest and Parks Department
- Washburn County Forestry Department
- UW-Extension. UWEX works with individuals, families, farms, business and communities, applying university knowledge and research to address issues in rural, suburban and urban settings. Locally-based Cooperative Extension staff collaborates with University of Wisconsin campus specialists to provide educational programming in Wisconsin's 72 counties and within three tribal nations.
- St. Croix Watershed Research Station. Station scientific staff conduct ongoing ecological research at the watershed scale.
- Federal Agencies. USDA Forest Service (USFS), National Park Service (NPS), Natural Resources Conservation Service (NRCS), and the U.S. Fish & Wildlife Service (USFWS).

Potential Partners

- Wisconsin Woodland Owners Association (WWOA). The statewide nonprofit organization that works on behalf of private woodland owners. WWOA – Northwest Chapter. The local chapter of WWOA serving landowners in Burnett and Washburn Counties.
- Northwest Wisconsin Regional Planning Commission. The NWRPC provides a variety of community and regional services focusing on economic, community and business development, transportation, land use, coastal and environmental resources.
- Burnett and Washburn County Land and Water Conservation Departments provide competent, professional services in the planning, design, and implementation of programs and projects that protect, restore, and sustain the soil and water resources.

- Other groups active in the Yellow River Major Watershed:
  - Yellow Lakes and River Associations
  - Burnett County Lakes and River Associations
  - Washburn County Lakes and Rivers Association
  - Lispett Lake Association
  - Voyager Village Homeowners Association
  - Spooner Lakes District
  - Shell Lake District
  - Others?

All of the partners are encouraged to be active through the coordination, implementation and monitoring phases of this Plan. They should all work to complement each other's efforts to increase the successful implementation of this Plan. The goals and objectives outlined in Part 2 of this Plan are attainable, but will be accomplished only if the people and the organizations in the watershed can muster the collective will to do what is necessary to make the plan goals a reality. So how should this network of partners work together?

Coordination Strategy # 1 – Convene, Support and Sustain the Coordination / Implementation Committee

The primary coordination strategy for this Plan is to convene a core group of partners – resource professionals, service providers, landowners, and local officials – into a team or committee that can effectively manage the coordination and implementation of this Plan. Partners will need to commit to sharing resources and active involvement on an ongoing basis to reaching the goals in this Plan. And while partnering organizations should understand that this landscape stewardship project should be considered a minimum 5 – 10 year commitment, resources from the WDNR and US Forest Service may be available to support the initial efforts of such a committee.

The core team members envisioned serving on a Coordination / Implementation Committee would include the SCRA, Burnett County Forest, Washburn County Forests, UW-Extension, NRCS, and WDNR Forestry. Other interested groups are welcome to join. The Coordination / Implementation Committee should meet on a regular basis to more proactively support the range of coordination and implementation activities recommended in the Plan. Responsibilities of the Coordination / Implementation Committee could include:

- Review and refine the initial implementation and monitoring frameworks.
- Develop the overall implementation strategies and programs described in Section 7.
- Support the completion of the demonstration project.
- Review and refine the Sub-watershed Action Plans in Section 7.
- Decide on which collaborative projects and programs to pursue in the upcoming year.
- Collaboratively pursue the development of project concept s and funding proposals.
- Support the preparation of progress reports and collection monitoring data.
- Support outreach and networking efforts by the Yellow River Watershed Partnership (YRWP, see Coordination Strategy #3).
- Meet with County Water Plan Task Forces to encourage using this plan as a guide for including forest management in County Water Plans.

- Periodically review and refine the recommendations to conservation agencies and organizations in Section 9. Forward specific recommendations to the relevant entities for their consideration. Follow up as appropriate.
- Provide guidance to the Project Coordinator.

Coordination Strategy # 2 – Hire a Project Coordinator

To support the work of the Coordination / Implementation Committee and ensure that all partners are on the same page, it would be beneficial to have one person serve as the point of contact to manage the coordination process. This should be a paid position and could be administered by the St. Croix River Association or other entity. Some seed moneys to support this position are already in place. Responsibilities of the Project Coordinator could include:

- Prepare for and facilitate all Coordination / Implementation Committee meetings.
- Develop outreach and marketing campaign materials, landowner surveys, various communications and reports, etc.
- Prepare grant applications and support their administration and progress reporting.
- Develop and advance specific ways to connect and coordinate the implementation of Yellow River Landscape Stewardship Plan DFCs, goals and strategies with the partner projects.
- Review and comment on draft documents prepared by committee members.
- Support efforts to increase involvement by the stakeholders in the watershed.
- Compile a report that summarizes activities completed by the Committee each year and present it to watershed stakeholders and other interested groups.
- Support the functions of the Yellow River Watershed Partnership (YRWP)

Coordination Strategy # 3 – Form the Yellow River Watershed Partnership (YRWP)

A third coordination strategy recommend by the Planning Committee is that a broader partnership of stakeholder groups working in the Yellow River Watershed be formed. This partnership of agencies and organizations is intended to be informal in nature and take on a limited or focused outreach and networking role. It would do this principally by convening an annual landowner meeting each year to convey progress made in the sustainable management of forests, water and recreation resources. Responsibilities of the Yellow River Watershed Partnership (YRWP) could include:

- Host an annual landowner meeting. Report the results of progress made in the implementation of this Plan.
- Support efforts to link landowners with resource professionals and service providers from public agencies, conservation organizations, private businesses and other relevant entities.
- Support efforts to increase the membership of the Wisconsin Woodland Owners Association – Northwest chapter.
- Maintain a list of members and contact information.

While resource agencies and organizations working in the Yellow River Tributary Watershed as well as in the St. Croix Basin have accomplished many good conservation projects over the years, the challenges facing water quality and sustainable forests are generally

outpacing our collective accomplishments. Planning Committee members identified a large number of outstanding issues such as declining water quality trends, land parcelization/forest fragmentation, increasing risks of wildfires with dispersed rural residential development are just a few. Couple these with declining budgets for natural resources and trends towards a global economic and climate change – it becomes obvious that we really need to dramatically step up the tempo of conservation.

Coordination Strategy # 4 – Growing Coordination through Partnerships in the Watershed

A good landscape stewardship plan will not in itself establish the level of coordination needed to ensure seamless, effective and efficient service delivery, especially when the plan covers multiple jurisdictions and operational territories involving many actual and potential partners and stakeholders. The commitment by partners and stakeholders to share resources and actively participate on an ongoing basis is the core to developing and expanding partnership and stakeholder capacity to reach the shared goals and objectives of this landscape stewardship plan. Landscape stewardship also depends on increasing partnership capacity across all levels of government as well as within the private and nonprofit sectors.

Partnership Capacity Development

The landscape approach to forest stewardship generates the need to develop new ways of serving greater numbers of landowners and communities. Program managers will need to develop approaches that encourage partners both at a statewide program level as well as within project coordination teams across the State to actively nurture and support growth in partnership capacity. The commitment to a sharing-of-resources philosophy in an ongoing fashion is the core to developing and expanding partnership capacity. Landscape stewardship depends on increasing partnership capacity across all levels of government as well as with private and nonprofit sectors.

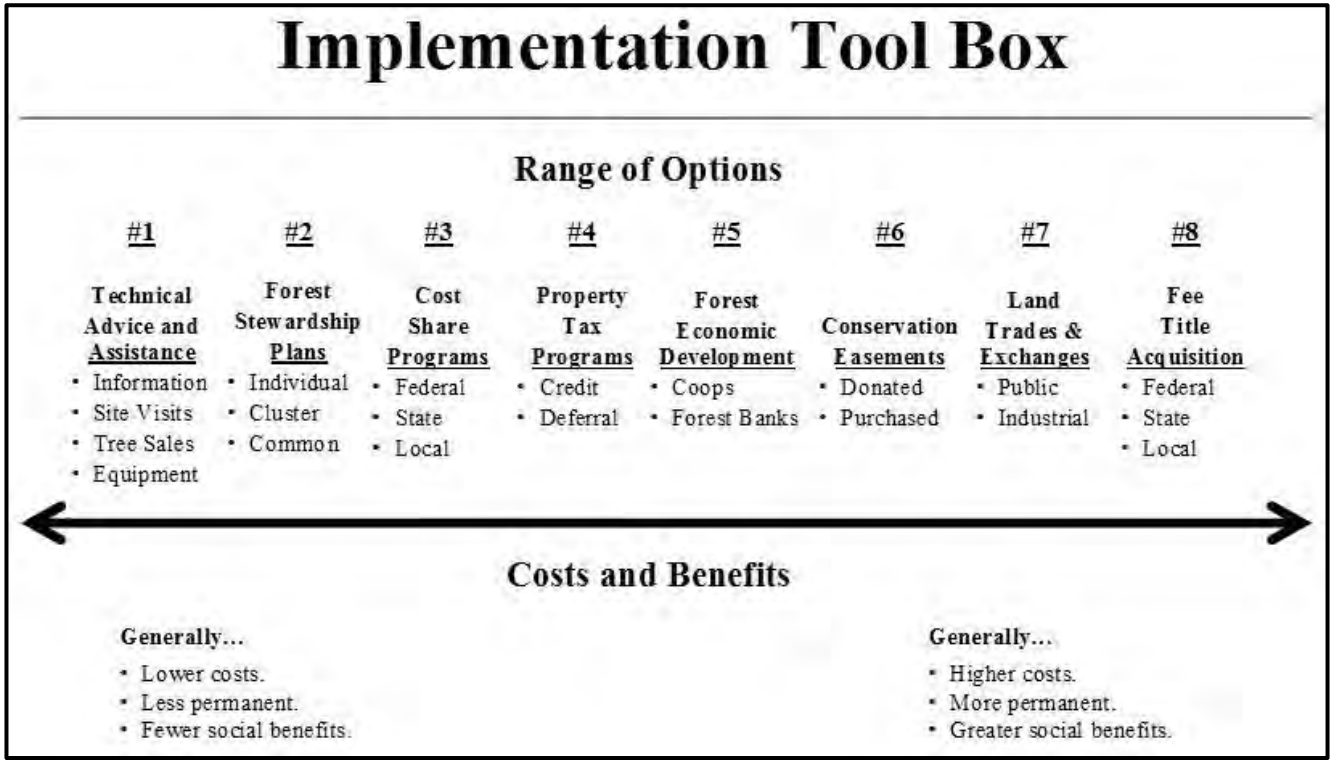
A fundamental difference in landscape stewardship is that the implementation is done with far more collaborative and coordinated efforts by service providers in partnership with local conservation staff and community leaders. Supporting their active involvement is critical. Sharing of resources amongst different levels of government (from Federal and State levels with local units) takes increased communication and effort, but will support improved service delivery. Citizens generally do not see nor care about the divisions in their governments; they expect the public sector to provide service.

Moving from a paradigm of serving one landowner at a time to a landscape approach that concurrently serves landowners and their communities will require Cooperative Forestry Managers and their State Foresters to encourage partners to significantly expand the sharing of their limited resources for landscape stewardship. The sharing of resources—staff, funding, equipment, information, and know-how—in far more robust and active ways is fundamental to partnership capacity development.

C. Implementation Programs and Priorities

The "PFM Implementation Tool Box": Foundation to Service Delivery to Private Woodland Owners

When outlining coordination and implementation strategies in resource management plans, it is beneficial to consider the entire range of tools available to resource managers. The "implementation tool box" for private woodland owners is often bigger than many people realize. The following diagram illustrates many of the major implementation tools and options that can be used to encourage landowners and community leaders to develop flexible and effective forest stewardship or other resource plans based on the all lands approach.



Source: Dan Steward, Minnesota Board of Water and Soil Resources

As the diagram suggests, services provided to landowners on the left tend to be less costly, but are also less permanent in nature and less explicitly connected with societal benefits. In contrast, techniques listed further to the right side of the spectrum, while more costly, generally tend to have a greater degree of permanence and produce more easily recognized benefits to society.

Wisconsin's Private Forestry Program

Wisconsin's 16 million acres of forestland cover nearly half of the state. Individuals and families hold the largest portion (57%). About 360,000 private, non-industrial landowners care for 10.4 million acres of woodland in Wisconsin. While private landowners are primarily responsible for the management of their land, help is available from the DNR and other public and private sources. DNR foresters work with about 9,000 landowners every year, providing personalized, on-site service. They administer a number of planning, management, property tax incentive and cost-sharing programs. Guidance for private landowners is also available from private Cooperating Foresters, and other partners offer informational bulletins, conferences about forestry and help organizing local forestry associations.

Wisconsin's Forest Tax Laws

Wisconsin's forest tax laws encourage sustainable forest management on private lands by providing a property tax incentive to landowners. Two different forest tax law programs currently exist: the Managed Forest Law (MFL) and the Forest Crop Law (FCL). Both programs encourage proper management of woodlands not only in their purposes and policies, but through a written management plan for a landowner's property. The management plan incorporates landowner objectives, timber management, wildlife management, water quality and the environment as a whole to create a healthy and productive forest. In exchange for following a written management plan and program rules, landowners pay forest tax law program rates in lieu of regular property taxes.

There are many rules and regulations for each program, so please use this website (http://dnr.wi.gov/topic/ForestLandowners/tax.html) and other resources to gather information and make informed decisions. For more specific information or inquiries, refer to the local DNR forester for guidance.

Wisconsin's Forest Legacy Program

As part of the 1990 Farm Bill, Congress created the Forest Legacy Program under the U.S. Department of Agriculture Forest Service to identify and protect environmentally important private forestlands threatened with conversion to non-forest uses - such as subdivision for residential or commercial development. To help maintain the integrity and traditional uses of private forestlands, the Forest Legacy Program promotes the use of conservation easements. These easements provide a new tool with which the federal government, in cooperation with state and local agencies, private organizations, and individuals can preserve the rich heritage of private forests across the nation.

The Department of Natural Resources Division of Forestry is responsible for administering the program offered by the USDA Forest Service. The program allows the state of Wisconsin to purchase conservation easements on forestland from willing sellers to keep the land in its forested state. Landowners may continue to own their land and retain all other rights to the property, including the right to sell. The conservation easement is recorded with the property deed and transferred with the sale or transfer of the property. USDA Forest Service funds cover 75 percent of the total program cost; the other 25 percent comes from nonfederal sources. These may include a donation of part of the easement value from the landowner, a non-profit organization interested in the project, or in some cases, state funds. In special situations, the state may consider purchasing the land with Forest Legacy Program funds. To learn more about Wisconsin's Forest Legacy Program, including how to apply visit the website at http://dnr.wi.gov/topic/ForestPlanning/legacy.html.

Implementation Strategies: A Framework for Building Systematic Implementation

There is no one tool or strategy that will solve the challenges of significantly increasing forest stewardship across a landscape or watershed and keeping forests as forest. One of the benefits of using a landscape approach to forest stewardship is that it encourages partners and stakeholders to consider multiple strategies at varying scales, to bring those strategies together in a cohesive plan, and then to take complimentary actions that are relevant to the local community with respect to its culture and traditions. Five general implementation strategies have been identified that can be used in most any resource management endeavor including forest stewardship:

- **Outreach & Education**
  Landowners, local officials, and the general public benefit from increased knowledge and awareness about the benefits that forests provide as well as ways they can support sustainable forest management practices. Outreach and education efforts coordinated and conducted at the watershed scale will help connect resource management initiatives and more effectively engage landowners or other target audiences.

- **Incentive Programs**
  Incentive programs provide technical and financial assistance that is designed to help achieve goals and policies established by Federal, State, and local agencies. Incentive programs have long been the foundation for promoting forest stewardship among landowners.

- **Public Investments**
  Local, State, and Federal investments are made in all communities on a regular basis. Public investments are obviously made to construct public facilities and support public lands, but their location and operation across the watershed can significantly impact, positively or negatively, private forest lands. Roads, bridges, and waterways support public good but also encourage and support private investment. Partners and stakeholders concerned about private forest management should consider strategies that help shape relevant decision-making processes related to public investments. This is especially critical in lean budget times.

- **Policy Integration**
  Forest resources in a given landscape can be directly impacted by management plans and policies that govern land use, economic development, transportation, utilities, water resources, forest resources and other natural resources. To better influence future policy and minimize issues, partners and key stakeholders must be aware of existing and proposed development policies and how they may impact natural resources stewardship planning efforts. They must also be engaged early in policy discussions to integrate sustainable resource management into the planning process. Landscape stewardship can provide reliable and relevant information for local officials to help define the context and value of forest resources in a community. Support developing goals that support local community development strategies related to conserving natural resources.

- **Regulation**
  Regulation is probably the least preferred of the implementation strategies. While most people can explain the need for regulation, getting agreement on specific details for a given ordinance or regulation becomes more difficult. However, while regulation as a strategy to implement a landscape stewardship project is not generally used, the overall goal of keeping forests as forests may require becoming

knowledgeable about approaches to land use planning and zoning. Although this arena is largely regulatory, there are many new and innovative approaches to land use planning that are incentive based. These include Low Impact Development (LID), density and cluster development bonuses, transfer of development rights, conservation easements, and deed restrictions.

Coordination Strategy # 5 – Synchronizing Watershed Priorities with Federal / State / Regional / Local Priorities

Wisconsin's 16 million acres of forestlands and millions of urban trees significantly enhance the quality of life in our state. The Wisconsin DNR dedicates itself to the sustainable management and protection of this precious resource so that it continues to provide a host of ecological, economic and social benefits for years to come. Some of the most important work of the Division is engaging with partners to advance the cause of sustainable forestry and to accomplish its goals. Below is a brief description of three documents that guide the work of the Division of Forestry in Wisconsin:

Wisconsin Statewide Forest Assessment
This document is an assessment of the "state of affairs" of Wisconsin's public and private forests and an analysis of the sustainability of our forested ecosystems. This Assessment identifies trends and issues with the resource, and is used : 1) by natural resource professionals to inform management and to design policy; 2) by the public and partners who require statewide forestry data; and 3) as a requirement of the U.S. Forest Service State & Private Forestry Program. This assessment presents data and analysis of all forests—rural and urban, public and privately owned.

Wisconsin Statewide Forest Strategy
Wisconsin's Statewide Forest Strategy is a statement of intent by those most involved in the protection and sustainable management of Wisconsin's forests regarding how to address the trends and issues that have the potential to significantly impact Wisconsin's forests over the next decade. It will provide a long-term, comprehensive, coordinated approach for investing resources to address the management and landscape priorities identified in the Statewide Forest Assessment. In their entirety, the strategies represent a very large investment of resources. Recognizing the current economic constraints at all levels of government and in the private sector, it is necessary to determine which strategies and actions are the most important to focus on.

WDNR – Division of Forestry Strategic Direction
The strategic direction states what the WDNR - Division of Forestry's niche and role will be to address major issues and priority topics. It describes the Division's objectives in main program areas. Much of what is presented in the strategic direction continues work the Division now does and, in many cases, has done for many years. This reflects the belief that these functions have been, and remain, an appropriate and valued role for the division. There are several significant changes described in the strategic direction to address the changing needs of the forestry community and citizens of Wisconsin. As a result the strategic direction identifies both those challenges that the Division has worked to address in the past and that continue to need attention, as well as new challenges and opportunities. The strategic direction will guide the division's work over the next five years. Implementation of the strategic direction began at the end of 2011.

D. Training and Funding

Coordination Strategy # 6 – Integrate Service Provider Training

While landscape approaches to forest stewardship provide significant benefits, successful implementation will likely require that agency staff and field foresters learn new skills in some or all of the following areas: media training, strategic communication, conservation marketing (also known as social marketing), working with local decisionmakers, and meeting facilitation.

Other training courses may be developed, or adapted from other fields, to help foresters acquire the skills necessary to be successful.

WDNR Forestry along with its partners will need to determine who will receive what training, and to what depth of knowledge. For example, field foresters will need to have a working knowledge of conservation marketing, without necessarily becoming experts in the field.

Many training resources already exist, but are not specific to forestry. The watershed planning and management discipline has developed a large number of publications and other resources that can be extremely useful in our new approach to forest stewardship. Though they address specific watershed-related topics, the processes used are essentially the same as those we want to use. Citations for several publications that are readily available on the Web are listed later in this document.

- State and federal agency staff.
- Local conservation agency staff.
- NGO staff.
- Consulting foresters.
- Loggers.
- Vendors.
- Expert volunteers – woodland advisors

Coordination Strategy # 7 – Collaborate on Funding Development Using this Plan as a Guide

How will the implementation of this landscape-scale forest stewardship initiative be funded? Experience has shown that landscape approaches to natural resource conservation tend to have a synergistic effect on funding. Partners that get involved in a landscape-scale project area do so because it meets some of their own resource or public relations goals. Because of this they can support efforts in the project area.

Landscape-scale, multi-partner, coordinated efforts often carry increased weight with foundations, trusts, and government agencies when it comes to applying for grants. Federal and state funding agencies as well as private foundations tend to look favorably on multi-partner project applications. There is a considerable amount of money available through grants and other programs that landscape stewardship approaches can facilitate.

An often untapped reservoir of funding may come from local businesses that will benefit from the results of the resource management activities taking place. For example, a local canoe outfitter may see benefit in financially aiding efforts that will result in maintenance or improvement in water quality in a local river. There are also opportunities for financial support opening up as more and more businesses want to project a "green" image.

Landscape stewardship projects also seek to encourage and promote greater levels of private investments in ways to leverage public investments. Private woodland owners make significant investments in their own lands. These investments may not end up on the balance sheets of service provider agencies (although they sometimes do), but the investments private landowners make on their lands are no less important. The bottom line is that there will likely be more money and resources for coordination and implementation available in a more coordinated way for on-the-ground resource management work.

Coordination Strategy # 8 – Maintain an Inventory of Available Resources for Implementation

The following is a list of potential resources available to the Coordination / Implementation Committee to pursue in the project and funding development stage. The Coordination / Implementation Committee should maintain and grow this inventory of administrative, technical, financial, and political resources as tools to foster increased success in implementation of this Plan.

Administrative Resources

- Landowners
- Lake/River/Homeowner Associations
- Township Officials
- Municipal Governments – Spooner, Shell Lake
- Northwest Wisconsin Regional Planning Commission
- County Boards – 2 counties
- Planning and Zoning – 2 different approaches to comprehensive planning and implementation
- WI DNR Forestry
- Northwest District Forestry Team
- Private Forestry Team
- WDNR – Wildlife Management, St. Croix Area
- County Land and Water Conservation Departments – Burnett and Washburn County
- UWEX – multiple programs
- USDA Forest Service, Northeastern Area, State and Private Forestry -- guest speaker

Technical Resources

- GIS mapping – WDNR GIS Staff
- State agency personnel - DNR Division of Forestry, Division of Wildlife, etc.
- County staff - P & Z staff, county water planners, SWCD technicians, etc.

- Consulting foresters (http://dnr.wi.gov/topic/ForestLandowners/assist.html)
- Loggers
- USDA Forest Service, Northeastern Area, State and Private

Financial Resources
- Clean Water Legacy Act program
- Costs Share programs
- WFLGP (WDNR)
- EQIP (NRCS)
- WHIP (NRCS)
- State agency programs - FSP, Stewardship Committee, etc.
- Financial incentives for restoring shorelands (http://dnr.wi.gov/topic/ShorelandZoning/Celebrate/incentives.html)
- County Water Plans projects and programs
- Burnett County Shoreline Incentive Program (http://www.burnettcounty.com/index.aspx?NID=526)
- Foundations and organizations
- Landowners - private investments
- Federal and State agency budgets - staff assistance

Political Resources
- Private landowners and landowner groups (e.g. WWOA)
- Townships
- Soil and Water Conservation Districts - supervisors and staff
- County boards and staff
- County water plan committees
- WI Council on Forestry

The Coordination / Implementation Committee should maintain and grow an inventory of administrative, technical, financial and political resources as tools to foster increased success in implementation of this Plan.

E. Engaging Communities and Landowners

Outreach to Community Leaders and Local Decision Makers

To gain the support of decision makers in the community, resource managers need to provide a convincing answer to the fundamental marketing question: "What is in it for them?" Broader community support is likely to depend on being able to demonstrate that conservation programs are effectively and efficiently addressing issues of importance in terms that residents and their decision makers easily understand. Increasing support for forest conservation that protects and enhances water quality will be based primarily on the off-site benefits that accrue to community residents, rather than on the on-site benefits that accrue to forest landowners.

Community Benefits of Forest Stewardship on a Landscape Scale

Contributes to Economic Prosperity
- Attract tourists.
- Attract businesses.
- Attract new residents (e.g. retirees).
- Enhance real estate value.
- Reduce taxes.
- Stimulate financial activity/sales.
- Reduce energy costs.

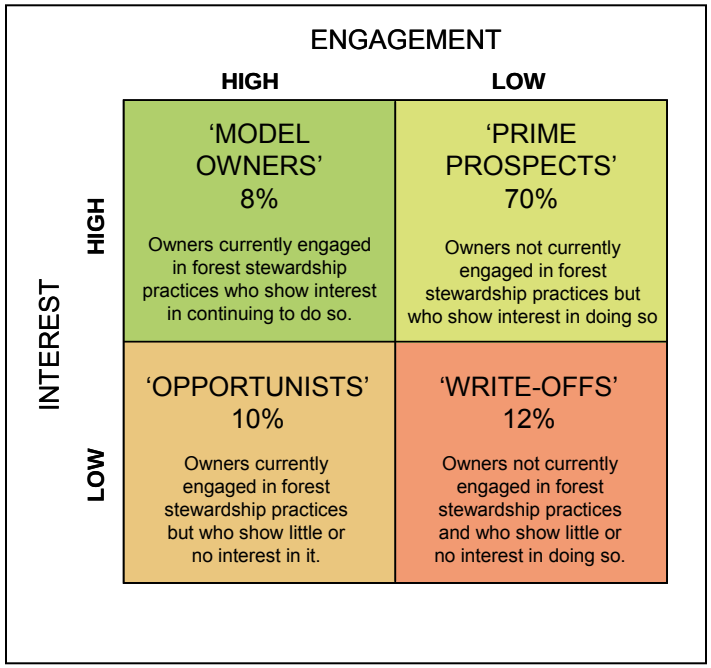
Helps to Alleviate Social Problems
- Promote cultural & historical preservation.
- Preserve/regenerate community character.
- Alleviate unemployment distress.
- Enhance quality of life.

Provides Environmental Services
- Provide clean water.
- Protect drinking water supplies.
- Improve flood control.
- Provide clean air.
- Preserve biological diversity.
- Mitigate climate change impacts

Coordination Strategy # 9 – Systematic and Comprehensive Landowner Outreach

Tools for Engaging Landowners Effectively (TELE) was developed by the Sustaining Family Forests Initiative (SFFI) to engage landowners effectively. The SFFI is a collaboration of government agencies, NGOs, certification systems, landowner groups, businesses, and universities organized to gain comprehensive knowledge about family forest owners (10-999 acres) in the United States. The SFFI has taken advantage of the wealth of information from the National Woodland Owner Survey database and linked this resource with demographic and behavior information to develop the TELE marketing approach to help natural resource professionals and others engage more effectively with family forest owners about their woods and woodland management. More information about the SFFI and TELE can be found at www.engaginglandowners.org.

Research indicates that about 15% of all family forest owners (25% of acres) across the Northeast and Midwest are currently "engaged" in the management of their woodlands. By "engaged", we mean owners who consult foresters, participate in programs such as cost-sharing or conservation easements, and are generally making good stewardship decisions on their land. This is the group of landowners we often work with. They will come to us for assistance on their own, and thus fit right in with the "first come – first served" landowner service model that many state forestry agencies practice. While easy to implement and politically expedient, working this way tends to keep us busy with the same group of landowners – those with whom we are comfortable, or who know how to ask for assistance. We do good work with these folks, but we need to have an impact on more and different privately owned forest land.



The best opportunity for expanding the reach and influence of forest stewardship lies with landowners described as "Prime Prospects" by the Family Forest Research Center. These are landowners who are not currently engaged in managing their forests (e.g., they don't have management plans, they don't consult foresters, and they don't participate in programs such as cost-sharing or conservation easements), yet they think managing their forest land is a good idea, *and* they are interested in doing so.

It is encouraging to know that as many as 70% of all private forest landowners in our 20-state region fall into the "Prime Prospects" category! Yet only 23% of all landowners across the region say they've "sought advice" on woodland management. One clue to engaging "Prime Prospects" has to do with management intentions. Most landowners report that they intend to *do nothing*, or nearly nothing, on their forest land for the next 5 years (NWOS 2010). Our challenge is to figure out *why* they intend to do nothing, *how* to communicate with them, and finally *what* will motivate them to take a more active role in the stewardship of their forest land … to begin making decisions that contribute to their personal objectives while also contributing to the needs of the broader community.

Understanding Landowner Behavior

Who are these "Prime Prospects"? We all know that they are a varied group. Even at the county level, forest landowners own their property for many different reasons, and expect different benefits from their lands. They may reside on their land, or be absentee landowners living in the city. They may own their land primarily for hunting, or own it as a sanctuary for wildlife because they oppose hunting. They may derive income from their land, either from agricultural operations or from forest management activities; or the thought may never have crossed their mind that they could make money from their land because all they are looking for is a peaceful place to spend the weekend.

To help make sense of these differences, the National Woodland Owner Survey (NWOS) has identified key variables that help us understand why landowners do what they do – or don't do. Why someone owns forest land is the most significant factor affecting how he or she uses it – and consequently, what society can expect from it. This is the crux of our conservation marketing approach. In order to meet our community/societal objectives, we first have to understand and then help landowners meet their objectives. Using NWOS data, the Sustaining Family Forest Initiative (SFFI) has identified four landowner segments in our region based on this variable:

There are other factors that also influence a forest landowner's behavior, including:

- **Parcel Size** – people with larger parcels tend to see woodlands as a financial asset and often have a family tradition of land ownership. Larger parcels are associated with regular timber harvests, employment of foresters, participation in government programs, and greater concern for restrictions on land use.
- **Land Tenure** – owners who have inherited their land are often most concerned about keeping it intact and passing it on to their heirs. New owners tend to be less knowledgeable but also more open to advice and information.
- **Residence** – people who live on their woodland are usually more emotionally attached to it than people who don't. They spend more time in their woods, and may know their woods better.
- **Farming** – farmers tend to have a deep understanding of land management and a pragmatic approach to tending and managing woodland. However, they value farm land more than woodland, and prefer to attend to their agricultural holdings.

It's easy to see the importance of understanding who our landowners are, and why they do what they do before approaching them with the "opportunity" to participate in a forest stewardship program.

How to Communicate with Landowners

As natural resource professionals we know that one-on-one conversation with landowners is the best way to influence them. This is because we intuitively tailor our conversations to the knowledge level, values and style of our conversation partners. We mirror their language, reflect their values, and try to build on the common ground we share with them. Landscape stewardship will help us do the same thing on a larger scale.

By targeting our outreach activities to specific landowner segments we will speak more meaningfully and persuasively to landowners, thus improving our conservation marketing results. Targeting works because it pushes us to understand the people we're trying to reach and find ways to connect with them.

The SFFI offers a number of suggestions on communicating effectively with forest landowners. Solve their problems … address their concerns. An old marketing maxim states that, "People buy holes, not drills." In other words, sell the solutions, not the products. The easiest way to get landowners to pay attention to our materials is to lead with the solutions they are already seeking. Once we have their attention, we can give them new information and ideas.

- **Connect through shared values**. Highlight the values we share with landowners and let them know we understand their perspective on the issue (even if it is different from ours). This makes our message more believable and relevant to our audience.
- **Recognize differences**. Landowners love their land for different reasons and express it in different ways. Don't ally yourself with the timber or any other industry, or with any group of service providers. Conversely, avoid taking an environmentalist perspective; landowners will respond best if they see us as an unbiased resource that is not wedded to any ideology or industry.
- **Get real**. Make sure people have the resources to do what we're asking them to do. And if our "ask" doesn't fit with their world view at all, back up a little – perhaps we can ask them to do something else that fits within their resources, is less intimidating, and/or more acceptable.
- **Avoid jargon**. Don't use technical terms that might be familiar to us but not to our audience. Instead, use language that landowners use themselves.
- **Lead Strongly**. Communicators often list all the reasons to take a particular action, hoping that people will focus on the ones that make most sense to them. That's asking people to do too much work – if they don't see a good reason up front, they won't pay attention to our message. Lead strongly with one or two points that are likely to resonate with each landowner segment.

	Woodland Retreat	**Working the Land**	**Supplemental Income**	**Uninvolved Owners**
How to reach this segment	• Give them specific, easy, low-cost actions to achieve their objectives (e.g. attracting wildlife) • Challenge their belief that woods are best left alone • Help them understand the ecological significance of all woodlands • Appeal to their sense of responsibility and stewardship • They like to receive information through printed materials or talking with a natural resource professional. Videos and Internet are also useful.	• Affirm their outdoorsy lifestyle and simple, traditional values • Give them information but don't tell them what to do--accept their independence and cautiousness • They actively seek information on land management; most like getting information through word of mouth, although relevant publications and direct mail also work	• Emphasize ways to enhance financial gains or maintain land value for future generations • Ready to learn more about land management--especially if it yields immediate or long-term financial benefits • Most keyed to the forest industry and "forestry" community, including landowner associations, trade publications, and events	• Not an easy target for conservation or woodland management campaigns • Messages should identify direct financial benefits, preferably without too much effort on their part • May be more receptive to incentives and programs that benefit both farms and woods • Can be reached by direct mail and traditional channels to reach farming community

According to the Family Forest Research Center, the basic principles of this approach are:

1. **Design your materials to appeal to a specific type of landowner.** Different types of landowners are persuaded by different arguments and incentives. It therefore makes sense to design materials for specific groups that share similar values and will be persuaded by the same messages.
2. **Make sure that your audience is exposed to your message several times and in the right contexts.** Do you remember all the advertisements you saw on TV last night or all the billboards that lined your route to work? Neither do the people you want to reach! We have to work hard to get people's attention. And most people need to see or hear (preferably both!) a message several times before they decide to act on it.
3. **Listen to your target audience.** Good communication, like good conversation, is a two-way exchange. Get landowner input before designing your marketing campaign, then seek feedback both during and after you implement the campaign.

Motivating Forest Landowners to Act

We now have a sense of why people own forest land, and how to effectively communicate with the various landowner segments that make up the Prime Prospects we're seeking to influence. What we have to keep in mind is that targeted marketing means designing communications to bring about a specific behavior change in a selected group of people. We are reaching out to small groups of people with tailored messages that are most likely to appeal to the people in each group, based on our understanding of that group's values, preferences, and other characteristics. This will help us move beyond our traditional audience and begin to engage the vast reservoir of Prime Prospects.

And you'll recall, conservation marketing is about the "trans-action." Be clear about what you want people to do after they hear or read your message. We emphasize do because it is always more effective to design your marketing campaign with clear action outcomes in mind. Yes, you want to educate or inform your audiences, but you really need them to take action if your program is to be a success. Studies of family forest owners across the Northeast and Midwest suggest that we may be successful at motivating Prime Prospects to become "engaged" in forest stewardship by:

1. Making them aware of the personal benefits of managing their forests; and
2. Connecting them with information and assistance resources appropriate to their needs.

Between reasons for owning forest land and concerns over issues that may impact land ownership, we have some powerful talking points vis-à-vis community incentives and policies (what the community can offer) and the adoption of stewardship practices that mitigate landowner concerns while contributing to ownership objectives. Because of their different backgrounds, interests, ages, and educational levels, subgroups of forest landowners get their information through different media types and sources. Given their different ownership objectives, they also respond to different motivational triggers; some are interested in money, but most are not. This all leads to the conclusion that we can't just communicate with something called "forest landowners" and hope to expand the reach and influence of forest stewardship.

F. Conclusion

Successful implementation starts with a small group of committed people. It requires timely and purposeful coordination. Coordination, before implementation, is one of the most overlooked and underestimated cost-saving management efforts in resource management. In an age of complex environmental and socio-economic issues and declining budgets for public and private conservation agencies, sharing resources and leveraging successes has never been more important. Services to private landowners must meet the needs of both the landowner and the needs of the community if we are going to address the forest and water quality issues at the watershed level with increasing effectiveness.

Coordinating and leveraging resources brings multiple benefits to partners including making grant funding more likely due to multi-agency approaches, removal of duplication of services, and delivering consistent services and information to the people who live, work, and recreate in the watershed. Targeted outreach to landowners and targeted conservation efforts result in messages that resonate with individuals and communities alike and in actions that get the most bang for the buck. Section 7 will expand on the sub-watershed analysis in terms of what can be done to focus implementation efforts in terms of clear messaging and targeted actions.

This type of coordinated effort is already happening in the Yellow River Watershed, but if shared projects do not continue to be leveraged and agencies do not step up their commitment to work together, the good things that are happening today may lose energy and wither away. We also cannot rely solely on the tools and skills of the past to carry us into an ever changing future. New tools and skills must become a part of a strategy of continuous improvement for all natural resources agencies both in internal and external operations. Emerging tools and skills will be covered in more detail in Section 7.

Part 3.
Section 7 – Implementation Framework

Implementation of landscape stewardship plans will be as successful as the imagination, creativity, and commitment that partners and stakeholders bring to the overall process. This section provides a more in-depth description on how the Coordination / Implementation Committee can implement the Plan over the next 10 – 20 years. The first part of this section describes seven overall implementation strategies and establishes a list of potential demonstration projects suggested by the Planning Committee. The second part provides an initial framework for guiding targeted and prioritized implementation activities at the sub-watershed level that can ultimately guide work down to a specific parcel of land.

A. Overview

The implementation of a landscape-scale 'all-lands' approach to forest stewardship is different from traditional approaches of the past in that it is much broader in scope. Landscape stewardship seeks to connect and implement multiple efforts at watershed, sub-watershed, community, and landowner levels, working toward shared goals and objectives that have been developed through a collaborative planning process as outlined in Section 5. The following are some suggested initial tasks to get this style of collaborative implementation started:

- Task 1: Celebrate: Congratulations! Enjoy the completion of the Yellow River Watershed Landscape Stewardship Plan! Take a breather and celebrate the completion of this Plan with your partners and stakeholders – it truly represents a major milestone.
- Task 2: Get Organized: Convene the Coordination / Implementation Committee. We've got money to spend, more money we can get...let's get rolling…
- Task 3: Take Action: Implement priority projects. Engage partners, stakeholders, and interested parties to get some things going on the ground and develop the relationships that will foster the long-term sustainable management of forest and water resources in the Yellow River Tributary Watershed and the sub-watersheds.
- Task 4: Celebrate Projects: Congratulations! Acknowledge and celebrate completed projects identified in the Yellow River Watershed. Highlight how they became successful collaborative efforts with partners, stakeholders and interested parties. Share these success stories with others to continue building support and momentum for future project implementation.
- Task 5: Evaluate and Repeat: Evaluate projects against the goals and objectives in the plan to make sure things are on track. Adjust priorities as needed and repeat Tasks 3 and 4.

B. Systematic Implementation Strategies

There is no one strategy that will solve the challenges of significantly increasing forest stewardship across the watershed while at the same time attaining other desired public outcomes such as increasing water quality protection. One of the benefits of using landscape approaches to forest stewardship concurrent with water resources as well as recreation management is that it encourages partners and stakeholders to consider multiple strategies at varying scales, bring those strategies together in a cohesive plan, and then take complimentary actions that are relevant to the local community with respect to its culture and traditions. The following narrative describes a package of overall systematic implementation strategies that the Coordination / Implementation Committee should develop and actively use to more successfully implement this plan. The Coordination / Implementation Committee should focus on growing these strategies, especially in the first three to five years.

Implementation Strategy # 1: Integrated Outreach and Education Program

Integrated Outreach and Education for Landowners

- Outreach Strategy. Develop an annual outreach strategy that identifies relevant tasks and responsible persons for those tasks.
- Executive Summary Mailing. Develop and distribute an executive summary of the Yellow River Watershed Landscape Stewardship Plan, its purpose and projected outcomes to partners and stakeholders.
- Tools for Engaging Landowners Effectively (TELE). Design and implement targeted marketing campaigns to reach selected audiences with messages that resonate with them to promote action. Hold community outreach and education events that build greater awareness of and support for the stewardship of forest land in the project area.
- Landowner Surveys. Develop and implement survey tools of private landowners specific to the project area. Consult the USDA Forest Service National Woodland Owner Survey as a baseline.
- Coordinated Educational Events. Develop a coordinated arrangement of educational events and resources among partners and stakeholders to provide useful information, increase skills and enhance knowledge for landowners, local officials, and the general public.
- Annual landowner workshops. Conduct landowner education workshops, field trips and other events on at least an annual basis to foster continued engagement in forest stewardship activities.
- Information Resources. In addition to workshops, other important landowner education tools, including agency websites and others such as the University of Wisconsin Extension and the American Forest Foundation's My Land Plan (http://mylandplan.org/), are aimed at private forest landowners. Many books and publications are also available. Develop a resource list that can be shared with private forest landowners that includes helpful local, regional and national information resources.

Integrated Continuing Education for Natural Resources Managers and Service Providers

Successful implementation of this Plan will likely require that natural resources managers and service providers learn new skills in some or all of the following areas: media training, land use planning, strategic communication, social/conservation marketing, working with local decision makers, and meeting facilitation.

- Workshops. Identify educational needs and offer continuing education workshops, webinars, and other training opportunities to meet those needs. Partner with the UWEX, SAF and others to convene these sessions.
- Courses. The USDA Forest Service, Northeastern Area State and Private Forestry is in the process of adapting the Changing Roles training courses used in the South to fit conditions across our region. This training will address some of these topics. Other training courses may be developed or adapted from other fields to help natural resources professionals and service providers acquire the skills necessary to be successful.

Implementation Strategy # 2 – Coordinated Technical and Financial Assistance Program

- Targeted and Prioritized Technical / Financial Assistance. Coordinate with partners and stakeholders to effectively deliver technical and financial assistance programs to landowners and community leaders. Use the sub-watershed assessments and modeling tools to help set priorities in promoting technical and financial assistance programs.
- Equipment Rental Programs. Develop new and/or support and enhance existing local equipment rental programs by both public and private providers – tree planters, drills (native grasses), controlled burn equipment, etc. Coordinate equipment resources from public agencies with nurseries, hardware stores and other private enterprises.

Implementation Strategy # 3: Leveraged Incentives Program

- Private Incentive Projects (Private Lands Projects). Support the development of cooperative forest resource management projects that engage multiple landowners on challenging forest management projects such as TSI, invasive control fuel load reduction, biomass harvesting, riparian tree planting, vegetative buffer strips, high cost BMPs, and others. Seek ways to leverage more implementation by leveraging resources available from watershed partners.

Implementation Strategy # 4 – Shared Data Management Program

- Resource Inventory and Assessment. Collect, organize, map, interpret and distribute useful data among partners and stakeholder groups.
- Landowner Outreach Database. Collect and track data about landowners and other target audiences to improve future education and outreach efforts and overall service delivery.
- Technical and Financial Assistance Inventory. Develop an inventory of agencies and organizations that support sustainable forest management and/or serve private landowners; include their responsibilities and authorities and the services they provide. This list should be maintained by all partners and stakeholders. This information can greatly enhance and support grant writing and fundraising.
- Resource Monitoring. Monitor and maintain data relating to land cover, forest conditions, habitat conditions, water quality and quantity

Implementation Strategy # 5: Cooperative Community Building/Resource Protection Policy and Regulation Coordination

Presentations to Local Governments

- Enlist the support of local decision-makers for programs and policies that enhance the viability of owning forest land in the community by periodically presenting the Plan and inviting their participation in its implementation.
- Enlist the support of local decision-makers who understand the impacts of local land use regulations and can enhance the viability of owning forest land in the community.

Support and Participate in Local Planning Processes

- Water Plans. Integrate sustainable forest management with county water plans, lake and river management plans, watershed studies, wellhead protection plans, and others through early involvement in the local planning process.
- Comprehensive/Land Use/Community Growth Plans. Integrate sustainable forest management with municipal, county and regional land use and community growth plans through early involvement in the local planning process.
- Public Investments. Public lands, roads and bridges, transmission lines and utilities, parks and trails, water and sewer facilities, land acquisition, public buildings, culverts, dams, public ditch maintenance, and other public facilities. Make sustainable forest management and community forestry projects a part of Capital Improvement Program (CIP) process as well as a part of any of the typical public infrastructure projects listed above.

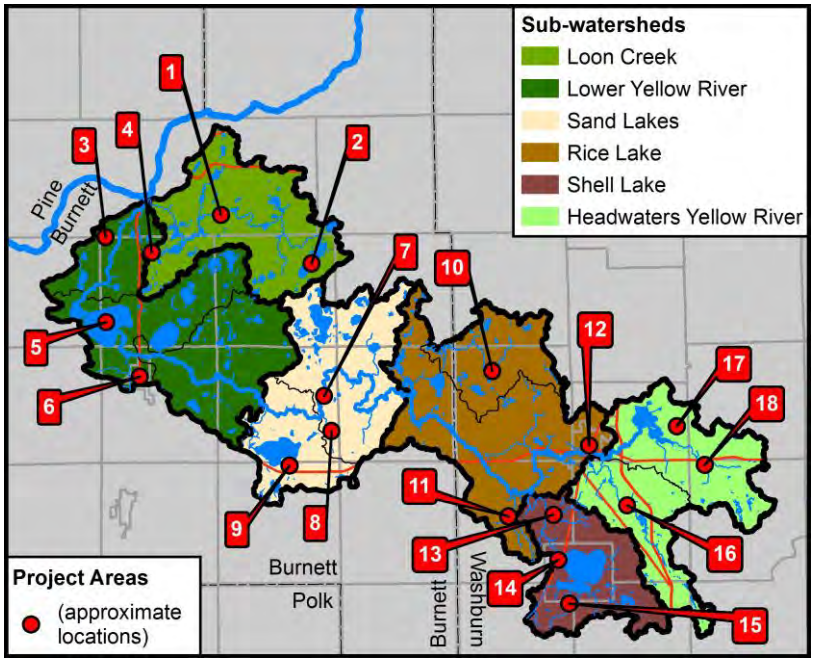
Implementation Strategy # 6: Regulatory Coordination

- Regulations and Ordinances. Encourage the integration and coordination of this Yellow River Watershed Landscape Stewardship Plan and identified projects with local governmental units in their regulation of land uses; promote education and incentives as a way to increase landowner compliance. Use demonstration projects on public sites as a way to promote better management of resources on private lands.

Implementation Strategy # 7: Purposeful Demonstration Projects

- Initial Demonstration Project. Work with partners and stakeholders to develop one demonstration project that implements an integrated forest/water quality objective from Section 5. Federal funding is available to support this first project. Possible projects suggested in the grant proposal include riparian buffers, restoration and management of lowland forests, and reforestation of marginal agricultural lands.
- Marketing Materials. Prepare and distribute marketing materials that describe the initial demonstration project and its outcomes. Develop the demonstration project as a model to help support future projects throughout the watershed.
- 10-Year Demonstration Project List. Maintain and prioritize a long term list of demonstration projects.

C. 10-year Demonstration Project List



Demonstration projects developed in an orchestrated manner can provide valuable insights to resource professionals and landowners alike in cost effective ways. As a part of the planning process, Planning Committee members were asked to brainstorm potential forest management projects that could improve or protect water quality in the watershed. To help members more quickly identify potential projects, primer materials including maps and data (land cover, ownership, stewardship plans, forest health threats, etc.) were provided at the meetings. Members were then asked to rank sub-watershed project priority.

As a result, members identified eighteen potential projects spread throughout the Yellow River Tributary Watershed. The map at right illustrates the project locations with map numbers corresponding to the table below. The table below for the 10-Year Demonstration Project List summarizes the list of potential projects, partners, initial priorities and suggested timelines. It should be noted that while this list will need more development by the Coordination/Implementation Committee, there are a lot of opportunities to build from given the amount of conservation work already in progress in the watershed. This list serves as one starting point for the Coordination/Implementation Committee to consider as a way to grow sustained momentum in supporting the robust implementation of this plan over the next ten years.

The Committee should periodically review and refine the 10-year project list. Some steps or tasks the Committee can consider to keep this list relevant include:

- Periodically consult with local officials, landowners, and stakeholders in the watershed for input on new or emerging resource problems – flooding, erosion, bank failures, under sized culverts, over harvest, blow downs, fires, etc.
- Look for project ideas identified in other natural resource management plans developed for the watershed.
- Review technical support documents developed in the process for relevant information to help develop project ideas – see the Appendix – State of the Forest Report, major and sub-watershed resource inventory and assessment reports, etc.
- Continue to gather and utilize natural resource GIS modeling studies to refine and evaluate target areas in the watershed.
- Inventory past conservation projects in the project area. Look for ideas on what was successful and what was not and why.
- Inventory and evaluate the specific interests and needs of property owners in sub-watershed target areas.
- Review and analyze potential funding sources.
- Re-brainstorm priority areas in each sub-watershed.

10-Year Demonstration Project List

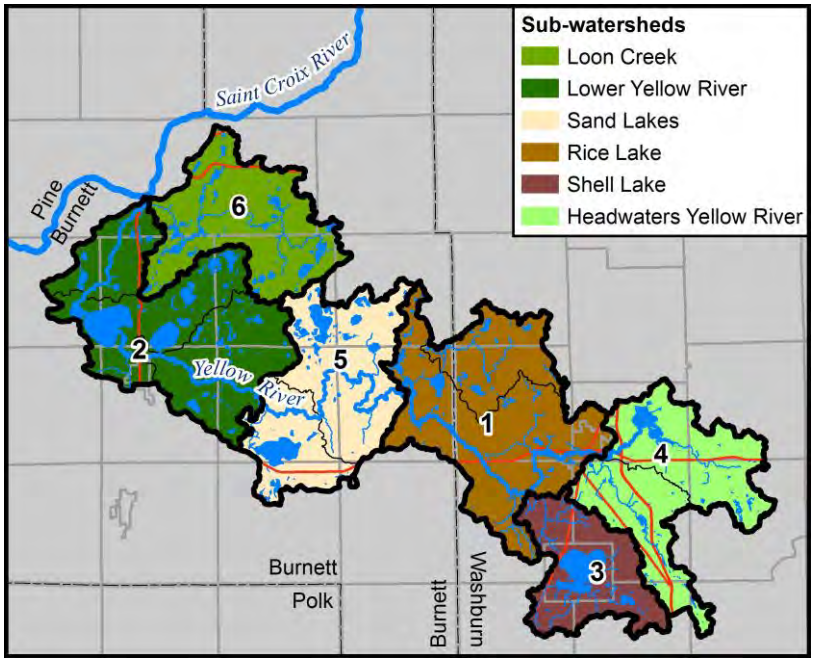
Map No.	Project Name and Brief Description	Subwd/ Project Priority	Lead Entity / Supporting Entities	Proposed Timeline
	Loon Creek Sub-watershed (SubWD # 1)	**6**		
1	Loon Creek: Loon Creek has a lot of mostly contiguous forest cover; prevent parcelization and fragmentation in this watershed. This may be a good place to focus on increasing landowners with stewardship plans since it is still heavily forested.			
2	Voyager Village: Landowners have become more familiar with forest management due to blow down. Leverage this opportunity to encourage more private forest stewardship.			
	Lower Yellow River Sub-watershed (SubWD # 2)	**2**		
3	Danbury Wildlife Area: Also Governor Knowles State Forest and Burnett County Forest Lands, expand protection to adjacent lands using tools in the Implementation Toolbox.			
4	Northwest Sands Corridor: In both Loon Creek and Lower Yellow River Sub-watersheds. Encourage private landowners to manage forests in conjunction with Northwest Sands Habitat Plan.			
5	Yellow Lake: Listed as impaired; home to over 2,000 lake sturgeon. The Yellow Lakes and River Association could be a potential partner. The YLRA has completed water quality monitoring.			
6	Village of Webster: Urban and community forestry, parkland, important areas for stormwater runoff.			

Map No.	Project Name and Brief Description	Subwd/ Project Priority	Lead Entity / Supporting Entities	Proposed Timeline
	Sand Lakes Sub-watershed (SubWD # 3)	**5**		
7	Yellow River - Sand Lakes: In this sub-watershed, the Yellow River flows through a large block of Burnett County Forest with interspersed private in-holdings adjacent to riparian areas. Encourage private landowners to use riparian BMPs and to protect lands.			
8	Spring Brook: Spring Brook is a tributary of the Yellow, is a Class I Trout Stream and an ERW. It flows through primarily private land between Spring Creek FA and Burnett County Forest. Encourage private landowners to use riparian BMPs and prevent creating barriers to fish passage.			
9	St. Croix Tribal Land: Work with the St. Croix Tribe to assist with forest management needs.			
	Rice Lake Sub-watershed (SubWD # 4)	**1**		
10	Rocky Ridge Creek Minor Watershed: Increase amount of protected forest in minor watershed using tools in Implementation Toolbox to ensure that enough forest is protected to maintain stable peak flows from spring snow melts.		Cranberry bog companies north and upstream from Lipsett Lake?	
11	Dahlstrom Brook: Designated trout stream, ERW. Flows through private land that is predominantly in pasture/hay. Encourage private landowners to use riparian BMPs and to protect lands.			
12	City of Spooner: Yellow River runs through. Urban and community forestry, parkland, important areas for stormwater runoff.			

Map No.	Project Name and Brief Description	Subwd/ Project Priority	Lead Entity / Supporting Entities	Proposed Timeline
	Shell Lake Sub-watershed (SubWD # 5)	**3**		
13	Sawyer Creek: Designated trout stream, ORW, meanders past several agricultural fields, between blocks of State-owned property, possible areas for some buffer expansion. Protect Sawyer Creek and areas around Sawyer Creek State Fishery Area.			
14	City of Shell Lake: Urban and community forestry, parkland, important areas for stormwater runoff.			
15	South Shell Lake Uplands: Shell Lake is ORW, south uplands are forested with large block of Washburn County Forest Land. Expand protection between Shell Lake and Washburn County Forest Lands.			
	Headwaters Yellow River Sub-watershed (SubWD # 6)	**4**		
16	Beaver Brook: Headwater Stream, designated trout stream, ORW, Beaver Brook State Wildlife Area, large block of Washburn County Forest Lands to the east. Expand protection around public lands using tools in Implementation Toolbox.			
17	East Spooner Lake: Mostly forested and all privately owned. Expand protection using tools in Implementation Toolbox.			
18	Crystal Brook: Headwater stream, designated trout stream, ERW. Flows through primarily privately owned woodland. Encourage private landowners to use riparian BMPs and to protect lands.			

Map No.	Project Name and Brief Description	Subwd/ Project Priority	Lead Entity / Supporting Entities	Proposed Timeline
	Additional Project Considerations for All Sub-watersheds			
	Cost-share Forest Stewardship Plans. Provide cost-share for forest stewardship plans for private land owners.			
	Culvert Replacements. Assist in culvert replacements where water quality and forested areas are threatened.			
	Township Road Culvert Inventories. Inventory township road culverts.			
	Beaver Control. Identify and control beaver damage in forested areas.			
	TMDL projects.			
	Increase awareness of fragmentation and parcelization in areas of the Yellow River Watershed with large blocks of mostly contiguous forest cover**.**			

D. Sub-watershed Management Strategy



As described in Section 3 and supporting technical documents, the sub-watershed analyses provide a useful evaluation of the land cover/watershed relationships and initial risk assessment. The intent of the following narrative is to provide the Coordination/Implementation Committee with resource management strategies at the sub-watershed scale in order to more effectively address key forest and water resource issues.

Based on the analysis, the six sub-watersheds are ranked below in order of priority from the most threatened to the least threatened. Individually, these sub-watersheds become the geographic basis for future forest planning areas.

1. Rice Lake Sub-watershed
2. Lower Yellow River Sub-watershed
3. Shell Lake Sub-watershed
4. Headwaters Yellow River Sub-watershed
5. Sand Lakes Sub-watershed
6. Loon Creek Sub-watershed

The following three steps are suggested as a basic guide to implementing the sub-watershed action plans:

- **Target** – identify specific key areas for forest management in each sub-watershed based on sub-watershed analyses in Section 3. The sub-watershed action plans provided later in this section provide an initial identification of target areas. Use the additional screening tools below to further prioritize sub-watersheds.
- **Implement** – Apply appropriate Systematic Implementation Strategies as described above and follow Site Level Implementation described below.
- **Monitor / Evaluate** – Measure activities and outcomes and determine if activities and outcomes are resulting in desired effects, modify implementation if not.

Minnesota DNR Fisheries Watershed Assessment Criteria and Management Strategies

Minnesota DNR Fisheries has assessed land cover on a watershed basis statewide and began to define general land management strategies to support the production of clean water that flows into streams, rivers and lakes. The following diagram summarizes these integrated concepts. This diagram provides the Coordination/Implementation Committee with additional quantifiable criteria for managing the sub-watersheds. Using the criteria for converted and protected land, all of the sub-watersheds fall under the "Protection" strategy. However, restoration strategies along lakes and streams of concern should also be considered in implementation of the Sub-watershed Action Plans.

Vigilance	Protection	Moderate Restoration	Intense Restoration
Sub-watershed having < 25% of converted cover and > 75% protection in public land ownership and private conservancy. Low risk/least threatened. This approach involves careful identification and monitoring of problems or signs of danger; being watchful. No immediate action needed unless conditions significantly deteriorate.	Sub-watershed having < 25% of converted cover and < 75% protection in public land ownership and private conservancy. Moderate risk/moderately threatened. This approach involves active protection of upland forest cover through fee title (purchase) or conservation easements, etc.	Sub-watershed having between 25% and 60% of converted cover and with > 75% protection in public land ownership and private conservancy. High risk/highly threatened. This approach involves active protection of upland forest cover through fee title (purchase) or conservation easements, etc. and active restoration/management of upland forest cover.	Sub-watershed having > 60% of converted cover and with < 75% protection in public land ownership and private conservancy. Extreme risk/extremely threatened. This approach involves immediate action to address the most threatened sub-watersheds by implementing restoration and management projects. Restore and increase forest land cover.

Prioritizing Service Delivery: Applying Additional Screening Tools

One of the first tasks for the Coordination/Implementation Committee in advancing the sub-watershed management strategy should be to develop a prioritized list of parcels in the target areas of each sub-watershed. The Coordination/Implementation Committee should consider using the following modeling tools when prioritizing clusters of parcels and refining work priorities for each sub-watershed action plan:

First level of screening
- Historic upland forest loss.
- Adjacency to riparian areas.
- Adjacency to public lands – wildlife areas, state parks, state forests, county forests, etc.

Second level of screening
- Forest threats (WI DNR Forestry – State Forest Action Plan)
- Areas of Special Natural Resource Interest (http://dnr.wi.gov/topic/surfacewater/datasets/designated_waters/asnri.html)

- Critical Habitat Areas (http://dnr.wi.gov/lakes/criticalhabitat/)
- NHI Natural Community Elements (http://dnr.wi.gov/topic/EndangeredResources/Communities.asp)
- Others?

Site-Level Implementation: WDNR Forestry Guidance for Managing Private Forestland

Below is the current guidance and resources WDNR - Forestry offers for managing private forestland. These guidelines can be used as a template for steps to take when working with private landowners.

1) Setting goals and developing a plan

Before establishing a new forest or caring an existing forest, set goals so you know what result you are working towards, and create a management plan.

"Many people own wooded acreage, and many others hope to acquire forestland. But few people have really analyzed why. Yet a full understanding of why you own land, what you want to do with it, and what is needed to reach your goals, can significantly help you get the most from your woodland." - Jeff Martin

Resources for getting started:

- Getting the Most from Your Woodland: http://forest.wisc.edu/sites/default/files/pdfs/publications/48.PDF
- Talk to a forester: http://dnr.wi.gov/topic/ForestLandowners/assist.html
- Chapter 10 Forest Management Planning, Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/documents/guidelines/chapter9.pdf

2) Establishing your forest

Tree planting can be one of the most rewarding forestry projects. Given soil, moisture, sun and a caring owner, tree seedlings can shape the landscape for generations to come. Planning is needed, however, to assure that your seedlings survive and grow.

- Design a Personalized Tree Planting Plan: http://dnr.wi.gov/topic/TreePlanting/plan.html
- Understanding what trees may do better as the climate changes: http://www.forestadaptation.org/
- For recommendations on what to plant, contact a forester: http://dnr.wi.gov/topic/ForestLandowners/assist.html
- Order tree and shrub seedlings: http://dnr.wi.gov/topic/TreePlanting/order.html

3) Caring for your Forest

Forests, both natural woodlands and planted trees, will often benefit from care.

- Trees can become too crowded and need thinning.
- Woodlands can be invaded by undesirable plants that kill what you want to grow: http://dnr.wi.gov/topic/Invasives/
- Trees may need pruning and shaping to grow straight and tall.

- You may want to grow trees for special products such as maple syrup.
- Forests may have erosion problems that need attention.
- Streams, wetlands or prairies that are part of your woodland may need improvement or protection.
- Forest health may be a concern if pests or weather cause damage: http://dnr.wi.gov/topic/ForestHealth/
- Wildlife needs for food, water and nesting sites may require work.
- Rare or endangered species on your site may require special protection: http://dnr.wi.gov/topic/EndangeredResources/
- Water quality needs to be protected using Best Management Practices.

Wisconsin Forest Management Guidelines (http://dnr.wi.gov/topic/ForestManagement/guidelines.html) is a great source for things to consider when managing your forest. The publication was written to provide basic, sensible concepts that outline responsible resource management at the site-level. While FMG is written for resource managers and enthusiasts, our hope is that it is straightforward and appealing enough to be understood with little effort. A companion publication 10 Ways to Protect Your Woodland Property (http://dnr.wi.gov/files/pdf/pubs/fr/FR0313.pdf) was written as an introduction for woodland owners to the FMG and to help them understand the value and benefits their woodlands provide.

Resources

- To Cut or Not to Cut? Managing Your Woodland for Wildlife: http://dnr.wi.gov/files/pdf/pubs/wm/WM0224.pdf
- UW-Extension: http://woodlandinfo.org/
- US Forest Service: http://www.fs.usda.gov/r9
- Basin Educators: http://naturalresources.uwex.edu/
- Climate Change Response Framework http://www.forestadaptation.org/

4) Harvesting your forest

Few people own woodlands because they want to cut trees. Timber harvesting, however, is one of the most important tools available to shape a woodland. Timber is cut to provide habitat needed for wildlife, control disease problems, open up vistas, make recreational trails, renew vigorous growth, earn income and many other reasons. Landowners have a personal responsibility to protect themselves in any business dealings, and selling timber is no exception. Plan your harvest well, and get professional help: http://dnr.wi.gov/topic/ForestLandowners/assist.html .

Both state and private groups are working to improve timber harvests. A fact sheet, Cutting Standing Timber (http://datcp.wi.gov/uploads/Consumer/pdf/LoggingTimber181.pdf) is available from the Department of Agriculture, Trade and Consumer Protection (DATCP). You can also check with DATCP at 1-800-422-7128 to see if complaints have been filed about a logger. The DNR is working with state legislators on a proposal to strengthen timber theft and timber trespass laws. The timber industry is also trying to weed out poor-quality loggers on its own.

- Conducting a successful timber sale: http://dnr.wi.gov/files/pdf/pubs/fr/FR0254.pdf
- Writing contracts: http://dnr.wi.gov/topic/ForestLandowners/contracts.html

Site-Level Implementation: Lake St. Croix TMDL Implementation Plan

The Lake St. Croix TMDL Implementation Plan specifically calls for the following to be observed to help reduce phosphorus loading from forest management activities:

- Maintenance of riparian management zones (RMZs)
  - Limit entry/light harvesting in proximity to riparian areas
  - Maintenance of long lived riparian tree species
- Proper planning, construction and maintenance of road/skid trail waterway crossings
- Proper planning and management of prescribed burning activities
- Proper methods and application of chemicals
- Avoiding excessive addition of organic material and debris to surface waters
- Minimize surface erosion
  - Proper road location and planning
  - Winter harvesting in sensitive areas
  - Installation of erosion control practices
    - Crowned roads
    - Water bars
    - Sediment capture basins
    - Proper ditching and culvert placement
- Post-harvest vegetation of skid trails and roads

E. Sub-watershed Action Plans

Guide

The sub-watershed risk assessment, using knowledge gained from the technical support documents, begins the process of establishing geographic targets within the Yellow River Tributary Watershed for applying forest management strategies interrelated to water quality strategies. An "action plan" for each of the six sub-watersheds in the Yellow River Tributary Watershed is provided below. Each Sub-watershed Action Plan identifies specific target areas and begins to identify forest management strategies. The contents of the Sub-watershed Action Plans include:

Water Resource Management Strategies: Strategies that address the forest and water quality relationship.

Context: Context of the forest and water quality relationship in the sub-watershed.

Priority Management Strategies: Suggested strategies to address issues relating to the forest and water quality relationship.

Forest Management Strategies: Strategies that address ecological conditions in the sub-watershed.

Context:

- *Ecological Landscapes, ECS Subsections, and ECS Land Type Associations*: Provided as part of the hierarchy for the Ecological Classification System. The Habitat Type groups that are part of these larger ECS groups can then be used to reference ECS Silviculture Prescriptions in the Silviculture Handbook that may apply within sub-watersheds.
- *Forest Habitat Type Classification System*: The forest habitat type classification system (FHTCS) is a site classification system based on the floristic composition of plant communities. Forest managers are often charged with the challenging task of assessing site potential and variability when developing management prescriptions and plans for forest stands and properties. The FHTCS provides a tool to improve the process of assessing site potential and evaluating management alternatives. Through application of the FHTCS, land managers are better able to assess site capabilities, identify ecological and silvicultural alternatives, predict the effectiveness of possible silvicultural treatments, evaluate feasible management alternatives, and choose appropriate management objectives.
- *Potential NHI Community Elements*: Established in 1985 by the Wisconsin legislature, Wisconsin's Natural Heritage Inventory program (NHI) is part of an international network of inventory programs. The program is responsible for maintaining data on the locations and status of rare species, natural communities, and natural features throughout the state.

General Forest Management Recommendations: Use the silvicultural methods and prescriptions described in Wisconsin's Silviculture and Forest Aesthetics Handbook and Wisconsin's Forest Management Guidelines to determine general forest management recommendations.

Silviculture handbook: http://dnr.wi.gov/topic/ForestManagement/silviculture.html

Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/guidelines.html

Loon Creek Sub-watershed Action Plan (SubWD # 1)

	Loon Creek (SubWD # 1)
Area	32,205 acres
Natural Factors	
Position in watershed	**L** Trib, low
Stream density	**L** 0.5 miles/sqmi
Sub-wd Slope	**H** 3.9%
Cultural Factors	
Upland forest loss	**L** 18.8%
Converted lands	**L** 7.0%
Public lands	**L** 41.0%
Protected upland forest	**L** 44%, 9,784 ac
Potential PFM	**L** 55%, 13,174 ac
Impaired streams (other than mercury)	**L** 0.0 miles
Impaired waters (other than mercury)	**L** 0 acres

Water Resource Management Strategies

Context:

- Overall Sub-watershed Risk Assessment: Low
- Isolated from the rest of the YRMW, flows into Yellow River less than a mile from the St. Croix Confluence
- Resource Management Challenges: High average watershed slope.
- Lakes of Concern: Loon Lake, Twenty-six Lake. Loon Creek has several flowage lakes.
- Tributaries of Concern: unnamed tributary associated with Tabor Lake/Robie Lake/Burlingame Lake; unnamed tributary associated with Culbertson Lake/North Lang Lake

Priority Management Strategies:

1. Extend protection of riparian areas in the bottom third of Loon Creek to the confluence with the Yellow River with targeted conservation easements or incentive programs.
2. Restore and protect riparian forests along primary tributaries to Loon Creek.
3. Look for opportunities to incorporate permanent or temporary barrens habitat, an historic cover type in this sub-watershed, into forest management plans.
4. Continue to work with and engage landowners in the blowdown area.
5. Most of the sub-watershed is at very high risk of wildfire and most townships are very high priority areas for "Communities-at-Risk" funding for hazard mitigation projects.
6. Others??

Forest Management Strategies

Context:

- Ecological Landscape - Northwest Lowland, Northwest Sands
- ECS Subsection – 212Ka Bayfield Sand Plains; 212Kb Mille Lacs Uplands
- ECS Land Type Associations:
  - St. Croix Plains
  - Danbury Trego Plains
  - Webb Lake Collapsed Barren
  - Lower Namekagon
- 212 Ka Habitat Type groups and potential natural vegetation:
  - Predominant habitat type group is very dry to dry.
    - Common trees currently growing on these sites are jack pine, red pine, oaks, and aspen.
    - Potential late-successional tree species include white pine, oaks, and red maple.

  - Dry to dry-mesic group is also common
    - Most common trees are aspen and white birch
    - Potential late-successional species include red maple, red oak, and white pine
  - Forest lowlands (wet-mesic to wet) are also present.
- Potential NHI Community Elements in Loon Creek Sub-watershed:
  - Alder Thicket
  - Northern Dry Forest
  - Northern Sedge Meadow
  - Pine Barrens
  - Karner Blue Butterfly High Potential Range

General Forest Management Recommendations: Use the silvicultural methods and prescriptions described in Wisconsin's Silviculture and Forest Aesthetics Handbook and Wisconsin's Forest Management Guidelines to determine general forest management recommendations.

Silviculture handbook: http://dnr.wi.gov/topic/ForestManagement/silviculture.html

Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/guidelines.html

Lower Yellow River Sub-watershed Action Plan (SubWD # 2)

	Lower Yellow River (SubWD # 2)
Area	52,466 acres
Natural Factors	
Position in watershed	**H** Main stem, low
Stream density	**L** 0.5 miles/sqmi
Sub-wd Slope	**L** 2.6%
Cultural Factors	
Upland forest loss	**L** 20.0%
Converted lands	**M** 9.6%
Public lands	**H** 12.6%
Protected upland forest	**H** 15%, 4,566 ac
Potential PFM	**H** 84%, 28,296 ac
Impaired streams (other than mercury)	**L** 0.0 miles
Impaired waters (other than mercury)	**H** 2,281 acres

Water Resource Management Strategies

Context:

- Overall Sub-watershed Risk Assessment: High
- Resource Management Challenges: Low percent area of public lands and protected upland forest, second highest potential PFM, Yellow Lake impaired for total phosphorus. Yellow River flows through almost exclusively private land in this sub-watershed.
- Lakes of Concern: Yellow Lake, Little Yellow Lake, Devils Lake, Bass Lake.
- Tributaries of Concern: None

Priority Management Strategies:

1. Shoreline protection and restoration.
2. Invasive plant removal, especially purple loosestrife.
3. Engage with private landowners; most of riparian corridor privately owned.
4. Most of the sub-watershed is at high to very high risk of wildfire and most townships and the City of Webster are very high priority areas for "Communities-at-Risk" funding for hazard mitigation projects.
5. Look for opportunities to incorporate permanent or temporary barrens habitat, as historic cover type in this sub-watershed, into forest management plans.
6. Others??

Forest Management Strategies

Context:

- Ecological Landscape - Northwest Lowland, Northwest Sands
- ECS Subsection – 212Ka Bayfield Sand Plains
- ECS Land Type Associations:
  - St. Croix Plains
  - Danbury Trego Plains
  - Webb Lake Collapsed Barren
  - Siren Plains
- 212 Ka Habitat Type groups and potential natural vegetation:
  - Predominant habitat type group is very dry to dry.
    - Common trees currently growing on these sites are jack pine, red pine, oaks, and aspen.
    - Potential late-successional tree species include white pine, oaks, and red maple.
  - Dry to dry-mesic group is also common

        - Most common trees are aspen and white birch
        - Potential late-successional species include red maple, red oak, and white pine
    - Forest lowlands (wet-mesic to wet) are also present.
- Potential NHI Community Elements in Lower Yellow River Sub-watershed:
    - Alder Thicket
    - Northern Dry Forest
    - Northern Dry Mesic Forest
    - Northern Sedge Meadow
    - Tamarack Swamp
    - Karner Blue Butterfly High Potential Range

General Forest Management Recommendations: Use the silvicultural methods and prescriptions described in Wisconsin's Silviculture and Forest Aesthetics Handbook and Wisconsin's Forest Management Guidelines to determine general forest management recommendations.

Silviculture handbook: http://dnr.wi.gov/topic/ForestManagement/silviculture.html

Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/guidelines.html

Sand Lakes Sub-watershed Action Plan (SubWD # 3)

	Sand Lakes (SubWD # 3)
Area	39,695 acres
Natural Factors	
Position in watershed	**M** Main stem, mid
Stream density	**L** 0.5 miles/sqmi
Sub-wd Slope	**L** 2.6%
Cultural Factors	
Upland forest loss	**L** 17.5%
Converted lands	**L** 8.2%
Public lands	**M** 23.2%
Protected upland forest	**M** 29%, 7,225 ac
Potential PFM	**M** 70%, 19,206 ac
Impaired streams (other than mercury)	**L** 0.0 miles
Impaired waters (other than mercury)	**L** 0 acres

Water Resource Management Strategies

Context:

- Overall Sub-watershed Risk Assessment: Low
- Resource Management Challenges: Moderate amount of public landownership with much of it located along the main stem of Yellow River, comparatively low amount of upland forest loss, moderate potential PFM.
- Lakes of Concern: Big Sand Lake (ORW), Sand Lake (ORW), Gaslyn Lake
- Tributaries of Concern:
  - Spring Brook – Class I Trout Stream, ERW
  - Black Creek – Class II Trout Stream,
  - Sand Creek

Priority Management Strategies:

1. Extend protection of riparian areas along the Yellow River with targeted conservation easements or incentive programs (private inholdings within Burnett County Forest).
2. Restore and protect riparian forests along primary tributaries to Yellow River.
3. Maintain and protect high quality resource waters.
4. Most of the sub-watershed is at high to very high risk of wildfire and all of the townships within the sub-watershed are high or very high priority areas for "Communities-at-Risk" funding for hazard mitigation projects.
5. Look for opportunities to incorporate permanent or temporary barrens habitat, as historic cover type in this sub-watershed, into forest management plans.
6. Others?

Forest Management Strategies

Context:

- Ecological Landscape - Forest Transition, Northwest Sands
- ECS Subsection – 212Ka Bayfield Sand Plains
- ECS Land Type Associations (LTAs):
  - Spooner Plains
  - Siren Plains
  - Webb Lake Collapsed Barren
  - St. Croix Moraine
- 212 Ka Habitat Type groups and potential natural vegetation:

  - Predominant habitat type group is very dry to dry.
    - Common trees currently growing on these sites are jack pine, red pine, oaks, and aspen.
    - Potential late-successional tree species include white pine, oaks, and red maple.
  - Dry to dry-mesic group is also common
    - Most common trees are aspen and white birch
    - Potential late-successional species include red maple, red oak, and white pine
  - Forest lowlands (wet-mesic to wet) are also present.
- Potential NHI Community Elements in Sand Lakes Sub-watershed:
  - Northern Sedge Meadow
  - Karner Blue Butterfly High Potential Range

General Forest Management Recommendations: Use the silvicultural methods and prescriptions described in Wisconsin's Silviculture and Forest Aesthetics Handbook and Wisconsin's Forest Management Guidelines to determine general forest management recommendations.

Silviculture handbook: http://dnr.wi.gov/topic/ForestManagement/silviculture.html

Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/guidelines.html

Rice Lake Sub-watershed Action Plan (SubWD # 4)

	Rice Lake (SubWD # 4)
Area	51,567 acres
Natural Factors	
Position in watershed	**M** Main stem, mid
Stream density	**M** 0.8 miles/sqmi
Sub-wd Slope	**M** 3.4%
Cultural Factors	
Upland forest loss	**H** 35.4%
Converted lands	**H** 12.6%
Public lands	**H** 2.6%
Protected upland forest	**H** 4%, 1,179 ac
Potential PFM	**H** 96%, 29,511 ac
Impaired streams (other than mercury)	**L** 0.0 miles
Impaired waters (other than mercury)	**L** 0 acres

Water Resource Management Strategies

Context:

- Overall Sub-watershed Risk Assessment: High
- Resource Management Challenges: Low amount of public landownership, high amount of upland forest loss, high potential PFM.
- Lakes of Concern: Benoit Lake, Rice Lake, Lipsett Lake
- Tributaries of Concern:
  - Rocky Ridge Creek
  - Dahlstrom Brook: Class I Trout Stream, ERW
  - Dago Creek: Class I Trout Stream, ERW
  - Whiskey Creek
  - Other high quality unnamed tributaries

Priority Management Strategies:

1. Extend protection of riparian areas along the Yellow River with targeted conservation easements or incentive programs (private inholdings within County Forest and adjacent to state-owned land).
2. Engage with private landowners; most of the riparian areas along the Yellow River and its tributaries are privately owned in this sub-watershed.
3. Assess and Protect high quality water resources.
4. Urban forestry in the City of Spooner (a Tree City USA Community).
5. Parts of the sub-watershed are at high to very high risk of wildfire and all of the townships within the sub-watershed are high or very high priority areas for "Communities-at-Risk" funding for hazard mitigation projects.
6. Look for opportunities to incorporate permanent or temporary barrens habitat, as historic cover type in this sub-watershed, into forest management plans.
7. Others??

