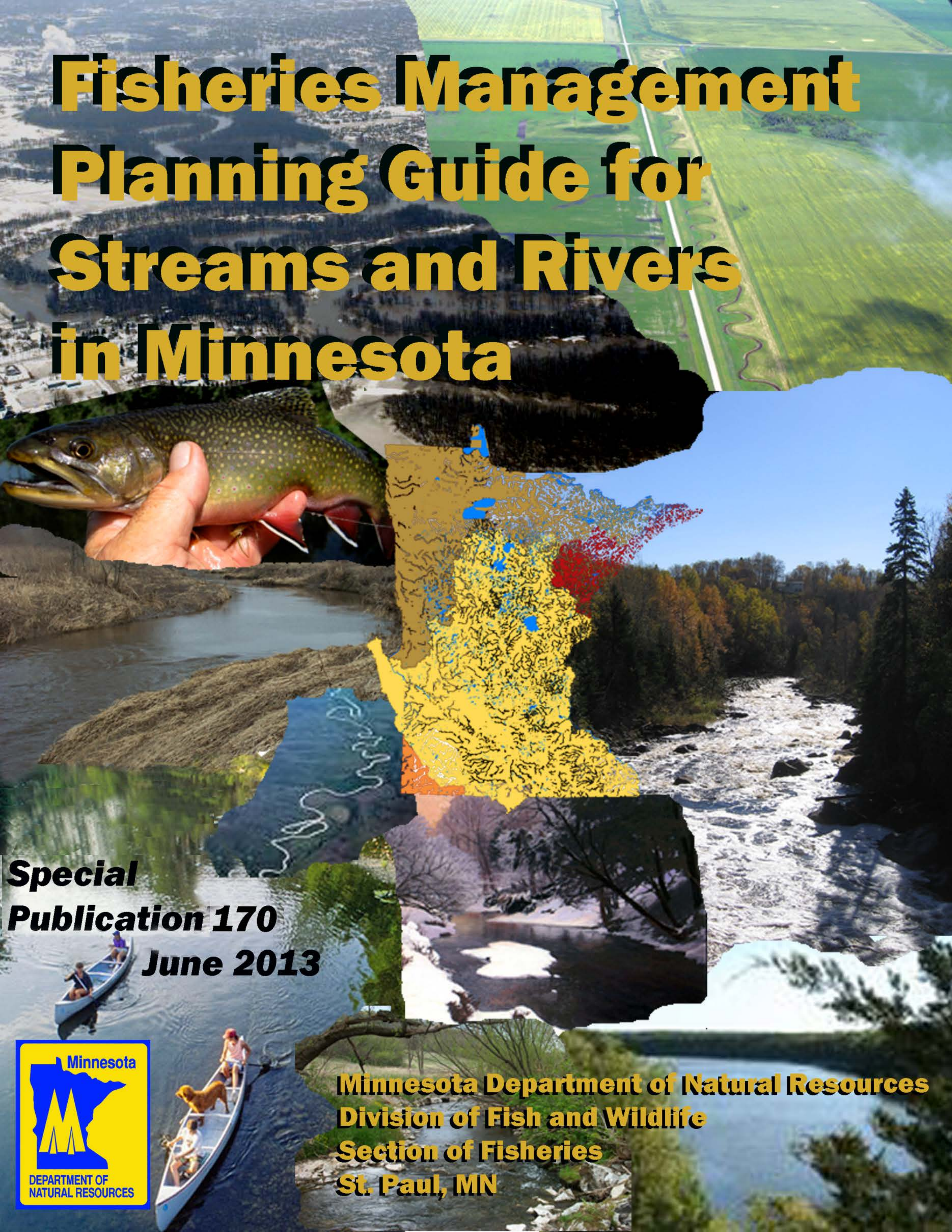
Fisheries Management Planning Guide for Streams and Rivers in Minnesota



Special Publication 170

June 2013

Minnesota
DEPARTMENT OF NATURAL RESOURCES

Minnesota Department of Natural Resources
Division of Fish and Wildlife
Section of Fisheries
St. Paul, MN

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Fisheries Management Planning Guide for Streams and Rivers in Minnesota

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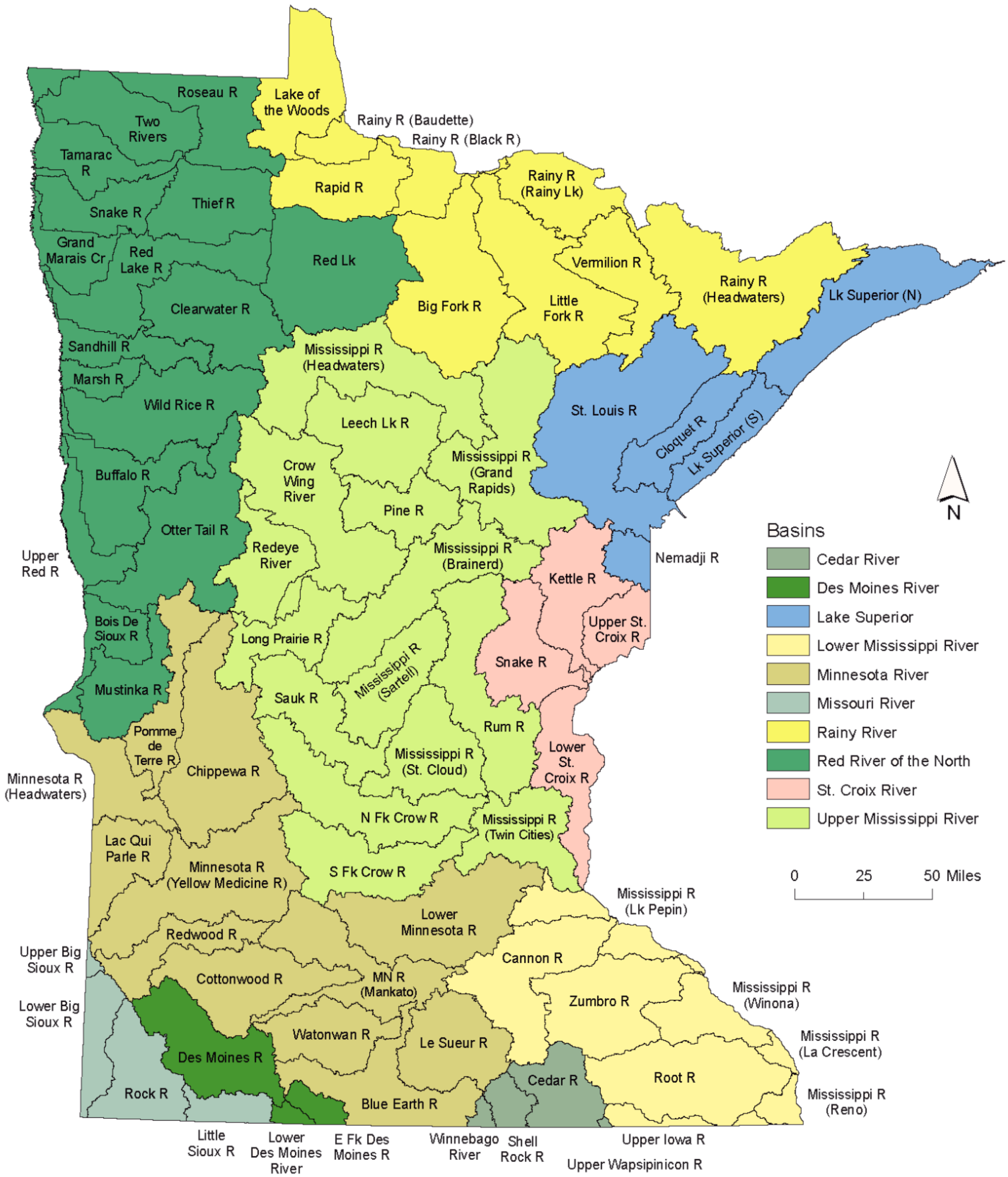
Minnesota
DEPARTMENT OF NATURAL RESOURCES

i. Table of Contents

Basins and Major Watersheds in Minnesota



Minnesota’s landscape is comprised of 10 basins and 81 major watersheds.

ii. Preface

This publication represents the second edition of a stream management planning guide to help fisheries professionals manage river and stream resources across the state of Minnesota. Minnesota's landscape is unique in that it is comprised of four major drainages: Hudson Bay (via the Red and Rainy Rivers), Great Lakes-St. Lawrence (via Lake Superior), Upper Mississippi (via most rivers), and Missouri River (via Rock, Big Sioux, and Little Sioux Rivers). These four drainages can be further divided into 10 basins and 81 major watersheds, making riverine conservation efforts a constant challenge. This guide was prepared as a companion document to three other river and stream management products. The Fisheries Stream Survey Manual (MNDNR 2007) was previously revised in 2004-2007. Stream Survey Manual Supplement 1 (MNDNR 2013) and a Stream Survey Report form were prepared in conjunction with this guide. Together these four products form the basis for acquiring information, interpreting and reporting that information, and ultimately writing a stream management plan for use by fisheries professionals, other governmental agencies, and conservation partners. Such management plans should prove effective aids for accomplishing conservation goals, strategies, and objectives outlined in planning documents of the Department of Natural Resources and conservation partners such as, A Strategic Conservation Agenda (MNDNR 2010), Fish Habitat Plan (MNDNR 2013), Minnesota's Aquatic Management Area Acquisition Plan 2008-2033 (AMAAPC 2007), Driftless Area Restoration Effort Strategic Plan (TU 2007), Red River of the North Fisheries Management Plan (MNDNR and others 2007), Long-Range Plan for Trout Stream Resource Management in Southeast Minnesota (MNDNR 2011), and others.

Dirk Peterson
Chief of the Fisheries Section
June 2013

iii. Introduction

Minnesota has a large and diverse stream and river resource. There are almost 69,000 miles of natural rivers and streams in Minnesota with over 15,000 miles supporting recreational or trophy fisheries for a variety of species including brook, brown, and rainbow trout, smallmouth bass and walleye, lake sturgeon, and catfish **(Table 1)**. Streams may represent an untapped recreational resource, provide vital locations for angler recruitment **(Figure 1)**, support critical habitat for rare species, and serve as a barometer of the environment which all Minnesotans are exposed to.

This diverse resource requires a flexible management program. Two main factors led to this revision of the Minnesota Department of Natural Resources (MNDNR) Section of Fisheries Stream Management Planning Guide. First, the previous Planning Guide published in 1993 (MNDNR 1993) was based in large part on a stream survey manual (MNDNR 1978) that used dated sampling methods and techniques. The new MNDNR Fisheries Stream Survey Manual (MNDNR 2007) offers many new methods and organizes these into five broad components that regulate rivers and streams: Hydrology, Geomorphology/Physical Habitat, Water Quality, Connectivity, and Biology (sensu Annear et al. 2004). Second, stream management in Minnesota has developed several new facets. In 1993, the Section of Fisheries was probably the primary agency that managed rivers and streams across the state of Minnesota.

Figure 1. A happy stream angler with a nice brook trout.

Table 1. Minnesota state record angling fish species caught in streams and rivers (N=34). Current through March 2013.

Species	Weight (lbs.-oz.)	Length/girth (inches)	Waterbody where caught	County	Date
Bass, White	4-2.4	18.5 / 15.1	Mississippi River Pool 5	Wabasha	05/04/2004
Bowfin	11-4	35/ 20	St. Croix River	Washington	10/07/2008
Buffalo, Bigmouth	41-11	38.5 / 29.5	Mississippi River	Goodhue	05/07/1991
Buffalo, Black	20-.5	34.2 / 20	Minnesota River	Nicollet	06/26/1997
Carpsucker, River	3-15	19.5 / 14	Mississippi River	Ramsey	03/09/1991
Catfish, Channel	38-0	44 / n/a	Mississippi River	Hennepin	1975
Catfish, Flathead	70-0	n/a	St. Croix River	Washington	1970
Crappie, Black	5-0	21 / n/a	Vermillion River	Dakota	1940
Drum, Freshwater(Sheepshead)	35-3.2	36 / 31	Mississippi River	Winona	10/05/1999
Eel, American	6-9	36 / 14	St. Croix River	Washington	08/08/1997
Gar, Longnose	16-12	53 / 16.5	St. Croix River	Washington	05/04/1982
Gar, Shortnose	4-9.6	34.6 / 10	Mississippi River	Hennepin	07/22/1984
Goldeye	2-13.1	20.1 / 11.5	Root River	Houston	06/10/2001
Hogsucker, Northern	1-15	14.25 / 7 1/8	Sunrise River	Chisago	08/16/1982
Mooneye	1-15	16.5 / 9.75	Minnesota River	Redwood	06/18/1980
Redhorse, Golden	3-15.5	20.125 / 12.375	Root River	Fillmore	04/30/2007
Redhorse, Greater	12-11.5	28.5 / 18.5	Sauk River	Stearns Wing	05/20/2005
Redhorse, River	12-10	28.38 / 20	Kettle River	Pine	05/20/2005
Redhorse, Shorthead	7-15	27 / 15	Rum River	Anoka	08/05/1983
Redhorse, Silver	9-15	26.6 / 16 7/8	Big Fork River	Koochiching	04/16/2004
Salmon, Atlantic	12-13	35.5 / 16.5	Baptism River	Lake	10/12/1991
Salmon, Chinook (King)-tie	33-4	44.75 / 25.75	Poplar River	Cook	09/23/1989
Salmon, Chinook (King)-tie	33-4	42.25 / 26.13	Lake Superior	St.Louis	10/12/1989
Salmon, Pink	4-8	23.5 / 13.2	Cascade River	Cook	09/09/1989
Sauger	6-2.75	23 7/8 / 15	Mississippi River	Goodhue	05/23/1988
Sturgeon, Lake	94-4	70 / 26.5	Kettle River	Pine	09/05/1994
Sturgeon, Shovelnose	6-7	33 / 13-3/4	Mississippi River (Red Wing)	Goodhue	02/20/2012
Sucker, Blue	14-3	30.4 / 20.2	Mississippi River	Wabasha	02/28/1987
Sucker, Longnose	3-10.6	21 / 10.25	Brule River	Cook	05/19/2005
Sunfish, Hybrid	1-12	11.5 / 12	Zumbro River	Olmsted	07/09/1994
Trout, Brook	6-5.6	24 / 14.5	Pigeon River	Cook	09/02/2000
Trout, Rainbow (Steelhead)	16-6	33 / 19.5	Devil Track River	Cook	04/27/1980
Trout, Tiger	2-9.12	20 / 9 5/8	Mill Creek	Olmsted	08/07/1999
Walleye	17-8	35.8 / 21.3	Seagull River	Cook	05/13/1979
Walleye-Sauger Hybrid	9-13.4	27 / 17 3/4	Mississippi River	Goodhue	03/20/1999

Since then, many other agencies and constituent groups have become active participants in the stream management process **(Table 2)**. These conservation partners have identified a wide range of needs for rivers and streams and have demanded new monies to address these concerns.

Table 2. Some selected conservation partners and their programs that have increased involvement in the management of stream resources across Minnesota since 1993.

Conservation Partners	Program(s)	Selected Goals
U.S. Fish & Wildlife Service, Trout Unlimited, MNDNR	National Fish Habitat Action Plans and Partnerships *Driftless Area Restoration Effort, w/ Trout Unlimited *Fishers and Farmers *Great Plains Partnership	Enhance and restore stream habitat for fishes
MNDNR-Ecological and Water Resources Division	Stream Habitat Program	Maintain healthy functioning river systems that include each of five components
MN Pollution Control Agency	Impaired Waters and Total Maximum Daily Loads (TMDL)	Restore impaired waters and protect healthy watersheds to ensure they meet water quality standards and biotic goals
Minnesota-Trout Unlimited, Anglers for Habitat	Lessard-Sams Projects	Restore and enhance instream habitat for fishes
Minnesota Department of Agriculture	Agricultural Best Management Practices, Clean Water Legacy, Comprehensive Groundwater Protection	Help agricultural producers, homeowners, and industry operate with minimal impacts to water resources
U.S. Fish & Wildlife Service	National Fish Passage	Reconnect stream habitats fragmented by dams and road crossings
Minnesota Board of Water and Soil Resources (BWSR)	Erosion Control and Water Management Program, Native Buffer Program	Prevent sediment and nutrients from entering rivers and streams, enhance fish and wildlife habitat, protect wetlands
Red River Watershed Management Board	Flood Damage Reduction Projects	Basin-wide water management with an emphasis on flooding

Potential new funding sources to accelerate stream management in Minnesota include Clean Water Legacy funding, Outdoor Heritage funding, and National Fish Habitat Partnerships.

In addition, several conservation plans have also been developed that emphasize increased management of stream resources in Minnesota. For example, the MNDNR's Strategic Conservation agenda (2009-2013) specifically included an objective for conservation and enhancement of water resources and watersheds with performance measures quantifying the number of stream restoration projects completed and number of unsafe dams removed or modified. The Section of Fisheries developed a vision statement and strategic plan to guide aquatic habitat management that specifically noted the need to protect, enhance, and restore aquatic habitats in collaboration with partners that provide sustainable fishing and diverse native fish communities.

Cumulatively, these internal plans in conjunction with external partners and funding sources signal an opportunity to increase and enhance stream and river management in Minnesota (see Appendix 1 for some suggestions to enhance stream management). The traditional "Stream Management Plan" will play an important role in helping facilitate these actions. This Planning Guide is intended to help stream managers write a stream management plan. Thus, the primary audience of this planning guide is Area and Statewide Fisheries staff. Stream management plans can be flexible in scope and length **(Box 1)**, depending on Area office needs, but whenever possible, management plans should seek to identify specific areas where conservation partners and new funding sources can facilitate enhanced management of stream and river resources.

Resource managers have become increasingly aware of the importance of aquatic habitat; as aquatic habitat has been identified as degraded or impaired in many watersheds throughout the state. This increased focus on aquatic habitat has brought on new partners and funding sources, and future management plans should reflect this change in an effort to be more effective with our conservation partners. The 1993 Planning Guide emphasized the need to consider aquatic habitat, but primarily for determination of factors limiting gamefish abundance. Clearly articulating goals and objectives specifically for aquatic habitat conditions in plans was not mentioned.

Box 1

The Case for Flexibility

1) **Stream management has become more complex over the past 20+ years with enhanced quantification of some components such as hydrology and geomorphology. For example, completion of a full stream survey can result in data for almost 700 variables to be interpreted in the development of a management plan.**

2) **There are 28 Area Fisheries Offices across Minnesota. Each office has varying levels of staff expertise and accomplishes differing levels of stream management depending on prioritization and available resources.**

3) **This planning document is intended to provide sufficient guidance for the development of management plans written by such a diverse staff for a diversity of stream resources across the state, all within the context of a fluctuating set of priorities and resources.**

4) **Although this planning guide includes all components of streams that CAN be managed (e.g., hydrological, biological, sociopolitical), local priorities and staff expertise dictate how many of these WILL be managed.**

5) **Plan authors should note that not every riverine component and spatial scale suggested in this guide has to be addressed in every Management Plan. So, for example, management plans may be simple and brief for streams of low priority with little information or be long and detailed for high priority streams with lots of information available and used.**

The Stream Management Planning Guide committee recommends that specific emphasis on aquatic habitat be included in stream management plans, along with measurable objectives for fish community attributes. The committee acknowledges the need to maintain recreational fisheries as a high priority in management plans, but strongly encourages adoption of goals and objectives for aquatic habitat and fish communities as well.

This revision of the Stream Management Planning Guide also deviates from the 1993 Guide by recasting the need for identification of limiting factors. The concept of limiting factors implied that these aquatic systems are steady state and that simply enhancing a limiting factor might elicit a desirable response in some system attribute, usually gamefish abundance. Streams and rivers are inherently variable. Because of this, the committee recommends that managers strive to identify the range of conditions or measures that describe the background variation that managers would like to see maintained or achieved for a given stream or river. These “range-of-variation” targets should be identified whenever possible.

Finally, the committee sought to maintain consistency with the 2007 Stream Survey Manual by organizing stream management plans around the five components **(Box 2)**. Our intent is to facilitate a continual integration and holistic approach to stream management that includes identification and remediation of all the disturbances a stream might endure. Maintaining an organization outline around the five components should foster this approach, but the committee also recognized that there will be potential for considerable overlap among the five components when writing a management plan. Some redundancy is appropriate, because it will acknowledge the pervasive effects of some factors. However, too much redundancy may result in a poorly written plan. We leave the final determination of what to repeat to each plan author, as they will have the most knowledge about the particular system they are trying to manage. Authors may choose to reference other sections of the ARC as a way to reduce redundancy in the document. An example would be to describe watershed land use in the hydrology section, then reference that description in other relevant sections (e.g., geomorphology, water quality). Each section should still describe how land use has impacted that component, but would not repeat a detailed description of land use patterns in the watershed. A proposed stream management plan template follows and should serve as an outline for subsequent sections of this Stream Management Planning Guide.

Box 2

The Value of Redundancy: Three Spatial Scales

- Plan authors are purposely directed to think about management concerns at watershed, riparian, and instream scales for each of the five riverine components, plus a sixth component, social considerations. This may result in some redundancy which is important because it will:

1) compel authors to think critically about how the primary concerns interact among the riverine components and spatial scales.

2) ensure that management plans identify the most pervasive concerns, (i.e., those that affect the most components at the most spatial scales).

3) identify scales and which components where Fisheries has the most management influence.

4) highlight scales and components where Fisheries has limited control, and would be more effectively addressed by conservation partners.

5) assist in targeting actions at the correct spatial scale with conservation partners for efficient use of limited conservation funds.

6) give plan authors the freedom to emphasize important concerns, goals, objectives, and operational plans. Plan authors need the final say on what to include and what to leave out of any given stream management plan.

iv. Fisheries Stream Management Plan Form

Minnesota DEPARTMENT OF NATURAL RESOURCES

STREAM MANAGEMENT PLAN

Stream name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
Major Watershed:		Minor Watersheds (significant tributaries)		

Similar Reach	Reach name	Stream Miles	Length miles	Rosgen Channel Type	Fisheries Ecological Classification[1]	Species of Management Interest

Long Range Goals

Goal 1:
Objectives (Desired Future Conditions) and Operational Plans:
1. Objective 1
   - Operational Plan
2. Objective 2
   - Operational Plan
3. Objective 3
   - Operational Plan

Goal 2:
Objectives (Desired Future Conditions) and Operational Plans:
1. Objective 1
   - Operational Plan
2. Objective 2
   - Operational Plan
3. Objective 3
   - Operational Plan

Future Potential Plans
1. Potential Plan
2. Etc.

Area Specific needs
▪ ▪ ▪ ▪

Approvals

Plan Authors			
Area Supervisor	*Date*	*Regional Manager*	*Date*

An electronic copy of this form can be found on the shared network drive:

\\P:\FAW\Fisheries Information System\Stream Surveys\Stream Mgmt Planning Guide

STREAM MANAGEMENT PLAN – Page 1

Stream Name			Kittle Number		Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Region	Area Fisheries Office		Plan Managed Segment (river miles)		Length (miles) Plan Managed Segment	
Major Watershed:			Minor Watersheds (significant tributaries)			

Similar Reach	Reach Name	Stream Miles	Length (miles)	Rosgen Channel Type	Fisheries Ecological Classification	Species of Management Interest

Long-Range Goals

Goal 1:

Objectives (Desired Future Conditions) and Operational Plans:

1. Objective 1
   - Operational Plan
2. Objective 2
   - Operational Plan
3. Objective 3
   - Operational Plan

Goal 2:

Objectives (Desired Future Conditions) and Operational Plans:

1. Objective 1
   - Operational Plan
2. Objective 2
   - Operational Plan
3. Objective 3
   - Operational Plan

Future Potential Plans

1. Potential Plan
2. Etc.

Area-Specific Needs
▪   ▪   ▪   ▪

Approvals

Plan Authors			
Area Supervisor	*Date*	*Regional Manager*	**Date**

STREAM MANAGEMENT PLAN – Page 2

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	

BACKGROUND INFORMATION

Priorities-

Description of Stream System-

Past Surveys and Investigations-

Past Management-

ASSESSMENT OF RESOURCE CONDITION

Hydrology

General Description of Current Conditions-

Management Concerns (at each of three spatial scales)-

Watershed-scale Concerns:

Riparian-scale Concerns:

Instream-scale Concerns:

Management Recommendations for Hydrology-

Connectivity

General Description of Current Conditions-

Management Concerns (at each of three spatial scales)-

Watershed-scale Concerns:

Riparian-scale Concerns:

Instream-scale Concerns:

Management Recommendations for Connectivity-

STREAM MANAGEMENT PLAN – Page 3

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	

Geomorphology and Fish Habitat

General Description of Current Conditions-

Management Concerns (at each of three spatial scales)-

Watershed-scale Concerns:

Riparian-scale Concerns:

Instream-scale Concerns:

Management Recommendations for Geomorphology and Fish Habitat-

Water Quality

General Description of Current Conditions-

Management Concerns (at each of three spatial scales)-

Watershed-scale Concerns:

Riparian-scale Concerns:

Instream-scale Concerns:

Management Recommendations for Water Quality-

Biology

General Description of Current Conditions-

Management Concerns (at each of three spatial scales)-

Watershed-scale Concerns:

Riparian-scale Concerns:

Instream-scale Concerns:

Management Recommendations for Biology-

STREAM MANAGEMENT PLAN – Page 4

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	

Social Considerations

General Description of Current Conditions-

Management Concerns (at each of three spatial scales)-

Watershed-scale Concerns:

Riparian-scale Concerns:

Instream-scale Concerns:

Management Recommendations for Biology-

1. Overview

1A. Stream Management Planning Framework

Stream management begins with identification of which streams to manage (**Figure 2**). Because stream management has been ongoing in Minnesota since at least the first half of the 20th century, many streams have existing survey data and/or management plans developed. This implies that streams and rivers have been informally prioritized for management by MNDNR Fisheries (i.e., streams with current management plans already have a higher priority than streams without management plans). Given this informal prioritization, streams and rivers can be placed into two broad groups: “actively-managed” streams, and “passively-managed” streams. Actively-managed streams are those with a management plan. Passively-managed streams may lack an active management plan, but are still of concern to MNDNR Fisheries staff. These streams will be considered to be managed passively, in the sense that, they will still be evaluated for environmental review concerns or may receive management actions implemented by other groups. MNDNR Fisheries will also conduct work as opportunities arise (i.e., these streams will not be intentionally ignored by MNDNR Fisheries).

Four categories are also proposed to help organize stream survey work in conjunction with these two broad groups: Fishery and Stream Management, Targeted Evaluations, Long-Term Monitoring, and Statewide Spatial Trends. Most will apply to actively-managed streams but some may be applicable to passively-managed streams. (**Figure 3**). These four categories represent “why” streams are sampled (**Figure 3**). There are also three types of stream surveys, Initial Survey, Full Survey, and Supplemental Survey listed in the Stream Survey Manual (MNDNR 2007). Initial and Full Surveys are similar to traditional approaches whereas Supplemental Surveys represent any other type of survey needed (e.g., a survey of just fishes as in a traditional Population Assessment, or a survey of habitat to evaluate a habitat improvement project). Initial, Full, and Supplemental surveys represent “how” to sample streams given the four “why” categories.