Forest Management Strategies

Context:

- Ecological Landscape - Forest Transition, Northwest Sands
- ECS Subsection – 212Ka Bayfield Sand Plains, 212Qa St Croix Moraine
- ECS Land Type Associations (LTAs):
  - Spooner Plains

  - Siren Plains
  - Webb Lake Collapsed Barren
  - St. Croix Moraine
- 212 Ka Habitat Type groups and potential natural vegetation:
  - Predominant habitat type group is very dry to dry.
    - Common trees currently growing on these sites are jack pine, red pine, oaks, and aspen.
    - Potential late-successional tree species include white pine, oaks, and red maple.
  - Dry to dry-mesic group is also common
    - Most common trees are aspen and white birch
    - Potential late-successional species include red maple, red oak, and white pine
  - Forest lowlands (wet-mesic to wet) are also present.
- 212 Qa Habitat Type groups and potential natural vegetation:
  - Predominant habitat type group is Dry Mesic.
    - Common trees currently growing on these sites are sugar maple, red maple, oaks, and aspen.
    - Potential tree species include white pine, oaks, red maple, aspen, and white birch.
  - Mesic group is also common
    - Most common trees are aspen, sugar maple, white oak and N. red oak
    - Potential species include sugar maple, red maple, oaks, white pine, aspen, birch, and bitternut hickory
  - The Mesic to Wet-Mesis type is also present
    - Most common trees are aspen and red maple
    - Potential species include red maple, pines, oaks, aspen, and birch
- Potential NHI Community Elements in Rice Lake Sub-watershed:
  - Karner Blue Butterfly High Potential Range

General Forest Management Recommendations: Use the silvicultural methods and prescriptions described in Wisconsin's Silviculture and Forest Aesthetics Handbook and Wisconsin's Forest Management Guidelines to determine general forest management recommendations.

Silviculture handbook: http://dnr.wi.gov/topic/ForestManagement/silviculture.html

Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/guidelines.html

Shell Lake Sub-watershed Action Plan (SubWD # 5)

	Shell Lake (SubWD # 5)
Area	21,520 acres
Natural Factors	
Position in watershed	**L** Trib, hi
Stream density	**H** 1.0 miles/sqmi
Sub-wd Slope	**M** 3.0%
Cultural Factors	
Upland forest loss	**H** 41.5%
Converted lands	**H** 12.1%
Public lands	**H** 10.0%
Protected upland forest	**M** 18%, 1,684 ac
Potential PFM	**M** 81%, 8,307 ac
Impaired streams (other than mercury)	**L** 0.0 miles
Impaired waters (other than mercury)	**L** 0 acres

Water Resource Management Strategies

Context:

- Overall Sub-watershed Risk Assessment: Moderate
- Resource Management Challenges: Low public land ownership, highest amount of upland forest loss, moderate PFM potential, more prime farmland land than other sub-watersheds, highest % of developed land. City of Shell Lake abuts northern end of Shell Lake and Southern end of Sawyer Creek.
- Lakes of Concern: Shell Lake – ORW, Wisconsin's largest spring fed lake
- Tributaries of Concern: Sawyer Creek – Class I Trout Stream, Class II Trout Stream, ORW

Priority Management Strategies:

1. Riparian buffers – Ag/pasture around Shell Lake and the edge of Sawyer Creek FA. Private land surrounds part of Sawyer Creek – maintain riparian forest cover in these areas.
2. Upland forests – much of the northern third of the sub-watershed lacks forest cover.
3. Protect state lands – Sawyer Creek FA surrounded by ag/pasture and developed land.
4. Urban forestry in the city of Shell Lake.
5. Others??

Forest Management Strategies

Context:

- Ecological Landscape - Forest Transition, Northwest Sands
- ECS Subsection – 212Ka Bayfield Sand Plains, 212Qa St Croix Moraine
- ECS Land Type Associations (LTAs):
  - Spooner Plains
  - St. Croix Moraine
- 212 Ka Habitat Type groups and potential natural vegetation:
  - Predominant habitat type group is very dry to dry.
    - Common trees currently growing on these sites are jack pine, red pine, oaks, and aspen.
    - Potential late-successional tree species include white pine, oaks, and red maple.
  - Dry to dry-mesic group is also common
    - Most common trees are aspen and white birch
    - Potential late-successional species include red maple, red oak, and white pine
  - Forest lowlands (wet-mesic to wet) are also present.
- 212 Qa Habitat Type groups and potential natural vegetation:

- Predominant habitat type group is Dry Mesic.
  - Common trees currently growing on these sites are sugar maple, red maple, oaks, and aspen.
  - Potential tree species include white pine, oaks, red maple, aspen, and white birch.
- Mesic group is also common
  - Most common trees are aspen, sugar maple, white oak and N. red oak
  - Potential species include sugar maple, red maple, oaks, white pine, aspen, birch, and bitternut hickory
- The Mesic to Wet-Mesic type is also present
  - Most common trees are aspen and red maple
  - Potential species include red maple, pines, oaks, aspen, and birch

- Potential NHI Community Elements in Shell Lake Sub-watershed:
  - Northern Sedge Meadow

General Forest Management Recommendations: Use the silvicultural methods and prescriptions described in Wisconsin's Silviculture and Forest Aesthetics Handbook and Wisconsin's Forest Management Guidelines to determine general forest management recommendations.

Silviculture handbook: http://dnr.wi.gov/topic/ForestManagement/silviculture.html

Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/guidelines.html

Headwaters Yellow River Sub-watershed Action Plan (SubWD # 6)

	Headwaters Yellow River (SubWD # 6)
Area	36,891 acres
Natural Factors	
Position in watershed	**L** Headwaters, hi
Stream density	**M** 0.7 miles/mi^2
Sub-wd Slope	**H** 4.0%
Cultural Factors	
Upland forest loss	**H** 32.5%
Converted lands	**H** 12.4%
Public lands	**M** 16.3%
Protected upland forest	**M** 23%, 5,059 ac
Potential PFM	**M** 77%, 18,328 ac
Impaired streams (other than mercury)	**L** 0.0 miles
Impaired waters (other than mercury)	**L** 0 acres

Water Resource Management Strategies

Context:
- Overall Sub-watershed Risk Assessment: Moderate
- Resource Management Challenges: Moderate amount of public landownership, high amount of upland forest loss, moderate amount of potential PFM, highest average slope.
- Lakes of Concern: Spooner Lake
- Tributaries of Concern:
  - Beaver Brook: Class I Trout Stream, ORW
  - Crystal Brook: Class I Trout Stream, ERW

Priority Management Strategies:
1. Riparian buffers – Protect the riparian areas of headwaters streams, Beaver Brook and Crystal Brook.
2. Extend protection of riparian areas with targeted conservation easements or incentives programs.
3. Engage private landowners in riparian corridors.
4. Protect state lands – Beaver Brook Wildlife Area.
5. Barren are an historic cover type in the northern half of the sub-watershed, look for opportunities to incorporate permanent or temporary barrens habitat into forest management plans.
6. Others??

Forest Management Strategies

Context:
- Ecological Landscape - Forest Transition, Northwest Sands
- ECS Subsection – 212Ka Bayfield Sand Plains, 212Qa St Croix Moraine
- ECS Land Type Associations (LTAs):
  - Spooner Plains
  - St. Croix Moraine
- 212 Ka Habitat Type groups and potential natural vegetation:
  - Predominant habitat type group is very dry to dry.
    - Common trees currently growing on these sites are jack pine, red pine, oaks, and aspen.
    - Potential late-successional tree species include white pine, oaks, and red maple.
  - Dry to dry-mesic group is also common
    - Most common trees are aspen and white birch
    - Potential late-successional species include red maple, red oak, and white pine

  - Forest lowlands (wet-mesic to wet) are also present.
- 212 Qa Habitat Type groups and potential natural vegetation:
  - Predominant habitat type group is Dry Mesic.
    - Common trees currently growing on these sites are sugar maple, red maple, oaks, and aspen.
    - Potential tree species include white pine, oaks, red maple, aspen, and white birch.
  - Mesic group is also common
    - Most common trees are aspen, sugar maple, white oak and N. red oak
    - Potential species include sugar maple, red maple, oaks, white pine, aspen, birch, and bitternut hickory
  - The Mesic to Wet-Mesic type is also present
    - Most common trees are aspen and red maple
    - Potential species include red maple, pines, oaks, aspen, and birch
- Potential NHI Community Elements in Headwaters Yellow River Sub-watershed:
  - Northern Sedge Meadow
  - Southern Dry-Mesic Forest
  - Northern Mesic Forest
  - Northern Wet Forest

General Forest Management Recommendations: Use the silvicultural methods and prescriptions described in Wisconsin's Silviculture and Forest Aesthetics Handbook and Wisconsin's Forest Management Guidelines to determine general forest management recommendations.

Silviculture handbook: http://dnr.wi.gov/topic/ForestManagement/silviculture.html

Forest Management Guidelines: http://dnr.wi.gov/topic/ForestManagement/guidelines.html

Part 3.
Section 8 – Monitoring and Evaluation

The purpose of this section is to provide an initial outline for monitoring and evaluating the implementation of this Plan over the next ten to twenty years. The Coordination / Implementation Committee will be responsible for developing this monitoring program. This Committee will periodically review progress made towards the implementation of this plan based on information provided by partners in the Watershed and report their findings to watershed stakeholders and other interested groups or agencies.

A. Overview

All landscape stewardship plans should include efforts to monitor what has been accomplished as well as evaluate the effectiveness of the project's approach to forest stewardship over time including biophysical and socio-economic factors. This involves an iterative process of assessing/identifying problems and recommending a series of solutions. Sustainable forest management and clean water projects, programs, and policies happen because of a series of decisions about how to allocate time and money, which expertise to tap, who to involve, and what practices and activities to implement. The quality of the decisions depends on the quality of understanding of the watershed system, definition of the problem, identification of causes of the problem, and effective solutions.

The goals and objectives included in Section 5 reflect the needs and interests of local as well as State and regional stakeholders and partners, and ultimately serve as the basis for evaluating and adjusting this Plan. Those goals and objectives lay the foundation for short-term monitoring of accomplishments as well as evaluating the long-term outcomes (the program impacts). Monitoring focuses on tracking what is accomplished, while evaluation seeks to measure program effectiveness.

Monitoring the project's accomplishments related to program activities is generally short term in nature. Evaluating outcomes or results, such as an increase in engaged landowners or increased acres of forest on privately owned lands, takes a longer-term perspective. Monitoring takes place on an ongoing basis or annually, whereas evaluation occurs less often.

A clear framework, agreed upon by the key stakeholders and partners at the end of the planning stage, is essential in order to carry out monitoring and evaluation systematically. This framework serves as a plan for monitoring and evaluation, and should clarify:

- What is to be monitored and evaluated
- The activities needed to monitor and evaluate
- Who is responsible for monitoring and evaluation activities
- When monitoring and evaluation activities are planned (timing)
- How monitoring and evaluation are carried out (methods)
- What resources are required and where they are committed

Developing a monitoring component to track and evaluate the effectiveness of your implementation efforts is very important. Measurable progress is critical to ensuring continued support of forest management and watershed projects, and progress is best demonstrated with the use of monitoring data that accurately reflect the biophysical and socio-economic changes relevant to the identified problems. Monitoring is used to fill in the identified data gaps as part of the iterative process.

Evaluation is a critical but often neglected step in forest and water resources management. Evaluation not only demonstrates whether project deliverables and goals were met, but also informs strategic planning and future projects, and helps build partnerships by demonstrating the impacts of activities. Evaluation is important to determine whether efforts have been successful in changing people's attitudes and behaviors (e.g. landowner's behavior towards sustainable forest management practices), implementing sustainable forest management practices in the Yellow River Major Watershed, and achieving the desired change (protection, improvements, restoration) in water quality.

It is recommended that the Coordination/Implementation Committee further develop the monitoring framework using this plan as a guide and prepare a report yearly to daylight goals and objectives that have been met in the Yellow River Watershed.

Data Sharing

Obtaining data from partners working in the watershed that is both useful and scalable to the watershed and sub-watershed levels is essential to the development of a monitoring program for the Yellow River Watershed.

For a watershed level monitoring program to be successful, land managers in the watershed need to be able to effectively share data regarding their activities in ways that can be used to evaluate if progress towards this plan's goals and objectives have been made or not.

It is important that partners and the public be aware that the landscape management process, including monitoring and evaluation, is voluntary, and that the primary purpose of landscape level monitoring is to support and enhance better forest resource planning and coordination.

B. Short-Term: Monitor Performance and Evaluate Process

There are several short term indicators that can be monitored (see the table below). Goals and a time frame to meet those goals should be set by the Coordination/Implementation Committee.

	Loon Creek (SubWD # 1)	Lower Yellow River (SubWD # 2)	Sand Lakes (SubWD # 3)	Rice Lake (SubWD # 4)	Shell Lake (SubWD # 5)	Headwaters Yellow River (SubWD # 6)
Area	32,205 acres	52,466 acres	39,695 acres	51,567 acres	21,520 acres	36,891 acres
Area of Private Ownership	18,888 acres	45,769 acres	29,762 acres	50,177 acres	19,373 acres	30,888 acres
Outreach & Education						
Mailings						
Phone calls						
Site visits						
Workshop participants						
Technical Assistance						
FSP Pamphlet						
Traditional Forest Stew Plan						
Forest Mgmt Projects						
Riparian buffer plantings						
Upland forest restoration						
Forest stand improvement						
Timber harvests						
Biomass harvests						
Incentive Programs						
Cost share assistance						
MFL						
Conservation Land Prot						
Conservation Easements						
Public Land Acquisitions						
Public Land Sales						
Land Trades / Exchanges						

C. Long-Term: Assess Results and Evaluate Effectiveness

There should be regular or periodic assessments of whether or not progress is being made towards the project's objectives for at least the intended life of the landscape stewardship plan. The long-term evaluation of this overall project should include each goal statement in the landscape stewardship plan and its corresponding measures or indicators used to assess whether or not progress is being made towards achieving that outcome (see the table below). Monitoring Questions and Potential Data Sources should be further developed by the Coordination/Implementation Committee. As the plan is implemented, the Coordination/Implementation Committee should periodically review if these objectives are being met by answering the Monitoring Questions.

Yellow River Plan Objective	Monitoring Question	Potential Data Source
Water Resources Goal 1. Protect Healthy Water Systems and Features		
Objective A: Protect Forested Riparian Corridors and Undeveloped Shorelands.	– How has the protection and maintenance of existing forested riparian corridors and undeveloped shorelands been supported?	– County Assessor's Office – DNR Area Fisheries Offices
Objective B: Protection BMPs.	– How has the implementation of Best Management Practices (BMPs) that guide the protection and maintenance of existing forested riparian corridors and shoreland areas been advocated and supported?	– TMDL Reporting – WQ BMP Monitoring Program and reports
Water Resources Goal 2. Improve Impaired Water Resources		
Objective A: Native Vegetation in Impaired Riparian Corridors.	– How many projects have been implemented that restore and improve native vegetation in riparian corridors?	– DNR Area Fisheries Offices – Burnett County Shoreline Incentive Program
Objective B: Shoreland Restoration Projects.	– How has the implementation of shoreland projects, especially erosion control projects that utilize native vegetation been supported?	– DNR Area Fisheries Offices – Burnett County Shoreline incentive program
Objective C: Local projects.	– How has the implementation of Best Management Practices that guide the restoration of forested riparian corridors and shoreland areas been advocated and supported?	– TMDL Reporting – WQ BMP Monitoring Program and Reports

Yellow River Plan Objective	Monitoring Question	Potential Data Source
Water Resources Goal 3. Advance Water Resources Knowledge		
Objective A. County Water Plans.	– What has been done to work with counties and other partners and stakeholders in the development and implementation of county water plans to include forest management practices?	– County Water Plan planning committee meeting minutes – County Water Plans
Objective B. Lake Management Plans.	– What has been done to work with partners and stakeholders in the development and implementation of lake management plans to include forest management practices?	– DNR Area Fisheries Offices Lake Associations – LWRDs
Objective C. Monitor Water Quality.	– What has been done to support efforts by local and state agencies and other partners and stakeholders to monitor water quality changes in the watershed and distribute results to the public?	– Water quality monitoring – Lake and river associations
Forest Resources Goal 1. Protect Healthy Forest Ecosystems		
Objective A. Public Forestlands.	– What has been done to support the protection and maintenance of public forestlands?	– WDNR forest inventory database – County forest management databases
Objective B. Private Forestlands.	– What has been done to implement projects that protect and maintain private forestlands using priorities established in the sub-watershed analyses and sub-watershed action plans?	– MFL database – Landowner Outreach Database
Objective C. Forest Health.	– What has been done to support and participate in programs and projects that promote proactive forest health practices as a form of prevention?	– EDD Maps database
Forest Resources Goal 2. Increase and Restore Native Cover Types		
Objective A. Forest Restoration Projects.	– How has the implementation of forest restoration projects on priority sites in each sub-watershed been supported?	– MFL database

Yellow River Plan Objective	Monitoring Question	Potential Data Source
Objective B. Insects, Diseases, and Invasive Species.	– How have efforts by local and state agencies, conservation groups, landowners and other partners and stakeholders to prevent and manage invasive species been supported?	– EDD Maps database
Objective C. Biomass/Forest Restoration Projects.	– What has been done to design and implement forest and other land-based restoration projects to maximize utilization of removed undesirable woody plant material?	– County cutting notices – Local forestry staff
Forest Resources Goal 3. Advance Forest Resources Knowledge		
Objective A. Watershed/Forest Land Cover Connections.	– How have partners and stakeholders in the watershed been actively educated about the watershed/forest land cover connection and its role in promoting water quality and quantity?	– Workshop attendance from workshop facilitators
Objective B. Local Conservation Groups.	– How have the expansion and effectiveness of local conservation groups through their active involvement in private forest management been supported?	– To be tracked by the Coordination / Implementation Committee
Objective C. Land Use Planning.	– How have the use of sound land-use planning and the recognition of forest resources in local planning and regulation processes been advocated?	– Land-use plans
Recreational Resources Goal 1. Protect Forest-Related Public Recreation and Tourism		
Objective A. Public Recreational Lands.	– How have programs and projects been supported that protect, maintain, and promote state-owned land (state forests, state parks, SNAs, etc.) and other public recreational resources?	– ?
Objective B. Scenic Roadways.	– How have programs and projects been supported that protect and maintain scenic roadways and view corridors in the watershed?	– ?

Yellow River Plan Objective	Monitoring Question	Potential Data Source
Objective C. Water-based Recreation.	– How have programs and projects been supported that protect, maintain, and promote water recreational areas?	– ?
Recreational Resources Goal 2. Encourage Forest-Related Private Land Recreation		
Objective A. Wildlife Habitat.	– How have programs and projects been supported that restore and improve wildlife habitat on private lands while providing access for recreational users?	– ?
Objective B. Technical and Financial Support.	– How have programs and projects been supported that provide technical and financial assistance to private landowners to increase outdoor recreation on their properties?	– ?
Objective C. Trail Networks.	– How has the development of new and the improvement of existing neighborhood trail networks been supported?	– ?
Recreational Resources Goal 3. Enhance the Awareness of the Natural Resource Base on Which Outdoor Recreation Depends		
Objective A. Increase Public Awareness.	– How has awareness been promoted about the value of forests and high quality natural resources to outdoor recreation?	– ?
Objective B. Collaborate with Partners and Stakeholders.	– How have partners and stakeholders including citizens and businesses in the watershed been included in efforts to support organizations actively working to protect, restore, and improve forest and water resources in the watershed?	– ?
Objective C. Outreach and Education.	– How have visitors to the Yellow River Major Watershed been educated about the high quality natural resources in the watershed and their role in protecting them?	– ?

Part 3.
Section 9 – Agency and Organization Recommendations

The purpose of this section is to summarize specific recommendations developed by the Planning Committee for specific agencies and organizations working in the Yellow River Major Watershed, St. Croix Basin or the state on related resource management. The purpose is to intentionally increase communications on how we can better integrate efforts by the various conservation agencies and organizations to help find ways to more effectively use the limited technical and financial resources available.

The following represents an initial list of recommendations developed by the Planning Committee:

A. Recommendations to Local Officials

1. Reference Document. Local officials are strongly encouraged to use this Plan as a reference document when developing their resource management plans including county water plans, local land use plans, and state resource plans. They are further encouraged to adopt this landscape stewardship plan as an appendix to their plans to provide more detailed guidance on sustainable forest resource management and support more proactive and collaborative funding development.
2. Consider Forests in Local Land Use Decisions. Local officials are encouraged to consider the values and benefits that forests can bring to their communities. Healthy and sustainable forests promote a high quality of life for citizens and can support increased economic opportunities as well. Forests should be included in the land use decision making process.
3. Alternative Land Development Options. Local officials are encouraged to use forestry as a design tool to help them work more effectively with landowners and developers. There are alternative ways that land can be developed to provide for both economic growth and the protection of forest and water resources. Large lot developments are not always desirable or cost effective from the public sector or taxpayers perspectives.
4. Washburn and Burnett Counties should investigate the possibility of coordinating monitoring efforts with lake and river associations.

B. Recommendations to Conservation and Non-governmental Organizations

1. Collaboration. Encourage the partnering of conservation and non-governmental organizations to address major resource management issues. Successful examples include the Wildlife Habitat Corridors Partnership and the Environmental Initiative.
2. Connections. Support the connecting of citizens with elected officials on sustainable forest management topics.
3. Reference Document. Conservation groups and NGOs are encouraged to use this Plan as a reference document when developing their plans and strategies. They also encouraged to share their plans and projects with the Coordination / Implementation Committee to increase coordination across the watershed.

D. Recommendations to Resource Agencies

WI DNR Forestry

1. Integrate Landscape Stewardship approaches into the regional forestry teams, other specialist teams, and partnership development efforts.
2. Encourage partnering between Regional Forestry staff and DNR – Wildlife Management, St. Croix Area Staff.
3. Integrate Landscape Stewardship Approaches into the Private Forestry Program. Overall, encourage integrated service delivery between the broad range of agencies and organizations that serve private woodland owners to make delivery of their programs better coordinated, simpler and less costly in processing, and less time consuming
4. Increase and sustain funding for the Private Forestry program.
5. Support increasing the RC&D capacity to serve as grant writers, grant administrators, and fiscal agents on forestry projects being developed by the regional committees.
6. Continue to support the Cooperating Forester and Certified Plan Writer programs.
7. Encourage the expanded involvement of the USDA NRCS in landscape management:
   - Engage NRCS regional staff.
   - Engage the district conservationists and technical field staff in regional committee work groups on committee projects.
   - Design future NRCS programs beyond EQIP to integrate and support landscape management projects.
8. Primary and Secondary Forest Products Industries. Find ways to more effectively support and foster economic development opportunities for the primary and secondary forest products industries in the region.

Other DNR Divisions

1. Improve Coordinated Service to Private Landowners. Strategically coordinate the delivery of technical and financial assistance to private landowners based on landscape stewardship principles and practices. Let DNR Forestry lead the service delivery program design and implementation.
2. ECS. Continue to promote the Ecological Classification System (ECS) and Ecological Landscapes a guide to developing land management strategies when working with landowners and local officials.
3. Important and Critical Areas. Continue to identify and protect important or critical ecological areas such as the joint effort by the Audubon Society and the DNR to identify and protect important bird areas.
4. Data Gathering. Support the collection, organization and evaluation of data collected relating to forestry at the local level on private lands. Encourage the coordination and sharing of data with other resource agencies and local officials.
5. Improve access to appropriate NHI information.
6. Invest resources in monitoring lakes and rivers in Burnett and Washburn Counties as recommended in the Basin Plans.

E. Recommendations to Education Groups

1. Use Existing Education Providers. All partners working in the watershed and the basin are encouraged to use existing education providers such as the UW Extension, Sustainable Forest Education Cooperative (SFEC), Wisconsin Master Logger Program, NRCS programs and others.
2. Collegial Connections. Colleges and universities throughout the state are encouraged to connect their students and faculty with DNR Forestry programs.

F. Recommendations to Private Landowners and Citizens

1. Become Informed. The YRWP and its partner agencies and organizations have numerous programs and resources to help landowners become more informed about sustainable forestry and the benefits of forests to our communities. All landowners are encouraged to become more knowledgeable about forest resources. Learning about best management practices (BMPs) is one easy way to get started. Recognize that forestry is a long-term endeavor and that changes on the land will generally take several years to become realized.
2. Seek Technical Assistance. While there are numerous sources of information available, landowners are encouraged to seek technical assistance to help manage their forestlands. Often a landowner may need assistance from many technical service providers. Developers can benefit from working with the forest resources on their lands and designing their developments. A good place to start: http://dnr.wi.gov/topic/forestlandowners/locator/
3. Get Involved. The Planning Committee members contributed hundreds of hours of time to develop this Plan. While they were not always in agreement, voicing their concerns and sharing their ideas has helped generate many new opportunities to improve forests and the quality of life in the Yellow River Major Watershed and the St. Croix Basin. They have taken a big first step to get involved. All citizens and landowners are encouraged to get involved in their communities and help promote sustainable forestry.

Appendix A
Yellow River Watershed Landscape Stewardship Planning Committee

The following people participated in the planning process for the Yellow River Landscape Stewardship Plan:

Name	Agency
Alles, Zach	TNC
Bartilson, Kathy	WI DNR
Carlier, Jill	Pine County SWCD
Cole, Liz	TNC
Diesen, Mark	Burnett County Forestry
Ekola, Lindberg	MFRC
Ferris, Dave	Burnett County LWCD
Gabrielson, Rob	MFRC
Galonska, Julie	NPS
Haack, John	UW Extension
Hanson, Bob	WI DNR
Hardin, Carmen	WI DNR Forestry
Havranek, Tony	St. Croix Tribe
Heimstead, Paul	WI DNR
Herrick, Sarah	WI DNR
Hoffman, Steve	WI DNR
Holman, Todd	TNC
Magdalene, Sue	SCWRS
Martin, Sam	Pine County SWCD
Matlack, Brad	Carlton County SWCD
McDougall, Dennis	USFS
Odegard, Doug	Pine County SWCD
Osterdyk, Kelly	Kanabec County SWCD

Name	Agency
Peichel, Jeremy	USFS
Pressman, Michael	TNC
Raines, Dana	NRCS
Reinhart, Jeff	MFRC
Runstrom, Steve	WI DNR Forestry
Ryun, Deb	SCRA
Salmon, Julie	NRCS
Sewell, Deb	MN DNR Fisheries
Spears, Barb	Consulting Forester
Stariha, Katie	St. Croix Tribe
Wendel, Jamison	WI DNR
Zachay, Monica	SCRA

Appendix B
Glossary

Glossary

Basin: St. Croix River Basin (HUC 04).

Major watersheds: Upper St. Croix Major Watershed (HUC 08) in the St. Croix River Basin.

Minor watersheds: 11 minor watersheds** (HUC 12) in the Yellow Tributary Watershed.

Sub-watersheds: 6 Sub-watersheds (HUC12 or combination of HUC12s) in the Yellow River Tributary Watershed. The sub-watershed level is being used for this Plan because the tributary watershed level is too large to effectively focus planning and implementation efforts and the minor watershed level includes too many units to manage.

Tributary watersheds: Upstream areas for pour points of rivers and streams that empty into the St. Croix River (collection of HUC 12 watersheds) used in the State of the Forest Report (e.g. Yellow River Tributary Watershed).

Acronyms

AMA: Aquatic Management Area

BMP: Best Management Practices

CAP: Conservation Action Plan

CWL: Clean Water Legacy

CWMA: Cooperative Weed Management Area

DATCP: Department of Agriculture, Trade and Consumer Protection

DFC: Desired Future Condition

DOT: Department of Transportation

EBI: Environmental Benefits Index

ECS: Ecological Classification System

EDD: Maps: Early Detection & Distribution Mapping System

EL: Ecological Landscape

EQIP: Environmental Quality Incentives Program

ERW: Exceptional Resource Waters

FAP: Forest Action Plan

FCL: Forest Crop Law

FHTCS: Forest Habitat Type Classification System

FIA: Forest Inventory and Analysis

FLP: Forest Legacy Program

FMG: Forest Management Guidelines

FSC: Forest Stewardship Council

GIS: Geographic Information System

GLTPA: Great Lakes Timber Professionals Association

GSD: Graduated Service Delivery

HUC: Hydrologic Unit Code

IBI: Index of Biological Integrity

IPAW: Invasive Plants Association of Wisconsin

LID: Low Impact Development

LSP: Landscape Stewardship Plan

LTA: Land Type Association

LWCD: Land and Water Conservation Departments

MFL: Managed Forest Law

MFRC: Minnesota Forest Resources Council

MIPN: Midwest Invasive Plant Network

MOU: Memorandum of Understanding

NGO: Non-Governmental Organization

NHI: National Heritage Inventory

NLCD: National Land Cover Dataset

NPC: Native Plant Communities

NPS: National Park Service

NRCS: National Resource Conservation Service

NWOS: National Woodland Owner Survey

NWRPC: Northwest Wisconsin Regional Planning Commission

ORW: Outstanding Resource Waters

PFM: Private Forest Management

RMZ: Riparian Management Zone

RNF: Rare and Natural Features

S&PF: State & Private Forestry

SAF: Society of American Foresters

SCCC: St. Croix Conservation Collaborative

SCRA: St. Croix River Association

SCRB: St. Croix River Basin

SFFI: Sustaining Family Forest Initiative

SNA: Scientific and Natural Area

SWAP: State Wildlife Action Plan

TELE: Tools for Engaging Landowners Effectively

TMDL: Total Maximum Daily Load

TNC: The Nature Conservancy

TPEC: Total Phosphorus Export Coefficient

TSI: Timber Stand Improvement

USDA: United States Department of Agriculture

USFS: United States Forest Service

USFWS: United States Fish & Wildlife Service

USGS: United States Geological Survey

UW: University of Wisconsin

UWEX: University of Wisconsin Extension

WDNR: Wisconsin Department of Natural Resources

WFLGP: Wisconsin Forest Landowner Grant Program

WHIP: Wildlife Habitat Incentive Program

WMA: Wildlife Management Area

WWOA: Wisconsin Woodland Owners Association

YRMW: Yellow River Major Watershed

YRWP: Yellow River Watershed Partnership

Appendix C
Websites and Resources for Private Forest Management

Introduction

The purpose of this Appendix is to provide links to websites that provide guidance to service providers in forest and water quality management and sustainable recreation efforts.

A. Forest

WDNR Division of Forestry http://dnr.wi.gov/topic/forestry.html

Wisconsin's 16 million acres of forestlands and millions of urban trees significantly enhance the quality of life in our state. The Wisconsin DNR Division of Forestry dedicates itself to the sustainable management and protection of this precious resource so that it continues to provide a host of ecological, economic and social benefits for years to come.

Ecological Landscapes of Wisconsin http://dnr.wi.gov/topic/landscapes/index.asp?mode=Choose

Ecological Landscapes are 16 areas of Wisconsin with different ecological attributes and management opportunities. They can be used to identify the best areas of the state to manage for different natural communities, key habitats, aquatic features and native plants and animals from an ecosystem management perspective. Descriptions of the Landtype Associations (LTAs) can also be accessed through this page.

Climate Change Response Framework http://www.forestadaptation.org/

The Framework is a collaborative, cross-boundary approach among scientists, managers, and landowners to incorporate climate change considerations into natural resource management. It provides an integrated set of tools, partnerships, and actions to support climate-informed conservation and forest management.

Wisconsin's Forestry Woody Biomass Harvesting Guidelines http://www.wisconsinforestry.org/initiatives/other/woody-biomass

Wisconsin's Forestland Woody Biomass Harvesting Guidelines focus on the sustainable harvest of fine woody material (<4"dib) from forested areas within the context of generally accepted forestry practices, and provide considerations and recommendations applicable to stand and site-level management based on best available information.

Wisconsin's Forestry Best Management Practices for Invasive Species
http://www.wisconsinforestry.org/initiatives/other/invasive-species-bmps/forestry-bmps

These BMPs offer a framework for addressing the state's invasive species problems. The Forestry BMPs for Invasive Species Manual offers voluntary practices that can be integrated with forest management activities. The manual includes standards of practice that will aid landowners, land managers, and loggers in limiting the introduction and spread of invasive plants, invertebrates, and diseases during forestry operations.

Wisconsin's Natural Heritage Inventory http://dnr.wi.gov/topic/nhi/

Established in 1985 by the Wisconsin legislature, Wisconsin's Natural Heritage Inventory program (NHI) is part of an international network of inventory programs. The program is responsible for maintaining data on the locations and status of rare species, natural communities, and natural features throughout the state. Species and natural communities tracked by the Wisconsin NHI Program can be found on the NHI Working List.

WDNR Forestry Assistance Locator http://dnr.wi.gov/topic/ForestLandowners/assist.html

A professional forester can explain how your forest ecosystem works and how it can be sustained to provide many benefits. Use the Forestry Assistance Locator to find cooperating foresters or DNR service foresters for your county.

Wisconsin's Forest Tax Laws http://dnr.wi.gov/topic/ForestLandowners/tax.html

Two different forest tax law programs currently exist: the Managed Forest Law (MFL) and the Forest Crop Law (FCL). Both programs encourage proper management of woodlands not only in their purposes and policies, but through a written management plan for a landowner's property. The management plan incorporates landowner objectives, timber management, wildlife management, water quality and the environment as a whole to create a healthy and productive forest. In exchange for following a written management plan and program rules, landowners pay forest tax law program rates in lieu of regular property taxes.

Wisconsin's Forest Legacy Program http://dnr.wi.gov/topic/ForestPlanning/legacy.html

As part of the 1990 Farm Bill, Congress created the Forest Legacy Program under the U.S. Department of Agriculture Forest Service to identify and protect environmentally important private forestlands threatened with conversion to non-forest uses - such as subdivision for residential or commercial development. The Department of Natural Resources Division of Forestry is responsible for administering the program offered by the USDA Forest Service. The program allows the state of Wisconsin to purchase conservation easements on forestland from willing sellers to keep the land in its forested state. Landowners may continue to own their land and retain all other rights to the property, including the right to sell. The conservation easement is recorded with the property deed and transferred with the sale or transfer of the property. USDA Forest Service funds cover 75 percent of the total program cost; the other 25 percent comes from nonfederal sources. These may include a donation of part of the easement value from the landowner, a non-profit organization interested in the project, or in some cases, state funds. In special situations, the state may consider purchasing the land with Forest Legacy Program funds

Wisconsin's Forest Health Program http://dnr.wi.gov/topic/ForestHealth/

Everyone can help keep Wisconsin forests healthy, from watching for threats to practicing sustainable forestry. Learn how to help by reading about the location, identification, signs and symptoms, management and prevention of many insects, diseases, and invasive plants that threaten our trees. Then use what you've learned to help protect healthy forests and all the benefits they give us.

Wisconsin's Forest Management Guidelines http://dnr.wi.gov/topic/ForestManagement/guidelines.html

The Wisconsin Forest Management Guidelines outline practical, site-specific considerations that land managers need to take into account when they plan and carry out forestry operations. The guidelines cover sustainable forest management principles that can serve recreation, wildlife habitat improvement, endangered species protection, water quality, forest products and many other objectives.

Wisconsin's Silviculture and Aesthetics Handbook http://dnr.wi.gov/topic/ForestManagement/silviculture.html

This Handbook provides silvicultural guidance that applies to all forest properties owned by the Department of Natural Resources (DNR), all county forest lands as specified in the comprehensive county forest land use plan, and private forest tax law lands. This Handbook is organized around general silvicultural practices, policies, and major forest cover types found in Wisconsin, presenting ecological characteristics and recommended silvicultural practices and systems.

B. Water Quality

Fish & Farmers Partnership for the Upper Mississippi River Basin http://fishersandfarmers.org/

Fishers & Farmers Partnership for the Upper Mississippi River Basin is a self-directed group of nongovernmental agricultural and conservation organizations, tribal organizations and state and federal agencies working to achieve the partnership's mission "… to support locally-led projects that add value to farms while restoring aquatic habitat and native fish populations."

Wisconsin's Forestry Best Management Practices for Water Quality http://dnr.wi.gov/topic/ForestManagement/bmp.html

Nonpoint source pollution occurs when rainfall and snowmelt move across the ground, picking up pollutants, like sediment and chemicals that are carried into lakes, rivers, and wetlands. The primary pollutant associated with forestry activities is sediment, especially at stream crossings for forest roads and skid trails. Wisconsin's Forestry Best Management Practices for Water Quality are intended to provide simple and cost-effective methods for protecting water quality in lakes, streams, and wetlands - including important ecological and waterbody characteristics - before, during, and after forest management activities.

Wisconsin DNR Impaired Waters List http://dnr.wi.gov/topic/impairedwaters/

Every two years, Section 303(d) of the Clean Water Act requires states to publish a list of all waters that water quality standards. The list, also known as the Impaired Waters List, is updated to reflect waters that are newly added or removed based on new information or changes in water quality status.

Burnett County Shoreline Incentives Program http://www.burnettcounty.com/index.aspx?NID=526

Burnett County provides incentives to encourage restoring or preserving your waterfront as a natural shoreline. Over 600 parcels have been enrolled in the Burnett County Shoreline Incentives Program since it began in the year 2000. Owners of these parcels receive an annual property tax credit in return for ensuring permanent protection for the shoreline zone. Incentives provided for each parcel enrolled in the Shoreline Incentives Program.

Washburn County Land and Water Resource Management Plan
http://www.co.washburn.wi.us/departments/landwatercons/info/WashburnCountyLandandWaterManagementPlan.pdf

The Washburn County Land and Water Resource Management Plan will assist the Land and Water Conservation Department (LWCD) in its efforts to protect and improve land and water resources in Washburn County. Goals established in the plan will guide LWCD activities from 2010 through 2015. They will also provide the basis for funding those activities with various private, local, state, and federal sources.

Setting up a Citizen Lake Water Quality Monitoring program
http://dnr.wi.gov/lakes/contacts/contacts.aspx?role=clmn_start

WDNR Contact information for getting a citizen science lake monitoring program set up.

C. Recreation

Tread Lightly http://treadlightly.org/

Tread Lightly! and its partners lead a national initiative to protect and enhance recreation access and opportunities by promoting outdoor ethics to heighten individuals' sense of good stewardship. Tread Lightly!'s goal is to balance the needs of the people who enjoy outdoor recreation with our need to maintain healthy ecosystems and thriving populations of fish and wildlife. The scope of our work includes both land and water, and is representative of nearly every form of outdoor recreation including, but not limited to hunting, recreational shooting, fishing and boating. We also have a niche in promoting safe and responsible use of motorized and mechanized vehicles in the outdoors.

Wisconsin's Outdoor Recreation Best Management Practices for Invasive Species
http://www.wisconsinforestry.org/initiatives/other/invasive-species-bmps/recreation-bmps

Best Management Practices for Preventing the Spread of Invasive Species by Outdoor Recreation Activities in Wisconsin. Invasive Species have been called a "catastrophic wildfire in slow motion" and are a profound threat to Wisconsin's forests. Through their varied forest-based activities, hikers, hunters, horseback riders, anglers, birders, and motorized vehicle riders among others can unknowingly cause new infestations of harmful invasive species in previously unaffected forest ecosystems. Recreation BMPs form the foundation of an educational approach that informs and assists recreational users in controlling the spread of invasive species and mitigating their negative ecological and economic impacts.

St. Croix River Basin - State of the Forest Report

March 8, 2013

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This report was made possible by grant funding from the U.S. Forest Service.

Acknowledgements

Bart Richardson, MN DNR Central Region GIS Coordinator, for development of the initial reclassifications of the NLCD, GAP Land Cover, and Presettlement Land Cover datasets. Michael Pressman, Director of Habitat Protection and Mark White, Forest Ecologist, The Nature Conservancy, for assistance in further development of the reclassification.

Suzanne Magdalene, St. Croix Watershed Research Station of the Science Museum of Minnesota, for assistance in further development of the reclassification, for research on phosphorus export coefficients, and for assistance in the development of this report.

Executive Summary

The St. Croix River Basin (SCRB) spans 7,700 square miles across the States of Minnesota and Wisconsin. The area drains to Lake St. Croix, a naturally impounded riverine lake that makes up the lower 25 miles of the St. Croix River. In 1968, the St. Croix River was designated a National Wild & Scenic River from the St. Croix Flowage dam to the dam near Taylors Falls. In 1972, this designation was expanded to the lower portion of the St. Croix, and in 1976 the designation was fully approved (BLM et. al., 2012). In 2008, Lake St. Croix was added to Minnesota's 303(d) Impaired Waters List due to eutrophication, or excess nutrients, resulting from phosphorus loading to the lake.

This report provides a historical analysis of land cover within the St. Croix River Basin (SCRB), with a focus on forested land cover. Presettlement land cover, such as forest, shrub, and grass, has a lower contribution to phosphorus loading than cover types converted by humans such as agriculture or urban development. Maintaining the forested land that is left in the SCRB will play a part in preventing further degradations in water quality. Understanding how land cover in the SCRB has changed over time will help to make management decisions that will protect forested land, and thus water quality, into the future. To this end, land cover change analyses were conducted at the basin, tributary, and riparian level.

Land cover datasets that cover the entire SCRB exist for four time periods: mid-late 1800s, 1992, 2001, and 2006. Each dataset uses a different collection/analysis methodology and classification system, with the exception of the 2001 and 2006 datasets. In the basin level land cover change analysis, datasets were aggregated to the boundaries of the SCRB. In the tributary level analysis, datasets were aggregated to drainage areas for tributaries that converge with the St. Croix River. To compare the distribution of land cover represented by these datasets, a reclassification of the cover types was completed. The distribution of land cover change within the basin was then described in relation to the location of the tributary watersheds within the SCRB.

The land cover in the SCRB in the mid-late 1800s (presettlement) ranged from upland forest and lowland vegetation in the north to grassland, prairie, and shrubs in the south and southwest. Since then, much of the southern half of the basin has been converted to agriculture, with pockets of non-cultivated lowland and upland vegetation remaining. Overall, forested cover types saw the largest decline both in area and in percent change. Analysis of the distribution of land cover change showed that the farther upstream a tributary watershed was from the mouth of the St. Croix River, the less likely the tributary was to see change to converted cover types such as cultivated crops and developed areas. Watersheds such as the Snake and the Kettle Rivers in Minnesota, and the Clam and the Yellow Rivers in Wisconsin are at the edge of this northeastward and upstream advance of converted lands, and represent good areas to focus protection strategies for forested lands.

In the riparian level land cover change analysis, datasets that were appropriate for the scale of riparian areas were used to show change between the time periods they represented (from 2001 to 2006). Geoprocessing methodologies were used that respected the scale of riparian zones, the cell size (resolution) of the land cover datasets, and the riparian buffer distance that had the greatest impact on water quality. The distribution of change once again showed an upstream pattern across the SCRB. However, the pattern switched from change from non-converted cover types to converted cover types to change within converted cover types. While change to developed cover types decreased farther upstream, change to cultivated crops reversed in this trend and increased farther upstream. Over half of the change to developed cover types was from cultivated crops. The majority of change for upland forest and woody wetland cover types was to other non-converted cover types. The most common cover types to be converted to developed cover types were from pasture/hay, cultivated crops, and deciduous forest.

An accuracy assessment was conducted using aerial imagery for select areas and cover types in riparian zones. Contiguous areas of change classifications were reviewed for whether the overall change classification was accurate. Because riparian zones constrict the size of the polygons that are analyzed for accurate change descriptions, the accuracy assessment may not be applicable to the datasets across the entire SCRB. The accuracy of the change classifications was moderate. Change to developed cover types was more accurate than change to cultivated crops.

Forested land has been lost on a large scale across the SCRB since presettlement times, amounting to over 20% of the basin. As human expansion has pushed upstream, change from low phosphorus export cover types such as forest, shrub, and grassland to high phosphorus export cover types such as cultivated crops and developed land has been the result. Riparian areas in downstream tributary watersheds are recently seeing advanced stages of this human expansion where cultivated crops are being converted to developed land.

While the relationship of tributary watershed position within the watershed to change to converted land cover types is complex, it exists and can be used to determine where to target particular types of water quality improvement strategies. In the downstream portion of the basin, restoration and mitigation strategies will be important because a higher portion of the land cover has already been converted to higher phosphorus exporting land cover types. Mid-basin, protection strategies would be more appropriate to preserve some of the low-phosphorus export land cover types that still exist in abundance. Failure to preserve these low phosphorus export land cover types could mean failure to meet water quality goals in the SCRB.

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INTRODUCTION

Phosphorus loading has been demonstrated to cause eutrophication of water bodies resulting in loss of biological diversity and recreational quality. Significant efforts have been undertaken to explain and calculate phosphorus loading within watersheds in Minnesota and Wisconsin, including the Legislative Report: Detailed Assessment of Phosphorus Sources to Minnesota Watersheds (MPCA 2004), the Lake St. Croix Total Phosphorus Loading Study (Magdalene 2009), and the Lake St. Croix Nutrient Total Maximum Daily Load (MPCA & WI DNR 2012). These studies have determined that forested land is among the lowest of the potential contributors of non-point source loading of phosphorus in terms of export rates by area.

This report is intended to provide a historical analysis of land cover within the St. Croix River Basin (SCRB) and the tributary watersheds within the SCRB with a focus on forested lands that protect water quality. This historical analysis of land cover will allow for assessment of how the land cover has changed in the basin both overall and at the tributary level. Analyzing recent land cover changes (from 2001 to 2006) at the riparian level will narrow the land cover analysis to areas that have the most impact on water quality using datasets that are appropriate for that scale. Illustrating how forested landscapes have changed over time can help to understand some of the reasons why water quality has declined in the SCRB, and to identify areas that could be protected to keep water quality from declining further than it already has.

BACKGROUND

St. Croix Basin Hydrology

For much of its length, the St. Croix River serves as a portion of the boundary between the States of Minnesota and Wisconsin. The St. Croix River Basin (SCRB) spans about 7,700 square miles (20,000 sq. km) across the two states (Figure 1). Overall drainage patterns are toward the center of the basin, and from north to south, toward the Mississippi River at its mouth.

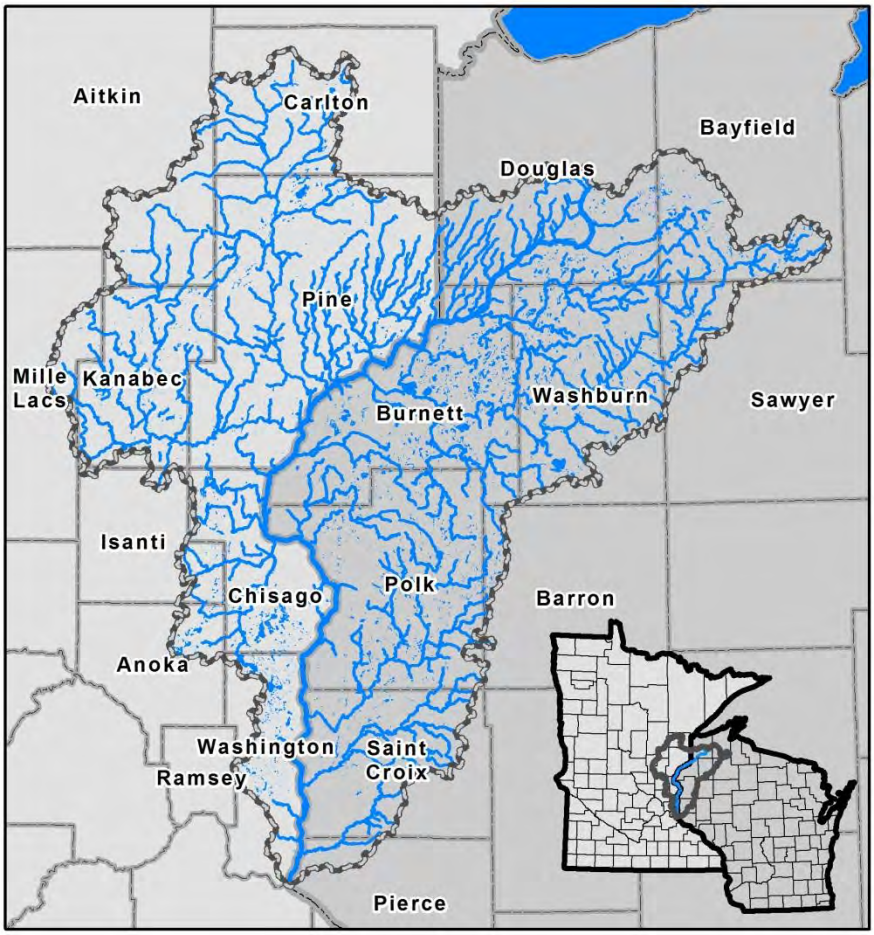

Figure 1. St. Croix River Basin in Minnesota and Wisconsin.

History of Land Cover Mapping in the St. Croix Basin

The mid-late 1800s mark the earliest available snapshot of land cover mapping in the SCRB which was developed in two parts, for each state. In Minnesota, Marschner (1974) developed a map from the notes of public land surveys that were conducted 1847-1907. The Marschner Presettlement Map was then digitized by the DNR Division of Forestry in the early 1990s to create the Presettlement Land Cover dataset. The digitization process omitted thousands of small polygons, primarily in the prairie and transitional forest areas of the state. In Wisconsin, Finley (1976) compiled notes of public land surveys that were conducted 1832-1866 to create the Original Vegetation Cover Map of Wisconsin. This map was then digitized by students at the UW-Madison under the direction of Professor Steve Ventura in 1990 to create the Original Vegetation Cover dataset.

Land cover was not mapped in a spatially continuous dataset across the SCRB for a second time until the 1990s. Advances in Geographic Information Systems software and availability of satellite imagery allowed for generation of land cover datasets by computer classification of remotely recorded brightness values from multiple bands of electromagnetic emissions. This automated process reduced necessary field work needed for data collection to only include accuracy checks of the computer generated land cover delineations. In Minnesota, a statewide land cover dataset titled “GAP Land Cover” was created using this process as part of the Upper Midwest Gap Analysis Program (1992). In Wisconsin, a statewide land cover dataset titled “WISCLAND” was created using this process as part of the Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (1992). Both datasets were created using Landsat Thematic Mapper (TM) satellite imagery.

Subsequent land cover datasets have become available through the Multi-Resolution Land Characteristics Consortium in the form of the National Land Cover Datasets (NLCD) for 2001 (Version 2.0) and 2006, which were created using Landsat Enhanced Thematic Mapper imagery. These two datasets represent the first nation-wide coverages that are directly comparable across different time periods. The NLCD 2001 and 2006 datasets use the same classification system. However, each of the other datasets discussed above uses a different system. By reclassifying all of the datasets using simplified cover types that apply across all time periods, a historical analysis of land cover change can be conducted.

As an example, the Aspen-Birch trending to Hardwood Forest of the mid-late 1800’s, the Mixed Deciduous Broadleaf Forest of 1992, and the Deciduous Forests of 2001 and 2006, were all classified as Upland Forest cover types (Appendix D). While this analysis requires a reduction in classification precision down to the level of the “lowest common denominator”, it can provide a good picture of how SCRB land cover has changed with time since the earliest available maps.

Linkages between Land Cover and Water Quality in the St. Croix Basin

One measure of water quality is the mass load (in pounds, kilograms, or tons) of total phosphorus that is carried by the water, or how much phosphorus loading is occurring. Some level of phosphorus loading is due to the original natural landscape, which is known as "background nonpoint source" loading. However, when we convert land from its natural state, this often results in increased loading, the difference in which can be referred to as "cultural nonpoint source" loading (Magdalene 2009).

The relationship between land cover and water quality is a complex interaction between climate, soils, vegetation, and topography. A forest on a steep slope with erodible soils near a water body will have a far different impact on water quality than a forest on a gentle a slope with stable soils that is far from a water body. An area of developed land that is further away from the water body may still have significant influence on water quality due to storm water drainage networks.

Significant efforts have been undertaken to explain and calculate phosphorus loading resulting from land cover within watersheds in Minnesota and Wisconsin. Reports that have covered this topic include the Legislative Report: Detailed Assessment of Phosphorus Sources to Minnesota Watersheds (MPCA 2004), the Lake St. Croix Total Phosphorus Loading Study (Magdalene 2009), and the Lake St. Croix Nutrient Total Maximum Daily Load (MPCA & WI DNR 2012). Each of these reports uses Total Phosphorus Export Coefficients (TPEC), or the mass of phosphorus erosion per unit area over a given period of time (e.g. kg/ha-yr) to quantify land cover contributions of phosphorus loads to water bodies.

The MPCA (2004) report was created to provide the information necessary to comply with newly enacted legislation surrounding phosphorus sources. The report estimated "the total amount of phosphorus entering all of the surface water areas that are present within each major basin" for a range of flow conditions. The MPCA (2004) focused on phosphorus sources delivered to the edge of surface waters, but did not estimate routing of phosphorus through surface waters.

Appendices C, I, and J of the MPCA 2004 report describe the methods used to estimate phosphorus loading from land cover to all surface waters. Coefficients used in calculations varied by watershed due to several factors including rainfall amounts and ecoregions. Non-urban areas were analyzed for agriculture (Appendix C) and non-agricultural rural land use (Appendix I) that existed within 100 meters of water bodies, the area where risk of phosphorus transport to surface waters was agreed to be are greatest. Incorporated urban areas were analyzed for all land cover within their boundaries (Appendix J) under the assumption that all areas drained to open waters via storm drainage networks. For agriculture and non-agricultural rural land use, phosphorus export coefficients were multiplied by the area of land cover types existing within 100 meters of water bodies to calculate expected phosphorus loading. For developed urban land

uses, the calculation of loads was more complex and involved basin specific concentration regression equations, runoff coefficients, and annual rainfall amounts.

Table 1 lists the phosphorus export coefficients for non-agricultural rural land, agriculture, and developed urban land uses. Non-agricultural rural land and agriculture export coefficients were taken from the tables in their respective appendices. Developed urban land use export coefficients were calculated based on calculated load for each cover type divided by the total area of the cover type in the incorporated urban area in the SCRB.

Table 1. Phosphorus export coefficients for the St. Croix River Basin (from MPCA 2004, appendices and source tables listed in table).

MPCA Assessment Land Cover		**Phosphorus Export Coefficients (kg/ha/yr)**		
Appendix, Table(s)	**Cover Type**	**Dry**	**Average**	**Wet**
Appendix I: Non-agricultural rural land, derived from Table 8 and Table 9	Deciduous Forest	0.044	0.075	0.110
	Evergreen Forest	0.071	0.123	0.181
	Mixed Forest	0.075	0.130	0.191
	Shrubland	0.075	0.129	0.190
	Grassland/Herbaceous	0.098	0.169	0.248
Appendix C: Agriculture, from Table 3	Agriculture	0.180	0.380	0.690
Appendix J: Developed urban land, derived from Table 6 and Table 10	Urban/Recreational Grasses	0.807	0.939	1.024
	Low Intensity Residential	0.807	0.939	1.024
	High Intensity Residential	1.022	1.192	1.295
	Commercial/Industrial/ Transportation	1.330	1.546	1.687

The MPCA (2004) report focused on watersheds within Minnesota, and did not consider the portion of the St. Croix River Basin that extends into Wisconsin. Both the Lake St. Croix Total Phosphorus Loading Study (Magdalene 2009) and the Lake St. Croix Nutrient Total Maximum Daily Load report (MPCA & WI DNR 2012) focused on phosphorus loading from the SCRB to Lake St. Croix. Upon agreement by representatives from Minnesota and Wisconsin "to achieve a 20% reduction in phosphorus loading to Lake St. Croix by the year 2020" and in preparation for an impending TMDL report, Magdalene (2009) sought to "develop as much information as possible for all that would be necessary for a basin-scale Lake St. Croix Total Maximum Daily Load (TMDL) project".

Magdalene (2009) inventoried all sources of phosphorus loading in the SCRB and focused on phosphorus delivery to Lake St. Croix. To account for nonpoint source loading, the report

employed a similar methodology to that used in the MPCA (2004) report in that areas of different land cover types were multiplied by phosphorus export coefficients to calculate phosphorus loads. The methodologies differed in the values used for phosphorus export coefficients and in how land cover proximity to water bodies was accounted for. Magdalene (2009) also accounted for in stream processes during transport of phosphorus to Lake St. Croix.

Magdalene (2009) arrived at phosphorus export coefficients based on numbers from the MPCA report, additional literature, and the professional judgment of several St. Croix River Basin Team runoff experts with a long history of experience in the SCRB. Table 2 lists the phosphorus export coefficients used in Magdalene (2009). Total areas of each cover type within the SCRB were calculated and multiplied by the corresponding export coefficient to arrive at total field-scale non-point source loads.

Table 2. Phosphorus export coefficients for the St. Croix River Basin (from Magdalene 2009, Table 5).

	Total Phosphorus Export Coefficients (kg/ha/yr)		
Covert Type	**Dry**	**Average**	**Wet**
Water	0.033	0.050	0.075
Forest	0.067	0.100	0.150
Shrub	0.067	0.100	0.150
Grass	0.167	0.250	0.375
Agriculture	0.500	0.750	1.125
Urban	0.500	0.750	1.125

To account for land and in stream processes during transport of phosphorus to Lake St. Croix the presettlement load amount (Triplett et al. 2009) to Lake St. Croix was used to determine the phosphorus delivery ratio (%) from the SCRB to the lake. An iteratively derived reduction of 12.2% was then applied to the total field-scale phosphorus source loads to arrive at the total phosphorus load that was measured in Lake St. Croix. This methodology differed from that used in the MPCA (2004) report in that the MPCA report only calculated loads within 100 meters of water bodies and incorporated urban areas and in that the MPCA (2004) report stopped at the water's edge and did not factor for where the phosphorus loads would eventually be deposited.

The Lake St. Croix Nutrient Total Maximum Daily Load (MPCA & WI DNR 2012), which sought to establish "the needed reduction in the loading of phosphorus from its contributing basin in order to achieve water quality standards", used phosphorus export coefficients "not as a means to estimate watershed loads that were initially unknown, but rather as a means only to estimate the spatial distribution of the Basin's known runoff P load." Phosphorus export coefficients were reduced by 18.5% to coincide with 1990s phosphorus loads entering Lake St.

Croix (Triplett et al. 2009). Areas of land cover types were then multiplied by corresponding phosphorus export coefficients to spatially distribute runoff loads between Minnesota and Wisconsin. Table 3 lists the adjusted phosphorus export coefficients used in MPCA and WI DNR (2012).

Table 3. Phosphorus export coefficients for 1990s average rainfall conditions in the St. Croix River Basin (from MPCA & WI DNR 2012, Table 10).

Cover Type	Phosphorus Export Coefficients (kg/ha/yr)
Water	0.007
Forest	0.098
Shrubland	0.098
Grassland	0.221
Agriculture	0.628
Urban	0.628

While the literature review demonstrates a variety of methods for estimating phosphorus runoff, all reports consistently show that forested lands are among the lowest in phosphorus export. This validates the importance of preserving forested land and other low phosphorus export land cover types for the protection of water quality. If these lands continue to be converted to higher phosphorus export cover types, achieving the goal of reduction of phosphorus loading to Lake St. Croix may prove difficult to achieve.

METHODS

Basin Level Land Cover Change Analysis

This land cover change analysis includes datasets representing mid-late 1800s land cover (Presettlement Land Cover (Minnesota), Original Vegetation Cover (Wisconsin)), early 1990s land cover (Gap Analysis Program Land Cover of Minnesota (GAP), Land Cover of Wisconsin (WISCLAND)), and 2001 and 2006 land cover (National Land Cover Dataset (NLCD)). Datasets that were originally created in raster format (GAP, WISCLAND, and NCLD) were converted from raster to vector format then projected to NAD 1983 UTM 15N. The Presettlement Land Cover and Original Vegetation Cover datasets were merged with areas of open water extracted from the GAP and WISCLAND datasets to account for lack of inclusion of these open water areas during the initial digitization processes.

Spatial resolutions vary across the datasets, which can pose problems in smaller areas such as riparian buffers, especially in the case of the mid-late 1800s data. Positional offsets in the Presettlement Land Cover dataset can be up to 1,000 feet (300 meters) in places, and the original maps were created at 1:1,000,000 and 1:500,000 scale for Marschner's Presettlement Map and the Original Vegetation Cover Map respectively. Spatial resolution greatly improves with the remaining datasets; each has an original cell size of 30 by 30 meters. Some caution must be taken in use of area estimates generated from each of the datasets, particularly in the case of the mid-late 1800s datasets.

In addition to differences in collection/analysis methodologies and spatial resolutions, land cover classification systems within the datasets also vary across the datasets (with the exception of the NLCD 2001 and 2006 datasets). To compare the datasets, they were reclassified into more simplified cover types (Appendix D). In the original dataset classification systems, lowland areas were grouped differently in each dataset. The National Land Cover Dataset grouped lowland forest and lowland shrub; mid-late 1800s datasets for both Minnesota and Wisconsin grouped lowland shrub and wetlands. These lowland areas cannot be split consistently throughout the datasets, and therefore were grouped as "Lowland Vegetation".

The watershed boundaries used to aggregate the land cover data were extracted from the National Hydrologic Dataset (NHD) Watershed Boundary Dataset (WBD) at the Hydrologic Unit Code (HUC) 12 level for the HUC 4 of 0703, which represents the area drained by the mouth of the St. Croix River (the St. Croix River Basin). Areas of each cover type were calculated for the basin and summarized by the simplified cover types (Appendix A).

Tributary Level Land Cover Change Analysis

HUC 12 units within the basin were allocated to tributaries for units upstream from tributary mouths for select streams and rivers to create "tributary watersheds" (Figure 2). Units that were immediately adjacent to the St. Croix River were grouped as "Adjacent Small Streams", and units that contained "Non-Contributing" in the HU_12_Name field were grouped as "Non-Contributing Areas". Areas of land cover types were then calculated for each of the tributary watersheds, summarized by the simplified cover types, and compared across the SCRB (Appendix B).

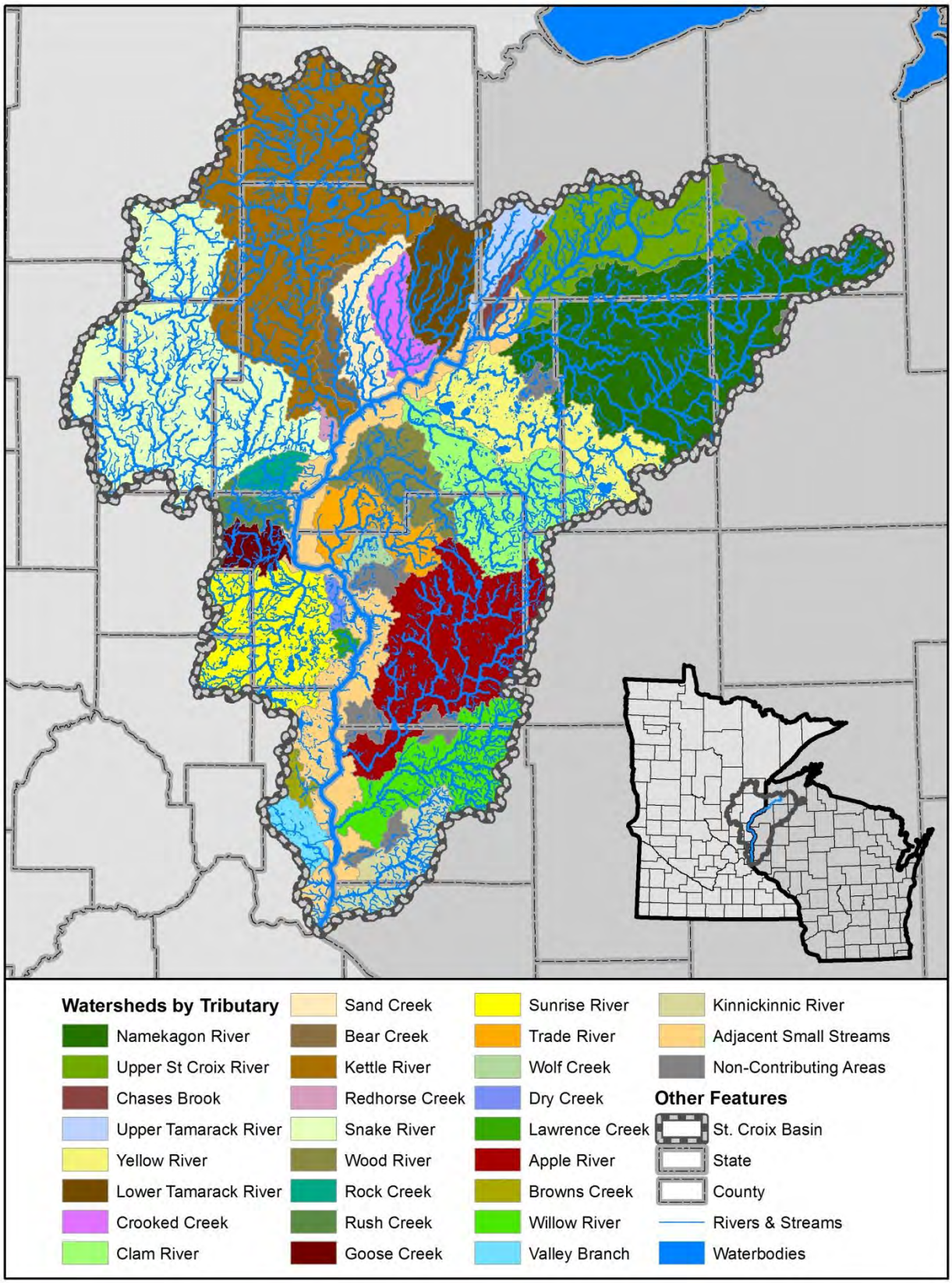

Figure 2. SCRB and tributary watersheds (tributary watersheds listed upstream to downstream).

Riparian Level Land Cover Change Analysis

Land cover change within riparian areas was analyzed using a more detailed geoprocessing methodology. The watershed level analysis employed methodology that converted any raster data to polygon and clipped the polygons to the watershed boundary. That methodology resulted in raster cells at the edge of the watershed being split by the watershed boundary, which may have resulted in a misrepresentation of the portion of the cell that was analyzed. For instance, if a cell was classified as upland forest, and the actual makeup of that cell was 60% upland forest and 40% grassland, and the 40% of grassland was inside the watershed and the 60% of upland forest was outside the watershed, that area inside the watershed would have been incorrectly recorded as upland forest due to the majority classification that was applied to the cell in the original dataset. However, at the basin and tributary levels, those potential misrepresentations, which only occur along the watershed boundary, were acceptable.

To conduct the riparian analysis, respect for the resolution of the land cover data was more imperative. A geoprocessing procedure was employed that maintained the 30 meter resolution of the NLCD data by avoiding resampling the data, and that factored for areas classified as open water within the dataset. This process involved creating a raster representation of the riparian zone that matched the cells of the NLCD data and included cells classified as open water within the 2001 and 2006 NLCD data. This involved a two-step process of (1) creating a polygon representation of water features that flow to the mouth of the St. Croix River using polygon and polyline data sources (NHD) and raster data sources (NLCD), and (2) buffering the water feature polygon representation at an appropriate buffer distance that respected both the cell size of the raster land cover data and that included riparian areas that have a significant influence on water quality.

To create the polygon representation of water features, four datasets were used including all types from NHD Flowlines (polyline) and Water Bodies (polygon) and NLCD 2001 and 2006 open water areas (raster). To create a polygon representation of the streams represented by line features in the Flowlines dataset, a buffer of 0.25 meters of the line features was created. The intent was to create polygon features, not to represent actual stream width. To expand the streams where Water Body polygons were present, polygons within the Water Bodies dataset that intersected Flowlines features were selected. To include areas of open water in the NLCD datasets, the raster datasets were converted to polygon datasets, and areas classified as “Open Water” that intersected Flowlines line features or that intersected Water Body polygons that intersected Flowlines were selected.

The polygon 0.25 meter buffer of the Flowlines, intersecting Water Bodies, and intersecting NLCD open water areas were then merged into one dataset and dissolved. This created one contiguous polygon for all water bodies that were shown to connect to the mouth of the St. Croix River, as well as several non-contiguous polygons for areas that did not show connectivity to the

mouth of the St. Croix River in the NHD datasets. All non-contiguous polygons were then deleted to remove potentially non-contributing water feature polygons. This process resulted in a water feature polygon representation that, when buffered for riparian areas, would result in minimal areas of open water occurring in the riparian buffer zone and would represent only water features that were shown to flow to the mouth of the St. Croix River.

To buffer the water feature polygons, two considerations were made including (1) to use a buffer distance that represented the riparian areas with the greatest influence on water quality, and (2) to respect the cell size of the NLCD dataset and avoid resampling that would result in degraded spatial accuracy. Areas within 31 meters (100 feet) of water bodies have been shown to have the greatest impact on water quality (Roberts et al., 2010). However, cells within the NLCD dataset are 30 x 30 meters, which presented two issues. First, a buffer distance of 30 meters would only include 1 cell next to the water feature. Second, only cells that have greater than half of their area within the buffer area would be analyzed, meaning that in some areas, there would not be any cells analyzed directly out from the water feature (Figure 3).

To account for these issues, a buffer distance of 60 meters was used, which resulted in buffer areas that were between 30 meters (the side of one cell) to 85 meters (two times the diagonal of a cell) from water body polygons. To show the difference in resulting analysis areas from different buffer distances, Figure 3 illustrates the results of the 30 meter (Figure 3.A) and 60 meter (Figure 3.B) buffers. Water body polygons are shown in blue, the polygon buffer is shown in red crosshatch, and the resulting cells to be analyzed are shown in gray.

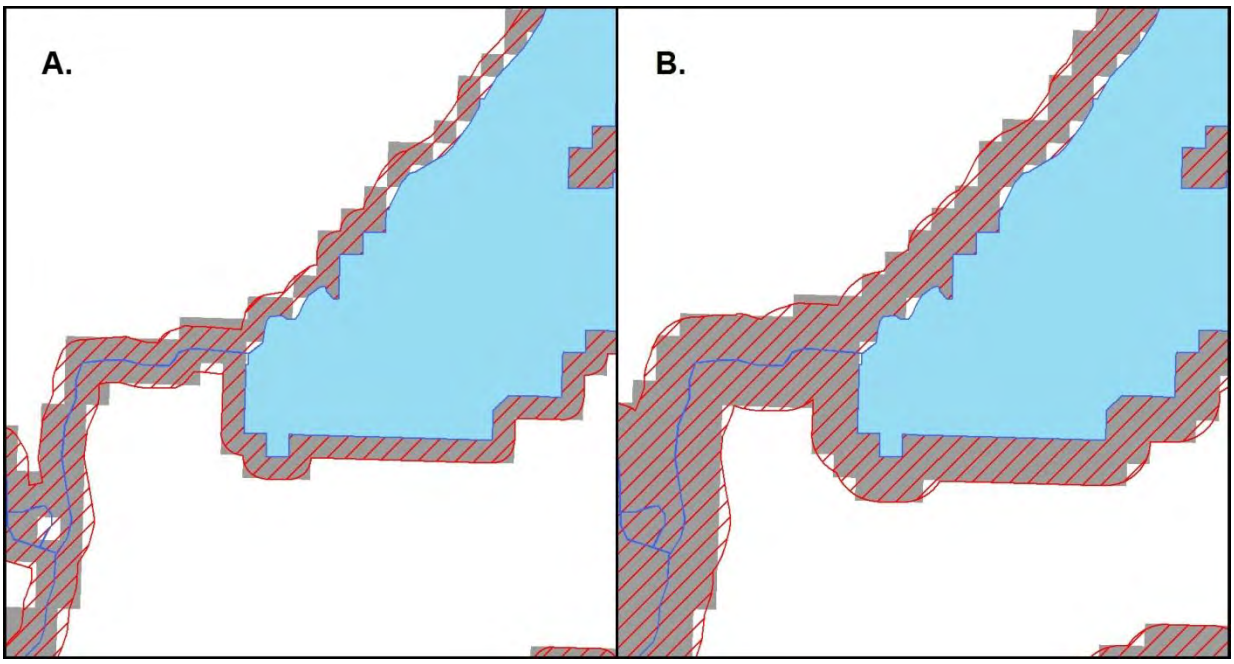

Figure 3. Water feature polygon representation in blue, buffered in red crosshatch at 30 meters (3.A.) and 60 meters (3.B.), and resulting riparian cells to be analyzed in gray.

Riparian Level Land Cover Change Accuracy Assessment

One cell in the NLCD dataset represents a 30 x 30 meter area, or 900 square meters, which is equal to 0.09 hectares, which rounds to 0.1 hectares. By using a geoprocessing methodology that did not resample the NLCD data, this spatial accuracy was maintained throughout the riparian level analysis. While the spatial accuracy of the riparian analysis was immediately quantifiable, the accuracy of the classifications made in the land cover datasets was not readily available. The MRLC website states that a "formal accuracy assessment of the NLCD2006 land cover change product is planned for 2011" (MRLC 2012). No other mention of the accuracy assessment was found on the website at the time it was reviewed. Within the contributing riparian areas in the basin, there are 2,354 polygons covering 605 hectares (1,495 acres) representing contiguous cover type changes as identified by the NLCD datasets.

To conduct an assessment of the accuracy of change in riparian areas from 2001 to 2006, each of these polygons could be evaluated using available aerial imagery. Imagery for 1992 (black/white), 2004 (color), and 2006 (color) is publicly available for most of the SCRB. While imagery from 2001 is not publicly available, the 1992 imagery adequately represents conditions before the change occurred, the 2004 imagery represents mid-change, and the 2006 represents the end of the change period. Conducting an accuracy assessment of all riparian polygons representing change was beyond the scope of this report. However, an evaluation of some select areas was completed.

Two accuracy assessments were conducted using available aerial imagery for whether the overall change description for contiguous areas was accurate or inaccurate. The first focused on watersheds that represented outliers in terms of change in percent cover of cultivated crops, developed cover types, or upland forest cover types. The second focused on change that involved converted cover types including cultivated crops and developed cover types. A random sample of 20% of contiguous cover change polygons were selected and assessed.

RESULTS AND DISCUSSION

Basin Level Land Cover Change

The land cover in the SCRB in the mid-late 1800s (presettlement) ranged from upland forest and lowland vegetation in the north to grassland, prairie, and shrubs in the south and southwest (Figure 3.A). Since then, much of the southern half of the basin has been converted to agriculture, with pockets of non-cultivated lowland and upland vegetation remaining. The northern half has retained much of its presettlement land cover characteristics of upland forests and lowland vegetation, with only pockets of agriculture and developed cover types changing the landscape (Figure 3.B).

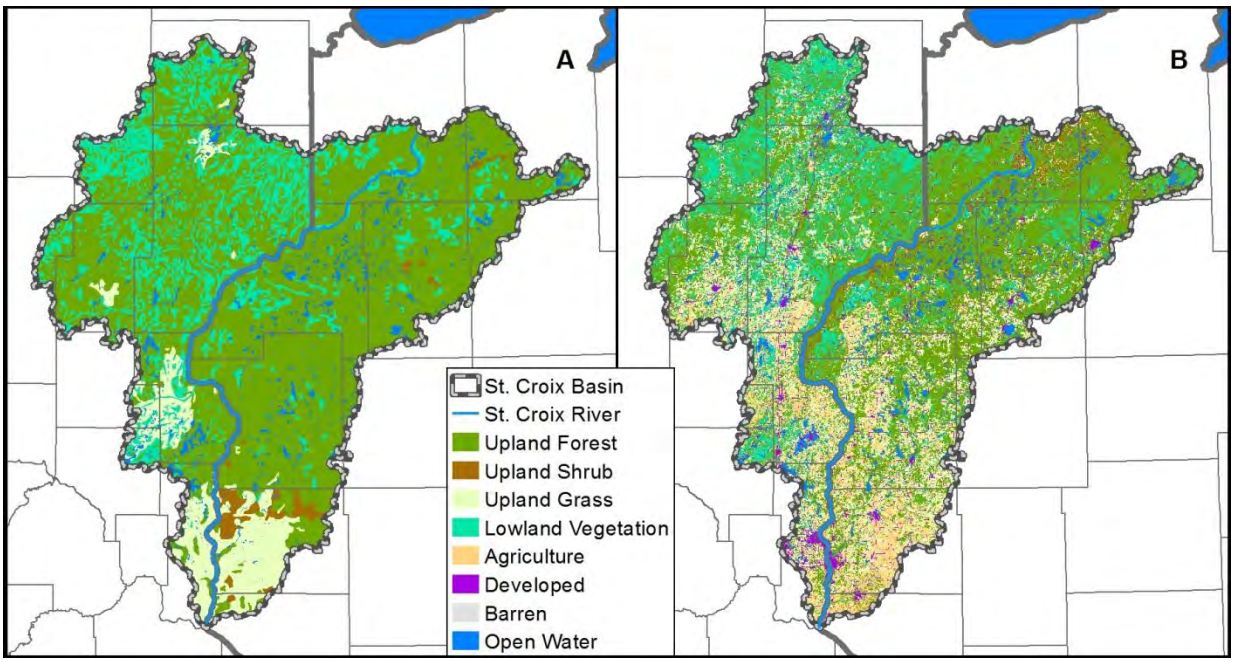

Figure 4. St. Croix River Basin land cover in, (A) mid-late 1800s, and (B) 2006.

Variability for collection methodologies caused significant issues in conducting a change comparison between 1992 datasets and the NLCD 2001 and 2006 datasets. For instance, a significant amount of the increase from 1992 to 2001 of the developed cover type can be attributed to better capture of transportation infrastructure by the methodology used for the NLCD data. In light of this, this discussion is limited to comparison between the first (mid-late 1800s) and last (2006) datasets available and to the directly comparable datasets (2001 and 2006).

From presettlement to 2006, land cover of agriculture, developed, upland grass, and upland shrub cover types increased while land cover of lowland vegetation and upland forest cover types decreased (Table 4). Developed cover types were minimal during presettlement times, and native settlements were not comparable to the impervious landscapes of modern cities. While

agricultural practices were employed in presettlement times by native populations, those practices were not comparable to what is now classified as "agriculture". Given these differences, developed and agriculture cover types can be said to not have existed in presettlement times.

Upland shrub, which was originally classified as "brush" or "brush prairie" in presettlement datasets, showed a high percent change (82%), but still remained a small portion of the basin (2.8%). Upland grass, which was originally classified as "prairie" or jack pine and/or oak openings in presettlement datasets showed a high increase, but much of that increase can be explained by looking at the more detailed NLCD classification (Table A3) for the 2006 land cover, which shows that much of that grassland (88%) is actually pasture/hay.

The starkest change from presettlement to 2006 land cover is the loss of upland forest. The loss of nearly 34% of upland forest, totaling 447,000 hectares (1.1 million acres), or more than 20% of the basin, puts the results of human activity into perspective.

Table 4. SCRB reclassified land cover areas (in hectares and acres) and change from mid-late 1800s to 2006.

	mid-late 1800s			**2006 (compared to mid-late 1800s)**			
Land Cover Reclassification	**Area (Hectares)**	**Percent of Total Area**		**Area (Hectares)**	**Percent of Total Area**	**Hectares Change**	**Percent Change**
Agriculture	0	0.0		192,757	9.6	192,757	-
Barren	0	0.0		271	0.0	271	-
Developed	0	0.0		103,486	5.2	103,486	-
Lowland Vegetation	374,346	18.8		356,906	17.9	-17,440	-4.7
Open Water	87,373	4.4		79,564	4.0	-7,809	-8.9
Upland Forest	1,322,725	66.3		875,280	43.8	-447,445	-33.8
Upland Grass	180,343	9.0		334,106	16.7	153,763	85.3
Upland Shrub	30,531	1.5		55,572	2.8	25,040	82.0
Totals	**1,995,319**	**100.0**		**1,997,942**	**100.0**	**-**	**-**
	mid-late 1800s			**2006 (compared to mid-late 1800s)**			
Land Cover Reclassification	**Area (Acres)**	**Percent of Total Area**		**Area (Acres)**	**Percent of Total Area**	**Acres Change**	**Percent Change**
Agriculture	0	0.0		476,312	9.6	476,312	-
Barren	0	0.0		669	0.0	669	-
Developed	0	0.0		255,719	5.2	255,719	-
Lowland Vegetation	925,030	18.8		881,935	17.9	-43,095	-4.7
Open Water	215,903	4.4		196,608	4.0	-19,295	-8.9
Upland Forest	3,268,525	66.3		2,162,865	43.8	-1,105,660	-33.8
Upland Grass	445,638	9.0		825,594	16.7	379,957	85.3
Upland Shrub	75,444	1.5		137,320	2.8	61,876	82.0
Totals	**4,930,541**	**100.0**		**4,937,022**	**100.0**	**-**	**-**

Table 5 shows changes and rates of change in percent cover for the basin. The date for the presettlement datasets is not exact; the date of 1866 was chosen simply to provide a 140 year time span with which to derive a rate of change. The expected change in percent cover over 5 years was calculated by dividing the change in percent cover from presettlement to 2006 by 140 years to obtain a rate of change, then multiplying that rate of change by 5 years.

Percent cover is more useful at the tributary level where it provides an area normalized statistic that can be used for comparison across each tributary. Analysis of change at the tributary level is included below in the riparian analysis. At the basin level, the changes and rates of change in percent cover can give context for the changes occurring at the tributary level by providing an expected rate of change. Comparing the rates of change in percent cover for different time periods at the basin level can also show whether the overall trends for each cover type have changed in the most current time period available.

Compared to the 140 year period from presettlement to 2006, the change occurring in the 5 year period showed that the increase in percent cover of agriculture changed to a slight decrease and the decrease in percent cover of lowland vegetation changed to an increase. Developed, upland grass, and upland shrub cover types continued to increase while upland forest continued to decrease. Rates of increase for developed and upland grass cover types were less than expected. Rates of decrease in upland forest were also less than expected.

Table 5. SCRB change in percent cover from presettlement (assuming 1866) to 2006, expected change in percent cover over 5 years, and change in percent cover from 2001 to 2006.

Land Cover Reclassification	Percent Cover, mid-late 1800s, assuming 1866	Percent Cover 2001	Percent Cover 2006	Change in Percent Cover, Presettlement to 2006	Expected Change in Percent Cover over 5 years	Change in Percent Cover, 2001 to 2006
Agriculture	0.000	9.649	9.648	9.648	0.345	-0.001
Barren	0.000	0.008	0.014	0.014	0.000	0.006
Developed	0.000	5.077	5.180	5.180	0.185	0.102
Lowland Veg	18.761	17.577	17.864	-0.898	-0.032	0.286
Open Water	4.379	4.025	3.982	-0.397	-0.014	-0.043
Upland Forest	66.291	44.345	43.809	-22.482	-0.803	-0.536
Upland Grass	9.038	16.597	16.723	7.684	0.274	0.125
Upland Shrub	1.530	2.721	2.781	1.251	0.045	0.060

Tributary Level Land Cover Change

The distribution of change in land cover types by tributary watersheds exhibited a spatial pattern for the two cover types with the highest export of phosphorus: agriculture and developed lands (converted cover types). The spatial distribution showed that the farther upstream a tributary is in the SCRB, the less likely it is to have high levels of conversion to converted cover types (Figure 5 and 6). In terms of developed lands, their distribution is most likely influenced by the location of major transportation routes, which successively in history were: rivers, railroads, and highways. The opening of new transportation routes are often followed by urban growth along those routes. For agriculture, location of soils, climates suitable for farming, and transportation routes to markets are the most likely driving factors.

Though determining the reasons for the correlation of distance upstream to increased change to converted lands is complicated, the relationship does exist. This relationship can help to decide what tributary watersheds to target for conservation of land cover types that have low phosphorus export such as forest, shrub, and grass, and to identify where there is high potential for phosphorus exports due to high concentrations of high phosphorus export cover types. Watersheds such as the Snake and the Kettle Rivers in Minnesota, and the Clam and the Yellow Rivers in Wisconsin are at the edge of this northeastward and upstream advance of converted lands. With more lands being converted to developed cover as cities expand and to agriculture as the climate changes and commodity prices rise, protection of low phosphorus export land cover types such as forests becomes an increasingly important piece to keeping water quality from degrading further than it already has.

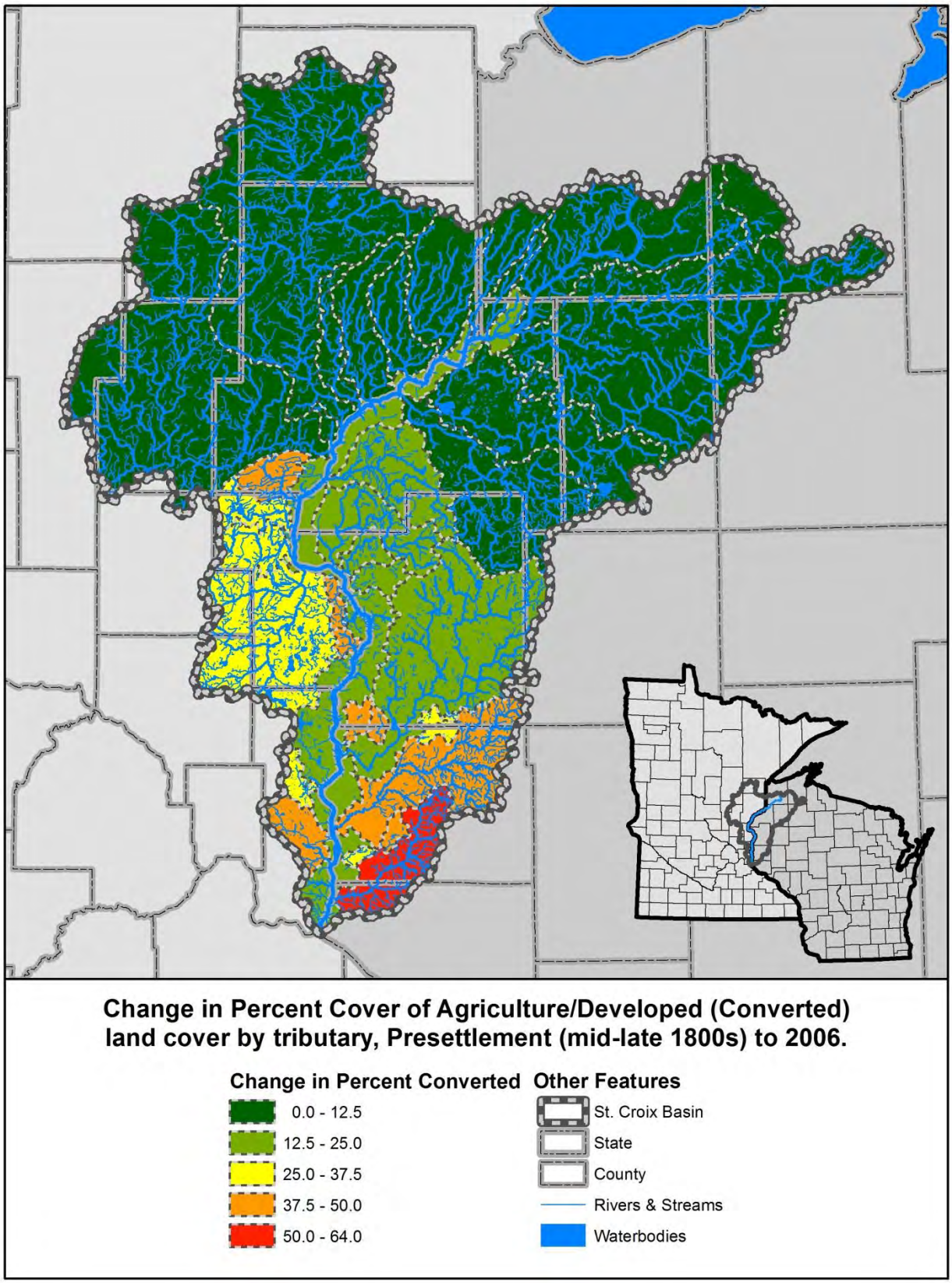

Figure 5. Change in percent cover of converted land cover, mid-late 1800s to 2006.

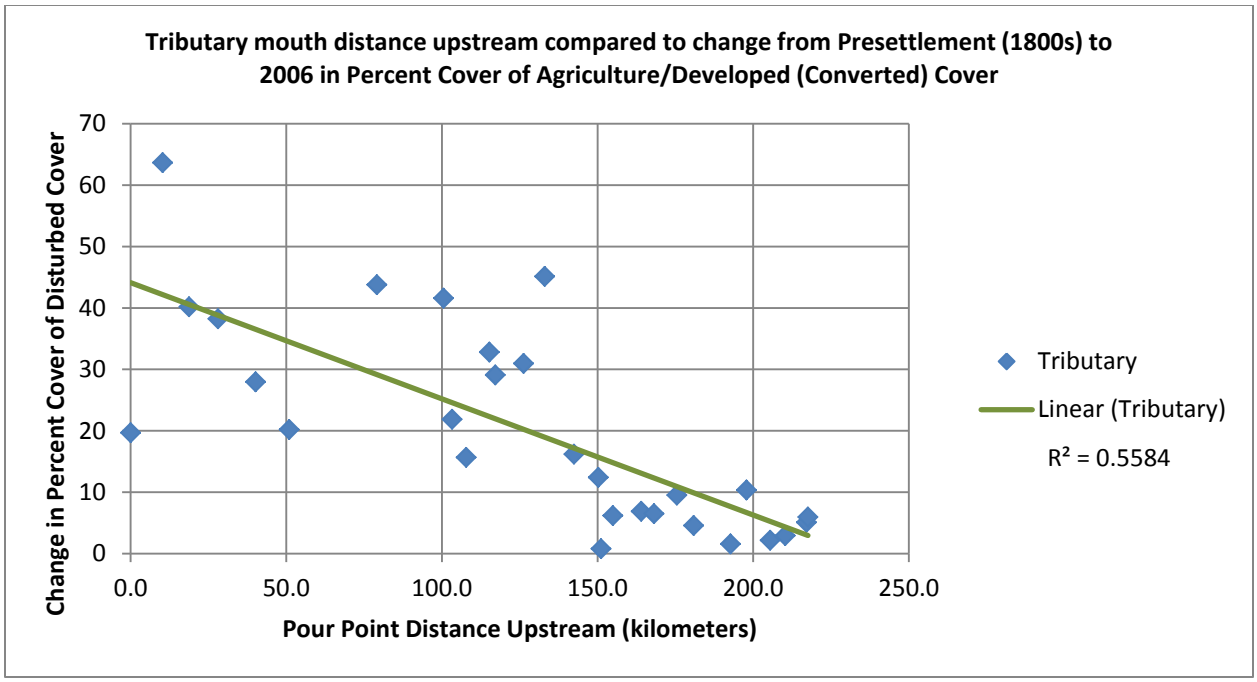

Figure 6. Tributary mouth distance upstream from the Mississippi River compared to change in percent converted cover.

Riparian Level Land Cover Change

The land cover in SCRB contributing riparian areas, which are areas that are within 30 to 85 meters of flow pathways that include all flow types (perennial, intermittent) and are connected to the mouth of the St. Croix River, showed similarities and differences compared to changes occurring basin-wide (Table 6 and Table 7). In contributing riparian areas and basin-wide, developed, lowland vegetation, upland grass, and upland shrub cover types showed increases in area and upland forest showed a decrease in area. Agriculture increased in contributing riparian areas while slightly decreasing basin-wide.

Table 6. SCRB contributing riparian area reclassified land cover areas (in acres and hectares) and change from 2001 to 2006.

Land Cover Reclassification	Area 2001 (Hectares)	Area 2006 (Hectares)	Area Change (Hectares)	Area 2001 (Acres)	Area 2006 (Acres)	Area Change (Acres)
Agriculture	10,536.8	10,560.7	23.9	26,036.9	26,096.0	59.2
Barren	3.1	3.1	0.0	7.6	7.6	0.0
Developed	6,344.7	6,418.9	74.2	15,678.2	15,861.4	183.3
Lowland Veg	46,546.3	46,558.1	11.8	115,018.4	115,047.5	29.1
Open Water	183.3	176.3	-7.0	453.0	435.7	-17.3
Upland Forest	53,770.6	53,599.5	-171.1	132,870.0	132,447.2	-422.8
Upland Grass	17,271.6	17,331.0	59.4	42,679.1	42,825.9	146.8
Upland Shrub	2,394.7	2,403.5	8.8	5,917.5	5,939.3	21.8
Total Riparian Area	**137,051.1**	**137,051.1**	**-**	**338,660.6**	**338,660.6**	**-**

Areas of open water represented less than two-tenths of a percent of the total riparian area analyzed, showing that the analysis methodology succeeded in filtering out open water areas (Table 7). Lowland vegetation and upland shrub showed very little change. The largest change was a decrease in upland forest, followed by an increase in developed and upland grass. Change in contributing riparian areas over the five year period was less pronounced than basin-wide change, except in the case of agriculture.

Table 7. SCRB contributing riparian area change in percent cover from 2001 to 2006, basin-wide change in percent cover from 2001 to 2006, and expected change in percent cover over 5 years.

Land Cover Reclassification	Percent Cover 2001	Percent Cover 2006	Riparian Change in Percent Cover, 2001 to 2006	Basin-wide Change in Percent Cover, 2001 to 2006	Expected Change in Percent Cover over 5 years
Agriculture	7.688	7.706	0.017	-0.001	0.345
Barren	0.002	0.002	0.000	0.006	0.000
Developed	4.629	4.684	0.054	0.102	0.185
Lowland Veg	33.963	33.971	0.009	0.286	-0.032
Open Water	0.134	0.129	-0.005	-0.043	-0.014
Upland Forest	39.234	39.109	-0.125	-0.536	-0.803
Upland Grass	12.602	12.646	0.043	0.125	0.274
Upland Shrub	1.747	1.754	0.006	0.060	0.045

The comparison of 2001 to 2006 NLCD data allows for a direct comparison where reclassification of cover types is no longer necessary. The following discussion on change in contributing riparian areas includes the more detailed NLCD classifications. Table 8 shows change in contributing riparian areas from 2001 to 2006 across the SCRB. Cultivated crops saw an increase of 23.9 hectares (59.2 acres). Upland forest cover types (deciduous, evergreen, and mixed forest) saw a decline of 171.1 hectares (422.8 acres). Within this decline, a net loss of 24.1 hectares (59.6 acres), or 14.1%, was to cultivated crops (Table 9) and 15.9 hectares (39.4 acres), or 9.3%, was to developed cover types (Table 10). Of the total decline of 171.1 hectares, 40.0 hectares, or 23.4% of the decline, was to converted cover types and 76.6% was within non-converted cover types.

The woody wetlands cover type saw the largest decline of 202.0 hectares (499.3 acres). Within this decline, a net loss of 12.6 hectares (31.1 acres), or 6.3%, was to cultivated crops (Table 11) and 2.9 hectares (7.1 acres), or 1.4%, was to developed cover types (Table 12). Of the total decline of 202.0 hectares, 15.5 hectares, or 7.7% of the decline, was to converted cover types. So while the decline of woody wetlands was the largest, a majority of this decline (92.3%) was to other non-converted cover types.

Developed cover types saw an increase of 74.2 hectares (183.3 acres). Within this increase, nearly half (49.0%) was to "developed, open space" (Table 13). Of the total increase in developed cover types, pasture/hay (32.9%), cultivate crops (31.4%), and deciduous forest (18.9%) were the most commonly converted cover types.

Table 8. SCRB contributing riparian area NLCD cover type areas (in hectares and acres) and change from 2001 to 2006.

NLCD Cover Type	2001 Area (Hectares)	2006 Area (Hectares)	Area Change (Hectares)		2001 Area (Acres)	2006 Area (Acres)	Area Change (Acres)
Open Water	183.3	176.3	-7.0		453.0	435.7	-17.3
Developed, Open Space	4,838.6	4,874.0	35.5		11,956.4	12,044.0	87.6
Developed, Low Intensity	1,165.6	1,188.3	22.7		2,880.2	2,936.3	56.0
Developed, Medium Intensity	270.1	284.1	14.0		667.4	702.1	34.7
Developed, High Intensity	70.5	72.5	2.0		174.1	179.0	4.9
Barren Land (Rock/Sand/Clay)	3.1	3.1	0.0		7.6	7.6	0.0
Deciduous Forest	46,280.5	46,139.5	-141.0		114,361.7	114,013.2	-348.5
Evergreen Forest	2,719.3	2,709.5	-9.8		6,719.4	6,695.2	-24.2
Mixed Forest	4,770.8	4,750.6	-20.3		11,788.9	11,738.9	-50.0
Shrub/Scrub	2,394.7	2,403.5	8.8		5,917.5	5,939.3	21.8
Grassland/Herbaceous	2,595.8	2,658.5	62.7		6,414.3	6,569.3	155.0
Pasture/Hay	14,675.9	14,672.5	-3.3		36,264.8	36,256.6	-8.2
Cultivated Crops	10,536.8	10,560.7	23.9		26,036.9	26,096.0	59.2
Woody Wetlands	27,269.2	27,067.1	-202.0		67,383.6	66,884.4	-499.3
Emergent Herbaceous Wetlands	19,277.1	19,490.9	213.8		47,634.8	48,163.2	528.4
Total Riparian Area	**137,051.1**	**137,051.1**			**338,660.6**	**338,660.6**	

Table 9. SCRB contributing riparian areas net change of Upland Forest to Cultivated Crops from 2001 to 2006.

2001	2006	Area (Hectares)	Area (Acres)
Deciduous Forest	Cultivated Crops	19.1	47.1
Evergreen Forest	Cultivated Crops	1.5	3.8
Mixed Forest	Cultivated Crops	7.0	17.3
Change of Upland Forest to Cultivated Crops		**27.6**	**68.3**
Cultivated Crops	Deciduous Forest	0.3	0.7
Cultivated Crops	Mixed Forest	3.2	8.0
Change of Cultivate Crops to Upland forest		**3.5**	**8.7**
Net change of Upland Forest to Cultivated Crops		**24.1**	**59.6**

Table 10. SCRB contributing riparian areas change of Upland Forest to Developed from 2001 to 2006.

2001	2006	Area (Hectares)	Area (Acres)
Deciduous Forest	Developed, Low Intensity	3.2	7.8
Deciduous Forest	Developed, Medium Intensity	1.7	4.2
Deciduous Forest	Developed, Open Space	9.2	22.7
Evergreen Forest	Developed, Low Intensity	0.2	0.4
Evergreen Forest	Developed, Open Space	1.4	3.6
Mixed Forest	Developed, Low Intensity	0.3	0.7
Change of Upland Forest to Developed		**15.9**	**39.4**

Table 11. SCRB contributing riparian areas net change of Woody Wetlands to Cultivated Crops from 2001 to 2006.

2001	2006	Area (Hectares)	Area (Acres)
Woody Wetlands	Cultivated Crops	21.2	52.5
Change of Woody Wetlands to Cultivated Crops		**21.2**	**52.5**
Cultivated Crops	Woody Wetlands	8.6	21.3
Change of Cultivated Crops to Woody Wetlands		**8.6**	**21.3**
Net change of Woody Wetlands to cultivated crops		**12.6**	**31.1**

Table 12. SCRB contributing riparian areas change of Woody Wetlands to Developed from 2001 to 2006.

2001	2006	Area (Hectares)	Area (Acres)
Woody Wetlands	Developed, Low Intensity	2.0	4.9
Woody Wetlands	Developed, Open Space	0.9	2.2
Change of Woody Wetlands to Developed		**2.9**	**7.1**

Table 13. SCRB contributing riparian areas change from non-Developed to Developed cover types from 2001 to 2006.

2001	2006	Area (Ha)	Area (Ac)	Percent of subtotal increase	Percent of total increase
Cultivated Crops	Developed, Open Space	6.5	16.0	17.8	8.7
Deciduous Forest	Developed, Open Space	9.2	22.7	25.2	12.4
Emergent Herbaceous Wetlands	Developed, Open Space	1.3	3.1	3.5	1.7
Evergreen Forest	Developed, Open Space	1.4	3.6	4.0	1.9
Grassland/Herbaceous	Developed, Open Space	1.4	3.3	3.7	1.8
Pasture/Hay	Developed, Open Space	14.8	36.5	40.6	19.9
Shrub/Scrub	Developed, Open Space	1.0	2.4	2.7	1.3
Woody Wetlands	Developed, Open Space	0.9	2.2	2.5	1.2
Subtotal (increase in Developed, Open Space)		**36.4**	**89.8**	**100.0**	**49.0**
Cultivated Crops	Developed, Low Intensity	7.6	18.7	33.3	10.2
Deciduous Forest	Developed, Low Intensity	3.2	7.8	13.9	4.2
Emergent Herbaceous Wetlands	Developed, Low Intensity	1.7	4.2	7.5	2.3
Evergreen Forest	Developed, Low Intensity	0.2	0.4	0.8	0.2
Grassland/Herbaceous	Developed, Low Intensity	0.8	2.0	3.6	1.1
Mixed Forest	Developed, Low Intensity	0.3	0.7	1.2	0.4
Pasture/Hay	Developed, Low Intensity	6.8	16.9	30.2	9.2
Shrub/Scrub	Developed, Low Intensity	0.2	0.4	0.8	0.2
Woody Wetlands	Developed, Low Intensity	2.0	4.9	8.7	2.7
Subtotal (increase in Developed, Low Intensity)		**22.7**	**56.0**	**100.0**	**30.6**
Cultivated Crops	Developed, Medium Intensity	8.0	19.8	61.0	10.8
Deciduous Forest	Developed, Medium Intensity	1.7	4.2	13.0	2.3
Emergent Herbaceous Wetlands	Developed, Medium Intensity	0.4	0.9	2.7	0.5
Grassland/Herbaceous	Developed, Medium Intensity	0.6	1.6	4.8	0.8
Pasture/Hay	Developed, Medium Intensity	2.4	6.0	18.5	3.3
Subtotal (increase in Developed, Medium Intensity)		**13.1**	**32.5**	**100.0**	**17.7**
Cultivated Crops	Developed, High Intensity	1.3	3.1	63.6	1.7
Grassland/Herbaceous	Developed, High Intensity	0.4	0.9	18.2	0.5
Pasture/Hay	Developed, High Intensity	0.4	0.9	18.2	0.5
Subtotal (increase in Developed, High Intensity)		**2.0**	**4.9**	**100.0**	**2.7**
Total increase in Developed cover types		**74.2**	**183.3**		**100.0**

To compare change across tributaries, areas of cover types were normalized by dividing by the total contributing riparian area in the tributary resulting in percent coverage of each cover type (Appendix C). The percent coverage from 2001 was subtracted from 2006 to find the percent cover change. Change in percent cover of converted cover types (cultivated crops and developed cover types) that have a higher phosphorus export than non-converted cover types are displayed in Figure 7. No tributary watersheds saw a decline in percent cover of total converted cover type areas; some smaller tributary watersheds saw no change in percent cover of total converted cover type areas.

Once again, a spatial pattern progressing upstream was evident. Although, as opposed to the pattern seen across the SCRB from mid-late 1800s to 2006 where less change to both agriculture and developed cover types occurred at distances further upstream, the pattern from 2001 to 2006 in riparian areas showed that the trend continued for developed cover types, but the trend for agriculture (cultivated crops) was reversed. This relationship is illustrated in Figures 7, 8, and 9. Browns Creek, which was an outlier for both increase in developed cover types and decrease in cultivated crops, was not included in the comparison charts (Figures 8 and 9). Figure 8 shows the correlation of less change to developed cover types with distances farther upstream and Figure 9 shows the reversal of this trend to more change in cultivated crops with distances farther upstream.

Agricultural cover and developed cover exhibited an inverse relationship where, as developed cover types increased, cultivated crops decreased (Figure 10). Over half (51.2%) of the change of cultivated crops to another cover type was to developed cover types (Table C8). As in the basin-wide analysis of mid-late 1800s to 2006 land cover, the datasets replicate a typical pattern of human expansion. However, in the more recent riparian land cover change analysis, the trend has progressed from increase of converted cover types to change within converted cover types where land that was first converted to agriculture is now being converted to developed land.

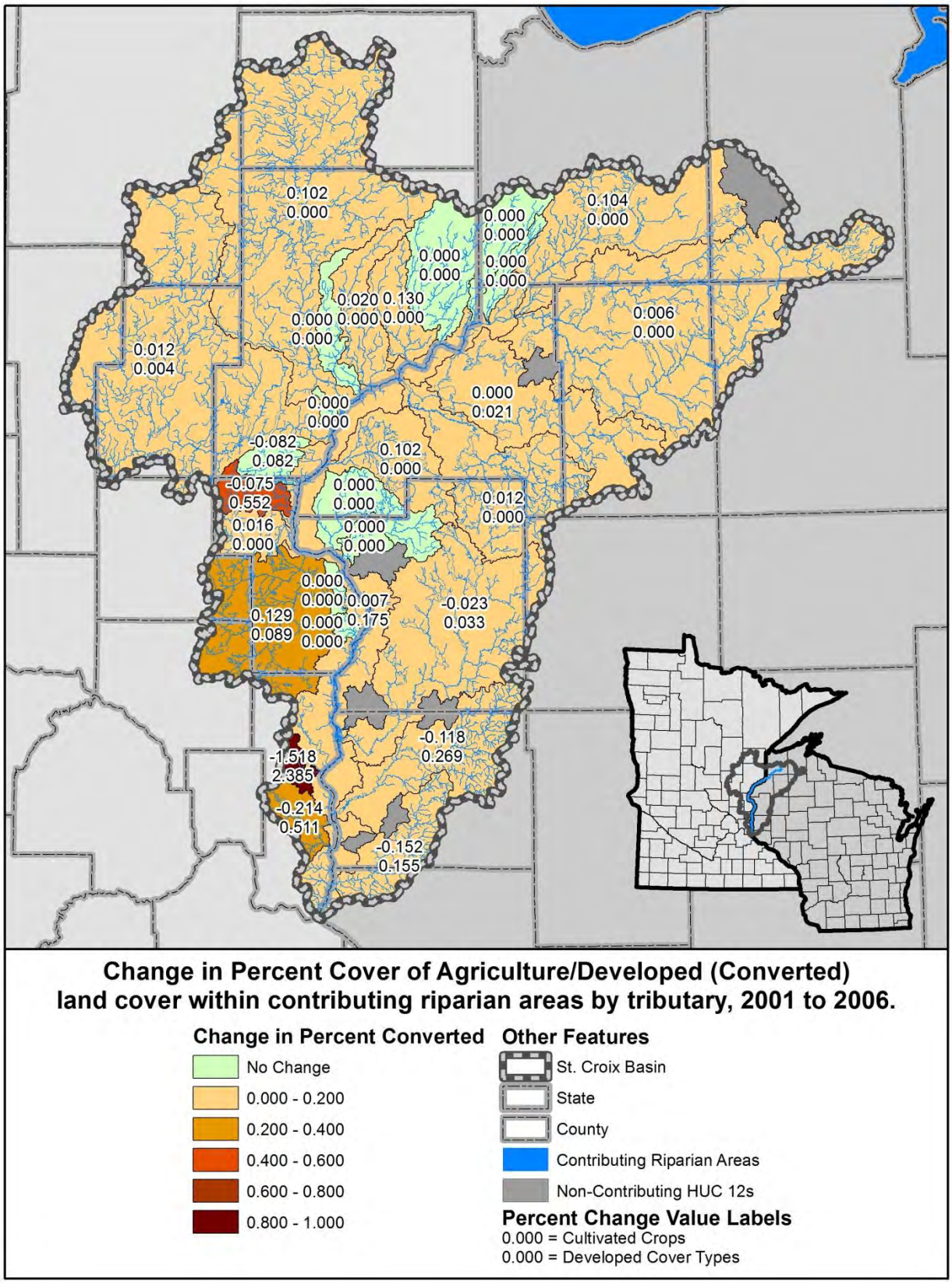

Figure 7. Change in percent cover of converted land cover in contributing riparian areas, 2001 to 2006.

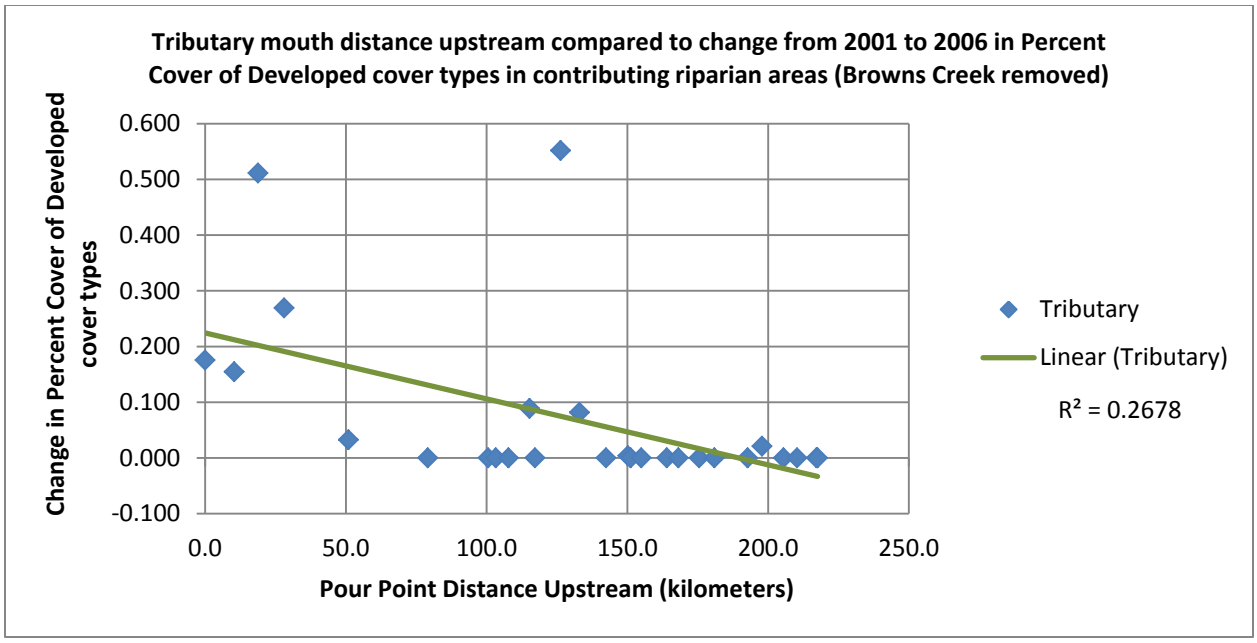

Figure 8. Tributary mouth distance upstream compared to change from 2001 to 2006 in Percent Cover of Developed cover types in contributing riparian areas (Browns Creek removed).

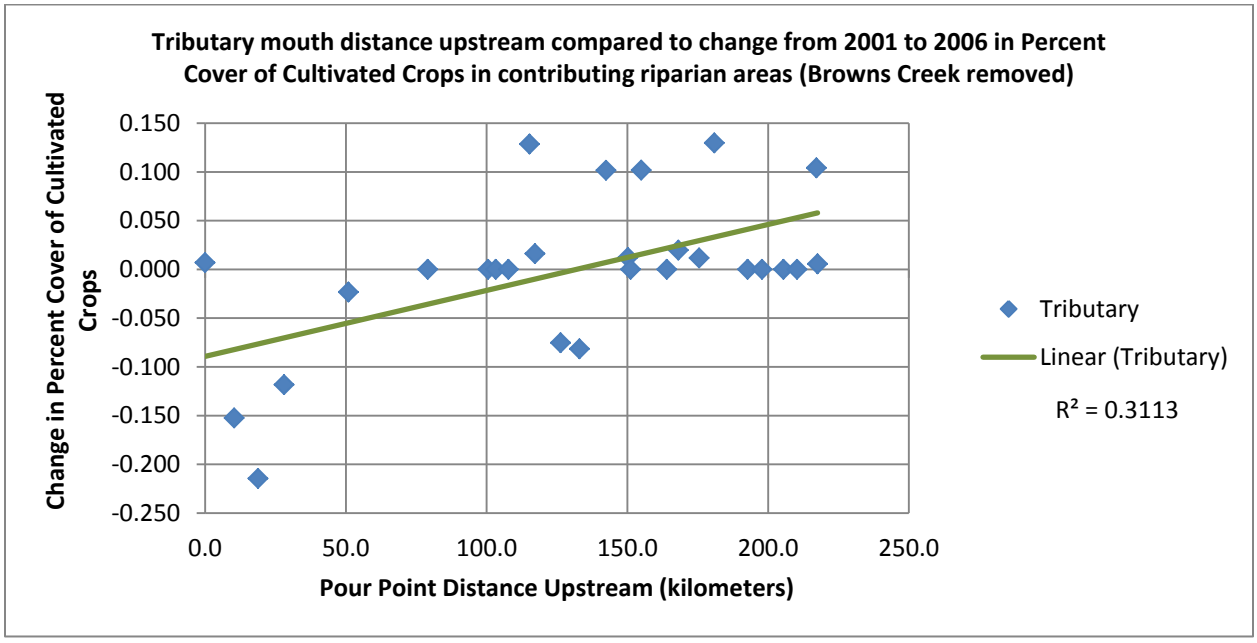

Figure 9. Tributary mouth distance upstream compared to change from 2001 to 2006 in Percent Cover of Cultivated Crops in contributing riparian areas (Browns Creek removed).

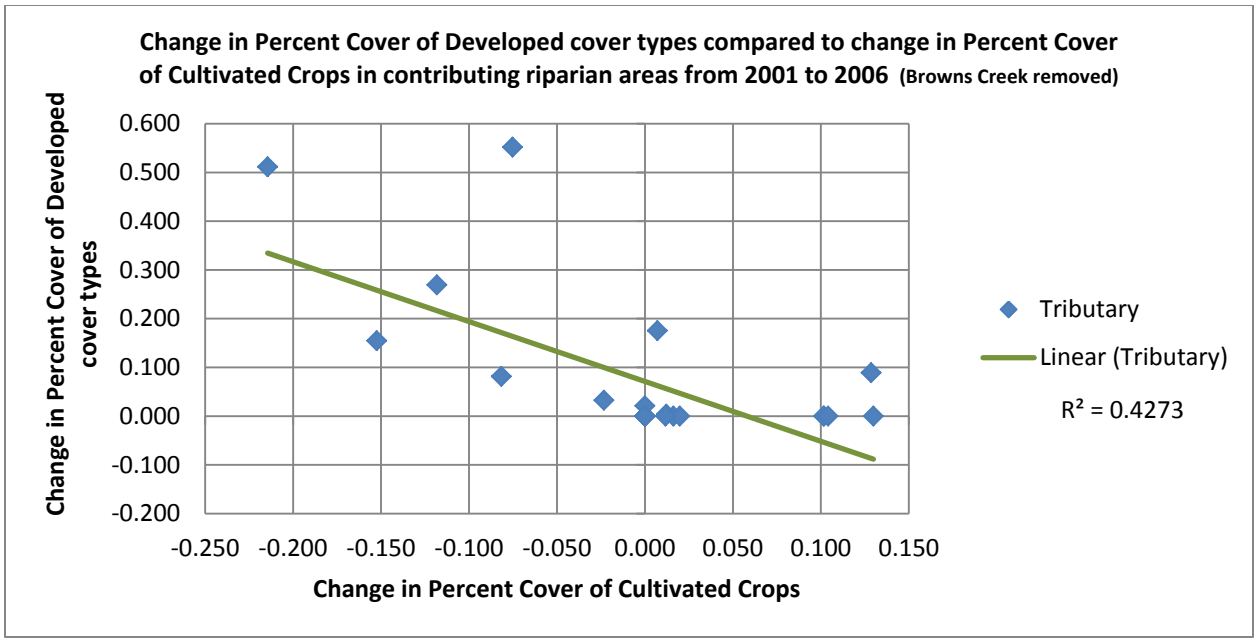

Figure 10. Change in Percent Cover of Developed cover types compared to change in Percent Cover of Cultivated Crops in contributing riparian areas from 2001 to 2006 (Browns Creek removed).

Riparian Level Land Cover Change Accuracy Assessment

The collection/analysis methodologies used to create the NCLD datasets (and others for that matter) have some inherent error included. A formal accuracy assessment conducted by the Multi-Resolution Land Characteristics Consortium (MRLC) of the change between the 2001 and 2006 NLCD datasets was underway at the time of the drafting of this report (MRLC 2012). Understanding the error inherent in the datasets is important when discussing their data.

To understand the accuracy of change represented by the NLCD datasets, an analysis was conducted of tributaries showing high amounts of change and of randomly selected areas throughout the basin where change involved converted cover types. It should be noted that extrapolating this accuracy assessment to the entire dataset would be inappropriate given the restrictions that riparian buffers impose on the size of contiguous polygons representing change. Change to and from cultivated crops and developed cover types was assessed, and overall accuracy was 52.5%. The accuracy of change to cultivated crops was at a low 13.3%. The accuracy of change to developed cover types was high at 73.2%.

To begin the accuracy assessment, outliers in terms of change in percent cover of cultivated crops, developed cover types, or upland forest cover types were selected for evaluation. All tributary watersheds showed an increase in percent cover of developed cover types of less than 1% except Browns Creek (increase of 2.385%) (Table C7). Browns Creek also showed the highest decrease in percent cover of agriculture (decline of 1.518%), yet still resulted in the highest increase of converted cover types (0.867%). All tributary watersheds showed increase or a decrease in percent cover of upland forest cover types of less than 1% except Redhorse Creek (decline of 1.892%). These two outlier tributary watersheds were evaluated for whether the overall change description was accurate or inaccurate.

All areas of change within Redhorse Creek (5.5 hectares) were either from woody wetlands (2.7 hectares), deciduous forest (2.6 hectares), or open water (0.1 hectare) to emergent herbaceous wetlands. Determining accuracy using aerial imagery was not possible for these changes. Within Browns Creek, 96% (7.0 hectares) of the total area of riparian change (7.3 hectares) was to developed cover types, and over half of this change (4.4 hectares) was from cultivated crops. These areas were verifiable from aerial imagery as suburban developments and represented accurate changes.

As found in the evaluation of Browns Creek and Redhorse Creek, change within non-converted cover types is generally difficult to assess using aerial imagery. Additionally, according to estimated phosphorus exports, change within non-converted cover types has less influence on water quality than does change involving converted cover types (MPCA 2004). To include a random sampling of accuracy of riparian change, areas of change were evaluated that involved converted cover types. Of the 2,354 polygons representing contiguous areas of change in riparian

areas, 607 involved converted cover types. A sample of 20% (121) of the polygons covering 33.7 hectares representing change to or from a converted cover type was evaluated for accuracy.

Of the riparian areas showing change involving converted cover types, 53% of the area was determined to be accurate, 46% of the area was determined to be inaccurate, and 1% of the area was indeterminable (Table C9). The most commonly misclassified change was woody wetlands to cultivate crops. Of the accurate change classifications, the majority (73.6% of the area) were to developed cover types. Of the change to developed cover types, 73.2% of the area was accurate. Of the inaccurate change classifications, the majority (66.9% of the area) were to cultivated crops. Of the change to cultivated crops, 86.7% of the area was inaccurate.

CONCLUSIONS

Forested land has been lost on a large scale across the St. Croix Basin since presettlement times. As human expansion has pushed upstream, change from low phosphorus export cover types such as forest, shrub, and grassland to high phosphorus export cover types such as cultivated crops and developed land has been the result. Riparian areas in downstream tributary watersheds are recently seeing advanced stages of this human expansion where cultivated crops are being converted to developed land.

The change description that was found to be most accurate in riparian areas for converted cover types from 2001 to 2006 was from all non-developed cover types to developed cover types. Of the non-developed cover types, pasture/hay, cultivated crops, and deciduous forest were the most common cover types to be converted to developed cover types in riparian areas. So while some of the change in riparian areas was within high phosphorus export cover types, some change from the lowest phosphorus export cover types (deciduous forest) to high phosphorus export cover types (Developed) was still occurring in these critical areas.

Where this change was occurring in terms of stream hierarchy was not examined. Additional analysis of the riparian land cover change data could provide additional insight into what impact this change had on overall water quality. Given the moderate level of accuracy exhibited by the 2001 and 2006 land cover datasets in riparian areas, additional verification of the change classification would be necessary.

While the relationship of tributary watershed position within the basin to change in converted land cover types is complex, it exists and can be used to determine where to target particular types of water quality improvement strategies. In the lower portion of the basin, mitigation and restoration strategies will be important because a higher portion of the land cover has already been converted to higher phosphorus exporting land cover types. Midway upstream, protection strategies would be more appropriate to preserve some of the low-phosphorus export land cover types that still exist in abundance. Failure to preserve some of these low phosphorus export land cover types such as forested lands could mean failure to meet water quality goals in the SCRB.

CITATIONS

Bureau of Land Management, National Park Service, US Fish & Wildlife Service, and US Forest Service (2012). National Wild and Scenic Rivers System, St. Croix River, Minnesota, Wisconsin. Retrieved 3/5, 2012, from http://www.rivers.gov/rivers/rivers/st-croix.php

Finley, R.W. (1976). Original vegetation cover of Wisconsin (map). Digitized and published by UW-Madison in 1990 as the Original Vegetation Cover dataset. Available at ftp://dnrftp01.wi.gov/geodata/

Magdalene, S. (2009). Lake St. Croix Total Phosphorus Loading Study. St. Croix River Basin Water Resources Planning Team Implementation Committee, May 7, 2009

Marschner, F.J. (1974). The original vegetation of Minnesota (map). Digitized and published by the Minnesota Department of Natural Resources in 1994 as the Presettlement Vegetation dataset. Available at http://deli.dnr.state.mn.us/

Minnesota Pollution Control Agency. (2004). Legislative Report: Detailed Assessment of Phosphorus Sources to Minnesota Watersheds. Retrieved 12/7, 2012, from http://www.pca.state.mn.us/index.php/about-mpca/legislative-resources/legislative-reports/detailed-assessment-of-phosphorus-sources-to-minnesota-watersheds-2004-legislative-report.html

Minnesota Pollution Control Agency, & Wisconsin Department of Natural Resources. (2012). Lake St. Croix Nutrient Total Maximum Daily Load. Retrieved 9/17, 2012, from http://www.pca.state.mn.us/index.php/view-document.html?gid=18417

Multi-Resolution Land Characteristics Consortium. (2012). National Land Cover Database 2006. Retrieved 1/7, 2013 from http://www.mrlc.gov/nlcd2006.php

Roberts, A. D., & Prince, S. D. (2010). Effects of urban and non-urban land cover on nitrogen and phosphorus runoff to Chesapeake Bay. Ecological Indicators, 10(2), 459-474. doi: 10.1016/j.ecolind.2009.07.017

Triplett, LD, Engstrom, DR and Edlund, MB (2009). A whole-basin stratigraphic record of sediment and phosphorus loading to the St. Croix River, USA. Journal of Paleolimnology DOI:10.1007/s10933-008-9290-7 (e-published 10 Jan 2009)

(Citations for GIS data are included in Appendix E – GIS Methodology Data Dictionary)

APPENDIX A – Summary tables of basin-wide analyses

Table A1. St. Croix Basin land cover areas (in hectares) and changes over time between mid-late 1800s, 1992, 2001, 2006. Land cover type losses are noted in red font.

	mid-late 1800s				1992 (compared to mid-late 1800s)		
Land Cover	**Hectares**	**Hectares Change**	**Percent Change**		**Hectares**	**Hectares Change**	**Percent Change**
Agriculture	0	-	-		335,728	335,728	-
Barren	0	-	-		8,616	8,616	-
Developed	0	-	-		14,272	14,272	-
Lowland Vegetation	374,346	-	-		371,825	-2,522	-0.7
Open Water	87,373	-	-		75,526	-11,847	-13.6
Upland Forest	1,322,725	-	-		859,438	-463,287	-35.0
Upland Grass	180,343	-	-		292,390	112,047	62.1
Upland Shrub	30,531	-	-		39,667	9,136	29.9
Totals	**1,995,319**	-	-		**1,997,463**	-	-
	2001 (compared to 1992)				**2006 (compared to 2001)**		
Land Cover	**Hectares**	**Hectares Change**	**Percent Change**		**Hectares**	**Hectares Change**	**Percent Change**
Agriculture	192,777	-142,951	-42.6		192,757	-21	0.0
Barren	153	-8,464	-98.2		271	118	77.3
Developed	101,443	87,170	610.8		103,486	2,043	2.0
Lowland Vegetation	351,185	-20,640	-5.6		356,906	5,721	1.6
Open Water	80,426	4,899	6.5		79,564	-861	-1.1
Upland Forest	885,983	26,545	3.1		875,280	-10,702	-1.2
Upland Grass	331,606	39,216	13.4		334,106	2,500	0.8
Upland Shrub	54,370	14,703	37.1		55,572	1,202	2.2
Totals	**1,997,942**	-	-		**1,997,942**	-	-

Table A2. St. Croix Basin land cover areas (in acres) and changes over time between mid-late 1800s, 1992, 2001, 2006. Land cover type losses are noted in red font.

	mid-late 1800s				1992 (compared to mid-late 1800s)		
Land Cover	**Acres**	**Acres Change**	**Percent Change**		**Acres**	**Acres Change**	**Percent Change**
Agriculture	0	-	-		829,602	829,602	-
Barren	0	-	-		21,291	21,291	-
Developed	0	-	-		35,268	35,268	-
Lowland Vegetation	925,030	-	-		918,799	-6,231	-0.7
Open Water	215,903	-	-		186,630	-29,274	-13.6
Upland Forest	3,268,525	-	-		2,123,717	-1,144,808	-35.0
Upland Grass	445,638	-	-		722,512	276,875	62.1
Upland Shrub	75,444	-	-		98,020	22,575	29.9
Totals	**4,930,541**	-	-		**4,935,839**	-	-
	2001 (compared to 1992)				**2006 (compared to 2001)**		
Land Cover	**Acres**	**Acres Change**	**Percent Change**		**Acres**	**Acres Change**	**Percent Change**
Agriculture	476,363	-353,239	-42.6		476,312	-51	0.0
Barren	377	-20,914	-98.2		669	291	77.3
Developed	250,670	215,402	610.8		255,719	5,049	2.0
Lowland Vegetation	867,797	-51,002	-5.6		881,935	14,138	1.6
Open Water	198,736	12,107	6.5		196,608	-2,128	-1.1
Upland Forest	2,189,311	65,594	3.1		2,162,865	-26,446	-1.2
Upland Grass	819,417	96,904	13.4		825,594	6,178	0.8
Upland Shrub	134,351	36,331	37.1		137,320	2,970	2.2
Totals	**4,937,022**	-	-		**4,937,022**	-	-

Table A3. St. Croix Basin land cover (in hectares and acres), reclassified and NLCD cover type classifications (2006).

Reclassification	NLCD Classification	Area in Hectares	Area in Acres
Agriculture	Cultivated Crops	192,757	476,312
Barren	Barren Land (Rock/Sand/Clay)	271	669
Developed	Developed, High Intensity	1,874	4,631
	Developed, Low Intensity	21,665	53,536
	Developed, Medium Intensity	5,788	14,303
	Developed, Open Space	74,158	183,249
Lowland Vegetation	Emergent Herbaceous Wetlands	127,013	313,855
	Woody Wetlands	229,894	568,080
Open Water	Open Water	79,564	196,608
Upland Forest	Deciduous Forest	733,132	1,811,609
	Evergreen Forest	65,898	162,837
	Mixed Forest	76,250	188,419
Upland Grass	Grassland/Herbaceous	38,517	95,178
	Pasture/Hay	295,589	730,416
Upland Shrub	Shrub/Scrub	55,572	137,320
Totals		**1,997,942**	**4,937,022**

APPENDIX B – Summary tables of tributary analyses

Table B1. Tributary areas (in hectares, acres, and percent total) of the St. Croix River Basin.

Tributary	Area, Hectares (ha)	Area, Acres (ac)	% of Basin
Namekagon River	256,730	634,394	12.8
Upper St Croix River	110,059	271,962	5.5
Chases Brook	9,424	23,288	0.5
Upper Tamarack River	25,664	63,417	1.3
Yellow River	94,836	234,344	4.7
Lower Tamarack River	50,483	124,747	2.5
Crooked Creek	25,964	64,158	1.3
Clam River	96,688	238,921	4.8
Sand Creek	36,365	89,860	1.8
Bear Creek	17,360	42,898	0.9
Kettle River	272,324	672,927	13.6
Redhorse Creek	3,385	8,363	0.2
Snake River	260,433	643,545	13.0
Wood River	46,361	114,560	2.3
Rock Creek	14,626	36,141	0.7
Rush Creek	14,777	36,514	0.7
Goose Creek	18,134	44,809	0.9
Sunrise River	99,164	245,041	5.0
Trade River	39,134	96,703	2.0
Wolf Creek	8,687	21,465	0.4
Dry Creek	4,478	11,066	0.2
Lawrence Creek	3,437	8,494	0.2
Apple River	144,640	357,414	7.2
Browns Creek	7,390	18,260	0.4
Willow River	74,145	183,216	3.7
Valley Branch	17,955	44,367	0.9
Kinnickinnic River	40,476	100,019	2.0
Adjacent Small Streams	147,243	363,845	7.4
Non-Contributing Areas	57,581	142,286	2.9
Totals	**1,997,942**	**4,937,022**	**100.0**

Table B2. Percent of tributary area in land cover type (mid-late 1800s).

mid-late 1800s	Percent of tributary area in land cover type								
Tributary	Agri-culture	Barren	Devel-oped	Lowland Veget-ation	Open Water	Un-classified	Upland Forest	Upland Grass	Upland Shrub
Namekagon River	0.0	0.0	0.0	9.5	6.1	0.0	83.5	0.0	0.9
Upper St Croix River	0.0	0.0	0.0	13.2	4.4	0.0	80.9	0.0	1.6
Chases Brook	0.0	0.0	0.0	14.5	0.7	0.0	84.8	0.0	0.0
Upper Tamarack River	0.0	0.0	0.0	37.5	1.0	1.2	60.3	0.0	0.0
Yellow River	0.0	0.0	0.0	4.1	10.2	0.0	85.7	0.0	0.0
Lower Tamarack River	0.0	0.0	0.0	56.7	0.7	0.3	42.4	0.0	0.0
Crooked Creek	0.0	0.0	0.0	29.3	1.6	0.0	69.0	0.0	0.0
Clam River	0.0	0.0	0.0	6.9	4.1	0.0	89.0	0.0	0.0
Sand Creek	0.0	0.0	0.0	40.5	0.8	0.0	57.6	1.1	0.0
Bear Creek	0.0	0.0	0.0	31.5	0.2	0.0	68.3	0.0	0.0
Kettle River	0.0	0.0	0.0	35.8	2.8	0.0	58.6	2.8	0.0
Redhorse Creek	0.0	0.0	0.0	60.1	0.7	0.0	39.2	0.0	0.0
Snake River	0.0	0.0	0.0	32.6	1.7	0.0	64.0	1.7	0.0
Wood River	0.0	0.0	0.0	17.0	5.1	0.0	77.9	0.0	0.0
Rock Creek	0.0	0.0	0.0	31.1	0.3	0.0	68.6	0.0	0.0
Rush Creek	0.0	0.0	0.0	17.4	12.0	0.0	65.8	4.8	0.0
Goose Creek	0.0	0.0	0.0	26.7	4.2	0.0	36.6	32.6	0.0
Sunrise River	0.0	0.0	0.0	22.7	9.3	0.0	34.9	33.1	0.0
Trade River	0.0	0.0	0.0	12.5	3.0	0.0	84.5	0.0	0.0
Wolf Creek	0.0	0.0	0.0	8.9	3.5	0.0	87.6	0.0	0.0
Dry Creek	0.0	0.0	0.0	8.2	0.2	0.0	87.2	4.4	0.0
Lawrence Creek	0.0	0.0	0.0	15.0	0.1	0.0	84.8	0.0	0.0
Apple River	0.0	0.0	0.0	3.6	7.0	0.0	80.7	4.5	4.1
Browns Creek	0.0	0.0	0.0	2.8	3.7	0.0	3.1	90.5	0.0
Willow River	0.0	0.0	0.0	0.7	1.7	0.0	50.3	35.1	12.2
Valley Branch	0.0	0.0	0.0	0.4	3.0	0.0	16.7	79.9	0.0
Kinnickinnic River	0.0	0.0	0.0	0.0	0.3	0.0	13.7	81.3	4.8
Adjacent Small Streams	0.0	0.0	0.0	11.8	6.2	1.4	52.9	23.7	3.8
Non-Contributing Areas	0.0	0.0	0.0	1.3	4.5	0.0	75.6	11.8	6.9

Table B3. Percent of tributary area in land cover type (1992).

1992	Percent of tributary area in land cover type								
Tributary	Agri-culture	Barren	Devel-oped	Lowland Veget-ation	Open Water	Un-classified	Upland Forest	Upland Grass	Upland Shrub
Namekagon River	1.3	0.3	0.2	17.0	5.4	0.0	65.2	7.2	3.5
Upper St Croix River	0.0	0.2	0.0	16.4	3.8	0.0	63.6	5.2	10.6
Chases Brook	0.0	0.6	0.0	28.9	0.6	0.0	63.5	6.5	0.0
Upper Tamarack River	0.3	0.2	0.0	38.9	0.9	0.1	55.7	3.9	0.0
Yellow River	4.8	0.4	0.4	13.6	9.0	0.0	53.8	15.2	2.6
Lower Tamarack River	1.4	0.1	0.0	33.7	0.7	0.0	60.7	2.9	0.5
Crooked Creek	7.9	0.3	0.0	27.8	1.1	0.0	54.8	7.6	0.4
Clam River	6.3	0.2	0.1	15.0	3.4	0.0	52.1	21.1	1.6
Sand Creek	10.4	0.2	0.0	28.0	0.4	0.0	50.9	9.3	0.8
Bear Creek	15.3	0.3	0.1	24.2	0.2	0.0	46.2	13.3	0.4
Kettle River	11.3	0.6	0.2	29.8	2.3	0.0	43.3	12.1	0.4
Redhorse Creek	0.4	0.1	0.0	48.2	0.7	0.0	45.3	3.8	1.6
Snake River	21.8	0.7	0.2	25.4	1.6	0.0	37.4	12.8	0.1
Wood River	7.8	0.5	0.4	25.0	3.7	0.0	35.7	23.7	3.3
Rock Creek	64.5	1.5	0.2	8.5	0.3	0.0	8.3	16.6	0.1
Rush Creek	43.1	1.2	0.7	14.8	9.1	0.0	13.3	17.8	0.0
Goose Creek	37.2	0.8	1.1	19.7	3.7	0.0	17.0	20.1	0.3
Sunrise River	39.4	0.6	2.8	17.9	7.7	0.0	17.9	13.3	0.4
Trade River	9.5	0.2	0.6	20.3	2.6	0.0	39.9	22.7	4.4
Wolf Creek	18.7	0.2	0.0	12.8	2.9	0.0	24.5	39.9	0.9
Dry Creek	54.0	0.7	0.1	6.5	0.2	0.0	20.4	18.1	0.1
Lawrence Creek	60.9	1.3	1.0	10.5	0.1	0.0	13.4	12.8	0.0
Apple River	23.6	0.4	0.4	10.0	6.2	0.0	33.0	26.4	0.1
Browns Creek	41.0	0.0	6.6	6.5	3.7	0.0	8.4	30.1	3.7
Willow River	46.5	0.3	1.1	4.1	1.5	0.0	15.2	31.2	0.0
Valley Branch	51.9	0.0	16.0	3.6	3.0	0.0	8.1	13.8	3.6
Kinnickinnic River	58.9	0.6	1.5	1.0	0.2	0.0	15.0	22.7	0.0
Adjacent Small Streams	22.1	0.4	2.1	10.1	5.7	0.3	38.2	16.7	4.4
Non-Contributing Areas	21.5	0.2	0.2	3.9	3.8	0.0	50.9	17.0	2.6

Table B4. Percent of tributary area in land cover type (2001).

2001	Percent of tributary area in land cover type								
Tributary	**Agri-culture**	**Barren**	**Devel-oped**	**Lowland Veget-ation**	**Open Water**	**Un-classified**	**Upland Forest**	**Upland Grass**	**Upland Shrub**
Namekagon River	1.0	0.0	4.9	13.1	5.8	0.0	69.0	4.1	2.1
Upper St Croix River	0.1	0.0	4.8	11.7	3.9	0.0	64.5	1.9	13.1
Chases Brook	0.4	0.0	2.4	11.8	0.2	0.0	78.3	2.9	4.0
Upper Tamarack River	0.4	0.0	1.7	26.7	0.6	0.0	64.1	1.4	5.1
Yellow River	3.9	0.0	6.4	7.2	10.2	0.0	59.4	11.9	1.0
Lower Tamarack River	0.2	0.0	1.4	40.6	1.2	0.0	53.0	1.1	2.5
Crooked Creek	2.7	0.0	1.8	27.6	1.9	0.0	55.9	8.3	1.7
Clam River	4.6	0.0	4.9	6.4	4.3	0.0	60.8	18.7	0.3
Sand Creek	3.7	0.0	2.7	32.5	0.9	0.0	47.5	10.4	2.3
Bear Creek	3.8	0.0	3.0	30.0	0.4	0.0	41.3	19.2	2.3
Kettle River	2.2	0.0	4.0	38.4	2.7	0.0	35.0	13.6	4.2
Redhorse Creek	0.4	0.0	0.4	48.5	1.6	0.0	47.2	0.3	1.6
Snake River	8.4	0.0	3.9	26.7	1.8	0.0	35.8	21.6	1.7
Wood River	11.3	0.0	4.9	15.5	4.0	0.0	41.9	21.0	1.5
Rock Creek	38.6	0.0	6.5	9.3	0.3	0.0	4.8	37.4	3.0
Rush Creek	24.0	0.0	6.7	18.8	9.3	0.0	9.8	27.9	3.4
Goose Creek	22.8	0.0	6.3	18.0	3.5	0.0	19.9	28.4	1.1
Sunrise River	25.2	0.0	7.5	15.7	7.0	0.0	22.6	21.7	0.3
Trade River	11.1	0.0	4.6	17.1	3.1	0.0	42.7	20.0	1.4
Wolf Creek	17.5	0.0	4.4	6.4	3.3	0.0	28.8	39.4	0.2
Dry Creek	37.3	0.0	4.4	4.0	0.1	0.0	21.9	32.1	0.1
Lawrence Creek	38.0	0.0	5.6	6.3	0.3	0.0	14.4	35.2	0.3
Apple River	14.7	0.0	5.3	6.0	5.7	0.0	38.3	29.9	0.2
Browns Creek	11.8	0.0	14.6	4.8	6.0	0.0	19.2	41.3	2.3
Willow River	31.1	0.0	6.9	2.3	1.2	0.0	21.0	37.4	0.2
Valley Branch	18.8	0.0	20.9	2.2	3.9	0.0	21.2	30.7	2.3
Kinnickinnic River	56.0	0.0	7.7	1.2	0.1	0.0	16.2	18.5	0.3
Adjacent Small Streams	12.8	0.0	6.6	8.5	6.0	0.0	42.7	19.2	4.2
Non-Contributing Areas	14.6	0.0	4.9	2.7	3.7	0.0	50.7	18.7	4.7

Table B5. Percent of tributary area in land cover type (2006).

2006	Percent of tributary area in land cover type								
Tributary	**Agri-culture**	**Barren**	**Devel-oped**	**Lowland Veget-ation**	**Open Water**	**Un-classified**	**Upland Forest**	**Upland Grass**	**Upland Shrub**
Namekagon River	1.1	0.0	4.9	13.1	5.8	0.0	67.9	4.8	2.3
Upper St Croix River	0.3	0.0	4.8	12.3	3.9	0.0	62.6	3.3	12.9
Chases Brook	0.5	0.0	2.4	12.8	0.4	0.0	77.1	2.9	3.8
Upper Tamarack River	0.4	0.0	1.7	27.5	0.6	0.0	63.2	1.5	5.0
Yellow River	3.9	0.0	6.5	7.4	10.2	0.0	58.9	11.9	1.2
Lower Tamarack River	0.2	0.0	1.4	41.1	1.2	0.0	52.4	1.2	2.5
Crooked Creek	2.8	0.0	1.8	29.2	1.7	0.0	54.2	8.5	1.9
Clam River	4.6	0.0	4.9	6.9	4.3	0.0	60.2	18.7	0.5
Sand Creek	3.8	0.0	2.7	33.5	0.8	0.0	46.5	10.4	2.4
Bear Creek	3.9	0.0	3.0	30.2	0.4	0.0	41.0	19.2	2.3
Kettle River	2.2	0.0	4.0	38.9	2.6	0.0	34.5	13.6	4.2
Redhorse Creek	0.4	0.0	0.4	49.6	1.3	0.0	46.4	0.3	1.5
Snake River	8.5	0.0	4.0	27.0	1.7	0.0	35.5	21.6	1.7
Wood River	11.3	0.0	4.9	15.8	3.9	0.0	41.5	20.9	1.6
Rock Creek	38.6	0.0	6.5	9.3	0.3	0.0	4.9	37.3	3.0
Rush Creek	24.0	0.0	7.0	18.8	9.4	0.0	9.8	27.8	3.3
Goose Creek	22.8	0.0	6.3	18.0	3.5	0.0	19.9	28.3	1.2
Sunrise River	25.1	0.0	7.7	15.7	7.0	0.0	22.5	21.5	0.4
Trade River	11.0	0.0	4.6	17.2	2.7	0.0	42.8	20.0	1.6
Wolf Creek	17.5	0.0	4.4	6.4	3.3	0.0	28.8	39.4	0.2
Dry Creek	37.2	0.0	4.4	4.0	0.1	0.0	21.9	32.0	0.3
Lawrence Creek	37.8	0.0	6.0	6.3	0.4	0.0	14.4	35.0	0.3
Apple River	14.7	0.0	5.4	6.1	5.7	0.0	38.2	29.7	0.2
Browns Creek	11.1	0.0	16.9	4.7	5.7	0.0	19.2	40.0	2.4
Willow River	31.0	0.0	7.2	2.3	1.2	0.0	20.9	37.1	0.2
Valley Branch	18.2	0.0	21.9	2.2	3.9	0.0	21.3	30.1	2.3
Kinnickinnic River	55.5	0.0	8.1	1.2	0.1	0.0	16.3	18.3	0.3
Adjacent Small Streams	12.8	0.0	6.9	8.8	5.9	0.0	42.3	19.0	4.3
Non-Contributing Areas	14.6	0.0	5.0	2.7	3.7	0.0	50.0	19.4	4.7

APPENDIX C – Summary tables of riparian analyses

Table C1. Land cover change (in hectares and acres) within contributing riparian areas (within 30 to 85 meters) in contributing HUC 12 units in the St. Croix River Basin, NLCD classifications (2001 to 2006).

	NLCD 2001				
NLCD Cover Type	**Area (Hectares)**	**Area (Acres)**	**Percent of Total Riparian Area**	**Area Change (Hectares)**	**Area Change (Acres)**
Open Water	183.3	453.0	0.1	-	-
Developed, Open Space	4838.6	11956.4	3.5	-	-
Developed, Low Intensity	1165.6	2880.2	0.9	-	-
Developed, Medium Intensity	270.1	667.4	0.2	-	-
Developed, High Intensity	70.5	174.1	0.1	-	-
Barren Land (Rock/Sand/Clay)	3.1	7.6	0.0	-	-
Deciduous Forest	46280.5	114361.7	33.8	-	-
Evergreen Forest	2719.3	6719.4	2.0	-	-
Mixed Forest	4770.8	11788.9	3.5	-	-
Shrub/Scrub	2394.7	5917.5	1.7	-	-
Grassland/Herbaceous	2595.8	6414.3	1.9	-	-
Pasture/Hay	14675.9	36264.8	10.7	-	-
Cultivated Crops	10536.8	26036.9	7.7	-	-
Woody Wetlands	27269.2	67383.6	19.9	-	-
Emergent Herbaceous Wetlands	19277.1	47634.8	14.1	-	-
Total Riparian Area	**137051.1**	**338660.6**			
	NLCD 2006				
NLCD Cover Type	**Area (Hectares)**	**Area (Acres)**	**Percent of Total Riparian Area**	**Area Change (Hectares)**	**Area Change (Acres)**
Open Water	176.3	435.7	0.1	-7.0	-17.3
Developed, Open Space	4874.0	12044.0	3.6	35.5	87.6
Developed, Low Intensity	1188.3	2936.3	0.9	22.7	56.0
Developed, Medium Intensity	284.1	702.1	0.2	14.0	34.7
Developed, High Intensity	72.5	179.0	0.1	2.0	4.9
Barren Land (Rock/Sand/Clay)	3.1	7.6	0.0	0.0	0.0
Deciduous Forest	46139.5	114013.2	33.7	-141.0	-348.5
Evergreen Forest	2709.5	6695.2	2.0	-9.8	-24.2
Mixed Forest	4750.6	11738.9	3.5	-20.3	-50.0
Shrub/Scrub	2403.5	5939.3	1.8	8.8	21.8
Grassland/Herbaceous	2658.5	6569.3	1.9	62.7	155.0
Pasture/Hay	14672.5	36256.6	10.7	-3.3	-8.2
Cultivated Crops	10560.7	26096.0	7.7	23.9	59.2
Woody Wetlands	27067.1	66884.4	19.7	-202.0	-499.3
Emergent Herbaceous Wetlands	19490.9	48163.2	14.2	213.8	528.4
Total Riparian Area	**137051.1**	**338660.6**			

Table C2. Land cover (in hectares) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001).

	NLCD 2001 Area (Hectares)							
Tributary	**Open Water**	**Developed, Open Space**	**Developed, Low Intensity**	**Developed, Medium Intensity**	**Developed, High Intensity**	**Barren**	**Deciduous Forest**	**Evergreen Forest**
Namekagon River	35.9	673.2	134.2	20.3	3.4	0.0	6676.8	757.9
Upper St Croix River	3.7	157.4	95.5	9.2	0.2	0.0	3475.4	348.2
Chases Brook	0.5	18.5	3.2	0.0	0.0	0.0	645.1	13.7
Upper Tamarack River	3.5	23.2	5.0	0.0	0.0	0.0	840.2	4.7
Yellow River	7.8	198.1	25.3	4.3	0.1	0.0	2106.3	87.8
Lower Tamarack River	9.3	41.9	4.4	0.0	0.0	0.0	1207.7	23.1
Crooked Creek	4.1	36.3	2.8	0.8	0.0	0.0	620.5	6.8
Clam River	12.3	331.0	9.7	1.2	0.0	0.0	4686.9	100.8
Sand Creek	6.6	57.1	5.7	0.0	0.0	0.0	616.7	7.7
Bear Creek	0.6	22.1	1.1	0.0	0.0	0.0	220.1	1.9
Kettle River	38.3	680.0	127.2	15.3	5.6	0.0	3761.5	346.7
Redhorse Creek	1.0	0.5	0.0	0.0	0.0	0.0	45.3	0.0
Snake River	13.2	577.3	133.3	9.3	2.5	0.0	5191.9	101.4
Wood River	3.0	179.0	11.7	3.6	0.5	0.0	954.5	157.8
Rock Creek	0.5	56.7	13.8	3.5	0.7	0.0	196.3	10.6
Rush Creek	0.4	94.1	19.7	5.4	0.4	0.0	115.7	24.7
Goose Creek	1.2	78.1	10.0	2.5	0.0	0.0	356.2	11.6
Sunrise River	4.9	279.1	144.0	46.0	9.7	0.0	1801.2	84.9
Trade River	2.5	138.7	13.9	1.4	0.2	1.0	1138.2	30.9
Wolf Creek	0.2	14.9	0.1	0.1	0.0	0.0	202.5	3.6
Dry Creek	0.0	9.5	0.7	0.0	0.0	0.0	88.5	2.7
Lawrence Creek	0.4	13.4	1.8	1.4	0.0	0.0	72.5	13.6
Apple River	7.3	316.9	49.8	10.2	2.3	0.1	3486.2	167.1
Browns Creek	0.1	12.2	14.7	3.6	0.0	0.0	53.7	3.0
Willow River	2.5	279.2	51.6	9.1	1.3	0.0	2265.8	91.4
Valley Branch	1.2	99.8	92.3	49.9	24.9	0.0	385.4	25.5
Kinnickinnic River	0.9	192.8	77.1	14.0	2.1	0.2	853.2	49.4
Adjacent Small Streams	21.7	257.6	117.3	59.2	16.7	1.8	4216.3	241.8
SCRB Contributing	**183.3**	**4838.6**	**1165.6**	**270.1**	**70.5**	**3.1**	**46280.5**	**2719.3**

Table C2. Land cover (in hectares) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001) (cont).

	NLCD 2001 Area (Hectares)						
Tributary	**Mixed Forest**	**Shrub/ Scrub**	**Grassland/ Herba-ceaous**	**Pasture/ Hay**	**Cultivated Crops**	**Woody Wetlands**	**Emergent Herba-ceous Wetlands**
Namekagon River	2343.5	222.5	59.6	217.9	66.5	4739.7	246.2
Upper St Croix River	832.8	422.9	33.9	45.5	9.5	1637.2	17.9
Chases Brook	7.5	57.2	6.0	14.8	4.1	95.5	2.9
Upper Tamarack River	16.5	118.9	12.3	14.8	3.4	709.9	41.0
Yellow River	525.9	21.2	20.3	267.3	65.9	659.9	297.4
Lower Tamarack River	10.1	65.4	9.6	36.5	4.9	1435.2	656.6
Crooked Creek	1.8	12.8	3.0	53.9	16.9	708.7	404.0
Clam River	422.3	8.8	63.5	1060.1	320.3	926.2	542.8
Sand Creek	6.7	31.6	3.0	144.1	56.4	1164.1	629.0
Bear Creek	3.3	18.0	3.3	131.1	37.7	441.6	330.0
Kettle River	157.7	536.7	69.6	1808.3	379.3	8109.9	4931.3
Redhorse Creek	0.0	1.1	0.0	0.0	0.0	68.0	22.1
Snake River	69.9	230.7	523.8	2648.0	1083.8	3380.3	4534.5
Wood River	105.8	27.8	190.9	469.4	452.3	152.0	746.3
Rock Creek	11.5	126.5	16.7	374.0	402.5	71.8	149.0
Rush Creek	23.8	72.7	8.3	294.3	322.7	197.7	255.7
Goose Creek	5.0	8.3	109.1	333.0	348.3	90.5	318.6
Sunrise River	11.6	27.5	526.2	1122.7	1390.2	218.9	1822.1
Trade River	27.7	11.0	99.3	507.0	340.9	116.3	623.9
Wolf Creek	1.1	2.3	50.0	146.8	46.6	25.7	79.1
Dry Creek	2.5	0.0	18.0	82.2	121.1	3.3	21.9
Lawrence Creek	3.5	0.3	12.9	102.8	95.1	3.1	24.6
Apple River	99.7	13.4	246.5	1069.1	540.9	614.0	1095.7
Browns Creek	0.0	12.6	26.0	101.9	17.1	1.5	44.2
Willow River	5.8	14.2	163.2	2236.1	1579.3	119.8	337.1
Valley Branch	1.5	53.6	45.0	191.4	77.0	12.7	31.1
Kinnickinnic River	3.1	17.8	28.6	565.7	2242.6	277.8	42.4
Adjacent Small Streams	70.5	259.1	247.2	637.3	511.6	1288.0	1029.9
SCRB Contributing	**4770.8**	**2394.7**	**2595.8**	**14675.9**	**10536.8**	**27269.2**	**19277.1**

Table C3. Land cover (in hectares) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2006).

	NLCD 2006 Area (Hectares)							
Tributary	**Open Water**	**Developed, Open Space**	**Developed, Low Intensity**	**Developed, Medium Intensity**	**Developed, High Intensity**	**Barren**	**Deciduous Forest**	**Evergreen Forest**
Namekagon River	36.3	672.8	134.2	20.7	3.4	0.0	6649.7	753.8
Upper St Croix River	4.1	157.4	95.5	9.2	0.2	0.0	3464.1	347.5
Chases Brook	0.5	18.5	3.2	0.0	0.0	0.0	644.4	13.7
Upper Tamarack River	3.6	23.2	5.0	0.0	0.0	0.0	838.4	4.7
Yellow River	7.8	197.9	25.7	5.0	0.1	0.0	2104.4	87.8
Lower Tamarack River	8.3	41.9	4.4	0.0	0.0	0.0	1206.2	23.1
Crooked Creek	3.5	36.3	2.8	0.8	0.0	0.0	614.7	7.2
Clam River	12.1	331.0	9.7	1.2	0.0	0.0	4674.1	100.3
Sand Creek	6.3	57.1	5.7	0.0	0.0	0.0	609.6	7.7
Bear Creek	0.6	22.1	1.1	0.0	0.0	0.0	219.1	1.9
Kettle River	34.8	680.0	127.2	15.3	5.6	0.0	3743.1	344.7
Redhorse Creek	0.8	0.5	0.0	0.0	0.0	0.0	42.7	0.0
Snake River	12.2	577.3	133.7	9.6	2.5	0.0	5176.5	100.2
Wood River	2.2	179.0	11.7	3.6	0.5	0.0	953.7	157.9
Rock Creek	0.5	56.7	14.0	4.5	0.7	0.0	196.3	10.6
Rush Creek	0.5	98.1	22.9	6.2	0.4	0.0	114.9	24.7
Goose Creek	1.2	78.1	10.0	2.5	0.0	0.0	355.1	11.6
Sunrise River	5.2	281.3	147.4	47.0	9.7	0.0	1794.8	84.6
Trade River	2.0	138.7	13.9	1.4	0.2	1.0	1138.4	30.9
Wolf Creek	0.4	14.9	0.1	0.1	0.0	0.0	202.5	3.6
Dry Creek	0.0	9.5	0.7	0.0	0.0	0.0	88.5	2.7
Lawrence Creek	0.4	13.4	1.8	1.4	0.0	0.0	72.5	13.6
Apple River	6.7	317.8	50.1	11.4	2.3	0.1	3477.4	167.1
Browns Creek	0.1	14.4	15.6	6.5	0.9	0.0	53.5	3.0
Willow River	3.1	287.1	60.8	11.3	1.3	0.0	2260.0	90.8
Valley Branch	1.2	102.1	93.9	50.6	26.0	0.0	385.1	25.5
Kinnickinnic River	0.9	194.8	79.5	16.4	2.1	0.2	853.4	49.2
Adjacent Small Streams	21.4	272.2	118.1	59.6	16.7	1.8	4206.5	241.2
SCRB Contributing	**176.3**	**4874.0**	**1188.3**	**284.1**	**72.5**	**3.1**	**46139.5**	**2709.5**

Table C3. Land cover (in hectares) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2006) (cont).