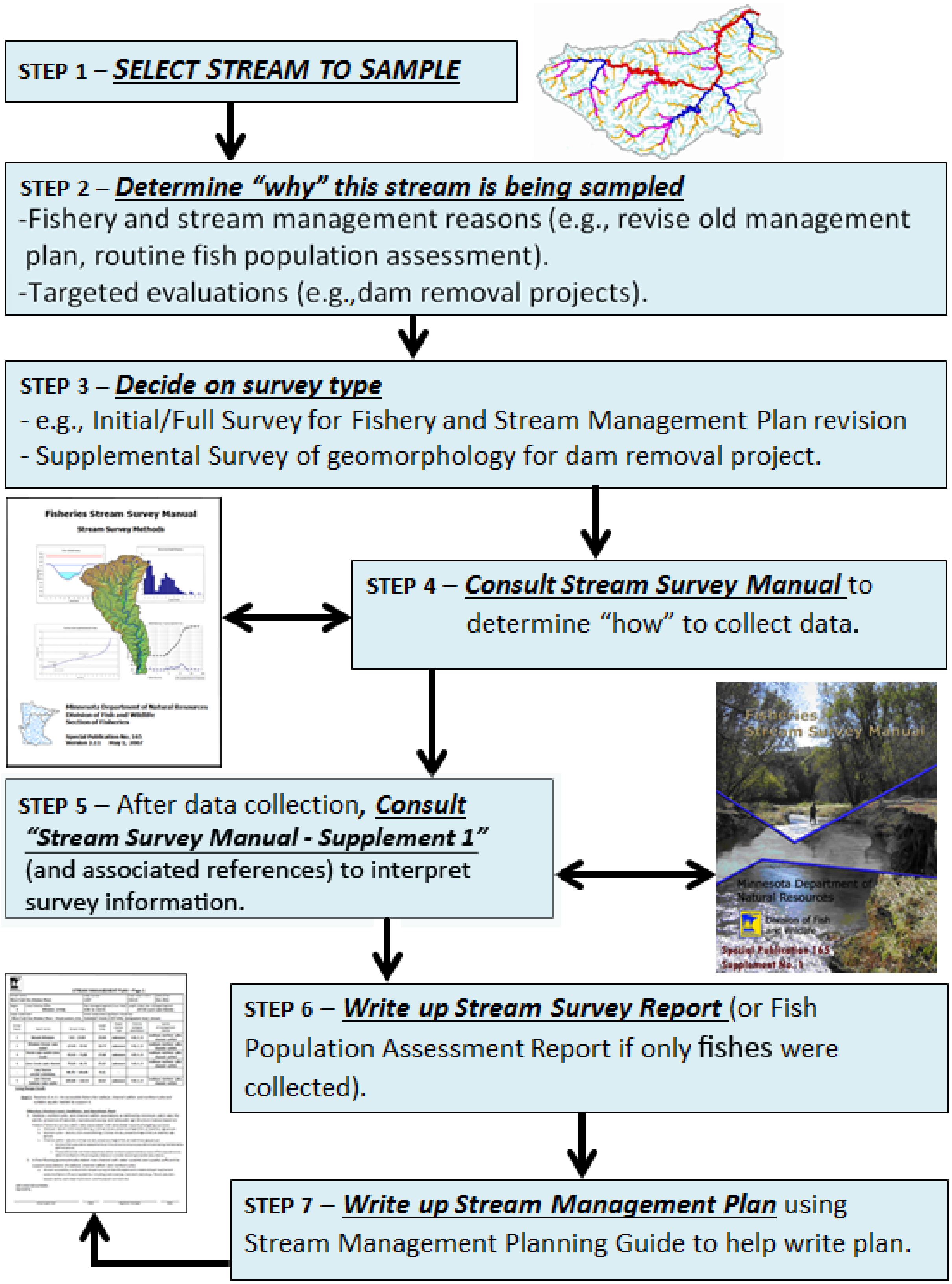


Figure 2. Stream management planning is a series of steps including selecting a candidate stream, determining objectives, collecting data, writing a stream survey report, and developing a fisheries management plan.

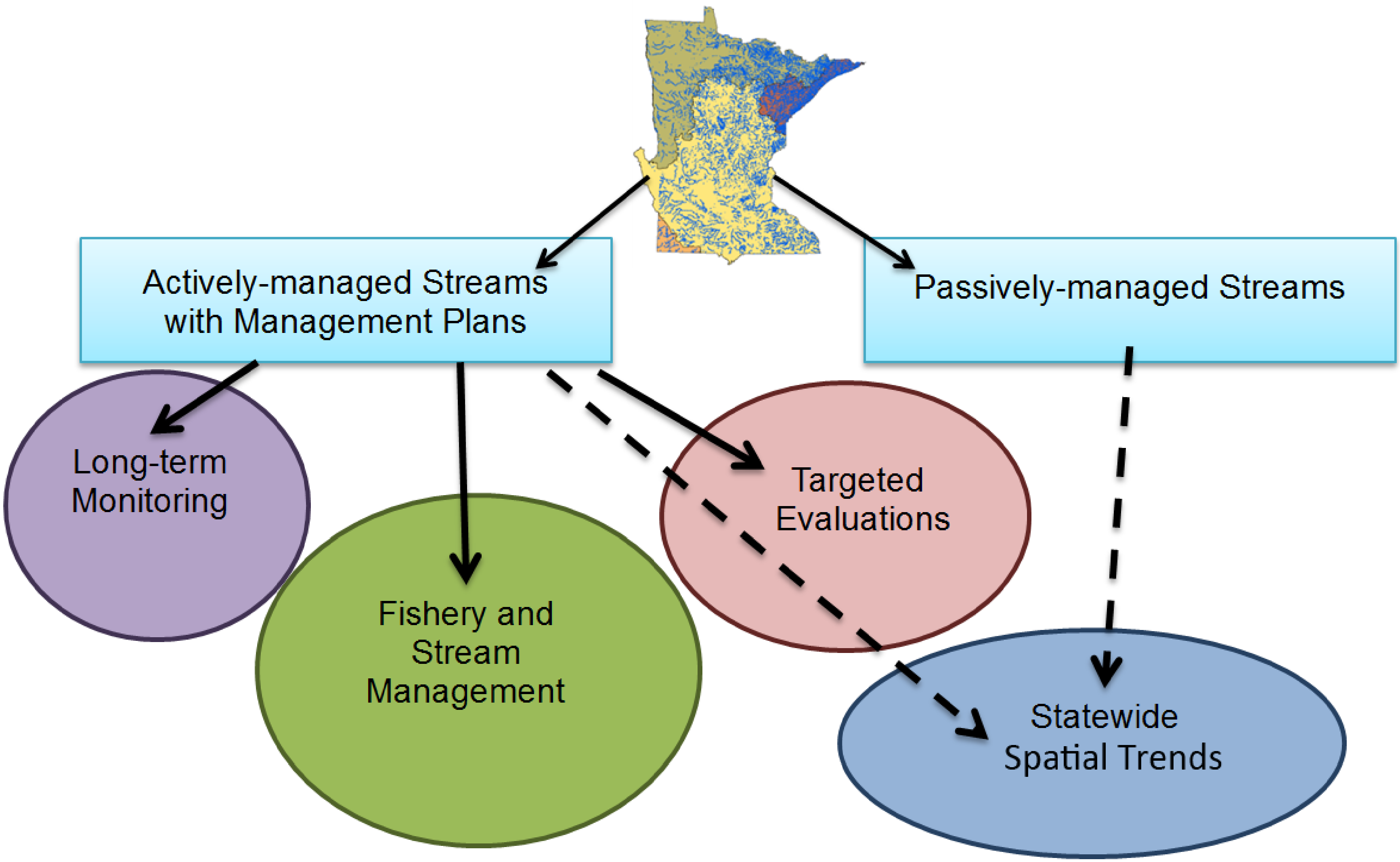


Figure 3. Proposed planning framework for managing streams and rivers in Minnesota. All streams can be placed in one of two broad groups, actively- or passively-managed streams. All actively-managed streams will have a stream management plan. Sampling of all streams, statewide, will be primarily for one of four purposes: fishery and stream management, targeted evaluations, long-term monitoring, or assessment of statewide spatial trends.

- Fishery and Stream Management. These surveys will be performed to either (1) develop a “new” management plan (i.e., for a stream with no existing plan), (2) to revise an existing stream management plan (e.g., resurvey), (3) to routinely assess fish populations if specified in a current management plan (e.g., annual checks of natural reproduction), or (4) to provide information needed to communicate with various stakeholders, often for questions on recreational angling opportunities (e.g., old population assessment primarily for social reasons; such “population assessments” should be dictated in an existing stream-specific management plan). Variables to be measured will likely be specified in management plans if a current plan exists.

- Targeted Evaluations. These are typically stream-specific investigations to assess specific management actions such as pre- and post-evaluation of aquatic habitat projects, dam removal, stocking, angling regulations, etc. These may or may not be identified in stream management plans and will depend on the chronology of the particular management action relative to the most recent management plan update. The goal of targeted management evaluations will be to determine the success or failure of a particular management action on a particular stream.

- Long-term Monitoring. These are selected streams that have been identified for annual sampling for many years. Goals of long-term monitoring streams can include to (1) better understand how fish populations are influenced by annual changes in aquatic habitat conditions; and (2) determine how these inter-relationships themselves are influenced by changes in climate, land use, and the establishment and proliferation of invasive species. This information will be critical to help guide management efforts on other streams as environmental conditions change. As of 2011, this category is only being implemented on specific streams of regional importance (e.g., southeast Minnesota trout streams), but may be expanded to other locations. Such long-term streams may be a lotic analogy to the sentinel lakes in the SLICE program. The Minnesota Department of Agriculture is similarly investigating the need to establish sentinel watersheds to better understand the processes that affect water quality in aquatic systems across Minnesota.

- Statewide Spatial Trends. The goal of this category is to characterize statewide (or possibly just regional) trends in fish populations and aquatic habitat. This category differs from long-term monitoring streams in that a random sample of different streams will likely need to be selected each year to provide an unbiased assessment of trends at this larger spatial scale. This group of streams would be analogous to the spatial components of the split-panel sampling design suggested by the SLICE program. However, as of 2013, there is no such statewide MNDNR sampling program established for streams and this category is only presented here in the event such a program element is implemented in the future. In Minnesota, the MPCA is currently serving this function through their HUC-8 Watershed/Stream sampling program.

Schedules for fishery and stream management, targeted evaluations, or long-term monitoring surveys will probably be included within the Operational Plan. Scheduled statewide spatial trend monitoring by MPCA can also be noted.

1B. Process to Complete a Stream Management Plan

1) ***First, identify streams to be actively-managed based on Area or Regional needs*** (i.e., streams needing either an initial management plan or an update of an existing plan).

2) ***Compile and complete Background Information.***

a) *Fill out the table at the beginning of plan record:*

Stream Name – Enter the full name of the stream. This is usually the name found in the MNDNR GIS Quick Layers data table, "Stream Routes with Kittle Numbers and Mile Measures" (hereafter referred to as the MNDNR GIS Stream data layer). Common alternate names can be added in parentheses after the *Stream Name.* For stream management plans that address multiple streams/tributaries, enter the name of the primary stream being addressed. Additional tributaries can be specified in the *Minor Watersheds* box and in the plan body.

Kittle Number – Enter the Kittle ID Number, which can also be found in the MNDNR GIS Stream data layer. The Kittle Number should be entered in the 3-digit format, e.g., "M-009-029." If there is question as to the accuracy of a Kittle Number, or a Kittle Number has not been assigned to a stream, you should contact MNDNR Fisheries GIS staff and request a Kittle Number. For more information on the Minnesota Stream Identification System (Kittle Number), refer to Appendix 3 in the Fisheries Stream Survey Manual (MNDNR 2007).

Total Miles in Minn. – Enter the total length of the stream main channel within Minnesota borders. For most streams, this is the length in miles calculated from the MNDNR GIS Stream data layer, from source to mouth. Include the total stream length even if it crosses multiple area boundaries. For streams that cross Minnesota borders, enter only the stream miles found in Minnesota. Stream miles should usually be estimated to the nearest one hundredth of a mile (2 decimal points, e.g., 24.95 miles).

Date of Plan (Mo.-Yr.) – Enter the month and year that the management plan received final approval by regional staff. This date usually corresponds to the signature date of the regional fisheries manager.

Region – Enter the Regional Number associated with the area fisheries office that authored the stream management plan.

Area Fisheries Office – Enter the name and identification number of the area fisheries office that authored the stream management plan, e.g., “Finland Area (F215).”

Plan Managed Segment (river miles) – For streams that are located entirely within an Area Fisheries Office boundary, this would usually be the entire stream length from source to mouth (e.g., mile 0.00 – mile 24.95). For streams that cross area Fisheries borders and have multiple management plans for different stream segments, enter the identifying river miles for the segment that is being addressed in the current management plan. In other cases, especially on larger streams and rivers, staff may author separate management plans for specific segments/reaches, even if these segments are within the same fisheries management area. In these cases, specify only the stream segment associated with the current management plan. River miles are best estimated by using the latest MNDNR GIS Stream data layer.

Length (miles) Plan Management Segment – Enter the length in miles of the stream segment the current plan is being written for, to the nearest hundredth of a mile (e.g., 4.25 miles). Stream channel lengths are usually calculated using ArcGIS tools with the MNDNR GIS Stream data layer (DNR Stream Routes with Kittle Numbers and Mile Measures).

Major Watershed – Enter the name of the MNDNR major watershed that the stream is located in, along with the two-digit ID number found in the MNDNR GIS Stream data layer “DNR Watershed Suite.” The major watershed is assigned to the “DNR Level 04 – HUC 08 – Majors” data table. For example, “Root River (43).”

Minor Watersheds (including significant tributaries) – Enter the DNR minor watershed ID numbers and minor watershed names of the stream channel and any significant tributaries that may be referred to in the stream management plan. These can be located using the MNDNR ArcGIS Watershed Suite, specifically the “DNR Level 07 – Minors” data layer. For smaller streams, this may be 1-5 minor watersheds and associated tributaries. For larger streams, entering the entire list of minor watersheds and tributaries impacting the stream may not be feasible. In this case, list the minor watersheds with higher management priority.

Similar Reach – Enter the data elements associated with the current DNR Fisheries Similar Reach designation, usually found in the latest Fisheries stream survey report. If there are multiple similar reach sets found in past surveys, clarify which similar reach designation was used in the current management plan. Refer to the Initial Survey – Hydrology section of the Fisheries Stream Survey Manual (MNDNR 2007) for additional information on identifying and assigning similar reaches.

Enter the number assigned to the similar reach, usually a numeric code, e.g., 1, 2, 3, etc. In some cases past similar reaches have been split into multiple similar reaches, resulting in ID numbers such as 1A, 1B, etc.

Similar Reach Name – Enter the name assigned to the similar reach. In some cases these are often short descriptions, such as "Downstream of Bucksnort Dam." If no names have been assigned, leave blank.

Stream Miles – Enter the lower and upper stream river miles that define the boundaries of the similar reach. These can be estimated from the MNDNR GIS Stream data layer. *Stream miles* should be estimated to the nearest hundredth of a stream mile (two decimal points, e.g., 11.04 – 17.05). (Note: X-Y coordinates or UTMs defining similar reaches should be maintained on file in the event the MNDNR GIS Stream data layer is modified or updated).

Length (miles) – Enter the calculated length of the similar reach using the similar reach lower and upper river miles, usually to a hundredth of a mile (two decimal points).

Rosgen Channel Type – Enter the primary Rosgen Channel Classification for the specific similar reach, usually found in the latest full stream survey. If multiple channel types are associated with the similar reach, enter all. This is usually the Rosgen Level I or Level II channel classification (refer to MNDNR 2007, adapted from Rosgen 1996). If the *Rosgen Channel Type* is unknown or undetermined, leave blank.

Fisheries Ecological Classification – List the primary fisheries ecological classification ID number and class name for the similar reach, e.g., "1A-Wild Trout." Refer to Appendix 4 for a list of classes and class definitions.

Species of Management Interest – List the common names of fish species that have fisheries management priority in the similar reach. If there are more than three species, use the three-digit code for fish species, which can be found in the Fisheries Lake and Stream Database.

b) *List potential reasons why this stream is a* ***<u>Priority</u>*** *for management by Area or Regional staff*. Reasons can be extremely varied and might include recreational importance (and types of recreation-swimming, fishing, canoeing, hunting, etc.), presence of state or county parks, designated trout stream, impaired-waters designation, unique aesthetic qualities, good candidate for habitat restoration or enhancement (dam removal, road crossings, instream projects, channel restoration), naturally reproducing populations of key species (e.g., lake sturgeon, walleye, rare or imperiled species), presence of invasive species, etc. Appendix 3 provides additional information on factors to consider and questions to ask when prioritizing streams.

c) *Provide a general* ***Description of the Stream System***. This description should be very general and may provide information on stream length, where the stream originates, information on major tributaries, watershed land uses, unique features, and any other information that Area staff thinks needs to be placed here.

d) *Provide a description of* ***Past Surveys and Investigations***. This information should include the dates and descriptions of each type of survey completed from MNDNR Fisheries and any other relevant agencies (e.g., MNDNR-EcoWaters, MPCA).

e) *Provide a description of* ***Past Management*** *actions such as previous management plans* (and their goals and objectives, especially if they were not met and if they will be modified in the current plan), *angling regulations* (including if they have been dropped and why), *stocking,* and *habitat work.*

3) ***Assess Current Resource Conditions*** based on some form of stream survey (see current Stream Survey Manual for options). Whenever possible, *Current Resource Condition* should be assessed for each of five components (hydrology, geomorphology/physical habitat, water quality, connectivity, and biology). A sixth component, social considerations, should also be considered. For each component provide the following:

a) *A* ***General Description*** *of current resource conditions should be provided*.

b) *From the general description, any* ***Management Concerns*** *present should be identified* at each of three spatial scales amenable to management: Watershed, Riparian, and Instream.

c) ***Management Recommendations*** *should then be formulated to address Management Concerns.*

d) Given all historical and current information, draft ***Goals, Objectives, Operational Plans, and Future Potential Plans* for the stream or river**. Staff should note that Goals, Objectives, Operational Plans, and Future Potential Plans will be placed at the beginning of the management plan document, even though they may be formulated after completing the ***Background Information*** and ***Assessment of Resource Conditions*** sections.

The next sections of this guide provide more detail on the types of information to include in the Assessment of Resource Condition sections. Staff are also encouraged to review the example Stream Management Plans (pages E1–E67) for even more clarification on types of information that could be included in stream management plans.

2. Assessment of Resource Condition (ARC)

The Assessment of Resource Condition (ARC) is a ***summary*** of all available and pertinent data to (a) describe the current state of the stream and its watershed; (b) identify any resource concerns (e.g., overexploited fish populations, unstable stream reaches, altered hydrology, impaired water quality, recreational user conflicts, etc.), and (c) determine if any critical information is missing. Resource concerns can be organized into one of three spatial scales to facilitate management options: watershed-scale, riparian-scale, and instream-scale (see **Box 2**). This information is then used to:

1) *Formulate the **Goals and Objectives** of the management plan, and*
2) *Recommend potential management actions to implement **Operational Plans, Future Potential Plans.***

ARC information can be collected by MNDNR Fisheries staff or from data collection activities of outside agencies and sources. Information collected by MNDNR Fisheries will most likely come from stream surveys conducted following the current Stream Survey Manual (MNDNR 2007). Although a Full Stream Survey following this manual will provide the most comprehensive information for Assessment of Resource Condition, managers should recognize that given time and budgetary constraints, they may also elect to survey only selected components of streams due to an immediate management need. Such partial surveys may include either Initial or Supplemental Surveys. See MNDNR (2007) for more information regarding these types of surveys. Most information following the current MNDNR Fisheries Stream Survey Manual and associated Assessment of Resource Condition should be presented in the Stream Survey Report following a stream survey, and only summarized information should be placed in the stream management plan.

Numerous additional data sources may be available (see **Table 3**) and managers are strongly encouraged to search for and use such information in preparation of their management plans. This should also help managers identify potential opportunities for collaborative partnerships to achieve mutual goals and objectives. However, the information in the management plan should typically be information already summarized by other agencies or groups (cite references), or by MNDNR Fisheries either in the Stream Survey report or else maintained in Area Office files.

All stream information acquired should be summarized and presented in the Stream Management Plan under the heading "Assessment of Resource Condition." This assessment should be organized around the five components regulating rivers and streams: Hydrology, Connectivity, Geomorphology and Fish Habitat, Water Quality, and Biology (MNDNR 2007). An additional sixth component, Social Considerations, may also be included if desired. Within each component should be three primary sections:

1) ***General Description of Current Conditions***,
2) ***Assessment of Management Concerns*** (at each relevant spatial scale-watershed, riparian, and instream), and
3) ***Management Recommendations***.

Assessment of Resource Condition summaries should also identify any information gaps in each of the components. Brief descriptions and examples of types of information to include in the ARC for each of the five components follows. These examples are provided but do not represent a list in its entirety. ***These examples serve as a starting point to get managers thinking about how the current conditions of the resources in their area may be a cause for management concern and what can be done to address various concerns in their watershed.*** Refer also to relevant sections in the *Stream Survey Manual Supplement 1* for help interpreting the stream survey data collected.

Table 3. List of potential agencies and groups that collect or have collected stream information across Minnesota. Streams managers are strongly encouraged to search for other available data sources during preparation of their management plans.

Agency	Potential Components	Website/Contact Info
Minnesota Pollution Control Agency	Water Quality, Geomorphology, Biology	http://www.pca.state.mn.us/water/index.html
U.S. Geological Survey	Hydrology	http://waterdata.usgs.gov/mn/nwis/ http://mn.water.usgs.gov/
Minnesota Board of Water and Soil Resources (BWSR)	Hydrology, Connectivity	http://www.bwsr.state.mn.us/directories/index.html
MNDNR-Division of Ecological and Water Resources	Hydrology	http://www.dnr.state.mn.us/waters/surfacewater_section/stream_hydro/products.html
MNDNR-Division of Ecological and Water Resources	Hydrology, Connectivity, Water Quality, Geomorphology, Biology	*Watershed Assessment Tool:* www.dnr.state.mn.us/watershed_tool/index.html *Stream Habitat Program:* http://www.dnr.state.mn.us/eco/streamhab/about.html
NOAA-National Weather Service	Hydrology	http://www.crh.noaa.gov/ncrfc/
U.S. Army Corps of Engineers-St. Paul District	Hydrology	http://www.mvp-wc.usace.army.mil/
Duluth streams.org	Hydrology, Water Quality	http://duluthstreams.org/streams/stream_data.html
Natural Resources Conservation Service (NRCS)	Hydrology, Connectivity	http://www.mn.nrcs.usda.gov/
MN Department of Agriculture	Water Quality, Hydrology	http://www.mda.state.mn.us/protecting.aspx
Soil and Water Conservation Districts; Watershed Districts	Water Quality, Hydrology	Varies by county.
UMN-BioProducts and BioSystems Engineering Department	Hydrology, Water Quality, Geomorphology	http://www.bbe.umn.edu/ExtensionandOutreach/EnvironmentandEcology/index.htm
UMN-Soil, Water and Climate Department	Hydrology, Water Quality, Geomorphology	http://www.swac.umn.edu/index.htm

3. ARC-Hydrology

Arguably the driving force behind all river processes is hydrology. Consequently, stream resources cannot be managed without, at a minimum, conceptually understanding the hydrology of a system at various scales. Stream Management Plan authors are encouraged to review appropriate sections in the *Stream Survey Manual* (MNDNR 2007, Chapter 1, Hydrology) and *Stream Survey Manual Supplement 1* (MNDNR 2013, Initial and Resurvey sections) for help interpreting hydrologic data for the ***General Description of Current Conditions***, assessing ***Management Concerns***, and formulating potential ***Management Recommendations*** to alleviate concerns.

3A. ***General Description of Current Conditions (Hydrology)*** – In this section of the Stream Management Plan, authors are encouraged to provide a general description of the hydrology of the stream. This information can be for the stream or watershed as a whole, or for specific reaches. The types of information presented in this section might include:

1) stream order
2) number and location of tributaries, especially tributaries contributing significant flow or that are designated trout streams
3) stream length
4) number and location of springs, seeps, instream sinks
5) locations and period of record of stream gages
6) where and when most flow originates (e.g., groundwater, overland flow, spring snowmelt-driven, or summer precipitation)
7) number and location of dams, levees, and channelized reaches
8) land use patterns in the watershed that might influence hydrology, such as abundance of wetlands, ditches, or drain tiles
9) water use/needs (e.g., water allocation and use descriptions).

If more advanced hydrological assessment techniques, such as baseflow hydrograph separation or use of the Indicators of Hydrologic Alteration software (see *Stream Survey Manual Supplement 1,* Chapter 1 Hydrology) were completed, their results should have been interpreted and summarized in the stream survey report, but their summaries should be placed in this section.

There are five primary elements to characterize the hydrology of a stream: (1) magnitude, (2) duration, (3) timing, (4) frequency, and (5) rate of change of high and low flow events (e.g., floods and droughts for stream flows or precipitation patterns) or of specific levels (e.g., bankfull flows in cfs**; Figure 4**). Authors of Stream Management Plans and Stream Survey Reports should attempt to characterize their stream's hydrology around these five elements.

***Management Concerns (Hydrology, at each of three spatial scales)*:** Broadly speaking, management concerns should identify any factor that changes any of the five hydrology elements listed above: magnitude, duration, timing, frequency, and rate of change of high and low flow events **(Figure 5)**. Alternatively, insufficient information may also be cited as a management concern.

3B. ***Watershed-scale Concerns (Hydrology)*:** Watershed-scale concerns influence all smaller scales, and often cumulate to impact larger watersheds. Land -use characteristics (e.g., number of wetlands in a watershed, amount of impermeable surfaces, percent of watershed in forested cover) and associated changes (e.g., wetland drainage, urban development, and forestry practices) regulate the delivery of water to the stream. Thus, many watershed-scale concerns may identify land use characteristics and land use changes that have altered water delivery to the stream resulting in changes to the magnitude, duration, timing, frequency, and rate of change of high and low flows. Changes to these five elements forces concomitant changes to downstream channel stability resulting in other geomorphic, water quality, and biotic adjustments. Increased delivery of water to the stream channel can also result in decreased recharge of groundwater supplies.

3C. ***Riparian-scale Concerns (Hydrology)**:* Most riparian-scale concerns also focus on land use characteristics and changes, but just within the riparian corridor. Potential land use concerns discussed above at the watershed scale, also apply to riparian zones. Of particular concern in riparian zones might be land use changes or urban development (or proposed developments) on or near significant water sources, such as springs or seeps. Other potential concerns include local water table impacts, and the presence of levees which might alter the pattern of flooding. Levees and loss of floodplains will also be riparian-scale concerns noted for stream connectivity.

3D. ***Instream-scale Concerns (Hydrology)**:* Primary instream-scale concerns would include the presence and operation of dams, presence of road crossings and culverts, and excessive water withdrawal appropriations, such as for irrigation or municipal water supplies. Many smaller-scale water-withdrawal operations, such as from irrigation, could also reduce aquifers, resulting in lower baseflows (i.e., lower magnitude of low flows). Alternatively, allocation permits may only be seasonal in nature, whereas in others an annual permit with a continuous withdrawal might be authorized. Both conditions could disrupt the timing of low flow events. Other potential instream-scale concerns that might be noted would include locations and lengths of channelized stream reaches that speed water delivery, beaver dams that impound water, and point-source discharges from municipal and industrial sources.