	NLCD 2006 Area (Hectares)						
Tributary	**Mixed Forest**	**Shrub/ Scrub**	**Grassland/ Herba-ceaous**	**Pasture/ Hay**	**Cultivated Crops**	**Woody Wetlands**	**Emergent Herba-ceous Wetlands**
Namekagon River	2332.7	226.6	143.5	216.9	67.4	4691.3	248.3
Upper St Croix River	825.8	418.9	33.9	45.5	16.8	1631.0	39.4
Chases Brook	7.5	57.0	5.9	14.9	4.1	95.5	4.0
Upper Tamarack River	16.5	116.8	12.3	15.0	3.4	707.0	47.4
Yellow River	525.7	21.2	25.3	266.6	65.9	655.6	298.5
Lower Tamarack River	10.1	65.3	9.6	36.5	4.9	1426.2	668.3
Crooked Creek	1.8	12.8	2.9	56.3	19.4	688.0	426.0
Clam River	421.5	9.0	64.2	1064.2	321.3	922.1	555.5
Sand Creek	5.9	32.9	3.0	144.1	57.0	1148.3	651.0
Bear Creek	3.0	18.0	3.3	131.1	37.7	440.6	332.4
Kettle River	156.0	532.4	68.7	1810.6	400.6	8047.7	5000.5
Redhorse Creek	0.0	1.1	0.0	0.0	0.0	65.3	27.6
Snake River	69.5	231.5	522.7	2654.8	1086.0	3354.1	4569.2
Wood River	105.8	29.3	189.5	470.1	455.8	152.0	743.7
Rock Creek	11.5	126.6	16.6	374.0	401.3	71.8	149.0
Rush Creek	23.8	72.4	6.9	290.7	321.6	197.1	255.5
Goose Creek	5.0	13.7	104.5	333.0	348.6	90.5	318.6
Sunrise River	11.3	30.2	518.1	1120.5	1399.9	210.1	1828.9
Trade River	27.6	11.1	99.3	507.0	340.9	116.3	624.2
Wolf Creek	1.1	2.3	49.8	146.8	46.6	25.7	79.1
Dry Creek	2.5	0.0	18.0	82.2	121.1	3.3	21.9
Lawrence Creek	3.5	0.3	12.9	102.8	95.1	3.1	24.6
Apple River	99.7	13.4	246.5	1072.4	539.1	623.3	1091.7
Browns Creek	0.0	12.5	24.7	101.1	12.7	1.5	44.2
Willow River	8.6	14.2	160.1	2231.6	1570.9	121.1	335.6
Valley Branch	1.5	53.6	44.4	189.2	74.6	12.7	30.9
Kinnickinnic River	3.4	17.6	28.6	565.5	2236.0	277.8	42.4
Adjacent Small Streams	69.5	263.1	243.5	629.5	512.2	1288.0	1032.8
SCRB Contributing	**4750.6**	**2403.5**	**2658.5**	**14672.5**	**10560.7**	**27067.1**	**19490.9**

Table C4. Land cover change (in hectares) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001 to 2006).

	NLCD Change Area (Hectares)							
Tributary	**Open Water**	**Developed, Open Space**	**Developed, Low Intensity**	**Developed, Medium Intensity**	**Developed, High Intensity**	**Barren**	**Deciduous Forest**	**Evergreen Forest**
Namekagon River	0.4	-0.5	0.0	0.5	0.0	0.0	-27.1	-4.1
Upper St Croix River	0.4	0.0	0.0	0.0	0.0	0.0	-11.3	-0.7
Chases Brook	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	0.0
Upper Tamarack River	0.1	0.0	0.0	0.0	0.0	0.0	-1.8	0.0
Yellow River	0.0	-0.2	0.5	0.6	0.0	0.0	-1.9	0.0
Lower Tamarack River	-1.0	0.0	0.0	0.0	0.0	0.0	-1.5	0.0
Crooked Creek	-0.6	0.0	0.0	0.0	0.0	0.0	-5.8	0.5
Clam River	-0.3	0.0	0.0	0.0	0.0	0.0	-12.9	-0.5
Sand Creek	-0.3	0.0	0.0	0.0	0.0	0.0	-7.1	0.0
Bear Creek	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	0.0
Kettle River	-3.4	0.0	0.0	0.0	0.0	0.0	-18.4	-2.0
Redhorse Creek	-0.2	0.0	0.0	0.0	0.0	0.0	-2.6	0.0
Snake River	-1.0	0.0	0.4	0.4	0.0	0.0	-15.4	-1.3
Wood River	-0.8	0.0	0.0	0.0	0.0	0.0	-0.8	0.1
Rock Creek	0.0	0.0	0.2	1.0	0.0	0.0	0.0	0.0
Rush Creek	0.1	4.0	3.2	0.8	0.0	0.0	-0.8	0.0
Goose Creek	0.0	0.0	0.0	0.0	0.0	0.0	-1.1	0.0
Sunrise River	0.4	2.3	3.4	1.0	0.0	0.0	-6.4	-0.3
Trade River	-0.5	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Wolf Creek	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lawrence Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apple River	-0.6	0.9	0.4	1.3	0.0	0.0	-8.7	0.0
Browns Creek	0.0	2.3	0.9	2.9	0.9	0.0	-0.3	0.0
Willow River	0.5	7.9	9.2	2.2	0.0	0.0	-5.8	-0.6
Valley Branch	0.0	2.3	1.5	0.7	1.1	0.0	-0.3	0.0
Kinnickinnic River	0.0	2.0	2.3	2.4	0.0	0.0	0.2	-0.2
Adjacent Small Streams	-0.3	14.6	0.8	0.4	0.0	0.0	-9.8	-0.6
SCRB Contributing	**-7.0**	**35.5**	**22.7**	**14.0**	**2.0**	**0.0**	**-141.0**	**-9.8**

Table C4. Land cover change (in hectares) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001 to 2006) (cont).

	NLCD Change Area (Hectares)						
Tributary	**Mixed Forest**	**Shrub/ Scrub**	**Grassland/ Herba-ceaous**	**Pasture/ Hay**	**Cultivated Crops**	**Woody Wetlands**	**Emergent Herba-ceous Wetlands**
Namekagon River	-10.8	4.1	83.9	-1.0	0.9	-48.3	2.1
Upper St Croix River	-6.9	-4.1	0.0	0.0	7.4	-6.2	21.5
Chases Brook	0.0	-0.3	-0.2	0.1	0.0	0.0	1.1
Upper Tamarack River	0.0	-2.1	0.0	0.3	0.0	-2.9	6.4
Yellow River	-0.2	0.0	5.0	-0.7	0.0	-4.3	1.2
Lower Tamarack River	0.0	-0.2	0.0	0.0	0.0	-9.0	11.7
Crooked Creek	0.0	0.0	-0.1	2.3	2.4	-20.7	22.0
Clam River	-0.8	0.2	0.6	4.1	1.0	-4.1	12.7
Sand Creek	-0.7	1.4	0.0	0.0	0.5	-15.8	22.0
Bear Creek	-0.4	0.0	0.0	0.0	0.0	-1.0	2.3
Kettle River	-1.7	-4.3	-0.9	2.3	21.3	-62.2	69.2
Redhorse Creek	0.0	0.0	0.0	0.0	0.0	-2.7	5.5
Snake River	-0.5	0.8	-1.1	6.8	2.3	-26.2	34.7
Wood River	0.0	1.4	-1.4	0.6	3.5	0.0	-2.6
Rock Creek	0.0	0.2	-0.2	0.0	-1.2	0.0	0.0
Rush Creek	0.0	-0.4	-1.4	-3.6	-1.1	-0.6	-0.2
Goose Creek	0.0	5.4	-4.6	0.0	0.3	0.0	0.0
Sunrise River	-0.4	2.7	-8.1	-2.2	9.6	-8.8	6.8
Trade River	-0.1	0.1	0.0	0.0	0.0	0.0	0.4
Wolf Creek	0.0	0.0	-0.2	0.0	0.0	0.0	0.0
Dry Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lawrence Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apple River	0.0	0.0	0.0	3.2	-1.8	9.4	-4.0
Browns Creek	0.0	-0.1	-1.4	-0.8	-4.4	0.0	0.0
Willow River	2.8	0.0	-3.1	-4.5	-8.5	1.4	-1.5
Valley Branch	0.0	0.1	-0.6	-2.3	-2.3	0.0	-0.2
Kinnickinnic River	0.4	-0.2	0.0	-0.3	-6.7	0.0	0.0
Adjacent Small Streams	-1.0	4.0	-3.7	-7.8	0.6	0.0	2.9
SCRB Contributing	**-20.3**	**8.8**	**62.7**	**-3.3**	**23.9**	**-202.1**	**213.8**

Table C5. Land cover (percent cover) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001).

	NLCD 2001 (percent of riparian area)							
Tributary	**Open Water**	**Developed, Open Space**	**Developed, Low Intensity**	**Developed, Medium Intensity**	**Developed, High Intensity**	**Barren**	**Deciduous Forest**	**Evergreen Forest**
Namekagon River	0.222	4.156	0.828	0.125	0.021	0.000	41.221	4.679
Upper St Croix River	0.052	2.220	1.347	0.129	0.003	0.000	49.024	4.912
Chases Brook	0.052	2.134	0.363	0.000	0.000	0.000	74.249	1.574
Upper Tamarack River	0.196	1.295	0.276	0.000	0.000	0.000	46.848	0.261
Yellow River	0.183	4.620	0.590	0.101	0.002	0.000	49.126	2.049
Lower Tamarack River	0.265	1.197	0.126	0.000	0.000	0.000	34.460	0.660
Crooked Creek	0.221	1.937	0.149	0.043	0.000	0.000	33.139	0.361
Clam River	0.145	3.901	0.115	0.014	0.000	0.000	55.231	1.188
Sand Creek	0.241	2.091	0.208	0.000	0.000	0.000	22.601	0.284
Bear Creek	0.052	1.821	0.089	0.000	0.000	0.000	18.173	0.156
Kettle River	0.182	3.243	0.607	0.073	0.027	0.000	17.940	1.653
Redhorse Creek	0.718	0.391	0.000	0.000	0.000	0.000	32.811	0.000
Snake River	0.072	3.120	0.720	0.050	0.014	0.000	28.065	0.548
Wood River	0.086	5.182	0.339	0.104	0.013	0.000	27.632	4.567
Rock Creek	0.031	3.954	0.960	0.245	0.050	0.000	13.688	0.741
Rush Creek	0.025	6.558	1.373	0.376	0.025	0.000	8.063	1.718
Goose Creek	0.070	4.671	0.597	0.151	0.000	0.000	21.300	0.694
Sunrise River	0.065	3.727	1.923	0.614	0.130	0.000	24.051	1.133
Trade River	0.083	4.543	0.454	0.044	0.006	0.032	37.286	1.011
Wolf Creek	0.031	2.608	0.016	0.016	0.000	0.000	35.350	0.628
Dry Creek	0.000	2.697	0.205	0.000	0.000	0.000	25.250	0.771
Lawrence Creek	0.104	3.883	0.521	0.417	0.000	0.000	21.006	3.935
Apple River	0.094	4.105	0.645	0.132	0.029	0.001	45.163	2.165
Browns Creek	0.031	4.182	5.050	1.239	0.000	0.000	18.494	1.022
Willow River	0.035	3.901	0.721	0.127	0.018	0.000	31.661	1.278
Valley Branch	0.107	9.147	8.463	4.569	2.285	0.000	35.318	2.334
Kinnickinnic River	0.021	4.414	1.766	0.319	0.047	0.004	19.534	1.131
Adjacent Small Streams	0.242	2.870	1.306	0.660	0.186	0.020	46.973	2.694
SCRB Contributing	**0.134**	**3.530**	**0.850**	**0.197**	**0.051**	**0.002**	**33.769**	**1.984**

Table C5. Land cover (percent cover) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001) (cont).

	NLCD 2001 (percent of riparian area)						
Tributary	**Mixed Forest**	**Shrub/ Scrub**	**Grassland/ Herba-ceaous**	**Pasture/ Hay**	**Cultivated Crops**	**Woody Wetlands**	**Emergent Herba-ceous Wetlands**
Namekagon River	14.468	1.374	0.368	1.345	0.411	29.262	1.520
Upper St Croix River	11.747	5.966	0.479	0.641	0.133	23.094	0.253
Chases Brook	0.860	6.588	0.694	1.699	0.466	10.990	0.331
Upper Tamarack River	0.918	6.630	0.688	0.823	0.191	39.586	2.288
Yellow River	12.265	0.495	0.472	6.234	1.537	15.391	6.935
Lower Tamarack River	0.288	1.867	0.275	1.040	0.139	40.952	18.733
Crooked Creek	0.096	0.683	0.159	2.879	0.904	37.850	21.579
Clam River	4.976	0.104	0.749	12.492	3.775	10.914	6.396
Sand Creek	0.244	1.158	0.109	5.281	2.068	42.663	23.053
Bear Creek	0.275	1.487	0.275	10.829	3.114	36.472	27.256
Kettle River	0.752	2.560	0.332	8.624	1.809	38.679	23.519
Redhorse Creek	0.000	0.783	0.000	0.000	0.000	49.250	16.047
Snake River	0.378	1.247	2.831	14.314	5.858	18.272	24.511
Wood River	3.061	0.805	5.526	13.589	13.092	4.400	21.603
Rock Creek	0.803	8.818	1.167	26.083	28.066	5.008	10.387
Rush Creek	1.655	5.066	0.577	20.502	22.476	13.774	17.812
Goose Creek	0.296	0.495	6.522	19.912	20.827	5.414	19.051
Sunrise River	0.155	0.367	7.027	14.991	18.564	2.923	24.331
Trade River	0.908	0.360	3.252	16.607	11.168	3.809	20.437
Wolf Creek	0.189	0.393	8.720	25.625	8.138	4.478	13.810
Dry Creek	0.719	0.000	5.137	23.452	34.575	0.950	6.242
Lawrence Creek	1.016	0.078	3.727	29.763	27.548	0.886	7.115
Apple River	1.292	0.174	3.194	13.850	7.007	7.954	14.194
Browns Creek	0.000	4.337	8.953	35.068	5.886	0.527	15.211
Willow River	0.080	0.199	2.280	31.247	22.069	1.674	4.711
Valley Branch	0.140	4.908	4.124	17.544	7.052	1.163	2.846
Kinnickinnic River	0.070	0.408	0.655	12.953	51.346	6.361	0.971
Adjacent Small Streams	0.785	2.887	2.754	7.100	5.699	14.349	11.474
SCRB Contributing	**3.481**	**1.747**	**1.894**	**10.708**	**7.688**	**19.897**	**14.066**

Table C6. Land cover (percent cover) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2006).

	NLCD 2006 (percent of riparian area)							
Tributary	**Open Water**	**Developed, Open Space**	**Developed, Low Intensity**	**Developed, Medium Intensity**	**Developed, High Intensity**	**Barren**	**Deciduous Forest**	**Evergreen Forest**
Namekagon River	0.224	4.153	0.828	0.128	0.021	0.000	41.054	4.653
Upper St Croix River	0.057	2.220	1.347	0.129	0.003	0.000	48.864	4.902
Chases Brook	0.052	2.134	0.363	0.000	0.000	0.000	74.166	1.574
Upper Tamarack River	0.201	1.295	0.276	0.000	0.000	0.000	46.748	0.261
Yellow River	0.183	4.616	0.600	0.115	0.002	0.000	49.082	2.049
Lower Tamarack River	0.236	1.197	0.126	0.000	0.000	0.000	34.416	0.660
Crooked Creek	0.187	1.937	0.149	0.043	0.000	0.000	32.832	0.385
Clam River	0.142	3.901	0.115	0.014	0.000	0.000	55.080	1.181
Sand Creek	0.231	2.091	0.208	0.000	0.000	0.000	22.341	0.284
Bear Creek	0.052	1.821	0.089	0.000	0.000	0.000	18.091	0.156
Kettle River	0.166	3.243	0.607	0.073	0.027	0.000	17.852	1.644
Redhorse Creek	0.587	0.391	0.000	0.000	0.000	0.000	30.920	0.000
Snake River	0.066	3.120	0.722	0.052	0.014	0.000	27.981	0.541
Wood River	0.063	5.182	0.339	0.104	0.013	0.000	27.609	4.570
Rock Creek	0.031	3.954	0.973	0.314	0.050	0.000	13.688	0.741
Rush Creek	0.031	6.834	1.592	0.433	0.025	0.000	8.006	1.718
Goose Creek	0.070	4.671	0.597	0.151	0.000	0.000	21.236	0.694
Sunrise River	0.070	3.757	1.969	0.627	0.130	0.000	23.966	1.130
Trade River	0.065	4.543	0.454	0.044	0.006	0.032	37.292	1.011
Wolf Creek	0.063	2.608	0.016	0.016	0.000	0.000	35.350	0.628
Dry Creek	0.000	2.697	0.205	0.000	0.000	0.000	25.250	0.771
Lawrence Creek	0.104	3.883	0.521	0.417	0.000	0.000	21.006	3.935
Apple River	0.086	4.117	0.649	0.148	0.029	0.001	45.050	2.165
Browns Creek	0.031	4.957	5.359	2.230	0.310	0.000	18.401	1.022
Willow River	0.043	4.012	0.849	0.157	0.018	0.000	31.580	1.269
Valley Branch	0.107	9.353	8.603	4.635	2.384	0.000	35.294	2.334
Kinnickinnic River	0.021	4.459	1.819	0.375	0.047	0.004	19.538	1.127
Adjacent Small Streams	0.239	3.032	1.316	0.664	0.186	0.020	46.864	2.687
SCRB Contributing	**0.129**	**3.556**	**0.867**	**0.207**	**0.053**	**0.002**	**33.666**	**1.977**

Table C6. Land cover (percent cover) within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2006) (cont).

	NLCD 2006 (percent of riparian area)						
Tributary	**Mixed Forest**	**Shrub/ Scrub**	**Grassland/ Herba-ceaous**	**Pasture/ Hay**	**Cultivated Crops**	**Woody Wetlands**	**Emergent Herba-ceous Wetlands**
Namekagon River	14.402	1.399	0.886	1.339	0.416	28.963	1.533
Upper St Croix River	11.649	5.908	0.479	0.641	0.237	23.007	0.556
Chases Brook	0.860	6.557	0.673	1.709	0.466	10.990	0.456
Upper Tamarack River	0.918	6.514	0.688	0.838	0.191	39.426	2.645
Yellow River	12.261	0.495	0.590	6.218	1.537	15.290	6.963
Lower Tamarack River	0.288	1.862	0.275	1.040	0.139	40.695	19.067
Crooked Creek	0.096	0.683	0.154	3.004	1.034	36.745	22.752
Clam River	4.967	0.106	0.756	12.540	3.786	10.867	6.546
Sand Creek	0.218	1.207	0.109	5.281	2.088	42.085	23.858
Bear Creek	0.245	1.487	0.275	10.829	3.114	36.391	27.449
Kettle River	0.744	2.539	0.328	8.636	1.911	38.383	23.849
Redhorse Creek	0.000	0.783	0.000	0.000	0.000	47.293	20.026
Snake River	0.376	1.251	2.826	14.350	5.870	18.131	24.699
Wood River	3.061	0.847	5.484	13.608	13.193	4.400	21.528
Rock Creek	0.803	8.830	1.155	26.083	27.984	5.008	10.387
Rush Creek	1.655	5.041	0.483	20.251	22.401	13.730	17.799
Goose Creek	0.296	0.818	6.248	19.912	20.843	5.414	19.051
Sunrise River	0.150	0.403	6.919	14.962	18.692	2.805	24.421
Trade River	0.905	0.363	3.252	16.607	11.168	3.809	20.449
Wolf Creek	0.189	0.393	8.688	25.625	8.138	4.478	13.810
Dry Creek	0.719	0.000	5.137	23.452	34.575	0.950	6.242
Lawrence Creek	1.016	0.078	3.727	29.763	27.548	0.886	7.115
Apple River	1.292	0.174	3.194	13.892	6.984	8.075	14.143
Browns Creek	0.000	4.306	8.488	34.789	4.368	0.527	15.211
Willow River	0.119	0.199	2.237	31.184	21.951	1.693	4.690
Valley Branch	0.140	4.916	4.066	17.338	6.838	1.163	2.829
Kinnickinnic River	0.078	0.404	0.655	12.947	51.193	6.361	0.971
Adjacent Small Streams	0.774	2.931	2.713	7.013	5.706	14.349	11.506
SCRB Contributing	**3.466**	**1.754**	**1.940**	**10.706**	**7.706**	**19.750**	**14.222**

Table C7. Land cover change in percent cover within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001 to 2006).

	NLCD Change (percent of riparian area)							
Tributary	**Open Water**	**Developed, Open Space**	**Developed, Low Intensity**	**Developed, Medium Intensity**	**Developed, High Intensity**	**Barren**	**Deciduous Forest**	**Evergreen Forest**
Namekagon River	0.002	-0.003	0.000	0.003	0.000	0.000	-0.167	-0.026
Upper St Croix River	0.005	0.000	0.000	0.000	0.000	0.000	-0.160	-0.010
Chases Brook	0.000	0.000	0.000	0.000	0.000	0.000	-0.083	0.000
Upper Tamarack River	0.005	0.000	0.000	0.000	0.000	0.000	-0.100	0.000
Yellow River	0.000	-0.004	0.010	0.015	0.000	0.000	-0.044	0.000
Lower Tamarack River	-0.028	0.000	0.000	0.000	0.000	0.000	-0.044	0.000
Crooked Creek	-0.034	0.000	0.000	0.000	0.000	0.000	-0.308	0.024
Clam River	-0.003	0.000	0.000	0.000	0.000	0.000	-0.152	-0.006
Sand Creek	-0.010	0.000	0.000	0.000	0.000	0.000	-0.261	0.000
Bear Creek	0.000	0.000	0.000	0.000	0.000	0.000	-0.082	0.000
Kettle River	-0.016	0.000	0.000	0.000	0.000	0.000	-0.088	-0.009
Redhorse Creek	-0.130	0.000	0.000	0.000	0.000	0.000	-1.892	0.000
Snake River	-0.005	0.000	0.002	0.002	0.000	0.000	-0.083	-0.007
Wood River	-0.023	0.000	0.000	0.000	0.000	0.000	-0.023	0.003
Rock Creek	0.000	0.000	0.013	0.069	0.000	0.000	0.000	0.000
Rush Creek	0.006	0.276	0.219	0.056	0.000	0.000	-0.056	0.000
Goose Creek	0.000	0.000	0.000	0.000	0.000	0.000	-0.065	0.000
Sunrise River	0.005	0.030	0.046	0.013	0.000	0.000	-0.085	-0.004
Trade River	-0.018	0.000	0.000	0.000	0.000	0.000	0.006	0.000
Wolf Creek	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dry Creek	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lawrence Creek	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Apple River	-0.008	0.012	0.005	0.016	0.000	0.000	-0.113	0.000
Browns Creek	0.000	0.774	0.310	0.991	0.310	0.000	-0.093	0.000
Willow River	0.008	0.111	0.128	0.030	0.000	0.000	-0.080	-0.009
Valley Branch	0.000	0.206	0.140	0.066	0.099	0.000	-0.025	0.000
Kinnickinnic River	0.000	0.045	0.054	0.056	0.000	0.000	0.004	-0.004
Adjacent Small Streams	-0.003	0.162	0.009	0.004	0.000	0.000	-0.109	-0.007
SCRB Contributing	**-0.005**	**0.026**	**0.017**	**0.010**	**0.001**	**0.000**	**-0.103**	**-0.007**

Table C7. Land cover change in percent cover within riparian areas (within 30 to 85 meters) of contributing water bodies by tributary watershed, NLCD classifications (2001 to 2006) (cont).

	NLCD Change (percent of riparian area)						
Tributary	**Mixed Forest**	**Shrub/ Scrub**	**Grassland/ Herba-ceaous**	**Pasture/ Hay**	**Cultivated Crops**	**Woody Wetlands**	**Emergent Herba-ceous Wetlands**
Namekagon River	-0.067	0.026	0.518	-0.006	0.006	-0.298	0.013
Upper St Croix River	-0.098	-0.057	0.000	0.000	0.104	-0.088	0.303
Chases Brook	0.000	-0.031	-0.021	0.010	0.000	0.000	0.124
Upper Tamarack River	0.000	-0.115	0.000	0.015	0.000	-0.161	0.356
Yellow River	-0.004	0.000	0.118	-0.017	0.000	-0.101	0.027
Lower Tamarack River	0.000	-0.005	0.000	0.000	0.000	-0.257	0.334
Crooked Creek	0.000	0.000	-0.005	0.125	0.130	-1.106	1.173
Clam River	-0.010	0.002	0.007	0.048	0.012	-0.048	0.150
Sand Creek	-0.026	0.049	0.000	0.000	0.020	-0.577	0.805
Bear Creek	-0.030	0.000	0.000	0.000	0.000	-0.082	0.193
Kettle River	-0.008	-0.021	-0.004	0.011	0.102	-0.297	0.330
Redhorse Creek	0.000	0.000	0.000	0.000	0.000	-1.957	3.979
Snake River	-0.002	0.004	-0.006	0.037	0.012	-0.142	0.188
Wood River	0.000	0.042	-0.042	0.018	0.102	0.000	-0.076
Rock Creek	0.000	0.013	-0.013	0.000	-0.082	0.000	0.000
Rush Creek	0.000	-0.025	-0.094	-0.251	-0.075	-0.044	-0.013
Goose Creek	0.000	0.323	-0.274	0.000	0.016	0.000	0.000
Sunrise River	-0.005	0.036	-0.108	-0.029	0.129	-0.118	0.090
Trade River	-0.003	0.003	0.000	0.000	0.000	0.000	0.012
Wolf Creek	0.000	0.000	-0.031	0.000	0.000	0.000	0.000
Dry Creek	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lawrence Creek	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Apple River	0.000	0.000	0.000	0.042	-0.023	0.121	-0.051
Browns Creek	0.000	-0.031	-0.465	-0.279	-1.518	0.000	0.000
Willow River	0.039	0.000	-0.043	-0.063	-0.118	0.019	-0.021
Valley Branch	0.000	0.008	-0.058	-0.206	-0.214	0.000	-0.016
Kinnickinnic River	0.008	-0.004	0.000	-0.006	-0.152	0.000	0.000
Adjacent Small Streams	-0.011	0.044	-0.041	-0.087	0.007	0.000	0.032
SCRB Contributing	**-0.015**	**0.006**	**0.046**	**-0.002**	**0.017**	**-0.147**	**0.156**

Table C8. Detail of land cover change (in hectares and acres) within riparian areas (within 30 to 85 meters) of contributing water bodies in contributing HUC12s in the SCRB, NLCD classifications (2001 to 2006).

2001	2006	Area (Hectares)	Area (Acres)
Cultivated Crops	Deciduous Forest	0.3	0.7
Cultivated Crops	Developed, High Intensity	1.3	3.1
Cultivated Crops	Developed, Low Intensity	7.6	18.7
Cultivated Crops	Developed, Medium Intensity	8.0	19.8
Cultivated Crops	Developed, Open Space	6.5	16.0
Cultivated Crops	Emergent Herbaceous Wetlands	0.7	1.8
Cultivated Crops	Grassland/Herbaceous	1.1	2.7
Cultivated Crops	Mixed Forest	3.2	8.0
Cultivated Crops	Open Water	0.7	1.8
Cultivated Crops	Pasture/Hay	3.0	7.3
Cultivated Crops	Shrub/Scrub	4.6	11.3
Cultivated Crops	Woody Wetlands	8.6	21.3
Deciduous Forest	Cultivated Crops	19.1	47.1
Deciduous Forest	Developed, Low Intensity	3.2	7.8
Deciduous Forest	Developed, Medium Intensity	1.7	4.2
Deciduous Forest	Developed, Open Space	9.2	22.7
Deciduous Forest	Emergent Herbaceous Wetlands	63.4	156.6
Deciduous Forest	Grassland/Herbaceous	26.6	65.8
Deciduous Forest	Mixed Forest	0.2	0.4
Deciduous Forest	Open Water	1.4	3.6
Deciduous Forest	Pasture/Hay	14.8	36.5
Deciduous Forest	Shrub/Scrub	7.5	18.5
Deciduous Forest	Woody Wetlands	6.5	16.0
Developed, Open Space	Developed, Medium Intensity	0.9	2.2
Emergent Herbaceous Wetlands	Cultivated Crops	9.3	22.9
Emergent Herbaceous Wetlands	Developed, Low Intensity	1.7	4.2
Emergent Herbaceous Wetlands	Developed, Medium Intensity	0.4	0.9
Emergent Herbaceous Wetlands	Developed, Open Space	1.3	3.1
Emergent Herbaceous Wetlands	Grassland/Herbaceous	5.0	12.2
Emergent Herbaceous Wetlands	Open Water	1.1	2.7
Emergent Herbaceous Wetlands	Pasture/Hay	3.8	9.3
Emergent Herbaceous Wetlands	Woody Wetlands	16.7	41.4
Evergreen Forest	Cultivated Crops	1.5	3.8
Evergreen Forest	Deciduous Forest	0.8	2.0
Evergreen Forest	Developed, Low Intensity	0.2	0.4
Evergreen Forest	Developed, Open Space	1.4	3.6
Evergreen Forest	Emergent Herbaceous Wetlands	2.5	6.2
Evergreen Forest	Grassland/Herbaceous	3.4	8.5
Evergreen Forest	Pasture/Hay	0.2	0.4
Evergreen Forest	Shrub/Scrub	0.4	0.9
Evergreen Forest	Woody Wetlands	0.8	2.0

Table C8. Detail of land cover change (in hectares and acres) within riparian areas (within 30 to 85 meters) of contributing water bodies in contributing HUC12s in the SCRB, NLCD classifications (2001 to 2006) (cont).

2001	2006	Area (Hectares)	Area (Acres)
Grassland/Herbaceous	Cultivated Crops	8.1	20.0
Grassland/Herbaceous	Deciduous Forest	0.5	1.1
Grassland/Herbaceous	Developed, High Intensity	0.4	0.9
Grassland/Herbaceous	Developed, Low Intensity	0.8	2.0
Grassland/Herbaceous	Developed, Medium Intensity	0.6	1.6
Grassland/Herbaceous	Developed, Open Space	1.4	3.3
Grassland/Herbaceous	Emergent Herbaceous Wetlands	2.2	5.3
Grassland/Herbaceous	Open Water	0.2	0.4
Grassland/Herbaceous	Pasture/Hay	2.2	5.3
Grassland/Herbaceous	Shrub/Scrub	11.9	29.4
Mixed Forest	Cultivated Crops	7.0	17.3
Mixed Forest	Deciduous Forest	3.4	8.5
Mixed Forest	Developed, Low Intensity	0.3	0.7
Mixed Forest	Emergent Herbaceous Wetlands	3.4	8.5
Mixed Forest	Grassland/Herbaceous	5.4	13.3
Mixed Forest	Open Water	0.1	0.2
Mixed Forest	Pasture/Hay	1.4	3.6
Mixed Forest	Shrub/Scrub	2.2	5.3
Mixed Forest	Woody Wetlands	0.7	1.8
Open Water	Cultivated Crops	1.2	2.9
Open Water	Deciduous Forest	2.7	6.7
Open Water	Emergent Herbaceous Wetlands	5.9	14.7
Open Water	Evergreen Forest	0.1	0.2
Open Water	Grassland/Herbaceous	0.2	0.4
Open Water	Pasture/Hay	0.7	1.8
Open Water	Shrub/Scrub	0.2	0.4
Open Water	Woody Wetlands	1.4	3.3
Pasture/Hay	Deciduous Forest	2.7	6.7
Pasture/Hay	Developed, High Intensity	0.4	0.9
Pasture/Hay	Developed, Low Intensity	6.8	16.9
Pasture/Hay	Developed, Medium Intensity	2.4	6.0
Pasture/Hay	Developed, Open Space	14.8	36.5
Pasture/Hay	Emergent Herbaceous Wetlands	1.0	2.4
Pasture/Hay	Evergreen Forest	1.3	3.1
Pasture/Hay	Grassland/Herbaceous	2.3	5.8
Pasture/Hay	Open Water	0.2	0.4
Pasture/Hay	Shrub/Scrub	1.4	3.3

Table C8. Detail of land cover change (in hectares and acres) within riparian areas (within 30 to 85 meters) of contributing water bodies in contributing HUC12s in the SCRB, NLCD classifications (2001 to 2006) (cont).

2001	2006	Area (Hectares)	Area (Acres)
Shrub/Scrub	Cultivated Crops	2.1	5.1
Shrub/Scrub	Deciduous Forest	1.7	4.2
Shrub/Scrub	Developed, Low Intensity	0.2	0.4
Shrub/Scrub	Developed, Open Space	1.0	2.4
Shrub/Scrub	Emergent Herbaceous Wetlands	10.5	26.0
Shrub/Scrub	Evergreen Forest	0.1	0.2
Shrub/Scrub	Grassland/Herbaceous	1.4	3.3
Shrub/Scrub	Mixed Forest	0.3	0.7
Shrub/Scrub	Open Water	0.2	0.4
Shrub/Scrub	Woody Wetlands	1.8	4.4
Woody Wetlands	Cultivated Crops	21.2	52.5
Woody Wetlands	Deciduous Forest	0.4	0.9
Woody Wetlands	Developed, Low Intensity	2.0	4.9
Woody Wetlands	Developed, Open Space	0.9	2.2
Woody Wetlands	Emergent Herbaceous Wetlands	163.4	403.6
Woody Wetlands	Grassland/Herbaceous	45.5	112.3
Woody Wetlands	Open Water	1.4	3.6
Woody Wetlands	Pasture/Hay	3.9	9.6

Table C9. Detail of evaluation of randomly selected riparian areas identified as having changed from 2001 to 2006 to or from a converted cover type.

Accuracy	Change from 2001 to 2006	Area (Hectares)	Percent of Subtotal	Percent of Total
Accurate	Cultivated Crops to Developed, High Intensity	0.4	2.5	1.3
	Cultivated Crops to Developed, Low Intensity	2.2	12.7	6.7
	Cultivated Crops to Developed, Medium Intensity	4.0	22.3	11.7
	Cultivated Crops to Developed, Open Space	1.3	7.1	3.7
	Cultivated Crops to Mixed Forest	1.4	8.1	4.3
	Cultivated Crops to Open Water	0.4	2.5	1.3
	Cultivated Crops to Pasture/Hay	1.1	6.1	3.2
	Cultivated Crops to Woody Wetlands	0.1	0.5	0.3
	Deciduous Forest to Cultivated Crops	0.8	4.6	2.4
	Deciduous Forest to Developed, Low Intensity	0.9	5.1	2.7
	Deciduous Forest to Developed, Medium Intensity	0.5	3.0	1.6
	Deciduous Forest to Developed, Open Space	0.4	2.5	1.3
	Developed, Open Space to Developed, Medium Intensity	0.1	0.5	0.3
	Grassland/Herbaceous to Cultivated Crops	0.1	0.5	0.3
	Grassland/Herbaceous to Developed, High Intensity	0.3	1.5	0.8
	Grassland/Herbaceous to Developed, Low Intensity	0.2	1.0	0.5
	Grassland/Herbaceous to Developed, Medium Intensity	0.2	1.0	0.5
	Mixed Forest to Cultivated Crops	0.7	4.1	2.1
	Pasture/Hay to Developed, Low Intensity	1.3	7.6	4.0
	Pasture/Hay to Developed, Medium Intensity	0.6	3.6	1.9
	Pasture/Hay to Developed, Open Space	0.4	2.0	1.1
	Shrub/Scrub to Developed, Open Space	0.2	1.0	0.5
Subtotal (Accurate)		**17.7**	**100.0**	**52.5**

Table C9. Detail of evaluation of randomly selected riparian areas identified as having changed from 2001 to 2006 to or from a converted cover type (cont).

Accuracy	Change from 2001 to 2006	Area (Hectares)	Percent of Subtotal	Percent of Total
Inaccurate	Cultivated Crops to Developed, Low Intensity	0.1	0.6	0.3
	Cultivated Crops to Developed, Open Space	0.1	0.6	0.3
	Cultivated Crops to Woody Wetlands	0.4	2.9	1.3
	Deciduous Forest to Cultivated Crops	2.0	12.6	5.9
	Deciduous Forest to Developed, Low Intensity	0.1	0.6	0.3
	Deciduous Forest to Developed, Open Space	3.0	18.9	8.8
	Emergent Herbaceous Wetlands to Cultivated Crops	1.1	6.9	3.2
	Emergent Herbaceous Wetlands to Developed, Low Intensity	0.1	0.6	0.3
	Evergreen Forest to Cultivated Crops	0.8	5.1	2.4
	Grassland/Herbaceous to Cultivated Crops	1.0	6.3	2.9
	Mixed Forest to Cultivated Crops	0.2	1.1	0.5
	Mixed Forest to Developed, Low Intensity	0.1	0.6	0.3
	Pasture/Hay to Developed, Medium Intensity	0.1	0.6	0.3
	Pasture/Hay to Developed, Open Space	0.6	4.0	1.9
	Shrub/Scrub to Cultivated Crops	0.2	1.1	0.5
	Shrub/Scrub to Developed, Low Intensity	0.1	0.6	0.3
	Woody Wetlands to Cultivated Crops	5.3	33.7	15.7
	Woody Wetlands to Developed, Low Intensity	0.4	2.3	1.1
	Woody Wetlands to Developed, Open Space	0.2	1.1	0.5
Subtotal (Inaccurate)		**15.7**	**100.0**	**46.7**
Unknown	Cultivated Crops to Woody Wetlands	0.3	100.0	0.8
Subtotal (Unknown)		**0.3**	**100.0**	**0.8**
Total Sample Area		**33.7**		

APPENDIX D – Land cover reclassification tables

Dataset: Presettlement Land Cover
Time Frame: Presettlement (mid-late 1800s)
Extent: Minnesota
Source: http://deli.dnr.state.mn.us/

Table D1. Presettlement Land Cover Reclassification.

Presettlement Land Cover	Reclassification
Aspen-Birch (trending to Conifers)	Upland Forest
Aspen-Birch (trending to hardwoods)	Upland Forest
Aspen-Oak Land	Upland Forest
Big Woods - Hardwoods (oak, maple, basswood, hickory)	Upland Forest
Mixed Hardwood and Pine (Maple, White Pine, Basswood, etc)	Upland Forest
Mixed White Pine and Red Pine	Upland Forest
Pine Flats (Hemlock, Spruce, Fir, White Pine, Aspen)	Upland Forest
White Pine	Upland Forest
Brush Prairie	Upland Shrub
Jack Pine Barrens and Openings	Upland Grass
Oak openings and barrens	Upland Grass
Prairie	Upland Grass
Conifer Bogs and Swamps	Lowland Vegetation
River Bottom Forest	Lowland Vegetation
Open Muskeg	Lowland Vegetation
Wet Prairie	Lowland Vegetation
Lakes (open water)	Open Water
Undefined	Unclassified

Dataset: Original Vegetation Cover
Time Frame: Presettlement (mid-late 1800s)
Extent: Wisconsin
Source: ftp://dnrftp01.wi.gov/geodata/

Table D2. Original Vegetation Cover Reclassification.

Original Vegetation	Reclassification
White spruce, balsam fir, tamarack, white cedar, white birch, aspen	Upland Forest
Beech, hemlock, sugar maple, yellow birch, white pine, red pine	Upland Forest
Hemlock, sugar maple, yellow birch, white pine, red pine	Upland Forest
Sugar maple, yellow birch, white pine, red pine	Upland Forest
White pine, red pine	Upland Forest
Jack pine, scrub (hill's), oak forest and barrens	Upland Forest
Aspen, white birch, pine	Upland Forest
Beech, sugar maple, basswood, red oak, white oak, black oak	Upland Forest
Sugar maple, basswood, red oak, white oak, black oak	Upland Forest
Oak -- white oak, black oak, bur oak	Upland Forest
Brush	Upland Shrub
Oak openings -- bur oak, white oak, black oak	Upland Grass
Prairie	Upland Grass
Swamp conifers -- white cedar, black spruce, tamarack, hemlock	Lowland Vegetation
Lowland hardwoods -- willow, soft maple, box elder, ash, elm, cottonwood, river birch	Lowland Vegetation
Marsh and sedge meadow, wet prairie, lowland shrubs	Lowland Vegetation
Open water	Open Water
Not identified	Unclassified

Dataset: GAP Land Cover
Time Frame: 1991-1993
Extent: Minnesota
Source: http://deli.dnr.state.mn.us/

Table D3. GAP Land Cover Reclassification.

GAP Level 4	Reclassification
Aspen/White Birch	Upland Forest
Balsam Fir mix	Upland Forest
Bur/White Oak	Upland Forest
Jack Pine	Upland Forest
Jack Pine-Deciduous mix	Upland Forest
Maple/Basswood	Upland Forest
Northern Pin Oak	Upland Forest
Red Oak	Upland Forest
Red Pine	Upland Forest
Red/White Pine	Upland Forest
Red/White Pine-Deciduous mix	Upland Forest
Redcedar	Upland Forest
Redcedar-Deciduous mix	Upland Forest
Spruce/Fir-Deciduous mix	Upland Forest
Upland Black Spruce	Upland Forest
Upland Conifer	Upland Forest
Upland Conifer-Deciduous mix	Upland Forest
Upland Deciduous	Upland Forest
Upland Northern White-Cedar	Upland Forest
White Pine mix	Upland Forest
White Spruce	Upland Forest
White/Red Oak	Upland Forest
Upland Shrub	Upland Shrub
Grassland	Upland Grass
Prairie	Upland Grass

Table D3. GAP Land Cover Reclassification (cont).

GAP Level 4	Reclassification
Black Ash	Lowland Vegetation
Cottonwood	Lowland Vegetation
Lowland Black Spruce	Lowland Vegetation
Lowland Conifer-Deciduous mix	Lowland Vegetation
Lowland Deciduous	Lowland Vegetation
Lowland Deciduous Shrub	Lowland Vegetation
Lowland Evergreen Shrub	Lowland Vegetation
Lowland Northern White-Cedar	Lowland Vegetation
Silver Maple	Lowland Vegetation
Stagnant Black Spruce	Lowland Vegetation
Stagnant Conifer	Lowland Vegetation
Stagnant Northern White-Cedar	Lowland Vegetation
Stagnant Tamarack	Lowland Vegetation
Tamarack	Lowland Vegetation
Broadleaf Sedge/Cattail	Lowland Vegetation
Floating Aquatic	Lowland Vegetation
Sedge Meadow	Lowland Vegetation
Cropland	Agriculture
Low intensity urban	Developed
Mixed Developed	Developed
High intensity urban	Developed
Transportation	Developed
Barren	Barren
Water	Open Water
Unidentified	Unclassified

Dataset: WISCLAND Land Cover
Time Frame: 1991-1993
Extent: Wisconsin
Source: http://dnr.wi.gov/maps/gis/datalandcover.html

Table D4. WISCLAND Land Cover Reclassification.

WISCLAND Class	Reclassification
FOREST: coniferous	Upland Forest
FOREST: jack pine	Upland Forest
FOREST: red pine	Upland Forest
FOREST: white spruce	Upland Forest
FOREST: mixed/other coniferous	Upland Forest
FOREST: broad-leaved deciduous	Upland Forest
FOREST: aspen	Upland Forest
FOREST: oak	Upland Forest
FOREST: northern pin oak	Upland Forest
FOREST: red oak	Upland Forest
FOREST: maple	Upland Forest
FOREST: sugar maple	Upland Forest
FOREST: mixed/other broad-leaved deciduous	Upland Forest
FOREST: mixed deciduous/coniferous	Upland Forest
SHRUBLAND	Upland Shrub
GRASSLAND	Upland Grass
WETLAND: lowland shrub	Lowland Vegetation
WETLAND: lowland shrub: broad-leaved deciduous	Lowland Vegetation
WETLAND: lowland shrub: broad-leaved evergreen	Lowland Vegetation
WETLAND: lowland shrub: needle-leaved	Lowland Vegetation
FORESTED WETLAND: broad-leaved deciduous	Lowland Vegetation
FORESTED WETLAND: coniferous	Lowland Vegetation
FORESTED WETLAND: mixed deciduous/coniferous	Lowland Vegetation
WETLAND: emergent/wet meadow	Lowland Vegetation
WETLAND: floating aquatic herbaceous vegetation	Lowland Vegetation

Table D4. WISCLAND Land Cover Reclassification (cont).

WISCLAND Class	Reclassification
AGRICULTURE	Agriculture
AGRICULTURE: herbaceous/field crops	Agriculture
AGRICULTURE: primary row crops	Agriculture
AGRICULTURE: corn	Agriculture
AGRICULTURE: other row crops	Agriculture
AGRICULTURE: forage crops	Agriculture
AGRICULTURE: cranberry bog	Agriculture
URBAN/DEVELOPED: high intensity urban	Developed
URBAN/DEVELOPED: low intensity urban	Developed
URBAN/DEVELOPED: golf course	Developed
BARREN	Barren
OPEN WATER	Open Water
CLOUD COVER	Unclassified

Dataset: National Land Cover Dataset (2001 Version 2.0, 2006)
Time Frame: 2001, 2006
Extent: Nationwide
Source: http://www.mrlc.gov/index.php

Table D5. NLCD Reclassification.

Land Cover	Description	Reclassification
Deciduous Forest	Dominated by trees generally over 5 meters tall, and more than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.	Upland Forest
Evergreen Forest	Dominated by trees generally over 5 meters tall, and more than 20% of total vegetation cover. More than 75% of the tree species remain in leaf all year. Canopy is never without green foliage.	Upland Forest
Mixed Forest	Dominated by trees generally over 5 meters tall, and more than 20% of total vegetation cover. Neither deciduous nor evergreen species are more than 75% of total tree cover.	Upland Forest
Shrub/Scrub	Areas dominated by shrubs under 5 meters tall with shrub canopy typically more than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	Upland Shrub
Grassland/Herbaceous	Areas dominated by graminoid or herbaceous vegetation, generally more than 80% of total vegetation. These areas are not subject to intensive management or tilling, but can be utilized for grazing.	Upland Grass
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or production of seed or hay crops, typically on a perennial cycle. Pasture/hay accounts for more than 20% of total vegetation.	Upland Grass

Table D5. NLCD Reclassification (cont).

Land Cover	Description	Reclassification
Woody Wetlands	Areas where forest or shrub land vegetation accounts for more than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	Lowland Vegetation
Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for more than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	Lowland Vegetation
Cultivated Crops	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for more than 20% of total vegetation. Includes all land being actively tilled.	Agriculture

Table C5. NLCD Reclassification (cont).

Land Cover	Description	Reclassification
Developed, Open Space	Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.	Developed
Developed, Low Intensity	Areas with a mixture of constructed materials and vegetation, impervious surfaces accounting for 20-49% of total cover. These areas most commonly include single-family housing units.	Developed
Developed, Medium Intensity	Areas with a mixture of constructed materials and vegetation, impervious surfaces accounting for 50-79% of the total cover. These areas most commonly include single-family housing units.	Developed
Developed, High Intensity	Highly developed areas where people live or work in high numbers, including apartment complexes, row houses and commercial/industrial zones. Impervious surfaces account for 80-100% of total cover.	Developed
Barren Land (Rock/Sand/Clay)	Bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Vegetation generally accounts for less than 15% of total cover.	Barren
Open Water	All areas of open water, generally with less than 25% cover of vegetation or soil.	Open Water
Unclassified	Areas along the International Border that were not classified.	Unclassified

APPENDIX E - GIS Methodology

Data Dictionary

Counties of Minnesota

Description: Minnesota county boundaries derived from a combination of 1:24,000 scale PLS lines, 1:100,000 scale TIGER, 1:100,000 scale DLG, and 1:24,000 scale hydrography lines. At the time of its development (1993), the largest available scale data were assembled to create the layer.

Source: g:\gdrs\data\pub\us_mn_state_dnr\bdry_counties_in_minnesota\bdry_counties_in_minnesota.gdb\mn_county_boundaries (also available at http://deli.dnr.state.mn.us/)

Counties of Wisconsin

Description: This polygon shapefile represents boundaries of the 72 counties in Wisconsin. The data is derived from 1:24,000-scale sources.

Source: ftp://dnrftp01.wi.gov/geodata/county_bnds/WI_County_Boundaries.zip

GAP Land Cover

Description: This raster dataset is a detailed (1-acre minimum), hierarchically organized vegetation cover map produced by computer classification of combined two-season pairs of early-1990s Landsat 4/5 Thematic Mapper (TM) satellite imagery, as part of the Upper Midwest Gap Analysis Program (UMGAP) of the U.S. Geological Survey. Units of analysis were Minnesota Ecological Classification System (ECS) subsections subdivided by TM scenes. GAP typology and classification protocols are closely comparable across Minnesota, Wisconsin and Michigan.

Source: g:\gdrs\data\pub\us_mn_state_dnr\biota_landcover_gap\biota_landcover_gap.gdb\landcover_gap (also available at http://deli.dnr.state.mn.us/)

NHD Watershed Boundary Dataset, Water Bodies, and Flow Lines

Description: The Watershed Boundary Dataset (WBD) defines the areal extent of surface water drainage to a point, accounting for all land and surface areas. Watershed Boundaries are determined solely upon science-based hydrologic principles, not favoring any administrative boundaries or special projects, nor particular program or agency. The intent of defining Hydrologic Units (HU) for the Watershed Boundary Dataset is to establish a base-line drainage boundary framework, accounting for all land and surface areas. At a minimum, the WBD is being delineated and georeferenced to the USGS 1:24,000 scale topographic base map meeting National Map Accuracy Standards (NMAS). Hydrologic units are given a Hydrologic Unit Code (HUC). For example, a hydrologic region has a 2-digit HUC. A HUC describes where the unit is in the country and the level of the unit.

Source: ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/

NLCD 2001 and 2006 Land Cover

Description: National Land Cover Database 2006 (NLCD2006) is a 16-class land cover classification scheme that has been applied consistently across the conterminous United States at a spatial resolution of 30 meters.

Source: http://www.mrlc.gov/nlcd2001.php and http://www.mrlc.gov/nlcd06_data.php

Original Vegetation Cover

Description: This is a polygon shapefile derived from a 1:500,000-scale map showing the original, presettlement vegetation cover in Wisconsin. The original vegetation cover data was digitized from a 1976 map created from land survey notes written in the mid-1800s when Wisconsin was first surveyed. Linework representing lakes and other hydrographic areas in other data sets were subsequently merged with the original vegetation cover data set to more closely match the source map.

Source: ftp://dnrftp01.wi.gov/geodata/orig_veg_cover/orig_veg_cover.zip

Presettlement Land Cover

Description: Presettlement vegetation of Minnesota based on Marschner's original analysis of Public Land Survey notes and landscape patterns. Marschner compiled his results in map format, which was subsequently captured in digital format.

Source: g:\gdrs\data\pub\us_mn_state_dnr\biota_marschner_presettle_veg\biota_marschner_presettle_veg.gdb\marschner_presettlement_vegetation (also available at http://deli.dnr.state.mn.us/)

Wisconsin Land Cover Grid

Description: This Grid-format data set, known as WISCLAND Land Cover, is a raster representation of land cover of Wisconsin derived from Landsat satellite imagery.

The source data were acquired from the nationwide MRLC (Multi-Resolution Land Characteristics Consortium) acquisition of dual-date Landsat Thematic Mapper (TM) data primarily from 1992. The image processing technique followed was published in the UMGAP Image Processing Protocol (1998).

The original pixel size of the source TM data is 30 meters, however the classified WISCLAND Land Cover data (excluding URBAN) are generalized or 'smoothed' to an area no smaller than four contiguous pixels (equivalent to approximately one acre). The result of this smoothing is that any feature five acres or larger may be resolved in the data (i.e., Minimum Mapping Unit (MMU) of five acres). The Land Cover data are usable at nominal scales of 1:40,000 to 1:500,000 for a wide variety of resource management and planning applications. The classification scheme was designed to be compatible with existing classification schemes such as UNESCO's and Anderson's.

Source: ftp://dnrftp01.wi.gov/geodata/landcover/wiscland_landcover.zip

Geoprocessing

Watershed Level Analysis Workspace: StateOfTheForestReport\Study.gdb

1. Import and process to unique/contiguous watersheds for basin:
    a. Run model "Watershed Boundary Imports": selects HUC_12 boundaries for Basin from NHD Watershed Boundary Dataset for MN and WI, saves to wshd_huc12_wi and wshd_huc12_mn
    b. Run model "Watershed Boundary Merge": merges watersheds from MN and WI for unique sheds, saves to wshd_huc12
    c. Create topology "NAD83_UTM15N_Topology" w/ wshd_huc12 Must Not Overlap and Must Not Have Gaps, repair errors (22 errors fixed)
    d. Delete topology, wshd_huc12_mn, wshd_huc12_wi
2. Group HUC12 by tributary sub-basins in wshd_huc12:
    a. Add Field: TRIB_SUB, Text, Length 50
    b. Using nps_stcroix_watersheds as reference, group sub-basins
    c. Confer with Sue Magdelene on groupings
3. Allocate basins to MN, WI, or SPLIT in wshd_huc12
    a. Add Field: STATE, Text, Length 20
    b. Update as needed
    c. Export each to wshd_huc12_*
4. Import NHD Water Bodies, NHD Flow Lines, and NHD Areas
    a. Run model "Import Water Features", imports from NHD datasets, saves to waterbody*, flowline*, and waterarea* (*mn, *wi, *split)
    b. Run model "Merge Water Features", merges waterbody*, flowline*, and waterarea* and saves to waterbody, flowline, waterarea
5. Dissolve Basins: Dissolve wshd_huc12 to wshd
6. Import Counties:
    a. "Counties of Minnesota" to "bdry_counties_mn"
        i. Select by Location "Counties of Minnesota" that intersect wshd
        ii. Export to bdry_counties_mn
    b. "Counties of Wisconsin" to "bdry_counties_wi"
        i. Select by Location "Counties of Wisconsin" that intersect wshd
        ii. Export to bdry_counties_wi_raw
        iii. Manually edge match bdry_counties_wi_raw to bdry_counties_mn
        iv. Saved to bdry_counties_wi
    c. Merge bdry_counties_mn and bdry_counties_wi to bdry_counties, update CTY_NAME from bdry_counties_wi.COUNTY_NAM, add field STATE, calculate to MN or WI, delete all other fields
7. Create watershed boundary split by state
    a. Intersect wshd and bdry_counties, save to wshd_state_all
    b. Dissolve on STATE field, save to wshd_state

   c. Export each state to wshd_mn an wshd_wi
   d. Delete wshd_state_all
8. "NLCD 2001 and 2006 Land Cover" to "nlcd2001" and "nlcd2006"
   a. Run model "NLCD Raster Clip": clips "NLCD 2001 and 2006" to watershed extent, saves to nlcd2001_orig and nlcd2006_orig (maintaining original NAD 83 Albers Conical Equal Area projection)
   b. Run model "NLCD Build Raster Tables": builds raster tables for clipped raster datasets nlcd2001_orig and nlcd2006_orig
   c. Run model "NLCD Raster to Poly": converts raster datasets to polygon feature classes, projects polygon feature classes to NAD83 UTM 15N, saves to nlcd2001_extract and nlcd2006_extract
   d. Run model "NLCD Poly Clip": clips polygon feature classes to watershed boundary, saves to nlcd2001 and nlcd2006
   e. Run model "NLCD Add Calc Fields":
      i. Adds and calculates fields from crosswalk_nlcd to nlcd200*_clip
      ii. Output fields:
         1. SHORT_DEF
         2. LONG_DEF
         3. COMP_CLASS
   f. Delete nlcd2001_extract and nlcd2006_extract
9. "GAP Land Cover" to "gap1992"
   a. Run model "GAP Raster Clip": clips "GAP Land Cover" to watershed boundary, saves to gap1992_orig
   b. Run model "GAP Raster To Poly": converts gap1992_orig to polygon (no simplify), saves to gap1992_extract
   c. Run model "GAP Poly Clip": clips gap1992_extract to watershed and Minnesota boundary, saves to gap1992
   d. Run script "Add Calc Fields":
      i. Adds and calculates fields from crosswalk_gap to gap1992
      ii. Output fields:
         1. GAPLVL4TXT
         2. COMP_CLASS
   e. Delete gap1992_extract
10. "Wisconsin Land Cover" to "wiscland1992"
   a. Run model "WISCLAND Raster Clip": clips "Wisconsin Land Cover" to watershed boundary, saves to wiscland1992_orig
   b. Run model "WISCLAND Raster To Poly": converts wiscland1992_orig to polygon (no simplify), saves to wiscland1992_extract
   c. Run model "WISCLAND Poly Clip": clips wiscland1992_extract to watershed and Wisconsin boundary, saves to wiscland1992

d. Run model “Add Calc Fields”:
    i. Adds and calculates fields from crosswalk_wiscland to wiscland1992
    ii. Output fields:
        1. WISCLAND
        2. COMP_CLASS

11. “Original Vegetation Cover” to “origveg”
    a. Run model “Clip Orig Veg”, clips “Original Vegetation Cover” to watershed and Wisconsin boundary, saves to origveg
    b. Run script “Add Calc Fields”, adds COMP_CLASS field, calculates from crosswalk_origveg
12. “Presettlement Land Cover” to “presettle”
    a. Run model “Clip Presettle”, clips “Presettlement Land Cover” to watershed and Minnesota boundary, saves to presettle
    b. Run script “Add Calc Fields”, adds COMP_CLASS field, calculates from crosswalk_presettle
13. Add 1992 open water areas to presettle and origveg classes
    a. Run model “Open Water to Presettle”
        i. Exports Open Water from 1992 feature classes
        ii. Union of Open Water with Watershed Boundary
        iii. Deletes Open Water from Union
        iv. Clips presettle and origveg to Union
        v. Merge Open Water to Clip
        vi. Saves to origveg_mod and presettle_mod
14. Calculate ACRES and HECTARES and build summary tables.
    a. Run script “Add Calc AC HA”, adds fields for acres and hectares, calculates based on Shape_Area field, which is in square meters. Conversion factors used:
        i. Square meters to Hectares: .0001
        ii. Square meters to Acres: .000247105381
    b. Run script “Summary Tables”
        i. Calculates summary tables for original classifications w/ reclass and original classification, and for reclass only
        ii. Includes statistics for acres and hectares
        iii. Saves to StateOfTheForestReport\Tables\Raw
15. Dissolve “wshd_huc12” to “wshd_tributaries” on TRIB_SUB
16. Create “wshd_contributing”
    a. Export wshd_huc12 to scratch as wshd_huc12_contributing
    b. Delete all from wshd_huc12_contributing where "TRIB_SUB" LIKE '%Non-Contributing'
    c. Dissolve to wshd_contributing
    d. Add field TRIB_SUB, Text, 50, calc to “Non-Contributing”

17. Create contiguous land cover sets for each time period dissolved to COMP_CLASS
    a. Create comp_preveg
        i. Merge presettle_mod and origveg_mod to comp_preveg_merge (scratch)
        ii. Dissolve to comp_preveg_dissolve (scratch)
        iii. Union on wshd and comp_preveg_dissolve to wshd_preveg_union (scratch)
        iv. Copy all shapes w/ no value in COMP_CLASS to comp_preveg_merge
        v. Field calculate copied shapes to COMP_CLASS = 'Unclassified'
        vi. Dissolve comp_preveg_merge on COMP_CLASS to comp_preveg
    b. Create comp_1992
        i. Merge gap1992 and wiscland to comp_1992_merge (scratch)
        ii. Dissolve to comp_1992_dissolve (scratch)
        iii. Union on wshd and comp_1992_dissolve to wshd_1992_union (scratch)
        iv. Copy all shapes w/ no value in COMP_CLASS to comp_1992_merge
        v. Field calculate copied shapes to COMP_CLASS = 'Unclassified'
        vi. Dissolve comp_1992_merge on COMP_CLASS to comp_1992
    c. Create comp_2001
        i. Dissolve nlcd2001 on COMP_CLASS
    d. Create comp_2006
        i. Dissolve nlcd2006 on COMP_CLASS
18. Summarize by Tributary and COMP_CLASS for each time period, pivot tables to get summary of each COMP_CLASS per Tributary
    a. Run script "Summary Tables Tribs Land Cover", creates summary tables by TRIB_ORDER, TRIB_SUB, and COMP_CLASS, then does Pivot Table for each
19. Add percent upland forest to tributaries:
    a. Copy wshd_tributaries to wshd_tributaries_uplandforest
    b. Run script "Add Calc Percent Upland Forest", adds field for acres and percent upland forest and calculates field from pivot table. Field names:
        i. HA_UFPRE, PRCNT_UFPRE
        ii. HA_UF92, PRCNT_UF92
        iii. HA_UF01, PRCNT_UF01
        iv. HA_UF06, PRCNT_UF06
20. Calculate difference between Percent Upland Forest from presettlement to 2006
    a. Run script "Calc Upland Forest Difference", adds field PREV_06_DIF to wshd_tributaries_uplandforest, calculates to PRCNT_UF06 - PRCNT_UFPRE
21. Add percent disturbed to tributaries:
    a. Copy wshd_tributaries to wshd_tributaries_agdev
    b. Run script "Add Calc Percent Ag Dev", adds fields for acres and percent for agriculture and developed, and for ag/dev combined (total disturbed) and

calculates field from pivot table. Given agriculture and developed values are zero, fields were not added for presettlement values. Field names:

i. HA_AG06, PRCNT_AG06 (agriculture)
ii. HA_DV06, PRCNT_DV06 (developed)
iii. HA_AD06, PRCNT_AD06 (agriculture/developed)

22. Given values for presettlement of agriculture and developed lands are zero, percent of each represents increase of each.
23. Analyze distance upstream correlation to percent disturbed
    a. Calculate pour point distance upstream
        i. From NHDH_MN.gdb\Hydrography\NHDFlowline, select "GNIS_Name" = 'Saint Croix River', export to flowline_saint_croix_river
        ii. From NHDH_MN.gdb\Hydrography\HYDRO_NET_Junctions, select points that intersect flowline_saint_croix_river, export to hydro_net_junctions_saint_croix_river
        iii. Copy hydro_net_junctions_saint_croix_river to tributary_pour_points, delete all but tributary pour points
        iv. Add field to tributary_pour_points “TRIB_SUB” type “Text” length 50, update field for each tributary
        v. Copy flowline_saint_croix_river to flowline_saint_croix_river_tributaries, merge each segment between tributary_pour_points
        vi. Add fields to flowline_saint_croix_river_tributaries: UP_TRIB (update as upstream “TRIB_ORDER” point), DOWN_TRIB (update as downstream “TRIB_ORDER” point), END_DIST
        vii. Run script “Calc Accumulated Distance”: calculates distance upstream of DOWN_TRIB (Adjacent Small Streams, which ends as pour point of basin)
        viii. Add field “UPSTR_M” to tributary_pour_points, join to flowline_saint_croix_river_tributaries on TRIB_ORDER to DOWN_TRIB, calc tributary_pour_points.UPSTR_M = [flowline_saint_croix_river_tributaries.END_DIST]
        ix. Add fields “UPSTR_KM” and “UPSTR_MI”, calc as [UPSTR_M]*.001 and [UPSTR_M] *0.000621371192 respectively
        x. Export to tributary_pour_points.dbf
    b. Compare distance upstream to percent disturbance
        i. Add tributary_pour_points.dbf to ChangeComparison.xlsx, create display table referencing this sheet and sheet for percent disturbed, do linear regression analysis

Riparian Level Analysis Workspace: StateOfTheForestReport\Study_Riparian.gdb

1. Create riparian buffer:
    a. Run script "AnalyzeRiparianBuffers1": buffers NHD Flowlines at 0.25 meters, selects NHD Water Bodies that intersect NHD Flowlines, selects areas of NLCD 2001 "SHORT_DEF" = 'Open Water' that intersect either flowlines or water bodies that intersect flowlines, merges and dissolves these datasets as single part features to flowlines to hydro_polys_flowlines
    b. Run script "AnalyzeRiparianBuffers2": backs up hydro_polys_flowlines to hydro_polys_flowlines_all, buffers hydro_polys_flowlines at 60 meters, projects buffer to Albers Conical Equal Area, converts buffer to raster w/ 30 meter cells to "riparian_raster".
2. Create raster datasets for NLCD
    a. Run model "CreateRiparianNlcd": raster calculator outputs from riparian_raster and nlcd_****_orig to nlcd_riparian_01 and _06
3. Create raster of tributaries, run zonal statistics, update AREA field from type "FLOAT" to type "DOUBLE"
    a. Run script "RiparianTablesTribs": creates raster of each tributary watershed in same projection as NLCD dataset as A**_* where * = TRIB_SUB
    b. Run script "RiparianTablesZonal": Runs zonal statistics on nlcd_riparian_** for each tributary raster, saves as nlcd_riparian_zonal_**_***_* where ** = NLCD year, *** = A+TRIB_ORDER, and * = TRIB_SUB
    c. Run script "RiparianTablesFixAreaField": deletes AREA field (type FLOAT), adds AREA field (type DOUBLE), calculates AREA field as COUNT*900
4. Add areas to wshd_tributaries
    a. Run model "RiparianTributaries": copies tributaries where NOT "TRIB_ORDER" = 'NON' to wshd_tributaries_riparian_** where ** = 2-digit year and to wshd_tributaries_riparian_change
    b. Run script "RiparianTablesPivot": pivots zonal statistics table nlcd_riparian_zonal_**_***_* for VALUE field with AREA statistics to pivot_nlcd_riparian_zonal_**_***_*
    c. Run script "RiparianTablesCompile": compiles pivot_nlcd_riparian_zonal_**_***_* to nlcd_riparian_zonal_**
    d. Run script "RiparianTablesJoin": moves fields/data from nlcd_riparian_** to wshd_tributaries_riparian_**
    e. Run script "RiparianTablesConversions": calculates hectares, acres, and percent of total in wshd_tributaries_riparian_**
    f. Run script "RiparianTablesCompClass": groups hectares, acres, and percent of total by comp class.
    g. Run script "RiparianTablesConv": groups hectares, acres, and percent of total by converted and non-converted.

5. Calculate change between 2001 and 2006
    a. Run script “RiparianTablesChange”, calculates difference for each field between wshd_tributaries_riparian_01 and wshd_tributaries_riparian_06
6. Check change of nlcd_riparian_01 and nlcd_riparian_06
    a. Run model “NlcdChangeRaster”: combines nlcd_riparian_01 and nlcd_riparian_06 to nlcd_riparian_01_06_change, adds CHANGE field
    b. Run script “NlcdChageDesc”: calculates CHANGE field to text description of change

Appendix E
Yellow River Watershed Resource Inventory and Assessment

Introduction

To facilitate the development of the visions, goals, and strategies of the Yellow River Watershed Landscape Stewardship Plan (LSPA), the following section on Resource Inventory and Assessment outlines the geography of the Yellow River Landscape Stewardship Project Area and the state of the LSPA in terms of land cover and water quality. From this outline, readers can make conclusions about the trends within the LSPA. The section begins with General Information to orient the reader within the political, ecological, and hydrological geographies of the State of Wisconsin and within the LSPA. Following this, discussions and illustrations of data concerning Landforms, Soils, and Land Cover, and Waters are provided. This is then framed against Ownership and Population within the LSPA.

Following the Resource Inventory, several Resource Assessment tools and information are discussed and illustrated. These include: Land Cover Change Analysis; Potential Private Forest Land, Managing Forests to Slow Spring Snow Melts; Wisconsin Statewide Forest Strategy Priority Landscapes & Issues, Natural Heritage Inventory, Water Quality, and Economic Sector Statistics. Descriptions of each assessment tool are included prior to illustrations and tables.

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- Rare and Natural Features (*Table 29 – Rare and natural features, zoological types; Table 30 – Rare and natural features, botanical types*)

6. Water Quality

- Water Quality (*Figure 28 – Impaired Waters, Outstanding/Exceptional Resource Waters, Trout Streams; Table 31 – Impaired waters areas; Table 32 – OERW streams; Table 33 – OERW lakes; Table 34 – Trout streams not listed as OERW*)

7. Economic Sector Statistics

- Agriculture (*Figure 29 – Farm and Non-Farm Jobs, Two County Region; Figure 30 – Farm Jobs as a Percent of Total Employment, 2010; Figure 31 – Farm Earnings as a Percent of Total Earnings, 2010*)
- Timber (*Figure 32 – Percent of Total Private Employment in Timber, 2010; Figure 33 – Percent of Total Private Employment in Timber, Two County Region*)
- Services (*Figure 34 – Percent of Total Private Employment in Services, 2010*)

- Tourism (*Figure 35 – Percent of Total Private Employment in Travel & Tourism, 2010*)

8. Sub-watershed Analysis

- Sub-watershed Analysis (*Figure 36 – Sub-watersheds; Table 35 – Sub-watershed areas*)
- Loon Creek
- Lower Yellow River
- Sand Lakes
- Rice Lake
- Shell Lake
- Headwaters Yellow River

C. Citations

1. In Text

2. Geographic Data

This document contains bookmarks that can be used for navigation.

A. Resource Inventory

1. General Information

Political Boundaries and Watersheds

The Yellow River Watershed collects waters that flow into the Yellow River, which then flows into the St. Croix River (Figure 1). The St. Croix River Basin, which spans 7,700 square miles across the States of Minnesota and Wisconsin, channels waters into the Mississippi River, which ultimately flows to the Gulf of Mexico. At 366 square miles, the Yellow River makes up about 5% of the St. Croix River Basin.

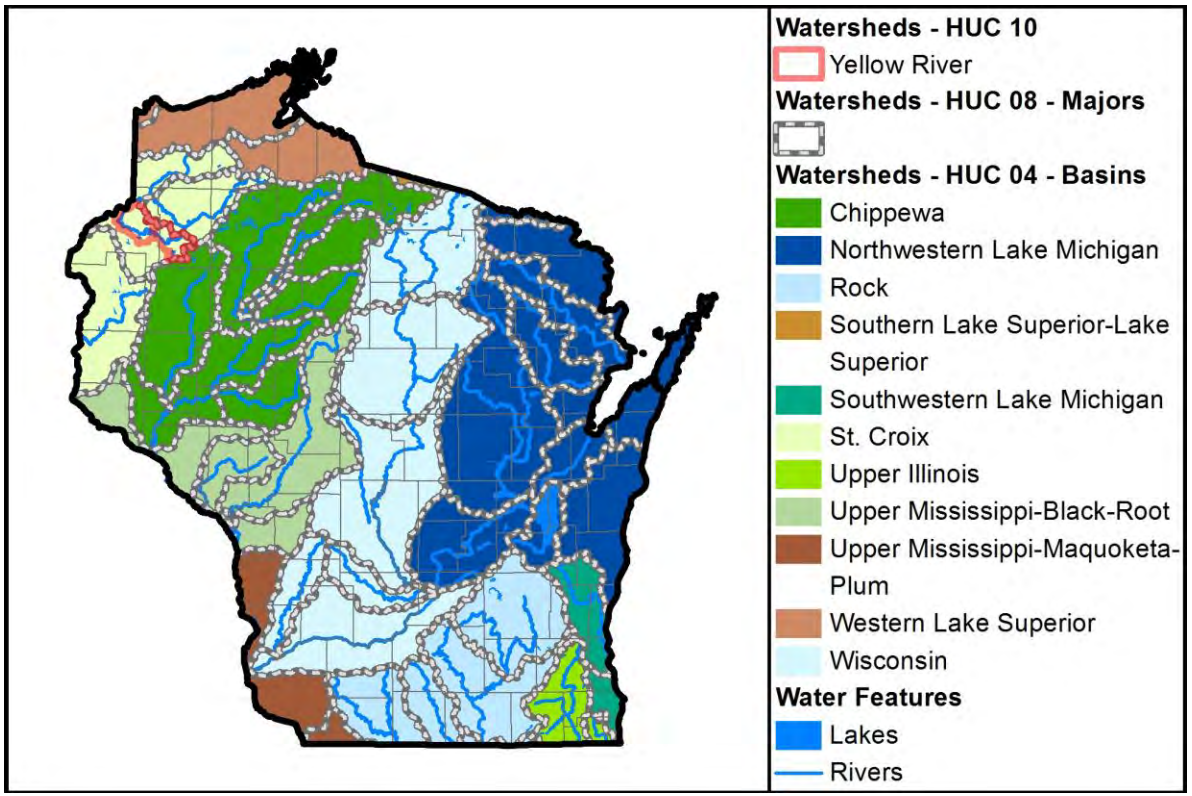


Figure 1. Watersheds in Wisconsin.

Political Units

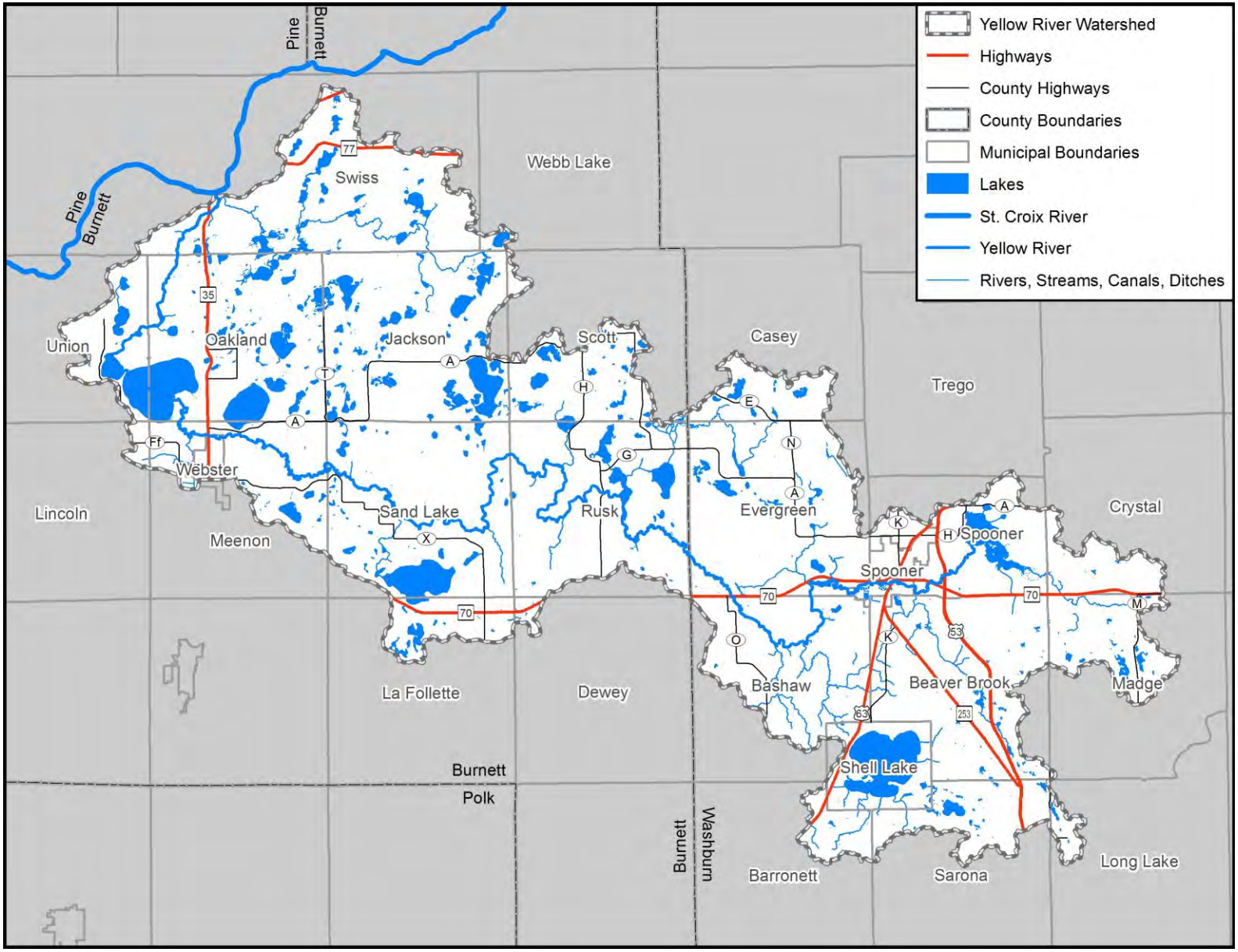


Figure 2. Political units.

Table 1. Political unit areas (acres) in watershed.

County	Area (Acres)		Percent In Watershed
	Total	In Watershed	
Burnett	562,935	137,006	24.3
Washburn	545,672	97,338	17.8
Total Watershed Area:		**234,344**	

The Yellow River Watershed stretches across the counties of Burnett (24% of the county) and Washburn (18% of the county) The Yellow River meets the St. Croix River as it meanders along its path, which at this reach, forms the border between the States of Minnesota and Wisconsin. Across the St. Croix River, Pine County, Minnesota neighbors Burnett County (Figure 2; Table 1).

The watershed covers areas in 23 townships, 2 cities, and 1 village; thirteen municipalities in Burnett County and thirteen in Washburn County. The Yellow River flows through the City of Spooner in Washburn County. Two municipalities, the City of Spooner and Oakland township are wholly contained within the Yellow River Watershed, and six other municipalities are more than 90% within the watershed, they are: Jackson Township, Rusk Township, and Sand Lake Township in Burnett County, and Beaver Brook Township, Evergreen Township, and the City of Shell Lake in Washburn County (Figure 2).

Watersheds

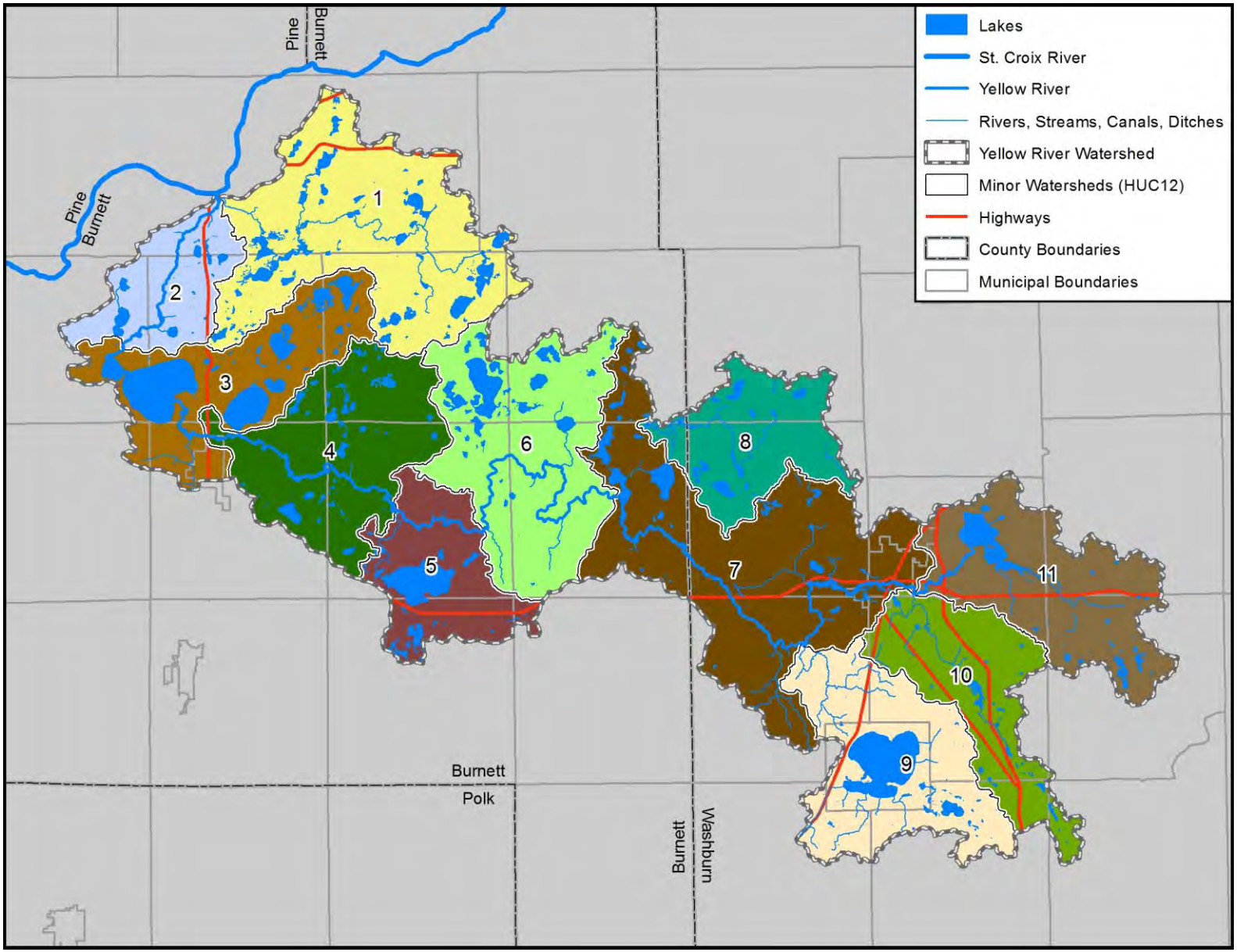


Figure 3. Watersheds.

Table 2. HUC 12 watersheds areas (acres), listed downstream to upstream, with row numbers and colors matching corresponding map labels and areas.

HUC 12 Name	Area (Acres)	% of Watershed
1. Loon Creek	32,205	13.7
2. Buffalo Lake-Yellow River	10,653	4.5
3. Yellow Lake	19,847	8.5
4. Bass Lake-Yellow River	21,966	9.4
5. Big Sand Lake-Yellow River	13,612	5.8
6. Sand Lake-Yellow River	26,083	11.1
7. Rice Lake-Yellow River	37,831	16.1
8. Rocky Ridge Creek	13,735	5.9
9. Shell Lake	21,520	9.2
10. Beaver Brook	16,115	6.9
11. Spooner Lake-Yellow River	20,776	8.9
Total	**234,344**	

Table 3. Watershed area (acres) in political units.

County	Acres in Watershed	% of Watershed
Burnett	137,006	58.5
Washburn	97,338	41.5
Total	**234,344**	

The Yellow River Watershed is made up of HUC 12 watersheds which range in size 10,653 acres to 37,831 acres. The mainstem of the Yellow River flows primarily east to west with tributaries flowing in from the north and south. Major tributaries of the Yellow River include Loon Creek, Whiskey Creek, Dahlstrom Brook, Sawyer Creek, Beaver Brook, and Crystal Creek (Figure 3; Table 2).

The majority of the Yellow River Watershed is held by Burnett County (58.5%) which holds the downstream portion of the watershed from Lipsettt Lake and downstream to the St. Croix River confluence. Washburn County holds the upstream portion

of the watershed (41.5%), including most of the larger tributary streams and the headwaters of the Yellow River (Figure 3; Table 3).

2. Landforms, Soils, and Land Cover

Relief and Drainage Areas

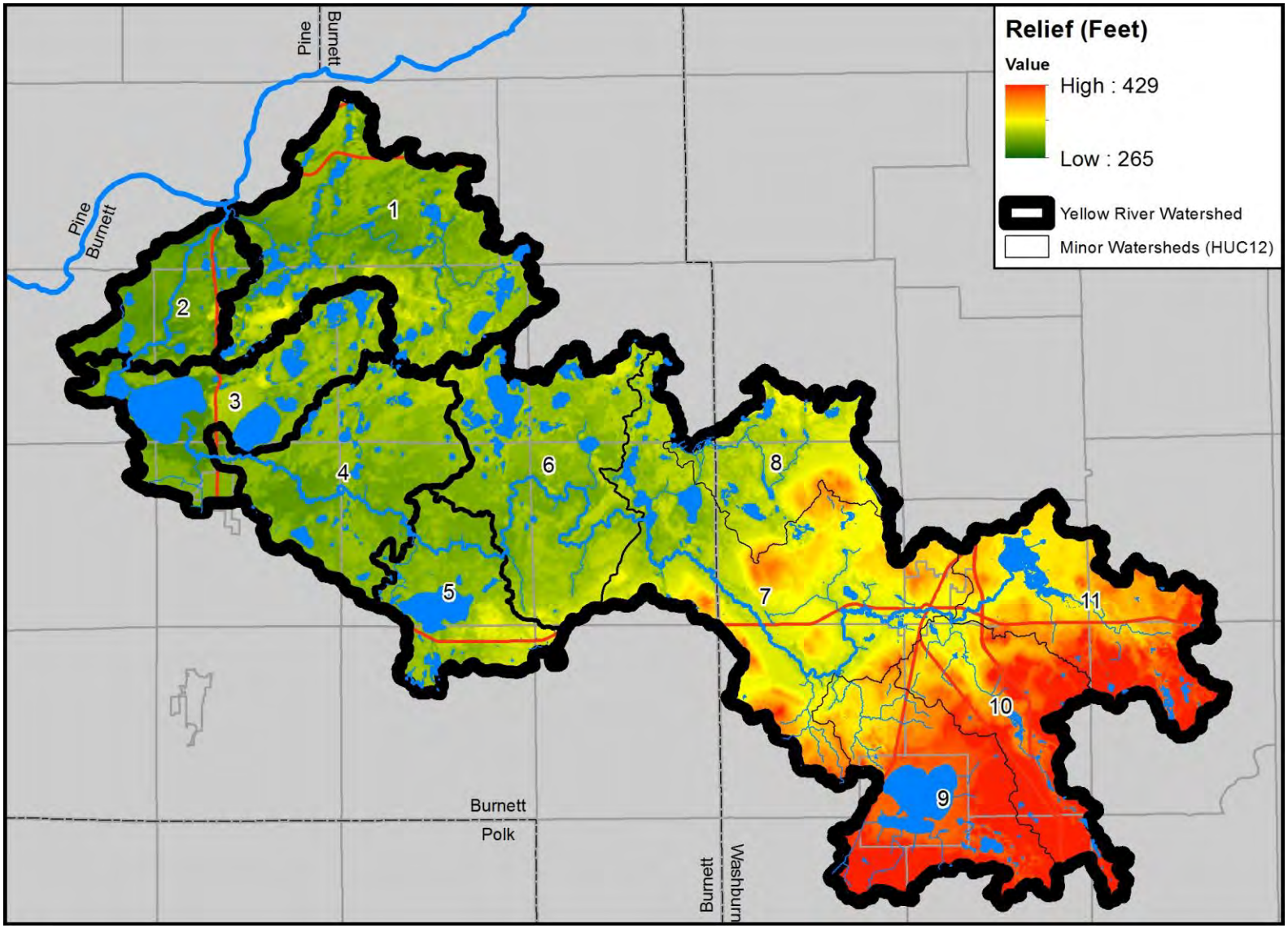


Figure 4. Relief and drainage areas.

Table 4. Watershed hierarchy and upstream drainage areas from HUC 12 watersheds, with watershed numbers corresponding to Figure 4.

<table>
<tr><th colspan="8">Watershed Hierarchy (to HUC 12 watersheds)</th><th>Acres of upstream drainage</th></tr>
<tr><td rowspan="10">Yellow River</td><td rowspan="7">2. Buffalo Lake-Yellow River</td><td rowspan="6">3. Yellow Lake</td><td rowspan="5">4. Bass Lake-Yellow River</td><td rowspan="4">5. Big Sand Lake-Yellow River</td><td rowspan="3">6. Sand Lake-Yellow River</td><td rowspan="4">7. Rice Lake-Yellow River</td><td>11. Spooner Lake-Yellow River</td><td>20,776</td></tr>
<tr><td>10. Beaver Brook</td><td>16,115</td></tr>
<tr><td>9. Shell Lake</td><td>21,520</td></tr>
<tr><td>8. Rocky Ridge Creek</td><td>13,735</td></tr>
<tr><td colspan="2">7. Rice Lake-Yellow River Total</td><td>109,978</td></tr>
<tr><td colspan="3">6. Sand Lake-Yellow River Total</td><td>136,061</td></tr>
<tr><td colspan="3">5. Big Sand Lake-Yellow River Total</td><td>149,673</td></tr>
<tr><td colspan="2">4. Bass Lake-Yellow River Total</td><td>171,639</td></tr>
<tr><td colspan="2">3. Yellow Lake Total</td><td>191,485</td></tr>
<tr><td colspan="3">2. Buffalo Lake-Yellow River Total</td><td>202,139</td></tr>
<tr><td colspan="2">1. Loon Creek</td><td colspan="5"></td><td>32,205</td></tr>
<tr><td colspan="8">Yellow River Total</td><td>234,344</td></tr>
</table>

The drainage in the Yellow River Watershed, which is driven by the relief of the land, is a fairly straightforward network of drainage areas that collect into the Yellow River tributary streams and eventually into the Yellow River itself. The numbering system used in Figure 4 and Table 4 increases from the downstream to the upstream watersheds. The line weight of the watershed boundary increases with each tier. First tier watersheds are those that are headwater streams.

For example, the Rice Lake-Yellow River River HUC 12 (7) has an upstream drainage that includes its area as well as that of HUC 12s numbered 8 – 11. The Buffalo Lake – Yellow River HUC 12 (2) has an upstream drainage that includes its area as well as HUC 12s numbered 3-11. The Loon Creek HUC 12 (1) is isolated from all other drainages in the wastershed and flows into the Yellow River just above the St. Croix Confluence (Table 4).

Soils Summary

This soils inventory includes Drainage Class, Farmland Class, and Hydric Rating for soil data, which is a product of the Soil Survey Geographic (SSURGO) Database – US Dept. of Ag. – National Resource Conservation Service.

Prime Farmland: Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, and few or no rocks. Its soils are permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time, and it either does not flood frequently during the growing season or is protected from flooding. Users of the lists of prime farmland map units should recognize that soil properties are only one of several criteria that are necessary. Other considerations include: land use, frequency of flooding, irrigation, water table, and wind erodibility.

Farmland of Statewide Importance: This is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oil seed crops. Criteria for defining and delineating this land are to be determined by the appropriate State agency or agencies. Generally, additional farmlands of statewide importance include those that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some may produce as high a yield as prime farmlands if conditions are favorable. In some States, additional farmlands of statewide importance may include tracts of land that have been designated for agriculture by State law.

Drainage Class: The dominant drainage class for the map unit, based on composition percentage of each map unit component.

Hydric Soils. A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soils along with hydrophytic vegetation and wetland hydrology are used to define wetlands (NRCS, Ecological and Interpretive Groups).

Soils – Drainage Class

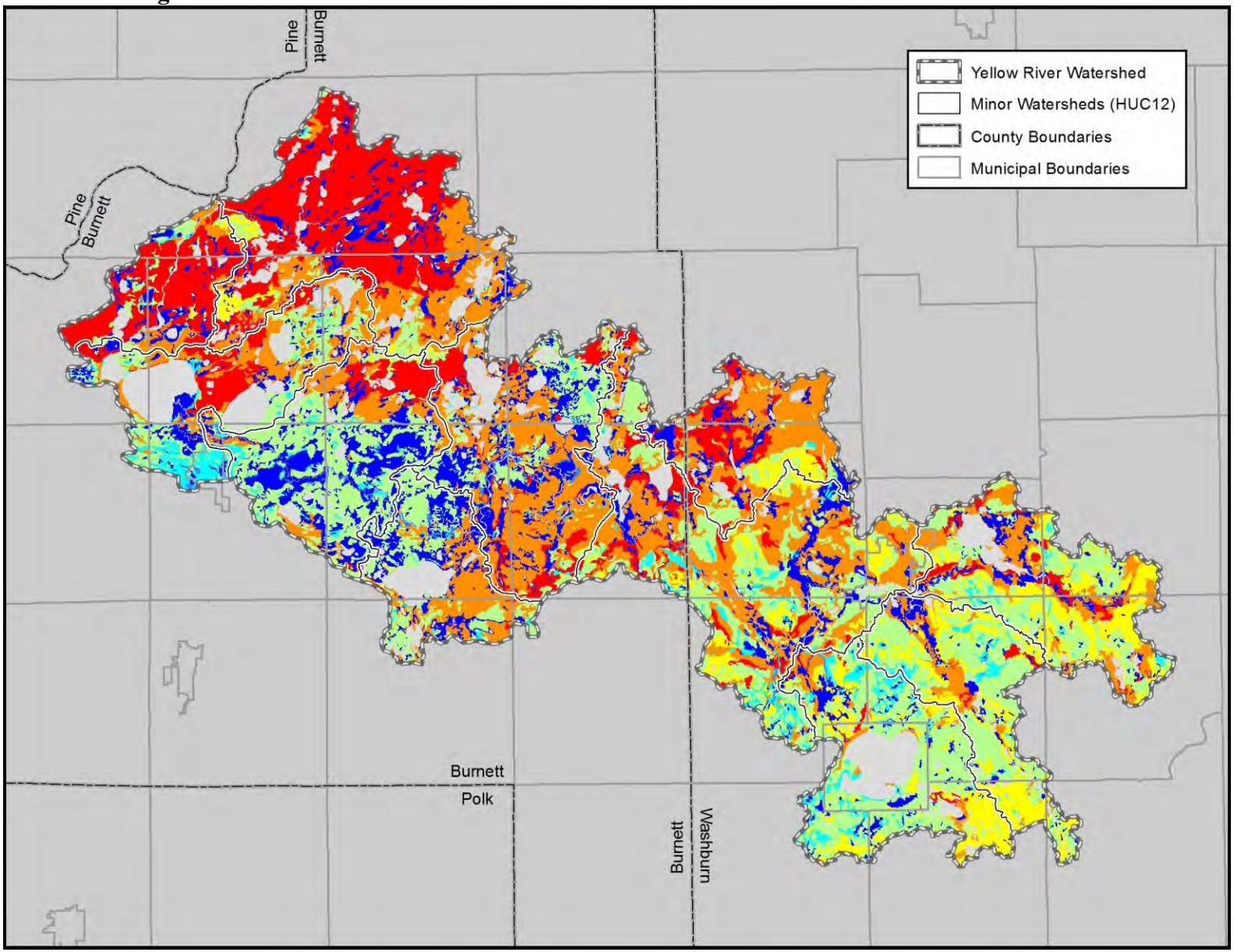


Figure 5. Soil drainage.

Table 5. Soil drainage areas (acres), with row colors matching corresponding map areas in Figure 5.

SSURGO Soils Drainage Class	Area (Acres)	% of Total
Excessively drained	37,864	16.2
Somewhat excessively drained	55,544	23.7
Well drained	18,086	7.7
Moderately well drained	61,364	26.2
Somewhat poorly drained	7,172	3.1
Poorly drained	892	0.4
Very poorly drained	28,493	12.2
Not Rated	24,929	10.6
Total Watershed Area	**234,344**	

The soils in the Yellow River Watershed tend to be drier with only 15.7% of the watershed classified as somewhat poorly drained or wetter. In general, the drier more xeric soils are found in the lower reaches on the northwest end of the watershed as the Yellow River descends toward its mouth at the St. Croix River confluence. The richer soils tend to be found in the upper watershed surrounding the Yellow River and its headwaters streams. Approximately 16.2% of the watershed has soils that are classified as excessively drained. These sandy soils tend to be concentrated on the lower end of the watershed in the Loon Creek and Buffalo Lake-Yellow River HUC 12 watersheds. Somewhat excessively drained soils, the second most common classification in the Yellow River Watershed are common throughout the central reaches of the watershed. Soils classified as well drained (7.7%) and moderately well drained (26.2%) are concentrated in the upper watershed in the Shell Lake, Beaver Brook, and Spooner Lake-Yellow River HUC 12 watersheds. There is also a concentrated area of moderately well drained to very poorly drained soils in the southwest portion of the central watershed primarily within the Bass Lake and Big Sand Lake HUC 12 watersheds.

Soils – Farmland Classification

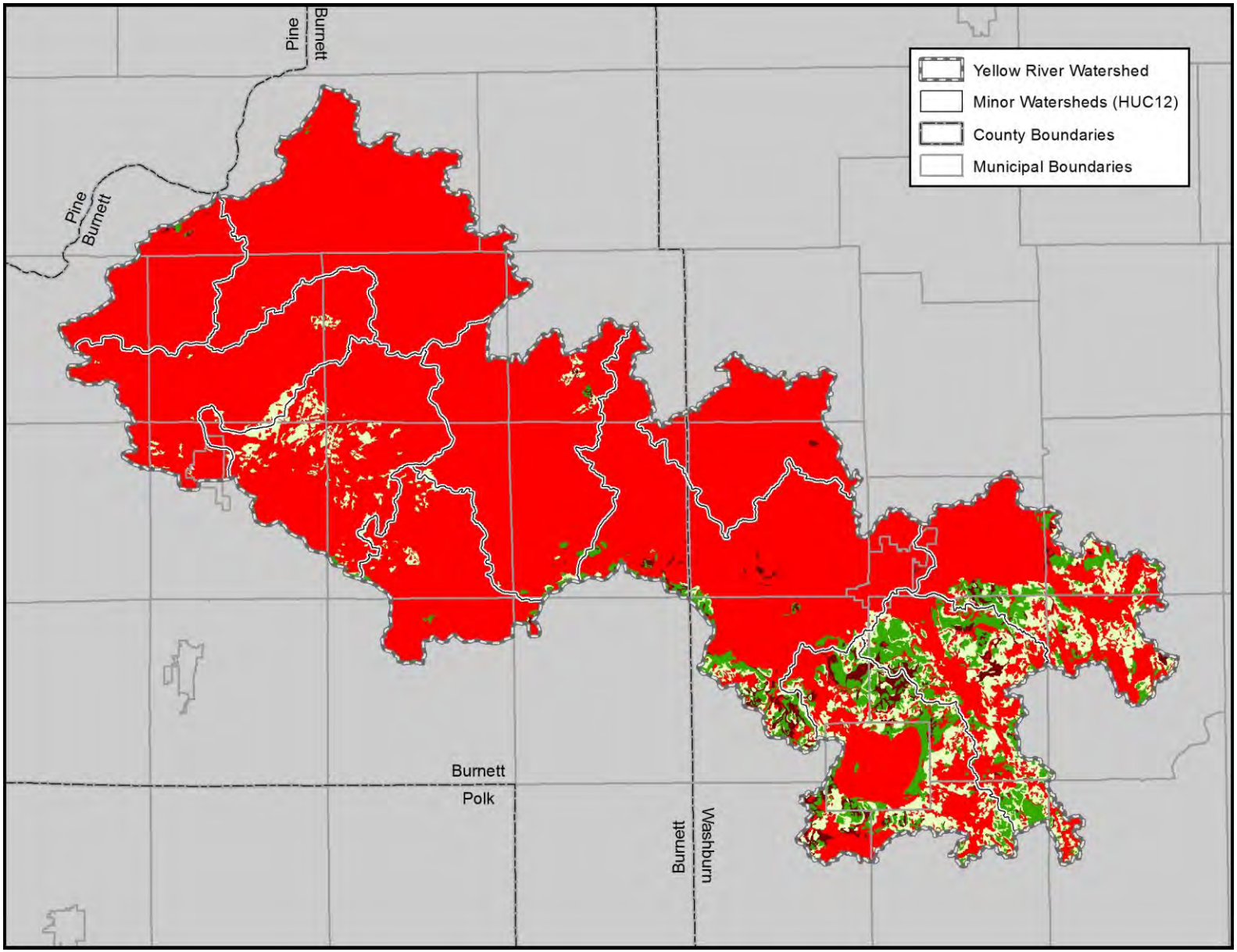


Figure 6. Soil farmland classification.

Table 6. Soil farmland class areas (acres), with row colors matching corresponding map areas in Figure 6.

SSURGO Soils Farmland Classification	Area (Acres)	% of Total
All areas are prime farmland	13,419	5.7
Farmland of statewide importance	18,289	7.8
Not prime farmland	198,980	84.9
Prime farmland if drained	3,656	1.6
Total Watershed Area	**234,344**	

The soils in the Yellow River watershed are generally xeric and excessively drained and not considered prime farmland. The majority of soils, 84.9%, are classified as not prime farmland. These soils dominate the watershed except in the upper watershed where richer soils are more favorable for agriculture. Soils classified as prime farmland, 5.7% of soils in the Yellow River Watershed, along with farmland of statewide importance, 7.8%, are primarily found in the upper watershed around Shell Lake, and the headwaters area of the Yellow River. Historically, farming in this area began in the 1860's after extensive logging of the of the white and red pine resources. However, due to low nutrient status of the soils, especially in the northwest sands portion of the watershed, farmers began abandoning non-productive farms in the 1930s and reforestation began throughout much of the watershed (Murphy, 1931). Farming continues to be an important land use in the richer parts of the upper watershed. When agricultural commodity prices rise as they have recently, areas that are not prime farmland have a greater potential for being converted to farmland.

Soils – Hydric

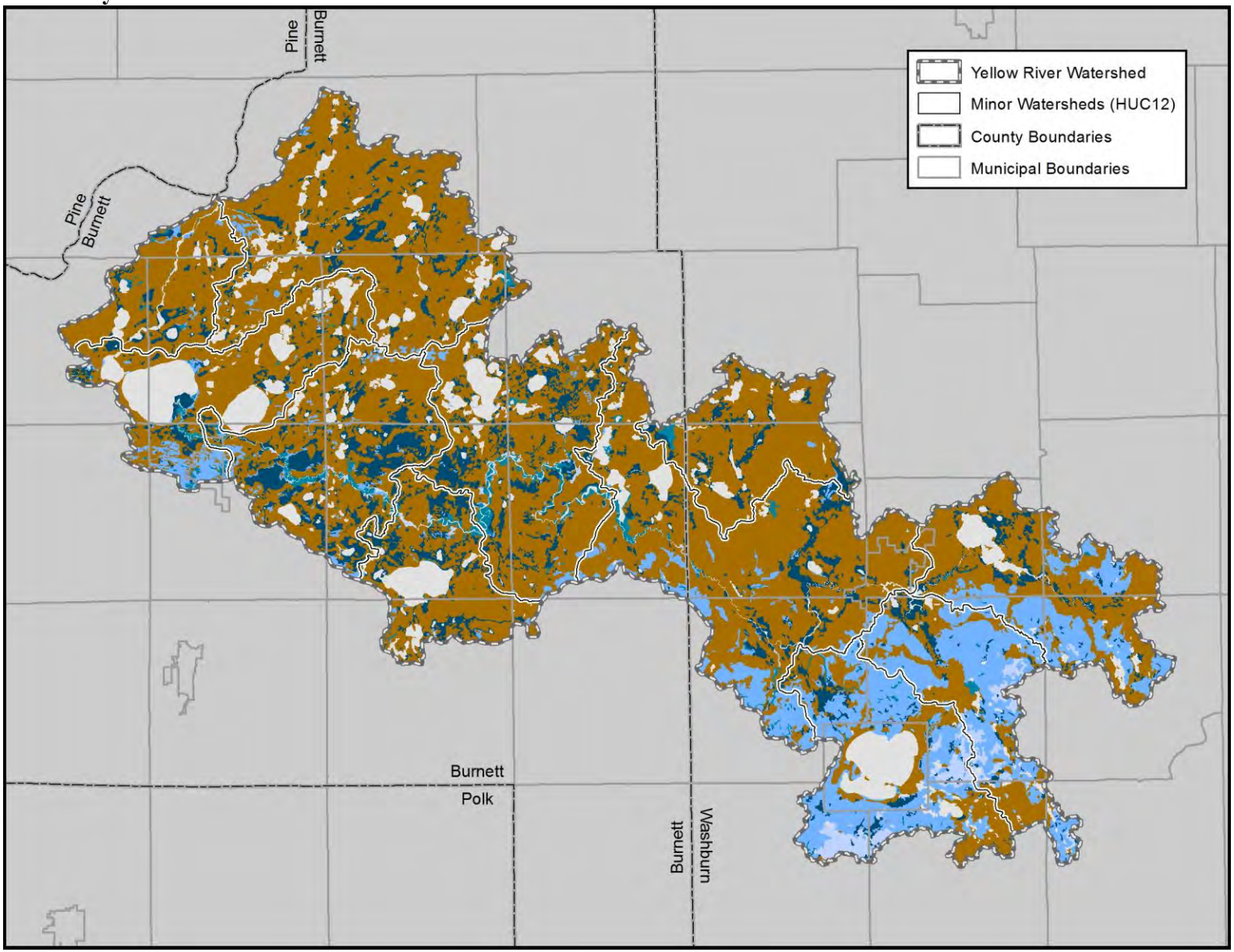


Figure 7. Soil hydric rating.

Table 7. Soil hydric rating areas (acres), with row colors matching corresponding map areas in Figure 7.

SSURGO Soils Hydric Rating by Map Unit	Area (Acres)	% of Total
All Hydric	25,260	10.8
Predominantly Hydric	3,658	1.6
Hydric Inclusions	31,805	13.6
Partially Hydric	3,589	1.5
Not Hydric	145,337	62.0
Not Rated	24,695	10.5
Total Watershed Area	**234,344**	

The soils in the watershed are predominately rated non-hydric (62%). These soils are primarily the excessively and somewhat excessively drained soils that are dominant in this watershed. Soils rated as all hydric (10.8%) and predominately hydric (1.6%) are found in small patches scattered throughout the watersheds on soils classified as poorly or very poorly drained. Soils rated as partially hydric (1.5%) or with hydric inclusions (13.6%) are concentrated in the southeast, upstream end of the watershed, primarily on soils classified as well or moderately well drained.

Presettlement Land Cover – Mid-late 1800s

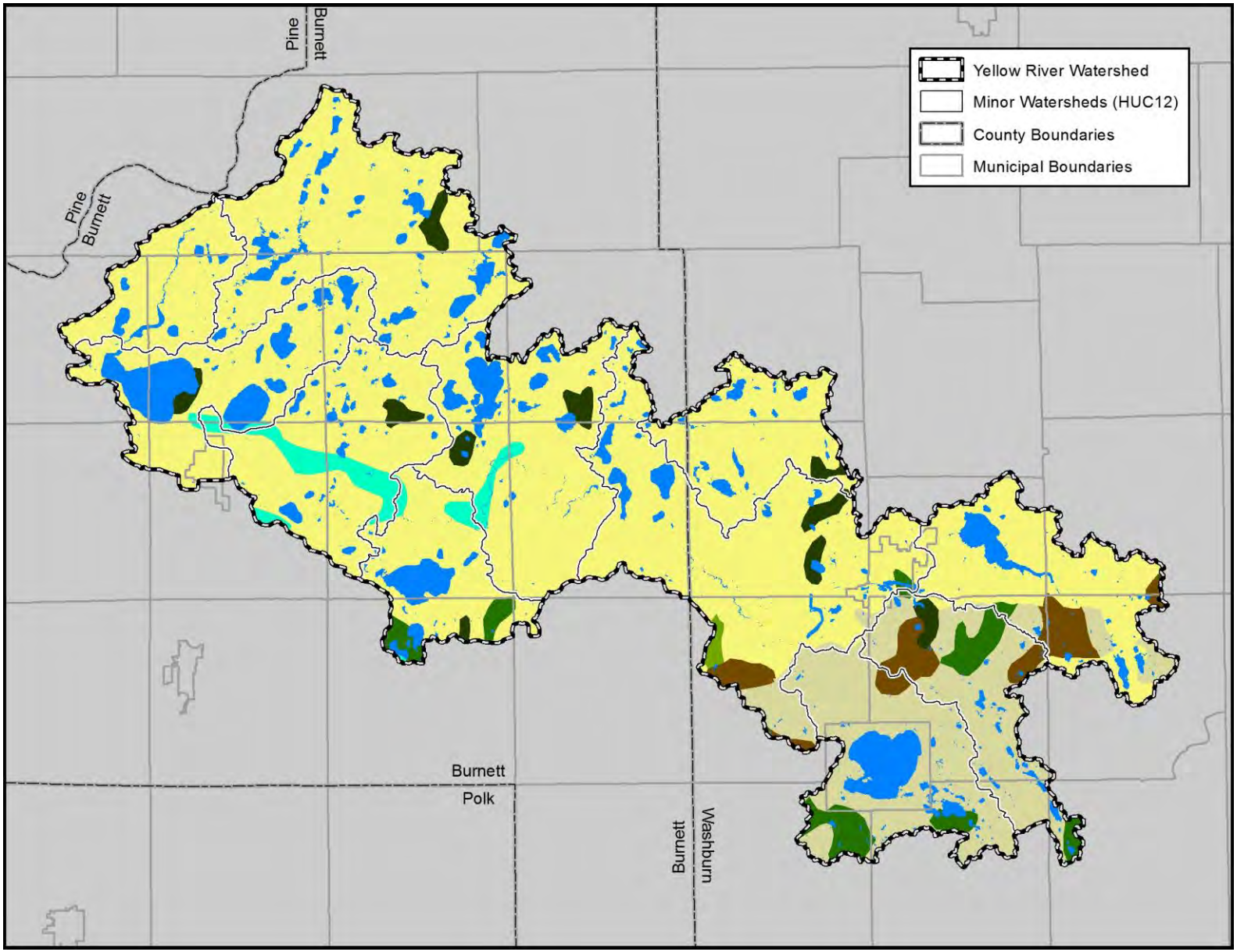


Figure 8. Presettlement land cover, mid-late 1800s.

Table 8. Presettlement land cover for mid-late 1800s (acres), with row colors matching corresponding map areas in Figure 8.

Comparison Class	Presettlement Vegetation Original Class	Area (Acres)	% of Total
Upland Forest	Jack pine, scrub (hills), oak forest and barrens	158,297	67.6
	Oak -- white oak, black oak, bur oak	473	0.2
	Sugar maple, basswood, red oak, white oak, black oak	5,808	2.5
	Sugar maple, yellow birch, white pine, red pine	30,425	13.0
	White pine, red pine	5,740	2.4
Lowland Vegetation	Lowland hardwoods -- willow, soft maple, box elder, ash, elm, cottonwood, river birch	4,786	2.0
	Swamp conifers -- white cedar, black spruce, tamarack, hemlock	4,813	2.1
Open Water	Lakes (open water, 1992 areas added)	23,947	10.2
Total Watershed Area		**234,289**	

Presettlement land cover was predominately the jack pine, scrub oak, barrens cover type which is characteristic of the drier sandy soils that are common in this watershed and in this area of Wisconsin. This cover type was dominant over most of the watershed, except in the southeast quarter of the watershed where richer soils supported a predominately maple/birch/pine covertype (13.0%) with small areas of maple/basswood/oak (2.5%), white pine/red pine (2.4%), and oak forest (0.2%). There were a couple large areas of lowland hardwoods (2.0%) along the mainstem of the Yellow River in the central watershed and scattered areas of swamp conifer (2.1%) throughout. Approximately 10% of the watershed was characterized as open water.

In presettlement times considerable area in northern Wisconsin, approximately 2,300,000 acres, was covered with pine barrens rather than closed forest. The origin of this covertype in this region is primarily fire, with soil and topography also major contributing factors. In the northwest sands just north of the tension zone where most of the Yellow River watershed lies, the scrub oak barrens of central Wisconsin gave way to jack pine barrens, though scrub oak remained a component of the system. The understory of this covertype was primarily sand barrens species such a sweet fern, blueberry and grasses or depauperate bracken grassland (Curtis, 1959). The northwest sands region of Wisconsin is particularly unique as it was once covered by an ancient Barrens Lake, possibly an interior arm of post-glacial Lake Superior which significantly influenced the landforms and vegetation of the area (Aldrich & Fassett, 1929; Murphy, 1931).

Current Land Cover – 2006

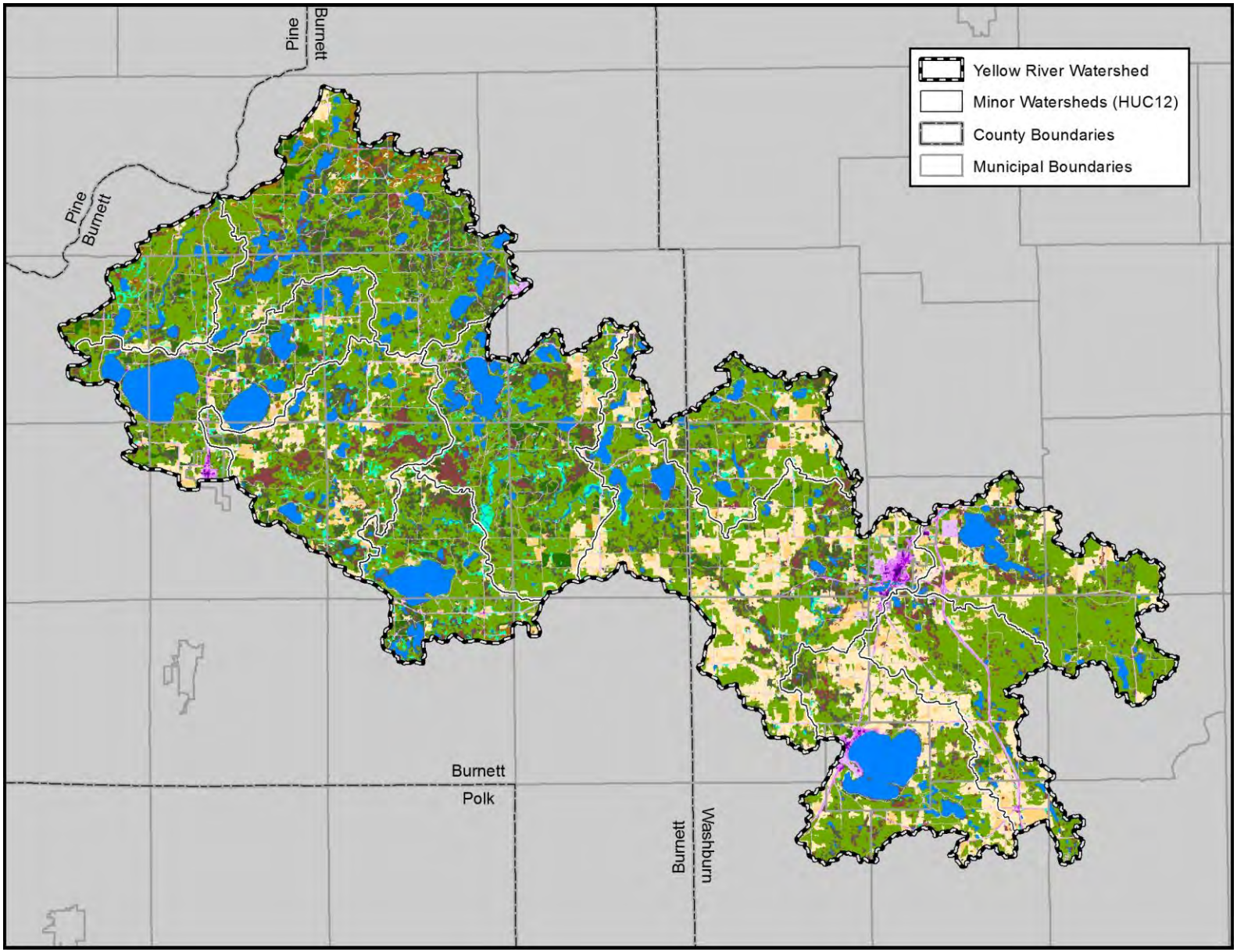


Figure 9. Current land cover, 2006.

Table 9. Current land cover areas for 2006 (acres), with row colors matching corresponding map areas in Figure 9.

Comparison Class	NLCD Original Classification	Area (Acres)	% of Total
Upland Forest	Deciduous Forest	107,653	45.9
	Evergreen Forest	7,779	3.3
	Mixed Forest	22,686	9.7
Upland Shrub	Shrub/Scrub	2,856	1.2
Upland Grass	Grassland/Herbaceous	1,150	0.5
	Pasture/Hay	26,840	11.5
Lowland Vegetation	Woody Wetlands	11,761	5.0
	Emergent Herbaceous Wetlands	5,489	2.3
Agriculture	Cultivated Crops	9,064	3.9
Developed	Developed, High Intensity	153	0.1
	Developed, Medium Intensity	350	0.1
	Developed, Low Intensity	1,831	0.8
	Developed, Open Space	12,845	5.5
Barren	Barren Land (Rock/Sand/Clay)	83	0.0
Open Water	Open Water	23,802	10.2
Total Watershed Area		**234,344**	

Today, 63.9% of the Yellow River watershed is in a forested condition. Approximately 46% is classified as upland deciduous forest, the dominant covertype for this watershed. Evergreen forest and mixed forest account for 3.3% and 9.7% of the watershed respectively and woody wetland (a combination of lowland forest and shrub) cover 5% of the land. Shrublands (1.2%), herbaceous grasslands (0.5%), and emergent herbaceous wetlands are minor covertypes for this watershed today. Agriculture, while not a dominating covertype is an important land use, particularly in the southeastern third of the watershed; pasture/hay accounts for 11.5% of the land, while cultivated crops occupy around 4%. Developed land covers 6.5% of the watershed; most of this, 5.5%, is developed open space which can be roads, parks, large mowed lots, golf courses etc. The remainder is primarily low intensity development (0.8%).

Ecological Classification Systems Summary

The Yellow River watershed encompasses part of three ecological landscapes: the Northwest Sands, the Northwest Lowlands, and the Forest Transition

Most of the Yellow River watershed (74.7%) is within the **Northwest Sands Ecological Landscape**. This ecological landscape encompasses approximately the western ¾ of the watershed (Figure 10). The Northwest Sands are characterized by rolling to flat topography and sandy soils. Land cover is primarily dry oak and pine forests, pine barrens, vast sedge meadow/marsh complexes and concentrations of lakes (WDNR, 2012).

Within the Northwest Sands the Yellow River Watersheds is part of the Bayfield Sand Plains Subsection which is distinguished from surrounding Subsections by its geomorphology; it is a large, xeric glacial outwash system surrounded by moraines. The Bayfield Sand Plains is an extensive outwash system formed of sands and gravels deposited by glacial meltwater. It is the largest continuous xeric Subsection in northern Wisconsin. The outwash system is made up of level terraces deposited along the Glacial Lake Superior spillway, and pitted outwash plains. Kettle lakes are common in the pitted outwash. The dominant habitat type group is very dry to dry, but dry to dry-mesic and wet-mesic to wet also are common. Historic vegetation included jack pine and oak forests, savannas and barrens, and some areas dominated by red and white pine. Fire was the dominant natural disturbance agent.

The Yellow River Watershed is located in the southwestern portion of the subsection with lower elevations and nearly level to rolling topography. Elevation gradually increases and topography becomes steep as the subsection extends into the hills of northern Bayfield County. In the south central part of the Bayfield Sand Plains where the Yellow River Watershed intersects with the subsection, historic vegetation was strongly dominated by jack pine forests of relatively small diameter trees. Density in this area was variable, with thick patches of forest interspersed with large openings. There were also areas of open savannas with large-diameter red pine and oak in areas transitional to the St. Croix moraines subsection. Around 1860, red and white pine began to be logged to make way for farming that began shortly thereafter. Logging intensified after 1910, when jack pine began to be used for pulp. Most of the farms in this subsection were abandoned by 1930. Extensive areas reforested naturally or were planted, and fire suppression began. In the south and central subsection, forest density increased, red pine and oak savannas disappeared, and other hardwood cover increased. In addition, jack pine abundance decreased, although a considerable amount of jack pine forest still exists today. Most of the barrens and savannas became forested (Kovach, 2005 – *unpublished*).

Within the Northwest Sands EL and the Bayfield Sand Plains subsection, the Yellow River Watershed intersects with five LTAs:

- Danbury-Trego Plains LTA on the northwest end of the Yellow River Watershed is characterized by undulating outwash plains with fans and stream terraces common. Soils are predominantly excessively drained sand over acid sand outwash. Historically the LTA was dominated by jack pine, scrub oak and barrens with small amounts of pine forest and swamp conifer. Today

upland coniferous forest and upland deciduous forest are the main cover types with smaller amounts of mixed forest, grassland, and forested wetland (WDNR, 2012).

- Lower Namekagon Rolling Barrens LTA intersects with the Yellow River Watershed in a small area on the western end of the watershed. The characteristic landform pattern for this LTA is rolling outwash plain. Soils are predominantly excessively drained sand over acid sand outwash. Historically the LTA was dominated by jack pine, scrub oak and barrens with small amounts of swamp conifer and lowland hardwoods. Today upland coniferous forest and upland deciduous forest are the main cover types with moderate amounts of mixed forest, shrubland, and non-forested wetland intermixed. The LTA also contains smaller amounts of grassland and forested wetland (WDNR, 2012).

- Web Lake Collapsed Barrens LTA intersects with the Yellow River Watershed across the northcentral watershed boundary into the western end of the watershed. The characteristic landform pattern for this LTA is rolling collapsed outwash plain with lakes common. Soils are predominantly excessively drained loamy sand over outwash. Historically this LTA was primarily jack pine, scrub oak and barrens with small amounts of pine forest and swamp conifer. Today the LTA is primarily upland deciduous forest with moderate amounts of upland coniferous forest, forested and herbaceous wetland, and small amounts of mixed forest, shrubland and agriculture (WDNR, 2012).

- The Siren Plains LTA intersects with the Yellow River Watershed in a band along the western half of the southern watershed boundary. The characteristic landform pattern for this LTA is undulating outwash plain and lake plain complex. Soils are predominantly moderately well drained sand over outwash or clayey lacustrine. Historically the LTA was primarily jack pine, scrub oak and barrens mixed with moderate amounts of pine forest and lowland hardwoods. Today, the primary land cover is upland deciduous forest with moderate amounts of forested and non-forested wetland and grassland, along with small amounts of upland coniferous and mixed forest, shrubland and agriculture (WDNR, 2012).

- The Spooner Plains LTA intersects with the southcentral portion of Yellow River Watershed along the transition from the northwest sands EL to the Forest Transition EL. The characteristic landform pattern for this LTA is undulating outwash plain with isolated morainic hills and ridges. Soils are predominantly well drained sand over outwash. Historically the LTA was primarily jack pine, scrub oak and barrens intermixed with small amounts of pine forest, maple/birch/pine forest, maple/basswood/oak forest, brushland, and swamp conifer. Today the LTA is primarily upland deciduous forest and grasslands with smaller amounts of coniferous and mixed forest, forested and herbaceous wetland, and agriculture (WDNR, 2012).

Two small sections of **Northwest Lowlands Ecological Landscape** extend into the far western edge of the Yellow River Watershed (1.3% of the watershed) (Figure 10). The Northwest Lowlands are characterized by gently rolling topography with

loamy and organic soils. Land cover is primarily mixed hardwood-conifer forests, large open peatlands, and many headwaters streams as well as, the corridor of the St. Croix River and associated habitats (WDNR, 2012).

Within the Northwest Lowlands the Yellow River Watersheds is part of the Mille Lacs Upland Subsection which extends across the St. Croix into eastern Minnesota. The Subsection consists of rocky, loamy ground moraine and end moraines; white pine-sugar maple, white pine-red pine, and aspen-birch forests, oak forests at south and west edge of subsection, and conifer swamps. This characteristic landform is primarily Superior lobe ground moraine and includes the Brainerd-Pierz and Automba drumlin fields and the McGrath till plain. The depressions between drumlin ridges contain peatlands with shallow organic material. Small areas of Des Moines lobe ground moraine are in the southeast part. In the northeast, the Sawyer-Cloquet and the Willow River outwash plains occupy more than 100,000 acres. The original vegetation consisted of a mosaic of forest types on the ground moraine. East of Mille Lacs Lake vegetation consisted primarily of white pine-red pine forest and aspen-white birch-white pine forest on the uplands, with conifer swamp on the lowlands (Finley 1976). Mixed hardwood-white pine forests were less common. The Sawyer-Cloquet and the Willow River outwash plains, also located east of Mille Lacs Lake, were dominated by white pine-red pine forests and less commonly by pure stands of white pine. Both of these outwash plains had large areas of jack pine barrens near their northeastern ends where the Yellow River watershed is located. Aspen-birch forest was also present, and conifer swamps and bogs were common in the kettle depressions of the moraines. White pine-red pine forest was abundant on the moraines north and east of Mille Lacs Lake. Both fire and windthrow were part of the natural disturbance regime that helped determine the vegetation of the subsection. White pine lumbering in the late 1800's eliminated much of the pine forest from the subsection (Kratz and Jensen 1983). Today, the following plant communities are common in this subsection: maple-basswood forest, mesic oak forest, northern hardwood forest, white pine-hardwood forest, black ash swamp, forested bog, poor fen, tamarack swamp, wet meadow (Albert, 1995).

Within the Northwest Lowlands EL and the Mille Lacs Upland subsection, the Yellow River Watershed intersects with one LTA:

- The St Croix Plains LTA extends into the Yellow River Watershed in two small separate sections on the western watershed boundary. The characteristic landform pattern for this LTA is undulating outwash plain and outwash-veneered moraine. Soils are predominantly excessively drained sand over acid sandy loam till or outwash. Historically the LTA was a mix of white pine/red pine forests, and jack pine/scrub oak/barrens cover types with moderate amounts of swamp conifer and lowland hardwoods. Today the LTA is primarily upland deciduous forest with moderate amounts of forested and herbaceous wetland and grasslands as well as small amounts of coniferous and mixed forest (WDNR, 2012).

The eastern ¼ of the Yellow River Watershed (24.0%) is within the **Forest Transition Ecological Landscape** (Figure 10). The Forest Transition is characterized by rolling to flat topography with productive silt loam soils. It is historically forested, but now

dominated by agricultural uses. There are extensive hemlock-hardwood forests to the east, and pine-oak forests to the west. Urban areas are concentrated near the Wisconsin River. In the Yellow River watershed, this ecological landscape contains most of the agricultural land use for the watershed (WDNR, 2012).

Within the Forest Transition EL the Yellow River Watersheds is part of the St Croix Moraine Subsection. Common landforms in this subsection are stagnation or end moraines, but ground moraine with drumlins are included at the southern margin of the sub-subsection. Moraines are cut by narrow, steep outwash channels, buried channels, and tunnel valleys. Shell Lake sits atop one of these moraines(?). Historically, red pine-white pine forests, along with trembling aspen-paper birch forests, occupied the rolling to irregularly sloped end moraines. Mixed hardwood-pine forest, dominated by a diverse mix of northern hardwoods and white pine, were found in the most fire-protected areas at the eastern edges of the sub-subsection, where fire protection was provided by irregular topography, broad wetlands, and relatively large lakes. This wetter, fire protected area is where the subsection intersects with the Yellow River Watershed. Immediately downwind from the outwash plains of Sub-subsection X.5.2, white pine-red pine forests or aspen-birch forests were probably the result of frequent fires that originated on the outwash. While, fire was the most prevalent form of disturbance, recurring every 10 to 40 years within the subsection as a whole; windthrow was probably more prevalent in the hardwood-pine forests area of the subsection where the Yellow River Watershed intersects. Present forests contain much more paper birch and trembling aspen than the original forests (Albert, 1995).

Within the Forest Transition EL and the St. Croix Moraine Subsection, the Yellow River Watershed intersects with one LTA:

- The Late St Croix Moraines LTA encompasses the eastern ¼ of the Yellow River Watershed. The characteristic landform pattern for this LTA is rolling collapsed moraine interlaced with outwash terraces and intermixed with ice-walled lake plains. Soils are predominantly moderately well drained sandy loam over dense, acid sandy loam till. Historically the LTA was primarily maple/birch/pine forest with small amounts of oak forest, maple/basswood/oak forest, jack pine/scrub oak/barrens, and aspen/birch/pine forest intermixed. Today this LTA contains most of the agricultural landuse for this watershed with large amounts of pasture land and cultivated crops. Upland deciduous forest is also common with smaller amounts of forested and herbaceous wetland (WDNR, 2012).

Ecological Landscapes

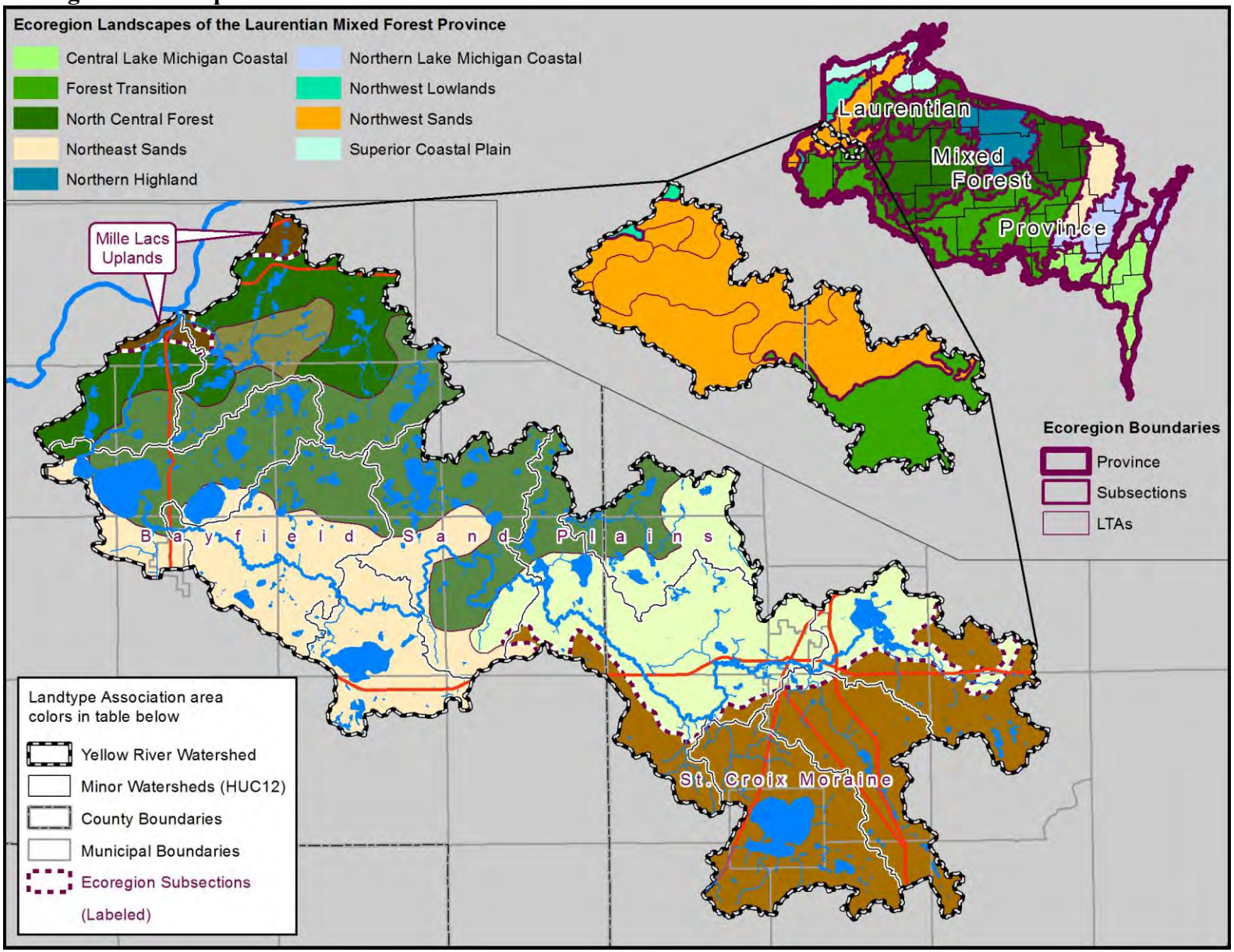


Figure 10. Ecological Landscapes

Table 10. Ecological Landscape areas (acres), with row colors matching corresponding map areas in Figure 10.

Ecological Landscape	Subsection	Landtype Association	Area (Acres)	% of Total
Forest Transition	St. Croix Moraine	Late St. Croix Moraines	56,357	24.0
Subtotal (Forest Transition, St. Croix Moraine)			**56,357**	**24.0**
Northwest Lowlands	Mille Lacs Uplands	St. Croix Plains	3,017	1.3
Subtotal (Northwest Lowlands, Mille Lacs Uplands)			**3,017**	**1.3**
Northwest Sands	Bayfield Sand Plains	Danbury-Trego Plains	21,281	9.1
		Lower Namekagon Rolling Barrens	5,114	2.2
		Siren Plains	42,212	18.0
		Spooner Plains	46,184	19.7
		Webb Lake Collapsed Barrens	60,179	25.7
Subtotal (Northwest Sands, Bayfield Sand Plains)			**174,971**	**74.7**
Total Watershed Area			**234,344**	

3. Waters

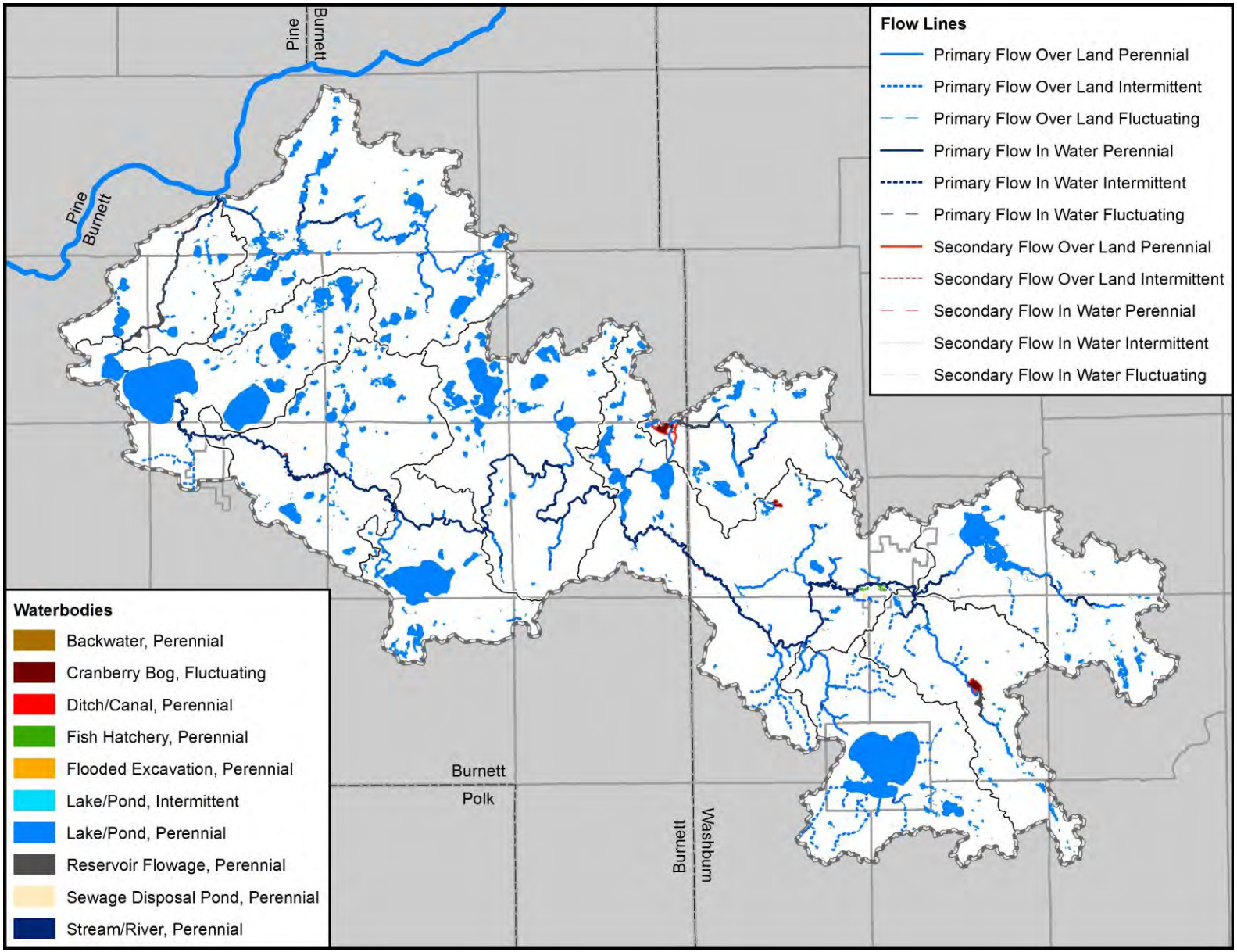


Figure 11. Waters.

Table 11. DNR Hydro Data flow lines.

Flow Type	Length (Miles)	% of Total
Primary Flow Over Land Perennial	58.2	23.7
Primary Flow Over Land Intermittent	40.1	16.4
Primary Flow Over Land Fluctuating	4.9	2.0
Primary Flow In Water Perennial	102.7	41.9
Primary Flow In Water Intermittent	5.0	2.1
Primary Flow In Water Fluctuating	22.7	9.3
Secondary Flow Over Land Perennial	9.9	4.0
Secondary Flow Over Land Intermittent	0.3	0.1
Secondary Flow In Water Perennial	0.9	0.4
Secondary Flow In Water Intermittent	0.2	0.1
Secondary Flow In Water Fluctuating	0.0	0.0
Total Length	**245.0**	

Table 12. DNR Hydro Data waterbodies

Waterbody Type	Area (Acres)	% of Total
Backwater, Perennial	14	0.1
Cranberry Bog, Fluctuating	130	0.6
Ditch/Canal, Perennial	3	0.0
Fish Hatchery, Perennial	38	0.2
Flooded Excavation, Perennial	1	0.0
Lake/Pond, Intermittent	4	0.0
Lake/Pond, Perennial	21,371	93.2
Reservoir Flowage, Perennial	380	1.7
Sewage Disposal Pond, Perennial	34	0.1
Stream/River, Perennial	949	4.1
Total Area	**22,923**	

According to the DNR Hydrography dataset, water body features cover 9.8 % of the total watershed area, which is consistent with the statistics from the National Land Cover Datasets (NLCD) 2006 data (Table 11). Perennial rivers, streams, and ditches run a total length of 171.7 miles in the watershed. Streams and ditches that are considered intermittent or fluctuating run a length of 73.2 miles. There are 21,371 acres of lakes in the Yellow River Watershed. Other notable water features include 130 acres of cranberry bog, 38 acres of rearing ponds at the Thompson State Fish Hatchery, and 34 acres of sewage disposal ponds primarily around the city of Spooner.

4. Ownership and Population

Ownership

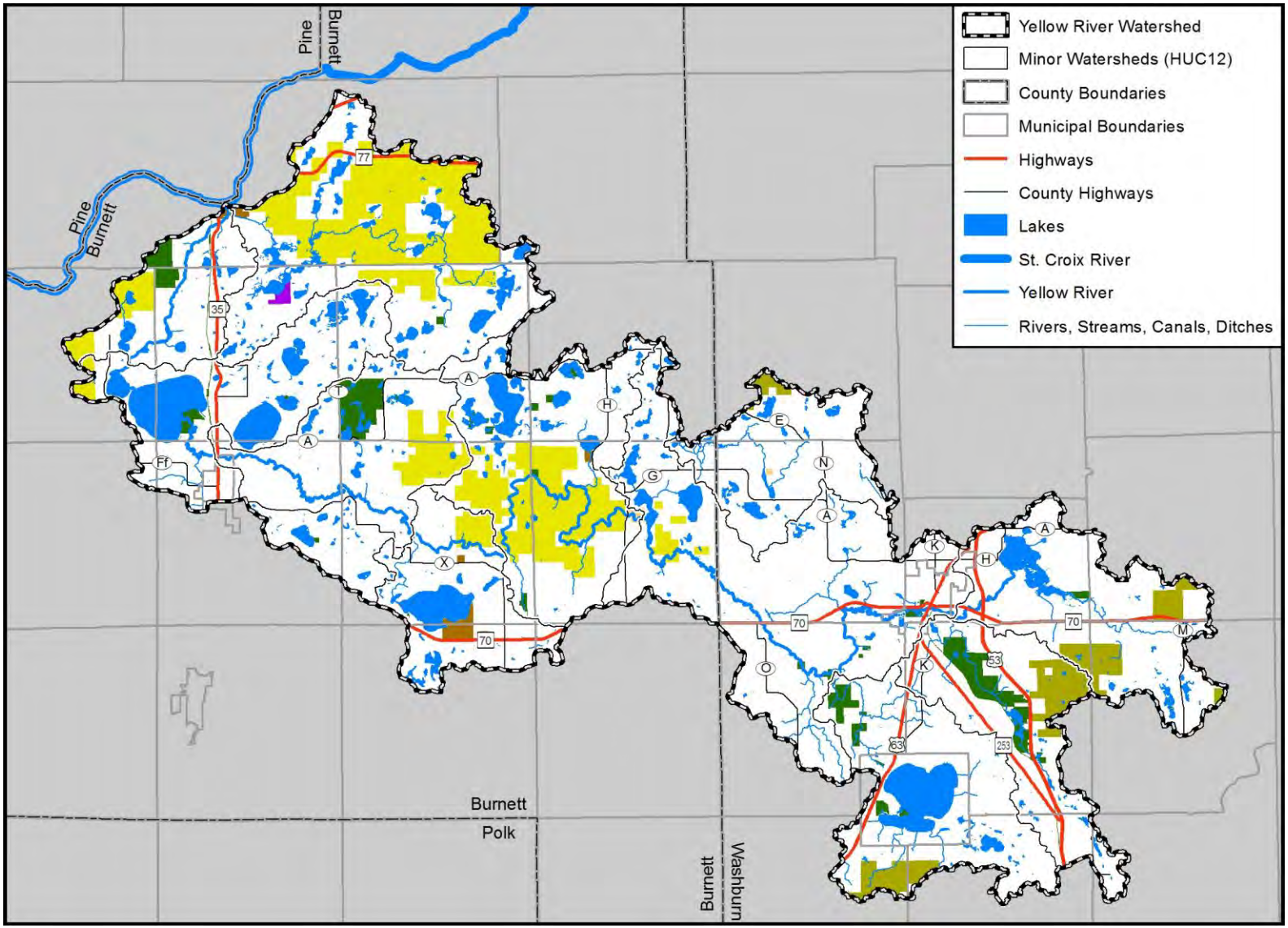


Figure 12. Ownership.

Table 13. Ownership areas (acres), with row colors matching corresponding map areas in Figure 12.

Owner Group	Owner Description	Ownership and Conservation Detail	Area (Acres)	% of Watershed
Public Ownership, Tribal Lands, and Private Conservancy	Tribal	Lac Courte Oreilles	178	0.1
		St. Croix	783	0.3
	Subtotal (Tribal)		**961**	**0.4**
	State	Wisconsin Department of Natural Resources	5,993	2.6
	Subtotal (State)		**5,993**	**2.6**
	County	Burnett County	26,652	11.4
		Washburn County	5,714	2.4
	Subtotal (County)		**32,366**	**13.8**
	Private Conservancy	The Nature Conservancy	167	0.1
	Subtotal (Private Conservancy)		**167**	**0.1**
Subtotal (Public Ownership, Tribal Lands, and Private Conservancy)			**39,488**	**16.9**
Private	Private	Private	194,856	83.1
Total			**234,344**	

Ownership in the watershed is primarily private, 83.1% of all lands in the watershed are privately held, non-conservancy lands. Tribal lands account for 0.4% of the land within the watershed; the Lac Courte Oreilles and St. Croix tribes own about 178 acres and 783 acres respectively. The Sigurd F. Olson Memorial Forest is a 167 acre private conservancy administered by the Nature Conservancy on Love Lake and Falk Lake, a part of the Loon Creek flowage. It represents about 0.1% of the watershed and is the only private conservancy land in the Yellow River Watershed.

Of the publicly held land, the largest land holder is Burnett County Forest which owns 26,652 acres; they are also the largest individual landowner within the watershed. Washburn County owns 5,714 acres within the watershed. The only other public land owner within the watershed is Wisconsin Department of Natural Resources, which owns 5,993 acres, about 2.6% of the land area. Public lands of note include:

- Burnett and Washburn County Forests
- Governor Knowles State Forest (partially)
- Governor Tommy G. Thompson State Fish Hatchery
- Beaver Brook Wildlife Area

- Sawyer Creek State Fishery Area
- Culbertson Springs State Fishery Area
- Keizer Lake State Wildlife Area
- Danbury Wildlife Area
- Spring Creek State Fishery Area
- Tozer Springs Fish and Wildlife Area
- Shell Lake Rearing Station

Population Change

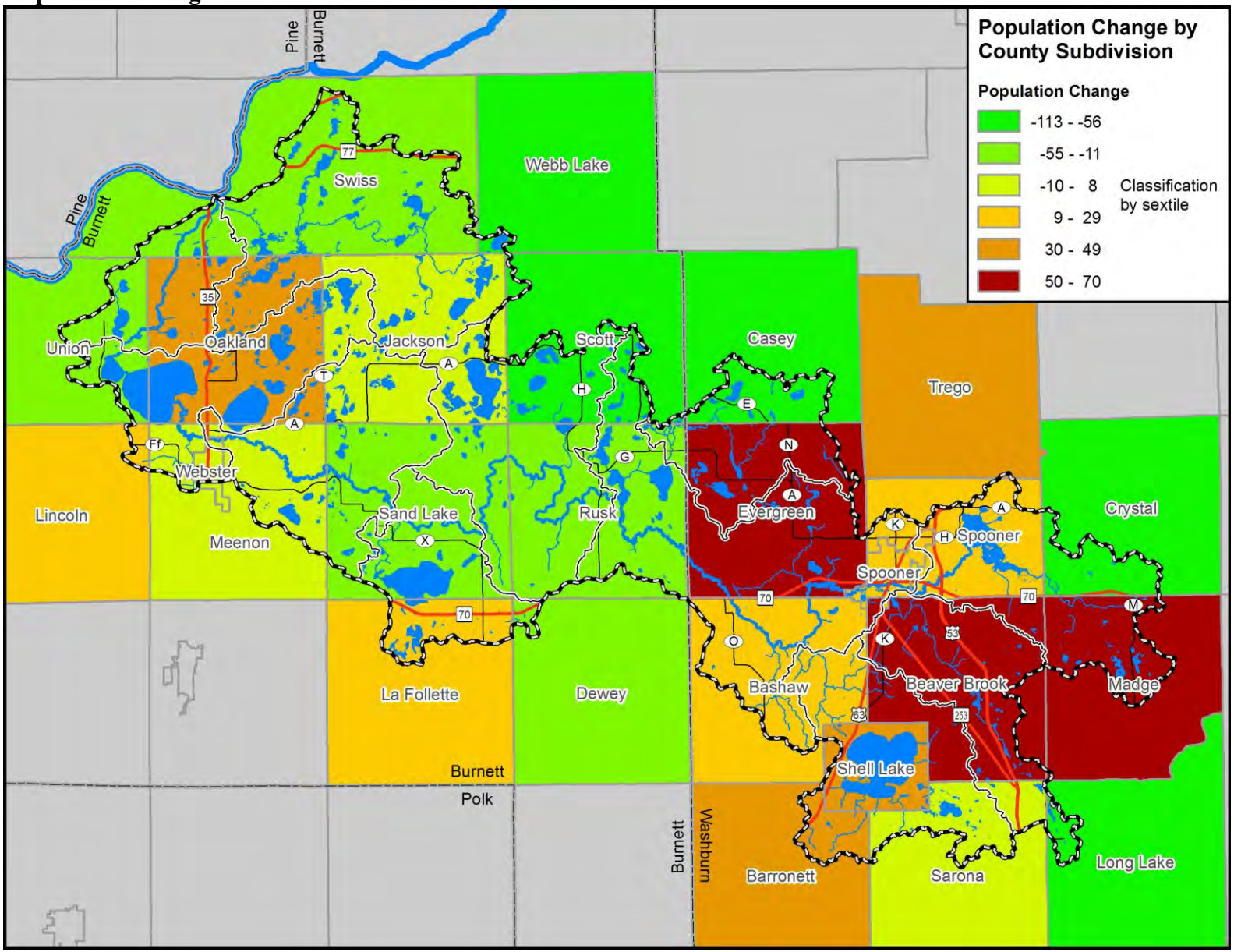


Figure 13. Population change from U.S. Census.

Table 14. Population change from U.S. Census, 2001 to 2011.

Municipality	U.S. Census Population				Municipality	U.S. Census Population			
	2001	2011	Change	% Change		2001	2011	Change	% Change
Barronett township	405	442	37	9.1	Oakland township	778	827	49	6.3
Bashaw township	921	946	25	2.7	Rusk township	420	409	-11	-2.6
Beaver Brook township	643	713	70	10.9	Sand Lake township	556	531	-25	-4.5
Casey township	466	353	-113	-24.2	Sarona township	382	384	2	0.5
Crystal township	323	267	-56	-17.3	Scott township	590	494	-96	-16.3
Dewey township	565	516	-49	-8.7	Shell Lake city	1,309	1,347	38	2.9
Evergreen township	1,076	1,135	59	5.5	Spooner city	2,653	2,682	29	1.1
Jackson township	765	773	8	1.0	Spooner township	677	706	29	4.3
La Follette township	511	536	25	4.9	Swiss township	815	790	-25	-3.1
Lincoln township	286	309	23	8.0	Trego township	885	932	47	5.3
Long Lake township	737	624	-113	-15.3	Union township	351	340	-11	-3.1
Madge township	454	508	54	11.9	Webb Lake township	381	311	-70	-18.4
Meenon township	1,172	1,163	-9	-0.8	Webster village	653	653	0	0.0
Total for all muncipalities intersecting watershed						**18,774**	**18,691**	**-83**	**-0.4**

Population is tracked by county subdivisions in the U.S. Census. For the 26 subdivisions in the watershed, which include cities, townships, and unorganized territories, the overall population growth from 2001 to 2011 was -83 persons (Table 14). Overall population remained fairly steady over this period for all subdivisions. The largest population growth occurred in the Beaver Brook Township (increase of 70 persons); the greatest loss occurred in Long Lake Township and Casey Township which each lost 113 persons. Population growth was the strongest in the eastern portion of the watershed in proximity to the cities of Spooner and Shell Lake (Figure 13)

B. Resource Assessment

1. Land Cover Change Analysis

This land cover change analysis includes Finley's Original Vegetation Cover of Wisconsin Map (published 1976) and the National Land Cover Datasets (NLCD) for 2001 and 2006. Finley's Original Vegetation Cover Map is based on Finley's original analysis of Public Land Survey notes and landscape patterns. Finley compiled his results in map format, and this was subsequently captured in digital format. The NLCD datasets were classified from satellite imagery and employ a two level classification system. The NLCD 2001 data has been revised to a second version which is directly comparable to the NLCD 2006 dataset.

Because the presettlement and NLCD datasets differ in collection/analysis methodologies and spatial resolutions, direct comparison at large scales is not recommended. The Presettlement and NLCD datasets also use different classification schemes, and so were reclassified to facilitate comparison at the watershed level. The comparison classes are included in Table 8 and Table 9. At the riparian level, where water features and riparian areas are captured at a scale of 1:24,000, analysis of the Presettlement data, which is at a scale of 1:500,000, would be inappropriate.

Riparian analysis was conducted on the NLCD 2001 and 2006 datasets, which were created at a scale large enough for riparian areas, and which can be compared directly both spatially and by classification system. The riparian analysis includes contributing riparian areas that are within 30 to 85 meters of flow pathways that include all flow types (perennial, intermittent) and that are connected to the mouth of the Yellow River. For more information on the riparian analysis, refer to the State of the Forest Report for the St. Croix River Basin.

Comparisons are made at the watershed level between pre-settlement (mid-late 1800s) and 2006 land cover and between 2001 and 2006 land cover, and at the riparian level between 2001 and 2006 land cover. Maps are included for the presettlement-2006 change and for contributing riparian areas. The display scale of the maps cannot illustrate a noticeable difference between 2001 and 2006 datasets, so the map displaying this comparison was not included. Tables are included for the watershed level presettlement-2006 and 2001-2006 comparisons and for the riparian level 2001-2006 comparison. Current political and ecological boundaries are included in the presettlement map to orient the map user.

Watershed Level Land Cover Change Analysis – Presettlement Land Cover (Mid-Late 1800s)

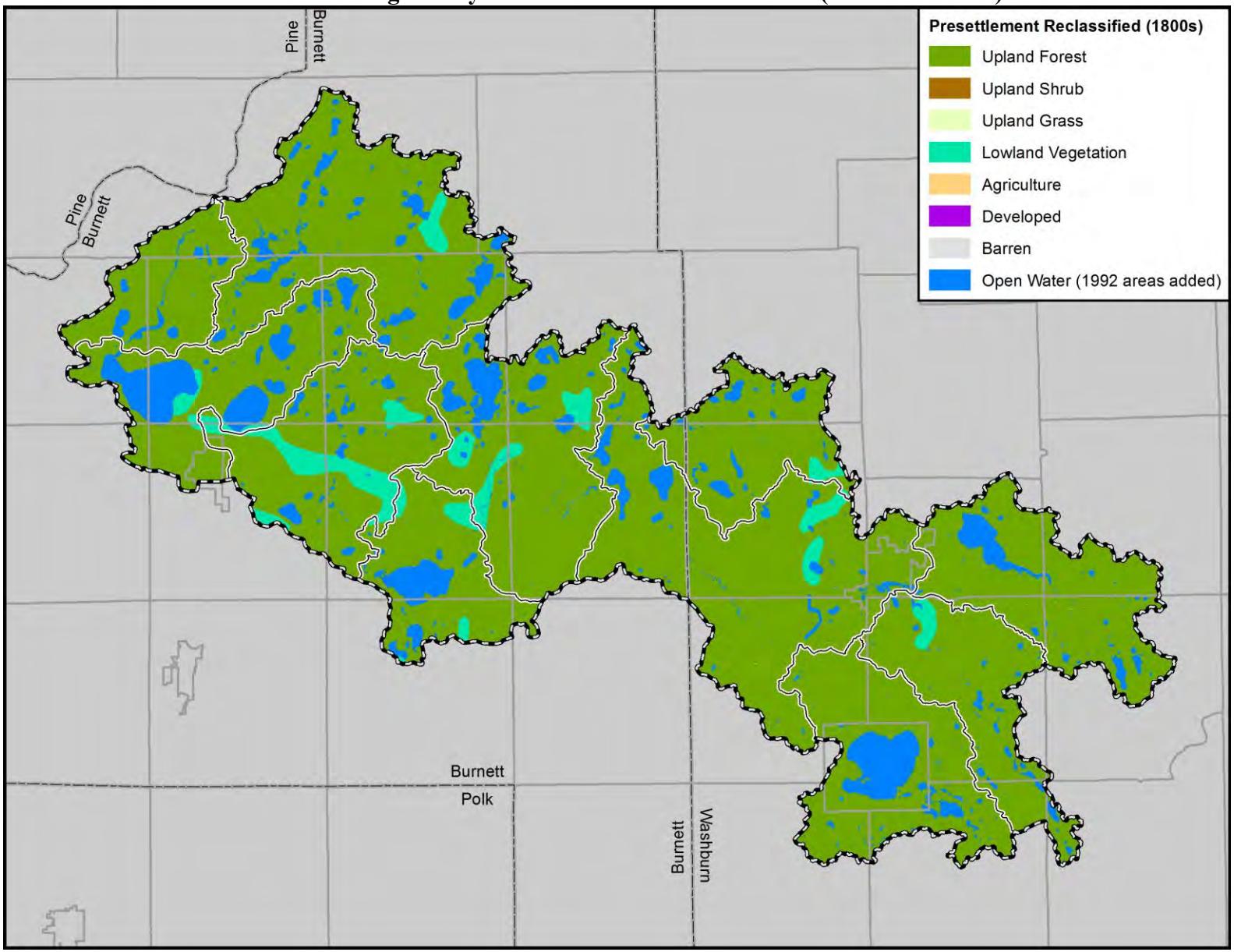


Figure 14. Presettlement land cover, mid-late 1800s (reclassified).