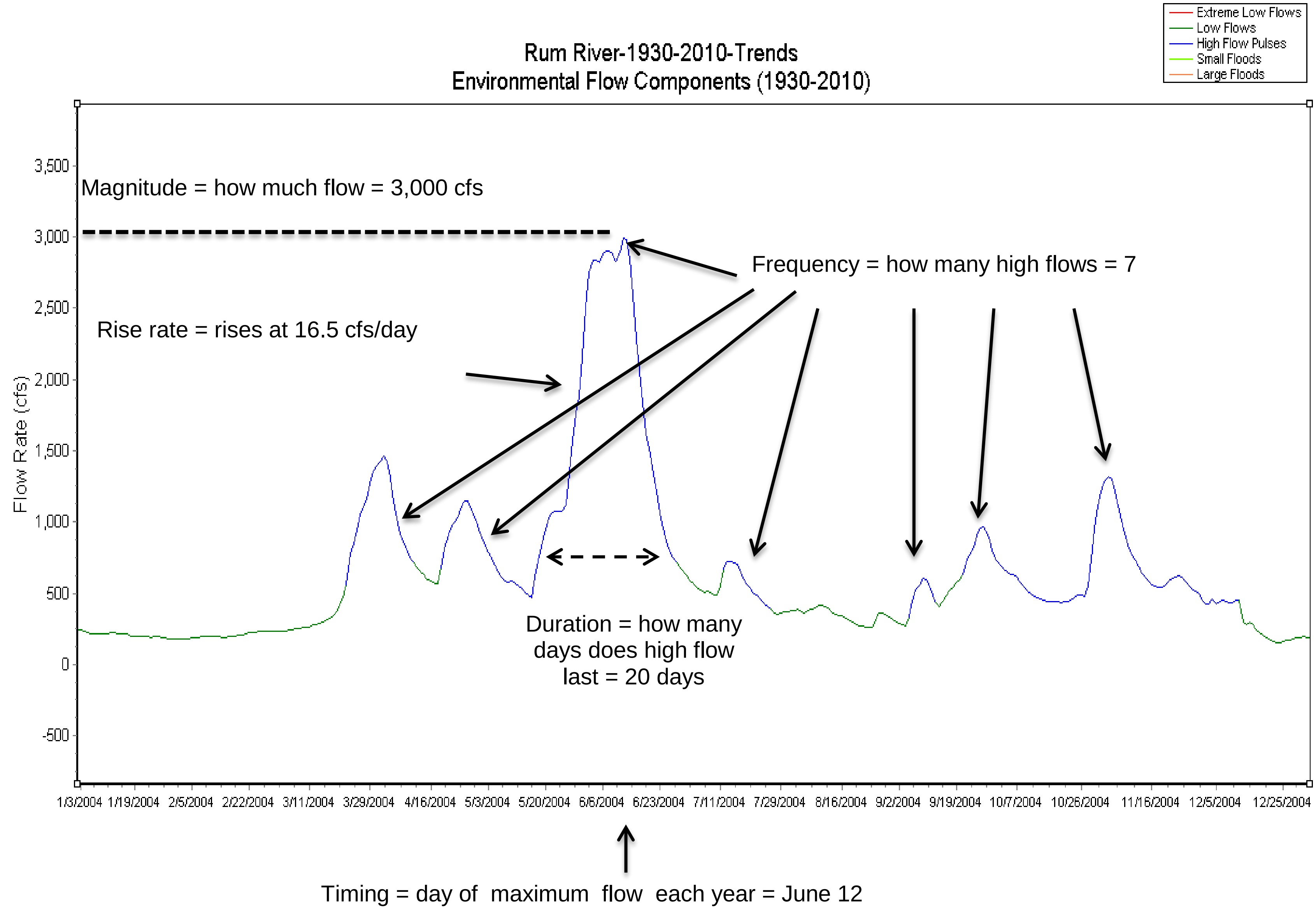
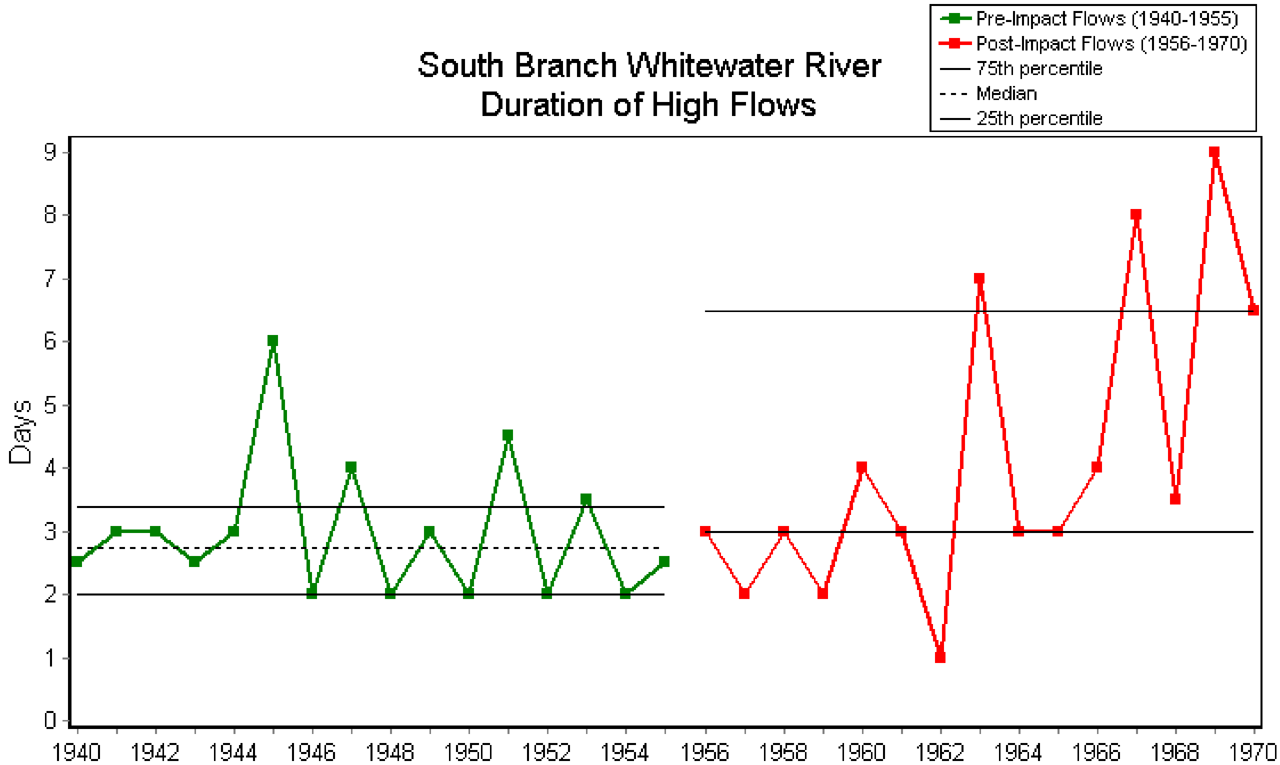


Figure 4. Discharge in the Rum River (M-063), Minnesota in 2004 showing the five primary elements of hydrology for high flow events in this year: magnitude, duration, timing, frequency, and rate of change (only rise rate shown here). Note similar elements could be generated for low flow events.



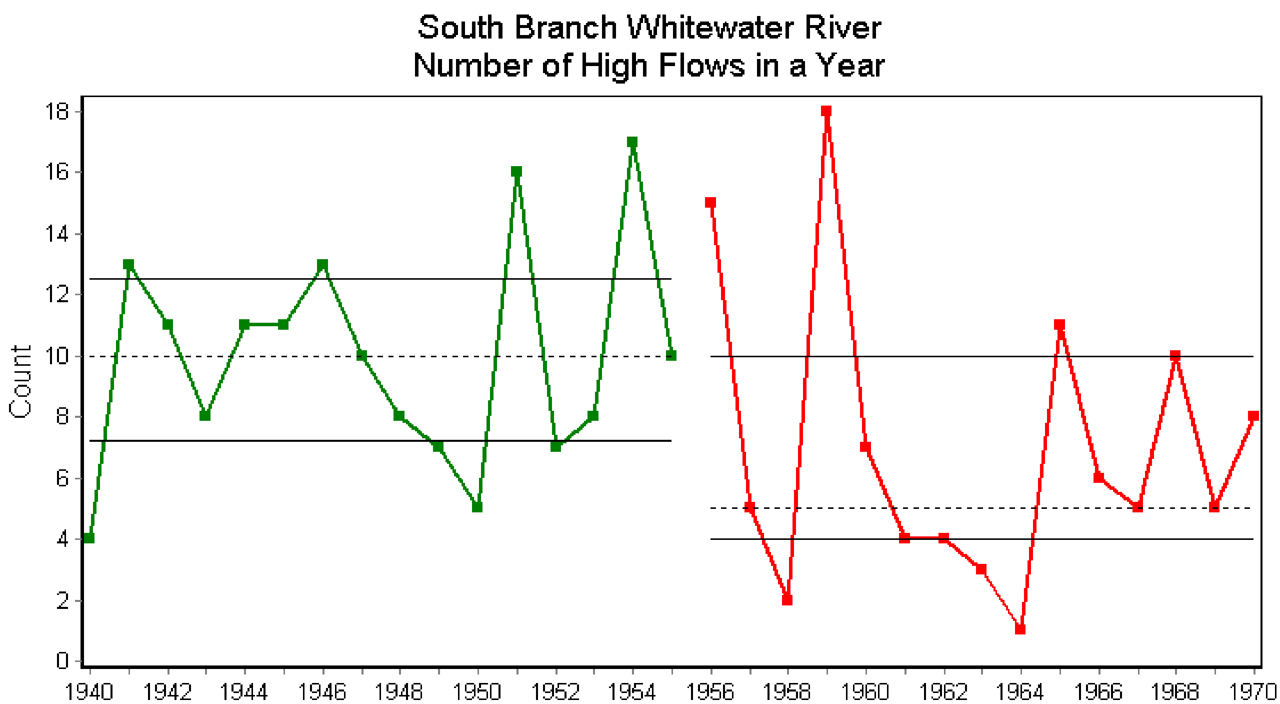


Figure 5. Selected hydrological changes in the South Branch Whitewater River (M-031-017). Top graph shows that before 1955, high flows lasted between 2 and 3.3 days (25^{th}-75^{th} percentiles) whereas after 1955, high flows lasted on average between 3 and 6.4 days. Bottom graph shows that the number of high flow events has decreased between the two time periods. Before 1955, there were about 7-12 high flow events each year but about 4-10 events each year after 1955.

3E. ***Management Recommendations (Hydrology):*** Management recommendations will be varied depending on management concerns identified. However, because many concerns will be dictated by land use changes at the watershed and riparian scales, actions to identify, protect, enhance, and restore key landscape features may be common to many management plans. Key landscape features may include wetlands (and associated drain tiles), sink holes, springs, seeps, impervious surfaces, and forested or shrub lands (especially as riparian buffers). The best approach to managing these watershed- and riparian-scale concerns may be to become active in land use management planning through partnerships with other agencies (e.g., MPCA, SWCD, MNDNR-Division of Wildlife, etc.), local government units, and conservation partners, such as Ducks Unlimited, Pheasants Forever, etc. The role of MNDNR Fisheries will probably be varied, but may include identification of key locations in the watershed for habitat protection, enhancement, or restoration by other conservation partners. For example, key wetland areas or sink holes might be identified for other groups to purchase or protect through conservation easements or as wildlife management areas. In riparian zones, key spring sources or riparian areas might be targeted for protection as Aquatic Management Areas.

At the instream-scale, management recommendations may identify key road crossings requiring modification, or channelized reaches that would benefit from stream restoration practices. Recommendations to modify or remove instream dams, including beaver dams, will be other obvious management actions to consider implementing. Dam operations that have modified magnitude, duration, timing, frequency, or rate of change of high and low flows, may require recommendations to dam operators to restore these characteristics, including through the Federal Energy Regulatory Commission (FERC) relicensing process for dams used in power generation. Improved scrutiny of MNDNR-administered water allocation permits might also be warranted.

4. ARC-Connectivity

Connectivity throughout river systems is important to maintain the flow, exchange, and pathways of organisms, energy, and matter among locations to provide a healthy self-sustaining and functioning river, with associated societal benefits (Annear et al. 2004). Critical items that move among riverine habitats include fishes, water, sediment, organic matter, and nutrients. Management plan authors are encouraged to review the Connectivity Section under Initial Survey Chapter in the *Stream Survey Manual* (MNDNR 2007), and Chapter 5 in *Stream Survey Manual Supplement 1* (MNDNR 2013) for help interpreting connectivity data.

There are four primary dimensions that characterize connectivity: longitudinal, lateral, vertical, and temporal. Longitudinal connectivity commonly characterizes upstream-downstream linkages, both within the stream (i.e., upstream-downstream) and from the upstream watershed (e.g., overland flow of water and sediment from the watershed). Lateral connectivity usually refers to movement and exchanges between the stream and its riparian zone or floodplain. Vertical connectivity often is defined by exchanges between the instream water column and the hyporheic or phreatic zones. The temporal dimension refers to connections through time. Both future stream conditions and historical context can be considered elements of the temporal dimension.

When considering connectivity conditions within a stream system, invasive species issues may influence the desire to maintain connectivity throughout. If invasive species are a concern, the ARC for connectivity within the management plan should discuss the relative costs and benefits to native species and aquatic habitat from an existing or proposed reduction in connectivity. Refer to Chapter 5 of the Stream Survey Manual, Supplement 1 (MNDNR 2013) for more discussion of this issue.

4A. ***General Description of Current Conditions (Connectivity)***: In this section of the management plan, authors should provide a general description of connectivity aspects of the stream. Connectivity information noted in this section may include (a) location and number of dams (including beaver dams), channelized reaches, road crossings, and natural barriers (e.g., waterfalls), (b) water quality barriers (e.g., low dissolved oxygen, thermal barriers, contaminants), (c) point-source water discharges, (d) locations of water withdrawals (some withdrawals may render riffles too shallow for fish passage or may impact vertical connectivity), (e) presence and height of riparian zone levees, (f) biological barriers (e.g., invasive species), and (g) any significant lengths of uninterrupted connectivity (i.e., identification of good connectivity sources to possibly target for protection).

Management Concerns (Connectivity, at each of three spatial scales):

Any factor that disrupts or fragments any of the four dimensions of connectivity is potentially a management concern. Although not entirely appropriate, authors may consider organizing three of the dimensions into the three spatial scales as: longitudinal is primarily a watershed-scale feature, lateral is primarily a riparian zone feature, and vertical may primarily be an instream feature, with temporal connectivity being a feature of all three scales. However, some features, such as dams, transcend all three scales and all four dimensions.

4B. ***Watershed-scale Concerns (Connectivity)****:* Connectivity concerns at the watershed scale may be primarily longitudinal. Land use changes that interrupt hydrological processes (see ARC-Hydrology section) can also constitute connectivity concerns at the watershed scale. The cumulative effect of multiple instream-scale barriers described above, such as multiple dams or road crossings **(Figure 6)**, can also constitute a watershed-scale concern. Finally, channelized reaches hasten the flow of water, sediments, and nutrients downstream and decrease habitat complexity.

Figure 6. Improperly designed or placed box culverts at road crossings can result in barriers to fish movement, and loss of connectivity in riverine systems.

Many times when trying to identify watershed-scale connectivity concerns, it becomes apparent that examining the entire major watershed results in identification of more general or qualitative concerns, such as land use practices in general. Parceling the major watershed into several sub-basin scales may help managers critically evaluate primary concerns, quantify their influence, and aid prioritization of future management efforts.

4C. ***Riparian-scale Concerns (Connectivity)****:* Riparian-scale concerns usually involve disruptions of lateral connection between the stream and its floodplain. Common concerns include the presence and height of levees, or possibly river terraces that may have resulted from geomorphic processes associated with unstable channels. A reduction in the width of the floodplain might be a concern. Land use practices within the riparian zone or floodplain, such as logging operations, drainage (tile or ditching), row cropping, or urban development, may disrupt the flow of nutrients or interfere with water flow from springs or seeps. Finally, excessive water appropriations located near the stream may reduce flows and disrupt lateral connectivity seasonally.

4D. ***Instream-scale Concerns (Connectivity)***: Instream-scale concerns for the vertical dimension (disruptions between the surface stream and the hyporheic zone) may be difficult to identify. Most such disruptions might be from excessive water appropriations. Other instream concerns, representing the longitudinal and temporal dimensions, may include physical barriers such as dams (natural, such as beaver dams, or manmade), sedimentation, improperly installed culverts, channelized reaches, road crossings, and fish barriers (mechanical or electrical). Chemical barriers could be in the form of altered thermal regimes, TMDL-listed reaches, point-source pollution, and endocrine disruptors. Biological barriers could be in the form of exotic species or extirpated native biota (e.g., extirpation of key host fishes for freshwater mussel recruitment).

4E. ***Management Recommendations (Connectivity)***: Specific recommendations will vary depending on the sources of connectivity disruptions. However, given the common examples outlined here, management recommendations might include removal or modification of dams, restoration of channelized reaches, modifications to road crossings, remediation of water quality problems, greater scrutiny of water appropriation permits, levee removal or greater setback distances, and improved land use practices.

5. ARC – Geomorphology and Fish Habitat

Habitat influences fish distribution, size, and abundance at all spatial and temporal scales. Therefore, habitat management is an integral part of an effective stream fish management program. Successful fish habitat management protects, restores, or enhances habitats necessary to maintain or improve target fish populations or diverse fish communities. A geomorphically-stable stream channel with natural dimension, pattern, and profile **(Box 3)** is the foundation for providing the diversity of habitats that support a healthy, aquatic biotic community, including sportfish populations. However, it is important to remember that hydrology and connectivity are often the major factors driving geomorphology and fish habitat.

5A. ***General Description of Current Conditions*:** The ultimate description of current conditions is a determination of whether existing channels are stable or not, whether they are departing from a central tendency, and if so, what state or channel type are they trying to move to.

Information collected according to the Geomorphology section of the 2007 *Stream Survey Manual* (Initial Survey and Full Survey sections) will help evaluate stream channel condition and stability, identify factors responsible for channel disturbances, and characterize aspects of instream aquatic habitat (e.g., mesohabitat distribution, substrate composition, water depths). For example, geomorphology concerns can be identified through the longitudinal profiles (e.g., overly steep nickpoints or head cuts), cross-sectional profiles (e.g., overly wide and shallow or narrowly incised stream channels [**Figure 7**]), and erosion data (e.g, Bank Erosion Hazard Index [BEHI], Near Bank Stress, and Annual Erosion Estimates). This information will help identify actions to stabilize the stream channel and/or improve instream habitat.

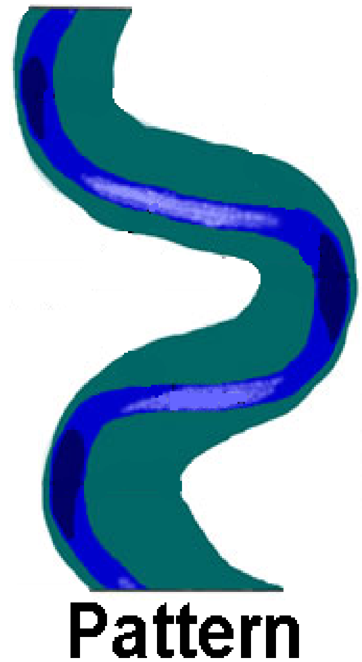
Box 3

What is a Stable Stream Channel?

1) **The dictionary may define stable as “not changing or fluctuating,” but we should think instead that stable streams are in a state of dynamic equilibrium where channel dimension (cross-section), pattern (sinuosity and bend curvature), and profile (longitudinal slope) remain relatively constant.**

2) **The stream may migrate laterally within its valley, but the processes of erosion and deposition of sediment are in balance. Although some sediment may be eroded from banks, an equal amount is deposited in the reach leading to no net loss or gain.**

3) **Instability is brought about by changes in water or sediment supply, or by changes to the channel dimensions or slope that affect the stream's ability to move water or sediment. (See Figure 8.)**



4) **Instability occurs when the stream is unable to transport the volume or size of inputted sediment, causing deposition (aggradation); conversely, when water discharge increases or when slope is increased, sediment scour predominates and degrades (lowers) the stream bed.**

Figure 7. Examples of unstable stream channels include narrow, deeply incised channels (top) and overly wide, shallow channel profiles (bottom).

Rosgen (1996) provides common ranges and central tendencies for most geomorphic variables measured to classify a stream type. Departures from these central tendencies and ranges might indicate that the channel is attempting to adjust to a sediment or water imbalance, or to changes in riparian conditions. For example, an unstable E-channel tending toward a C-channel might have width:depth ratios increasing to above 12, decreasing channel sinuosity, and water surface slopes increasing from 0.006 to 0.009. Some channel types such as G or F are inherently unstable, and are in the process of adjustment. The stream type or trend of stream conditions will indicate where in a channel evolution process the stream is currently.

If a stream survey has not yet been conducted, the Minnesota Stream Habitat Assessment (MSHA), found in the Initial Survey – Geomorphology section of the *Stream Survey Manual*, should be conducted at a minimum. The MSHA, though subjective, will give managers direction on instream conditions, potential problems, and subsequent surveys needed to gather additional information.

Management Concerns (Geomorphology and Fish Habitat at each of three spatial scales): Managers should recognize that physical disturbances and processes affect stream morphology and habitat at multiple spatial scales. Unstable stream channels are often characterized by an imbalance in the amount of water and/or sediment conveyed with sediment either accumulating (aggradation) or being actively eroded or removed (degradation) **(Figure 8)**. Such geomorphically unstable stream channels with poor aquatic habitat may be symptoms of larger-scale problems, often revolving around hydrology problems (water conveyance) or poor land use practices in the watershed (sediment conveyance). Multiple temporal scales may be influenced as well. For example, unstable stream channels in the present day may be due to historical effects from poor land use practices implemented decades earlier. A good example of this is the sediment-filled valleys in southeast Minnesota.

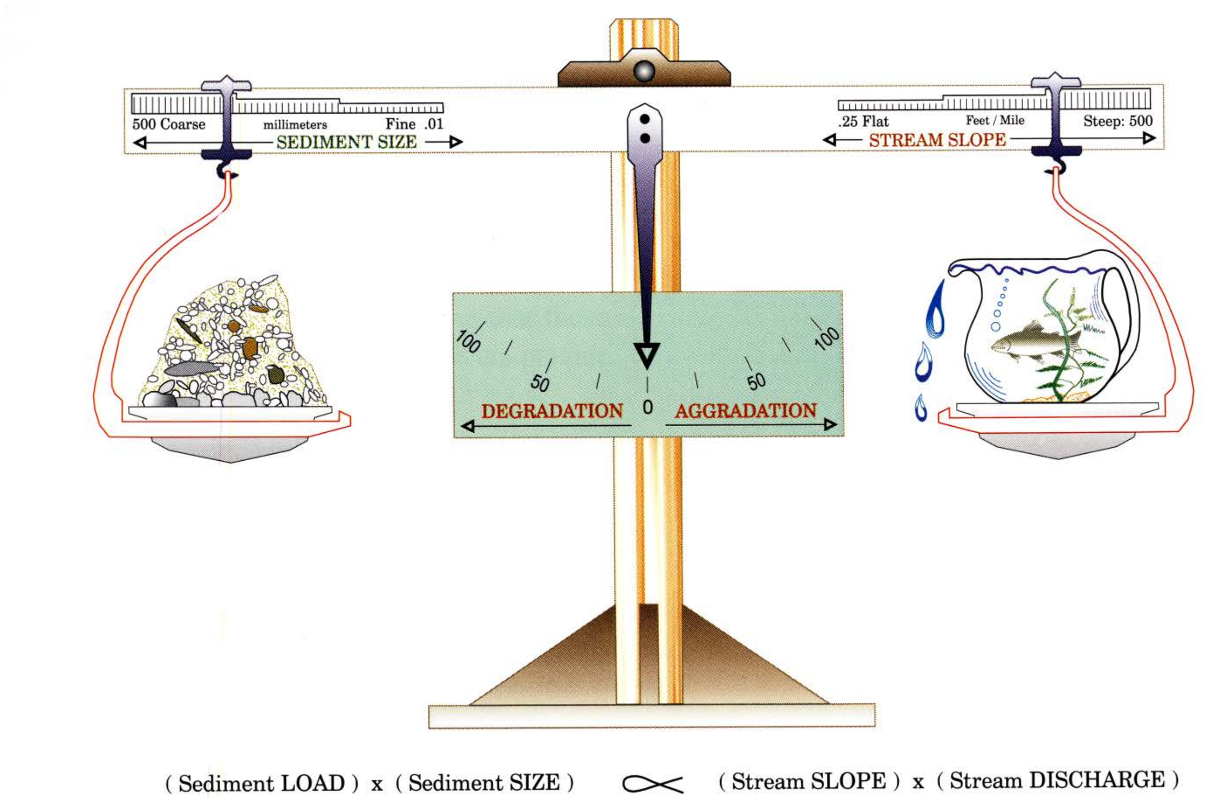


Figure 8. Factors affecting channel equilibrium. At equilibrium, slope and flow balance the size and quantity of sediment particles the stream moves (Rosgen 1996, from Lane 1955).

Listed below are three general spatial scales in which to view stream systems and some examples of issues to consider that may impact streams at each spatial scale.

5B. ***Watershed-scale Concerns (Geomorphology and Fish Habitat)***:

Geomorphic instability and degraded instream habitat are most commonly influenced by an imbalance in the amount of water and sediment conveyed from the watershed to downslope stream channels. At the watershed scale, land cover, land use practices, and even climate (as it alters precipitation patterns) can all alter the amount or type of sediment and water delivered. Thus, land cover and land use practices such as timber harvest, grazing, agricultural crops, or urban expansion might need to be identified as watershed-scale concerns in management plans.

Changes in land conservation practices, such as a reduction in CRP or expansion of mining practices are other examples. Altered precipitation patterns from changes in climate should be noted as well.

5C. ***Riparian-scale Concerns (Geomorphology and Fish Habitat)***: Riparian-scale concerns generally involve improper land cover types or land management practices such as excessive grazing, timber harvest, or the cultivation of plant species that provide poor rooting depth (e.g., mowing or planting crops in the riparian area and too close to the stream edge) and result in increased streambank erosion and an over-wide stream channel. Improper streamside development, such as extensive rip rap to protect stream banks, may also hinder natural geomorphic processes of erosion and deposition.

5D. ***Instream-scale Concerns (Geomorphology and Fish Habitat):*** It is imperative for managers to continually be aware that instream geomorphic characteristics of streams that provide undesirable habitat for fishes (e.g., shallow depths in over-wide or braided channels) may be the result of ongoing watershed-scale land use practices or even natural causes of local hydrology. When manipulation of instream geomorphology or fish habitat is done without consideration of watershed processes (especially hydrology and connectivity), failure is frequently inevitable. Consequently, geomorphology and fish habitat restoration projects must account for watershed processes. That said, common management concerns from a geomorphic perspective include (1) channelization, (2) head cuts, (3) incised or entrenched stream channels, (4) dams and improperly designed stream crossings, and (5) inadequate cover for fishes or poor habitat for other life history stages (e.g., spawning habitat; **Figure 9**).

If a stream is channelized, the habitat complexity of a meandering stream has been replaced by uniform depths and velocities more suitable to generalist fish species. Stream pattern will often be characterized by low sinuosity and a straighter stream channel. Stream profile, or slope, will be increased, and the channel may be overly wide and uniformly shallow.

Figure 9. Channel alterations include channelization (above) resulting in straight, uniform channels that lack instream habitat for aquatic organisms, including fishes.

Head-cuts are the result of a localized change in stream power, often associated with stream straightening and an increase in slope. Incised (entrenched) streams are caused by either down-cutting (degradation) of the stream channel, possibly due to a head cut, or by excessive deposition (aggradation) of sediment on the floodplain. Incised streams do not allow frequent flood flows to spread out onto the floodplain, thereby increasing stream power and instream erosion (degradation), resulting in further entrenchment of the stream. Dams and road crossings with improper dimension, pattern, and profile characteristics will often lead to a decrease in stream slope with the stream being less able to convey instream sediment. The result will be substantial accumulation (aggradation) of sediment upstream from the dam or road crossing with degradation (i.e., mobilization of bed and bank sediments) downstream.

Poor habitat conditions for fishes **(Figure 9)** to complete their life history and, in particular, lack of sufficient cover for adult fishes should also be noted whenever necessary. Poor habitat conditions will almost always be further symptoms of a geomorphic imbalance with the stream being unable to transport water and sediment efficiently. Thus, management goals to improve stream stability should also help alleviate poor habitat conditions. Several indices have been developed to provide specific guidance on interpreting instream habitat conditions for fishes in Minnesota streams (see page 33 and associated tables).

5E. ***Management Recommendations (Geomorphology and Fish Habitat):*** Once issues and problems have been identified, management recommendations can be formulated (remember, taking no action can be a management strategy). If there is insufficient information to adequately define either the problem or the solution, it is acceptable to recommend appropriate steps to get the information needed. Management recommendations should be directed toward addressing causes versus symptoms, and be as specific as possible to achieve the desired result.

Watershed- and riparian-scale issues often require cooperative management efforts between various partners so recommendations at this scale will often involve working with other entities such as local governmental units, federal or state agencies, private individuals, and conservation groups. One recommendation would be to identify key areas where a disproportionate amount of water or sediment originates. These areas could then be targeted for acquisition, protection through the environmental review process, or education efforts for private landowners. Stream managers may need to partner with others to promote use of Best Management Practices on these areas, such as conservation tillage, contouring, windbreaks, terraces, grassed waterways, wetland restoration, vegetative buffer strips, livestock exclusion fences, etc. Re-establishment or reconnection of the stream to its floodplain may be a recommendation specific to the riparian scale.

At the instream scale two broad, but not mutually exclusive, approaches are possible: (1) stream channel and floodplain restoration and (2) addition of specific instream habitat structures (i.e., habitat improvement). Both approaches can effectively enhance instream habitat for fishes but may have varying costs and duration of benefits.

Stream channel and floodplain restoration should work well for channelized reaches, head cuts, and incised (entrenched) streams. Establishment of proper dimension, pattern, and profile characteristics to these streams should result in reaches that provide a balanced transport of sediment and water. For example, instream work to address head-cuts may take several approaches, including grade control structures or creation of a new stream channel. If head-cuts are found during inventory work, the first priority should be to stabilize them before they progress upstream through creation of a grade control structure, such as a rock riffle. For incised channels, the source of the channel incision (e.g., head-cut or land use practices) should be determined first and ameliorated, if possible. Channel incision can then be addressed by either (1) constructing grade control structures to raise the bed of the stream or (2) creating a new stream channel at the lower elevation, including establishment of a floodplain at the lower elevation.

Establishment of proper geomorphic dimension, pattern, and profile will also be needed to address dams and especially stream crossings. Stream crossings should follow the MESBOAC principles. First (M)atch total culvert width to the bankfull width of the channel. (E)xtend the culvert through the side-slope toe of the road. (S)et slope of culvert equal to stream slope. (B)ury the culvert to a depth of 1/6 of the stream width, up to a maximum of 1.5 feet. (O)ffset multiple culverts, where only one culvert is set at the stream bottom elevation while additional culverts are set at the floodplain elevation. (A)lign the culvert with the stream channel and (C)onsider headcuts, and potentially place grade control downstream of the culvert.

Addition of instream habitat features, such as adult fish cover, will vary depending on the fish species of interest. Selected habitat variables found to be important for some fishes and streams in Minnesota and recommendations for their abundance are presented in **Tables 4 and 5**. Information on other instream habitat characteristics important for stream fishes in Minnesota can be found in Aadland et al. (1991), Aadland (1993), Thorn et al. (1997), Thorn and Anderson (2001), and Aadland and Kuitunen (2006). A checklist for stream managers seeking to develop and implement instream habitat projects has also been developed (Appendix 2).

Table 4. Recommended abundance of important habitat variables (percent of total stream area except as indicated) in pools and stream reaches for brown trout in southeast Minnesota streams (from Thorn et al. 1997).

Variable	**Recommended abundance or range**
Overhead bank cover (%)	2
Instream rock cover (%)	1-2
Riprap cover[a] (%)	1
Overhead cover (%)	10
Debris cover (%)	5
Total cover[b] (%)	20
Length overhead bank cover/thalweg length (%)	20
Area of water deeper than 60 cm (%)	25
Pool bank shade (%)	75
Pool length to stream reach length (% pool)	75
Stream slope (m/km)	5-7
Velocity (cm/s)	15-25

[a] When necessary for erosion control.
[b] Sum of overhead bank cover, instream rock, riprap, overhead cover, debris cover.

Table 5. Suggested guidelines for abundance or range of selected habitat features in streams with smallmouth bass or, more broadly, large (>30 ft wide) and small (<30 ft wide) warmwater streams in Minnesota. (Guidelines inferred from Thorn and Anderson 2001).

Variable	**Recommended abundance or range**
Smallmouth Bass	
Pool area (%)	51-75
Mean pool depth (ft)	3-15
Coarse substrates (≥ 2 mm diameter) (%)	>65
Dominant substrate in pools	Gravel, Cobble, Boulder
Cover[a]	19-24
Stream width (ft)	26-50
Large Warmwater Streams	
Maximum thalweg depth (ft) x 2	> 4.5
Coarse substrates (≥ 2 mm diameter) (%) x 2	>65
Cover[a] x 2	12-15
Small Warmwater Streams	
Pool area (%)	40-60
Width:depth ratio x 1.5	< 8
Fine substrates (≤ 1 mm diameter) (%)	< 10
Cover[a] x 1.5	12-15

[a] Five cover types (log jams – LJ, boulder – B, overhead cover – OC, undercut banks – UB, and instream vegetation – IV) can be recorded in surveys, and are rated as scarce (1), occasional (2), or frequent (3). Cover for smallmouth bass streams is calculated from: C = 2LJ + 2B + OC + 2UB + IV. Cover variables weighted by 2 provide year-around cover for smallmouth bass, and the other two variables are most abundant in summer. For large and small warmwater streams, cover variables are not weighted.

6. ARC-Water Quality

Water is the defining feature of habitat for aquatic biota, especially fishes. Chemical characteristics of water, such as dissolved oxygen, alkalinity, nitrogen, and pH, and physical characteristics, such as temperature and turbidity, regulate the presence and abundance of all aquatic biota and reflect local conditions of geography, land use, climate and human use of water supplies (Annear et al. 2004). Geography and climate, as ultimate drivers of water quality, are more difficult to manage than more proximate drivers such as land use and human uses. Historical uses and abuses of water supplies by humans have been well documented and led to a strong public desire to improve water quality conditions in the water resources of the United States. The Federal Clean Water Act set the basic structure in regulating discharge of pollutants into waters of the United States. While the federal Environmental Protection Agency was given that responsibility, much permitting, administrative, and enforcement responsibilities were given to individual state governments with the Minnesota Pollution Control Agency (MPCA) as Minnesota's lead.

Because MNDNR Fisheries has little direct oversight over many of the factors influencing water quality, it will be imperative for staff to work with other agencies and consider use of guidelines established by others. The Assessment of Resource Condition for Water Quality in stream management plans may rely heavily on established criteria or standards set by MPCA to protect aquatic biota. Water quality protection and enhancement is an excellent example of where stream management plans can be written to emphasize collaboration with one of our key conservation partners, MPCA. Management plan authors should consult the Connectivity sections in the 2007 *Stream Survey Manual*; Chapter 3 of *Stream Survey Manual Supplement 1*; and the MPCA website: (http://www.pca.state.mn.us/index.php/water/water-home.html), for help in interpreting water quality information.

6A. ***General Description of Current Conditions (Water Quality):*** In this section, authors should provide a description of the current water quality conditions of the stream being managed. Much of this information should be a summary of data gathered during the most recent stream survey but could include a summary of information from other agencies as well, especially MPCA. Initial stream surveys capture information about temperature, pH, dissolved oxygen, conductivity, and transparency in each similar reach. Laboratory analysis of water samples in each reach is required for full surveys (minimum of two samples per stream), but the analysis is often incorporated into the initial survey as well. Contaminant levels in fishes (e.g., mercury) resulting in fish consumption guidelines should also be noted in this section. Plan authors may note locations where water quality standards are not being met or where there are insufficient data. Also, authors are encouraged to not rely on just existing water quality standards for aquatic biota in general, but, rather, to examine the professional literature for ranges of water quality conditions that support recreationally important fishes. For example, water temperatures between 7°C and 19°C often provide good conditions for brown trout growth (Raleigh et al. 1986).

Management Concerns (Water Quality, at each of three spatial scales): Managers may identify locations where water quality standards are not being met, where insufficient data have been collected, or where water quality measurements may be outside the range of conditions that commonly support a primary fish species being managed. Managers may speculate on the source of these water quality deficiencies, such as land uses, industrial discharges, or bank erosion, or may suggest partnering with MPCA to more definitively identify sources and develop management recommendations.

6B. ***Watershed-scale Concerns (Water Quality):*** Water quality protocols in the 2007 *Stream Survey Manual* primarily result in a coarse sampling scale, with many water quality impairments suggesting watershed-scale disturbances. Unless smaller-scale site-specific impairments are suspected and documented by additional water samples, identification of point sources (riparian or instream concerns) may prove difficult. Many watershed-scale concerns will derive from land use practices whether agricultural, forest management, or urbanization. Some example watershed-scale concerns might include elevated levels of nutrients (phosphorus and nitrates), fine sediment and turbidity, or water temperature, such as from increased surface runoff of impervious surfaces. At an even larger scale, watershed geology, regional patterns in climate, or areal transport of contaminants might result in low levels of pH (e.g., acid rain) or alkalinity. In Minnesota, mercury is the contaminant in fishes that causes the most concern. Air pollution is the major source of mercury that contaminates fishes in Minnesota's rivers. This mercury is the result of emissions from coal combustion, mining, incineration of mercury-containing products, and other human sources. Over time, fishes can accumulate high mercury concentrations. Many other contaminants (e.g., PCP, PBDE, PFC, and dioxin) also present health risks.

6C. ***Riparian-scale Concerns (Water Quality):*** Concerns at this scale may be difficult to identify, but obvious examples might include increased bank erosion that causes elevated levels of fine sediment and turbidity. A large, poorly managed feedlot in the riparian zone may cause low levels of dissolved oxygen and high levels of fecal bacteria. Land use practices in the riparian zone, such as poor agricultural or forestry practices, may reduce shade from tree removal and result in elevated water temperatures. Similarly, poorly managed stormwater runoff, such as from an adjacent parking lot in the riparian zone, could result in elevated levels of solids or water temperatures at a specific location. Finally, improperly stored wastes or abandoned dumps, if located in the riparian zone, could contribute several types of contaminants.

6D. ***Instream-scale Concerns (Water Quality):*** Many instream-scale concerns may already be identified as point sources of pollution. Common examples will include low dissolved oxygen levels from wastewater discharge from sewage treatment plants and altered water temperatures (either too warm or too cold) from industrial plant discharges or impoundments, including beaver dams and hypolimnetic water releases from large anthropogenic dams.

6E. ***Management Recommendations (Water Quality):*** Management recommendations may often be to support more intensive water-quality sampling efforts from other agencies, especially MPCA to better identify sources of water quality concerns. Where concerns are influenced by land use practices, either in the watershed or the riparian zone, management recommendations may be to work with other agencies and conservation partners to implement better land use programs. With little or no regulatory authority for land use modification, MNDNR Fisheries will need to work with and support the MPCA and other agencies during their sampling events and stakeholder meetings. Only after additional sampling and analysis, can watershed concerns be identified for corrective action. More specific management recommendations may be available for some concerns such as forestry practices in the riparian zone or stream banks with excessive erosion. Finally, management plans may need to articulate the continuing need to conduct contaminant analyses (in conjunction with the Minnesota Department of Health) on fishes harvested for consumption.

7. ARC-Biology

Gamefish species (**Figure 10**) are frequently the focal point of management plans, and with good reason–our constituents desire robust gamefish populations. While fisheries managers are tasked with managing gamefish populations, it is important that they also place a high priority on diversity and non-game species. Poor fish community attributes (e.g., low IBI score or decreased diversity) often reflect disturbances within the system, sometimes from beyond the banks of the stream. Therefore, managers should take a broad view of the biology of a lotic resource at the watershed, riparian, and instream scales when developing a management plan. Managers should consult the Initial and Full Survey (Biology) sections in Part II of the 2007 *Stream Survey Manual* for help interpreting biological data if necessary. Managers may also consult the MPCA website, and associated materials, for guidance interpreting region-specific IBI scores if necessary.

7A. ***General Description of Current Conditions (Biology):*** When writing a general description of the biotic component of a resource, provide a summary of current biological conditions based on previous survey information and available data from partner agencies (e.g., IBI scores from MPCA). Fisheries surveys typically provide data that can be used to describe the quality of the fishery. Common population measures for recreationally important fishes (**Figure 10**), fish species of greatest conservation need (SGCN, including lake sturgeon, **Figure 11**), or exotic-invasive fishes (including silver carp, **Figure 12**), might include estimates of (a) population size or catch rates, (b) recruitment, (c) growth, (d) mortality, and (e) size structure. Indices to describe the fish community may include (f) IBI scores or species (g) richness, (h) diversity, or (i) evenness. Succinctly describing other aspects of the biotic community may facilitate the identification of concerns (by reach if possible) at the three spatial scales. Some examples might include (j) distribution and abundance of non-fish

Figure 10. Important game fish species occupying Minnesota streams include channel catfish, smallmouth bass, walleye, brown trout, and brook trout.

invasive species, (k) presence and qualitative abundance of aquatic invertebrates, (l) aquatic plants, (m) freshwater mussels, (n) keystone species (e.g., beaver), (o) avian and terrestrial predators such as heron, mink, and otter (**Figure 13**), and (p) the vegetative composition of the riparian zone. The general description should note where these indices suggest good conditions as well as locations for subsequent management concerns. For example, a general description may note good IBI scores in three of four reaches on a stream. The location of the poor IBI score may subsequently be listed as an instream concern so an appropriate management action can be developed to address this concern.

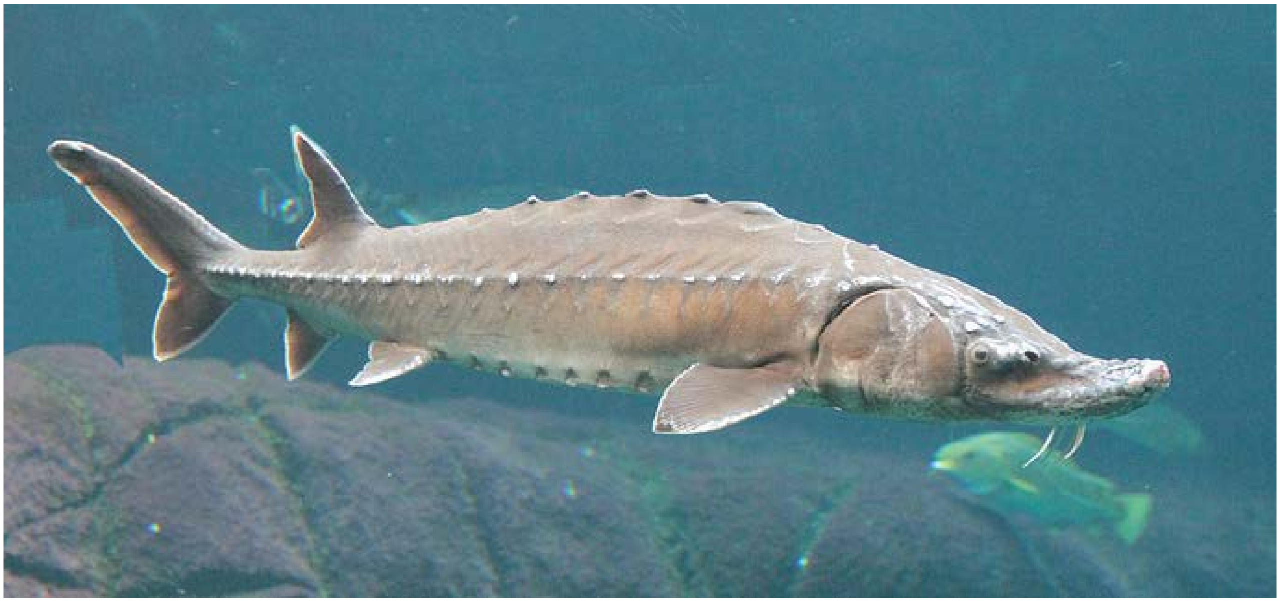


Figure 11. Game fish species making a comeback in Minnesota rivers include the lake sturgeon *Acipenser fulvescens,* once nearly extinct (photo courtesy Montréal Biodôme).

Figure 12. Recent invasive species immigrants into Minnesota waters include the silver carp *Hypophthalmichthys molitrix*. Bighead carp (*Hypophthalmichthys nobilis,* not shown) are also recent immigrants from Asia (photo courtesy Wikipedia).

Figure 13. Natural predators of fish in streams and rivers include mink (upper left), otter (lower left), great blue heron (upper right), and belted kingfisher (lower right).

Management Concerns (at each of three spatial scales):

7B. ***Watershed-scale Concerns (Biology):*** Watershed-scale concerns are typically more prominent in the other components, with the biotic community simply responding to disturbances in hydrology, geomorphology, connectivity, and water quality. However, managers must think broadly about large-scale biological concerns when developing a management plan. For example, reduction in the spatial distribution of native brook trout due to expansion of brown trout may be a watershed-scale concern. Other biological watershed-scale concerns may include changes in the distribution (expansion, contraction, or apparent extirpation) of any species of management interest. Such distributional changes could be caused by changing habitat conditions or competitive interactions.

7C. ***Riparian-scale Concerns (Biology):*** Riparian-scale concerns can vary widely, from evident changes to a stream's riparian zone caused by beaver or cattle to a less conspicuous problem, such as reduced allochthonous inputs from loss of tree species. Biological riparian-scale problems can affect other components, such as water quality or geomorphology. For example, conversion of woody riparian zones to grass/forb communities on stream types C, D, E, and F may increase width:depth ratios, lateral erosion, and instream sediment deposition (Rosgen 1996). Alternatively, loss of vegetative buffers may result in greater overland contributions of nutrients or other pollutants. Finally, presence or spread of invasive terrestrial species (plants or invertebrates) may also be a cause of concern.

7D. ***Instream-scale Concerns (Biology):*** Fish species, aquatic plants, invertebrates, mammals, and even viruses can be responsible for undesirable conditions of the biotic community. Managers must also be cognizant of biological instream concerns and their impact among various user groups. Zebra mussels can dramatically affect the forage base available to juvenile fish, and also create unsafe wading and swimming conditions. Examples of instream concerns may include poor community diversity/low IBI scores, exotic or undesirable species, overabundance of an organism, rare or endangered species, lack of gamefish species, population dynamics (poor size or age structures, growth, recruitment, densities), loss of genetic diversity, or diseases.

7E. ***Management Recommendations (Biology):*** Management recommendations for biological concerns can be general or specific, depending on the situation and the manager's ability to directly influence the identified concern. When insufficient data are available to determine the cause of the concern, the recommendation may simply be to collect additional data, perhaps through a supplemental survey or targeted sampling effort. Angling regulations based on a biological problem could be a management recommendation, but when no biological reason is present for implementing a regulation, the concern becomes social and should be addressed within that component.

When used properly, stocking can be a good tool employed by fisheries managers. Stocking guidelines for trout are available when this strategy is chosen to address an identified concern (**Tables 6-9**). Stocking guidelines for walleye in warmwater streams in Minnesota has not been extensively determined. However, stocking guidelines from other Midwestern states (**Table 10**) may be useful to Minnesota managers. Stocking guidelines for other warmwater species such as smallmouth bass and channel catfish have not been developed for Minnesota. Consequently, adjustments to all stocking rates can be made if more information becomes available to the manager.

Table 6. Habitat quality rating inferred from existing trout population data (i.e., standing stock biomass, lbs/acre) for trout streams in Minnesota.

	Trout standing stock biomass, pounds/acre (lbs/acre)		
Habitat quality	**Southern region**	**Central region**	**Northern region**
Excellent	>200	>100	>50
Good	100 – 200	50 – 100	30 – 50
Fair	50 – 100	30 – 50	10 – 30
Poor	<50	<30	<10

Table 7. Recommended trout spring fingerling stocking rates (number/acre) for streams in Minnesota based on reproduction and habitat quality. Habitat quality can be estimated from just fish data (Table 6) or from the habitat quality index in Thorn and Anderson (2001).

Spring trout stocking rates (no. fingerlings/acre)

Reproduction	**Location**	**Habitat Quality**			
		Poor	Fair	Good	Excellent
None	Southern	0 – 500	1000	1500	2000
	Central	0 – 500	750	1000	1500
	Northern	0 – 500	500	750	1000
Poor – inconsistent	Southern	0 – 500	750	1000	1500
	Central	0 – 500	500	750	1000
	Northern	0 – 500	250	500	750
Good – inconsistent	Southern	0 – 500	500	750	1000
	Central	0 – 500	250	250	500
	Northern	0 – 500	250	250	250
Good – consistent	Southern	none	none	none	none
	Central				
	Northern				

Table 8. Recommended trout fall fingerling stocking rates (number/acre) for streams in Minnesota based on reproduction and habitat quality. Habitat quality can be estimated from just fish data (Table 6) or from the habitat quality index in Thorn and Anderson (2001).

Fall trout stocking rates (no. fingerlings/acre)

Reproduction	**Location**	**Habitat Quality**			
		Poor	Fair	Good	Excellent
None	Southern	0 – 100	200	400	500
	Central	0 – 100	100	200	400
	Northern	0 – 100	100	100	200
Poor – inconsistent	Southern	0 – 100	100	200	400
	Central	0 – 100	100	100	200
	Northern	0 – 100	100	100	100
Good – inconsistent	Southern	0 – 100	100	100	200
	Central	0 – 100	100	100	100
	Northern	0 – 100	100	100	100
Good – consistent	Southern	none	none	none	none
	Central				
	Northern				

Table 9. Recommended stream stocking rates of catchable trout (number/acre) based on annual angling pressure (hours/acre) and habitat quality.

Catchable trout stocking rates (number/acre)

Annual angling pressure (hours/acre)	**Habitat Quality**			
	Poor	Fair	Good	Excellent
<50	10	10	none	none
50 – 200	15	15	none	none
200 – 500	20	20	50	none
>500	50	50	100	none

Table 10. Walleye stocking strategies for rivers and streams in upper Midwestern states as summarized by Kerr (2008).

State	**Walleye stocking strategies**
North Dakota	Summer fingerlings in late June.
South Dakota	Streams and rivers not stocked.
Iowa	Summer fingerlings at 250/km. Stock upstream of targeted area but avoid stocking during high discharge.
Minnesota	Not considered necessary (MNDNR 1996).
Illinois	Summer fingerlings at 62/ha.
Wisconsin	No information specific for rivers but guidelines suggest spring fry at 1,800/acre or summer fingerlings (2+ inches TL) at densities up to 100/acre.
Michigan	Warmwater rivers not usually stocked.

8. ARC-Social Considerations

Social considerations can be extremely variable depending on the resource and associated stakeholder groups. This section of the plan is intended to provide a place for managers to list all the stakeholders and their concerns about the stream resource being managed. The stream management plan should provide stakeholders with a clear understanding of management goals, objectives, and prescribed activities to protect, enhance, or restore the stream. While social considerations are not included in the five-component methodology used in the Stream Survey Manual (MNDNR 2007), they are important in the development of how a manager sets Goals and Objectives for a resource.

8A. *General Description of Current Conditions (Social Considerations):*

Describing the current state of social aspects will likely be extremely variable. Some examples of stakeholder groups or items to consider might include (a) number and location of access points (designated takeout spots for canoe routes, boat ramps), (b) recent angler creel or broader stakeholder surveys, (c) stakeholder groups or conservation partners and their associated values, concerns, pertinent relationships, and potential contributions (e.g., river advisory groups, tribal interests, such as 1837 Treaty Area, watershed districts, Trout Unlimited, Smallmouth Bass Alliance), (d) other agencies such as U.S. Forest Service, relevant local government units, other MNDNR Divisions, (e) boating regulations including no-wake zones, (f) location and agencies responsible for other public lands, state and county parks, or Wild and Scenic River designation, (g) bait dealers and fishes targeted, (h) fishing tournament interests, and (i) commercial fisheries. Plan authors might also consider adding cultural resources, informational and educational materials, and possibly the need for a communications plan.

Management Concerns (Social Considerations, at each of three spatial scales): Most management concerns associated with a stream's social considerations will highlight areas of conflict among stakeholders and user groups.

Box 4

Working with Watershed Councils and Other Groups

1) **Developing a network of peer leaders increases the community's awareness and breaks down barriers to project implementation. Landowners who have successfully changed management practices can become a watershed council's best advocates.**

2) **Private landowners who are involved from the beginning in developing goals and guidelines for restoration work and who continue their participation in ecological monitoring are most likely to become involved in coordinated restoration projects. Trusted working relationships can be established when council leaders integrate local knowledge, respond to the fears and concerns of residents, and explain the scientific basis for proposed projects.**

3) **Generously sharing technical expertise with stakeholders and practicing transparency in long-term data collection, interpretation, and reporting can catalyze landscape-level change through regional policy initiatives**.

from Oliver (2010)

8B. ***Watershed-scale Concerns (Social Considerations):*** Watershed-scale concerns may often represent conflicts among landowners (public and private), local and state units of government, and special interest or user groups. Plan authors might seek to describe the nature of these conflicts, primarily as they relate to the stream resource being managed and as they reflect the values and concerns of each interested party.

8C. ***Riparian-scale Concerns (Social Considerations):*** Some example riparian-scale concerns might include lack of appropriate stream access points and their condition, and local riparian land uses or developments.

8D. ***Instream-scale Concerns (Social Considerations):*** Instream-scale concerns could include angling regulations if implemented primarily for a sociological reason such as anglers desiring to fish catch-and-release only areas, or if the objective is simply to increase angler catch rates or satisfaction. Other concerns might include removal of dams or woody log jams that might be barriers to canoes or boats. Alternatively, dam removals may generate social conflicts when river users view them as desirable for historical and aesthetic reasons, or because they are perceived to be barriers to upstream movements of invasive species. Other instream-scale concerns might include conflicts over fishing tournaments, bait harvesters, commercial fisheries, or other conflicts between user groups (e.g., anglers versus tubers).

8E. ***Management Recommendations (Social Considerations):*** Management recommendations may be difficult to formulate in many instances because many social decisions will be arrived at outside of the jurisdiction of MNDNR Fisheries. Managers can help ease tensions through increased communication, education, and coordination with the multiple stakeholder groups present. Managers may have opportunities for more direct recommendations when the need is for more access points to the stream. Managers may target specific riparian areas for easement considerations. **Box 4** provides additional considerations for managers working with watershed councils. While focus is often on points of conflict, it is equally important that good working partnerships and cooperation be highlighted within this section of the management plan.

9. Stream Management Plan Goals and Objectives

Stream management plans are the basis for a majority of current and future fisheries management planning efforts. These plans will likely be used in management planning efforts and decisions of local, state, and federal conservation efforts. As such, they may be viewed and used by a wide range of stakeholders.

Stream management plan goals and objectives should be formulated after gathering all the historical background information available for the stream along with a current Assessment of Resource Conditions. Managers may also seek input from any stakeholder groups necessary. From this information, managers should develop: (1) Long-range Goals, (2) Objectives, (3) Operational Plans, and (4) Future Potential Plans.

- ***Long-Range Goals:*** In general, goals convey Department, Section, Regional, Area and often stakeholder visions centering on the protection, enhancement, and restoration of healthy ecosystems that provide sustainable fishing and diverse native fish communities. Goals should be clear, well-defined, unambiguous statements that are brief, yet visionary, and are used as the basis for more specific objective setting (Tear et al. 2005). The committee recommends that goals should encompass a time interval of approximately 10-20 years. Managers should feel free to specify as many goals as are deemed necessary.
- ***Objectives:*** Objectives should be specific measureable statements, preferably over some time period and spatial extent. Objectives are what you, as the manager, want to achieve. Objectives should provide a more specific description of elements articulated in the goal statement. For example, if a goal states "maintenance of a self-sustaining smallmouth bass population," an appropriate objective might include a definition of what constitutes a self-sustaining smallmouth bass population (e.g., electrofishing catch rate of four smallmouth bass/hr with four or more age groups present, including at least age-0 or age-1 fish to represent natural recruitment). Managers are encouraged to consider objectives for recreationally (fish species of primary management interest in particular) and commercially important fishes (including baitfishes), native fish

communities and aquatic habitat, especially habitat features important to fishes of primary management interest. Identification of important habitat features may help direct new conservation funding sources as well as efforts of conservation partners using those funds.

- ***Operational Plans:*** Operational plans specify activities to be implemented to achieve the stated objectives. For example, an Operational Plan to achieve a self-sustaining smallmouth bass population will include a description of sampling efforts to determine if the population is meeting the objective, but might also include an identification of the need to determine factors influencing natural recruitment. Some of the management recommendations developed in the ARC sections may be appropriate to include in the Operational Plans.
- ***Future Potential Plans:*** Future potential plans should include projects that could be accomplished with expanded funding or partnerships. Management recommendations developed in the ARC sections, but not included in the Operational Plans (because they transcend current staff and funding levels), will likely be placed here.

The Stream Management Plans that follow should provide additional examples of Long-Range Goals, Objectives, Operational Plans, and Future Potential Plans.

10. Literature Cited

Aadland, L. P. 1993. Stream habitat types: their fish assemblages and relationship to flow. North American Journal of Fisheries Management 13:790-806.

Aadland, L. P., C. M. Cook, M. T. Negus, H. G. Drewes, and C. S. Anderson. 1991. Microhabitat preferences of selected stream fishes and a community-oriented approach to instream flow assessments. Investigational Report 406, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

Aadland, L. P., and A. Kuitunen. 2006. Habitat suitability criteria for stream fishes of Minnesota. Special Publication 162, Minnesota Department of Natural Resources, St. Paul.

AMAAPC (Aquatic Management Area Acquisition Planning Committee). 2007. Minnesota's aquatic management area acquisition plan 2008-2033: shoreline habitat, angling, and clean water for our future. Report to Fish and Wildlife Division, Minnesota Department of Natural Resources, St. Paul.

Annear, T. I., I. Chisholm, H. Beecher, A. Locke, and 12 other authors. 2004. Instream flows for riverine resource stewardship, revised edition. Instream Flow Council, Cheyenne, Wyoming.

Kerr, S. J. 2008. A survey of walleye stocking activities in North America. Fish and Wildlife Branch, Ontario Ministry of Natural Resources, Peterborough, Ontario.

Lane, E. W. 1955. The importance of fluvial morphology in hydraulic engineering. Proceedings of the American Society of Civil Engineers 81(745):1-17.

MNDNR (Minnesota Department of Natural Resources). 1978. Fisheries stream survey manual. Special Publication 120, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

MNDNR (Minnesota Department of Natural Resources). 1993. Fisheries stream management guide for streams and rivers. Special Publication 148, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

MNDNR (Minnesota Department of Natural Resources). 1996. Walleye stocking guidelines for Minnesota fisheries managers. Special Publication 150, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

MNDNR (Minnesota Department of Natural Resources). 2007. Fisheries stream survey manual. Special Publication 165, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

MNDNR (Minnesota Department of Natural Resources). 2010. A Strategic conservation agenda 2009-2013. Part 1: Strategic directions. Part 2: Performance and accountability report. Minnesota Department of Natural Resources, St. Paul. Available: http://www.dnr.state.mn.us/conservationagenda/index.html . (May 2011).

MNDNR (Minnesota Department of Natural Resources). 2011. Fisheries long-range plan for trout stream resource management in southeast Minnesota 2010-2015 and progress report. Section of Fisheries, Minnesota Department of Natural Resources, St. Paul. Available: http://files.dnr.state.mn.us/areas/fisheries/lanesboro/setrout_mgtplan/full_report.pdf. (October 2012).

MNDNR (Minnesota Department of Natural Resources). 2013. Fisheries stream survey manual. Supplement 1. Major components of stream systems. Division of Fish and Wildlife Special Publication 165, St. Paul.

MNDNR (Minnesota Department of Natural Resources). 2013. Fish habitat plan: a strategic guidance document. Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

MNDNR and others (Minnesota Department of Natural Resources, North Dakota Game and Fish Department, Manitoba Water Stewardship, South Dakota Department of Game, Fish and Parks). 2007. Red River of the North fisheries management plan. Section of Fisheries, Minnesota Department of Natural Resources, Bemidji, Minnesota. Available: http://files.dnr.state.mn.us/areas/fisheries/baudette/redriver_mangement_plan_2008.pdf. (May 2011).