Watershed Level Land Cover Change Analysis – Current Land Cover (2006)

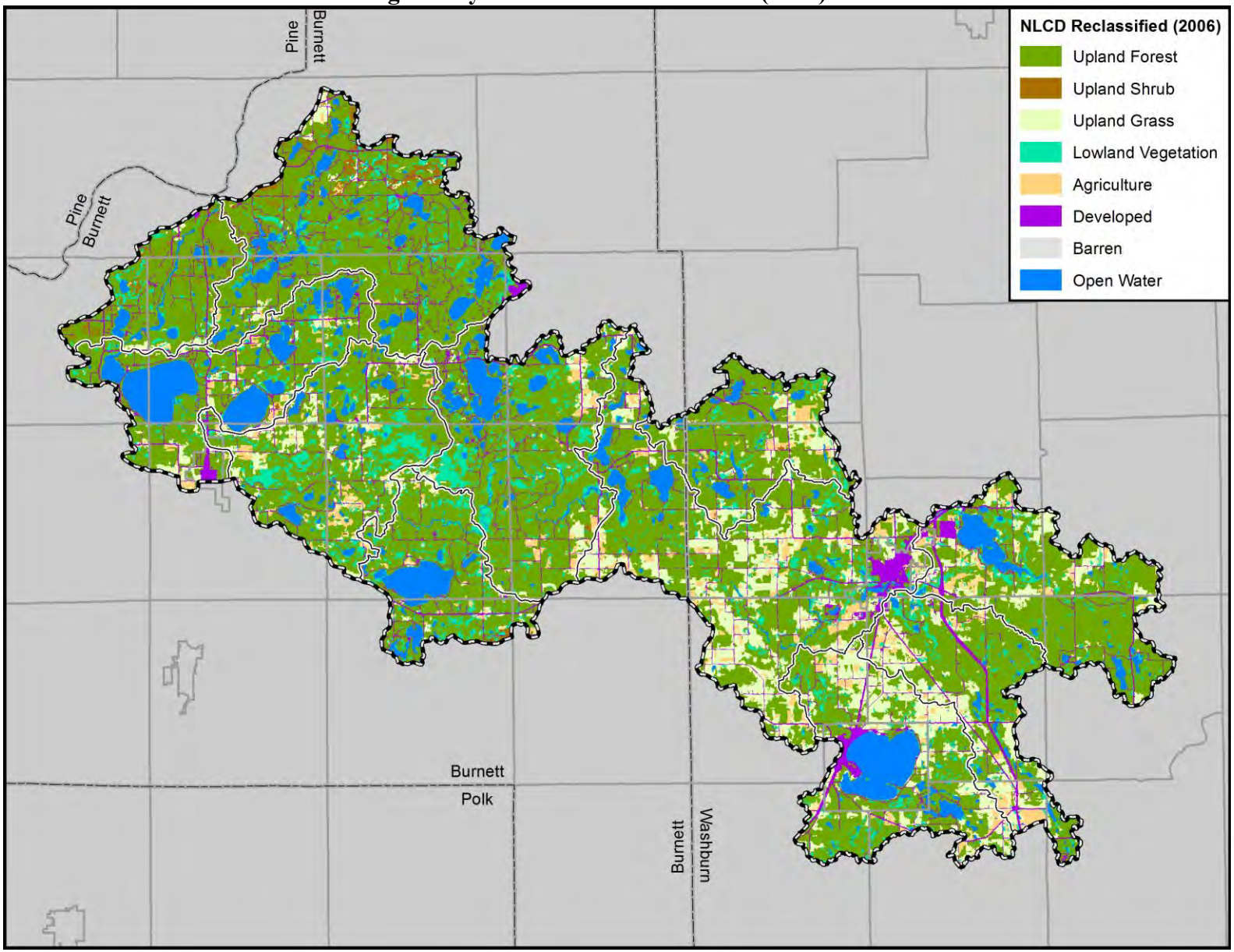


Figure 15. Current land cover, 2006 (reclassified).

Watershed Level Land Cover Change Analysis – Discussion

Table 15. Watershed land cover change from presettlement (mid-late 1800s) to 2006.

Land Cover (Reclassified)	Land Cover Mid-late 1800s)		Land Cover (2006)		Change (Acres)	Change in Percent Cover
	Area (Acres)	Percent Cover	Area (Acres)	Percent Cover		
Upland Forest	200,744	85.7	138,118	58.9	-62,625	-26.7
Upland Shrub	0	0.0	2,856	1.2	2,856	1.2
Upland Grass	0	0.0	27,990	11.9	27,990	11.9
Lowland Vegetation	9,599	4.1	17,250	7.4	7,651	3.3
Agriculture	0	0.0	9,064	3.9	9,064	3.9
Developed	0	0.0	15,180	6.5	15,180	6.5
Barren	0	0.0	83	0.0	83	0.0
Open Water	23,947	10.2	23,802	10.2	-145	-0.1
Totals	**234,289**		**234,344**			

The generalized land use change is helpful to see the overall picture, but in the Yellow River watershed the presence of jack pine barrens during times prior to settlement confuses the picture somewhat. There have been many important changes to the vegetation of the Yellow River watershed since presettlement times. Jack pine was the most extensive tree species throughout most of the watershed and the northwest sands prior to settlement. It is now very limited. Red and white pine are no longer widespread and hardwood species, especially oak and aspen now occupy large areas that used to be pine systems. In general, forest cover decreased within the watershed (a loss of over 62,000 acres), but the remaining forest has changed substantially from presettlement times. Forested area is more closed and a lot of the jack pine/barrens mosaic typical to this part of Wisconsin has been lost which has resulted in the decline of wildlife species adapted to open habitats (Radeloff, 1999).

While changes to the natural vegetation are less clear due to the patchwork of forest, shrub, and grassland areas that made up the jack pine barrens, anthropological changes to the landscape are clearly evident. An increase in agriculture, upland grassland (primarily pasture and hayfields), and developed land has resulted in the remaining forest being in a more fragmented condition. This is especially evident in the eastern half of the Yellow River Watershed where agriculture and pasture/hayfields are more prevalent and some of the watershed's larger towns are found (Figure X). The State of the Forest Report for the St. Croix Basin describes how these changes can affect water quality. An analysis of land cover change between 2001 and 2006 shows continued small declines in all forest types including forested wetland. There have not been significant declines in riparian forest cover

between 2001 and 2006 (Table 15).

Table 16. Watershed land cover change from 2001 to 2006.

Land Cover (Reclassified)	Land Cover (NLCD Classification)	Land Cover (2001)		Land Cover (2006)		Change (Acres)	Change in Percent Cover
		Area (Acres)	Percent Cover	Area (Acres)	Percent Cover		
Upland Forest	Deciduous Forest	108,212	46.18	107,653	45.94	-559	-0.24
	Evergreen Forest	7,961	3.40	7,779	3.32	-182	-0.08
	Mixed Forest	23,119	9.87	22,686	9.68	-433	-0.18
Subtotal (Upland Forest)		**139,292**	**59.44**	**138,118**	**58.94**	**-1,174**	**-0.50**
Upland Shrub	Shrub/Scrub	2,435	1.04	2,856	1.22	422	0.18
Subtotal (Upland Shrub)		**2,435**	**1.04**	**2,856**	**1.22**	**422**	**0.18**
Upland Grass	Grassland/Herbaceous	939	0.40	1,150	0.49	211	0.09
	Pasture/Hay	26,947	11.50	26,840	11.45	-107	-0.05
Subtotal (Upland Grass)		**27,886**	**11.90**	**27,990**	**11.94**	**104**	**0.04**
Lowland Vegetation	Emergent Herbaceous Wetlands	4,927	2.10	5,489	2.34	561	0.24
	Woody Wetlands	11,902	5.08	11,761	5.02	-140	-0.06
Subtotal (Lowland Vegetation)		**16,829**	**7.18**	**17,250**	**7.36**	**421**	**0.18**
Agriculture	Cultivated Crops	9,080	3.87	9,064	3.87	-16	-0.01
Subtotal (Agriculture)		**9,080**	**3.87**	**9,064**	**3.87**	**-16**	**-0.01**
Developed	Developed, Open Space	12,661	5.40	12,845	5.48	184	0.08
	Developed, Low Intensity	1,807	0.77	1,831	0.78	24	0.01
	Developed, Medium Intensity	338	0.14	350	0.15	12	0.01
	Developed, High Intensity	140	0.06	153	0.07	14	0.01
Subtotal (Developed)		**14,945**	**6.38**	**15,180**	**6.48**	**235**	**0.10**
Barren	Barren Land (Rock/Sand/Clay)	3	0.00	83	0.04	80	0.03
Subtotal (Barren)		**3**	**0.00**	**83**	**0.04**	**80**	**0.03**
Open Water	Open Water	23,874	10.19	23,802	10.16	-72	-0.03
Subtotal (Open Water)		**23,874**	**10.19**	**23,802**	**10.16**	**-72**	**-0.03**
Total Watershed Area		**234,344**		**234,344**			

Riparian Level Land Cover Change Analysis

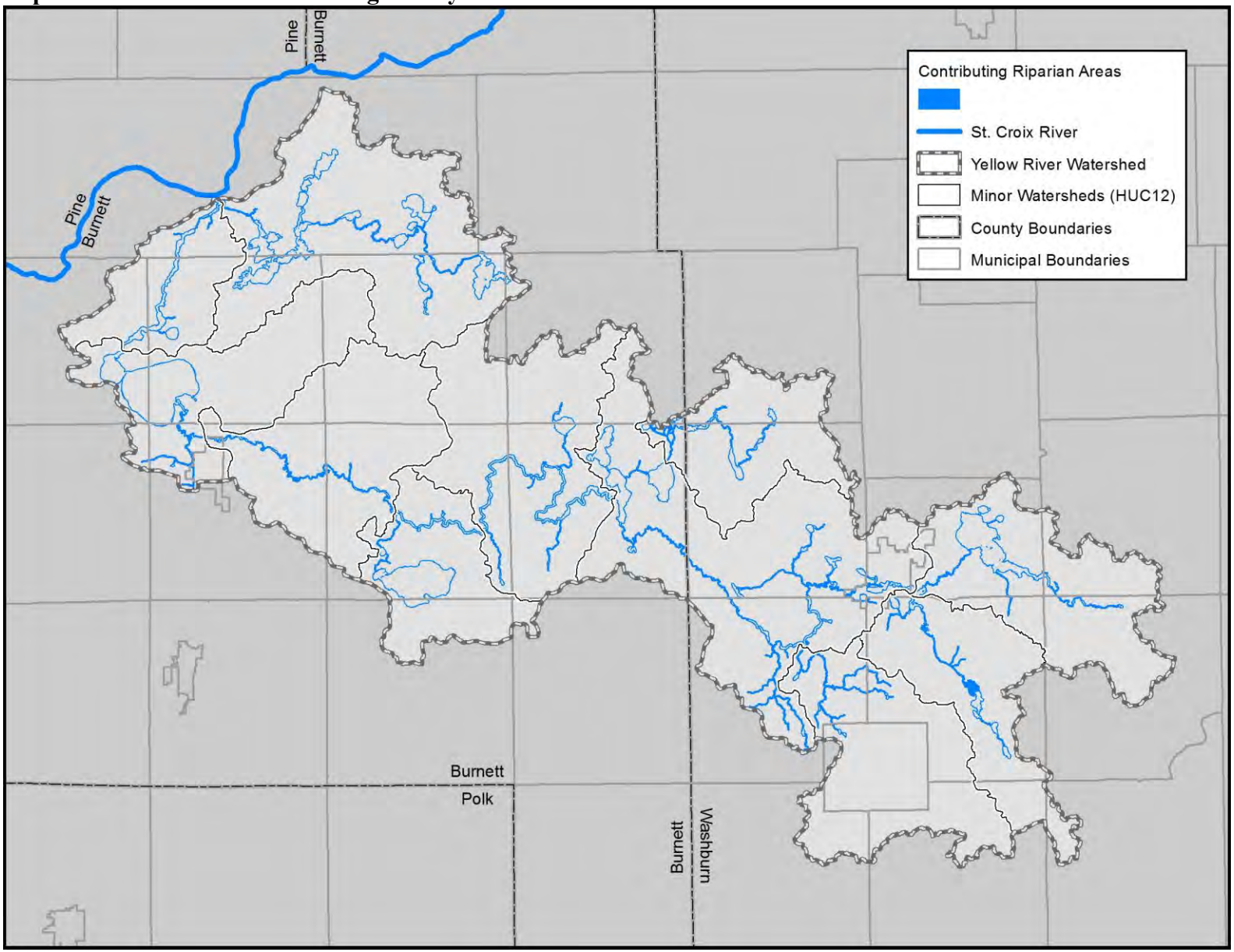


Figure 16. Contributing riparian areas.

Table 17. Contributing riparian areas land cover change from 2001 to 2006.

Land Cover (Reclassified)	Land Cover (NLCD Classification)	Land Cover (2001) Area (Acres)	Land Cover (2001) Percent Cover	Land Cover (2006) Area (Acres)	Land Cover (2006) Percent Cover	Change (Acres)	Change in Percent Cover
Upland Forest	Deciduous Forest	5,204.7	49.13	5,200.0	49.08	-4.7	-0.04
	Evergreen Forest	217.1	2.05	217.1	2.05	0.0	0.00
	Mixed Forest	1,299.5	12.27	1,299.0	12.26	-0.4	0.00
Subtotal (Upland Forest)		**6,721.2**	**63.44**	**6,716.1**	**63.39**	**-5.1**	**-0.05**
Upland Shrub	Shrub/Scrub	52.5	0.50	52.5	0.50	0.0	0.00
Subtotal (Upland Shrub)		**52.5**	**0.50**	**52.5**	**0.50**	**0.0**	**0.00**
Upland Grass	Grassland/Herbaceous	50.0	0.47	62.5	0.59	12.5	0.12
	Pasture/Hay	660.5	6.23	658.7	6.22	-1.8	-0.02
Subtotal (Upland Grass)		**710.6**	**6.71**	**721.2**	**6.81**	**10.7**	**0.10**
Lowland Vegetation	Emergent Herbaceous Wetlands	734.8	6.94	737.7	6.96	2.9	0.03
	Woody Wetlands	1,630.6	15.39	1,619.9	15.29	-10.7	-0.10
Subtotal (Lowland Vegetation)		**2,365.4**	**22.33**	**2,357.6**	**22.25**	**-7.8**	**-0.07**
Agriculture	Cultivated Crops	162.8	1.54	162.8	1.54	0.0	0.00
Subtotal (Agriculture)		**162.8**	**1.54**	**162.8**	**1.54**	**0.0**	**0.00**
Developed	Developed, Open Space	489.5	4.62	489.0	4.62	-0.4	0.00
	Developed, Low Intensity	62.5	0.59	63.6	0.60	1.1	0.01
	Developed, Medium Intensity	10.7	0.10	12.2	0.12	1.6	0.01
	Developed, High Intensity	0.2	0.00	0.2	0.00	0.0	0.00
Subtotal (Developed)		**562.9**	**5.31**	**565.1**	**5.33**	**2.2**	**0.02**
Barren	Barren Land (Rock/Sand/Clay)	0.0	0.00	0.0	0.00	0.0	0.00
Subtotal (Barren)		**0.0**	**0.00**	**0.0**	**0.00**	**0.0**	**0.00**
Open Water	Open Water	19.3	0.18	19.3	0.18	0.0	0.00
Subtotal (Open Water)		**19.3**	**0.18**	**19.3**	**0.18**	**0.0**	**0.00**
Total Watershed Area		**10,594.7**		**10,594.7**			

Figure 16 shows the contributing riparian areas that were analyzed for the riparian analysis. From 2001 to 2006, landcover in riparian areas within the Yellow River Watershed remained mostly steady. Riparian upland forest cover declined by 0.05%, and forested wetland cover in riparian areas declined by 0.10%. There was no increase in agriculture in the riparian zone and only a 0.02% increase in developed land. Overall, riparian cover has not experienced a significant decline at the watershed level, though localized impacts from small losses may be significant (Table 17).

2. Potential Private Forest Land

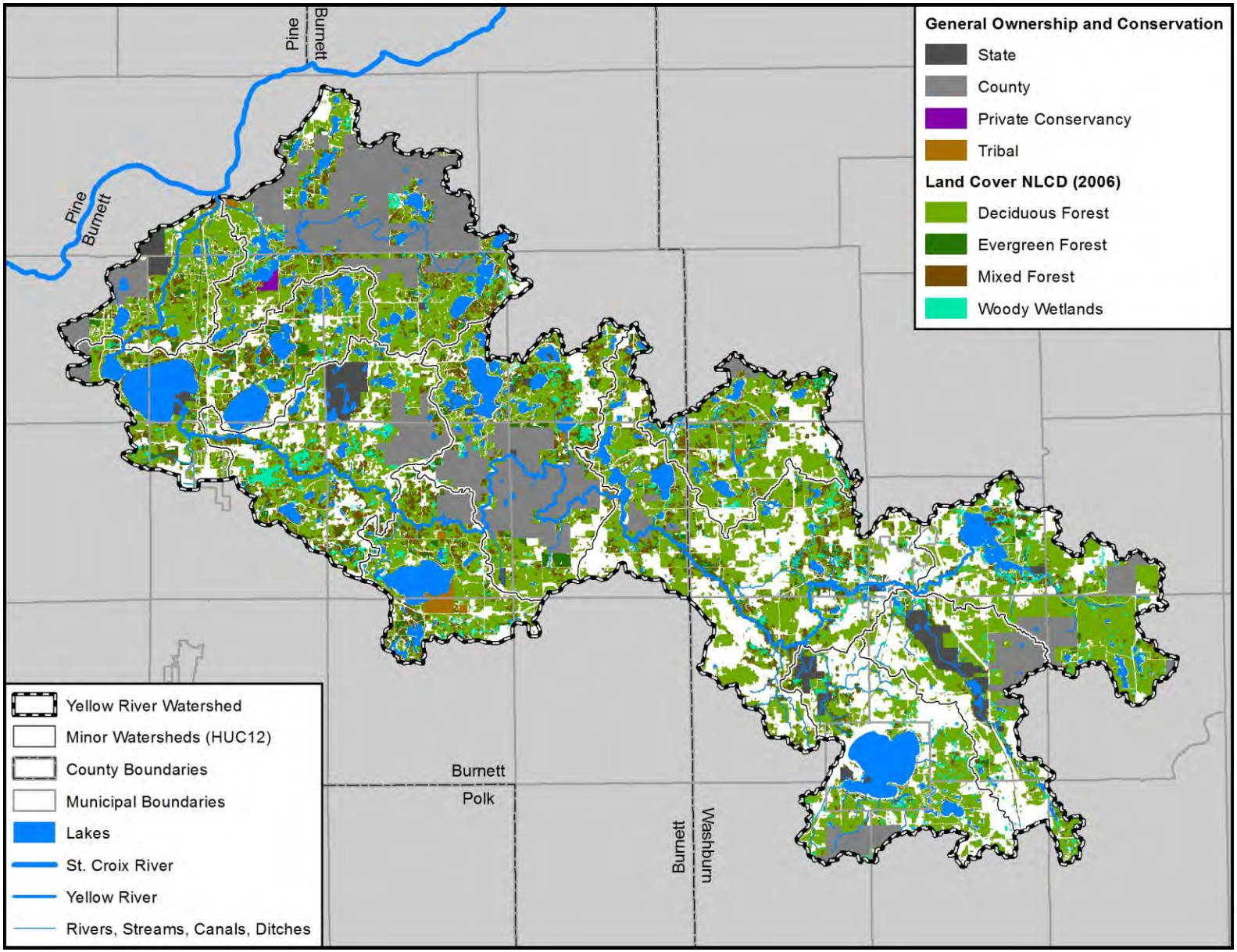


Figure 17. Potential private forest land.

Table 18. Forest cover type and ownership/conservation.

Land Cover NLCD (2006)	Ownership	Area (Acres)	% of Subtotal	% of Total
Deciduous Forest	State	3,357	3.1	2.2
	County	17,492	16.2	11.7
	Private Conservancy	115	0.1	0.1
	Tribal	641	0.6	0.4
	Private with Unknown Conservation Status	86,048	79.9	57.4
Subtotal (Deciduous Forest)		**107,653**	**100.0**	**71.8**
Evergreen Forest	State	183	2.3	0.1
	County	2,252	28.9	1.5
	Private Conservancy	11	0.1	0.0
	Tribal	13	0.2	0.0
	Private with Unknown Conservation Status	5,320	68.4	3.5
Subtotal (Evergreen Forest)		**7,779**	**100.0**	**5.2**
Mixed Forest	State	752	3.3	0.5
	County	4,581	20.2	3.1
	Private Conservancy	29	0.1	0.0
	Tribal	71	0.3	0.0
	Private with Unknown Conservation Status	17,252	76.0	11.5
Subtotal (Mixed Forest)		**22,686**	**100.0**	**15.1**
Woody Wetlands	State	563	4.8	0.4
	County	2,976	25.3	2.0
	Private Conservancy	1	0.0	0.0
	Tribal	19	0.2	0.0
	Private with Unknown Conservation Status	8,202	69.7	5.5
Subtotal (Woody Wetlands)		**11,761**	**100.0**	**7.8**
Total Upland Forest and Woody Wetlands Area		**149,880**		**100.0**

Table 18 provides statistical understanding for what ownership and/or conservation regime forests in the Yellow River are under. Public Ownership, Tribal Lands, and Private Conservancy lands are, for the most part, protected. Figure 17 shows where these areas are, and the forested lands that are not covered by these areas. The Yellow River Watershed covers a small geographic area (234,000 acres), but is heavily forested (58% Upland Forest and 5% Woody Wetlands). Of these forested areas, 77.9% are under private ownership with unknown conservation status. From another perspective, within the Yellow River Watershed, private lands with unknown conservation status account for 79.9% of all deciduous forest, 68.4% of all evergreen forest, 76.0% of all mixed forest, and 69.7% of all woody wetland (lowland forest and shrubs).

Private land ownership patterns in Wisconsin, as a whole, are changing and forest land values are increasing, which makes it difficult to keep forests as forest. Large forest landholdings in amenity rich areas are particularly at risk of being split as landowners can sell smaller parcels at a higher price. Industrial land holders selling large forest blocks off in small parcels are one of the largest factors influencing this change. In the State of Wisconsin, the portion of land owned by forest products companies fell from 62% in 2002 to 24% in 2008, the majority of these lands having been transferred to Real Estate Investment Trusts (REITs) (WDNR, 2011).

The average non-industrial private forest parcel shrank from 37 acres in 1997 to 28 acres in 2006. The number of small parcels of 1-9 acre category nearly doubled. Owners of small non-industrial private forest parcels are challenged, due to operational inefficiencies, to implement management to meet their objectives in a manner that produces an economic return. The ability to manage for some ecosystem services, including those associated with broader landscapes, is compromised as parcel sizes decrease (WDNR, 2011).

Of the 10.4 million acres of privately owned non-industrial forest land in the state, less than a third is enrolled in the Managed Forest Law. While many forest owners not in the MFL are sustainably managing their land, there are others who are not aware of professional forestry services available to them. A 2006 survey indicated that 85% of the landowners who had a harvest on their property within the last five years did not have a plan. Whether or not a landowner wants a plan to direct the management of their forest, professional assistance can help them achieve objectives they have for their land and do so in a manner that sustains the forest and the many benefits, such as water quality, it provides (WDNR, 2011).

3. Managing Forests to Slow Spring Snow Melts

Cover from mature upland forests slows spring snow melts, thus mitigating peak flows that, when increased, can cause in-channel erosion during peak flow events. Areas of lowland vegetation and open water are also important; they act as a storage area for water during spring snow melts. Watersheds that have greater than 40% of their area covered by mature upland forests, lowland vegetation, and open water have enough shade (mature upland forests) and storage (lowland vegetation and open water) to keep peak flows from spring snow melts at levels that will not cause in-channel erosion in streams (Verry 2000).

When the land cover in the watershed drops below 40% of mature upland forests, lowland vegetation, and open water, that watershed will begin to see peak flows from spring snow melts increase in intensity. This increased peak flow will then cause in-channel erosion, which causes the streams to change. The changes in the streams result in sedimentation and aquatic habitat fragmentation. In watersheds where there is not enough storage (over 40% of the watershed) to manage spring snow melts, managing mature upland forests is important to ensure that there is enough shade to keep the watershed covered during spring snow melts.

Figure 18 shows the watershed hierarchy, which was also illustrated in Figure 4 and discussed in Section A.2, and highlights areas of potential risk. Figure 19 shows the decision structure for determining whether watersheds are at risk for increased peak flow from spring snow melts and offers mature upland forest management recommendations. Each of the drainage areas meets the decision structure criteria in terms of total area (all are greater than 10 square miles or 6,400 acres), therefore land cover was evaluated.

Table 19 shows the main factors for determining if a portion of the drainage area in the Yellow River watershed is at risk for increased peak flows from spring snow melt due to loss of mature upland forest. If a watershed has enough area of storage to absorb spring snow melts (greater than 40% of the watershed), then harvest of mature upland forests will not significantly affect peak flows from spring snow melt (Decision Structure Status 1). If the watershed does not have enough area of storage to absorb spring snow melts (less than 40% of the watershed), but the area of mature upland forest plus the storage area is greater than 40%, then some mature upland forest can be lost before the streams in the watershed are at risk (Decision Structure Status 2). Management of mature upland forests will be necessary to ensure that overall loss does not put the streams in the watershed at risk. If the total area of storage and mature upland forest is less than 40% of the total watershed area, then the streams in the watershed are at risk (Decision Structure Status 3). If the watershed is in this condition, no additional forest should be lost and reforestation should be considered.

The Yellow river has the potential to be at risk if too much mature upland forest is lost throughout the watershed, and this potential risk continues all the way up to the first tier HUC12s on the upstream end of the watershed. It is positive to see that none of the streams are currently at risk for in-channel erosion from increased peak flows from spring snow melt. However, if mature upland forests are harvested beyond what the rest of the watershed can handle, water quality will begin to decline. It is

recommended that for watersheds where there is not enough storage area to mitigate peak flows from spring snow melts, enough area of mature upland forest is preserved to keep over 40% of the upstream area under either mature upland forest or storage land cover. The two right-most columns of Table 19 list the percent of the watershed that should be preserved as mature upland forest and the amount of acres of mature upland forest that should be preserved.

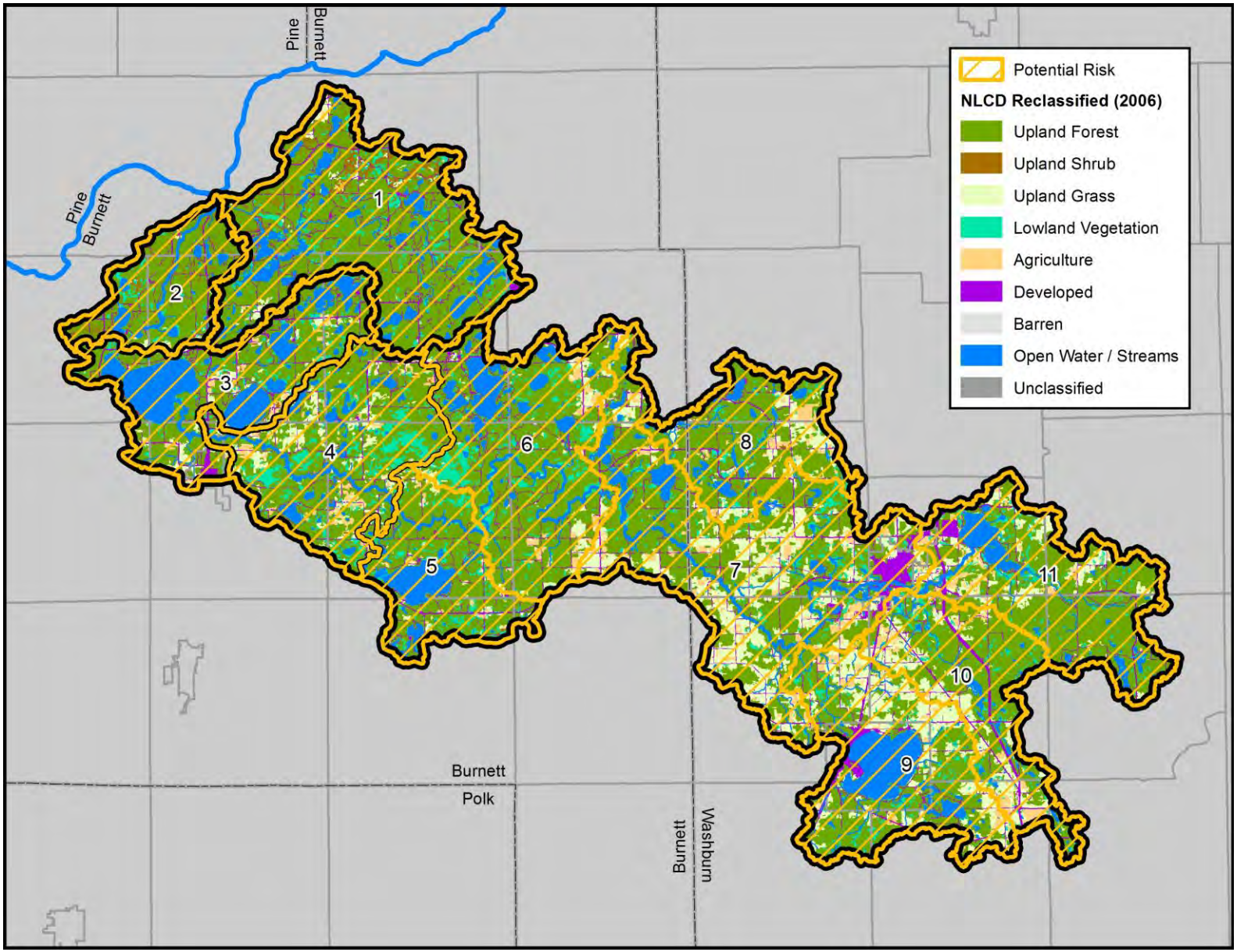


Figure 18. Land cover, watershed hierarchy, potential risk.

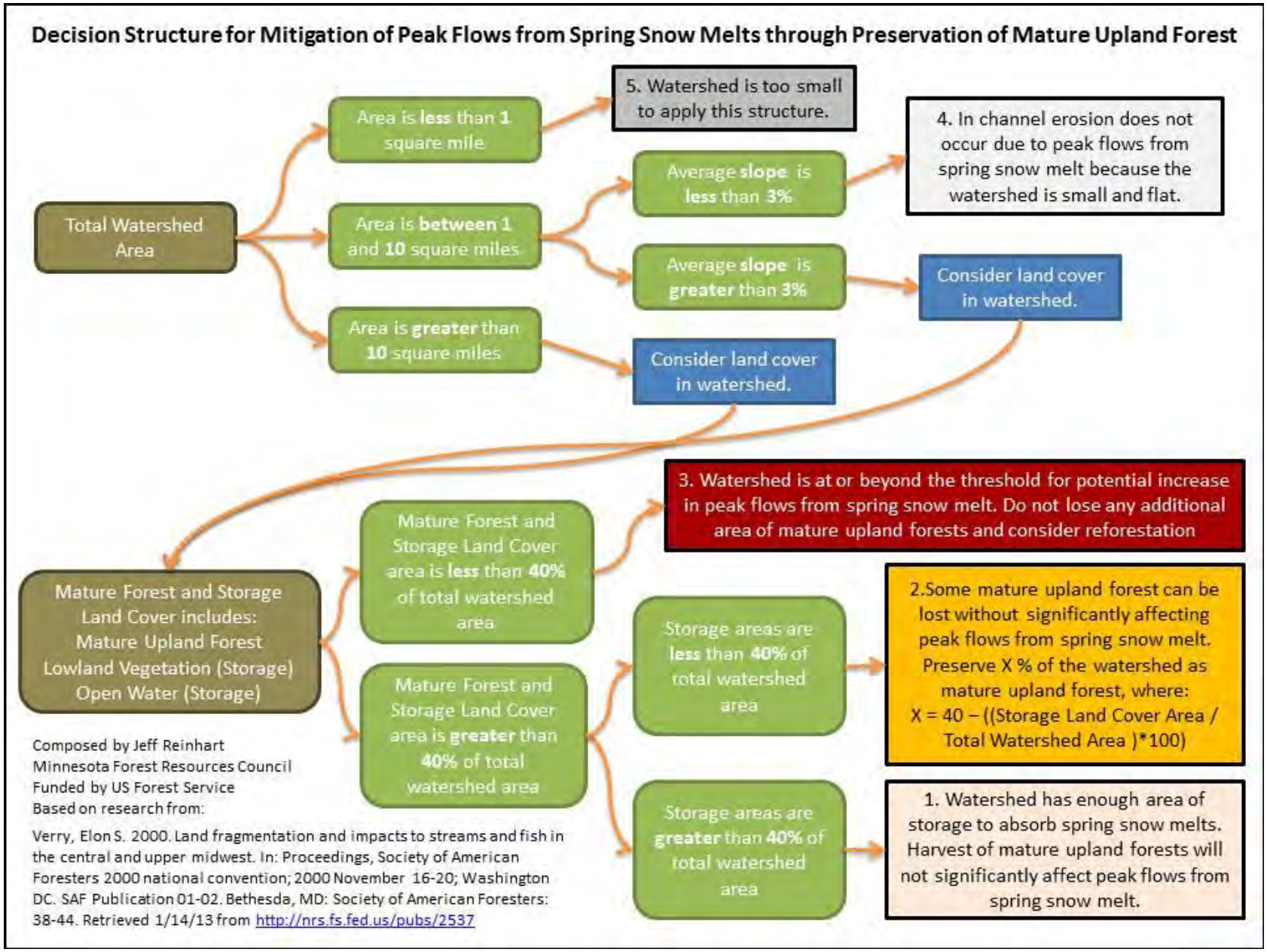


Figure 19. Decision structure for mitigation of peak flows from spring snow melts through preservation of mature upland forest.

Table 19. Watershed potential risk for increased peak flow due to loss of mature upland forest and mature upland forest loss limits.

Watershed (HUC12 and Upstream)	Potential Peak Flow Risk	Decision Structure Status	Total Upstream Drainage Area (acres)	Upland Forest Area (acres)	Upland Forest % of Total	Storage (Lowland Vegetation / Open Water) Area (acres)	Storage (Lowland Vegetation / Open Water) % of Total	Preserve % of watershed as mature upland forest	Preserve area of mature upland forest (acres)
11. Spooner Lake-Yellow River	Yes	2	20,776	12,879	62.0	2,920	14.1	25.9	5,390.6
10. Beaver Brook	Yes	2	16,115	8,902	55.2	1,520	9.4	30.6	4,925.9
9. Shell Lake	Yes	2	21,520	9,168	42.6	4,543	21.1	18.9	4,065.0
8. Rocky Ridge Creek	Yes	2	13,735	9,057	65.9	1,587	11.6	28.4	3,906.9
7. Rice Lake-Yellow River and Upstream	Yes	2	109,978	59,850	54.4	14,581	13.3	26.7	29,409.8
6. Sand Lake-Yellow River and Upstream	Yes	2	136,061	76,781	56.4	20,190	14.8	25.2	34,233.8
5. Big Sand Lake-Yellow River and Upstream	Yes	2	149,673	85,069	56.8	23,679	15.8	24.2	36,190.6
4. Bass Lake-Yellow River and Upstream	Yes	2	171,639	98,254	57.2	27,895	16.3	23.7	40,760.3
3. Yellow Lake and Upstream	Yes	2	191,485	108,515	56.7	34,017	17.8	22.2	42,576.8
2. Buffalo Lake-Yellow River and Upstream	Yes	2	202,139	115,950	57.4	35,501	17.6	22.4	45,354.8
1. Loon Creek	Yes	2	32,205	22,168	68.8	5,551	17.2	22.8	7,331.1
Yellow River Total	**Yes**	**2**	**234,344**	**138,118**	**58.9**	**41,052**	**17.5**	**22.5**	**52,685.9**

4. Wisconsin Statewide Forest Strategy Priority Landscapes & Issues

In 2008 WDNR – Division of Forestry initiated a Statewide Forest Assessment process that analyzed the current condition of forests (both public and private), looked for trends, and identified issues and threats to Wisconsin's forests for the next 10 years. From that assessment grew the Statewide Forest Strategy which is a collection of many strategies and actions. It includes multiple ideas on how the forestry community as a whole can address major issues and priority topics over the next five to ten years and includes the Priority Landscapes & Issues document. The assessment and strategy were both completed in June of 2010. They can be accessed here:

http://dnr.wi.gov/topic/ForestPlanning/assessment2010.html
http://dnr.wi.gov/topic/ForestPlanning/strategy2010.asp

After this process, each strategy and possible action in the Statewide Forest Strategy was reviewed and assessed to determine which actions the Division of Forestry could play a role in and what our niche should be, recognizing the work of others within the forestry community and drawing upon Department assessments such as the State Comprehensive Outdoor Recreation Plan, State Wildlife Action Plan, Land Legacy Report, and Impaired Waters List. The Strategy provided a base from which to assess where Forestry have a role based on the conditions today, which may or may not be where we have traditionally had a role. We have also strived to develop a Strategic Direction which enables us to be flexible so that we may be better able to adapt to the rapidly changing economic and ecological conditions. Lastly, in developing the Strategic Direction, we asked partners to identify actions offered in the Statewide Strategy in which they believe we have a role and the relative priority of that role. The WDNR – Divison of Forestry Strategic Direction can be accessed here:

http://dnr.wi.gov/topic/ForestPlanning/strategyDirection.html

The strategic direction states what the Division of Forestry's niche and role will be to address major issues and priority topics. It describes our objectives in our main program areas. Much of what is presented in the strategic direction continues work we now do and, in many cases, have done for many years. This reflects our belief that these functions have been, and remain, an appropriate and valued role for the division. There are several significant changes described in the strategic direction to address the changing needs of the forestry community and citizens of Wisconsin. As a result we believe the strategic direction identifies both those challenges that we have worked to address in the past and that continue to need our attention, as well as new challenges and opportunities that demand our attention. The strategic direction will guide the division's work over the next five years. Implementation of the strategic direction began at the end of 2011.

Potential for Managing and Reducing Threats to Forest and Ecosystem Health

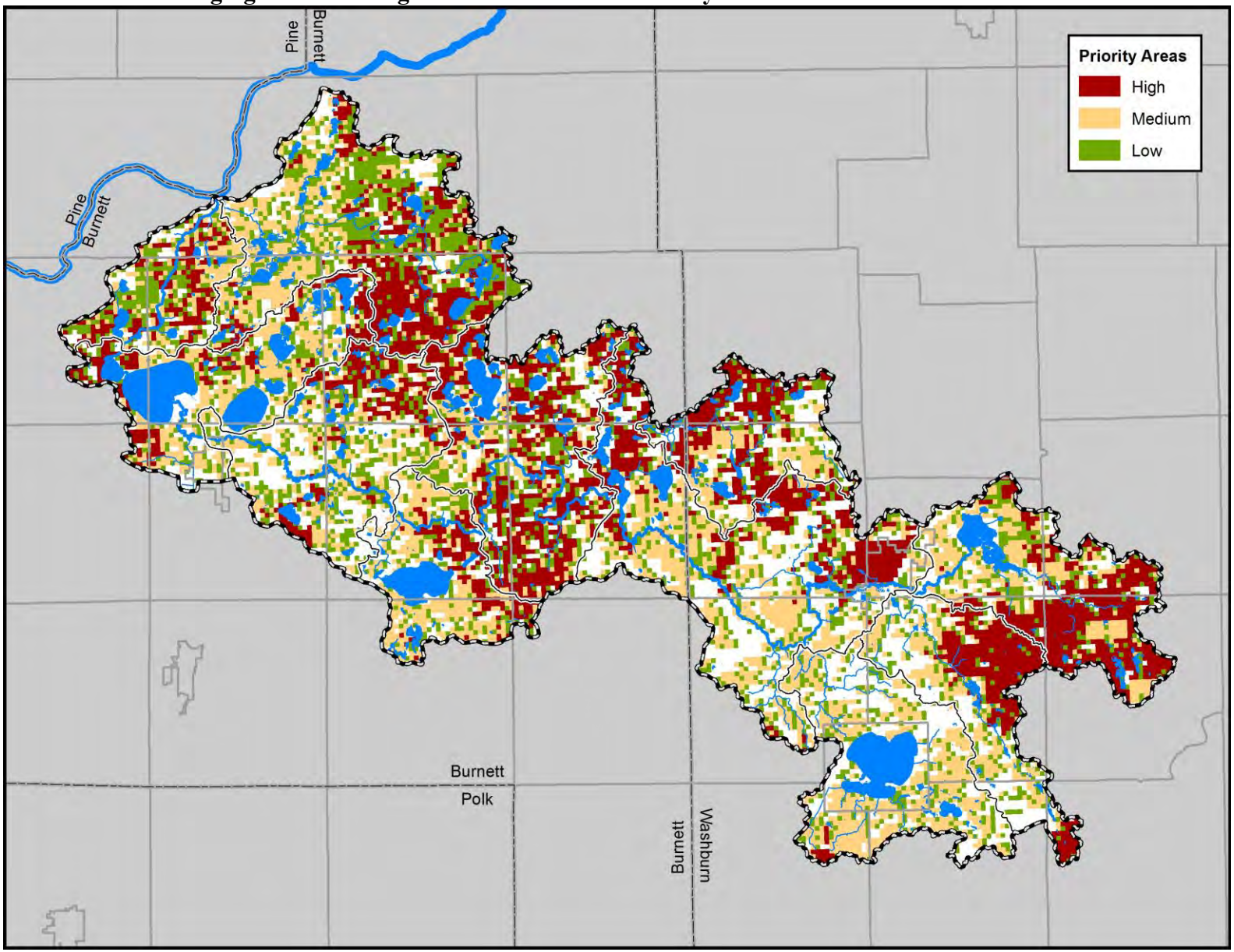


Figure 20. Map 1: Potential for Managing and Reducing Threats to Forest and Ecosystem Health.

Table 20. Areas of priority for managing and reducing threats to forest and ecosystem health.

Priority Areas	Area (Acres)	% of Total
High	55,980	23.9
Medium	62,688	26.8
Low	52,908	22.6
Masked	62,223	26.6
Total Watershed Area	**233,798**	

Throughout the state, Wisconsin's forests are at risk of mortality from both native and exotic insects and diseases, invasive plants, deer, damaging storms, climate and air pollutants. The threats to forest trees have long played an important role in forest succession, reducing tree density in overstocked stands, creating openings in the canopy that encourage successful regeneration and providing down woody material. In some cases, tree diseases or insect infestations can cause such high levels of mortality that a species may be reduced to only a few individuals on a site or over an extensive area. The above map, considered with other information from research, surveys and monitoring, helps determine which issues are the most critical to address.

The following criteria identify areas at risk of experiencing 25% or more tree mortality over 15 years from a combination of insects and diseases.

Insects and Disease: Native forest insects and diseases contributing to risk of mortality include forest tent caterpillar, jack pine budworm, red pine pocket mortality and pine bark beetle. Exotic insects and diseases contributing to risk of mortality include gypsy moth, hemlock woolly adelgid, beech bark disease, sudden oak death, oak wilt and emerald ash borer.

In order to evaluate risk for any particular insect or disease, a list of contributing factors needs to be determined. Factors are different for each insect and disease. Sources of input factors include census data (population density, median housing value, density of campgrounds), species density maps (normal range, canopy cover or basal area maps), climate data (mean annual temperature or precipitation), historical presence of the particular disease or insect in the area, and habitat type. Once these factors are weighted, every acre of land then has a value representing the overall risk of the particular disease or insect occurring on that acre.

In the Yellow River Watershed about 24% of the land area is considered high priority area for managing and reducing the threats from insects and disease. Another 27% is considered a medium priority area. Overall the Yellow River Watershed has a higher proportion of the high priority land than Wisconsin as a whole, where somewhat less that 25% of the land area is considered high priority for managing and reducing threats from insects and disease.

Urban Forests: Potential for Increasing Urban Forest Canopy Cover

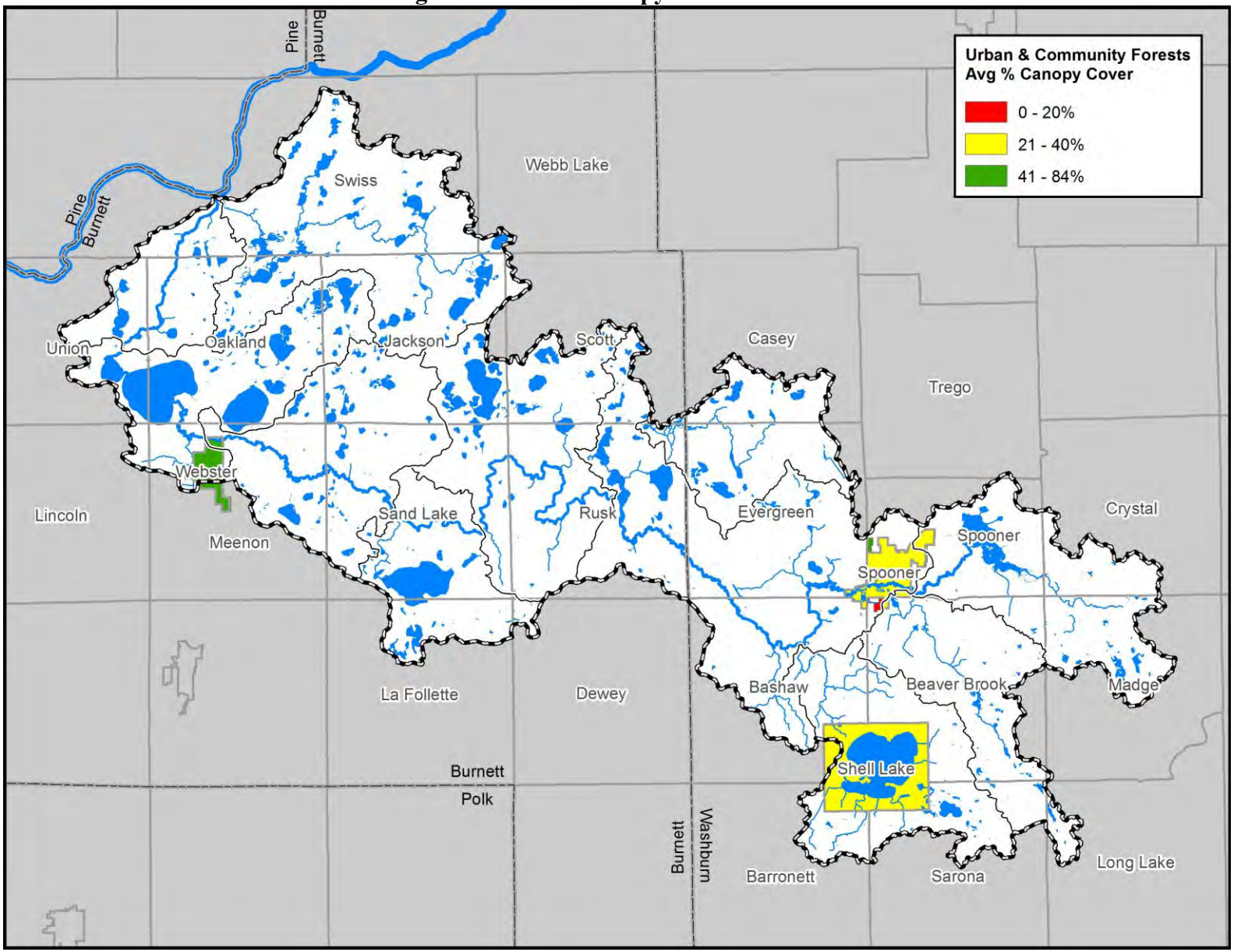


Figure 21. Map 2(a): Potential for Increasing Urban Forest Canopy Cover.

Table 21. Communities and average percent canopy cover.

Urban Area or Community	Area (Acres)	Average % Canopy Cover
Southern edge of Spooner in Beaver Brook Township	68	11
Northwestern edge of Spooner in Evergreen Township	3	63
City of Shell Lake	6,562	25
City of Spooner	2,246	30
Southeastern and Northwestern corners of Spooner in Spooner Township	56	79
City of Webster	1,124	42

Wisconsin's urban forests are a significant resource. They cover about 5% of the state's land area and are home to about 80% of the state's population as measured in 2002. The amount of urban forest is increasing as agricultural and forest lands are converted to development. Forecasts predict urban land in the state will grow to 8.3% of the land area by 2050.

The average urban tree canopy statewide is low compared to many other states with similar ecotypes. There is an opportunity to fill vacant planting space and manage existing trees to increase canopy cover in urban forests. The national benchmark for canopy cover is 40%. Areas under 40% that should be prioritized for increased canopy cover. Canopy cover can fluctuate with changes in land use. Conversion of agricultural or other open land to development will initially decrease average canopy statewide, but these areas offer the greatest opportunity for planting and increasing overall tree canopy over time. For the most part urban forests within the Yellow River Watershed fall short of the national benchmark for canopy cover of 40% but are above the statewide average, which is below 20%. More specifically, the City of Webster exceeds the national benchmark with an average % canopy cover of 42%. The cities of Shell Lake and Spooner fall short with % canopy covers of 25% and 30% respectively. Conversion of forest land to urban forest will increase overall average urban tree canopy at the expense of rural forests. This may be happening on the southeastern & northeastern and northwestern edges of the City of Spooner where % canopy cover is 79% and 63% respectively.

Urban Forests: Potential for Improving Communities Urban Forest Management

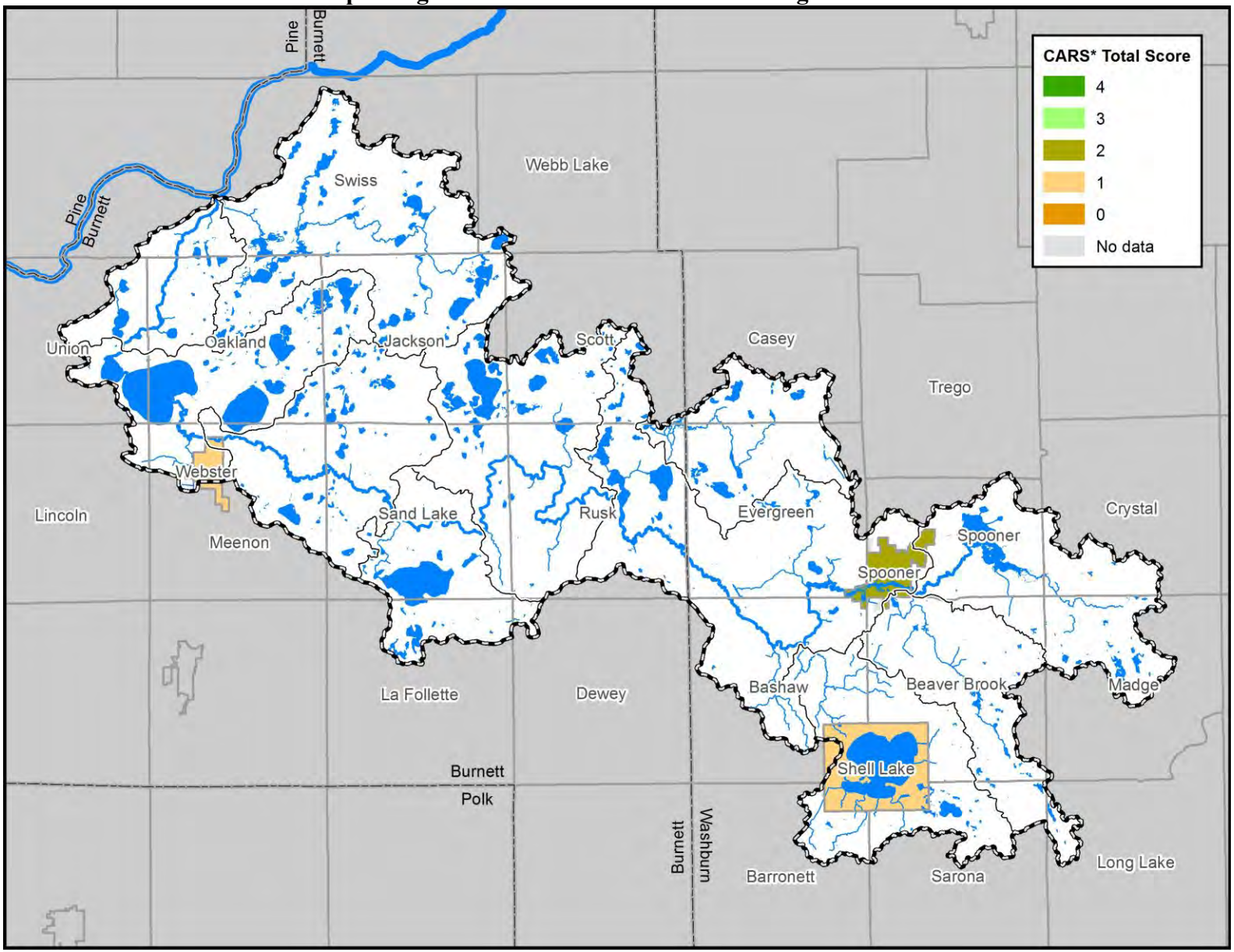


Figure 22. Map 2(b): Potential for Improving Communities Urban Forest Management: CARS* Scores.

Table 22. Communities and CARS* Total Scores.

Urban Area or Community	Area (Acres)	CARS* Total Score
Southern edge of Spooner in Beaver Brook Township	68	0
Northwestern edge of Spooner in Evergreen Township	3	0
City of Shell Lake	6,562	1
City of Spooner	2,246	2
Southeastern and Northwestern corners of Spooner in Spooner Township	56	0
City of Webster	1,124	1

Good urban forest management includes up-to-date inventories that support operational plans. While there has been a steady increase in communities that have urban forest inventories over the last 16 years, two-thirds of Wisconsin communities still lack an inventory of their resource. The number of communities with some type of urban forestry plan increased somewhat since 1992, however this still represents less than one-third of Wisconsin communities.

Figure 22, above, shows urban and community 'Accomplishments Reporting System' (CARS) scores. This national scoring system identifies communities that have one or more of the following attributes: an active urban and community tree and forest management plan; a professional forestry staff; ordinances or policies that focus on planting, protecting and maintaining their urban and community trees and forests; and an Advisory Organization that advocates or advises on urban forestry related issues within the community. A score of one means they have any one of the attributes, and a score of four means they have all. The cities of Shell Lake, Spooner and Webster have scores that are in line with other cities in WI of a similar size. In Wisconsin larger cities such as Milwaukee, Madison, and La Crosse are more likely to have a CARS score of 3 or 4 than smaller cities which tend to have scores of 1 or 2. Webster and Shell Lake have scores of 1 and Spooner has a score of 2 and has been a Tree City USA community since 2003 (http://www.arborday.org/programs/treeCityUSA/standards.cfm).

Reducing Wildfire Risk: Wisconsin Fire Risk Analysis

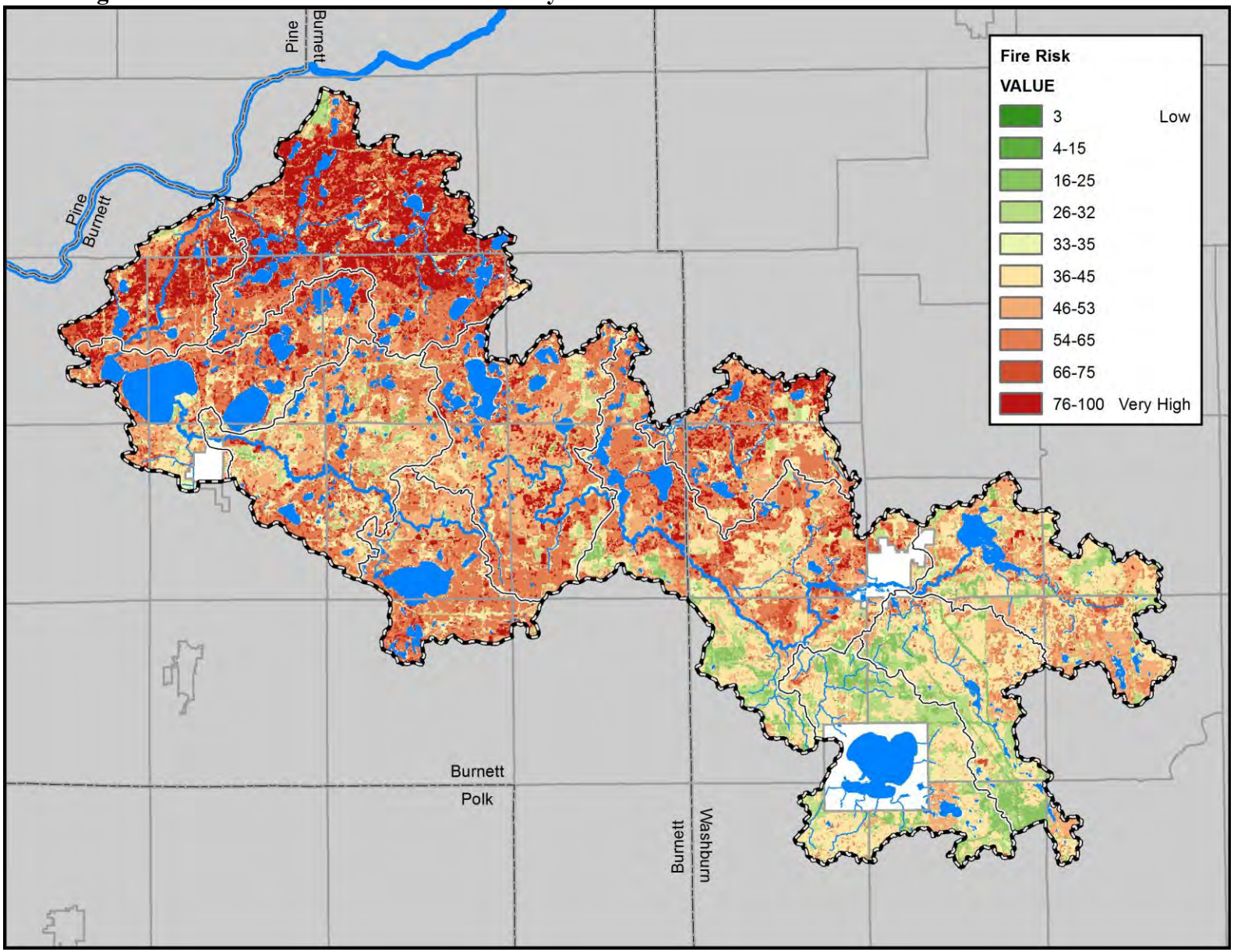


Figure 23. Map 3(a): Reducing Wildfire Risk: Wisconsin Fire Risk Analysis.

Table 23. Areas of wildfire risk

Fire Risk		Area (Acres)	% of Total
	No Data	27,453	11.7
Low	3	0	0.0
	4-15	60	0.0
	16-25	7,535	3.2
	26-32	16,683	7.1
	33-35	6,248	2.7
	36-45	46,012	19.6
	46-53	36,431	15.5
	54-65	56,349	24.0
	66-75	13,864	5.9
Very High	76-100	23,710	10.1
Total Watershed Area		**234,344**	

Wisconsin DNR Forestry is statutorily responsible for suppressing wildfires across a significant portion of the state. We utilize various methods, such as partnerships with fire departments and other agencies, to protect human life and property and natural resources. We prioritize how and where state and federal resources will be spent based on fire risk within areas that are designated as DNR protection areas or areas where we work cooperatively with partners (Figure 23). Statewide, we prioritize areas for hazard mitigation with our Communities-at-Risk analysis (Figure 24).

The Fire Risk Analysis (Figure 23) conducted in 2010 developed levels of fire suppression risk for the state based on elements that could be used to determine the level of suppression need. This in turn helps DNR Forestry make resource decisions regarding facilities, prevention education, communications, and other suppression and detection needs. The analysis was conducted by overlaying data considered instrumental in predicting fire hazard (vegetation, ecological landscapes, soil, forest patch size, and parcel improvements). Wisconsin DNR cooperates with local fire departments (municipal and volunteer), tribes, and other agencies as part of our statewide fire suppression mandate. The analysis is one tool that can be used to award vital funding for local fire departments. **It is also important to note that the dataset is only intended to display trends in fire risk and is not suitable for site-level analysis**.

The Yellow River Watershed is located primarily in the Northwest Sands Ecological Landscape where fire risk is generally high to very high and generally higher than most of Wisconsin as a whole. Within the Yellow River Watershed itself, about 10% of

the land area is considered to be a very high fire risk and these areas tend to be concentrated in the northwest corner of the watershed where soils are excessively drained and more xeric. The central watershed is generally rated as high for fire risk and the eastern quarter of the watershed in generally rated as moderate to low for fire risk where wetter soils and irregular topography offer some fire protection (Figure 23, Table 23)

Potential for Assisting Communities at Risk to Wildfire

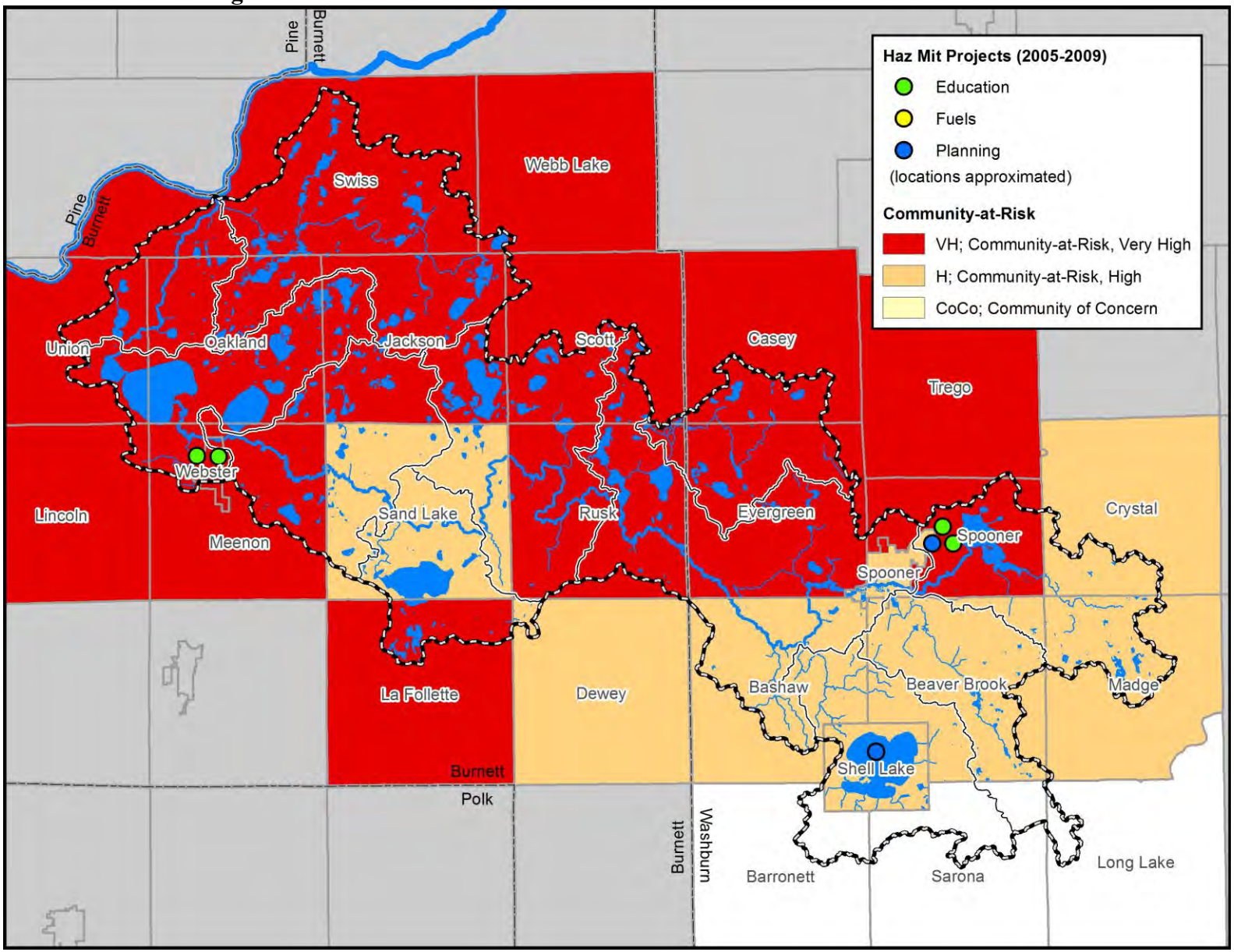


Figure 24. Map 3(b): Potential for Assisting Communities at Risk to Wildfire.

Table 24. Haz Mit Projects (2005-2009).

Project Type	Municipality	Project
Planning	Shell Lake	HIZ Training
Education	Spooner	Jack Pine Budworm Brochure
Education	Spooner	Smokey Pencils
Planning	Spooner	Washburn ICP'S
Education	Webster	Cumberland Area Radio PSAs
Education	Webster	Smokey Bear Statue

Table 25. Communities-at-Risk.

Community-at-Risk	Municipalities
Community-at-Risk, Very High	Casey (T), Evergreen (T), Jackson (T), La Follette (T), Lincoln (T), Meenon (T), Oakland (T), Rusk (T), Scott (T), Spooner (T), Swiss (T), Trego (T), Union (T), Webb Lake (T), Webster (V)
Community-at-Risk, High	Bashaw (T), Beaver Brook (T), Crystal (T), Dewey (T), Madge (T), Sand Lake (T), Shell Lake (C), Spooner (C)

The federal initiative "Communities-at-Risk" (Figure 24) helps Wisconsin prioritize areas for hazard mitigation. This includes projects for planning (e.g., Firewise), education, and fuels reduction. There are currently over twenty Firewise communities and nineteen Community Wildfire Protection Plans (CWPP) either created or in development. Communities-at-Risk are identified by community/population weighted criteria (vegetation, historic fire regime, wildland-urban interface, population density, historic fire occurrence, and proximity to road or railroad). Communities identified as a Community-at-Risk, or Community-of-Concern are prioritized to receive hazard mitigation funds based on their geographic location as well as non-geospatial criteria that measure a project's individual merits.

The Yellow River Watershed is located in a region of Wisconsin where communities are generally more at risk from fire than in other parts of the State. All the cities and townships within the Yellow River Watershed are identified as Communities-at-Risk High or Very High. The Townships of Casey, Evergreen, Jackson, La Follette, Lincoln, Meenon, Oakland, Rusk, Scott, Spooner, Swiss, Trego, Union, Webb Lake, and the Village of Webster are all considered Communities-at-Risk, Very High. The Village of Webster has completed two hazard mitigation education projects that include radio public service announcements and a Smokey the Bear Statue.

The Townships of Bashaw, Beaver Brook, Crystal, Dewey, Madge, Sand Lake, and the Cities of Shell Lake and Spooner are considered Communities-at-Risk, High. The Cities of Shell Lake and Spooner have both completed harzard mitigation projects. Shell Lake has completed a HIZ training project. Spooner developed a jack pine budworm brochure, purchased smokey pencils, and developed the Washburn ICP'S.

The Yellow River Watershed Townships of Jackson, Scott, and Webb Lake are in the heart of an area hit by a massive wind event on July 1, 2011. A 6,000-acre homeowner association, Voyager Village, lies within portions of each township. Local DNR Forestry staff had been working with Voyager Village for more than a year prior to the storm, guiding them through the steps to become a recognized Firewise Community. A Firewise assessment had been conducted in 2010. Local DNR staff and fire department personnel toured the development with community members, discussing forest fire and emergency access concerns. In turn, the board of Voyager Village agreed to begin work to educate their community on fire prevention and they quickly began implementing fuels reduction efforts. Voyager Village was assisted with National Fire Plan funds provided to them through the Division of Forestry's hazard mitigation program. Over the next year Voyager Village sent a Firewise mailing to property owners, erected a Smokey Bear fire danger sign, and completed fuels reduction work in commonly-owned portions of the development. After the storm hit the area, property owners in Voyager Village were in a better position to begin the long, arduous task of mitigating the damage to their community. Relationships with Department staff were in place, they had already demonstrated accountability in conducting hazard mitigation projects, and they were well within the process of becoming a Firewise Community. Voyager Village was recognized as a Firewise Community in 2012.

Actively and Sustainably Managing Forests

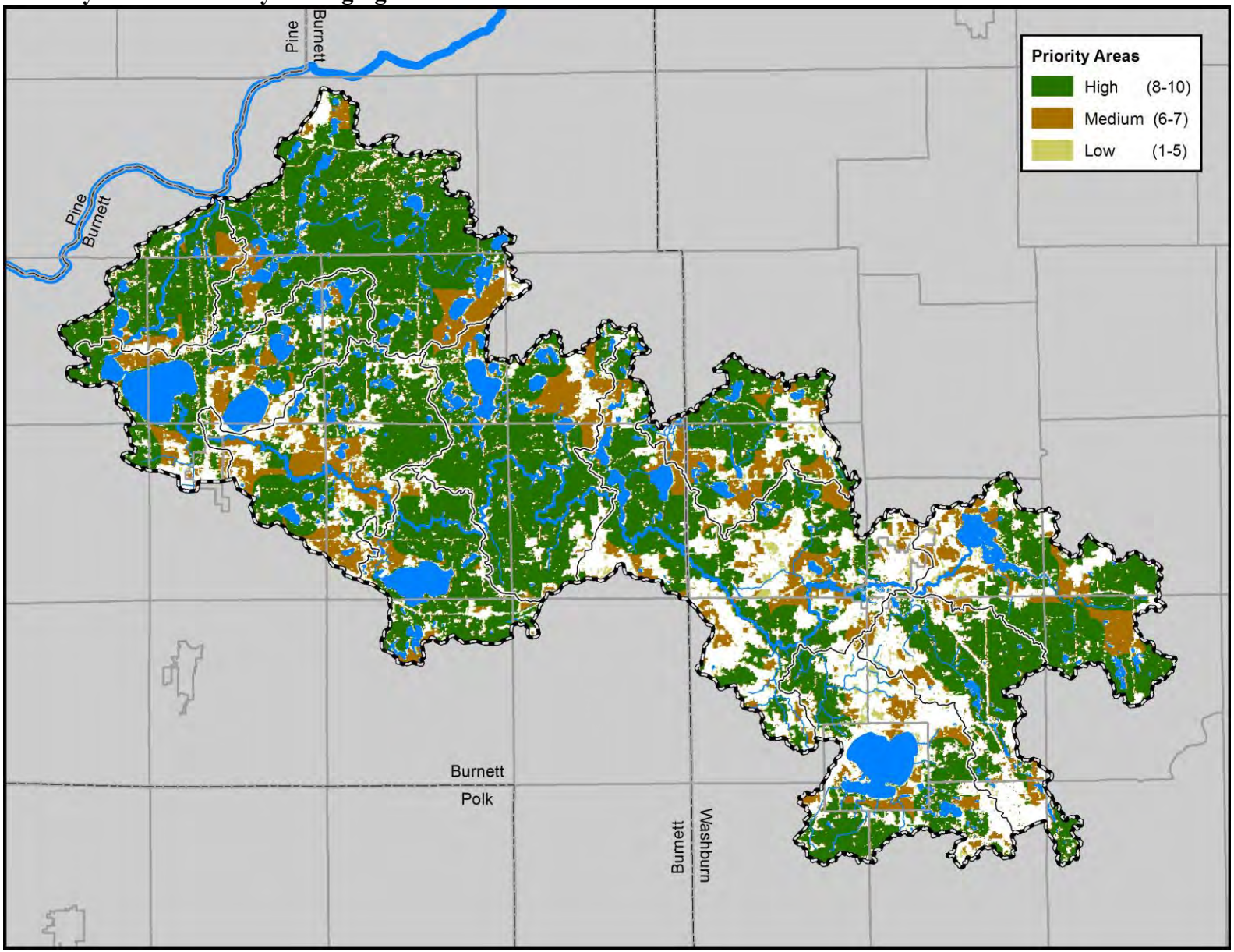


Figure 25. Map 4: Actively and Sustainably Managing Forests.

Table 26. Areas of priority for actively and sustainably managing forests.

Priority Areas	Area (Acres)	% of Total
High	113,750	48.5
Medium	35,938	15.3
Low	8,423	3.6
Masked	76,233	32.5
Total Watershed Area	**234,344**	**100.0**

This map and narrative describe relative potential for active and sustainable management on a geographic basis. This does not only refer to production of forest products, but also includes areas that benefit from sustainable management such as improving forest habitat in Conservation Opportunity Areas identified in the Wildlife Action Plan or Outstanding and Exceptional Resource Waters that benefit from forested riparian areas. This map will help focus where to implement strategies to address issues as diverse as parcelization, composition and structure, climate change, and recreation opportunities.

The following criteria identify forests that have desirable conditions for actively and sustainably managing forests and also forests that would benefit from management. An area that has multiple criteria will have a higher score.

Forest patch size: The benefits of large forest patches include but are not limited to wildlife habitat for species that need remote interior forest, wilderness aesthetics, recreation activities, and producing economies of scale for timber management. The minimum patch size mapped is 10 acres. This is the typical limit for possible management. Patch size in the northern and southern ecological province (NHFEU1) are rated with different scales. In the north, patch size of greater than 500 acres is given the highest ranking and in the south, patch size of greater than 100 acres is given the highest ranking. *(Weight: one to three points, with three points going to the larger patch sizes.)*

Proximity to protected and conserved land: This layer includes forested lands that are managed for various objectives and in a legal status that will keep the forest as forest. This includes public forest land (national, state, county), State Natural Areas, publicly held forest easements on private land, Board of Commissioners of Public Land, Native American lands, private lands enrolled in the Managed Forest Law and Forest Crop Law, and Forest Legacy Areas. These are forests that will remain forests for an extended period of time and have a management plan. Lands in close proximity to these are important because if they are actively and sustainably managed, they essentially make the protected areas larger.

Communities that zone working forest areas in their jurisdiction provide another category of protected land that keep forests as forests. We do not have geospatial data for these and so they are not included in this map but are considered a potential area for

active and sustainably managed forest. *(Weight: one to three points, with three points going to protected, conserved, and public lands and their immediate, less than .25 miles, surrounding area.)*

Wildlife Action Plan – Conservation Opportunity Areas (COA's) in forested habitats: The Wildlife Action Plan identified COA's to protect native Wisconsin species of greatest conservation need. Some of these species require forest habitat which could benefit from management. COA's that are forested are shown on the map. Forest communities that are under-represented in the state are also of special concern and will be considered when prioritizing areas for management. These are difficult to map and are not shown. For a complete description of COA's, please see: http://dnr.wi.gov/org/land/er/wwap/implementation/. *(Weight: one point for forest within a COA.)*

Outstanding and Exceptional Resource Waters (OERW): Wisconsin's OERW designation is designed to maintain the water quality in Wisconsin's cleanest waters. An outstanding resource water is defined as a lake or stream having excellent water quality, high recreational and aesthetic value, high quality fishing and being free from point source or non-point source pollution. Exceptional resource water is defined as a stream exhibiting the same high quality resource values as outstanding waters, but with existing or potential impact by point source pollution or future discharge from a small sewer community. Sustainably managed forests assist in keeping these waters clean by the use of best management practices and other management considerations. *(Weight: one point for forested OERW's unless it is also a classified as part of a COA.)*

Priority watersheds: Forests play a critical role in preserving clean water supplies by maintaining a protective forest floor that prevents soil erosion, and filters and infiltrates water. This map layer identifies watersheds that have large areas of private forests that are important for maintaining clean water and in need of protection from development pressures. Low scoring watersheds either have a large percentage of protected forest land, low percentage of private forest land, low development pressure, or low ability to produce clean water. A low score does not mean a watershed is unimportant; rather depending on why it is ranked low, it may be an example of a successfully managed and protected forested watershed or it may be a priority for reforestation and other efforts. *(Weight: one to three points, with three points going to the highest priority watersheds)*

The Yellow River Watershed is in a relatively forested condition, especially in the western half of the watershed, there is a relatively large amount of County Forest and DNR owned property and lots of high quality water resources within the watershed. As a result, close half of the watershed (48.5%) is rated as a high priority area for actively and sustainably managing forests. Another 15.3% is considered medium priority and only 3.6% is rated as low priority. The watershed is located in a part of Wisconsin with a relatively high proportion of high priority areas as compared to the state as a whole.