Oliver, M. 2010. Watershed councils: it takes a community to restore a watershed. Science Findings 129, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland.

Raleigh, R. F., L. D. Zuckerman, and P. C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: brown trout, revised. Biological Report 82(10.124), U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Rosgen, D. L. 1996. Applied river morphology. Wildland Hydrology Pagosa Springs, Colorado.

Tear, T. H., P. Kareiva, P. L. Angermeier, P. Comer, B. Czech, R. Kautz, L. Landon, D. Mehlman, K. Murphy, M. Ruckelshaus, J. M. Scott, and G. Wilhere. 2005. How much is enough? The recurrent problem of setting measurable objectives in conservation. BioScience 55:835-849.

Thorn, W. C., and C. S. Anderson. 2001. Evaluating habitat quality from stream survey variables. Fish Management Report 35, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

Thorn, W. C., C. S. Anderson, W. E. Lorenzen, D. L. Hendrickson, and J. W. Wagner. 1997. A review of trout management in southeast Minnesota streams. North American Journal of Fisheries Management 17:860-872.

TU (Trout Unlimited). 2007. Driftless Area restoration effort strategic plan. Trout Unlimited. Madison, Wisconsin. Available: http://namekagon.org/wp-content/uploads/2013/07/TU-Driftless-Strategic-Plan-4-08.pdf. (May 2011).

11. Stream Management Plan Examples

STREAM MANAGEMENT PLAN – Page 1

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Rum River **West Branch Rum River**		**M-063** **M-063-026**	**150.78 (M-063)** **55.93 (M-063-026)**	**April 2012**
Region **3**	Area Fisheries Office **Little Falls Area (F312)**	Plan Managed Segment (river mi.) **83.54 to 150.78 (M-063)** **0.00 to 55.93 (M-063-026)**	Length (miles) Plan Managed Segment **67.24 (M-063)** **55.93 (M-063-026)**	

Major Watershed:

Both the Rum River (M-063) and West Branch Rum River (M-063-026) are in the Rum River watershed (Major 21)

Minor Watersheds (significant tributaries)

Rum River: **Round L (21001), Mille Lacs L (21002), Malone Cr (21003), Unknown (21004), Cedar Cr (21005), Seventeen Cr (21006), Twenty L, (21007), Borden Cr (21008), Co Ditch #36 (21009), Peterson Cr (21010), Whitefish L (21011), Ogechie L (21012), N Fk Bradbury Bk (21013), Rum R (21014), L Onamia (21015), Black Bk (21016), Unknown (21017), Rum R (21018), Rum R (21019), Rum R (21021), Tibbetts Bk (21022), Stony Bk (21023), Unknown (21024), Chase Bk (21025), Rum R (21026), Whitney Bk (21027), Mike Drew Bk (21028), Vondell Bk (21030), Bogus Bk (21032), Washburn Bk (21033), Rum R (21034), S Stanchfield L (21035), Unknown (21036), Rum R West (21040), Prairie Cr (21041), W Br Rum R (21042), Woodward Bk (21043), Estes Bk (21045), Unknown (21046), Estes Bk (21047), W Br Rum R (21048), Rum R (21049), Bradbury Bk, (21050), W Br Rum R (21053), Unknown (21054), W Br Rum R (21055), Unknown (21056), Unknown (21057), Garrison Cr (21058), Seguchie Cr, (21059), Unknown (21103)**

West Branch Rum River: Stony Br (21023), Unknown (21024), Rum River – West (21040), Prairie Cr (21041), W Br Rum R (21042), Co Ditch #9 (21044), Estes Bk (21045), Unknown (21046), Estes Bk (21047), W Br Rum R (21048), W Br Rum R (21053), Unknown (21054), W Br Rum R (21055), Unknown (21056), Unknown (21057)

Similar Reach	Similar Reach Name	Stream Miles	Length (miles)	Rosgen Channel Type	Fisheries Ecological Classification	Species of Management Interest[1]
	RUM RIVER (M-063)					
1	**Mouth to Princeton**	**0.00 – 83.54**	**83.54**	**-**	**-**	**-**
2	**Mille Lacs County**	**83.54 – 102.60**	**19.06**	**C5**	**II-A**	**SMB**
3	**Milaca**	**102.60 – 140.60**	**38.00**	**C4**	**II-A**	**SMB**
4	**Headwaters**	**140.60 – 150.78**	**10.18**	**Lake**	**II-A**	**SMB**
	WEST BRANCH RUM RIVER (M-063-026)					
1	**Mille Lacs County**	**0.00 – 33.71**	**33.71**	**C5c**	**II-A**	**SMB**
2	**Benton-Morrison County**	**33.71 – 55.93**	**22.22**	**C4**	**III-E**	**Cosmopolitan**

[1]SMB= smallmouth bass

Long Range Goals (10-20-year time frame)

Goal 1: *Provide an accessible high-quality self-sustaining smallmouth bass fishery and a diverse native fish community.*

Objectives (Desired Future Conditions) and Operational Plans:

1. Objective 1 – Maintain electrofishing catch rate of 4 smallmouth bass greater than 10 inches per hour.
   a. Conduct directed sampling effort to assess smallmouth bass populations with spring time electrofishing every five years starting in 2014.
2. Objective 2 – Maintain multiple year-classes of walleye.
   a. Conduct targeted springtime electrofishing to assess walleye populations every five years starting in 2014.
3. Objective 3 – Maintain a diverse fish community that includes the presence of northern pike, bluegill, crappie spp. and with IBI scores above the impairment threshold values (specific threshold value depends on stream class and size, for Rum River similar reach 2, IBI = 32; for similar reaches 3, 4, IBI = 40).

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Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
3	**Little Falls Area (F312)**	**83.54 to 150.78 (M-063)** **0.00 to 55.93 (M-063-026)**	**67.24 (M-063)** **55.93 (M-063-026)**	

a. Assess the fish community including IBI calculations every 5 years beginning in 2014 and coordinate with MPCA assessments.
b. Assess tributaries for biological impairment (IBI scores) as needed and work with local partners to address impaired reaches.

Goal 2: *Maintain high-quality instream habitat with a stable stream channel.*

Objectives (Desired Future Conditions) and Operational Plans:

1. Objective 1 – Maintain median flows at the St. Francis gage site between 393-1,163 cfs in June, 350-766 cfs in July, and 244-584 cfs in August and the annual 1-day peak flow between April 4 and June 11 in half of the years between 2010 and 2030 (duration of this Rum River plan).
   a. Quantify the mean and range of variation in timing, frequency, magnitude, and duration of high and low flow events.
2. Objective 2 – Further define the dimension, pattern, and profile that will provide a stable stream channel and quality fish habitat in the mainstem Rum River.
   a. Obtain geomorphology on additional stations to better grasp stream geomorphology in these large reaches and to assess temporal changes by revisiting existing sites.
   b. Gather additional information on fish habitat–see Fisheries Stream Survey Manual (MNDNR 2007).
   c. More geomorphic information should be gathered specifically on the West Branch, by 2015, because of channelization issues.
   d. Evaluate stream channel stability (e.g., with BEHI) at locations where excessive erosion has been identified.
3. Objective 3 – Provide unimpeded fish passage throughout the Rum River Basin as opportunities arise.
   a. Continue to seek local support to change the structure in Milaca to a rock/boulder riffle structure or remove the existing dam on the Rum River.
   b. Work with county engineers as road-crossing issues arise on the Rum River, West Branch, and other tributaries.
   c. Specifically work to improve connectivity through the downstream dam at Anoka (river mile 0.81).

Future Potential Plans

1. Hydrology
   1) Identify key land areas for wetland restoration and work with partners to protect, enhance, or restore, or for AMA acquisition.
   2) Explore structural modifications to existing and future tiling efforts, work with partners to provide alternative to future tiles.
   3) Work with local partners to identify and address problems associated with ditches.
   4) Work with municipalities to improve stormwater management and other runoff issues associated with impervious surfaces in the watershed or riparian locations.
   5) Work with partners to restore the channelized reaches on the West Branch.
   6) Install additional stream flow gages on the West Branch of the Rum River to obtain more data on how stream hydrology is affected by water appropriations.
   7) Repair areas where erosion is causing habitat degradation or excessive sediment bedload.

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Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
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Future Potential Plans *(continued)*

2. Water Quality
    1) Support efforts of other partners (e.g., MPCA) in the basin to reduce nitrate levels to values below the North Central Hardwood Forest EcoRegion Standard/Range/Target 75th percentile=0.12 mg/l.
    2) Support more intensive water-quality sampling efforts from other agencies including MPCA.
    3) Work with the MPCA during their intensive watershed sampling effort in 2014, including participation in MPCA stakeholder meetings.
    4) Work with Department of Health to assess the need for fish consumption advisories for the Rum River Basin.

3. Biology
    1) Survey freshwater mussel populations to assess zebra mussel effects.
    2) Monitor spread of spiny waterflea and zebra mussels from upper basin.
    3) Sample freshwater invertebrates.
    4) Identify distribution and abundance of terrestrial invasive species in the riparian zone for conservation partners to address.
4. Social Considerations
    1) Actively participate in discussions with Parks, Trails and Waterways divisions or whomever, regarding potential Wild and Scenic River designation.
    2) Engage in conversations and provide information on options to address the Milaca Dam.
    3) Evaluate the adequacy of the number, location, and facilities of existing access points for recreational users, including physically challenged users.
    4) Coordinate wood-removal practices with MNDNR Trails and Waterways.
    5) Work with local hydrologist to maintain current outlet elevation on Mille Lacs Lake via the proposed water-control structure on the outlet of Mille Lacs Lake. Maintain a natural flow regime via the modified water-control structure (Buckmore Dam) on the outlet of Ogechie Lake.

Area-Specific Needs
- Mille Lacs Kathio State Park - Mille Lacs Band Ojibwe reservation lands - 1837 Treaty territory

Approvals

Plan Authors			
Steve Marod, Fisheries Specialist			
Area Supervisor	***Date***	***Regional Manager***	**Date**

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
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BACKGROUND INFORMATION

Priorities – Moderate recreational importance (angling, canoeing, moderate public access), designated canoe route, Mille Lacs-Kathio State Park, not on state impaired waters list although selected reaches may be, unique floodplain forests present, four designated trout streams in the watershed..

Description of Stream System – The Rum River Watershed is located in the east-central portion of the Mississippi River Watershed and covers 1,557.9 square miles with a basin length (L) of 85.2 miles. Basin relief ranged from a maximum elevation of 1,454 feet to a minimum of 829 feet for a total elevation change of 625 feet. The basin relief ratio (R_r) was 0.00139 and the elongation ratio (Re) was 0.5227. The Rum River is a fifth-order stream with a length of 150.72 miles and stream slope (S_c) of 2.83 feet/mile.

The Rum River begins at the Mille Lacs Lake outlet and flows directly into Lake Ogechie (Figure 1). A fixed-crest structure controls water levels on Mille Lacs Lake at the Rum River outlet from Lake Ogechie. The river then flows to the southeast through Shakopee Lake and Lake Onamia where another fixed-crest rock dam exists. From Onamia the Rum River flows to the south through Milaca, then Princeton, at the southern boundary of Mille Lacs County. The river then bends to the east through northeast Sherburne County, into central Isanti County before turning back south into Anoka County. Stream sinuosity on the Rum River varied by similar reach and increased in a downstream direction ranging from 1.17 in similar reach 1 to 1.89 in similar reach 3.

The West Branch Rum River sub-watershed is located in the western portion of the Rum River Watershed and had a basin area of 187.7 square miles and a basin length (L) of 31.1 miles. Basin relief ranged from 1,342 feet to 951 feet for a difference of 391 feet in elevation. The basin relief ratio (R_r) was 0.00238 and the elongation ratio (R_e) was 0.4971. The West Branch Rum River was also a fifth order stream with a length of 55.66 miles and a mean stream slope (S_c) of 6.25 feet/mile. The West Branch of the Rum River has its source in southeastern Morrison County and flows to the southeast through northeast Benton County and southwest Mille Lacs County before entering the Rum River at Princeton. Sinuosity was 1.55 in similar reach 1 and 1.80 in similar reach 2.

Past Surveys and Investigations –

MNDNR 2010. Rum River Basin stream survey report: Lake Onamia Outlet to Princeton, MN. Steven M. Marod, Author. 85 pp.
MNDNR 2004. Rum River fisheries stream population assessment (Lake Onamia to Princeton). Steven M. Marod, Author. 6 pp.
MNDNR 2003. Fish community IBI assessment of the Rum River Basin.
MNDNR 1998. Fisheries reconnaissance of deep-water pool habitats.
MNDNR 1992, 1987. Fisheries population assessments.
MNDNR 1994, 1995, 1996, 1997. Special smallmouth bass fisheries assessments.
MNDNR 1978. Biological reconnaissance of the Rum River.
MPCA (multiple years). Biological monitoring in Rum River watershed streams, water quality analysis.

Past Management – This management plan is a revision of the 2003 Rum River Management Plan in the Little Falls Area from Mille Lacs Lake to Princeton (similar reaches 2, 3, 4). Similar reach 1 (~84 miles in length) is managed by three other Area Fisheries Offices: East Metro Area (river mile 0.00 to mile 26.55); Hinckley Area (mile 26.55 to mile 77.72); and Montrose Area (mile 77.72 to mile 83.54).

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Fish Stocking:

1) 5,260 fingerling smallmouth bass were stocked from 1977 to 1979 in the Rum River.
2) 25 adult smallmouth bass were collected from the Mississippi River and stocked into the Rum River.

Special Fishing Regulations:

1) An experimental regulation on smallmouth bass was in place from 1990 through 1998. This regulation consisted of a protected slot on all bass between 10 and 18 inches, a three-fish possession limit, and only one fish over 18 inches allowed in a limit. The smallmouth bass regulations were discontinued in 1999 due to their ineffectiveness in improving the quality of the bass population. Regulation evaluations indicated abiotic factors such as stream flow, climate, and physical habitat influenced bass populations to a much greater extent than fishing regulations. Management efforts have shifted emphasis to watershed approaches directed at maintaining the stream's ecological functions as a headwaters nursery stream.

Watershed Management:

1) The Mille Lacs County NRCS along with 12 other counties in the Rum River watershed received $120,000 in 1998 and $250,000 in 1999 from MPCA/EPA to implement watershed improvement practices including: wetland restoration, rotational grazing, nutrient management, and no-till farming.
2) The Mille Lacs Lake Watershed Management Plan recently received $170,000 in a challenge grant from MPCA to evaluate water quality in the Mille Lacs Lake watershed. MPCA monitors water quality at the outlet of Mille Lacs on an annual basis.
3) The concrete outlet control structure for Lake Onamia was removed and replaced with a rock ramp riffle in 2007.
4) The outlet structure on Lake Ogechie will also be replaced in the near future to maintain lower water levels seasonally for the purpose of managing wild rice in Lake Ogechie, and a more natural flow regime at the headwaters of the Rum River.

ASSESSMENT OF RESOURCE CONDITION (ARC)

HYDROLOGY

General Description – A total of six third-order streams (Strahler stream order) form the source of the Rum River. The West Branch Rum River has its source in eastern Morrison County and eventually becomes a fifth-order stream when Stony Brook enters the river in eastern Benton County. The first 4.67 miles of the upper West Branch Rum River has been straightened. At the confluence of the Rum River and West Branch, the Rum River becomes a fifth-order stream from near Princeton to the mouth in Anoka. The Mille Lacs Lake levels are dependent on the MNDNR-owned dam (Buckmore Dam) on the Rum River at the outlet of Ogechie Lake, which is managed for wild rice production by the MNDNR and Mille Lacs Band.

A proposed project will create a new water-control structure on the outlet of Mille Lacs Lake. The Buckmore Dam at the outlet of Ogechie Lake will be modified to lower water levels in lake, and provide a more natural flow regime to manage wild rice in Ogechie Lake.

Natural features such as springs, stream sinks, and sink holes have not been mapped in the Rum River Basin. Four coldwater streams exist within the Rum River watershed: Black Bear Creek, Borden Creek, Barbour Creek, and Camp Creek, all in Crow Wing County (Brainerd Fisheries Management Area). Of the four, only Borden Creek is known to currently have trout present.

The United States Geological Survey (USGS) maintains an active stream flow gage in the Rum River watershed at Anoka. Gage Station #05286000 is located near the confluence of the Rum and Mississippi rivers. Mean annual discharge for the Rum River in 2009 (518.1 cfs) was below average when compared to the mean (640.3 cfs) for the period of record (1931-2009). The highest instantaneous peak daily flow (10,000 cfs) occurred on April 13, 1969, while the lowest recorded daily flow (30 cfs) occurred on August 3, 1934. Mean monthly flow for 2009 was compared to historical mean monthly flows. In general, discharge in 2009 was above normal in March, normal in April, below normal in summer, and normal in fall. The hydrograph of the Rum River from 1970-2010 (current conditions) reflects a primarily snowmelt-spring precipitation-driven river with peak flows usually in April, low flows in August, a small rise in October, and lowest flows in January and February. High flows (i.e., floods) are estimated to happen at

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about 554 cfs. On average, these floods peak on April 29th each year and last for about 24 days. However, the normal variability in peak flows can be anytime between April 4 and June 11. The Rum River tends to rise slightly faster than it recedes during flooding. On average the river rises by about 20 cfs per day on the rising limb and recedes at about 15 cfs per day on the descending limb. Hydrology in summer may be important to aid recruitment of smallmouth bass during their nesting (i.e., June) and juvenile nursery (July and August) time periods. Flows normally have ranges of 393-1,163 cfs in June, 350-766 cfs in July, and 244-584 cfs in August.

No gage information is available for the West Branch of the Rum River.

The precipitation pattern in the watershed as measured at Milaca deviated from normal during summer and fall 2009. Mean monthly precipitation was above normal in March and October; below normal from May through July, September, and November; and normal in all other months. Rainfall events of greater than one inch occurred in March, July, August, and October. Total annual precipitation for the year was lower than average at Milaca.

Management Concerns for Hydrology (at each of three spatial scales)

Watershed-scale Concerns – Ditching, tiling, and wetland drainage (storage of water on the land) are likely problems based on known effects from these land use activities. USGS records do not pre-date ditching, tiling, and wetland drainage activities; therefore, we cannot specifically identify altered hydrology for this specific river, and instead rely on proxy variables such as wetland loss, etc. Downstream urbanization results in impervious surfaces that may result in stormwater discharge that may further alter hydrology. Many gravel road crossings on tributaries and mainstream Rum and West Branch probably contribute sediment also.

Riparian-scale Concerns – In selected locations, mostly in similar reach 1, riparian zone land use in the form of urbanization has resulted in increased impervious surfaces and manicured lawns that may also contribute to elevated flows and altered hydrology. In most of the watershed, riparian zones are intact.

Instream-scale Concerns – 10.8 percent of the West Branch Rum River is channelized and has water withdrawal appropriations (water allocation). However, specific effects from these activities are unknown. A series of dams at Ogechie (Mille Lacs Kathio State Park), Milaca, and Anoka have differing levels of hydrologic impacts. Ogechie Dam is in the process of modification to better manage for fish passage and rice production in Ogechie Lake. Milaca Dam is in the process of removal (2013). Anoka Dam may need some repair to remain an effective barrier to Asian carp or may be considered for removal if political will allows. More detailed analyses of the hydrology of other reaches upstream and downstream from dams may be needed to better identify instream hydrology concerns

Management Recommendations for Hydrology:

1) Identify key land areas for wetland restoration and work with partners to protect, enhance, or restore these areas.
2) Explore structural modifications to existing and future tiling efforts, work with partners to provide alternative to future tiles.
3) Work with local partners to identify and address problems associated with ditches.
4) Work with municipalities to improve stormwater management and other runoff issues associated with impervious surfaces in the watershed or riparian locations.
5) Work with partners to restore the channelized reaches on the West Branch Rum River.
6) Install additional stream flow gages on the West Branch Rum River to obtain more data on how stream hydrology is affected by water appropriations.

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CONNECTIVITY

General Description – Of the four connectivity aspects (lateral, longitudinal, vertical, and temporal), longitudinal was the only aspect for which issues were recorded. On the Rum River a fixed-crest water-control structure exists at the outlets of Ogechie Lake and Lake Onamia. An additional dilapidated dam is present in the city of Milaca. These structures have been a barrier to upstream fish movement during low-water events. MNDNR Fisheries has sought funding and local support to change the structure in Milaca to a rock/boulder riffle structure in place of the existing dam. In the 2009 stream survey there were a total of 24 road crossings (majority bridges) over the Rum River. No dams exist on the West Branch Rum River. There were a total of 28 road crossings (mostly culverts) over the West Branch Rum River.

Management Concerns for Connectivity (at each of three spatial scales)

Watershed-scale Concerns – None identified.

Riparian scale Concerns – None identified.

Instream scale Concerns – Loss of longitudinal connectivity on the mainstem from the four dams. Longitudinal connectivity impacts associated with the 24 road crossings are unknown at this time.

Management Recommendations for Connectivity:

1) Continue to seek funding and local support to change the structure in Milaca to a rock/boulder riffle structure in place of the existing dam.
2) Work with county engineers as road crossing issues arise on the Rum River, West Branch and other tributaries.
3) Specifically work to improve connectivity through the downstream dam at Anoka.

GEOMORPHOLOGY AND FISH HABITAT

General Description – During the 2009 stream survey, morphological descriptions were calculated at one site within each similar reach on the Rum and West Branch Rum Rivers with exception of similar reach 4 on the Rum River, which was highly influenced by lakes and associated control structures. Stream classifications were assigned to each similar reach at the sampling station based on Rosgen methodologies. Conditions at most sites were in adequate geomorphic condition providing reasonable access to the floodplain. All surveyed reaches were classified as C channels with only slight entrenchment. Substrates were dominated by either gravel or sand. The first 4.67 miles of the upper West Branch Rum River has been straightened in conjunction with agriculture activities, but this site was not specifically surveyed.

Management Concerns for Geomorphology and Fish Habitat (at each of three spatial scales)

Watershed-scale Concerns – The present data either do not suggest a geomorphologically unstable stream or are insufficient to detect determine if the stream is stable or not. Any channel instability is likely localized at riparian or instream scales.

Riparian-scale Concerns (e.g., eroded banks) – Localized erosion present, particularly in the West Branch. More data may be needed to fully assess. Localized floodprone area widths may be impacted.

Instream-scale Concerns – Some localized geomorphic disturbances are likely associated with the presence of dams which likely cause sediment imbalance and lack of downstream transport. Several dirt and gravel roads cross the rivers and may be local sources of erosion and sediment as well.

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Management Recommendations for Geomorphology and Fish Habitat:

1) Obtain geomorphology on additional stations to better grasp stream geomorphology in these large reaches and to assess temporal changes by revisiting existing sites.
2) Gather additional information specifically on fish habitat.
3) More geomorphic information should be gathered specifically on the West Branch, by 2015.
4) Consider restoration of ditched channel on the West Branch.
5) Evaluate stream channel stability (e.g., with BEHI) at locations where excessive erosion has been identified.

WATER QUALITY

General Description – Water quality was monitored at two sites on the Rum River, RR1 (Stations S002-955) near Milaca, and RR3 (S004-409) near Princeton, and one site on the West Branch Rum River WB1 (Station S002-953) west of Princeton by MPCA in 2009. An additional MPCA water-quality site on the Rum River near Pease, RR2 (Station S000-045), was included in the survey, only to report *E. coli* counts, as more data were collected at this site. Parameters measured at water-quality sites included transparency, dissolved oxygen (D.O.), Kjeldahl nitrogen (TKN), nitrate and nitrite nitrogen (N-N N), pH, total phosphorus (TP), suspended solids (TSS), temperature, and *E. coli* count. All sites had typical water quality values for the north central hardwood forest ecoregion observed by MPCA, except for the West Branch where readings for nitrate exceeded the 75th percentile for streams in the north central hardwood forest (NCHF) ecoregion. Although not tested, there appears to be a strong association between precipitation events and peaks in TKN, N-N N, TP, TSS, Turbidity and *E. coli* counts.Sampling for *E. coli* was completed only three times at both RR1 and RR2, of which only one exceeded the MPCA threshold (126). *E. coli* counts at RR1 ranged from 1 to 38 per 100 ml and counts at RR3 ranged from 7 to 131 per 100 ml. No counts were obtained at WB1. A total of nine counts were obtained at RR2 and ranged from 11 to 980 per 100 ml. Two readings exceeded the MPCA threshold at RR2, 690 on 15 July, 2009 and 980 on 7 October, 2009. Despite these high readings, not enough samples were taken to cause the stream to be listed as impaired by MPCA. The geometric mean of a total of five counts in a month over 126 is required for listing. Feedlots and agricultural land use were high in areas with high nitrate and *E. coli* readings.

Management Concerns for Water Quality (at each of three spatial scales)

Watershed scale Concerns – Elevated nitrogen levels likely from land use practices in the West Branch.

Riparian scale Concerns – None known at this time.

Instream scale Concerns – None known at this time.

Management Recommendations for Water Quality:

1) Support more intensive water-quality sampling efforts from other agencies, including MPCA.
2) Work with the MPCA during their intensive watershed-sampling effort in 2014, including participation in MPCA stakeholder meetings.
3) Only walleye and common carp have been tested for fish consumption guidelines. Walleye have been found to contain mercury, with guidelines suggesting no more than one meal/week for the general population. Other recreationally important fishes, such as smallmouth bass, should be assessed as well.

BIOLOGY

General Description – A total of 35 fish species and two hybrids were captured at 31 electrofishing stations on streams within the Rum River Basin. The most dominant species collected were central mudminnow (14.4 %), white sucker (13.7%), common shiner

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Rum River **West Branch Rum River**		**M-063** **M-063-026**	**150.78** **55.93**	**April 2012**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
3	**Little Falls Area (F312)**	**83.54 to 150.78 (M-063)** **0.00 to 55.93 (M-063-026)**	**67.24 (M-063)** **55.93 (M-063-026)**	

(12.1%), and creek chub (11.1%). Other species common in the catch included central stoneroller (6.3%), finescale dace (6.2%), Johnny darter (5.4%), brook stickleback (5.0%), pearl dace (4.8%), and hornyhead chub (4.8%). Gamefish species included smallmouth bass (3.8%), yellow perch (0.6%), rock bass (0.5%), largemouth bass (0.3%), northern pike (0.2%), bluegill (0.1%), and walleye (0.1%). Most recreationally important fishes were in similar reaches 2, 3, and 4 on the mainstem Rum River. Several species considered intolerant of pollution were represented and included hornyhead chub, blacknose shiner, longnose dace, greater redhorse, rock bass, and smallmouth bass. The entire mainstem Rum River is listed as infested waters due to spiny waterfleas and zebra mussels. Curly-leaf pondweed is also present in selected water bodies in the watershed.

Fish community IBI scores were calculated for all 31 electrofishing stations. Scores ranged from 90 (excellent) to 17 (very poor). "Excellent" scores were recorded for stations on Estes Brook (2 sites), West Branch Rum River, and Bogus Brook. "Good" scores were common and were calculated at stations on Tibbetts Brook, Vondell Brook, Rum River (3 sites), West Branch Rum River (3 sites), Bogus Brook (2 sites), and a tributary to Estes Brook. Scores indicative of "fair" biological integrity were recorded at stations on the South Fork Bradbury Brook, Rum River, an unnamed ditch and Prairie Brook. "Poor" biological integrity scores were calculated at sites on West Branch Rum River, County Ditch #4, Stony Brook, and Mike Drew Brook. Bradbury Brook was the only station that received a "very poor" score.

Management Concerns for Biology (at each of three spatial scales)

Watershed-scale Concerns – Most watershed-scale problems may be in selected smaller-scale locations (e.g., HUC-12 sub-watersheds). Sub-watersheds with low IBI scores included West Branch Rum River, County ditch #4, Stony Brook, and Mike Drew Brook. Watershed-scale factors may be contributing to low IBI scores in these locations, but more information is needed to verify.

Riparian-scale Concerns – Primary noxious plant species or other exotic invasive species (e.g., emerald ash borer) may be found in the riparian zone in selected locations. However, specific locations were not identified in the current stream survey.

Instream-scale Concerns – Aquatic invasive species including zebra mussels and spiny waterfleas may displace native species and alter substrates (e.g., dead zebra mussel shells). Their presence and abundance should be monitored and managed if possible. Rare fishes are present and include blacknose shiner, trout-perch, and greater redhorse (special concern). Most fishes collected were common to this basin and represented good aquatic habitat. However, low IBI scores at some sites may indicate localized areas of poor fish community structure that may require additional management strategies. Current sampling targeted an assessment of the fish community and may not have sufficiently sampled populations of recreationally important fishes. More data specific to recreational species may need to be collected. Bait dealers are permitted to operate in the basin and may potentially serve as vectors for invasive species.

Management Recommendations for Biology:

1) Get more information on gamefish populations to guide development of management strategies.
2) Consider surveys of freshwater mussel populations to permit assessment of zebra mussel effects.
3) Monitor spread of spiny waterflea and zebra mussel from upper basin.
4) Consider future invertebrate sampling.
5) Consider identifying distribution and abundance of terrestrial invasive species in the riparian zone.

SOCIAL CONSIDERATIONS

General Description – Social aspects of the Rum River watershed were not surveyed or quantified during the present survey. Old creel surveys exist and need to be summarized. In general, the Rum River is a designated canoe route that sustains canoeing,

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Rum River West Branch Rum River		M-063 M-063-026	150.78 55.93	April 2012
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tubing, swimming, camping, and other similar activities. In winter, snowmobilers may use the frozen mainstem channel as a trail. There is a no-wake boating regulation on the lower Rum River near Anoka. There are 8 access points; all 8 provide canoe take-out facilities, 2 have boat ramp facilities, and 2 are in state parks. Lack of access is probably not a major concern. There are two campsites within Mille Lacs Kathio State Park and five state-maintained remote campsites along the Rum River between Onamia and Princeton. Dams may be safety hazards to some uses, especially the dam at Milaca. A Rum River advisory board exists and has been working to request designation as a wild and scenic river. Bait dealers harvest bait on this river, primarily hornyhead chub. Part of the watershed lies within the 1837 Treaty area. Significant cultural resources (e.g., burial sites) exist in the upper basin, near Lake Mille Lacs. No commercial fisheries are present in the mainstem Rum River at this time.

Management Concerns for Social Considerations (at each of three spatial scales)

Watershed scale Concerns – This watershed crosses six counties lines, three legislative districts, and three Area fisheries offices. Potential designation as a Wild and Scenic River may lead to increased conflicts among multiple users groups. There is no organized watershed district or interest group present in this basin yet.

Riparian scale Concerns – Adequacy of existing access points may need to be evaluated. There is minimal development in the riparian zone at this time.

Instream scale Concerns – Dams are barriers to recreational boaters and create unsafe conditions. MNDNR Trails and Waterways removes woody fish cover to promote safer canoeing. Dam removal may create social conflict as a loss of aesthetic beauty and because it may allow downstream invasive species to move upstream. Bait dealers may be vectors of invasive species transport.

Management Recommendations for Social Considerations:

1) Identify all stakeholders and maintain communication and coordination to manage conflicts.
2) Actively participate in discussions with Parks, Trails and Waterways division, or whomever, regarding potential Wild and Scenic River designation.
3) Engage in conversations and provide information on options to address the Milaca Dam.
4) Evaluate adequacy of existing access points for recreational users. Determine need for more access points. Determine adequacy of existing access points for all users (e.g., physically challenged users).
5) Coordinate wood-removal practices with MNDNR Trails and Waterways.
6) Work with local hydrologist to maintain current outlet elevation on Mille Lacs Lake via the dam on Ogechie Lake.

Reference

MNDNR (Minnesota Department of Natural Resources). 2007. Fisheries stream survey manual, version 2.5. Special Publication 165, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

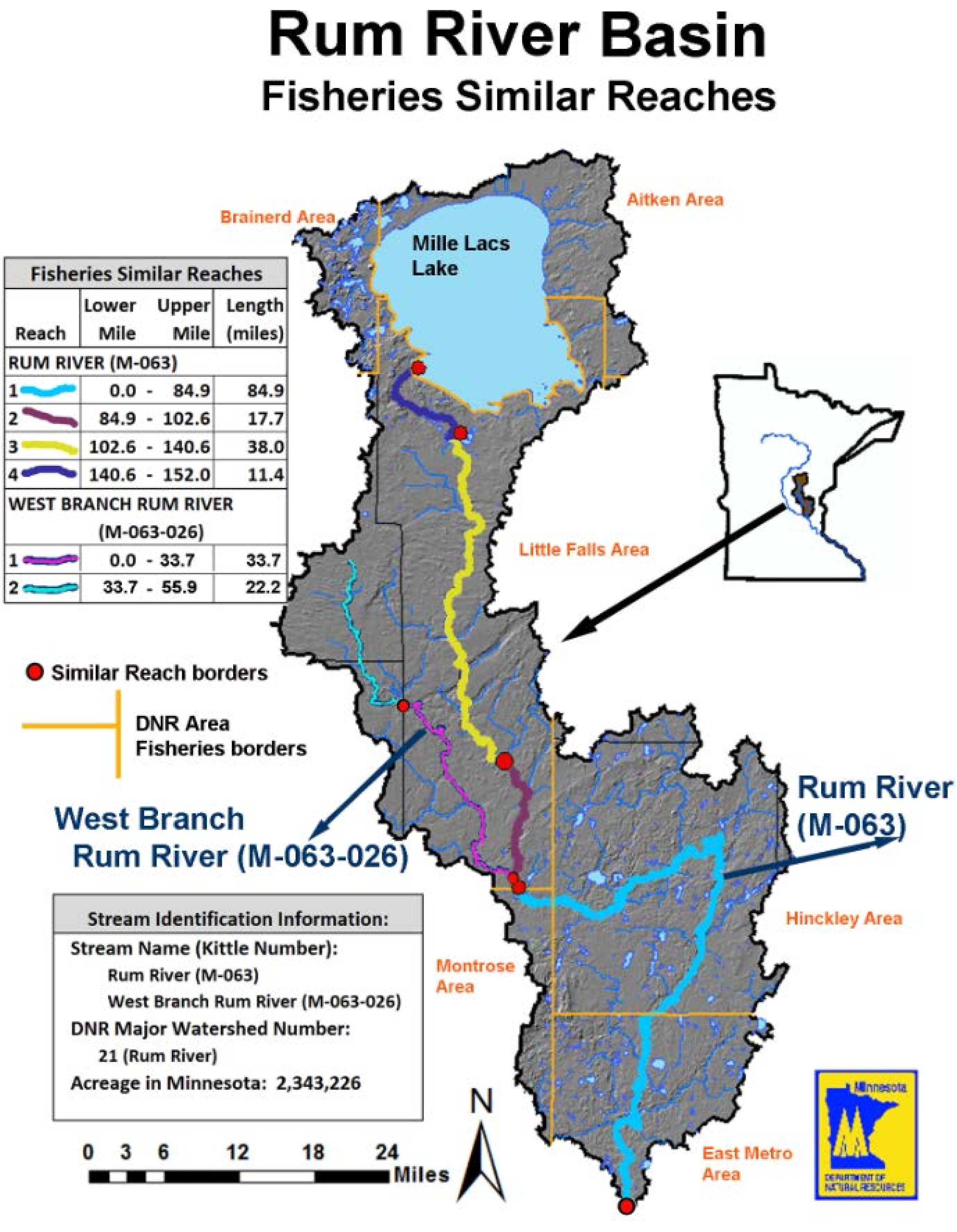

Figure 1. Map of Rum River (M-063) basin and fisheries similar reaches.

STREAM MANAGEMENT PLAN – Page 1

<table>
<tr><td colspan="3">Stream Name
Manitou River</td><td colspan="2">Kittle Number
S-045</td><td>Total Miles in Minn.
24.95</td><td>Date of Plan (Mo.-Yr.)
April 2012</td></tr>
<tr><td>Region
2</td><td colspan="2">Area Fisheries Office
Finland (F215)</td><td colspan="2">Plan Managed Segment (river miles)
0.0 – 24.95 (entire)</td><td colspan="2">Length (miles) Plan Managed Segment
24.95</td></tr>
<tr><td colspan="3">Major Watershed:
Lake Superior North (1)</td><td colspan="4">Minor Watersheds (significant tributaries)
1084 (Hoist Cr.); 1085 (Moose L. Cr.); 1086 (Ninemile Cr.); 1087-1088 (Manitou R.); 1089 (S.Br.Manitou R.)</td></tr>
<tr><td>Similar Reach</td><td>Similar Reach Name</td><td>Stream Miles</td><td>Length (miles)</td><td>Rosgen Channel Type</td><td>Fisheries Ecological Classification</td><td>Species of Management Interest</td></tr>
<tr><td>**1**</td><td>**Park**</td><td>**0.00 - 5.14**</td><td>**5.14**</td><td>**B**</td><td>**IA Wild trout**</td><td>**Brook trout**</td></tr>
<tr><td>**2**</td><td>**Tributaries**</td><td>**5.14 - 11.04**</td><td>**5.90**</td><td>**C**</td><td>**IA Wild trout**</td><td>**Brook trout**</td></tr>
<tr><td>**3**</td><td>**Patch Area**</td><td>**11.04 - 17.05**</td><td>**6.01**</td><td>**B**</td><td>**IA Wild trout**</td><td>**Brook trout**</td></tr>
<tr><td>**4**</td><td>**Grade**</td><td>**17.05 - 21.12**</td><td>**4.07**</td><td>**C**</td><td>**IA Wild trout**</td><td>**Brook trout**</td></tr>
<tr><td>**5**</td><td>**Swamp**</td><td>**21.12 - 23.98**</td><td>**2.86**</td><td>**E**</td><td>**IA Wild trout**</td><td>**Brook trout**</td></tr>
<tr><td>**6**</td><td>**Lakes**</td><td>**23.98 - 24.95**</td><td>**0.97**</td><td>**C**</td><td>**ID marginal**</td><td>**Brook trout**</td></tr>
</table>

This is a revision of the Initial 2009 Manitou River Management Plan.

Long-Range Goals

Goal 1: *A self-sustaining brook trout population and appropriate native fish community.*

Objectives (Desired Future Conditions) and Operational Plans:

1) Four year classes of brook trout present in the Manitou River.
   a. Conduct a fish survey every five years using the same stations and methods used in the 2010 survey; next survey 2015.
2) Age-1+ brook trout electrofishing overall catch rate at or above 150 fish per/mile, in similar reaches 1 through 5.
   a. Conduct a fish survey every five years using the same stations and methods used in the 2010 survey; next survey 2015.
3) Fish IBI score shall exceed the MPCA threshold value.
   a. Calculate IBI values for the Manitou River and compare against MPCA threshold values.

Goal 2: *Quality instream habitat suitable for brook trout and a native fish community with a stable stream channel.*

Objectives (Desired Future Conditions) and Operational Plans:

1) Maintain the quality (MSHA scores above 65 in similar reaches 1-4) instream habitat documented in the 2010 survey.
   a. During each survey evaluate MSHA scores and cover types for large fishes, addressing any changes from previous investigations.
   b. Continue association with the Manitou Collaborative and maintain temperature loggers in the Manitou River Patch Project through 2019.
   c. Coordinate with Parks and Trails regarding activities along the Manitou River and Manitou River watershed within George Crosby Manitou Park.
   d. Passively manage the beaver population in similar reaches 3 and 6.
      d.1. Inform local trappers of problem beaver populations.
      d.2 Encourage Forest Management activities that promote coniferous species in the riparian area.
   e. Ensure MFRC Best Management Practices are followed.

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Manitou River		**S-045**	**24.95**	**April 2012**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Finland (F215)**	**0.0 – 24.95 (entire)**	**24.95**	

Long-Range Goals *(continued)*

f. Consult with MNDNR Foresters on timber management activities adjacent to waters of the Manitou Watershed on state lands.

g. Review and comment on all Division of Waters permits in the Manitou Watershed.

2) Evaluate stream stability in similar reach 2.

a. Conduct a Geomorphology Survey in similar reach 2 near mile 7.43, identified as a potential problem area in the 2010 survey, before the next scheduled Fish Survey on the Manitou River (2015).

Future Potential Plans

1) Work with partners to encourage the installation of a USGS stream flow gage on the Manitou River.
2) Conduct an invertebrate survey and calculate an Invertebrate IBI score.
3) Identify distribution and abundance of terrestrial invasive species in the riparian zone.
4) Encourage bridge replacement of the General Grade Road culverts to improve connectivity.
5) Consider easements on private lands as opportunities arise in similar reaches 2 and 3.
6) Conduct Geomorphology Survey on similar reach 3 near stream mile 15.74 (location of failing habitat structures) in order to recommend structures that will complement the geomorphology of the channel.

Area-Specific Needs
■ 1854 Ceded Territory
■ Designated trout stream
■ MN State Park
■ USFS District: Tofte

Approvals

Plan Authors			
Kelly McQuiston			
Area Supervisor	**Date**	**Regional Manager**	**Date**
Kelly J McQuiston	4/17/2012	[signature]	4/23/12

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Manitou River		**S-045**	**24.95**	**April 2012**
Region **2**	Area Fisheries Office **Finland (F215)**	Plan Managed Segment (river miles) **0.0 – 24.95 (entire)**	Length (miles) Plan Managed Segment **24.95**	

BACKGROUND INFORMATION

Priorities – The Manitou River is one of the top priorities in the Finland management area because of its pristine nature, scenic beauty, and a quality brook trout fishery along with the presence of a state park and partnership with the Manitou Collaborative.

Description of Stream System – The 24.95-mile Manitou River (Figure 1; designated trout stream) begins at Delay Lake (38-0415), an 18-foot-deep 102-acre lake that is currently managed for walleye, but also contains northern pike, smallmouth bass, yellow perch, rock bass, and white sucker. The river then flows into 54-acre Round Island Lake (38-0417), which is 4 feet deep and hosts a population of northern pike, yellow perch, white sucker, and an occasional migrant walleye from Delay Lake. Between Round Island Lake and Lake Superior, the Manitou River is joined by 60 tributaries totaling 154.5 miles of stream. The upper reaches (similar reaches 4 to 6) of the Manitou River are characterized by extensive timber cuts in the surrounding hills. Heavy beaver activity and low channel slopes result in many expansive pool areas surrounded by brushy swampland. The middle reaches (similar reaches 2 and 3) contain the major tributaries, greatly increasing the flow and width of the stream. Extensive areas of past logging are present and timber management is ongoing. The brook trout population in the Manitou River is self-sustaining, with the last stocking made over 18 years ago (1993). The lower portion of the Manitou River is a well-known brook trout fishery, prized for its ample although sometimes arduous access points in George Crosby Manitou State Park, where larger brook trout can be caught in the deep plunge pools. The wide impounded area above the General Grade Road is a well-known local fishing spot that regularly produces fish over eight inches. It is unknown how many anglers brave the maze of logging roads between Lake County Road 7 and the General Grade, but little evidence of fishing was found during the most recent survey.

Past Surveys and Investigations-

Initial survey: 1940 (John B. Moyle)
Stream resurvey: 2003
Stream population assessments: 1986, 1988, 2010
PCA assessments: 1998
Stream habitat improvement structures: 1987, 1989, and 1991

Past Management – An initial Management Plan was created in 2009. The goal from the 2009 management plan was to maintain an adult brook trout catch rate at or above 150 fish per mile. The most recent survey (2010) recorded a catch rate of 105 fish per mile. Possible reasons for not attaining the goal are discussed in the Biology section of the Assessment of Resource Condition.

Manitou River has received numerous stream habitat alterations from 1987 to 1990 located in similar reach 3. Improvements included beaver dam and log jam removal, access trail construction, and stream habitat structures (Table 1). The Manitou River watershed is part of the 100,000-acre Manitou Landscape where land resource managers (public and private) formed the Manitou Collaborative in 2000 to work together to conserve and manage the

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ecological, recreational, and economic values of the Manitou Landscape.

The 1940 report recommended stocking brook trout in the upper portion and brown and rainbow trout in lower reaches. Although stocking records are available only back to 1955 for the Manitou River, the 1940 survey suggests that the stream at that time was receiving stockings of trout, but "… better fishing could be had by stocking more and larger trout." Brook, brown, and **rainbow trout were all sampled in the 1940 survey. Eventually all trout stocking was discontinued; brown trout in 1962**, rainbow trout in 1974, and brook trout in 1993 when the Finland Management Area was striving to have a wild naturally reproducing brook trout population in all suitable area streams.

ASSESSMENT OF RESOURCE CONDITION

HYDROLOGY

General Description – The stream appears to be stable with little geomorphic impact, suggesting the current hydrologic regime has been constant for some time.

The Manitou River begins at the outlet of Delay Lake and continues through swamp land before entering Round Island Lake. Between Round Island Lake and Lake Superior it is joined by 60 tributaries (35 have spring sources) totaling 154.5 miles of stream.

Although many tributaries contribute flow to the Manitou River, summer flow is highly dependent on precipitation. Annual precipitation has been recorded at Finland for 35 years (DNR Forestry) with a mean annual precipitation of 32.42 inches, with an average of 15.13 inches of precipitation recorded between June 1st and the end of September. Total annual precipitation recorded in 2010 was 32.03 inches, with 16.97 inches recorded between June 1st and the end of September. Most flooding typically occurs with spring snowmelt, although fall flooding can occur after heavy rainfall events.

Management Concerns for Hydrology (at each of three spatial scales)

Watershed scale Concerns – Land use alterations, mostly from timber harvest, have taken place in the watershed (63,601 acres), impacting the Manitou River. This alteration may have affected the holding capacity and temperature of the headwater swamps and changed runoff patterns. About 18% of the watershed has been altered in the past 25 years. Upon inspection of the 1991 aerial photos, 6,651 acres (10.5% of the total acreage) of watershed contained alterations. The 2003 photos showed 3,673 acres were altered since 1991 (5.8%) and 1,065 acres (1.6%) showed alterations in the 2009 aerial photos (Figure 2), one of the lowest percentages of alterations in the Finland management area.

Riparian-scale Concerns – No concerns identified at this time.

Instream-scale Concerns – Beaver dams in similar reaches 3 and 4 impound water, impacting water temperatures and promoting evaporation. However, water storage in beaver dams may also increase baseflow during dry periods.

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Manitou River		S-045	24.95	April 2012
Region 2	Area Fisheries Office Finland (F215)	Plan Managed Segment (river miles) 0.0 – 24.95 (entire)	Length (miles) Plan Managed Segment 24.95	

Management Recommendations for Hydrology:

1) Minimize changes to existing hydrology from timber management through partnership with the Manitou Collaborative.
2) Work with USGS to establish a gaging station to better define the present hydrologic regime of the Manitou River.
3) Encourage forest management activities that encourage spruce in riparian areas to minimize amount of deciduous trees available for beaver forage.

CONNECTIVITY

General Description – The natural upstream barrier (i.e., natural falls) on the Manitou River at mile 0.21 prevents passage of fish and other aquatic organisms (including exotic invasive species from Lake Superior). Sixty-seven beaver dams were recorded during the 2003 survey; most were located in similar reaches 5 and 6 and no beaver dams were found below similar reach 3. Most dams were listed as impeding fish movement and also movement of natural woody debris. Although most could be categorized as seasonal barriers, some may impede trout movement to spawning areas and deep water wintering pools. In the 2010 Stream Survey there were a total of eight road crossings – five bridges and three culverts – located at stream mile 17.65 and above; none were listed as continuous barriers to fish or sediment movement. During low water, the culverts at the General Grade Road Crossing may potentially impede upstream fish movement. Timber management activities can temporarily or permanently redirect the natural drainage pattern; temporary logging roads may alter the flow of small tributaries through failure to remove temporary culverts or debris used to create ice dams.

Management Concerns for Connectivity (at each of three spatial scales)

Watershed-scale Concerns – Cumulative impacts of crossings from temporary forest roads and other timber management activities on small tributaries may affect the longitudinal and lateral connectivity to the Manitou River.

Riparian-scale Concerns – No concerns identified at this time.

Instream-scale Concerns – Beaver dams in similar reaches 3 and 4 can potentially block spawning and wintering areas.

Management Recommendations for Connectivity:

1) Ensure that Forestry Best Management practices are followed. Tributaries impacted by logging activities should be restored to their natural channels.
2) Encourage forest management activities that encourage coniferous species in riparian areas to minimize amount of deciduous trees available for beaver activity.
3) Passively manage beaver populations in similar reaches 3 and 4. Beaver dams in similar reaches 5 and 6 are numerous but are of low priority.
4) Encourage replacement of the General Grade Road culverts with a bridge.

Stream Name Manitou River		Kittle Number S-045	Total Miles in Minn. 24.95	Date of Plan (Mo.-Yr.) April 2012
Region 2	Area Fisheries Office Finland (F215)	Plan Managed Segment (river miles) 0.0 – 24.95 (entire)	Length (miles) Plan Managed Segment 24.95	

GEOMORPHOLOGY AND FISH HABITAT

General Description – During the 2010 Initial Survey six similar reaches were assigned a Level I stream classification (Table 2). Habitat was scored through the Minnesota Stream Habitat Assessment (MSHA) and cover for large fishes was observed and recorded; no cover types were listed as abundant. MSHA stream ratings were between 41 and 86 (out of potential of 100). Most similar reaches were lacking in the "Riparian Area" category (narrow areas and little shade in areas surrounded by bog/swamp), "Cover Type" (lack of variety or limited quantity), and "Substrates" (increasing amounts of muck and detritus with slightly embedded substrates in middle to upper reaches).

Only one station was surveyed in similar reach 1. This station had a moderate MSHA score of 65 and cover types were deep pools and boulder pockets and low amounts of woody debris. These findings are not considered limiting for a ledge rock- and boulder- dominated B-channel type. Similar reaches 2 and 3 had the highest MSHA ratings and both reaches contained all possible cover types although the abundance of cover was low. Despite high MSHA ratings at station 7.43 (similar reach 2/Channel type C) it is beginning to show some characteristics of an F-channel, becoming wider with poorly defined channel characteristics and lateral bank erosion (likely due to high-volume timber management activities in the watershed directly upstream and from the influence from the bridge crossing of Lake County Road 7 directly downstream). Similar reach 3 contains habitat-improvement projects constructed in 1987 which were last maintained in 1989; most bank shelters and weirs are non-functioning, while Hewitt ramps are in good to fair condition. At station 15.74 the MSHA Score was 86 (highest calculated in the survey); most of the deep water in this reach was associated with Hewitt ramps built during habitat-improvement work. Similar reach 4 contained all possible cover types for large fish and had the most abundance of fish cover of all the reaches. Stations in similar reaches 5 and 6 received lowest scores, which would be expected in the low-gradient headwaters area. The types of cover in these upper reaches were limiting, although the quantity of cover was higher than in other reaches. Erosion was observed at station 21.87 at the culvert, which may be associated with extensive beaver activity in similar reach 5.

Management Concerns for Geomorphology and Fish Habitat (at each of three spatial scales)

Watershed-scale Concerns Timber management activities in the watershed may increase sediment supply, and alter hydrology, and as a result affect stream geomorphology.

Riparian-scale Concerns – The bridge crossings in similar reach 2 may be impacting the stream, causing erosion and altering stream geomorphology. Overhead cover is an issue in areas with bog/swamp riparian zones.

Instream-scale Concerns – Pool habitat may be limiting near areas of stream improvements at station 15.74, as most deep water was associated with Hewitt ramps installed in 1987.

Management Recommendations for Geomorphology and Fish Habitat:

1) Collect geomorphology data on similar reach 2.
2) In the event an outside partner with funding desires to address stream structures, collect additional geomorphology data near stream mile 15.74 to recommend structures that will complement channel

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Manitou River		**S-045**	**24.95**	**April 2012**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Finland (F215)**	**0.0 – 24.95 (entire)**	**24.95**	

geomorphology.

3) Review Division of Waters permits for proposed stream crossings.
4) Ensure Forestry Best Management practices are followed.

WATER QUALITY

General Description – Stream temperatures were acceptable in the Manitou River for brook trout survival at most stations during the summer of 2010. Growth hours were less than adequate at three sites (similar reaches 4 and 5 and just below Nine Mile Creek in similar reach 2). Factors relating to stream temperature that were noted in the 2010 survey included low 2010 spring water levels and higher-than-average summer air temperatures combined with normal levels of precipitation, to produce warm rainfalls that reduced the natural buffering capacity of the Manitou River and many cold-water spring-fed tributaries.

Temperature influences from major Manitou River tributaries were also monitored during the summers of 2009 and/or 2010. Most tributaries had slightly higher temperatures than the Manitou River, most notably Nine Mile Creek. These warmer streams often have connections to shallow warm-water lakes and few tributaries from spring sources. Rock Cut Creek and the Little Manitou River had stream temperatures cooler than the Manitou River, thus more favorable to brook trout in summer months. In cooperation with the Manitou Collaborative, MNDNR Fisheries is monitoring summertime temperatures through continuous recording temperature loggers for a ten-year span (2009-2019). The goal is to record Manitou River water temperature in relation to timber harvest in the vicinity of Balsam Creek and Manitou River (similar reaches 3 and 4).

Sixty-seven beaver dams were recorded during the 2003 survey; most were located in similar reaches 5 and 6, while no beaver dams were found below similar reach 3. Extensive land use alterations, mostly from timber harvest, have taken place in the watershed (63,601 acres), impacting the Manitou River. This alteration may have affected the holding capacity and temperature of headwater swamps and changed runoff patterns. Eight stream crossing were noted, which puts the Manitou River at risk for receiving sediment and pollutants via runoff along with the potential for erosion at times of high flow.

Water chemistry results from the 2010 survey were similar for all stream reaches and within typical ranges established by the Environmental Protection Agency, and considered normal for the “Northern Lakes and Forest” ecoregion with the exception of pH. All samples fell below the typical range (7.6 to 7.9); low pH is common for waters in northeastern Minnesota, especially when associated with bog drainage.

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2	Finland (F215)	0.0 – 24.95 (entire)	24.95	

Management Concerns for Water Quality (at each of three spatial scales)

Watershed-scale Concerns – Timber management activities may influence stream temperatures and water quality (suspended sediments) through runoff and holding capacity of wetland areas.

Riparian-scale Concerns – Timber management activities may influence stream temperatures and water quality (suspended sediments) through runoff and holding capacity of wetland areas, and affect shading if riparian guidelines are not followed. Improperly sized road crossing may have effects on erosion and sediments.

Instream-scale Concerns – Beaver dams may elevate water temperatures and with failure could contribute pulses of sediment.

Management Recommendations for Water Quality:

1) Protect water quality through review of proposed timber sales, ensuring MFRC Best Management Practice Guidelines are followed.
2) Review Division of Waters permits for proposed stream crossings.
3) Continue association with the Manitou Collaborative and maintain temperature loggers in the Manitou River Patch Project through 2019.
4) Passively manage the beaver population.

BIOLOGY

General Description – The Manitou River currently has a self-sustaining brook trout population. A total of 13 fish species were captured at nine electrofishing stations and two angling stations on the Manitou River (Table 3). The goal from the 2009 management plan was to maintain an electrofishing adult brook trout catch rate at or above 150 fish per mile, with 10% greater than 9 inches in similar reaches 1 through 5. Neither of these goals were met in the 2010 survey (105 fish per mile and 2.6% over 9 inches). When evaluating all stations sampled in 2010 by electrofishing, the catch of adult brook trout per mile was the lowest on record. Although of concern, it is not distressing as there were additional stations sampled and historical stations were modified and given that natural population do fluctuate. If future surveys continue to find low brook trout numbers, this may be cause for concern. Previous catches have ranged from 127 to 175 fish per mile. Despite the lower catch rate more adult brook trout were captured than any previous year, and average size (5.43 inches) was similar to the two previous assessments (5.4 and 5.9 inches). Four year classes of brook trout were sampled in 2010 (age-0 to age-3). The number of young -of- year brook trout and their representative catch rate has increased each investigation (Table 4). Brook trout were collected for fish contaminant sampling; no restrictions were place on consumption. Nine invertebrate families were documented in the 2010 survey; caddis fly, stonefly, and crayfish were the most abundant. Thirteen aquatic plant species were identified in 2010 along with three wetland riparian plant species. No terrestrial invasive species were observed during the 2010 survey, but some have been found and mapped in the watershed. Mapping completed in 2004 along the trails and roads within Crosby Manitou State Park found oxeye daisy, orange hawkweed, and Canada thistle; most were located on the park entrance road and the Benson Lake Trail, with a single occurrence of orange hawkweed on the Misquah Trail. Terrestrial invasive mapping along the North Shore state snowmobile trail and Lake County Road 7 occurred in 2008 and 2009; species

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Manitou River		**S-045**	**24.95**	**April 2012**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Finland (F215)**	**0.0 – 24.95 (entire)**	**24.95**	

sampled in the park were again sampled along with birdsfoot trefoil, hairy vetch, and reed canary grass. Terrestrial invasive species are suspected to be present in much the Manitou Watershed, especially in areas near roads and trails.

Sixty-seven beaver dams were recorded during the 2003 survey; most were located in reaches 5 and 6, and no beaver dams were found below reach 3. Most dams were listed as impeding fish movement, although they could be categorized as seasonal barriers. Some may impede trout movement to spawning areas and deep-water wintering pools. Lake Superior has various known invasive species and its waters have tested positive for Viral Hemorrhagic Septicemia VHS; the upstream barrier (waterfall at mile 0.21) provides protection from these afflictions. The area below the upstream boundary has special regulations pertaining to Lake Superior tributaries (see current MN Fisheries Regulations for details).