Potential for Managing for Ecosystem Services

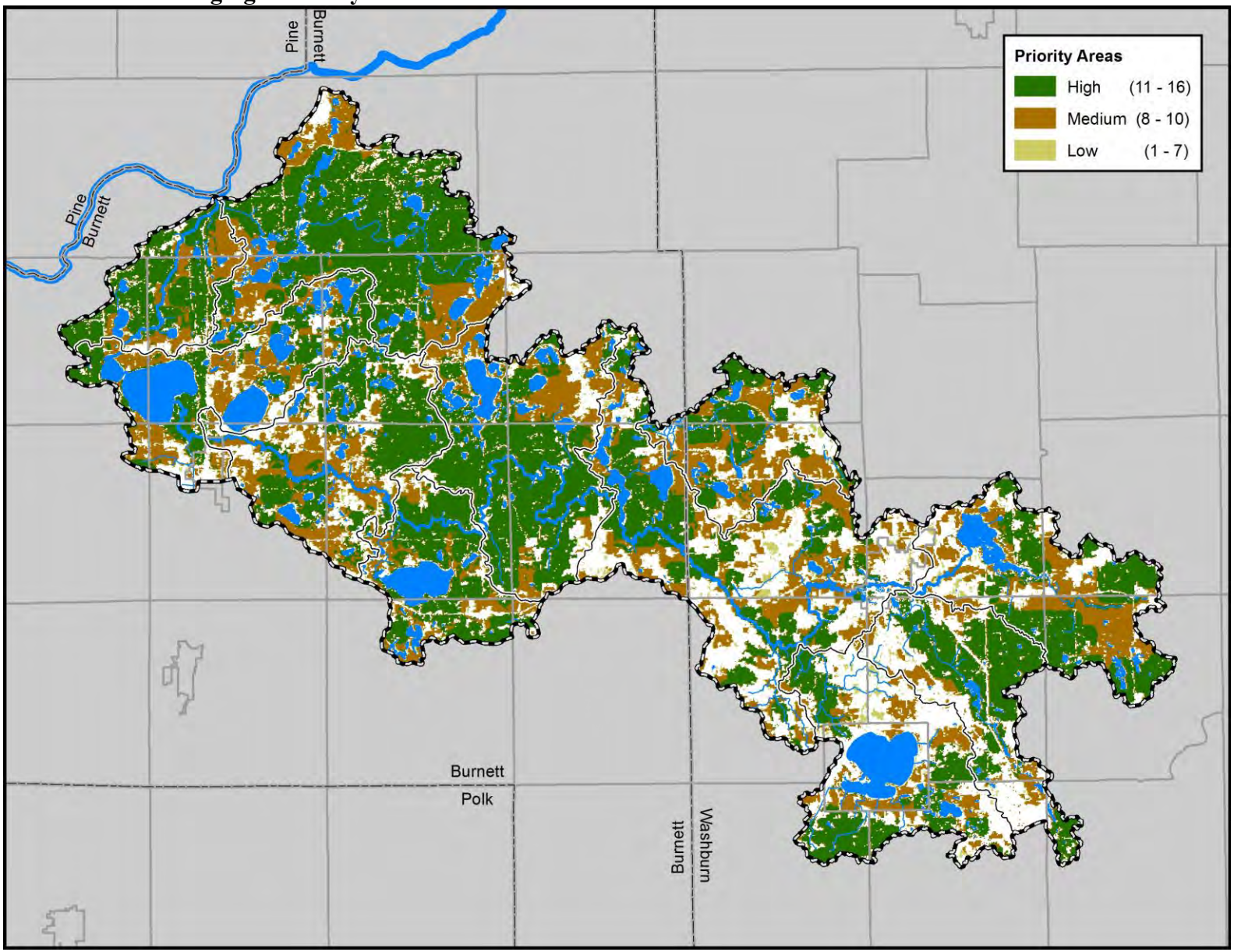


Figure 26. Map 5: Potential for Managing for Ecosystem Services.

Table 27. Areas of priority for managing for ecosystem services.

Priority Areas	Area (Acres)	% of Total
High	92,969	39.7
Medium	57,728	24.6
Low	7,414	3.2
Masked	76,233	32.5
Total Watershed Area	**234,344**	**100.0**

This map and narrative describe potential areas for managing for ecosystem services such as water quality, air quality, carbon sequestration, and habitat for threatened or endangered species. All forests provide ecosystem services in different amounts. The areas identified as high in this map represent multiple attributes. This map does not show where ecosystem services could be improved or enhanced, rather where we want to keep managing for the ecosystem services provided. For example, this map does not include marginally productive agricultural lands. While they are lands that have the potential to provide greater ecosystem services if they were planted with trees, they do not currently provide such services.

Several of the following criteria are the same as those for the previous section 'Potential for Actively and Sustainably Managing Forests.'

Forest patch size: (see description in previous section)

Proximity to protected and conserved: (see description in previous section)

Wildlife Action Plan – Conservation Opportunity Areas in forested habitats: (see description in previous section)

Outstanding and Exceptional Resource Waters (OERW): (see description in previous section)

Threatened and endangered species or NHI forested community2: This input shows forested habitat where threatened and endangered species have been observed and where there are forested communities of concern. The presence of one or more rare species and natural communities in an area can be an indication of the area's health and ecological importance. Similarly, maintaining these features also sustains habitat for common and perhaps other rare species and maintains the larger complex of which the natural community or feature is a part. All are important elements of biodiversity which is an ecosystem service. *(Weight: one to two points depending on forest community and species of concern overlap.)*

Priority watersheds: (see description in previous section)

Forested wetlands: Wetlands provide habitat for more species of plants and animals than any other type of landscape in Wisconsin. Habitat is not their only functional value. Wetlands can also store water to prevent flooding, purify water, protect lake and stream shores from eroding and provide recreational opportunities for wildlife watchers, anglers, hunters, and boaters. Forest management is an important tool to support the benefits wetlands provide. *(Weight: one point for areas classified as a forested wetland type.)*

Carbon sequestration: Forests sequester carbon in different amounts depending on a wide variety of factors. Carbon sequestration can be managed for anywhere, but there are certain areas where sequestration is greatest. It is represented as biomass in this map and areas that have more biomass are scored higher. By county, the amount of biomass (as proxy for carbon) will be ranked high, medium, and low. *(Weight: one to three points, with three points going to counties with the largest amount of biomass.)*

The Yellow River Watershed is heavily forested, and rich in high quality water resources. As a result, 39.7% of the watershed is considered high priority for managing for ecosystem service such as water quality, air quality, carbon sequestration, and habitat for threatened or endangered species. Much of the high priority and medium priority (24.6%) area is concentrated in the western half of the watershed. Much of the eastern third of the watershed in not rated most likely because this area has a lot of cultivated crops and pasture/hay. This data set does not include marginally productive agricultural lands that have the potential to provide greater ecosystem services if they were planted with trees, because they do not currently provide such services. The watershed is located in a part of Wisconsin with a relatively high proportion of high priority areas as compared to the state as a whole.

Potential for Maintaining and Enhancing Economic Benefits from Forests

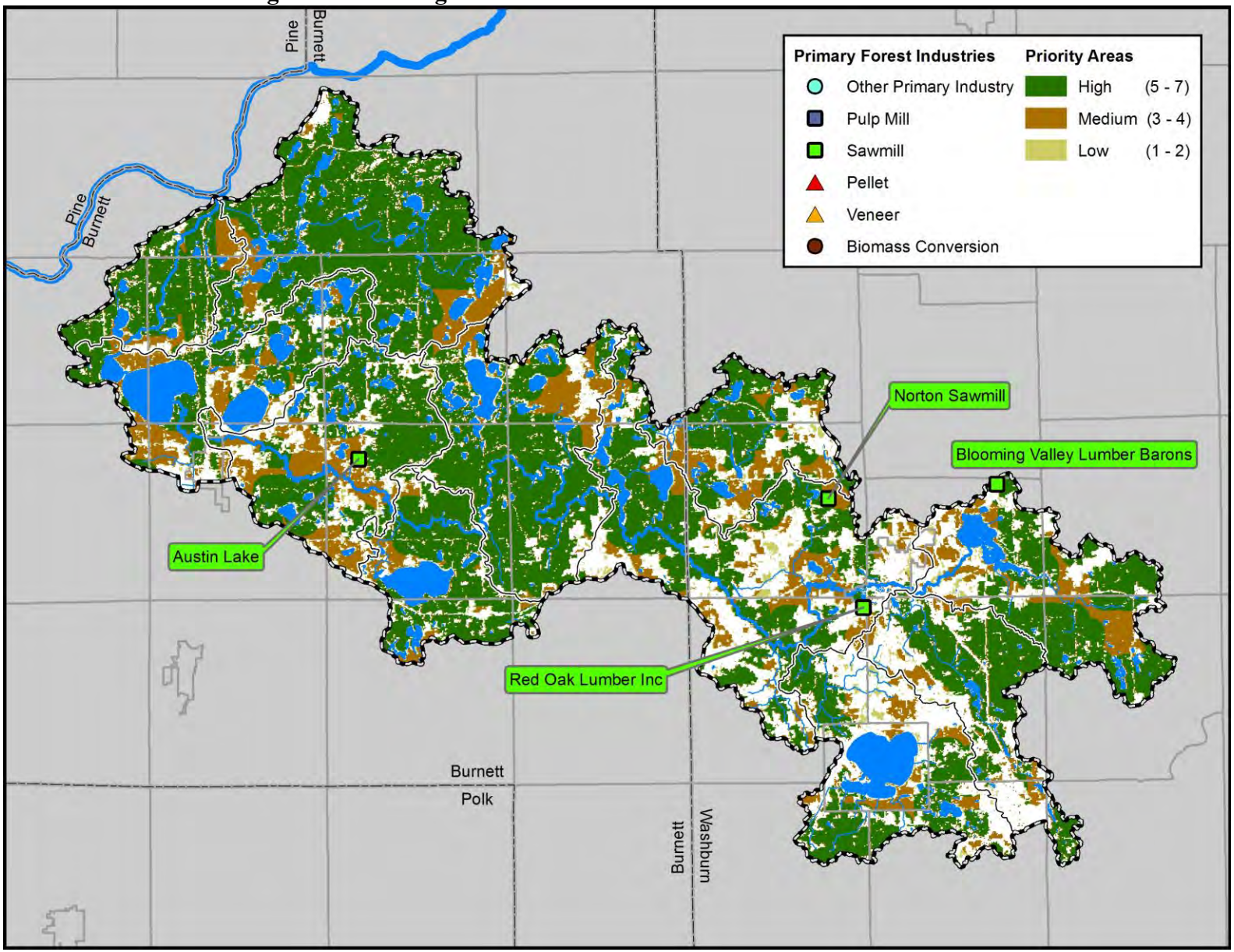


Figure 27. Map 6: Potential for Maintaining and Enhancing Economic Benefits from Forests.

Table 28. Areas of priority for maintaining and enhancing economic benefits from forests.

Priority Areas	Area (Acres)	% of Total
High	111,671	47.7
Medium	37,916	16.2
Low	8,524	3.6
Masked	76,233	32.5
Total Watershed Area	**234,344**	**100.0**

This map and narrative describes potential areas for maintaining and enhancing economic benefits from forests. Forests provide a variety of economic benefits including, but not limited to, traditional forest products. Many communities in forested areas depend heavily on forest industry and forest based recreation and tourism dollars. Ecosystem services are beginning to be monetarily quantified as research can assess impact costs or alternatives that produce the same benefits. These will be important to consider as markets are established.

To identify priority areas for maintaining and enhancing economic benefits from forests, the following criteria are used:

Proximity to protected and conserved: (see description for Figure 25)

Third party certified forests: A requirement of some ecosystem markets is that lands be 3rd party certified as sustainably managed. When a forest is certified, it can open up more economic opportunities for the landowner. Forest lands (all ownerships) that are certified are presented on this map. *(Weight: one point for lands that are certified.)*

Forest industry: Forests that are near a forest products company or a utility using renewable material are likely to be able to sell forest products easier due to their proximity to these companies. Wisconsin's primary wood-using industry consists of firms that manufacture logs and pulpwood into value-added wood products. Locations of the following are displayed on the map but are not included in the analysis: pulp mills, sawmills, pellet makers, veneer plants, biomass conversion facilities and as well as companies that manufacture such products as composite panels, log cabins, and treated wood. This data is routinely updated and new data will be available late summer, 2010.

The Yellow River Watershed is heavily forested, has a significant acreage of SFI and FSC certified county forestland, and is home to four sawmills. As a result, nearly half of the watershed (47.7%) is a high priority area for maintaining and enhancing the economic benefits from forests. Much of the high priority and medium priority (16.2%) area is concentrated in the western two-thirds of the watershed. Much of the eastern third of the watershed in unrated most likely because this area has a lot of cultivated crops and pasture/hay that would have the potential to provide economic benefit from forest if they were planted with

trees, but they do not currently. The watershed is located in a part of Wisconsin with a relatively high proportion of high priority areas as compared to the state as a whole.

5. Natural Heritage Inventory

Tables 29 and 30 list the endangered, threatened, and special concern species observed in or near the Yellow River Watershed. This list was created by a check of the Wisconsin Natural Heritage Inventory for the townships and ranges that are intersected by the Yellow River Watershed. Established in 1985 by the Wisconsin legislature, Wisconsin's Natural Heritage Inventory program (NHI) is part of an international network of inventory programs. The program is responsible for maintaining data on the locations and status of rare species, natural communities, and natural features throughout the state. Species and natural communities tracked by the Wisconsin NHI Program can be found on the NHI Working List (http://dnr.wi.gov/topic/nhi/).

In addition to the species listed below, it is important to note that most of the Yellow River Watershed falls into the Karner Blue Butterfly Federal High Potential Range, where there is a high likelihood for habitat conditions that would support the host plant, wild lupine, and the federally endangered butterfly (http://dnr.wi.gov/topic/ForestPlanning/karner.html).

Table 29. Rare and natural features, zoological types.

Scientific Name	Common Name	Scientific Name	Common Name
Acipenser fulvescens	Lake Sturgeon	*Hemaris gracilis*	Slender Clearwing
Agabetes acuductus	A Water Scavenger Beetle	*Hygrotus farctus*	A Predaceous Diving Beetle
Agabus leptapsis	A Predaceous Diving Beetle	*Ixobrychus exilis*	Least Bittern
Alasmidonta marginata	Elktoe	*Lycaeides melissa samuelis*	Karner Blue Butterfly
Ammodramus leconteii	Le Conte's Sparrow	*Lycaena dione*	Gray Copper
Atrytonopsis hianna	Dusted Skipper	*Moxostoma carinatum*	River Redhorse
Botarus lentiginosus	American Bittern	*Moxostoma valenciennesi*	Greater Redhorse
Bucephala clangula	Common Goldeneye	*Myotis lucifugus*	Little Brown Bat
Buteo lineatus	Red-shouldered Hawk	*Notropis anogenus*	Pugnose Shiner
Camnula pellucida	Clear-winged Grasshopper	*Notropis nubilus*	Ozark Minnow
Canus lupis	Gray Wolf	*Notropis texanus*	Weed Shiner
Catocala whitneyi	Whitney's Underwing Moth	*Nycticorax nycticorax*	Black-crowned Night-heron
Chlidonias niger	Black Tern	*Oeneis chryxus*	Chryxus Arctic
Chlosyne gorgone	Gorgone Checker Spot	*Ophiogomphus anomalus*	Extra-striped Snaketail
Coturnicops noveboracensis	Yellow Rail	*Ophiogomphus howei*	Pygmy Snaketail
Cumberlandia monodonta	Spectacle Case	*Ophiogomphus smithi*	Sioux (Sand) Snaketail
Cycleptus elongatus	Blue Sucker	*Ophiogomphus susbehcha*	Saint Croix Snaketail

Table 29. Rare and natural features, zoological types (Cont.).

Scientific Name	Common Name	Scientific Name	Common Name
Cyclonaias tuberculata	Purple Wartyback	*Ophulella pelidna*	Spotted-winged Grasshopper
Cygnus buccinator	Trumpeter Swan	*Oporornis agilis*	Connecticut Warbler
Emydoidea blandingii	Blanding's Turtle	*Papaipema beeriana*	Liatris Borer Moth
Erynnis martialis	Mottled Dusty Wing	*Parkesia motacilla*	Louisiana Waterthrush
Erynnis persius	Persius Dusty Wing	*Percina evides*	Gilt Darter
Etheostoma microperca	Least Darter	*Pituophis catenifer*	Gophersnake
Glaucomys sabrinus	Nothern Flying Squirrel	*Plestiodon septentrionalis*	Prairie Skink
Glyptemys insculpta	Wood Turtle	*Schinia indiana*	Phlox Moth
Gomphus graslinellus	Pronghorned Clubtail	*Stenelmis antennalis*	A Riffle Beetle
Haliaeetus leucocephalus	Bald Eagle	*Triaenodes nox*	Long-horned Casemaker Caddisfly
Haliplus leopardus	A Crawling Water Beetle	*Tympanuchus phasianellua*	Sharp-tailed Grouse

Table 30. Rare and natural features, botanical types.

Scientific Name	Common Name	Scientific Name	Common Name
Arabis missourienis	Missouri Rock-cress	*Platanthera hookeri*	Hooker's Orchid
Artemisia dracunculus	Dragon wormwood	*Poa paludigena*	Bog Bluegrass
Artemisia frigida	Prairie Sagebrush	*Potamogeton pulcher*	Spotted Pondweed
Ascelpias ovalifolia	Dwarf Milkweed	*Scirpus heterochaetus*	Slender Bulrush
Crotalaria sagittalis	Arrow-headed Rattle-box	*Scirpus torreyi*	Torrey's Bulrush
Eleocharis robbinsii	Robbins' Spike-rush	*Utricularia resupinata*	Northeastern Bladderwort
Platanthera flava var. herbiola	Pale Green Orchid		

6. Water Quality

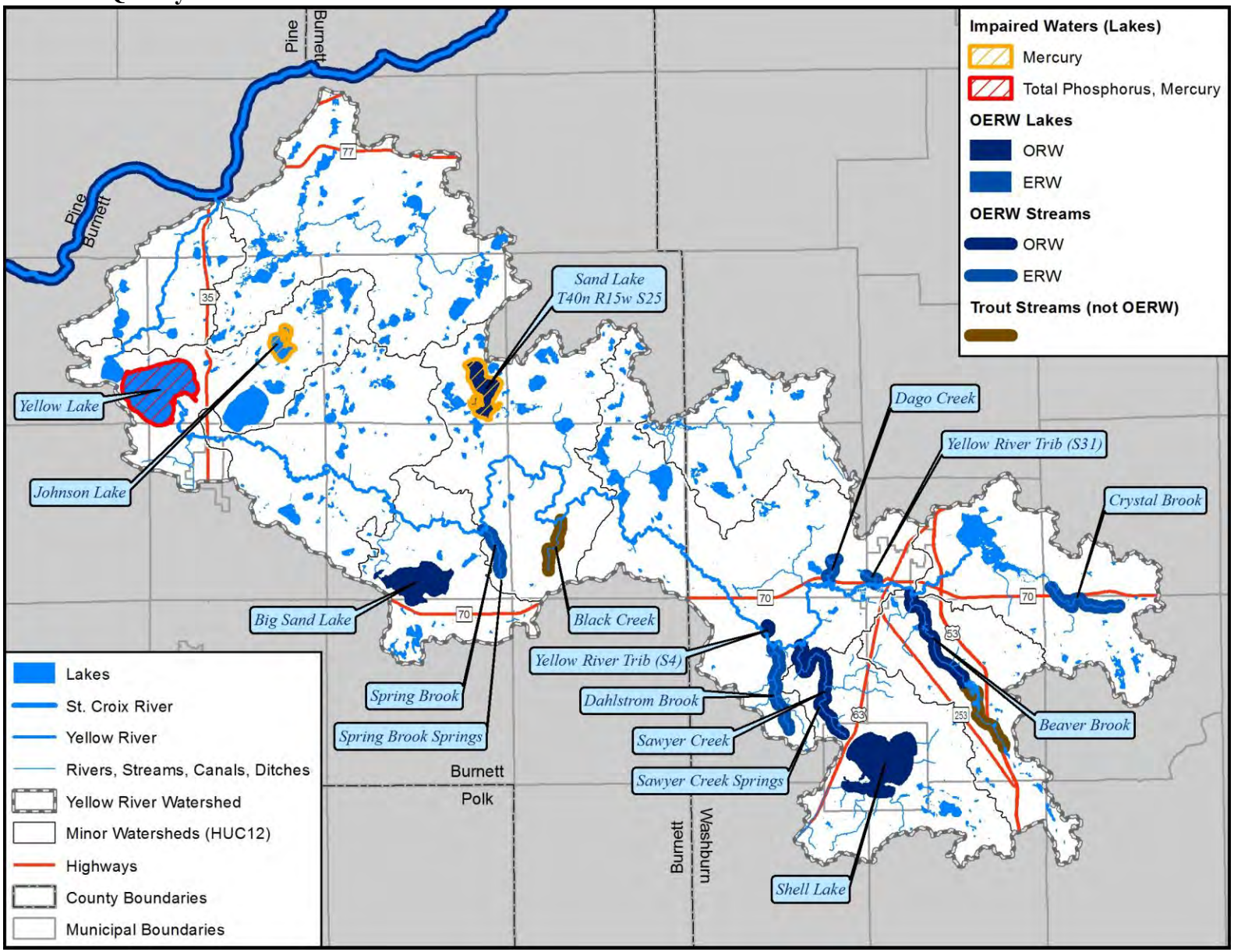


Figure 28. Impaired Waters, Outstanding/Exceptional Resource Waters, Trout Streams.

Table 31. Impaired waters areas.

Lake Name	Impairment	Impairment Status	Impaired Water Priority	Area (acres)
Johnson Lake	Mercury	303d Listed	Low	399
Sand Lake T40n R15w S25	Mercury	303d Listed	Medium	900
Yellow Lake	Total Phosphorus, Mercury	Pollutant Removed, 303d Listed	Delisted 2006, Low	2,282
Total Area				**3,580**

Table 32. OERW streams.

OERW Status	Stream Name	Trout Class	Length (miles)
ERW	Crystal Brook	CLASS I	3.4
	Dago Creek	CLASS I	1.2
	Dahlstrom Brook	CLASS I	3.8
	Spring Brook	CLASS I	1.9
	Yellow River Trib (S31)	CLASS I	0.6
Subtotal (ERW)			**10.9**
ORW	Beaver Brook	CLASS I	4.4
	Sawyer Creek	CLASS I	2.8
	Sawyer Creek	CLASS II	3.7
	Yellow River Trib (S4)	CLASS I	0.4
Subtotal (ORW)			**11.3**
Total Length			**22.2**

Table 33. OERW lakes.

OERW Status	Lake Name	Area (acres)
ERW	Spring Brook Springs	5
Subtotal (ERW)		**5**
ORW	Big Sand Lake	1,433
	Sand Lake T40n R15w S25	900
	Sawyer Creek Springs	2
	Shell Lake	2,512
Subtotal (ORW)		**4,847**
Total Area		**4,852**

Table 34. Trout streams not listed as OERW.

Stream Name	Trout Class	Length (miles)
Beaver Brook	CLASS I	3.3
Black Creek	CLASS II	2.3
Total Length		**5.6**

The federal Clean Water Act requires states to adopt water quality standards to protect lakes, streams, and wetlands from pollution. The standards define how much of a pollutant (bacteria, nutrients, turbidity, mercury, etc.) can be in the water and still meet designated uses, such as drinking water, fishing, and swimming. A water body is "impaired" if it fails to meet one or more water quality standards (WI DNR source on Impaired Waters).

Table 31 lists the impaired waters in the Yellow River Watershed. There are no streams listed as impaired in the Yellow River Watershed. The St. Croix River is not listed as impaired until Lake St. Croix, which is impaired due to excess nutrients and resulting eutrophication. However three lakes are listed as impaired. Impairments include Total Phosphorus and Mercury in Yellow Lake which is 303d listed, but polluntants have been removed, and it was delisted in 2006. Johnson Lake is 303d listed for Mercury and is a low priority impaired water, and Sand Lake is 303d listed for mercury and is a medium priority imparied water.

The Yellow River Watershed is home to high qaulity water resources including 10.9 miles of streams and 5 acres of lake designated as Exceptional Resource Waters and 11.3 miles of stream and 4,847 acres of lakes designated as Outstanding Resource Waters. Crystal Brook, Dago Creek, Dahlstrom Brook, Spring Brook, and YR Trib S31 and Spring Brook Springs are all designated Exceptional Resource Waters. Beaver Brook, Sawyer Creek, YR Trib S4, along with Big Sand Lake, Sand Lake, Sawyer Creek Springs, and Shell Lake are all designated Outstanding Resource Waters.

Forested riparian areas are critical to trout habitat in northern Wisconsin. Trout need cold water, gravel streambeds and shelter from predators. Healthy riparian areas minimize fluctuations in water temperature, reduce sediment washing into the stream, and help control water flows in streams. Trout build gravel nests for spawning and egg incubation in stream segments with cold, well-oxygenated water and gravel-bottoms.When the coarse rock and gravel in streambeds is surrounded or covered by fine sediment, like sand and clay, the quality of spawning habitat declines. Riparian forest cover also slows water speed, another factor limiting trout survival; if the speed of stream flow is too great, juvenile trout need to use too much energy to swim. Riparian forest cover also influence in-stream structure which help protect trout from predators and provide a resting place. The Yellow River watershed has 21.8 miles of Class I trout streams and 4 miles of Class II trout streams. Important Class I Trout Streams in the watershed include Crystal Brook, Dago Creek, Dalhstrom Brook, Spring Brook, 2.8 miles of Sawyer Creek, and 7.7 miles of Beaver Brook. Class II Trout Streams in the watershed are Black Creek and 3.7 miles of Sawyer Creek.

7. Economic Sector Statistics by County

Agriculture

- From 1970 to 2010, earnings from farm jobs in the two county region held steady.
- From 1970 to 2010, earnings from non-farm jobs in the two county region increased by approximately $500 million.
- Farms jobs account for 7% of total employment in the two-county region. Above the state non-metro average and the US average.
- Farm earnings account for 2.8% of total earnings in the two-county region. Less than the state non-metro average, but significantly above the Us average.

Figure 29. Farm and Non-Farm Jobs, Two County Region.

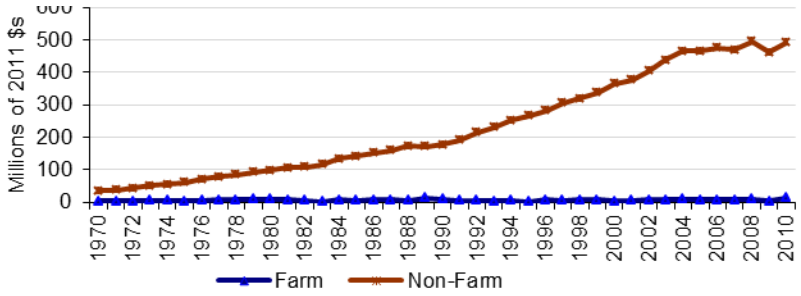


Figure 30. Farm Jobs as a Percent of Total Employment, 2010

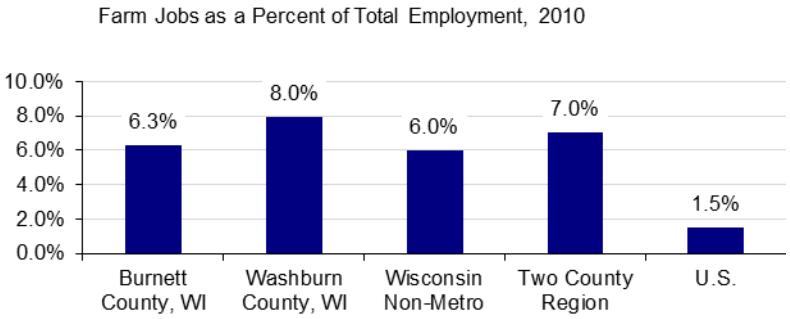
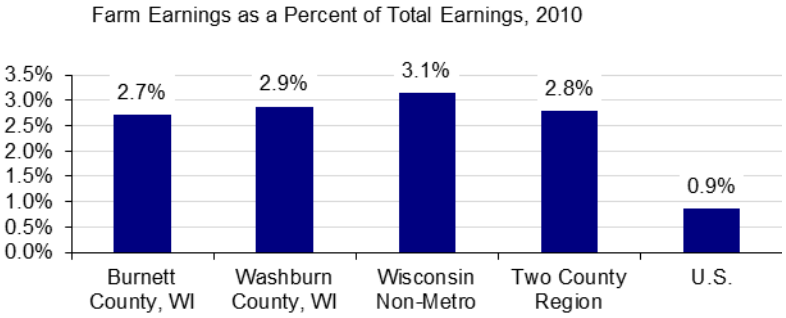


Figure 31. Farm Earnings as a Percent of Total Earnings, 2010



Timber

- Private employment in timber accounts for 3.72% of total employment in the two-county region, higher than the state non-metro average and the national average.
- Timber employment in Washburn County is 4.77% of total employment; in Burnett County timber employment is 2.21% of total employment.
- Since 1998, the percent of total employment in timber for the two county region has declines approximately 2%.

Figure 32. Percent of Total Private Employment in Timber, 2010

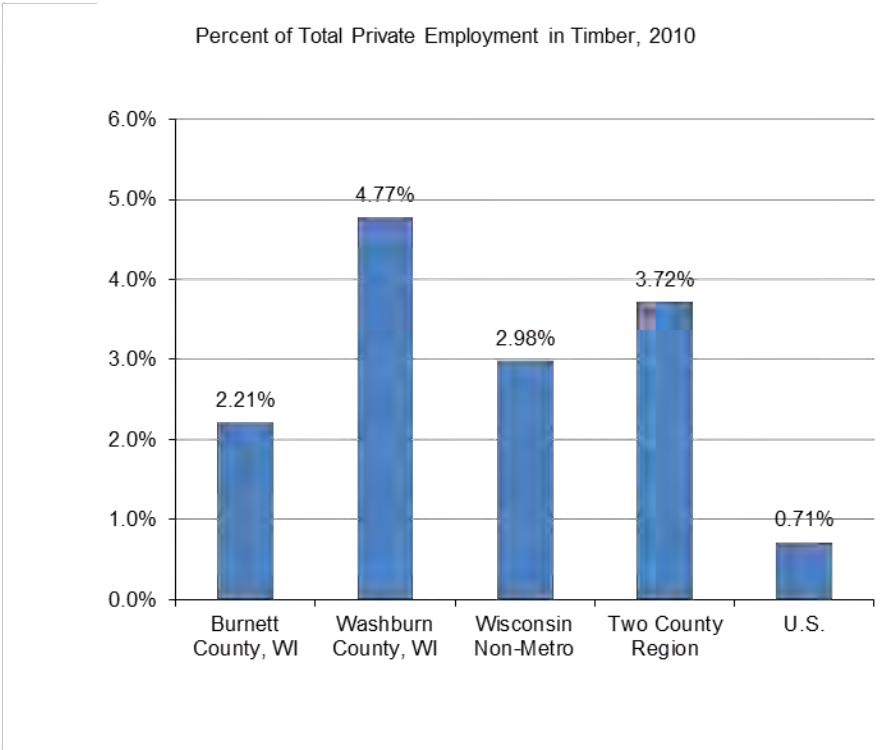
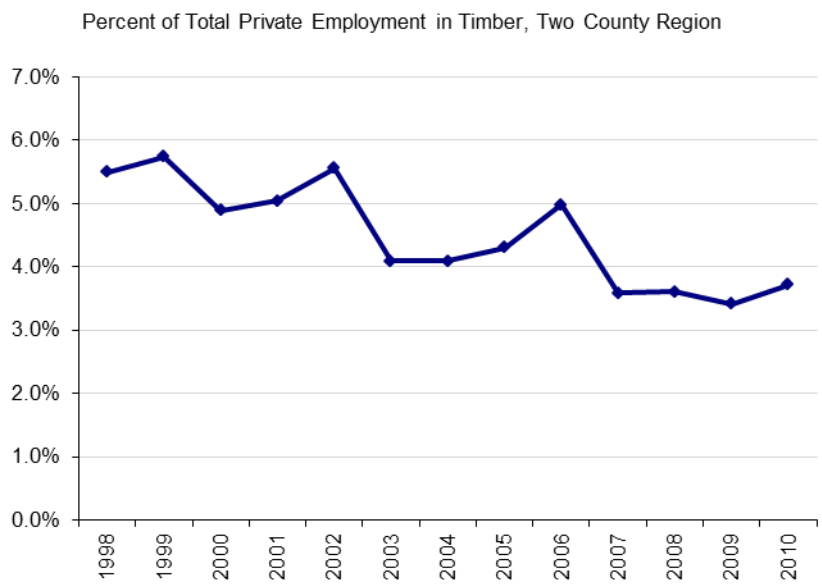


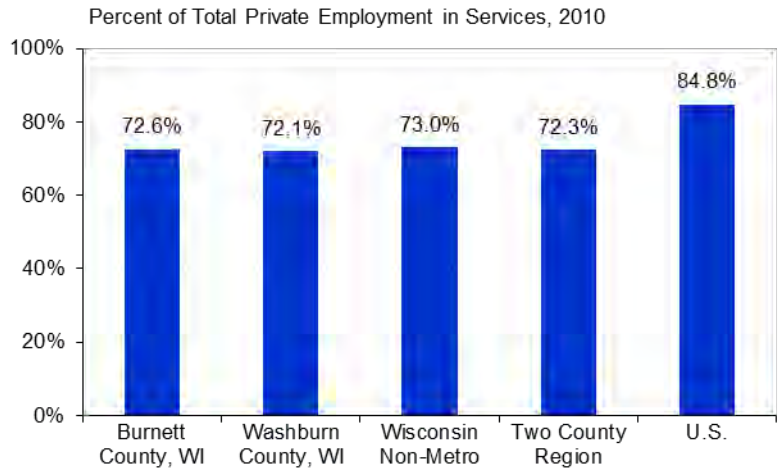
Figure 33. Percent of Total Private Employment in Timber, Two County Region



Services

- Services accounted for 72.3% of private employment in the two-county region. This slightly below the WI non-metro average of 73% and well below the national average of 84.8%.
- Employment in services accounts for 72.6% of employment in Burnett County and 72.1% of employment in Washburn County.

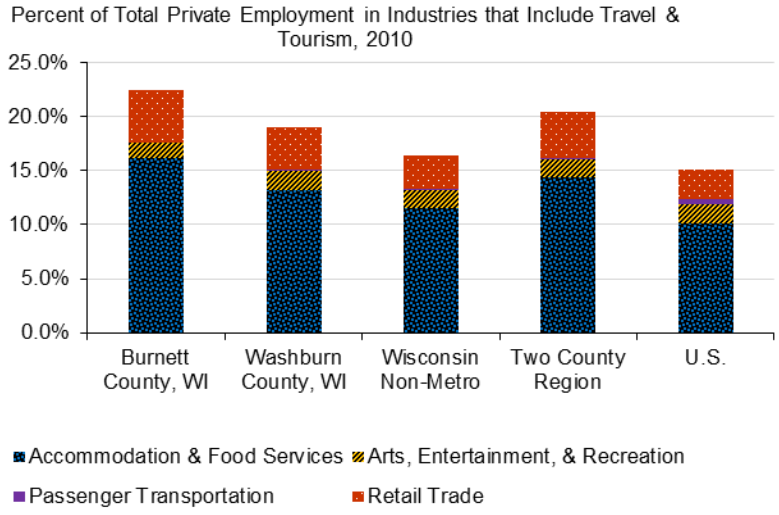
Figure 34. Percent of Total Private Employment in Services, 2010



Tourism

- Private employment in industries that include Travel & Tourism in the two county area was approximately 20% of total private employment exceeding both the WI non-metro average (16%) and the National average (15%).
- Approximately 15% of employment in the two-county region is in accomodation and food services. Exceeding Wisconsin and national averages.

Figure 35. Percent of Total Private Employment in Travel & Tourism, 2010



All economic sector statistics data was generated using the Economic Profile System – Human Dimensions Toolkit created by Headwaters Economics for the Bureau of Land Management and the U.S. Forest Service, which is available at http://headwaterseconomics.org/tools/eps-hdt

8. Sub-watershed Analysis

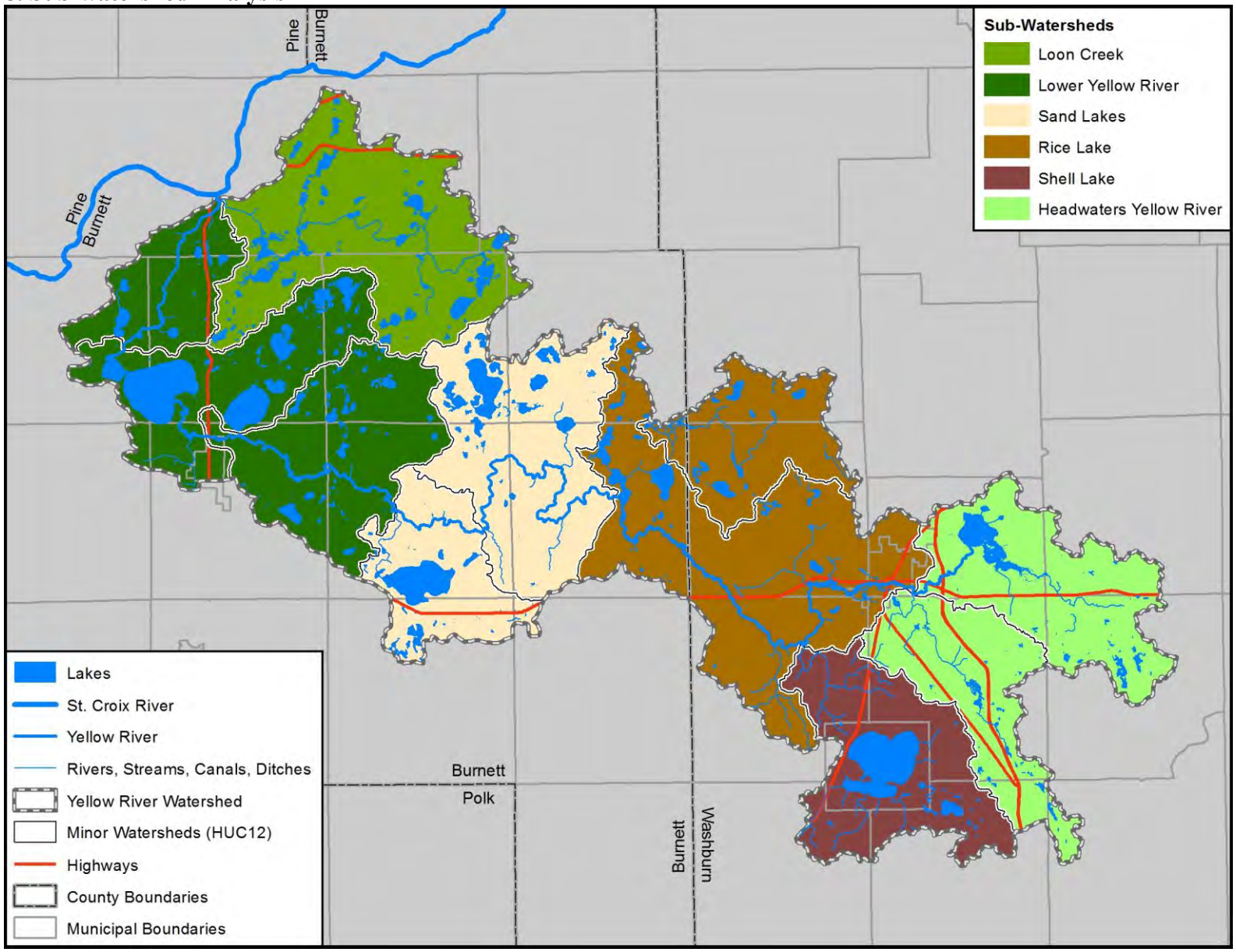


Figure 36. Sub-watersheds of the Yellow River Major Watershed.

Table 35. Sub-watershed Areas.

Sub-watershed	Area (Acres)	% of Total
Loon Creek	32,205	13.7
Lower Yellow River	52,466	22.4
Sand Lakes	39,695	16.9
Rice Lake	51,566	22.0
Shell Lake	21,520	9.2
Headwaters Yellow River	36,891	15.7
Total Watershed Area	**234,344**	

The Yellow River Watershed covers approximately 234,344 acres. Planning in such a large area can be complicated. Grouping the watershed into smaller portions can facilitate more focused planning. To inform sub-watershed descriptions, analysis for watershed characteristics was completed for each of the sub-watersheds. For Hydrologic Unit Codes, the watershed is split into two HUC10 watersheds, Yellow Lake-Yellow River and Shell Lake-Yellow River. Splitting the watershed into two sections was not enough of a sub-division to merit analysis, so HUC12 watersheds were grouped to evenly distribute areas throughout the watershed.

When grouping the HUC12 watersheds, the HUC10 split was respected; the lower three sub-watersheds are in the lower HUC10, and the upper three sub-watersheds are in the upper HUC10. Loon Creek is an isolated HUC12 watershed, and so was kept as the HUC12. The remaining 5 HUC12s of the Yellow Lake-Yellow River HUC10 were split. Detailed characteristics and figures for each sub-watershed are included in the addendum "1 2 Inv Assess Subwatersheds.doc." The key characteristics of each sub-watershed are outlined below.

Loon Creek

- Isolated from the rest of the Yellow River Watershed. Flows in the Yellow River less than a mile before the St. Croix confluence.
- Stream density is 0.5 miles/mi^2.
- Soils predominately excessively (51.5%) and somewhat excessively (20.9%) drained. 99.9% of soils classified as not prime farmland and 78.7% rated as not hydric.
- Pre-settlement vegetation was predominately jack pine/scrub oak/barrens (87.6%).

- Today the sub-watershed has the highest percentage of upland forest (68.8%); mostly upland deciduous forest (47.3%). 2.6% of the sub-watershed is agriculture or upland grass (hay/pasture); 6.5% is developed.
- From pre-settlement times to 2006 the sub-watershed lost 6,027 acres of upland forest, a 18.8% loss.
- The sub-watershed has 10 lakes over 100 acres and is 10.4% open water.
- Highest percentage of county-owned land (40.4%). Lowest percentage of private non-conservancy land (58.6%).
- Only conservancy land in the Yellow River Major Watershed – 167 acres of Nature Conservancy land.
- No rivers, streams or lakes that are listed as impaired. There are no designated trout streams and no streams or lakes that are designated as either exceptional resource waters or outstanding resources waters.
- If 22.8% of the watershed area is not kept as mature upland forest (a total of 7,331 acres of mature upland forest), the main stem of Loon Creek would be at risk for increased peak flows from spring snow melts.

Lower Yellow River

- Largest sub-watershed within the Yellow River Major Watershed at 52,466 acres. The villages of Webster and Danbury are located in this sub-watershed.
- Stream density is 0.5 miles/mi^2.
- The sub-watershed has 11 lakes over 100 acres and is 13.7% open water.
- Yellow Lake is home to a population of over 2,000 Lake Sturgeon.
- 36% of soils are excessively to somewhat excessively drained; 27.9% are well to moderately well drained soils; 21% are somewhat poorly to very poorly drained soils. The majority of soils within the sub-watershed (63%) are rated as not hydric. 94.1% of soils are classified as not prime farmland.
- Presettlement land cover in the Sub-watershed was primarily jack pine/scrub oak/barrens (78.9%) and lowland vegetation (7.8%).
- Today the sub-watershed is 58.9% upland forest – predominately upland deciduous forest (44.3%). 11% of the sub-watershed is agriculture or upland grass (hay/pasture); 6.1% is developed.
- From pre-settlement times to 2006 the sub-watershed lost 10,467 acres of upland forest, a 20% loss.
- Ownership in the Lower Yellow River Sub-watershed is 87.2% private non-conservancy, 7.7% county, 4.9% state, and 0.2% tribal.
- Johnson Lake is listed as impaired for mercury. Yellow Lake is listed as impaired by total phosphorus and mercury. There are no designated trout streams and no streams or lakes that are designated as either exceptional resource waters or outstanding resources waters.

Sand Lakes

- The Sand Lakes Sub-watershed encompasses 39,695 acres in Burnett County.
- Stream density is 0.5 miles/mi^2.
- The sub-watershed has 10 lakes over 100 acres and is 12.4% open water.
- 42.7% of soils in the sub-watershed are excessively to somewhat excessively drained; 23.4% of soils are well drained to moderately well-drained; 21.3% of soils are somewhat poorly to very poorly drained soils. 65.1% of soils in the sub-watershed are rated as not hydric. 96.7% of soils are classified as not prime farmland.
- Pre-settlement land cover in the Sub-watershed was primarily jack pine/scrub oak/barrens (77.9%) with small amounts of pine forest (3.1%) and lowland vegetation (7.1%).
- Today the sub-watershed is 63.5% upland forest – predominately upland deciduous forest (45.7%). 7.7% of the sub-watershed is agriculture or upland grass (hay/pasture); 5.2% is developed – the smallest percentage of developed land among sub-watersheds in the Yellow River Major Watershed.
- From pre-settlement times to 2006 the sub-watershed lost 6,937 acres of upland forest, a 17.5% loss – the smallest loss of any sub-watershed in the Yellow River Major Watershed..
- Ownership in the Sand Lakes Sub-watershed is 75.0% private non-conservancy, 22.5% county, 0.7% state, and 1.8% tribal.
- In the Sand Lakes Sub-watershed, Sand Lake is listed as impaired for mercury. Spring Brook is a designated Class I trout stream and Black Creek is a designated Class II trout stream. Spring Brook is also a designated Exceptional Resource Water. Both Sand Lake and Big Sand Lake are designated as Outstanding Resource Waters and Spring Brook Springs is a designated Exceptional Resource Water.

Rice Lake

- The Rice Lake Sub-watershed encompasses 51,566 acres. 24.5% of the sub-watershed is in Burnett County, 75.5% is in Washburn County. The City of Spooner is within this sub-watershed.
- Stream density is 0.8 miles/mi^2.
- The sub-watershed has 6 lakes over 100 acres and is 5.3% open water.
- The Rice Lake sub-watershed is home to the Governor Tommy G. Thompson State Fish Hatchery, the state's largest cool water facility and the world's largest musky hatchery.
- There are approximately 73 acres of cranberry bogs in the sub-watershed.

- 48.8% of soils in the sub-watershed are excessively to somewhat excessively drained; 32.1% of soils are well drained to moderately well-drained; 13.5% of soils are somewhat poorly to very poorly drained soils. 75.6% of soils in the sub-watershed are rated as not hydric. 91.9% of soils are classified as not prime farmland.
- Pre-settlement land cover in the sub-watershed was primarily upland forest (91.5%) with a small amount lowland vegetation (2.8%). The presettlement upland forest was primarily jack pine/scrub oak/barrens openings (83.1%) with small amounts of oak forest (0.9%), maple-basswood-oak forests (2.5%), maple-birch-pine forest (4.7%), and white pine/red pine forest (0.3%).
- Today the sub-watershed is 56.0% upland forest – predominately upland deciduous forest (44.7%). 25.9% of the sub-watershed is agriculture or upland grass (hay/pasture); 6.9% is developed.
- From pre-settlement times to 2006 the sub-watershed lost 18,260 acres of upland forest, a 35.4% loss.
- Ownership in the Rice Lake Sub-watershed is 97.3% private non-conservancy, 2.1% county, 0.5% state, and 0.1% tribal. This sub-watershed has the highest percentage of privately owned land and the least amount of publically owned land (State & County) in the Yellow River Watershed.
- There are no rivers, streams or lakes in the sub-watershed listed as impaired for mercury or total phosphorus and mercury.
- There are 6 miles of designated Class I trout streams including Dahlstrom Brook and Dago Creek. Dahlstrom Brook, Dago Creek and an unnamed Tony Lake stream (5.6 miles) are also designated Exceptional Resource Waters. An unnamed tributary downstream of the Dahlstrom Brook confluence (0.4 miles) is listed as an Outstanding Resource Water.

Shell Lake

- Smallest sub-watershed within the Yellow River Major Watershed at 21,519 acres all within Washburn County. The City of Shell Lake is located in this sub-watershed
- Highest stream density at 1.0 miles/mi^2
- The sub-watershed has 2 lakes over 100 acres and is 15.7% open water.
- Shell Lake, Wisconsin's largest land-locked, spring-fed lake at approximately 2,500 acres is the defining feature of the sub-watershed.
- The main stem of the Yellow River does not flow through this sub-watershed, but Sawyer Creek, a tributary of the Yellow River drains the northwestern portion of the sub-watershed. Sawyer Creek is a clear water spring fed trout stream that is notable as home to a trout stocking and research program that goes back to 1933. It flows through the state-owned Sawyer Creek Fishery Area.

- 7.3% of soils in the sub-watershed are excessively to somewhat excessively drained; 61.8% of soils are well drained to moderately well-drained; 15.1% of soils are somewhat poorly to very poorly drained soils. 50.4% of soils in the sub-watershed are rated as hydric or with hydric inclusions.
- Agriculture is more important in this sub-watershed where 19.6% of the area is considered prime farmland and 23.4% is farmland of statewide importance - the highest percentages of any of the sub-watersheds within the Yellow River watershed. 40.5% is rated as not prime farmland and 7.4% of the area is too wet for agriculture, but would be considered prime farmland if it was drained.
- Pre-settlement land cover in the sub-watershed was primarily upland forest (84.1%) with no or very little lowland vegetation. This sub-watershed mostly lacked the jack pine/scrub oak/barrens cover type (0.3%) common in the other sub-watersheds. The presettlement upland forest of the Shell Lake sub-watershed consisted primarily of maple-birch-pine forest (71.9%) and smaller amounts of white/red pine forest (9.7%) and maple-basswood-oak forest (2.3%).
- Today the sub-watershed is 42.6% upland forest – predominately upland deciduous forest (37.2%). 28.5% of the sub-watershed is agriculture or upland grass (hay/pasture); 7.6% is developed. This sub-watershed has the least amount of forestland and the highest percentages of agriculture/grassland and developed land.
- From pre-settlement times to 2006 the sub-watershed lost 8,934 acres of upland forest, a 41.5% loss – the highest percentage in the Yellow River Watershed.
- Ownership in the Shell Lake Sub-watershed is 90% private non-conservancy, 6.3% county, and 3.7% state.
- There are no rivers, streams or lakes in the sub-watershed listed as impaired for mercury or total phosphorus and mercury.
- Two separate stretches of Sawyer Creek, approximately 2.8 total miles, are designated as Class I trout stream. In addition, 3.7 miles of Sawyer Creek are designated Class II trout streams. Sawyer Creek and Shell Lake are designated Outstanding Resource Waters.

Headwaters Yellow River

- The Headwaters Yellow River Sub-watershed encompasses 36,891 acres in Washburn County.
- Stream density is 0.7 miles/mi^2
- The sub-watershed has 2 lakes over 100 acres and is 6.1% open water.
- 20.5% of soils in the sub-watershed are excessively to somewhat excessively drained; 63.2% of soils are well drained to moderately well-drained; 10.1% of soils are somewhat poorly to very poorly drained soils. 45.5% of soils in the sub-watershed are rated as hydric or with hydric inclusions; 45.2% are rated as not hydric.

- 56.9% of soils in the sub-watershed are classified as not prime farmland. 17.8% of soils are rated as prime farmland and 22.6% as farmland of statewide importance.
- Pre-settlement land cover in the sub-watershed was primarily upland forest (91.6%) with a small amount of lowland vegetation (1.6%). Presettlement upland forest consisted of jack pine/scrub oak/barrens (40.5%), maple-birch-pine forest (34.0%%), white/red pine forest (6.1%) and maple-basswood-oak forest (11%).
- Today the sub-watershed is 59.0% upland forest – predominately upland deciduous forest (54.1%). 21.4% of the sub-watershed is agriculture or upland grass (hay/pasture); 7.2% is developed.
- From pre-settlement times to 2006 the sub-watershed lost 11,997 acres of upland forest, a 32.5% loss.
- Ownership in the Headwaters Yellow River Sub-watershed is 83.7% private non-conservancy, 10.7% county, and 5.6% state.
- There are no rivers, streams or lakes in the sub-watershed listed as impaired for mercury or total phosphorus and mercury.
- There are 11.1 miles of designated Class I trout streams in the sub-watershed including the entire length of Beaver Brook River and Crystal Brook. In addition, Beaver Brook is a designated Outstanding Resource Water and Crystal Brook is a designated Exceptional Resource Water.
- The sub-watershed is home to the Beaver Brook Wildlife Area (BBWA), surrounding Beaver Brook and the many spring ponds and bank seeps that feed it.
- In the Beaver Brook HUC12, if 30.6% of the watershed area is not kept as mature upland forest (a total of 4,926 acres of mature upland forest), Beaver Brook and the main stem of the Yellow River may be at risk for increased peak flows from spring snow melts.
- In the Spooner Lake –Yellow River HUC12, if 25.9% of the watershed area is not kept as mature upland forest (a total of 5,391 acres of mature upland forest), Crystal Brook and the main stem of the Yellow River may be at risk for increased peak flows from spring snow melts.
- If 28.0% of the overall sub-watershed is not kept as mature upland forest (a total of 10,316 acres of mature upland forest), the main stem of the Yellow River downstream from the sub-watershed may be at risk for increase peak flows from spring snow melts.

C. Citations

Albert, Dennis A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. Gen. Tech. Rep. NC-178. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/habitat/rlandscp/index.htm (Version 03JUN1998).

Aldrich, H.R. and N.C. Fassett. 1929. Botanical and Geological Evidence for and Ancient Lake. *Science* 70(1802): 45-46.

Curtis, John. 1959. The Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison, WI.

Finley, R.W. 1976. Original vegetation cover of Wisconsin. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 1 map (1:500,000) and accompanying text.

Kovach, J. 2005. Subsection Descriptions: Bayfield Sand Plains – *unpublished*.

Kratz, T.K.; Jensen, G.L. 1983. Minnesota's landscape regions. *Natural Areas Journal*. 3(2): 33-44.

Murphy, R.E. 1931. Geography of the northwest pine barrens of Wisconsin. *Trans. Wis. Acad. Sci. Arts Lett.,* 26: 69-120.

Radeloff, V.C., D.J. Mladenoff, H.S. He, and M.S. Boyce. 1999. Forest landscape change in the northwestern Wisconsin Pine Barrens from pre-European settlement to the present. Can. J. For. Res. 29: 1649-1659.

Verry, Elon S. 2000. Land fragmentation and impacts to streams and fish in the central and upper midwest. In: Proceedings, Society of American Foresters 2000 national convention; 2000 November 16-20; Washington DC. SAF Publication 01-02. Bethesda, MD: Society of American Foresters: 38-44. Retrieved 1/14/13 from http://nrs.fs.fed.us/pubs/2537

Wisconsin Department of Natural Resources. 2012. *Ecological landscapes of Wisconsin*. Handbook 1805.1, Wisconsin Department of Natural Resources, Madison.

Wisconsin Department of Natural Resources – Division of Forestry. 2011. *Division of Forestry Strategic Direction*. Wisconsin Department of Natural Resources, Madison.

Appendix J
Yellow River Sub-watershed Resource Inventory and Assessment

Introduction

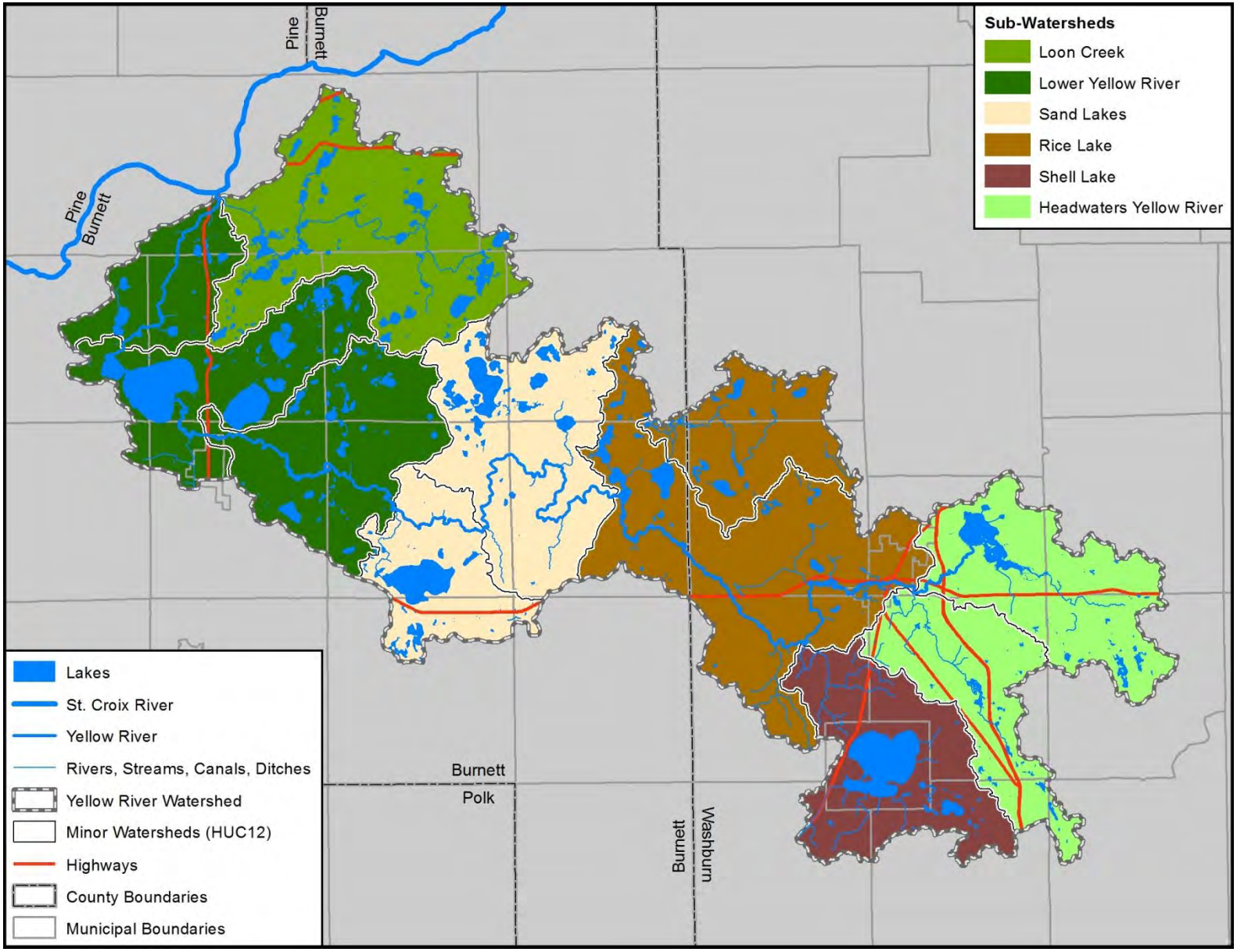
This document is an addendum to the Yellow River Watershed Landscape Stewardship Plan. The Yellow River Watershed covers over 234,000 acres. Planning can be difficult for such a large area. Splitting the watershed into smaller portions will allow for more focused planning. Key characteristics of each watershed are described in the following pages to assist in identifying trends and conditions across the watershed.

Analysis for watershed characteristics included in the Inventory & Assessment Section was carried out at the sub-watershed level. For Hydrologic Unit Codes, the watershed is split into two HUC10 watersheds, Yellow Lake -Yellow River and Shell Lake -Yellow River. Splitting the watershed into two sections was not enough of a sub-division to merit analysis, so minor (HUC12) watersheds were grouped to evenly distribute areas throughout the watershed.

When grouping the minor watersheds, the HUC10 split was respected; the lower three sub-watersheds are in the lower HUC10 (Yellow Lake -Yellow River), and the upper three sub-watersheds are in the upper HUC10 (Shell Lake -Yellow River). The Loon Creek minor watershed is isolated from the western and downstream end of the Yellow River Watershed, and so was designated as a sub-watershed (see map on next page). The Lower Yellow River Sub-watershed is a grouping of three minor watersheds that extends from the mouth of the Yellow River to the confluence of the Yellow River and the Big Sand Lake outflow. The Sand Lakes Sub-watershed includes the Big Sand Lake - Yellow River and Sand Lake - Yellow River minor watersheds, and extends upstream along the Yellow River from the Big Sand Lake outflow to the pour point of Rice Lake, which also marks the edge of the Yellow Lake – Yellow River HUC10.

The Rice Lake Sub-watershed includes the Rice Lake - Yellow River and Rocky Ridge Creek minor watersheds, and extends upstream along the Yellow River from the pour point of Rice Lake to the confluence of Beaver Brook and the Yellow River just east of the City of Spooner. The Shell Lake Sub-watershed (also a minor watershed) is an isolated (first-tier) watershed which empties into the Yellow River through Sawyer Creek. The Shell Lake Sub-watershed was split from the remaining first-tier minor watersheds due to its unique hydro-geologic features (spring fed lakes and streams). The Headwaters Yellow River Sub-watershed is a grouping of two first-tier minor watersheds including Beaver Brook and Spooner Lake – Yellow River.

Yellow River Sub-watersheds



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This document contains bookmarks than can be used for navigation.

A. Loon Creek

1. General Information

The Loon Creek Sub-watershed sits on the northwest, downstream end of the Yellow River Watershed. The watershed extends east past Little Bear Lake and Loon Lake into Scott and Web Lake townships and west to the convergence of Loon Creek and the Yellow River just a few hundred yards from where the Yellow flows into the St Croix within the Lower Yellow River Sub-watershed. The Loon Creek sub-watershed stretches north past Island Lake and just north State Highway 35, nearly to the St. Croix Riverway. The watershed extends south past Phernetton Lake nearly to County Highway A in the east and southwest to the intersection of County Highway C and State Highway 35 just past Fremstadt Lake. Loon Creek watershed encompasses 32,205 acres entirely within Burnett County. There are no cities within the sub-watershed but it is primarily within the Swiss, Oakland, and Jackson Townships.

Loon Creek flows mainly east to west through the sub-watershed with tributaries flowing primarily north or south into Loon Creek. There is a total of 27.4 miles of streams; 23.1 miles (84.4%) of streams in the watershed are considered perennial including 16.9 miles which are the main stem of Loon Creek. 4.3 miles (15.6%) are considered intermittent or fluctuating. The steam density in the watershed is 0.5 miles/mi^2.

There are 10 lakes over 100 acres in the sub-watershed. On the upstream (east) end of the watershed, Myre Lake, Little Bear Lake, and Shoal Lake are not connected to the main stem of Loon Creek by any perennial streams. Cadotte Lake and Loon Lake form the headwaters of Loon Creek. Further downstream, Twenty-six Lake empties to Loon Creek from the north. Tabor Lake, in the northern part of the sub-watershed, is connected to Loon Creek by a series of perennial streams and smaller lakes. Minerva Lake and Gull Lake in the southern reaches of the sub-watershed are part of the Loon Creek flowage and Love Lake, also in the south, is connected to the flowage through the smaller Falk Lake.

2. Soils

Soils in the Loon Creek Sub-watershed are generally excessively drained to somewhat excessively drained, about 72% of the total acreage within the sub-watershed. The excessively drained soils are concentrated in the northern two-thirds of the sub-watershed with the somewhat excessively drained soils generally in a band along the southern and eastern sub-watershed boundary. Well to moderately well drained soils (7.6%) occur in concentrated pockets in the southern reaches of the sub-watershed. Somewhat poorly to very poorly drained soils occur in small pockets scattered throughout the sub-watershed (9.1%). These soils are generally rated as hydric, predominately hydric or with hydric inclusions (10.2%). All other soils within the sub-watershed are rated as not hydric (78.7%).

Soils in the Loon Creek sub-watershed are primarily Grayling and related sands and are thus classified as not prime farmland (99.9%). Only 17.5 acres within this sub-watershed are classified as either prime farmland or farmland of statewide importance.

3. Land Cover

Presettlement

Presettlement (mid-late 1800s) land cover in the Loon Creek Sub-watershed was primarily upland forest (87.6%) with a small amount of lowland vegetation (2.2%). The presettlement upland forest of the Loon Creek sub-watershed was a mosaic of jack pine, some scrub oak, and barrens openings which are characteristic cover types for the sandy, excessively drained soils that are predominant in the Loon Creek sub-watershed. A large 700 acre conifer swamp along Loon Creek and the eastern end of Twenty-six lake accounts for the only known presettlement lowland vegetation within the Loon Creek sub-watershed.

Current

Current (as of 2006) land cover in the Loon Creek Sub-watershed consists of primarily upland forest (68.8%), along with smaller amounts of upland shrub and grassland (6.9%), lowland vegetation (6.9%), development (6.5%), and a miniscule amount of agriculture (0.5%). Open water covers 10.4% of the sub-watershed. The upland forest cover type is predominately deciduous forest with smaller amounts of evergreen and mixed forest scattered throughout the sub-watershed. Small areas of shrub/scrub and grasslands, mostly hay or pasture, are found primarily in the northern third of the sub-watershed. Lowland vegetation consists primarily of wooded wetlands and a small amount of emergent herbaceous wetland. These wetland areas are primarily located through the central portion of the watershed along and surrounding Loon Creek. Approximately 6.5% of the sub-watershed is considered to be developed; most of this (6.1% of sub-watershed) is classified as developed open space which is generally park areas, golf courses of other areas of lawn grasses and/or impervious surfaces. A golf course on the eastern tip of the sub-watershed accounts for most of this area.

Change

From presettlement to 2006, forest cover in the Loon Creek sub-watershed decreased from 87.6% of land area within the sub-watershed to 68.8%. That represents a loss of approximately 6,000 acres of previously forested land. These acres have primarily been converted to shrub land, hay field/pasture, and development. However, it is important to note that although much of the Loon Creek sub-watershed remains forested, the presettlement cover type has been almost completely eliminated from the landscape. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 6% of the total land area in the Loon Creek sub-watershed is in a primarily evergreen cover type and there are virtually no barrens opening within the sub-watershed. This represents a significant loss of the native cover type.

4. Ecological Landscapes

The Loon Creek sub-watershed spans part of two of Wisconsin's Ecological Landscapes, The Northwest Lowlands in the extreme northwest corner of the sub-watershed and the Northwest Sands which encompass the remainder of the sub-watershed. Approximately 6% of the Loon creek sub-watershed falls within the Northwest Lowlands Ecological Landscape. Within the Northwest Lowlands, the sub-watershed intersects with the St. Croix Plains Ecoregion. The St. Croix Plains LTA is characterized by land forms that are primarily undulating outwash plain and outwash-veneered moraine. Soils are

predominantly excessively drained sand over acid sandy loam till or outwash. Common habitat types include forested lowland, PAm, hydromesic, and AAs. Within the Loon Creek sub-watershed the St. Croix Plains area is mostly deciduous forest with small areas of evergreen forest and some significant areas of shrub land and woody wetland. It also contains the largest contiguous area of pastureland/hayfield and cultivated crops for this sub-watershed.

The remainder of the sub-watershed is encompassed by the Northwest Sands Ecological Landscape where it intersects with 3 different ecoregions. In the Danbury Trego Plains LTA which makes up 44.2% of the Loon Creek sub-watershed primarily in the central and northern sections of the sub-watershed, the characteristic landform pattern is undulating outwash plain with fans and stream terraces common. Soils are predominantly excessively drained sand over acid sand outwash and common habitat types include QGCe and PAm. Within the Loon Creek sub-watershed, the Danbury Trego LTA contains most of the sub-watershed's shrubland and herbaceous wetland as well as nearly all of the herbaceous grassland (non-pasture/hay). It also contains significant amounts of the sub-watersheds evergreen and mixed forest cover type. There is very little agriculture or pasture/hay land within this LTA.

The Webb Lake Collapsed Barren LTA encompasses 33.9% of the Loon Creek sub-watershed in a band along the southern sub-watershed boundary. Its characteristic landform pattern is rolling collapsed outwash plain with lakes common. Soils are predominantly excessively drained loamy sand over outwash and common habitat types include PAm, QGCe, and forested lowland. Within the Loon Creek sub-watershed, the Webb Lake Collapsed Barrens LTA is primarily forested, with upland deciduous forest being the dominant cover type. Wetland areas in this LTA are small and scattered and there are some areas of cultivated crops and pasture/hay fields.

The Lower Namekagon LTA makes up 15.8% of the Loon Creek sub-watershed. The characteristic landform pattern for this LTA is rolling outwash plain. Soils are predominantly excessively drained sand over acid sand outwash and common habitat types include QGCe and PAm. This LTA is located in the center of the Loon Creek sub-watershed. It is primarily deciduous upland forest with significant patches of evergreen and mixed forest as well as wooded wetland. Agriculture and pasture/hay are not prominent land uses within this LTA.

5. Ownership

Ownership in the Loon Creek Sub-watershed is 58.6% private, 40.4% county, 0.5% private conservancy, 0.3% tribal, and 0.1% state. Burnett County forest accounts for about 40.4% of the land within the Loon Creek sub-watershed. The county forests are fairly contiguous and are primarily located in the central and north-central portions of the sub-watershed. Much of the main stem of Loon Creek runs through county forest land, which consists mainly of upland deciduous forest with pockets of mixed forest, evergreen forest, and woody wetlands. The only other parcel of publically owned land within the sub-watershed is the Culbertson Springs State Fishery Area; approximately 40 acres of WDNR owned land in the southeastern quarter on the Loon Creek sub-watershed in the area of Culbertson Lake and an associated stream that is a tributary to Loon Creek. This unnamed stream flows mainly through private land that is primarily upland deciduous forest. The remainder of the land in the Loon Creek

sub-watershed is under private ownership. The Sigurd F. Olson Memorial Forest is a 167 acre private conservancy administered by the Nature Conservancy on Love Lake and Falk Lake, a part of the Loon Creek flowage. Loon Creek flows mainly through private land in the western portion of the sub-watershed. Most of this land is upland deciduous forest with scattered areas of mixed and evergreen forest and woody wetlands; the conservation status of most of this forest land is unknown. At the confluence of Loon Creek and the Yellow River, Loon Creek flows through approximately 103acres of St. Croix Tribal land consisting of upland deciduous forest, mixed and evergreen forest and some areas of scrub/shrub.

6. Potential Private Forest Land

Of the upland forest and woody wetlands in the Loon Creek Sub-watershed 55.2% is in private ownership with unknown conservation status, 44.5% is in public ownership or private conservation ownership, and 0.3% is under tribal ownership.

7. Managing Forests to Slow Spring Snow Melts

The Loon Creek Sub-watershed is larger than 10 square miles and mature forest and storage areas are greater than 40 percent of total area. The sub-watershed does not have enough area of storage alone to absorb spring snow melts. If 22.8% of the watershed area is not kept as mature upland forest (a total of 7,331 acres of mature upland forest), the main stem of Loon Creek would be at risk for increased peak flows from spring snow melts.

8. Water Quality

In the Loon Creek Sub-watershed, there are no rivers, streams or lakes that are listed as impaired for mercury or total phosphorus and mercury. There are no designated trout streams and no streams or lakes that are designated as either exceptional resource waters or outstanding resources waters.

B. Lower Yellow River

1. General Information

The Lower Yellow River sub-watershed lies at the northwestern, downstream end of the Yellow River Watershed and includes the confluence of the Yellow River and the St. Croix River at the northern tip of the sub-watershed near the town of Danbury. The sub-watershed extends west into Union Township past Little Yellow Lake and Bass Lake. The Lower Yellow River Sub-watershed extends south to Tucker Lake in Sand Lake Township and east past Round Lake. The Lower Yellow River Sub-watershed encompasses 52,465 acres entirely within Burnett County and is the largest of the sub-watersheds within the Yellow River watershed. It includes the towns of Webster and Danbury. The watershed is approximately bisected from North to South by State Highway 35.

The Lower Yellow River flows primarily from southeast to northwest through the lower reaches of the watershed before turning sharply at Little Yellow Lake and flowing north northeast to the confluence of the Yellow River and the St Croix River. Tributaries flow primarily north or south into the Lower Yellow River. There are 43 miles of streams in the sub-watershed; 27 miles (62.7%) of streams are considered perennial, including the 26 miles of the Lower Yellow River. 16 miles (37.2%) of streams in the sub-watershed are considered intermittent or fluctuating. The stream density in the watershed is 0.5 miles/mi^2.

There are 11 lakes over 100 acres in the Lower Yellow River sub-watershed. On the upstream (east) end of the watershed there are a number of lakes that are not connected to the Lower Yellow River by any perennial or intermittent streams. These include Point Lake, Ham Lake, Crooked Lake, and Johnson Lake. In the lower (southern) reaches of the upstream end of the watershed, Bass Lake is not connected to the Lower Yellow River by any streams and is separated by County Highway X, which runs between Bass Lake and the Lower Yellow River. In the central portion of the sub-watershed, Mud Lake and Conner's Lake are not connected to the main stem of the Yellow River. Nearby Devils Lake is only one-tenth of a mile from the banks of the Lower Yellow River, but is separated by County Highway A and appears unconnected by any streams or wetland areas. Similarly in the downstream (western) portion of the sub-watershed, Bass Lake is less than a quarter mile from the main stem of the yellow river, but appears unconnected by any streams or wetland areas. Yellow Lake and Little Yellow Lake in the southwestern portion of the sub-watershed are part of the Lower Yellow River Flowage. The stretch of the Lower Yellow River from Little Yellow Lake to the St. Croix River is known as the Danbury Flowage. Water levels in these lakes and the flowage are maintained by a water control structure at the Danbury flowage near the Yellow River and St. Croix confluence. This structure is a fish barrier which is notable because Yellow Lake is home to over 2,000 Lake Sturgeon which have been isolated form the St. Croix population of sturgeon since the 1930's.

2. Soils

Soils in the Lower Yellow River sub-watershed are less xeric than in the Loon Creek watershed to the north; 36% are rated as excessively to somewhat excessively drained and tend to be concentrated along the northern third of the sub-watershed. The

southern two-thirds of the sub-watershed are intermingled inclusions of well to moderately well drained soils (27.9%) and somewhat poorly to very poorly drained soils (21%). Most of the poorly drained soils, particularly those along the Yellow River corridor, are rated as hydric or predominately hydric (16.5%). The majority of soils within the sub-watershed (63%) are rated as not hydric. Approximately 14% of the watershed is open water.

Soils within the Lower Yellow River sub-watershed are predominately sands and are rated as not prime farmland (94.1%). There are some farmlands of statewide importance concentrated in the central portion of the sub-watershed (5.5%).

3. Land Cover

Presettlement

Presettlement (mid-late 1800s) land cover in the Lower Yellow River Sub-watershed was primarily upland forest (78.9%) and lowland vegetation (7.8%). The presettlement upland forest of the Lower Yellow River sub-watershed was a mosaic of jack pine, some scrub oak, and barrens openings which are characteristic cover types for the sandy, excessively drained soils that are predominant in the sub-watershed. The lowland vegetation consisted of lowland hardwoods (6.2%) and conifer swamp (1.6%). The conifer swamp occurred in two areas: approximately 350 acres on the east end of Yellow Lake and approximately 400 acres of swamp near Leaf and Mollete Lakes. The lowland hardwoods occurred in a continuous band along the Yellow River from Sand Creek to the south end of Devils Lake.

Current

Current (as of 2006) land cover in the Lower Yellow River Sub-watershed consists of primarily upland forest (58.9%), along with smaller amounts of upland shrub and grassland (9.0%), lowland vegetation (8.8%), agriculture (3.5%) and development (6.1%). Open water covers 13.7% of the sub-watershed and there are around 1.3 total acres of barrens, a historically important cover type for this landscape. The upland forest cover type is predominately deciduous forest with mixed forest and smaller amounts of evergreen forest scattered throughout the sub-watershed. Small parcels of shrub/scrub and herbaceous grasslands are scattered throughout the sub-watershed. This sub-watershed has a larger concentration of cultivated crops and pasture/hay than Loon Creek. These areas are somewhat concentrated in the central portions of the sub-watershed particularly around Devils Lake and the surrounding upland. Lowland vegetation consists primarily of wooded wetlands and a small amount of emergent herbaceous wetland. Small wetland areas are scattered throughout the sub-watershed, but larger lowland complexes are primarily located through the southern portion of the sub-watershed in proximity to the Yellow River. Approximately 6.1% of the sub-watershed is considered to be developed; most of this (5.4% of sub-watershed) is classified as developed open space which is generally park areas, golf courses of other areas of lawn grasses and/or impervious surfaces. There are also small amounts of low, medium and high intensity development. The villages of Webster and Danbury which lie on the southern and northeastern borders of the sub-watershed respectively account for most of this area.

Change
From presettlement to 2006, forest cover in the Lower Yellow River sub-watershed decreased from 78.9% of land area within the sub-watershed to 58.9%. That represents a loss of approximately 10,000 acres of previously forested land. These acres have primarily been converted to shrub land, hay field/pasture, cultivated crops and development. This includes the conversion of thousands of acres of forest and forested wetland in proximity to the Yellow River and Devils Lake. It is also important to note that although much of the Lower Yellow River sub-watershed remains forested, the presettlement cover type has declined significantly on the landscape. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 3.8% of the total land area in the Lower Yellow River sub-watershed is in a primarily evergreen cover type and only around 140 acres of barrens openings remain. This represents a significant loss of a historically important cover type for this watershed.

4. Ecological Landscapes
The Lower Yellow River sub-watershed includes part of two of Wisconsin's Ecological Landscapes, The Northwest Lowlands in the extreme northwest corner of the sub-watershed and the Northwest Sands which encompass the remainder of the sub-watershed. Approximately 2% of the Lower Yellow River sub-watershed falls within the Northwest Lowlands Ecological Landscape. Within the Northwest Lowlands, the sub-watershed intersects with the St. Croix Plains Ecoregion. The St. Croix Plains LTA is characterized by land forms that are primarily undulating outwash plain and outwash-veneered moraine. Soils are predominantly excessively drained sand over acid sandy loam till or outwash. Common habitat types include forested lowland, PAm, hydromesic, and AAs. Within the Lower Yellow River sub-watershed the St. Croix Plains area was historically dominated by the jack pine/scrub oak/barrens cover type. Today, this LTA is primarily deciduous forest within the Lower Yellow sub-watershed, with some areas of scrub/shrub and woody wetland. It also supports some agriculture in the form of pastureland/hayfield and cultivated crops and includes the town of Danbury.

The remainder of the sub-watershed is encompassed by the Northwest Sands Ecological Landscape where it intersects with 3 different ecoregions. In the Danbury Trego Plains LTA, which makes up 13.4% of the Lower Yellow River sub-watershed primarily on the western border of the sub-watershed, the characteristic landform pattern is undulating outwash plain with fans and stream terraces common. Soils are predominantly excessively drained sand over acid sand outwash and common habitat types include QGCe and Pam. Within the Lower Yellow River sub-watershed, the Danbury Trego LTA was historically dominated by the jack pine/scrub oak/barrens cover type. Today this LTA contains primarily deciduous forest with scattered areas of mixed and evergreen forest. There are a several lakes within the LTA and a mosaic of scrub/shrub. Herbaceous and woody wetland areas. There is very little agriculture or pasture/hay land within this LTA.