Between 1999 and 2002 Minnesota County Biological Survey assessed 34,537 acres in the Manitou River Watershed (387 acres were in the Manitou River corridor) for species biodiversity. Approximately 35% of acres received an "Outstanding" rating, 25% a "High" rating, and 40% were rated as "Moderate" for species diversity. Overall, fifteen rare plant species were documented; eight are species of "Species of Special Concern" and two are listed as "Threatened" species in Minnesota.

Management Concerns for Biology (at each of three spatial scales)

Watershed-scale Concerns – Suspected presence of terrestrial invasive species in the watershed.

Riparian-scale Concerns – Suspected presence of terrestrial invasive species in the watershed.

Instream-scale Concerns – The previous catch rate goal/objective for brook trout was not met. Quantitative invertebrate information is limited. Seasonal beaver dam barriers may impede trout movement to spawning areas and deep-water wintering pools.

Management Recommendations for Biology:

1) Revise goals and objectives for brook trout in light of information collected in the most recent survey. Evaluating the long-range goal to "Maintain the self-sustaining brook trout population and native fish community" is dependent on being able to effectively sample this river in the future.
2) Passively manage the beaver population in similar reaches 3 and 4.
3) Continue to monitor the fish community in the Manitou River.
4) Consider scheduling aquatic invertebrate survey in future surveys.
5) Map distribution and abundance of terrestrial invasive species in the riparian zone.

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Manitou River		S-045	24.95	April 2012
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	Finland (F215)	0.0 – 24.95 (entire)	24.95	

SOCIAL CONSIDERATIONS

General Description – Stakeholders in Manitou River Watershed include Lake County, U.S. Forest Service, State of Minnesota (multiple divisions), private land owners (including industrial forest management), Trout Unlimited, 1854 Authority, and Fond du Lac band. Many of these stakeholders are involved in the Manitou Collaborative. As a tributary to Lake Superior the Manitou River also includes all the stakeholders involved with Lake Superior fish management, with an emphasis on the anadromous area. Ownership along the stream corridor includes State (51%), Federal (20.5%), Private (18.4%), and Lake County (10.1%). Watershed uses include timber management, gravel pits, railroad (currently not used), and recreational use. George Crosby Manitou State park is located in the lower reach and surrounds nearly seven miles of the Manitou River. A few residences and cabins are also located within the watershed, although most are located on the lower end near the MN Highway 61 crossing.

Public comment was sought for the development of this Stream Management Plan. A request for comment was published on-line at the MNDNR website, the Duluth News Tribune, Star Tribune, and the Lake County News-Chronicle in March of 2012. Three people requested copies of the draft plan and no response to the management of the stream was received.

The lower portion of the Manitou River is a well-known brook trout fishery, prized for its ample although sometimes arduous access points where larger brook trout can be caught in deep plunge pools. The wide impounded area above the General Grade Road is a well-known fishing spot that regularly produces fish over eight inches. It is unknown how many anglers brave the maze of logging roads between Lake County Road 7 and the General Grade Road, but little evidence of fishing was found during the 2010 survey.

Two Aquatic Management Areas (AMA) are located in the Manitou River Watershed. The 142-acre Balsam Lake AMA surrounds the south and northeast shores of Balsam Lake. The 1,160-acre Manitou River AMA contains a total 2.24 miles along the river in similar reaches 1 and 2 along with sections on the South Branch Manitou, Moose Creek, East Moose Creek, Cabin Creek, Cramer Lake, Nine Mile Creek, and an unnamed tributary in similar reach 1.

An inquiry of easement was desired in 1969 on the lower portion of the stream as a part of an initiative to acquire easements along all North Shore streams. An easement to the privately owned 0.21-mile-long anadromous area would provide little additional angler opportunities due to the steep river banks; therefore no further action has taken place to acquire an easement.

Management Concerns for Social Aspects (at each of three spatial scales)

Watershed-scale Concerns – Given the number of stakeholders in the Manitou watershed, land use conflicts in the watershed are common. The high percentage of public land in the watershed limits the need for additional land acquisition for the state, although angler easements on private lands upstream of the state park would be valuable.

Riparian-scale Concerns – Land use is often influenced by timber management activities.

Stream Name **Manitou River**		Kittle Number **S-045**	Total Miles in Minn. **24.95**	Date of Plan (Mo.-Yr.) **April 2012**
Region **2**	Area Fisheries Office **Finland (F215)**	Plan Managed Segment (river miles) **0.0 – 24.95 (entire)**	Length (miles) Plan Managed Segment **24.95**	

Instream-scale Concerns – None documented at this time.

Management Recommendations for Social Aspects:

1) Maintain communication and coordination with multiple user groups including the Manitou Collaborative.
2) Consider easements on private lands as opportunities arise.

Table 1. Summary of stream improvement structures in the Manitou River.

Year	Location	Improvements	Condition (year)
1987	Between Co. Rd 7 and General Grade Rd.	Built 10,000 feet of angler access trail. Improved 12,000 feet of stream by removing 14 beaver dams, 4 large log jams, and numerous small log jams and downed trees.	Angler access trail was grown over and difficult to find. New log jams and beaver dams had been established. (2003)
1989	Between Co. Rd 7 and General Grade Rd.	Log jam and beaver dam removal. Low-head dam construction and wing deflector installation. Repair of other existing stream structures (year unknown).	Bank shelters, wing deflectors, and low-head dams are in good to excellent shape. (2003)
1990	Miles 15.75-16.49 just below General Grade Rd. Near mouth of Little Manitou River	Removal of 4 beaver dams and installation of 3 Hewitt ramps, 2 bank shelters, and 3 current deflectors.	Bank shelters, deflectors, and Hewitt ramps were in good to excellent shape (2003). Shelters and deflectors in poor shape or not functioning (2010). Hewitt ramps in fair shape. Ramp most upstream has log jam on top of it. (2010)

Table 2. Summary of Level I geomorphology characteristics and Minnesota Stream Habitat Assessment (MSHA) scores.

Similar Reach	Stream Miles	Channel Type	Slope	Sinuosity	Dominant Substrates	MSHA Score (100 max)
1 (Park)	0.00 - 5.14	B	2.65%	1.38	Boulder, bedrock, cobble	65
2 (Tributaries)	5.14 - 11.04	C	0.56%	1.39	Cobble, gravel	84, 71, 79
3 (Patch Area)	11.04 - 17.05	B	0.95%	1.21	Boulder, cobble, gravel	82, 77, 86
4 (Grade)	17.05 - 21.12	C	0.42%	1.74	Boulder, cobble, detritus	73, 50
5 (Swamps)	21.12 - 23.98	E	0.39%	1.83	Muck, silt	53
6 (Lakes)	23.98 - 24.95	C	0.08%	1.04	Muck, detritus	41

Stream Name **Manitou River**		Kittle Number **S-045**	Total Miles in Minn. **24.95**	Date of Plan (Mo.-Yr.) **April 2012**
Region **2**	Area Fisheries Office **Finland (F215)**	Plan Managed Segment (river miles) **0.0 – 24.95 (entire)**	Length (miles) Plan Managed Segment **24.95**	

Table 3. Fish Species sampled in the Manitou River.

Sample Year	**1986**	**1988**	**1998**	**2003**	**2010**	
Agency [1]	MNDNR	MNDNR	MPCA	MNDNR	MNDNR	
Fish Species						
Blacknose dace	X	X	X	X	X	
Blacknose shiner	X	X				
Brook stickleback	X	X		X	X	
Brook trout	X	X	X	X	X	
Central mudminnow		X	X	X	X	
Common shiner			X	X	X	
Creek chub	X	X	X		X	
Fathead minnow	X					
Finescale dace	X	X			X	
Iowa darter	X				X	
Johnny darter			X			
Longnose dace	X	X	X	X	X	
Northern pike	X			X		
Sand shiner					X	
Slimy sculpin	X	X	X		X	
White sucker	X			X	X	
Yellow perch					X	

[1]MNDNR: Minnesota Department of Natural Resources (Finland Station)
MPCA: Minnesota Pollution Control Agency

Stream Name **Manitou River**		Kittle Number **S-045**	Total Miles in Minn. **24.95**	Date of Plan (Mo.-Yr.) **April 2012**
Region **2**	Area Fisheries Office **Finland (F215)**	Plan Managed Segment (river miles) **0.0 – 24.95 (entire)**	Length (miles) Plan Managed Segment **24.95**	

Table 4. Brook trout historical MNDNR catch statistics, summarized by sample year.

Year sampled	1986	1988	2003	2010
Number stations	5	4	5*	9*
Total length sampled (feet)	1606	1621	2676	5088
Number of adults	53	39	79	102
Adult CPUE (fish/min)	0.84	0.29	0.52	0.39
Number of YOY[1]	3	9	19	50
YOY CPUE catch (fish/min)	0.05	0.07	0.12	0.19
Adult catch (fish/mile)	175	127	156	105
% Adults over 9”	5.7%	2.6%	1.3%	2.9%
Mean length adult fish (inches)	~6.5	5.9	5.4	5.43
Largest fish sampled (inches)	~10.2	9.2	9.2	10.6

*= Does not include stations angled
[1]YOY = young-of-the-year
~ Approximate, length range given, no individual lengths

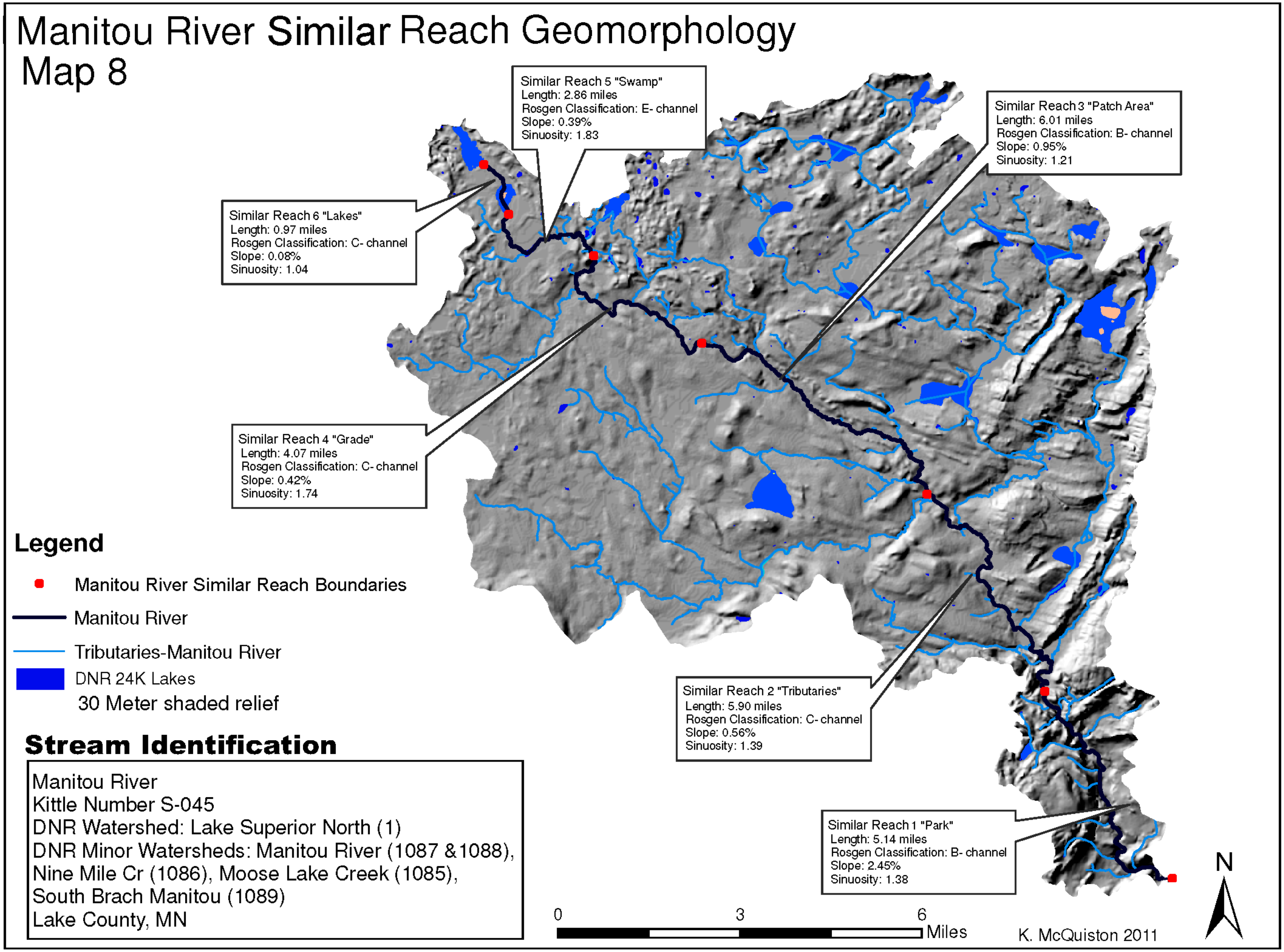

Figure 1. Map of Manitou River (S-045) fisheries similar reaches.

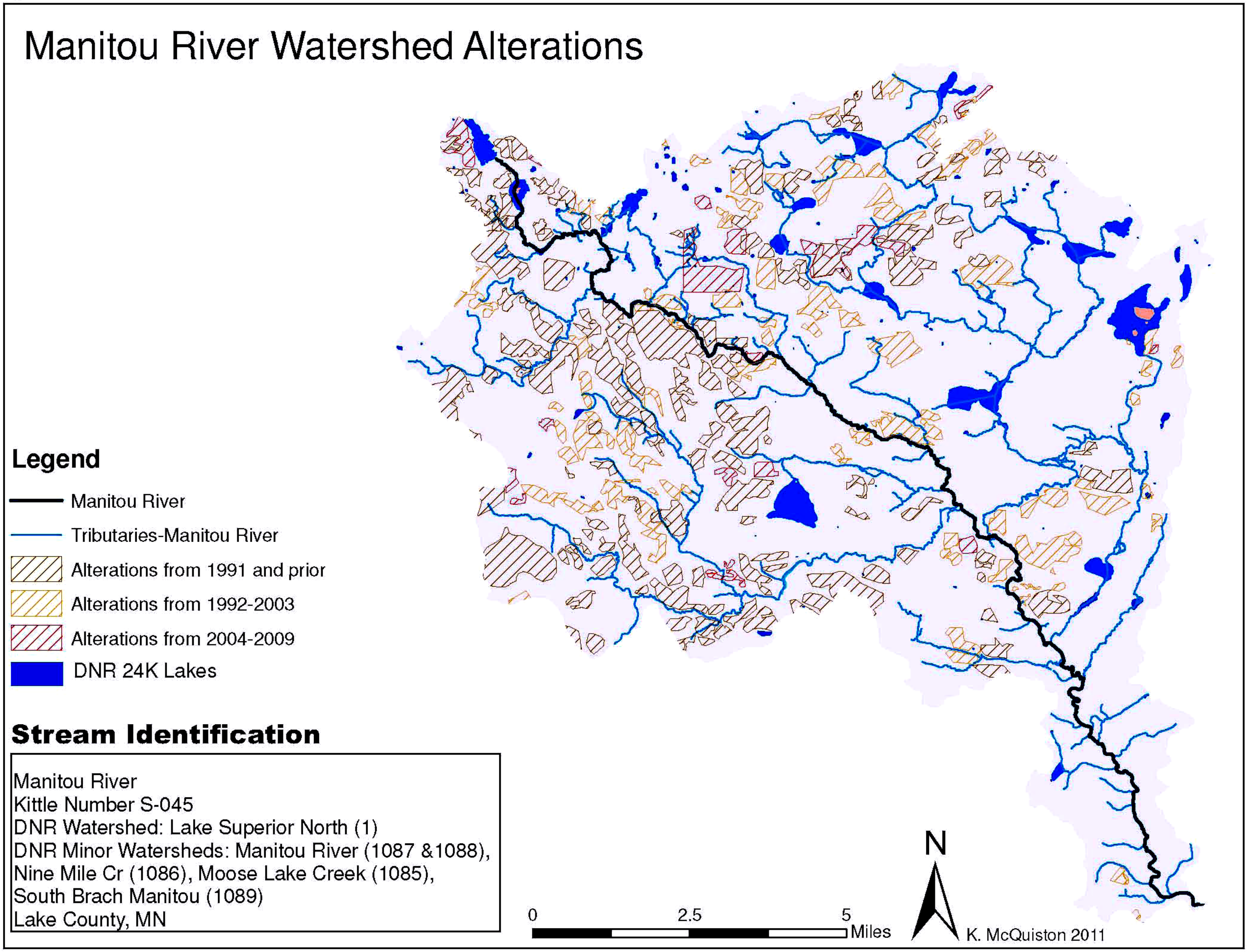

Figure 2. Map of Manitou River (S-045) watershed alterations.

STREAM MANAGEMENT PLAN – Page 1

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region **3**	Area Fisheries Office **Lanesboro (F318)**	Plan Managed Segment (river miles) **0.00 – 13.11**	Length (miles) Plan Managed Segment **13.11**	
Major Watershed: **Root River (43)**		Minor Watersheds (significant tributaries) **43053 (Trout Run)**		

Similar Reach	Similar Reach Name	Stream Miles	Length miles	Rosgen Channel Type	Fisheries Ecological Classification	Species of Management Interest
1	**Downstream of Bucksnort Dam**	**0.00 – 3.10**	**3.10**	**C3b and C4**	**Wild trout 1-A**	**Brown trout**
2	**Upstream of Bucksnort Dam**	**3.10 – 13.11**	**10.01**	**B4, B6 and F6B**	**Wild trout 1-A**	**Brown trout**

Long-Range Goals

Goal 1: *Similar reach 1 – Maintain a wild brown trout population.*

Objectives (Desired Future Conditions) and Operational Plans:

1) Maintain a wild brown trout population over the next ten years (2008-2018) in similar reach 1 as defined by:
   a. >1,000 adults/mile.
   b. >500 recruits/mile.
   c. 10% of adults ≥12 inches (>100/mile)
   d. Total brown trout biomass >125 lbs/acre
      i. To determine if the brown trout population is meeting the Objective and to ensure habitat remains suitable for maintenance of this population in similar reach 1, a full stream survey will be scheduled for 2016.
      ii. To ensure habitat improvement projects continue to increase abundance of brown trout in Trout Run, sufficient to meet the Objectives of this plan, annual fish population assessments will be completed from 2006-2012 in conjunction with the project at Station 0.98 (Hakim's).

Goal 2: *Similar reach 2: Maintain a wild brown trout population.*

Objectives (Desired Future Conditions) and Operational Plans:

1) Maintain a wild brown trout population over the next ten years (2008-2018) in similar reach 2 as defined by:.
   a. >2,000 adults/mile.
   b. >1,500 recruits/mile
   c. 5% of adults ≥12 inches (>100/mile)
   d. Total brown trout biomass should be maintained >200 lbs/acre
      i. To ensure a wild trout population is being maintained annually, Station 8.63 (Long-term Monitoring) will be electrofished in the fall every year.
      ii. Maintenance of a wild trout population is dependent on adequate flow and appropriate water quality, especially water temperature. To ensure these are not deviating from conditions suitable for maintenance of a wild trout population, water quality and quantity information will continue to be collected at Station 8.63. These data will be shared with the Minnesota Pollution Control Agency to ensure state standards are maintained and for additional interpretation.
      iii. To ensure broader habitat conditions remain suitable for brown trout, a full stream survey will be scheduled for 2016.

STREAM MANAGEMENT PLAN – Page 2

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		M-009-029	13.11	April 2008
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	Lanesboro (F318)	0.00 – 13.11	13.11	

Survey and Assessment Schedule			
Next scheduled assessment(s)	Station (river mile)	Objective	Report due
Annually	8.63	Long-term monitoring	Annually
2006-2012	0.98	Evaluate Hakim's habitat improvement project	2013
2016	0.98, 1.31, 1.98, 2.50, 4.46, 5.95	Revise management plan	2017
	7.35, 8.63, 10.21, 11.90		

Stocking Schedule				
Next scheduled stocking	Species - size	Quantity	Similar Reach	Specific location
No stocking needed				

Future Potential Plans

1). Hydrology and Connectivity

a. Help advocate for programs initiated by others that seek to reduce effects of climate change on precipitation patterns and continue monitoring efforts for hydrology to detect any changes in Trout Run Creek.

b. Hydrology management may be enhanced through land use management. More specifically:

i. Identify key headwater areas for wetland restoration and work with partners to protect, enhance, or restore for Aquatic Management Area acquisition.

ii. Map the springsheds for springs 1, 8, 25, and 27 and prioritize for protection or enhance land use practices within these springsheds.

iii. Clark, Nichol's, and Wiskow creeks contribute substantial baseflow and their watersheds should be prioritized for protection and enhancement by partners such as NRCS, SWCD, and others.

c. Investigate the influence of Bucksnort Dam, beaver dams, and road crossings on stream hydrology and connectivity.

2). Geomorphology and Fish Habitat

a. Several sites appear to have unstable stream channels. These sites should be resurveyed and reasons for instability should be better defined.

b. All road crossings should be evaluated as potential constriction points that influence sediment movement.

3). Water Quality

a. Work with local partners to identify and address problems associated with cattle in the riparian zone (use grazing plans with flash and rotational grazing).

b. Support efforts by Fillmore County SWCD, Winona County SWCD, and Olmsted County SWCD to reduce impairment of surrounding watersheds.

4). Biology

a. Survey presence/absence of black redhorse in the downstream areas of Trout Run Creek.

b. Sample aquatic invertebrates in multiple stations and investigate reasons for impairments where macroinvertebrate bioassessments suggest a problem.

c. Identify distribution and abundance of terrestrial and aquatic invasive species, especially plants in the stream and riparian zone, specifically including easement corridors.

STREAM MANAGEMENT PLAN – Page 3

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**	

5). Social Considerations

a. Institute an angler creel survey to determine satisfaction, harvest, methods, etc., especially as related to the slot-limit regulation.
b. Actively seek angling easements in the area of Nichol's Spring and the mouth of Trout Run on the Middle Branch Root River.
c. Support the development of a watershed initiative.

Area-Specific Needs

Approvals

Plan Authors			
Vaughn Snook, Assistant Area Fisheries Supervisor			
Area Supervisor	***Date***	***Regional Manager***	**Date**

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**	

BACKGROUND INFORMATION

Priorities – Angling easement acquisition, riparian corridor management, and increasing or maintaining angler satisfaction are priorities for successful fisheries management of Trout Run Creek.

1) Angling easement acquisition: An easement should be acquired downstream from Station 0.98 (Hakim's) to the mouth of Trout Run Creek. This purchase would result in a large cooperative habitat-improvement project through the easement corridor. Because of the severity of habitat degradation in this section of Trout Run, this project would require most of a field season for the Habitat Improvement Crew to complete.

   Easements should be acquired downstream of Nichol's Spring. This area is one of the last large tracts of Trout Run Creek not under angling easement. Recently anglers have been told to leave this section of trout water due to a new landowner. Conservation officers have been notified of the situation.

   Easements should also be acquired in the headwaters of Tributary 2 (M-009-029-002). Currently the MNDNR has an easement on the downstream end of Tributary 2 (~2,000 feet). The upstream end of this tributary is an important water source for Trout Run. Agricultural lands dominate but several cattail marshes exist with opportunities for sediment control. The upstream end of Tributary 2 has recently come under scrutiny due to a large section being illegally channelized. A restoration order has been issued to the landowner by MNDNR Division of Waters and Ecological Resources to lower the created dikes and allow the remeandering of the stream channel. The project is being completed in cooperation with Olmsted County SWCD staff.

2) Riparian Corridor Management: Because of the intensity of habitat improvement and the amount of money spent on these projects on Trout Run, it is important to prioritize management of the riparian corridor in areas with and without state angling easements.

   Development of grazing plans based on Natural Resource Conservation Service guidelines and standard practices is needed.

3) Angler Satisfaction: Trout Run Creek is one of Minnesota's premier trout stream angling destinations. Because of this it is important to maintain angler satisfaction relative to the intensity of angling pressure.

Description of Stream System – Trout Run Creek is a designated trout stream with a watershed of 32.5 miles^2 in Olmsted, Winona, and Fillmore counties, Minnesota. The stream is 13.11 miles long and runs through the towns of Saratoga, Troy, and Bucksnort and eventually flows into the Middle Branch Root River. There is a dam (10' head) at Bucksnort Park, approximately three miles upstream from the mouth.

Stream Source and Location: Spring seepage in T.105N, R.10W, S.18 (SW ¼)

Stream Mouth Location: T.104N, R.10W, S.20 (SE ¼)

Trout Stream Angling Easement Length: In 1991, 9.75 miles in angling easements (74% of stream length) and 3.36 miles without angling easements. In 2006, there were 10.85 miles in angling easements (83%) and 2.36 miles without angling easements.

Stations most frequently used for trout population assessment can be found in Table 1.

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**	

Past Surveys and Investigations – Thaddeus Surber completed the first survey on Trout Run Creek in 1920 (or 1924 depending on the source) and W. Kenyon conducted an additional survey in 1946. Both of those documents are not available at the Lanesboro Fisheries Office. The earliest available survey was written by Philip Gilderhus and completed on July 5, 1956. The Gilderhus document includes chemical, biological (fish population and stocking), and physical data.

1) Surber, T. 1924. A biological reconnaissance of the Root River Drainage Basin, southeastern Minnesota.
2) Kenyon, W. 1946. Stream survey report, Trout Run Creek.
3) Johnson, Kenyon, and Moyle. 1949. A biological survey and fishery management plan for streams of the Root River basin. Investigational Report No. 87.
4) Gilderhus, P. 1955. Stream survey report, Trout Run Creek.
5) Schumacher. 1956. Aerial car counts on trout streams of southeastern Minnesota. Investigational Report No. 171.
6) Minnesota Pollution Control Agency. 1971. Water Quality Management Plan, Interim, Lower-upper Mississippi River Basin.
7) Haugstad, M. 1972. Stream survey report, Trout Run Creek.
8) Hawkinson and Krosch. 1972. Annual report of statewide creel census on 80 lakes and 38 trout streams in Minnesota, May 1971 to February 1972. Investigational Report No. 319.
9) Kucera, Torp, and Hawkinson. 1977. Annual report of statewide creel census on 83 lakes and 36 trout streams in Minnesota, April 29, 1972 to February 28, 1973. Investigational Report No. 319.
10) Kucera and Torp. 1976. Annual report of statewide creel census on 83 lakes and 36 trout streams in Minnesota, April 27, 1973 to February 28, 1974. Investigational Report No. 342.
11) Kucera and Torp. 1976. Annual report of statewide creel census on 90 lakes and 32 trout streams in Minnesota, May 5, 1974 to September 28, 1975. Investigational Report No. 344.
12) Kucera, Torp, and Clymer. 1976. Annual report of statewide creel census on 75 lakes and 30 trout streams in Minnesota, May 3, 1975 to September 28, 1975. Investigational Report No. 344.
13) Haugstad, M. 1975 - 1979. Stream survey report, Trout Run Creek.
14) Haugstad, M. 1986. Study of special angling regulations in Trout Run Creek (includes 1984 creel census data), 1980 – 1986.
15) Haugstad, M. 1972, 1974, 1975, 1976, 1977, 1978, 1979, 1982, 1983, 1984, and 1985. Fish population assessments.
16) Haugstad, M. 1986. Stream survey report, Trout Run Creek.

Past Management – Trout were first stocked in the stream in 1945 (Tables 2, 3, and 4). Most fish stocked were brown trout, though brook and rainbow trout of various sizes have also been stocked. Surveys found that brown trout reproduced successfully in similar reach 2, upstream of Bucksnort Dam. Therefore, the upstream-most 10.1 miles of stream is managed as a wild trout stream. Similar reach 1 was stocked annually with fingerling brown trout until 2002, but this reach is also now managed as a wild trout stream. The last stocking of fingerling brown trout took place in 2002 (20,000 fingerling brown trout totaling 250 lbs).

Extensive stream habitat improvement work has been completed dating back to 1958 (Table 5). As of 2008, total cost of improvement and maintenance was $388,175.72. Older improvements have included bank stabilization, Hewitt ramps, bank shelters, and numerous maintenance activities. Similar reaches 1 and 2 received trout stream habitat improvement work in 1987 ($24,535).

In 1992, a large habitat improvement project was completed on Lyman Roeder's property, a non-eased section of Trout Run. MNDNR Waters permits and habitat improvement plans can be found attached to the September 15, 2001 Stream Population Assessment report for Trout Run.

In 2005, the MNDNR Habitat Improvement Crew began a large project in Station 0.98 (Forre's, Hakim's, Egge's). This project involved an extremely degraded section of Trout Run. The HI Crew moved approximately 15,000 cubic yards of soil during the field season.

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		M-009-029	13.11	April 2008
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	Lanesboro (F318)	0.00 – 13.11	13.11	

A special regulation (1983-1986) to create a trophy fishery in a 1.24-mile-long section of similar reach 2 was unsuccessful. Release of all trout >11 inches was required. Numbers of fish within the protected size range increased; however, growth and condition of these fish were poor.