The Webb Lake Collapsed Barren LTA encompasses 44.8% of the Lower Yellow River sub-watershed in a band straddling the northern sub-watershed boundary with the Loon Creek sub-watershed. The characteristic landform pattern is rolling collapsed

outwash plain with lakes common. Soils are predominantly excessively drained loamy sand over outwash and common habitat types include PAm, QGCe, and forested lowland. Within the Lower Yellow River sub-watershed, this LTA was historically dominated by the jack pine/scrub oak/barrens cover type with small areas of lowland hardwood and swamp conifer. Today, the Webb Lake Collapsed Barrens LTA is primarily upland deciduous forest with significant areas of mixed and evergreen forest and woody wetland. There are small herbaceous wetlands scattered throughout the LTA in this sub-watershed and many lakes. There are also small but significant areas of cultivated crops and pasture/hay fields throughout.

The Siren Plains LTA makes up 39.7% of the Lower Yellow River sub-watershed. The characteristic landform pattern is undulating outwash plain and lake plain complex. Soils are predominantly moderately well drained sand over outwash or clayey lacustrine. Common habitat types include PAm, forested lowland, and hydromesic. This LTA is located along the entire southern boundary of the sub-watershed. Within the Lower Yellow River sub-watershed, the Siren Plains LTA was historically dominated by the jack pine/scrub oak/barrens cover type with significant areas of lowland hardwood along the main stem of the Yellow river, which flows through this LTA. Today, the landscape in this LTA is heterogeneous with significant amounts of deciduous upland forest, woody and herbaceous wetlands, and concentrated areas of cropland and pasture/hay – most of the agriculture for this sub-watershed is within this LTA. There are also smaller scattered areas of mixed and evergreen forest on the landscape and a few large lakes.

5. Ownership

Ownership in the Lower Yellow River Sub-watershed is 87.2% private, 7.7% county, 4.9% state, and 0.2% tribal. There is about 4,044 acres of Burnett County forest in the Lower Yellow sub-watershed broken up into three blocks one on the eastern sub-watershed boundary and two on the western sub-watershed boundary. Theses consist mainly of upland deciduous forest, woody and herbaceous wetland and small amounts of mixed and evergreen forest. In this sub-watershed, the Yellow river does not flow through county forest land and no tributary of the Yellow river is connected to the county forestland. There are several lakes on county forestland within the sub-watershed.

There are approximately 2,567 acres of state-owned land within the Lower Yellow River sub-watershed dived between three properties. The Keizer Lake State Wildlife Area in the east central portion of the sub-watershed is administered by WDNR-Wildlife Management. The property is approximately 1,352 acres with aspen, northern hardwoods, jack pine, wetlands, and old field. There are six named and several unnamed lakes within the property which may be connected to the Yellow river via an intermittent stream. Adjacent to the Danbury Flowage portion of the Yellow River on the western edge of the sub-watershed the Danbury Wildlife Area, also a DNR-Wildlife Management property, is an approximately 450 acres consisting of shallow marsh interspersed with aspen islands and surrounded by aspen, oak, jackpine forests, and agricultural fields. The lowland forests are dominated by trembling aspen with scattered swamp hardwoods and swamp conifers. The drier sandy sites contain vegetation

typical of the original pine barrens. In the absence of fire, these sites have grown into oak-jackpine forests. Both scrub (Hill's Oak) and bur oak are common. Large red and white pine are scattered throughout the property. The Danbury Wildlife Area is adjacent to a 250 acre section Governor Knowles State Forest on the western boundary of the sub-watershed. A third block of state owned land is a 230 acre WDNR State Habitat Area straddling the Yellow River as it flows into Yellow Lake. The property consists of woody and herbaceous wetlands adjacent to the river and deciduous forest in the surrounding upland. At the confluence of the Yellow River and the St. Croix River, The Yellow River flows through approximately 85 acres of St. Croix Tribal land consisting of upland deciduous forest, mixed and evergreen forest and some areas of scrub/shrub.

The remainder of the land within the Lower Yellow River sub-watershed (45,768 acres) is in private ownership. Virtually the entire length of the Yellow River in this sub-watershed flows through private lands. Adjacent cover types are primarily upland deciduous forest with pockets of woody wetland and mixed and evergreen forest. In some areas agricultural lands (crops & pasture/hay) are adjacent to the river corridor especially south of Devils Lake and just north of Little Yellow Lake. Nearly all of the private land in the Lower Yellow River sub-watershed is of unknown conservation status.

6. Potential Private Forest Land

Of the upland forest and woody wetlands in the Lower Yellow River Sub-watershed 84.0% is in private ownership with unknown conservation status, 15.8% is in public ownership or private conservation ownership, and 0.2% is under tribal ownership.

7. Managing Forests to Slow Spring Snow Melts

The Lower Yellow River Sub-watershed is larger than 10 square miles and mature forest and storage areas are greater than 40 percent of total area. However, for the main stem of the Yellow River, its entire upstream drainage must be considered when evaluating the impacts of peak flows from spring snow melt. Upstream areas plus the sub-watershed area total 202,139 acres, and within this area, if 22.4% of the watershed area is not kept as mature upland forest (a total of 45,355 acres of mature upland forest), the main stem of the Yellow River would be at risk for increased peak flows from spring snow melts. For smaller contributing streams within the sub-watershed, their drainage areas would need to be analyzed individually to determine risk. This level of analysis has not been completed for this study.

8. Water Quality

In the Lower Yellow River Sub-watershed, Johnson Lake is listed as impaired for mercury. This represents 398.6 acres of lake area for this sub-watershed. Yellow Lake is listed as impaired by total phosphorus and mercury which represents 2,281 acres of lake area within the sub-watershed. There are no designated trout streams and no streams or lakes that are designated as either exceptional resource waters or outstanding resources waters.

C. Sand Lakes

1. General Information

The Sand Lakes sub-watershed is in the central reaches of the Yellow River Watershed between the Lower Yellow River Sub-watershed to the west and the Rice Lake Sub-watershed to the east. The Sand Lakes sub-watershed extends north beyond Bone, Oak, and Behr Lakes. State Highway 70 skirts the southern portion of the watershed which extends beyond Warner and Bass Lakes south of the highway. The watershed encompasses 39,695 acres entirely within Burnett County.

The Yellow River flows approximately east to west through the Sand Lakes Sub-watershed with a large oxbow between the confluences of the Black creek and Spring Brook tributaries respectively which flow in to the Yellow River from the south. Sand Creek flows into the Yellow River from the south. The sub-watershed contains 33.5 miles of rivers and stream, 30.4 miles (90.7%) are considered to be perennial, including The Yellow River itself, Black Creek, Spring Brook, Sand Creek and an unnamed perennial stream that flows into the Yellow River from Gaslyn Lake to the north. 3.1 miles (9.2%) of streams in the watershed are considered to be fluctuating or intermittent. Stream density in the watershed is 0.5 miles/mi^2.

There are 9 lakes over 100 acres in the Sand Lakes Sub-watershed. Gaslyn Lake in the upstream portion of the watershed is about 1 mile from the Yellow River, and is connected by an unnamed perennial stream which flows into the Yellow River from the north. Gaslyn Road runs between Gaslyn Lake and the Yellow River. Big Sand Lake in the downstream portion of the watershed is connected by Sand Creek, a perennial stream which empties into the Yellow River from the south. Sand Lake is about 1 mile from the banks of the Yellow River, with County Highway X running between them. Warner Lake is in the southwest corner of the sub-watershed, south of State Highway 70 and is not connected to the Yellow River by any perennial or intermittent stream or wetland areas. Six lakes in the northern reaches of the sub-watershed are also unconnected to the Yellow River; they are Green Lake, Sand Lake, Mallard Lake, Upper and Lower Twin Lakes, and Oak Lake.

2. Soils

Excessively to somewhat excessively drained soils make up approximately 42.7% of the Sand Lakes sub-watershed, predominately in the north and south reaches of the watershed, outside of the Yellow River corridor. Well drained to moderately well drained soils are well represented (23.4%) and concentrated in the western and far northeastern reaches of the watershed, with a few areas along the southern sub-watershed boundary. Somewhat poorly to very poorly drained soils (21.3%) tend to be found along the Yellow River and are intermixed with well drained soils in the northeastern corner of the sub-watershed. These soils are generally rated as hydric, predominately hydric, or with hydric inclusions (21.5%). Most of the soils in the sub-watershed are rated as not hydric (65.1%). Approximately 12% of the sub-watershed is open water.

Soils within the Sand Lakes sub-watershed are primarily rated as not prime farmland (96.7%), though there are small pockets of prime farmland and farmland of statewide importance within the sub-watershed.

3. Land Cover

Presettlement

Presettlement (mid-late 1800s) land cover in the Sand Lakes Sub-watershed was primarily upland forest (81.0%) and lowland vegetation (7.1%). The presettlement upland forest of the Sand Lakes sub-watershed was primarily jack pine, some scrub oak, and barrens openings which are characteristic cover types for the sandy, excessively drained soils that are predominant in the lower reaches of the Yellow River watershed. There were also approximately 1,200 acres of white pine/red pine forest along the southern boundary of the sub-watershed. The lowland vegetation consisted of lowland hardwoods (3.9%) and conifer swamp (3.2%). Presettlement conifer swamps occurred in three areas: A lowland areas surrounding Baker and Swamp Lakes in the western portion of the sub-watershed, an area on the eastern border of the sub-watershed around Gaslyn Lake, and a small conifer swamp along the southern sub-watershed boundary. The lowland hardwoods occurred in a continuous band along the Yellow River corridor in the central watershed.

Current

Current (as of 2006) land cover in the Sand Lakes Sub-watershed consists of primarily upland forest (63.5%), along with smaller amounts of upland shrub and grassland (5.3%), lowland vegetation (10.6%), agriculture (3.0%) and development (5.2%). Open water covers 12.4% of the sub-watershed. The upland forest cover type is predominately deciduous forest with mixed forest and smaller amounts of evergreen forest scattered throughout the sub-watershed. Small parcels of shrub/scrub and herbaceous grasslands are scattered throughout the sub-watershed. This sub-watershed has about 7.4% of its land area in cultivated crops and/or pasture/hay. These areas are somewhat concentrated to the north and the south in the eastern third of the sub-watershed. Lowland vegetation consists primarily of wooded wetlands and a small amount of emergent herbaceous wetland. Small wetland areas are scattered throughout the sub-watershed, but larger lowland complexes are primarily located through the central portion of the sub-watershed in proximity to the Yellow River. This includes large areas of lowland hardwoods immediately adjacent to the Yellow River which were also present in presettlement times. Approximately 5.2% of the sub-watershed is considered to be developed; most of this (5.0% of sub-watershed) is classified as developed open space which is generally park areas, golf courses of other areas of lawn grasses and/or impervious surfaces. There are also small amounts of low and medium intensity development.

Change

From presettlement to 2006, upland forest cover in the Sand Lakes sub-watershed decreased from 81.0% of land area within the sub-watershed to 63.5%. Lowland forest cover decreased from 7.1% to 5.7% of land area within the watershed. That represents a loss of approximately 7,500 acres of previously forested land. These acres have primarily been converted to shrub land, hay field/pasture, cultivated crops and development. It is also important to note that although much of the Sand Lakes sub-watershed

remains forested, the presettlement cover type has declined significantly on the landscape. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 4.9% of the total land area in the Sand Lakes sub-watershed is in a primarily evergreen cover type and only 0.4% of the land area is in potential barrens openings. This represents a significant loss of a historically important cover type for this watershed.

4. Ecological Landscapes

The Sand Lakes sub-watershed includes part of two of Wisconsin's Ecological Landscapes, The Forest Transition in the extreme southeastern corner of the sub-watershed and the Northwest Sands which encompass the remainder of the sub-watershed. Approximately 0.2% of the Sand Lakes sub-watershed falls within the Forest Transition Ecological Landscape. Within the Forest Transition EL, the sub-watershed intersects with the St. Croix Moraine Ecoregion. The St. Croix Moraine LTA characteristic landform pattern is rolling collapsed moraine interlaced with outwash terraces and intermixed with ice-walled lake plains. Soils are predominantly moderately well drained sandy loam over dense, acid sandy loam till. Common habitat types include AcaCi and AAt. Within the Sand Lake sub-watershed the St. Croix Moraine area was historically dominated by the jack pine/scrub oak/barrens cover type. Today, this LTA is primarily cultivated crops and pasture/hay within the Sand Lakes sub-watershed, with small areas of upland deciduous forest.

The remainder of the sub-watershed is encompassed by the Northwest Sands Ecological Landscape where it intersects with 3 different ecoregions. In the Spooner Plains LTA which makes up 5.9% of the Sand Lakes sub-watershed primarily on the eastern border of the sub-watershed the characteristic landform pattern is undulating outwash plain with isolated morainic hills and ridges. Soils are predominantly well drained sand over outwash. Common habitat types include PAm, QGCe, AVDe, and AAt. Within the Sand Lakes sub-watershed, the Spooner Plains LTA was historically dominated by the jack pine/scrub oak/barrens cover type. Today this LTA contains primarily cultivated crops, pasture/hay and upland deciduous forest with small but significant amounts of mixed and evergreen forest and woody and herbaceous wetland. There are a no lakes within the LTA in this sub-watershed, but the Yellow River flows through the LTA and the Black Creek tributary is within the Spooner Plains.

The Webb Lake Collapsed Barren LTA encompasses 40.9% of the Sand Lakes sub-watershed in a band along the northern sub-watershed boundary extending into the central sub-watershed from the northeastern corner. The characteristic landform pattern is rolling collapsed outwash plain with lakes common. Soils are predominantly excessively drained loamy sand over outwash and common habitat types include PAm, QGCe, and forested lowland. Within the Sand Lakes sub-watershed, this LTA was historically dominated by the jack pine/scrub oak/barrens cover type with small areas of swamp conifer. Today, the Webb Lake Collapsed Barrens LTA is primarily upland deciduous forest with significant areas of mixed and evergreen forest and woody wetland. There are small herbaceous wetlands scattered throughout the LTA in this sub-watershed and many lakes. A significant amount of the cultivated crops and pasture/hay fields for this sub-watershed are within this LTA.

The Siren Plains LTA makes up 53.0% of the Sand Lakes sub-watershed. The characteristic landform pattern is undulating outwash plain and lake plain complex. Soils are predominantly moderately well drained sand over outwash or clayey lacustrine. Common habitat types include PAm, forested lowland, and hydromesic. The southern half of the Sand Lakes sub-watershed is within the Siren Plains LTA. Within the Sand Lakes sub-watershed, the Siren Plains LTA was historically dominated by the jack pine/scrub oak/barrens cover type with significant areas of lowland hardwood along the main stem of the Yellow river, and smaller areas of swamp conifers and white pine/red pine forest. Today, the primary cover type within this LTA is deciduous upland forest. However, within this sub-watershed this LTA supports significant amounts of mixed and evergreen forest, woody and herbaceous wetlands, and concentrated areas of cropland and pasture/hay – most of the agriculture for this sub-watershed is within this LTA. There are a few lakes within this LTA with Big Sand Lake a dominant feature in the southwest corner of the sub-watershed, and the Yellow River flows through the LTA in this sub-watershed and is joined by the Spring Brook Tributary within the Siren Plains ecoregion.

5. Ownership

Ownership in the Sand Lakes Sub-watershed is 75.0% private, 22.5% county, 0.7% state, and 1.8% tribal. Within the Sand Lakes sub-watershed, the Yellow River flows primarily through Burnett County Forestland and Lac Courte Oreilles Tribal Land. There is about 8,940 acres of Burnett County forest in the Sand Lakes sub-watershed. The county forest land forms a fairly contiguous block in the central sub-watershed where the Yellow River flows through upland deciduous forest, woody wetland and smaller amounts of mixed and evergreen forest. Significant areas of herbaceous wetland are immediately adjacent to the River as it flows through the county forest. There are also several lakes on county forestland within the sub-watershed. Within the County forest, the Yellow River flows through a few parcels of privately owned land. These small parcels are primarily upland deciduous forest with herbaceous wetlands adjacent to the river.

As the Yellow River flows out of Rice Lake and into the Sand Lakes sub-watershed on the eastern sub-watershed boundary, it flows through 113 acres of Lac Courte Oreilles Tribal Land that consists primarily of upland deciduous forest with some herbaceous wetland and mixed forest. There are also approximately 594 acres of St. Croix Tribal land within the sub-watershed. The areas are along the western side of Big Sand Lake and the southern end of Gaslyn Lake. These lands consist primarily of upland deciduous forest, mixed forest and woody and herbaceous wetland. An unnamed perennial stream that is tributary of the Yellow River flows through the St. Croix Tribal Land south of Gaslyn Lake.

There approximately 285 acres of state-owned land within the Sand Lakes sub-watershed in several small properties scattered throughout the sub-watershed. The most notable is Spring Creek State Fishery Area, a 70 acre parcel of upland deciduous forest and woody wetland surrounding the headwaters of Spring Brook, a tributary to the Yellow River. There is also a 40 acre state-owned parcel directly adjacent to the Yellow River within the Burnett County Forest. The rest of the state-owned land within the

Sand Lakes sub-watershed consists of widely scattered forestland parcels primarily administered as wildlife management or habitat areas and as public access to waterways.

The remainder of the land within the Sand Lakes sub-watershed (29,762 acres) is in private ownership. The Yellow River flows through private lands in the western part of this sub-watershed and most of the tributaries flow through some private land as well. Adjacent cover types are primarily upland deciduous forest, mixed forest, and woody wetland. There is not much agricultural land use in close proximity to the Yellow River in this sub-watershed. However, the Black Creek Tributary flows through cultivated cropland before it reaches county forestland. Nearly all of the private land in the Sand Lakes sub-watershed is of unknown conservation status.

6. Potential Private Forest Land

Of the upland forest and woody wetlands in the Sand Lakes Sub-watershed 69.9% is in private ownership with unknown conservation status, 28.0% is in public ownership or private conservation ownership, and 2.0% is under tribal ownership.

7. Managing Forests to Slow Spring Snow Melts

The Sand Lakes Sub-watershed is larger than 10 square miles and mature forest and storage areas are greater than 40 percent of total area. However, for the main stem of the Yellow River, its entire upstream drainage must be considered when evaluating the impacts of peak flows from spring snow melt. Upstream areas plus the sub-watershed area total 149,673 acres, and within this area, if 24.2% of the watershed area is not kept as mature upland forest (a total of 36,191 acres of mature upland forest), the main stem of the Yellow River would be at risk for increased peak flows from spring snow melts. For smaller contributing streams within the sub-watershed, their drainage areas would need to be analyzed individually to determine risk. This level of analysis has not been completed for this study.

8. Water Quality

In the Sand Lakes Sub-watershed, Sand Lake (899.8 acres) is listed as impaired for mercury. Spring Brook (1.9 miles) is a designated Class I trout stream and Black Creek (2.3 miles) is a designated Class II trout stream. Spring Brook (1.9 miles) is also a designated Exceptional Resource Water. Both Sand Lake and Big Sand Lake, 2,332.8 acres of lake area within the sub-watershed, are designated as Outstanding Resource Waters and Spring Brook Springs (4.7 acres) is a designated Exceptional Resource Water.

D. Rice Lake

1. General Information

The Rice Lake sub-watershed is in the central reaches of the Yellow River Watershed. It is bordered to the west by the Sand Lakes sub-watershed, to the east by the Headwaters sub-watershed and to the southeast by the Shell Lake sub-watershed. The sub-watershed extends north past Deep Lake on the western end of the watershed and Bass Lake and Jerry Lake on the eastern end. To the south, the Rice Lake sub-watershed extends past the main stem of the Yellow River. The sub-watershed is 51,566 acres is size, 24.5% within Burnett County and 75.5% within Washburn County. The city of Spooner, WI is located on the eastern edge of the sub-watershed. State Highway 70 approximately bisects the watershed from east to west and State Highway 63 skirts the eastern tip of the Rice Lake Sub-watershed.

There are 67.9 miles of rivers and streams in the Rice Lake sub-watershed, the most of any of the sub-watersheds within the Yellow River Watershed. The Rice Lake sub-watershed has the second highest stream density at 0.8 mi/mi^2. 54.3 miles (79%) are considered to be perennial, including approximately 17 miles of the main stem on the Yellow River. Some of the larger tributaries to the Yellow River in this watershed include Whiskey Creek and the Dahlstrom Branch. 13.5 miles are considered to be intermittent or fluctuating. The flow in the sub-watershed is from east to west with significant north/south meanders in the Yellow River and smaller tributaries.The Rice Lake sub-watershed is home to the Governor Tommy G. Thompson State Fish Hatchery, the state's largest cool water facility and the world's largest musky hatchery. The hatchery is on the banks of the Yellow River and includes 40 – 1 acre and 6 – 0.5 acre rearing ponds. There are also approximately 73 acres of cranberry bogs in the sub-watershed. There is a small cranberry operation with about 15 acres of bog in the central portion of the watershed. These bogs are associated with Dock Lake. A larger Cranberry operation with approximately 58 acres of bog is located along the northern border of the sub-watershed. These bogs are associated with Lost Lake and Lipsett Lake via Rocky Creek.

There are 6 lakes over 100 acres in the Rice Lake sub-watershed all located in approximately the northwest section of the sub-watershed north of the Yellow River. Bass Lake in the north central portion of the sub-watershed, is unconnected to the Yellow River. Ellsworth Lake and Wikerson Lake are also unconnected to the Yellow River. Rice Lake forms part of the Yellow River Flowage. Benoit Lake and Lipsett Lake are connected to Rice Lake via perennial streams.

2. Soils

Excessively to somewhat excessively drained soils comprise approximately 48.8% of the total watershed area. Well drained to moderately well drained soils make up about 32.1% and somewhat poorly to very poorly drained soils about 13.5%. The sub-watershed trends from more moderately well drained soils in the southeastern corner to more excessively drained soils in the northern portion. The majority of the poorly drained soils are rated as hydric (10.4%). Soils rated as not hydric are dominant in the sub-watershed (75.6%). The Rice Lake sub-watershed is approximately 5% open water.

Soils rated as not prime farmland comprise 91.9% of the sub-watershed; 6.3% is classified as prime farmland or farmland of statewide importance.

3. Land Cover

Presettlement

Presettlement (mid-late 1800s) land cover in the Rice Lake Sub-watershed was primarily upland forest (91.5%) with a small amount lowland vegetation, just 2.8% of presettlement land area. The presettlement upland forest of the Rice Lake sub-watershed was primarily jack pine, some scrub oak, and barrens openings (83.1%) which are characteristic cover types for the sandy, excessively drained soils that cover a large part of the sub-watershed. In presettlement times the Rice Lake sub-watershed also had small amounts of oak forest (0.9%), maple-basswood-oak forests (2.5%), maple-birch-pine forest (4.7%), and white pine/red pine forest (0.3%). These cover types were primarily situated on the southern tip of the sub-watershed, except for the white pine/red pine cover type which was located on the eastern edge of the sub-watershed around was is know the City of Spooner. The lowland vegetation cover type was conifer swamp which was situated in a band along the Whiskey Creek tributary to the Yellow River.

Current

Current (as of 2006) land cover in the Rice Lake Sub-watershed consists of primarily upland forest (56.0%), along with smaller amounts of upland shrub and grassland (20.4%), lowland vegetation (5.6%), agriculture (5.8%) and development (6.9%). Open water covers 5.3% of the sub-watershed. The upland forest cover type is predominately deciduous forest with mixed forest and very small amounts of evergreen forest. Mixed and evergreen forests, along with woody wetlands, tend to be concentrated along the Yellow River and its tributaries in this sub-watershed. Very small parcels of shrub/scrub and herbaceous grasslands are scattered throughout the sub-watershed primarily intermingling with crops and pasture lands and herbaceous wetlands. This sub-watershed has about 25.9% of its land area in cultivated crops and/or pasture/hay. These areas are scattered throughout the watershed with large concentrations in the central and southern portions of the sub-watershed. Lowland vegetation consists of wooded wetlands and emergent herbaceous wetland primarily adjacent to waterways. Approximately 6.9% of the sub-watershed is considered to be developed, most of this (5.4% of sub-watershed) is classified as developed open space which is generally park areas, golf courses of other areas of lawn grasses and/or impervious surfaces. There are also small amounts of low, medium, and high intensity development. The City of Spooner and surrounding areas located on the eastern border of the sub-watershed account for most of this area.

Change

From presettlement to 2006, upland forest cover in the Rice Lake sub-watershed decreased from 91.5% of land area within the sub-watershed to 56.0%. That represents a loss of approximately 18,000 acres of previously forested land – 35% of the watershed converted. These acres have primarily been converted to hay field/pasture, cultivated crops and development with much of this conversion in close proximity to the Yellow River and its tributaries within the sub-watershed. The Rice Lake sub-

watershed has experienced a significant decrease in forested area since presettlement times, and the dominant presettlement cover type has virtually disappeared from the Rice Lake sub-watershed. Presettlement data indicates that most of the sub-watershed was in a mosaic of jack pine, scrub oak and barrens openings. Today only around 2.4% of the total land area in the Rice Lake sub-watershed is in a primarily evergreen cover type and only 0.4% of the land area is in potential barrens openings. This represents a significant loss of a historically important cover types for this sub-watershed.

4. Ecological Landscapes

The Rice Lake sub-watershed includes part of two of Wisconsin's Ecological Landscapes, The Forest Transition EL along the southern boundary of the sub-watershed and the Northwest Sands which encompass the remainder of the sub-watershed. Approximately 13.5% of the Sand Lakes sub-watershed falls within the Forest Transition Ecological Landscape. Within the Forest Transition EL, the sub-watershed intersects with the St. Croix Moraine Ecoregion. The St. Croix Moraine LTA characteristic landform pattern is rolling collapsed moraine interlaced with outwash terraces and intermixed with ice-walled lake plains. Soils are predominantly moderately well drained sandy loam over dense, acid sandy loam till. Common habitat types include AcaCi and AAt. Within the Rice Lake sub-watershed the St. Croix Moraine area was historically a mix of jack pine/scrub oak/barrens, oak forest, maple/basswood/oak, and maple/birch/pine cover types. Today, this LTA is primarily cultivated crops and pasture/hay within the Sand Lakes sub-watershed, with significant areas of upland deciduous forest. Very few of the sub-watershed's lakes are within this LTA, though the Dahlstrom Branch, a tributary to the Yellow River, is within the St. Croix Moraine LTA.

The remainder of the sub-watershed is encompassed by the Northwest Sands Ecological Landscape where it intersects with 3 different ecoregions. The Siren Plains LTA makes up 0.7% of the Rice Lake sub-watershed in the extreme southwestern corner of the sub-watershed. The characteristic landform pattern is undulating outwash plain and lake plain complex. Soils are predominantly moderately well drained sand over outwash or clayey lacustrine. Common habitat types include PAm, forested lowland, and hydromesic. Within the Rice Lake sub-watershed, the Siren Plains LTA was historically dominated by the jack pine/scrub oak/barrens cover type. Today, the primary cover type within this LTA is cultivated crops and pasture/hay with significant deciduous upland forest.

The Webb Lake Collapsed Barren LTA encompasses 18.4% of the Rice Lake sub-watershed in the northwest corner of the sub-watershed. The characteristic landform pattern is rolling collapsed outwash plain with lakes common. Soils are predominantly excessively drained loamy sand over outwash and common habitat types include PAm, QGCe, and forested lowland. Within the Rice Lake sub-watershed, this LTA was historically dominated by the jack pine/scrub oak/barrens cover type. Today, the Webb Lake Collapsed Barrens LTA is primarily upland deciduous forest with significant areas of cultivated crops and pasture/hay. There are also smaller but significant areas of mixed and evergreen forest and woody wetland. There are also small herbaceous

wetlands scattered throughout the LTA in this sub-watershed and many lakes. A significant amount the cultivated crops and pasture/hay fields within this sub-watershed are within this LTA.

The Spooner Plains LTA makes up 67.3% of the Rice Lake sub-watershed. The characteristic landform pattern is undulating outwash plain with isolated morainic hills and ridges. Soils are predominantly well drained sand over outwash. Common habitat types include PAm, QGCe, AVDe, and AAt. Within the Rice Lake sub-watershed, the Spooner Plains LTA was historically dominated by the jack pine/scrub oak/barrens cover type with smaller amounts of swamp conifer, maple/birch/pine forest and white pine/red pine forest. Today this LTA contains primarily cultivated crops, pasture/hay and upland deciduous forest with small but significant amounts of mixed and evergreen forest and woody and herbaceous wetland. There are several lakes within this LTA and a large portion of the Yellow River flows through the Spooner Plains in this sub-watershed. The city of Spooner is also within this LTA.

5. Ownership

Ownership within the Rice Lake sub-watershed is 97.3% private, 2.1% county, 0.5% state, and 0.1% tribal. There are about 660 acres of Burnett County forest in the Sand Lakes sub-watershed, and about 412 acres of Washburn County Forest. The Yellow River flows through Burnett County Forest on the western side of the sub-watershed, just before the river enters Rice Lake. Adjacent cover types are upland deciduous forest, mixed forest and woody wetland. There is a block of Washburn County Forest on the northern tip of the sub-watershed, which consists of upland deciduous forest, mixed and evergreen forest and woody and herbaceous wetland. This block of county forest is not connected to the Yellow River or a tributary. There are a few lakes on county forestland in this sub-watershed. There is a small 65 acres parcel of Lac Courte Oreilles Tribal land along the western edge of Rocky Ridge Lake. The parcel is upland deciduous forest and mixed pine forest.

There are approximately 251 acres of state-owned land within the Rice Lake sub-watershed. Sixty-four acres of the Sawyer Creek State Fishery Area surround the Yellow River in the southeast corner of this sub-watershed. The SCFA extends along Sawyer Creek, a trout stream, into the Shell Lake sub-watershed. Adjacent vegetation includes tag alder-tamarack-black spruce swamps, sedge marshes and well-drained wooded upland. Just downstream from the SCFA is a 40 acres block of Board of Commissioners of Public Lands (BPCL) administered land straddling the Yellow River consisting of mixed and evergreen forest and woody wetland. Just northeast of the SCFA is the Tozer Springs Fish and Wildlife Areas, a 31 acre property protecting two high quality spring ponds on the Yellow River. Cover around the spring ponds includes associated wetlands and a few acres of upland hardwoods with mixed pine. The Rice Lake sub-watershed is also home to the Governor Tommy G. Thompson State Fish Hatchery, the state's largest cool water facility and the world's largest musky hatchery. The hatchery is on the banks of the Yellow River on the eastern sub-watershed boundary and includes 40 – 1 acre and 6 – 0.5 acre rearing ponds and associated facilities.

The remainder of the land within the Rice Lake sub-watershed (50,176 acres) is in private ownership. The Yellow River flows through private lands through most this sub-watershed and major tributaries such as Whiskey Creek and the Dahlstrom Branch,

flow through primarily private land as well. Adjacent cover types are primarily upland deciduous forest with significant amounts of mixed and evergreen forest and woody wetland. There is also a significant amount of agricultural land in close proximity to the Yellow river within this sub-watershed, and Dahlstrom tributary, a Class I trout stream, flows mostly through land in pasture/hay and cultivated crops. The Whiskey Creek tributary flows primarily through privately owned forestland with large amounts of woody wetland and mixed forest adjacent to the creek. Nearly all of the private land in the Rice Lake sub-watershed is of unknown conservation status.

6. Potential Private Forest Land

Of the upland forest and woody wetlands in the Rice Lake Sub-watershed 96.0% is in private ownership with unknown conservation status, 3.9% is in public ownership or private conservation ownership, and 0.2% is under tribal ownership.

7. Managing Forests to Slow Spring Snow Melts

The Rice Lake Sub-watershed is larger than 10 square miles and mature forest and storage areas are greater than 40 percent of total area. However, for the main stem of the Yellow River, its entire upstream drainage must be considered when evaluating the impacts of peak flows from spring snow melt. Upstream areas plus the sub-watershed area total 109,978 acres, and within this area, if 26.7% of the watershed area is not kept as mature upland forest (a total of 29,410 acres of mature upland forest), the main stem of the Yellow River would be at risk for increased peak flows from spring snow melts. Rocky Ridge Creek would be at risk for increased peak flows if 3,907 acres of upland forest was lost in its drainage area. For smaller contributing streams within the sub-watershed, their drainage areas would need to be analyzed individually to determine risk. This level of analysis has not been completed for this study.

8. Water Quality

In the Rice Lake Sub-watershed, there are no rivers, streams or lakes that are listed as impaired for mercury or total phosphorus and mercury. There are 6 miles of designated Class I trout streams including Dahlstrom Brook, a small unnamed tributary to the Yellow River just downstream from the Dahlstrom Brook confluence, Dago Creek, and another unnamed stream between Tony Lake and the Yellow River. Dahlstrom Brook, Dago Creek and the unnamed Tony Lake stream (5.6 miles) are also designated Exceptional Resource Waters. The unnamed tributary downstream of the Dahlstrom Brook confluence (0.4 miles) is listed as an Outstanding Resource Water. There are no lakes within the Rice Lake sub-watershed that are designated as Outstanding or Exceptional Resource Waters.

E. Shell Lake

1. General Information

The Shell Lake sub-watershed is on the southeastern edge of the Yellow River Watershed. It is bordered to the north and east by the Headwaters sub-watershed and to the north and west by the Rice Lake sub-watershed. The sub-watershed extends south of Shell Lake past county Highway D. The Shell Lake is the smallest of the sub-watersheds with the Yellow River watershed at approximately 21,520 acres, all within Washburn County. The town of Shell Lake lies on the western boundary of the sub-watershed. State Highway 63 run north to south through the sub-watershed.

The Shell Lake sub-watershed contains 35 miles of streams, 11.4 miles of which are considered perennial and 23.8 are considered intermittent or fluctuating. Shell Lake has the highest stream density of the sub-watersheds at 1.0 mi/mi^2. The main stem of the Yellow River does not flow through this sub-watershed, but Sawyer Creek, a tributary of the Yellow River drains the northwestern portion of the sub-watershed. Sawyer Creek is a clear water spring fed trout stream that is notable as home to a trout stocking and research program that goes back to 1933. It flows through the state-owned Sawyer Creek Fishery Area. Sawyer Creek originates from springs at the base of steep hills just north of the Village of Shell Lake and flows in a northerly direction (6.2 miles) to its confluence with the Yellow River. As the stream flows from its headwaters, it passes through tag alder-tamarack-black spruce swamps, sedge marshes and well-drained wooded upland. The stream picks up additional water from numerous spring seeps. Sawyer Creek Springs (a 1.1-acre natural spring pond), Beaver Lodge Pond (a 4.0-acre natural spring pond which empties into Sawyer Creek by way of Creek 15-1), and two tributaries (Creeks 14-14 and 23-16) all support trout.

There are two lakes over 100 acres in the Shell Lake sub-watershed. Shell Lake, Wisconsin's largest land-locked, spring-fed lake at approximately 2,500 acres and the defining feature of the sub-watershed, is unconnected to the Yellow River by overland flow. It is separated from the Sawyer Creek drainage by topography and State Highway 63. Ripley Lake in the southern portion of the sub-watershed is also unconnected to the Yellow River.

2. Soils

The Shell Lake sub-watershed in the upper elevations of the Yellow River watershed near the headwaters area is a much richer landscape than the drier, sandier areas that occur at the bottom of the watershed. Only 7.3% of the soils in this sub-watershed are excessively to somewhat excessively drained. Most of the soils in the sub-watershed are well to moderately well drained (61.8%) or somewhat poorly to very poorly drained (15.1%). Most of the soils rated moderately well drained or wetter are rated as hydric or with hydric inclusions, 50.4% across the sub-watershed. 25.3% of soils are not hydric. Approximately 15% of the watershed is open water.

Agriculture is more important in this sub-watershed where 19.6% of the areas are considered prime farmland and 23.4% is farmland of statewide importance - the highest percentages of any of the sub-watersheds within the Yellow River watershed.

Approximately half of the area (40.5%) is rated as not prime farmland. Another 7.4% of the area within the sub-watershed is too wet for agriculture, but would be considered prime farmland if it was drained.

3. Land Cover

Presettlement

Presettlement (mid-late 1800s) land cover in the Shell Lake Sub-watershed was upland forest (84.1%) with no or very little lowland vegetation. The only other presettlement cover type was open water (15.9%). Unlike the other sub-watersheds within the Yellow River watershed, Shell Lake has predominately richer soils and therefore mostly lacked the jack pine, scrub oak, barrens cover type (0.3%) common in the other sub-watersheds. The presettlement upland forest of the Shell Lake sub-watershed consisted primarily of maple-birch-pine forest (71.9%) and smaller amounts of white/red pine forest (9.7%) in the southern portions of the sub-watershed and maple-basswood-oak forest (2.3%) concentrated in the north.

Current

Current (as of 2006) land cover in the Rice Lake Sub-watershed is a mix of upland forest (42.6%), pasture/hay grassland (23.1%), lowland vegetation (5.4%), agriculture (4.5%) and development (7.6%). Open water covers 15.7% of the sub-watershed. The upland forest cover type covers most of the northwest corner and the southern half of the sub-watershed and is predominately deciduous forest with small amounts of mixed forest and very small amounts evergreen forest. Mixed and evergreen forests, along with woody wetlands tend to be concentrated in the Sawyer Creek drainage area, an important tributary to the Yellow River. Very small parcels of shrub/scrub and herbaceous grasslands are scattered throughout the sub-watershed primarily intermingling with crops and pasture lands and woody wetland areas. Cultivated crops and pastures and hayfields are fairly dominant cover types in the northern and eastern portions of the watershed, though this land use is found throughout. Lowland vegetation consists of primarily wooded wetlands concentrated in the Sawyer Creek area, and scattered through the southern portion of the watershed. Approximately 7.6% of the sub-watershed is considered to be developed, most of this (5.5% of sub-watershed) is classified as developed open space which is generally park areas, golf courses of other areas of lawn grasses and/or impervious surfaces. There are also small amounts of low, medium, and high intensity development. The Town of Shell Lake and surrounding areas located on the western border of the sub-watershed account for most of this area.

Change

From presettlement to 2006, upland forest cover in the Shell Lake sub-watershed decreased from 84.1% of land area within the sub-watershed to 42.6%. That represents a loss of approximately 9,000 acres of previously forested land – 41.5% of the watershed converted – the largest of any of the sub-watersheds within the Yellow River watershed. Much of that land was converted to pastures and hay fields, agriculture, and development. The Shell Lake sub-watershed has richer soils and higher amounts of prime and important farmland than other sub-watersheds within the Yellow River watershed, an important factor in the loss of forested lands here.

4. Ecological Landscapes

The Shell Lake sub-watershed includes part of two of Wisconsin's Ecological Landscapes, The Forest Transition EL and the Northwest Sands. Only about 0.2% of the Shell Lake sub-watershed falls within the Northwest Sands Ecological Landscape. Within the Northwest Sands, the sub-watershed intersects with the Spooner Plains Ecoregion. The Spooner Plains LTA characteristic landform pattern is undulating outwash plain with isolated morainic hills and ridges. Soils are predominantly well drained sand over outwash. Common habitat types include PAm, QGCe, AVDe, and AAt. Within the Shell Lake sub-watershed the Spooner Plains area was historically a mix of jack pine/scrub oak/barrens and maple/birch/pine cover types. Today, the small part of the Shell Lake sub-watershed that falls within the Spooner Plains LTA (45.6 acres) is primarily upland deciduous forest, mixed forest, and woody wetland.

The Majority of the sub-watershed (99.8%) is encompassed by the Forest Transition Ecological Landscape where it intersects with the St. Croix Moraines ecoregion. The characteristic landform pattern is rolling collapsed moraine interlaced with outwash terraces and intermixed with ice-walled lake plains. Soils are predominantly moderately well drained sandy loam over dense, acid sandy loam till. Common habitat types include AcaCi and AAt. Within the Shell Lake sub-watershed, the St. Croix Moraines LTA was historically dominated by the maple/birch/pine cover type, with smaller areas of white pine/red pine forest. Today, the primary cover types within this LTA are a mix of primarily cultivated crops and pasture/hay with significant deciduous upland forest. There are also smaller but significant amounts of mixed and evergreen forest and woody wetland. Sawyer Creek and Shell Lake are the major water bodies within the LTA.

5. Ownership

Ownership within the Shell Lake sub-watershed is 90.0% private, 6.3% county, and 3.7% state. There are about 1,357 acres of Washburn County Forest within the Shell Lake sub-watershed. The county forestland forms a contiguous block in the southwest corner of the sub-watershed and includes a few small lakes and the headwaters of an intermittent stream that flows into Shell Lake. Covertypes within the county forest include upland deciduous forest, mixed forest and woody wetland.

There are approximately 789 acres of state-owned land within the Shell Lake sub-watershed. Most of that area is in the northwest corner of the sub-watershed in the Sawyer Creek State Fishery Area. The fishery area protects portions of Sawyer Creek, a Class I trout stream, and extends up into the Rice Lake sub-watershed to the confluence of Sawyer Creek and the Yellow River. Vegetation in the SCFA includes tag alder-tamarack-black spruce swamps, sedge marshes and well-drained wooded upland. The Shell Lake Rearing Station is a 16 acre state-owned property on Unspring Lake. Two other small state-owned properties on the west side of Shell Lake are managed as state habitat areas and include forest and wetland areas.

The remainder of the land within the Shell Lake sub-watershed (19,372 acres) is in private ownership. Most of the lakes and streams within this sub-watershed flow through privately owned land, much of it in agricultural uses (cultivated crops or pasture/hay). Much of Sawyer Creek and its tributaries, not within the SCFA, flow through fields and pastures. The City of Shell Lake is along the western shore of Shell Lake. Nearly all of the private land in the Rice Lake sub-watershed is of unknown conservation status.

6. Potential Private Forest Land

Of the upland forest and woody wetlands in the Shell Lake Sub-watershed 80.9% is in private ownership with unknown conservation status and 19.1% is in public ownership or private conservation ownership. There is no tribal within the Shell Lake sub-watershed.

7. Managing Forests to Slow Spring Snow Melts

The Shell Lake Sub-watershed is larger than 10 square miles and mature forest and storage areas are greater than 40 percent of total area. The sub-watershed does not have enough area of storage alone to absorb spring snow melts. If 18.9% of the watershed area is not kept as mature upland forest (a total of 4,065 acres of mature upland forest), this analysis indicates streams would be at risk for increased peak flows from spring snow melts. However, the upper portion of the watershed has several pockets that are not connected by overland flow to the Yellow River (including Shell Lake). Additional analysis would be necessary to determine if loss of upland forest would affect small streams in the watershed.

8. Water Quality

In the Shell Lake Sub-watershed, there are no rivers, streams or lakes that are listed as impaired for mercury or total phosphorus and mercury. Sawyer Creek is the only designated trout stream within the Shell Lake sub-watershed. Two separate stretches of Sawyer Creek, approximately 2.8 total miles, are designated as Class I trout stream: from the source to Sawyer Creek Springs and the stretch from Beaver Lodge Pond to the confluence of Sawyer Creek and the Yellow River. In addition, 3.7 miles of Sawyer Creek, between Sawyer Creek Springs and Beaver Lodge Pond are designated Class II trout streams. The entire length of Sawyer Creek is also a designated Outstanding Resource Water. Shell Lake (2,514 acres) is also a designated Outstanding Resource Water.

F. Headwaters Yellow River

1. General Information

The Yellow River Headwaters sub-watershed is the eastern most watershed within the Yellow River watershed. It is bordered to the west and south by the Rice Lake and Shell Lake sub-watersheds. The Headwaters sub-watershed extends east past Seymour Lake and south past Pavlas Lake. The sub-watershed encompasses approximately 36,891 acres and is completely within Washburn County. State Highway 70 approximately bisects the watershed from east to west and State Highways 53 and 253 run north to south through the western portion of the sub-watershed. The City of Spooner's southeast corner intersects the western edge of the watershed, though most of the city is actually within the neighboring Rice Lake sub-watershed.

The Headwaters sub-watershed contains 38.2 miles of streams. 25 miles are considered perennial and 13.2 are considered intermittent or fluctuating. Crystal Brook begins in the eastern edge of the sub-watershed, then pools to form Spooner Lake. The pour point of Spooner Lake, on the southwest edge of the northwest bay of the lake, is the headwaters of the Yellow River, which then flows southwest to meet Beaver Brook. Beaver Brook flows northwest from the southeast corner of the sub-watershed to its confluence with the Yellow River. The Headwaters sub-watershed has the third highest stream density at 0.7 mi/mi^2.

There are two lakes over 100 aces in the Headwaters sub-watershed. Leesome Lake on the eastern edge of the sub-watershed is not connected to the headwater streams of the Yellow River. Spooner Lake in the northern portion of the sub-watershed is part of the Yellow River/Crystal Brook flowage.

2. Soils

The Headwaters sub-watershed has about 10.1% of soils that are rated somewhat poorly to very poorly drained. These soils are primarily concentrated immediately adjacent to the Yellow river, its headwater streams and Spooner Lake. 20.5% of the soils are excessively to somewhat excessively drained. These soils are also concentrated along the Yellow River, its headwaters, and Spooner Lake adjacent to the band of very poorly drained soils. The rest of the sub-watershed is primarily made up of well to moderately well drained soils (63.2%). Most of the soils rated moderately well drained or wetter are also rated as all or predominately hydric or as having hydric inclusions (45.5%). 45.2% of soils within the sub-watershed are not hydric. Approximately 6% of the watershed is open water.

Most of the Headwaters sub-watershed, 56.9%, is classified as not prime farmland. 17.8% of soils are rated as prime farmland and 22.6% as farmland of statewide importance. The better farmland is generally found in the central portion of this sub-watershed.

3. Land Cover

Presettlement

Presettlement (mid-late 1800s) land cover in the Headwaters sub-watershed was upland forest (91.6%) with very little lowland vegetation (1.6%). The only other presettlement cover type was open water (6.9%). The presettlement upland forest of the Headwaters sub-watershed consisted of jack pine-barrens (40.5%) which was the dominant cover type in the northern half of the sub-watershed and maple-birch-pine forest (34.0%%) which was the dominant cover type in the southern half of the sub-watershed. There were also smaller amounts of white/red pine forest (6.1%) and maple-basswood-oak forest (11%) that intermingled with the maple-birch-pine forests in the southern reaches of the sub-watershed. Lowland vegetation consisted primarily of swamp conifers located along the northern/downstream stretch of Beaver Brook, a headwaters stream for the Yellow River.

Current

Current (as of 2006) land cover in the Headwaters sub-watershed is a mix of upland forest (59.0%), pasture/hay grassland (15.1%), lowland vegetation (5.9%), agriculture (5.1%) and development (7.2%). Open water covers 6.1% of the sub-watershed. The upland forest cover type is predominately deciduous forest with small amounts of mixed forest and evergreen forest. Mixed and evergreen forest, along with larger tracts of woody wetlands tend to be concentrated adjacent to waterways within the sub-watershed, including Yellow River, Spooner Lake, Beaver Brook, and Crystal Brook. Very small parcels of shrub/scrub, usually associated with wetland areas, and herbaceous grasslands, concentrated in the northern half of the sub-watershed, are present on the landscape. Cultivated crops and pastures and hayfields are fairly dominant cover types along the western boundary of the sub-watershed and within the northern half of the sub-watershed. Lowland vegetation consists of primarily wooded wetlands. Larger wetland areas are concentrated along the sub-watershed's major waterways, but smaller parcels are found throughout the southern portion of the watershed. Approximately 7.2% of the sub-watershed is considered to be developed, most of this (5.6% of sub-watershed) is classified as developed open space which is generally park areas, golf courses of other areas of lawn grasses and/or impervious surfaces. There are also small amounts of low, medium, and high intensity development. The outlying areas of the City of Spooner and a golf course on the west end of Spooner Lake account for most of this area.

Change

From presettlement to 2006, upland forest cover in the Headwaters sub-watershed decreased from 91.6% of land area within the sub-watershed to 59.0%. That represents a loss of approximately 12,000 acres of previously forested land –32.5% of the watershed converted. Most of that area has been converted to pastures and hay fields, agriculture, and/or development. Like the Shell Lake sub-watershed, the Headwaters sub-watershed has some richer soils and higher amounts of prime and important farmland than many of the other sub-watersheds within the Yellow River watershed, an important factor in the loss of forested lands here. In addition, the northern half of this sub-watershed was dominated by jack pine and barrens. Today only around 1.3%

of the total land area in the headwaters sub-watershed is in a primarily evergreen cover type – a loss of approximately 14,000 acres. This represents a significant loss of a historically important cover types for this sub-watershed.

4. Ecological Landscapes

The Headwaters Yellow River sub-watershed includes part of two of Wisconsin's Ecological Landscapes, The Forest Transition EL and the Northwest Sands. Approximately 24.6% of the Headwaters sub-watershed falls within the Northwest Sands Ecological Landscape. Within the Northwest Sands, the sub-watershed intersects with the Spooner Plains Ecoregion. The Spooner Plains LTA characteristic landform pattern is undulating outwash plain with isolated morainic hills and ridges. Soils are predominantly well drained sand over outwash. Common habitat types include PAm, QGCe, AVDe, and AAt. Within the Headwaters sub-watershed, the Spooner Plains LTA was historically dominated by the jack pine/scrub oak/barrens cover type with smaller amounts of maple/birch/pine, white pine/red pine, and swamp conifer cover types. Today, the portion of the Headwaters sub-watershed that falls within the Spooner Plains LTA is primarily cultivated crops, pasture/hay and upland deciduous forest. There are also some mixed forest, evergreen forest and woody wetland. Open water is a major cover type within the LTA for this sub-watershed as Spooner Lake is located here.

The majority of the Headwaters sub-watershed (75.4%) is encompassed by the Forest Transition Ecological Landscape where it intersects with the St. Croix Moraines ecoregion. The characteristic landform pattern is rolling collapsed moraine interlaced with outwash terraces and intermixed with ice-walled lake plains. Soils are predominantly moderately well drained sandy loam over dense, acid sandy loam till. Common habitat types include AcaCi and AAt. Within the Headwaters sub-watershed, the St. Croix Moraines LTA was historically dominated by the maple/birch/pine cover type, with a large amount of jack pine/scrub oak/barrens and smaller areas of maple/basswood/oak and white pine/red pine forest. Today, the primary cover type within this LTA is upland deciduous forest with cultivated crops and pasture/hay also a major cover type. Small amounts of mixed and evergreen forest and woody wetland are clustered around the Yellow River and its headwater streams in this LTA.

5. Ownership

Ownership within the Yellow River Headwaters sub-watershed is 83.7% private, 10.7% county, and 5.6% state. There are about 3,944 acres of Washburn County Forest within the Headwaters sub-watershed. Within this sub-watershed county forestland is found primarily in the south and east and includes several named and unnamed lakes. County forest within this sub-watershed is nearly all upland deciduous forest with small amounts of mixed forest and woody wetland.

The Headwaters sub-watershed contains approximately 2,059 acres of state-owned land. Most of the state-owned land is found at Beaver Brook Wildlife Area (BBWA), surrounding Beaver Brook, a Class I trout stream and one of the headwater streams of the Yellow River. Beaver Brook is fed along its course by 10 spring ponds and many bank seeps, and flows into the Yellow River Flowage on the north end of the property. The mouth and a section of Randall Creek are also part of the Beaver Brook property. 17 acre Harrison Lake lies in the north end of Beaver Brook and 18 acre Lutz Lake lies on part of the south end.

Numerous wetlands associated with the brook, springs and lakes can be found throughout the property. Red oak stands, aspen, mixed hardwoods, upland and lowland brush, swamp hardwood and conifer, tamarack, pine, old fields and openings make up the other habitats of the 1,964 acre wildlife area. In addition to BBWA, the sub-watershed contains an 82 acre block of state-owned property along the southeast shore of Spooner Lake that includes woody wetland, mixed forest and upland deciduous forest.

The remainder of the land within the Headwaters sub-watershed (19,372 acres) is in private ownership. Beaver Brook, one of the Headwaters streams flows primarily through publically owned forest land. Spooner Lake and Crystal Brook, the other headwaters flowage, are surrounded primarily by private land. Land cover adjacent to Crystal Brook is primarily upland deciduous forest along with mixed forest and woody wetland with some agricultural land use in proximity especially on the western side of Spooner Lake and near the confluence of Crystal Brook and Spooner Lake on the southeastern side of Spooner Lake. Nearly all of the private land in the Rice Lake sub-watershed is of unknown conservation status.

6. Potential Private Forest Land

Of the upland forest and woody wetlands in the Shell Lake Sub-watershed 76.8% is in private ownership with unknown conservation status and 23.2% is in public ownership or private conservation ownership. There is no tribal within the Headwaters sub-watershed

7. Managing Forests to Slow Spring Snow Melts

While the Yellow River Headwaters Sub-watershed is grouped together, Beaver Brook and Spooner Lake –Yellow River HUC12s are essentially separate drainage areas. Each is larger than 10 square miles and mature forest and storage areas are greater than 40 percent of total area, and each of the sub-watersheds do not have enough area of storage alone to absorb spring snow melts. In the Beaver Brook HUC12, if 30.6% of the watershed area is not kept as mature upland forest (a total of 4,926 acres of mature upland forest), Beaver Brook and the main stem of the Yellow River may be at risk for increased peak flows from spring snow melts. In the Spooner Lake –Yellow River HUC12, if 25.9% of the watershed area is not kept as mature upland forest (a total of 5,391 acres of mature upland forest), Crystal Brook and the main stem of the Yellow River may be at risk for increased peak flows from spring snow melts. If 28.0% of the overall sub-watershed is not kept as mature upland forest (a total of 10,316 acres of mature upland forest), the main stem of the Yellow River downstream from the sub-watershed may be at risk for increase peak flows from spring snow melts.

8. Water Quality

In the Yellow River Headwaters Sub-watershed, there are no rivers, streams or lakes that are listed as impaired for mercury or total phosphorus and mercury. There are 11.1 miles of designated Class I trout streams in the sub-watershed including the entire length of Beaver Brook (7.7 miles) from Browns Lake to the confluence of Beaver Brook and the Yellow River and the entire length of Crystal Brook (3.4 miles) from the source until it flows into Spooner Lake. In addition, Beaver Brook is a designated Outstanding Resource Water and Crystal Brook is a designated Exceptional Resource Water. There are no lakes within the Headwaters sub-watershed that are designated as Outstanding or Exceptional Resource Waters.

G. Tables

1. General Information

Table 1. Area.

Total Area	Loon Creek	Lower Yellow River	Sand Lakes	Rice Lake	Shell Lake	Headwaters Yellow River
Acres	32,205.2	52,465.6	39,695.3	51,566.6	21,519.9	36,891.4

Table 2. Elevation.

Elevation	Loon Creek	Lower Yellow River	Sand Lakes	Rice Lake	Shell Lake	Headwaters Yellow River
Percent Rise (average)	3.9	2.6	2.6	3.4	3.0	4.0

Table 3. Streams and stream density.

	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
Flow lines	**Length (Miles)**	**% of Total**	**Length (Miles)**	**% of Total**	**Length (Miles)**	**% of Total**	**Length (Miles)**	**% of Total**	**Length (Miles)**	**% of Total**	**Length (Miles)**	**% of Total**
Primary Flow Over Land Perennial	11.4	41.5	0.7	1.7	10.3	30.7	16.9	24.9	9.7	27.6	9.2	24.2
Primary Flow Over Land Intermittent	0.6	2.2	7.4	17.3	0.0	0.0	8.9	13.1	16.1	45.8	7.1	18.6
Primary Flow Over Land Fluctuating	0.1	0.3	0.9	2.2	0.0	0.0	1.2	1.7	1.4	3.9	1.3	3.5
Primary Flow In Water Perennial	11.3	41.1	26.0	60.5	20.1	60.2	32.8	48.3	1.7	4.8	10.8	28.3
Primary Flow In Water Intermittent	0.0	0.0	0.2	0.5	0.0	0.0	0.0	0.0	4.7	13.3	0.2	0.4
Primary Flow In Water Fluctuating	3.6	13.3	6.8	15.9	3.1	9.1	3.1	4.6	1.6	4.5	4.5	11.8
Secondary Flow Over Land Perennial	0.0	0.0	0.3	0.7	0.0	0.0	4.5	6.7	0.0	0.0	5.0	13.2
Secondary Flow Over Land Intermittent	0.0	0.0	0.1	0.3	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0
Secondary Flow In Water Perennial	0.4	1.6	0.3	0.8	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0
Secondary Flow In Water Intermittent	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0
Secondary Flow In Water Fluctuating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Length	**27.4**		**43.0**		**33.5**		**67.9**		**35.0**		**38.2**	
Stream Density = Total Length/Total Sub-watershed Area (miles/sq mile)	**0.5**		**0.5**		**0.5**		**0.8**		**1.0**		**0.7**	

2. Soils

Table 4. Drainage class.

Soil Drainage	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Excessively Drained	16,580.3	51.5	10,839.2	20.7	2,845.2	7.2	5,773.1	11.2	304.1	1.4	1,521.8	4.1
Somewhat Excessively Drained	6,724.7	20.9	8,050.5	15.3	14,093.3	35.5	19,386.9	37.6	1,252.3	5.8	6,036.0	16.4
Well Drained	793.2	2.5	268.1	0.5	103.8	0.3	3,708.6	7.2	3,915.5	18.2	9,297.2	25.2
Moderately Well Drained	1,630.8	5.1	14,351.0	27.4	9,166.5	23.1	12,815.6	24.9	9,378.2	43.6	14,022.2	38.0
Somewhat Poorly Drained	59.9	0.2	2,517.7	4.8	478.0	1.2	1,537.6	3.0	1,614.0	7.5	964.3	2.6
Poorly Drained	0.0	0.0	300.5	0.6	321.5	0.8	134.6	0.3	113.5	0.5	22.0	0.1
Very Poorly Drained	2,864.0	8.9	8,453.4	16.1	7,643.1	19.3	5,273.1	10.2	1,521.7	7.1	2,738.1	7.4
Not Rated	3,552.3	11.0	7,685.2	14.6	5,043.9	12.7	2,937.0	5.7	3,420.7	15.9	2,289.8	6.2
Total Sub-watershed Area	**32,205.2**		**52,465.6**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

Table 5. Farmland class.

Soil Farmland Classification	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
All areas are prime farmland	12.2	0.0	170.6	0.3	347.2	0.9	2,115.5	4.1	4,223.9	19.6	6,549.5	17.8
Farmland of statewide importance	5.3	0.0	2,895.0	5.5	868.7	2.2	1,150.8	2.2	5,045.4	23.4	8,324.2	22.6
Not prime farmland	32,187.7	99.9	49,347.7	94.1	38,396.9	96.7	47,393.7	91.9	10,661.4	49.5	20,992.2	56.9
Prime farmland if drained	0.0	0.0	52.3	0.1	82.5	0.2	906.7	1.8	1,589.2	7.4	1,025.5	2.8
Total Sub-watershed Area	**32,205.2**		**52,465.6**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

Table 6. Hydric rating.

Soils Hydric Rating	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
All Hydric	2,702.9	8.4	7,530.4	14.4	6,466.5	16.3	4,592.8	8.9	1,391.7	6.5	2,575.2	7.0
Predominantly Hydric	161.1	0.5	1,094.5	2.1	1,183.8	3.0	790.7	1.5	243.4	1.1	184.9	0.5
Hydric Inclusions	432.7	1.3	2,966.9	5.7	863.0	2.2	4,317.9	8.4	9,212.3	42.8	14,012.2	38.0
Partially Hydric	0.0	0.0	129.0	0.2	314.3	0.8	48.3	0.1	1,925.0	8.9	1,172.2	3.2
Not Hydric	25,356.3	78.7	33,059.6	63.0	25,823.8	65.1	38,993.4	75.6	5,447.2	25.3	16,657.0	45.2
Not Rated	3,552.3	11.0	7,685.2	14.6	5,043.9	12.7	2,823.6	5.5	3,300.2	15.3	2,289.8	6.2
Total Sub-watershed Area	**32,205.2**		**52,465.6**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

3. Land Cover

Presettlement

Table 7. Presettlement land cover (mid-late 1800s).

Presettlement Land Cover (mid-late 1800s)	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Jack pine, scrub (hills), oak forest and barrens	28,195.8	87.6	41,348.7	78.9	30,935.1	77.9	42,829.7	83.1	63.0	0.3	14,925.0	40.5
Oak -- white oak, black oak, bur oak	0.0	0.0	0.0	0.0	0.0	0.0	473.1	0.9	0.0	0.0	0.0	0.0
Sugar maple, basswood, red oak, white oak, black oak	0.0	0.0	0.0	0.0	0.0	0.0	1,268.4	2.5	490.2	2.3	4,049.6	11.0
Sugar maple, yellow birch, white pine, red pine	0.0	0.0	0.0	0.0	0.0	0.0	2,410.5	4.7	15,468.4	71.9	12,546.2	34.0
White pine, red pine	0.0	0.0	0.0	0.0	1,221.7	3.1	178.9	0.3	2,080.9	9.7	2,258.4	6.1
Subtotal (Upland Forest)	**28,195.8**	**87.6**	**41,348.7**	**78.9**	**32,156.8**	**81.0**	**47,160.7**	**91.5**	**18,102.6**	**84.1**	**33,779.2**	**91.6**
Lowland hardwoods -- willow, soft maple, box elder, ash, elm, cottonwood, river birch	0.0	0.0	3,231.4	6.2	1,554.9	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Swamp conifers -- white cedar, black spruce, tamarack, hemlock	703.3	2.2	851.7	1.6	1,253.6	3.2	1,425.6	2.8	0.0	0.0	578.5	1.6
Subtotal (Lowland Vegetation)	**703.3**	**2.2**	**4,083.1**	**7.8**	**2,808.5**	**7.1**	**1,425.6**	**2.8**	**0.0**	**0.0**	**578.5**	**1.6**
Lakes (open water, 1992 areas added)	3,287.1	10.2	6,998.2	13.3	4,730.0	11.9	2,980.3	5.8	3,417.4	15.9	2,533.7	6.9
Subtotal (Open Water)	**3,287.1**	**10.2**	**6,998.2**	**13.3**	**4,730.0**	**11.9**	**2,980.3**	**5.8**	**3,417.4**	**15.9**	**2,533.7**	**6.9**
Total Sub-watershed Area	**32,186.2**		**52,429.9**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

Current

Table 8. Current land cover (2006).

Current Land Cover (2006)	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Deciduous Forest	15,233.8	47.3	23,255.3	44.3	18,121.0	45.7	23,052.7	44.7	8,015.0	37.2	19,975.4	54.1
Evergreen Forest	1,916.5	6.0	1,992.4	3.8	1,940.4	4.9	1,217.8	2.4	243.1	1.1	469.1	1.3
Mixed Forest	5,017.7	15.6	5,633.4	10.7	5,157.9	13.0	4,630.2	9.0	909.8	4.2	1,336.8	3.6
Subtotal (Upland Forest)	**22,168.0**	**68.8**	**30,881.2**	**58.9**	**25,219.4**	**63.5**	**28,900.7**	**56.0**	**9,167.8**	**42.6**	**21,781.3**	**59.0**
Shrub/Scrub	1,550.2	4.8	801.1	1.5	255.9	0.6	176.6	0.3	31.1	0.1	41.5	0.1
Subtotal (Upland Shrub)	**1,550.2**	**4.8**	**801.1**	**1.5**	**255.9**	**0.6**	**176.6**	**0.3**	**31.1**	**0.1**	**41.5**	**0.1**
Grassland/Herbaceous	75.0	0.2	140.7	0.3	143.1	0.4	189.8	0.4	180.1	0.8	421.7	1.1
Pasture Hay	603.0	1.9	3,773.5	7.2	1,727.7	4.4	10,172.1	19.7	4,975.1	23.1	5,588.6	15.1
Subtotal (Upland Grass)	**678.0**	**2.1**	**3,914.2**	**7.5**	**1,870.8**	**4.7**	**10,362.0**	**20.1**	**5,155.2**	**24.0**	**6,010.4**	**16.3**
Woody Wetlands	1,680.5	5.2	2,786.0	5.3	2,245.0	5.7	1,854.8	3.6	1,106.7	5.1	2,088.3	5.7
Emergent Herbaceous Wetlands	536.3	1.7	1,832.6	3.5	1,947.1	4.9	1,007.5	2.0	59.0	0.3	106.1	0.3
Subtotal (Lowland Vegetation)	**2,216.9**	**6.9**	**4,618.6**	**8.8**	**4,192.0**	**10.6**	**2,862.3**	**5.6**	**1,165.7**	**5.4**	**2,194.4**	**5.9**
Cultivated Crops	170.7	0.5	1,849.1	3.5	1,197.1	3.0	2,978.9	5.8	974.9	4.5	1,893.2	5.1
Subtotal (Agriculture)	**170.7**	**0.5**	**1,849.1**	**3.5**	**1,197.1**	**3.0**	**2,978.9**	**5.8**	**974.9**	**4.5**	**1,893.2**	**5.1**
Developed, High Intensity	0.0	0.0	31.0	0.1	0.0	0.0	74.0	0.1	21.6	0.1	26.9	0.1
Developed, Medium Intensity	11.9	0.0	66.4	0.1	5.5	0.0	175.1	0.3	54.5	0.3	36.6	0.1
Developed, Low Intensity	98.5	0.3	243.0	0.5	64.0	0.2	510.2	1.0	378.7	1.8	536.5	1.5
Developed, Open Space	1,977.0	6.1	2,856.3	5.4	1,985.3	5.0	2,783.7	5.4	1,174.3	5.5	2,069.0	5.6
Subtotal (Developed)	**2,087.3**	**6.5**	**3,196.7**	**6.1**	**2,054.8**	**5.2**	**3,543.1**	**6.9**	**1,629.0**	**7.6**	**2,669.1**	**7.2**
Barren Land (Rock/Sand/Clay)	0.0	0.0	1.3	0.0	0.0	0.0	7.1	0.0	19.0	0.1	55.8	0.2
Subtotal (Barren)	**0.0**	**0.0**	**1.3**	**0.0**	**0.0**	**0.0**	**7.1**	**0.0**	**19.0**	**0.1**	**55.8**	**0.2**
Open Water	3,334.1	10.4	7,203.5	13.7	4,905.3	12.4	2,736.0	5.3	3,377.2	15.7	2,245.7	6.1
Subtotal (Open Water)	**3,334.1**	**10.4**	**7,203.5**	**13.7**	**4,905.3**	**12.4**	**2,736.0**	**5.3**	**3,377.2**	**15.7**	**2,245.7**	**6.1**
Total Sub-watershed Area	**32,205.2**		**52,465.6**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

Change

Table 9. Land cover change from mid-late 1800s to 2006.

Land Cover Change (mid-late 1800s to 2006)	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area Change (Acres)	Percent Cover Change	Area Change (Acres)	Percent Cover Change	Area Change (Acres)	Percent Cover Change	Area Change (Acres)	Percent Cover Change	Area Change (Acres)	Percent Cover Change	Area Change (Acres)	Percent Cover Change
Upland Forest	-6,027.8	-18.8	-10,467.5	-20.0	-6,937.5	-17.5	-18,260.0	-35.4	-8,934.7	-41.5	-11,997.9	-32.5
Upland Shrub	1,550.2	4.8	801.1	1.5	255.9	0.6	176.6	0.3	31.1	0.1	41.5	0.1
Upland Grass	678.0	2.1	3,914.2	7.5	1,870.8	4.7	10,362.0	20.1	5,155.2	24.0	6,010.4	16.3
Lowland Vegetation	1,513.5	4.7	535.5	1.0	1,383.6	3.5	1,436.8	2.8	1,165.7	5.4	1,615.9	4.4
Agriculture	170.7	0.5	1,849.1	3.5	1,197.1	3.0	2,978.9	5.8	974.9	4.5	1,893.2	5.1
Developed	2,087.3	6.5	3,196.7	6.1	2,054.8	5.2	3,543.1	6.9	1,629.0	7.6	2,669.1	7.2
Barren	0.0	0.0	1.3	0.0	0.0	0.0	7.1	0.0	19.0	0.1	55.8	0.2
Open Water	47.0	0.1	205.3	0.4	175.3	0.4	-244.3	-0.5	-40.2	-0.2	-287.9	-0.8

4. Ecological Landscapes

Table 10. Ecoregions.

Ecoregions	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Danbury Trego Plains	14,242.0	44.2	7,038.8	13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Late St. Croix Moraines	0.0	0.0	0.0	0.0	87.7	0.2	6,977.5	13.5	21,474.3	99.8	27,817.1	75.4
Lower Namekagon Rolling Barrens	5,099.6	15.8	14.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Siren Plains	0.0	0.0	20,809.3	39.7	21,029.5	53.0	373.5	0.7	0.0	0.0	0.0	0.0
Spooner Plains	0.0	0.0	0.0	0.0	2,338.6	5.9	34,725.6	67.3	45.6	0.2	9,074.2	24.6
St. Croix Plains	1,941.3	6.0	1,075.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Webb Lake Collapsed Barrens	10,922.3	33.9	23,527.7	44.8	16,239.4	40.9	9,490.0	18.4	0.0	0.0	0.0	0.0
Total Sub-watershed Area	**32,205.2**		**52,465.6**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

5. Ownership and Administration

Table 11. Ownership.

Ownership	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Lac Courte Oreilles	0.0	0.0	0.0	0.0	113.0	0.3	65.3	0.1	0.0	0.0	0.0	0.0
St. Croix	103.7	0.3	84.9	0.2	594.1	1.5	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal (Tribal)	**103.7**	**0.3**	**84.9**	**0.2**	**707.2**	**1.8**	**65.3**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**
Wisconsin Department Of Natural Resources	39.9	0.1	2,567.3	4.9	285.7	0.7	251.6	0.5	789.6	3.7	2,059.1	5.6
Subtotal (State)	**39.9**	**0.1**	**2,567.3**	**4.9**	**285.7**	**0.7**	**251.6**	**0.5**	**789.6**	**3.7**	**2,059.1**	**5.6**
Burnett County	13,006.3	40.4	4,044.8	7.7	8,940.1	22.5	660.7	1.3	0.0	0.0	0.0	0.0
Washburn County	0.0	0.0	0.0	0.0	0.0	0.0	412.4	0.8	1,357.4	6.3	3,944.6	10.7
Subtotal (County)	**13,006.3**	**40.4**	**4,044.8**	**7.7**	**8,940.1**	**22.5**	**1,073.1**	**2.1**	**1,357.4**	**6.3**	**3,944.6**	**10.7**
The Nature Conservancy	167.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal (Private Conservancy)	**167.1**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Private	18,888.3	58.6	45,768.6	87.2	29,762.2	75.0	50,176.6	97.3	19,372.9	90.0	30,887.6	83.7
Subtotal (Private)	**18,888.3**	**58.6**	**45,768.6**	**87.2**	**29,762.2**	**75.0**	**50,176.6**	**97.3**	**19,372.9**	**90.0**	**30,887.6**	**83.7**
Total Sub-watershed Area	**32,205.2**		**52,465.6**		**39,695.3**		**51,566.6**		**21,519.9**		**36,891.4**	

6. Potential Private Forest Land

Table 12. Potential private forest land.

Ownership	Forestland	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
		Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Tribal	Deciduous Forest	65.2	0.3	43.6	0.1	484.9	1.8	47.4	0.2	0.0	0.0	0.0	0.0
	Evergreen Forest	4.5	0.0	6.8	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mixed Forest	3.6	0.0	2.7	0.0	52.6	0.2	11.8	0.0	0.0	0.0	0.0	0.0
	Woody Wetlands	0.1	0.0	0.0	0.0	18.8	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Subtotal (Tribal)		**73.3**	**0.3**	**53.0**	**0.2**	**558.2**	**2.0**	**59.2**	**0.2**	**0.0**	**0.0**	**0.0**	**0.0**
Public Ownership & Private Conservation	Deciduous Forest	5,777.4	24.2	3,515.1	10.4	4,640.4	16.9	923.9	3.0	1,328.7	12.9	4,778.7	20.0
	Evergreen Forest	1,330.7	5.6	318.8	0.9	676.7	2.5	26.8	0.1	65.1	0.6	27.9	0.1
	Mixed Forest	2,603.1	10.9	679.3	2.0	1,368.7	5.0	169.1	0.5	290.7	2.8	252.2	1.1
	Woody Wetlands	889.6	3.7	804.8	2.4	1,014.6	3.7	65.2	0.2	283.1	2.8	482.9	2.0
Subtotal (Public Ownership & Private Conservation)		**10,600.8**	**44.5**	**5,318.0**	**15.8**	**7,700.5**	**28.0**	**1,184.9**	**3.9**	**1,967.5**	**19.1**	**5,541.7**	**23.2**
Private	Deciduous Forest	9,391.1	39.4	19,696.7	58.5	12,995.7	47.3	22,081.4	71.8	6,686.3	65.1	15,196.7	63.7
	Evergreen Forest	581.3	2.4	1,666.8	5.0	1,261.7	4.6	1,191.0	3.9	178.0	1.7	441.2	1.8
	Mixed Forest	2,411.1	10.1	4,951.5	14.7	3,736.6	13.6	4,449.4	14.5	619.1	6.0	1,084.6	4.5
	Woody Wetlands	790.9	3.3	1,981.2	5.9	1,211.6	4.4	1,789.5	5.8	823.6	8.0	1,605.4	6.7
Subtotal (Private)		**13,174.4**	**55.2**	**28,296.2**	**84.0**	**19,205.6**	**69.9**	**29,511.3**	**96.0**	**8,307.0**	**80.9**	**18,327.9**	**76.8**
Total Upland Forest and Woody Wetlands		**23,848.5**		**33,667.2**		**27,464.3**		**30,755.5**		**10,274.6**		**23,869.6**	

7. Managing Forests to Slow Spring Snow Melts

Table 13. Managing forest to slow peak flows from spring snow melts.

Managing Forests for Peak Flows	Loon Creek	Lower Yellow River	Sand Lakes	Rice Lake	Shell Lake	Headwaters Yellow River
Storage (Lowland Vegetation / Open Water) Area (acres)	5,551.0	11,822.0	9,097.3	5,598.3	4,542.9	4,440.1
Storage (Lowland Vegetation / Open Water) % of Total	17.2	22.5	22.9	10.9	21.1	12.0
Upland Forest and Storage Area (acres)	27,719.0	42,703.2	34,316.7	34,499.0	13,710.8	26,221.4
Upland Forest and Storage % of Total	86.1	81.4	86.5	66.9	63.7	71.1
Preserve % of watershed as mature upland forest	22.8	N/A	N/A	N/A	18.9	28.0
Preserve area of mature upland forest (acres)	7,331.1	N/A	N/A	N/A	4,065.0	10,316.4
Watershed Description	Watershed is large and mature forest and storage areas are greater than 40 percent of total area.	Upstream areas not included, does not apply to Yellow River main stem.	Upstream areas not included, does not apply to Yellow River main stem.	Upstream areas not included, does not apply to Yellow River main stem.	Watershed is large and mature forest and storage areas are greater than 40 percent of total area.	Watershed is large and mature forest and storage areas are greater than 40 percent of total area.
Watershed Recommendation	Watershed does not have enough area of storage alone to absorb spring snow melts. Preserve a minimum of 22.8 percent of watershed, 7331.1 acres, as mature upland forest.	N/A	N/A	N/A	Watershed does not have enough area of storage alone to absorb spring snow melts. Preserve a minimum of 18.9 percent of watershed, 4065.0 acres, as mature upland forest.	Watershed does not have enough area of storage alone to absorb spring snow melts. Preserve a minimum of 28.0 percent of watershed, 10316.4 acres, as mature upland forest.

8. Water Quality

Table 14. Impaired waters lakes.

Impaired Waters Lakes	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
Mercury	0.0	n/a	398.6	14.9	899.8	100.0	0.0	n/a	0.0	n/a	0.0	n/a
Total Phosphorus, Mercury	0.0	n/a	2,281.7	85.1	0.0	0.0	0.0	n/a	0.0	n/a	0.0	n/a
Total Impaired Waters Area	**0.0**		**2,680.3**		**899.8**		**0.0**		**0.0**		**0.0**	

Table 15. Trout streams.

Trout Streams	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total
Class I	0.0	n/a	0.0	n/a	1.9	46.2	6.0	100.0	2.8	43.3	11.1	100.0
Class II	0.0	n/a	0.0	n/a	2.3	53.8	0.0	0.0	3.7	56.7	0.0	0.0
Total Trout Streams Length	**0.0**		**0.0**		**4.2**		**6.0**		**6.5**		**11.1**	

Table 16. OERW streams.

OERW Streams	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total	Length (Miles)	% of Total
ERW	0.0	n/a	0.0	n/a	1.9	100.0	5.6	94.0	0.0	0.0	3.4	43.1
ORW	0.0	n/a	0.0	n/a	0.0	0.0	0.4	6.0	6.5	100.0	4.4	56.9
Total OERW Length	**0.0**		**0.0**		**1.9**		**6.0**		**6.5**		**7.8**	

Table 17. OERW lakes.

OERW Lakes	Loon Creek		Lower Yellow River		Sand Lakes		Rice Lake		Shell Lake		Headwaters Yellow River	
	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total	Area (Acres)	% of Total
ERW	0.0	n/a	0.0	n/a	4.7	0.2	0.0	n/a	0.0	0.0	0.0	n/a
ORW	0.0	n/a	0.0	n/a	2,332.8	99.8	0.0	n/a	2,514.5	100.0	0.0	n/a
Total OERW Area	**0.0**		**0.0**		**2,337.5**		**0.0**		**2,514.5**		**0.0**	