On April 16, 2005, a special regulation was placed on all of Trout Run Creek. This regulation included a gear restriction of artificial lures and flies only with a protected slot of 12-16 inches. Anglers can keep 5 trout with only one >16 inches. No fish can be kept in the protected slot. Many other streams in southeast Minnesota were also included in a special regulation package which includes catch-and-release, protected slot 12-16 inches (bait allowed), and a 12-inch minimum for brook trout (bag limit of 1).

ASSESSMENT OF RESOURCE CONDITION

HYDROLOGY

General Description – Trout Run Creek drains a 32.5-mi^2 watershed primarily composed of agricultural land uses with 63% as cropland, 26% as grass or pasture, and about 8% as some sort of deciduous woodland. The mainstem reaches a 4th-order stream about midway along its path before discharging into the Middle Branch Root River. Total stream length is about 17.0 miles but only the most downstream 13.11 miles is considered to have permanent flow.

Trout Run is primarily a groundwater-fed stream with 33 known springs located either on the mainstem or one of 12 tributaries. Stream baseflow is almost entirely due to these spring sources. Springs originates either directly from stream banks (24 springs), vertically from the stream bed (4 springs), as seepage from riparian wetlands (3 springs), or from agricultural drainage tile (2 springs). Four of the 33 known springs contribute over 60% of all the spring inputs combined. All originate along stream banks and are numbered as 1, 8, 25, and 27 in the Stream Survey Report (Snook 2008). Spring 27 by itself contributes over a third of all springflow. The 12 tributaries also drain the watershed via overland flow and further contribute water volume to the mainstem. Of the 12 tributaries, three of them contribute almost 80% of the flow from all tributaries combined, suggesting that these three are particularly important (Stream Report Table 6; Snook 2008). The three tributaries are Clark Creek, Nichol's Creek, and Wiskow Creek.

Precipitation and associated overland flow augments instream baseflow and likely contributes to a seasonal discharge pattern. Most precipitation falls as rain during spring and summer. Typically rainfall increases from April to June, stabilizing at about 4 inches through September, before declining to about 2 inches in October. Within the past 10 years monthly precipitation has increased during the months of May to August and decreased during September. Overall, between 1960 and 2005, total annual precipitation has increased from about 30 inches to about 40 inches. There is no formal gaging station present on Trout Run; however, the USGS maintains a gage (#05383950) on the Middle Branch Root River near Trout Run's confluence. Records from this gage suggest a flashy flow regime with numerous peaks (i.e., rapid increases and decreases in flow) in response to episodic snowmelt events in late winter-early spring or rainfall events across spring and summer months. Lack of a specific gage on Trout Run does not allow a more formal quantification of hydrology but the general pattern appears to be a stream with stable baseflows (due to presence of numerous springs) that also has frequent (multiple times a year) precipitation-driven high flow pulses of short duration (typically less than 2 days), rising and falling rapidly, usually during spring and summer months. Consequently, the primary factors governing hydrology are precipitation and land use (including land uses that influence infiltration and subsequent groundwater recharge). A stream stage recorder was established by MNDNR Fisheries in 2006 as part of a long-term monitoring effort to acquire data on stream stage and discharge specifically for Trout Run Creek so that more precise hydrology management can be formulated.

There is a low-head dam (10' head) located about 3 miles upstream from the mouth that is judged to have minimal impact on the hydrology of the stream, but may influence other riverine components such as connectivity and geomorphology. Beaver dams are ephemeral but can reach rather large sizes, some up to 4 feet high or higher. Their hydrologic impact may be short lived but has not been adequately assessed. There are nine road crossings present that may influence downslope water movement. However, the impact of these road crossings is unknown.

There does not appear to be any large-scale channelization or ditching although agricultural drain tiles are present at several locations, which can influence the timing and rate of change of high flow pulses. Also, water-withdrawal operations directly from the stream are uncommon but groundwater is a primary source of domestic and agricultural activities. Most of the watershed is in agricultural land use, so impervious surfaces are uncommon as well.

<u>Management Concerns for Hydrology (at each of three spatial scales)</u>

<u>Watershed-scale Concerns</u> – The two most important factors influencing hydrology of Trout Run Creek likely occur at the watershed scale. They are precipitation events that contribute flow volume and land use practices that move this water to the stream. Precipitation influences all five elements of hydrology: the magnitude (how much water), timing (when that water comes), frequency (how often the water rises), duration (how long it lasts), and rate of change (how rapidly it rises and then falls). Land use practices also influence these five but have a greater influence on duration (how quickly the water gets to the stream, e.g., via drain tiles or ditches) and consequently how rapidly the water rises and falls (rate of change). Land use practices can also influence groundwater recharge through interception or facilitation of surface water-groundwater connections. Because precipitation and land use practices generally fall outside the management authority of MNDNR Fisheries, proper management of hydrology for Trout Run Creek will depend on involvement of other agencies and conservation partners. However, MNDNR Fisheries may have a role in identification of important land areas to target for conservation efforts by partners and to monitor fish and instream habitat benefits in response. Finally, establishment and proliferation of ethanol plants may be a problem in the future due to the potentially harmful water management associated with such plants. Future ethanol development should be monitored to ensure Trout Run hydrology is not impacted.

<u>Riparian-scale Concerns</u> – The most obvious riparian-scale concern is the protection and maintenance of known spring sources (see Table 7 in Snook 2008). Riparian levees and impervious surfaces are rare and either constitute a minor concern or no concern. The importance of floodplain access to mediate flood peaks is unknown. Further investigation may be warranted. Habitat-improvement projects are numerous on Trout Run and an effort to significantly slope existing banks to a 4:1 ratio is common. This is intended to partially help restore lost floodplain habitat and reduce stream power during floods.

<u>Instream-scale Concerns</u> – Several potential instream impediments to water flow are present along the mainstem Trout Run and associated tributaries. These include occasional beaver dams, Bucksnort Dam, and road crossings. Whether these structures influence the magnitude, timing, duration, frequency, and rate of change of high and low flow pulses is unknown. Thus, additional data may need to be acquired to ensure these structures are not having an impact. To accomplish this, stream-stage or discharge-recording equipment may need to be established upstream and downstream from these structures to assess impacts. Alternatively, differences in geomorphology (i.e., channel dimension, pattern, and profile) could also be collected and used as a surrogate assessment. If dimension, pattern, and profile differ between upstream and downstream stations, this might also suggest concerns (however, such differences may be more related to geomorphology concerns such as improper sediment movement than to primarily hydrology concerns). Because of numerous habitat improvement projects that do not consider dimension, pattern, and profile in their designs, instream scale hydrological concerns may be more of an issue than understood.

<u>Management Recommendations for Hydrology:</u>

1) Successful direct management of precipitation seems unlikely other than through advocation of programs designed to reduce effects of climate change. Most such programs will be developed and implemented by others. MNDNR Fisheries can contribute to such efforts mostly as an advocate and through monitoring efforts to demonstrate either continued alterations or perhaps re-establishment of preferred conditions.
2) More direct management of hydrology may be accomplished through better management of land use practices in the

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basin. For example, springs 1, 8, 25, and 27 contribute large amounts of baseflow. Their springsheds should be mapped and prioritized for protection or enhancement of land use practices. Similarly, because Clark Creek, Nichol's Creek, and Wiskow Creek contribute substantial baseflow as well, their watersheds should be prioritized for protection and enhancement by partners such as NRCS, SWCD, and others.

3) Fisheries should continue acquiring stage and discharge data in the long-term monitoring station.
4) The influence of Bucksnort Dam, beaver dams, and road crossings on stream hydrology is unknown and should be investigated.

CONNECTIVITY

General Description – Surface connectivity of most of Trout Run is intact, suggesting that this riverine component is healthy. There is one man-made dam present, Bucksnort Dam. Nine road crossings are also present. Beaver dams are occasionally present but have not been quantified across the watershed. Levees are almost non-existent; however, the upstream areas are very entrenched. Surface connectivity of groundwater flow to the stream has not been determined, but is likely critical to maintenance of appropriate water temperature and stream flow to support the fish species of primary management interest.

Management Concerns for Connectivity (at each of three spatial scales)

Watershed-scale Concerns – Nine road crossings are present on the mainstem of Trout Run and on several tributary streams. The cumulative effect of these road crossings has not been formally assessed as barriers. Most crossings on the mainstem have been subjectively deemed to allow movement of fishes at most flows. Similarly, several beaver dams exist across the watershed but have not been completely inventoried and their influence on the stream as a whole is unknown. In summary, several potential connectivity barriers exist across the surface of Trout Run but their impacts are either unknown or subjectively deemed to be of lesser importance than other factors. Sub-surface groundwater patterns are completely unknown, but are likely critical for maintenance of the angler-preferred fishes to be managed (i.e., salmonids).

Riparian-scale Concerns – Lateral riparian connectivity concerns are few. There are essentially no floodplain barriers because there are no levees. Geomorphic surveys of most sites suggest that Trout Run Creek has access to its floodplain at most sites (i.e., because few sites were characterized as being entrenched). Perhaps the only site that could be considered entrenched is station 11.9 (Wiskow's). This site was classified as an F-channel, which means it has an entrenchment ratio between 1.0 and 1.4. This suggests that the stream is attempting to rebuild a new floodplain within the existing confines of the old stream channel. Thus, given time, this site might develop an active floodplain, but at present the stream is probably decoupled from its active floodplain for all but the largest flood events.

Instream-scale Concerns – There are several road crossings and beaver dams present but a complete inventory has not been completed. Further, the impact of each of these individually or comprehensively is unknown. Bucksnort Dam is a moderate barrier located at about river mi 2.8. Bucksnort Dam does not appear to block movement of invertebrates, as most species found downstream of the dam have also been found upstream. This is not surprising because many invertebrates have winged-adult life stages that allow aerial dispersal over such structures. Eleven fish species have been found downstream of the dam but not upstream, suggesting a barrier to fish movement of selected species. Brown trout are routinely successful at negotiating this barrier. However, cooler water temperatures upstream from the dam (i.e., closer to springs) may also be responsible for the differing fish community. This is because most fishes found below the dam, but not above, are more associated with cool- and warm-water streams.

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Management Recommendations for Connectivity:

1) Because adequate amounts of groundwater essentially maintain the ability of Trout Run to support a recreational fishery, more information should be gathered on where and how groundwater supplies this stream. This can be accomplished by initiating of supporting ongoing springshed mapping projects.
2) Bucksnort Dam may serve as a barrier to fish movement. However, several invasive aquatic species exist downstream from this dam in the Root River system. Thus, some consideration should be given to maintenance of this dam to prevent expansion of such invasive species upstream into Trout Run.
3) A more complete inventory of all beaver dams and other road crossings should be completed as time allows. These barriers can then be individually assessed as potential barriers to all fishes or species of primary management interest following methods in Gallagher (1999) or MNDNR (2007). Following such evaluations, road crossings and other barriers can be prioritized for removal or modification.

GEOMORPHOLOGY AND FISH HABITAT

General Description – Seven sites were surveyed to assess geomorphology and fish habitat. The most upstream station (11.90) indicated a silt-dominated entrenched F-channel. F-channels tend to be unstable and represent a transitional channel type moving to a more stable form. F-channels commonly evolve to C-channels following extreme bank erosion where the channel is attempting to break down its existing entrenched streambanks so that a new floodplain can be developed within the confines of the old stream channel. The current width:depth ratio of 25.1 is very close to the central tendency for this stream type, which suggests that this F-channel is in the middle of its transformation and not rapidly adjusting to a sediment or water imbalance. This is supported by the relatively high channel stability rating observed (90, see Table 8) for this stream type. Thus, it may take time for this stream channel to change, but biologists should note that it will continue to change because the F-channel type is not a "stable" channel type itself. Cover for larger fishes was substantial (64% of surface area). This station has the highest percent of undercut banks. These banks are very stable and covered with heavy upland and wetland vegetation. Station 11.90 also had the highest percent of overhanging vegetation and woody debris. Depths greater than 2' and 3' were also the highest in this station. The abundance of so much instream cover may suggest little concern for immediate attention to trout habitat management. Within the next stream mile, at Station 10.21, the channel has changed into a B6 stream type. Substrate is still dominated by silt, which is probably a reflection of its headwater position in the watershed where historical land cover included several wetland areas. According to Figure 4 (in Snook 2008) this is also an area of rapidly decreasing stream slope, suggesting that it is the first depositional area for upstream eroded sediments. B-channels in general tend to be moderately stable systems; however, the channel stability rating suggested an unstable stream. This could be due to its location along the entire longitudinal profile of Trout Run (Figure 4 in Snook 2008) where this appears to be an area of lower gradient resulting in substantial sediment deposition and contributing to the instability. Total cover for larger fishes was 29.5% of surface area, which was well within guidelines recommended for brown trout (i.e., ≥ 20%), but was lower than any other station surveyed.

The next three stations downstream to Bucksnort Dam were geomorphologically similar, being gravel-dominated B-channels. As such, they probably represent a single geomorphically-similar reach. B4 stream channels are relatively stable and are not considered large sources of sediment to downstream locations (Rosgen 1996). However, all channel stability evaluations suggested unstable stream channels. Width:depth ratios for these sites were all higher than the reported central tendency for B4 stream types. This suggests that these channels are wider and shallower than typically found for B4 streams. Increasing channel widths are often associated with either an increase in sediment load or a decrease in water supply. Both factors reduce the channel's ability to move sediment, which causes mid-channel deposition and subsequent lateral erosion of streambanks. If accurate, it is unclear what stream type such channels might be transitioning to. These were some of the first geomorphic surveys conducted by field staff and as such should not be over-interpreted. These sites may need to be resurveyed to verify these patterns. All three stations appeared to have adequate cover for larger fishes, which is probably a reflection of the extensive instream habitat enhancement these sites have received.

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Both stations downstream from Bucksnort Dam (Stations 2.50 and 0.98) reflected the likely geomorphic influence of the dam. Both sites were relatively stable C-channels but were characterized by much larger sediment particle sizes. Cobble was dominant at the station closest to the dam, whereas gravel was dominant farther downstream. An instream habitat project at Station 0.98 substantially improved the channel stability evaluation score. Cover for larger fishes was lower than recommended for brown trout at the site closest to the dam, being only about 10.9% of surface area.

Management Concerns for Geomorphology and Fish Habitat (at each of three spatial scales)

Watershed-scale Concerns – The primary factors that influence stream geomorphology from watershed sources are amounts of water and sediment. Average annual precipitation has increased over the past 50 years, suggesting that water volume has increased. Trout Run would have had to (and may continue to) change in response to the large influx of water. Land use practices may ameliorate or increase the effects of this increase in water volume. Similarly, excessive sediment may fill stream channels, either from erosion as water rushes overland or by instream bank erosion due to higher stream flows. Because most of the watershed is in agriculture, land use plays an important role in regulating water and sediment delivery to the stream.

Riparian-scale Concerns – Streambank erosion is present at some sites which will increase sediment delivery to the stream channel. Similarly, inadequate flood-prone widths may not allow dissipation of stream power during high flows.

Instream-scale Concerns – Many survey stations were found to have unstable stream channels, especially stream banks. In addition, several stream crossings exist that may impede adequate movement of sediment and water at a variety of stream flows. The presence of Bucksnort Dam definitely alters geomorphology, especially sediment movement. Cover for larger fishes may not be sufficient at some locations.

Management Recommendations for Geomorphology and Fish Habitat:

1) Several sites appear to have unstable stream channels as a result of either increased delivery of water or sediment. More advanced techniques may need to be employed to specify important sediment sources within the watershed (e.g., the WARSSS procedure) so that remedial measures can be employed.
2) Where unstable channels exist, stream channel restoration projects may need to be implemented. This should include ditched channels present in headwater wetland areas.
3) Implement instream habitat projects where cover for larger fishes is less than recommended, especially for brown trout.
4) All road crossings should be evaluated as potential constriction points that affect movement of water and sediment using the MESBOAC procedure.
5) Gather additional information on trout habitat, pre- and post-habitat improvement project.
6) Intensively review MNDNR Division of Ecological and Water Resources permits for proposed stream crossings and bridges.

WATER QUALITY

General Description – Water quality was assessed at the seven sampling locations in the 2006 stream survey from one grab sample conducted in late October. All water quality variables were indicative of good habitat for coldwater fishes. The samples indicated that Trout Run Creek has water quality conditions similar to those of most other southeast Minnesota coldwater streams with pH ranging between 7.8 and 8.6, conductivity between 533 and 545 mS/cm, and alkalinity between 255 and 262 ppm. Dissolved oxygen, at least in late October, was excellent being greater than 10 mg/L at all sites. Turbidity information from the single grab sample indicated very low amounts of turbidity. However, because most of the land use in the basin is in agricultural production, especially row crops (63%), there is concern that stressful turbidity levels from farmland soil loss may be infrequent and episodic. More frequent or continuous monitoring will be needed to assess such episodic events of stressful turbidity. Soil loss from erosion of unstable banks or in conjunction with activities of beaver may be another concern. Beaver activity has not been observed by field staff in the past seven years. Historically, agricultural chemicals entering the stream were

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responsible for fish kills in 1977 and 1979. The Minnesota Pollution Control Agency (MPCA) has listed one of the tributaries in 2012 as Impaired for Aquatic Recreation purposes due to *E. coli,* which is likely another indication of the effects of agricultural practices. The MPCA has also listed the mainstem of Trout Run as Impaired for Aquatic Life based on a low score for aquatic macroinvertebrate bioassessment. No specific pollutant or stressor was identified.

Perhaps the most important water-quality factor influencing the primary fishes of management interest (i.e., coldwater salmonids) is water temperature. Water temperatures monitored during both grab samples and placement of continuous monitors all suggested adequate thermal regimes, at least during 2006. Some infrequent temperature increases exceeding 5°F occurred in midsummer in association with precipitation events. Flow of rain water across the warm ground and into the streams was the likely reason for the episodic temperature increases. The magnitude of the temperature increases never reached thermally stressful levels for brown trout (i.e., stream temperatures never exceeded 67°F); however, the rate of change may be a cause for concern. Finally, there did not appear to be a large influence of Bucksnort Dam on thermal regimes, probably because this dam is believed to have a short water-retention time.

Management Concerns for Water Quality (at each of three spatial scales)

Watershed-scale Concerns – Agricultural practices in the watershed remain a general concern that could result in increased turbidity levels from soil loss, increased water temperatures (via more overland flow from midsummer rain storms), and other pollutants such as *E. coli* or agricultural chemicals. The tributary specifically listed as Impaired for *E. coli* should be targeted for remediation efforts by MPCA. MNDNR Fisheries can help play an advocacy role in that process and possibly through cooperative monitoring efforts with MPCA staff.

Riparian-scale Concerns – Localized areas where cattle use riparian zones or where beaver are active may decrease bank stability resulting in more bank erosion and higher turbidity levels. Areas in and around Station 10.21 and 4.46 require the most immediate attention with regards to heavy livestock use. Station 11.90 and 8.63 are probable areas for use by beavers and have been used by such in the past. Such concerns will need to be addressed on a case-by-case basis.

Instream-scale Concerns – Water quality at present is adequate for most fishes, so instream scale concerns are few. Although instream beaver activity (e.g., dams) is not presently common, staff should remain vigilant to future beaver presence. Perhaps the most important instream concern is lack of water-quality information collected at a finer temporal scale. Consequently, MNDNR Fisheries will have difficulty identifying episodic periods of stressful water-quality parameters.

Management Recommendations for Water Quality:

1) Support more intensive water-quality sampling efforts, especially as related to herbicide and agricultural chemical testing by other agencies including MPCA.
2) Where needed, support land use practices advocated by other conservations partners, such as BWSR or NRCS, to ensure water quality remains adequate for fishes, especially streambank conditions impacted by heavy livestock use.

BIOLOGY

General Description – Trout Run Creek is primarily a coldwater stream supporting a recreational fishery for salmonids. The most upstream areas support a typical coldwater fish community of low species richness that includes brown trout, white sucker, and sculpin spp. Downstream reaches, especially below Bucksnort Dam, have fishes that suggest a transition to a more coolwater fishery. A total of nine fish species were captured below the dam in the most recent 2006 survey. All fishes collected represent native fauna, with the exception of brown trout. This includes black redhorse, a fish species proposed for state listing as special concern. Black redhorse were collected in 2005 and 2006. All individuals of this species were of similar size (8-10 inches), suggesting they were all from the same year class. The coldwater fish community was assessed with the Index of Biotic Integrity for coldwater streams (Mundahl and Simon 1999). Station 10.21 (McGuire's) had the highest IBI score of 100 (120 maximum). This

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reflects the lack of warmwater fish species and the high percent of intolerant species. As is predicted from any coldwater stream biotic index, Station 0.98 (the station farthest downstream) had the lowest score of 45. This reflected the high number of minnow and benthic species and the low number of coldwater species. Bucksnort Dam dropped the IBI scores substantially between Station 4.46 (Lohman's) and 2.50 (Kleven's).

Brown trout are the most dominant and recreationally important fish species present. The trout population in similar reach 2 of Trout Run Creek (upstream of Bucksnort Dam) appears to be typical of wild streams in the area. Growth and condition of adult brown trout in similar reach 2 are poor. Good recruitment and subsequent high population density may be responsible, resulting in limited prey availability. This causes reduced growth and poor condition (low weight). In 1986, four prey species were captured in similar reach 2. White suckers comprised most of the available prey fishes. Longnose dace, blacknose dace, and fathead minnow were also present in very low numbers. Fewer non-game fishes are being collected in the long-term monitoring station each year (only sculpin and white suckers in 2010). However, these trout populations still provide excellent fisheries and are among the most important resources of southeast Minnesota. The highest number of adults per mile was found in Station 8.63 (Control; 4,168 adult BNT/mile) and in Meyer's post-habitat improvement assessment (4,158 adult BNT/mile; river mi 5.95). The lack of adults in Station 10.21 (McGuire's; 1,211 adult BNT/mile) is most likely directly related to the lack of cover for large fish (see Table 11 in Snook 2008). This is also reflected in the number of trout greater than 12 inches (20), 14 inches (7), 15 inches (7), and 16 inches (0).

The greatest number of brown trout greater than 16 inches was in Station 11.90 (Wiskow's; 8), 4.46 (Lohman's; 6), and 0.98 (Hakim's; 5). Smith's and Roeder's also appear to be areas suited for large trout. The high number of brown trout greater than 16 inches in Roeder's is a reflection of the diversity of habitats, pool depth, overhead cover, and lack of angling harvest, and may also reflect the date of sampling when large trout move up from the Root River to spawn.

Natural reproduction is no longer limited in similar reach 1, so stocking is unnecessary to maintain the trout population below Bucksnort Dam. It is unknown why reproduction was limited in the past, but Bucksnort Dam and its associated effects on the stream may be partly responsible. The effects of a large redhorse population (shorthead, golden, silver, and black) may be to blame as well because they may consume trout eggs, therefore limiting natural reproduction. Station 0.98 (Hakim's) was sampled before habitat improvement had been completed and this is reflected in the lack of adult brown trout/mile (1,073/mile). Station 2.50 (Kleven's) appeared to lack numbers of larger adults similar to Station 10.21 (McGuire's) upstream from the dam (i.e., numbers greater than 12 inches (32), 14 inches (5), 15 inches (5), and 16 inches (0).

At least 10 aquatic plant species were found in Trout Run Creek in 2006 (Table 25 in Snook 2008). These plants provide important linkages in the food chain and cover for fishes and aquatic macroinvertebrates. Water buttercup (*Ranunculus* sp.) is most abundant throughout the stream but is not found at all in the uppermost station. American brooklime (*Veronica americana*) is typically found in springs and headwater areas of Trout Run. Spotted touch-me-not (*Impatiens capensis*) commonly provides much of the overhanging vegetation along stream banks. Two invasive plants were also found; curly-leaved pondweed (*Potamogeton crispus*) was most abundant in Station 7.35, and reed canary (*Phalaris arundinacea*) was common in Station 11.90.

Many invertebrate taxa, some likely key prey items, were also found. Amphipods, specifically *Gammarus pseudolimnaeus*, were abundant throughout Trout Run. *Baetis* spp. were the most common Ephemeropteran sampled. This mayfly was abundant in Stations 7.35 and 8.63 and was present in all stations. When specific species could be identified in this genus, they were identified as *Baetis brunneicolor*. Trichopterans were the most diverse order of aquatic invertebrates in Trout Run. Of the Brachycentrids, *Brachycentrus occidentalis* were the most common. Several *Micrasema* sp., a very small purse-making caddis, were collected in Station 11.90 (Wiskow's). Hydropsychidae (net-spinning caddis) were most abundant in Station 7.35. Specific genera identified were *Ceratopsyche* sp. and *Cheumatopsyche* sp. This family was not identified in the most upstream two stations (11.90 and 10.91) and most downstream station (0.98). Limnephilidae (case-making caddis) were identified in the four most-upstream stations. *Optioservus* sp. and *Stenelmis* sp., both Elmids (aquatic beetles), were identified in Station 7.35 (Special Regulations) and Station 2.50 (Kleven's). Both stations had heavily forested riparian zones. Megalopterans were only found in Station 7.35 (Special

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Regulations) in the form of *Sialis* sp. Chironomids were present in all stations and most abundant in Station 11.90, 2.50, and 0.98. This family composed 57.6% of individuals collected in Station 0.98. Black fly larvae (*Simulium* sp.) were most abundant in Stations 0.98 and 7.35. Tipulids were identified to four genera as *Antocha* sp., *Dicranota* sp., *Hexatoma* sp., and *Tipula* sp. They were present in all stations except Stations 4.46 and 0.98. As noted above, the MPCA has also listed the mainstem of Trout Run as Impaired for Aquatic Life based on a low score for aquatic macroinvertebrate bioassessment; however, no specific pollutant or stressor was identified.

Beaver can be an important component of the biotic fauna of stream systems in particular as ecosystem engineers. Beaver have historically been found on Trout Run but were not observed between 2003 and 2010. A large beaver dam has recently become established in 2012 in the middle of Station 8.63 (Control). As this is the long-term monitoring station, adverse effects of this beaver dam will be monitored and, if necessary, remediation efforts may be implemented.

Management Concerns for Biology (at each of three spatial scales)

Watershed-scale Concerns – Based on information available, there doesn't appear to be any high priority watershed-scale concerns for the biology component, although a complete inventory of invasive species, especially invasive plants, has not been completed.

Riparian-scale Concerns – Invasive plant species dominate some riparian areas. Those species include wild parsnip, European buckthorn, and reed-canary grass. Specific concerns for fishery management are not presently known so the situation will continue to be monitored. If needed, control measures will be implemented.

Instream-scale Concerns – At present brown trout populations appear to be adequate to support recreational fisheries across most of Trout Run. Natural recruitment of brown trout is currently sufficient to maintain populations. Low abundance of cover for adult brown trout in selected locations may limit abundance of larger trout. Curly-leafed pond weed dominates some sections of stream channels. Specific effects are unknown, but thick stands may increase fish cover. Monitoring will be continued and control measures investigated should the need arise. The MPCA macroinvertebrate bioassessment protocol suggested potential problems. A more definitive understanding will be needed before more specific concerns (and necessary management approaches) can be formulated.

Management Recommendations for Biology:

1) Continue monitoring brown trout to ensure maintenance of populations that support angling interests.
2) The lower reaches of Trout Run appear to provide habitat suitable for black redhorse (candidate species of special concern). This population should continue to be monitored and its complete use of downstream areas documented.
3) Investigate reasons for impairment listing via the macroinvertebrate bioassessment.
4) Document riparian areas in angling easement corridors that could be more intensively managed against invasive vegetation.
5) Consider additional instream habitat-enhancement projects, when needed, to further bolster numbers of larger brown trout.

SOCIAL CONSIDERATIONS

General Description – Trout Run Creek is considered one of the most popular trout streams in Minnesota; consequently, angler use is relatively high. In 1984, a creel survey was conducted as part of a special regulation study. Angler effort for the trout stream was estimated at 1,459 ± 674 hours in a control station and 1,485 ± 830 hours in a regulation station. A 2001 survey noted that about 18% of all anglers fishing southeast Minnesota streams fished on Trout Run. This equated to over 5,000 individual anglers who collectively fished almost 20,000 days. Across all of southeast Minnesota, the most important reasons trout anglers fished in 2001 were fishing in a wilderness or rural setting, and catching at least one trout over 6 or 12 inches (both lengths were rated

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Region 2	Area Fisheries Office Lanesboro (F318)	Plan Managed Segment (river miles) 0.00 – 13.11	Length (miles) Plan Managed Segment 13.11	

high). The least important reasons anglers fished included keeping a trophy fish, catching your limit or enough fish for a meal, and fishing for stocked trout.

Trout Unlimited and the Minnesota Trout Association are two of the primary organized stakeholder groups, and several cooperative habitat improvement projects have been completed with them on the stream. Fishing access is widespread with over 12 miles of easements in the riparian zone. This provides protection to almost 95% of the riparian corridor along the 13.11 miles of continuous flow. There are still a few sections of Trout Run Creek that remain a priority for easement purchase, such as downstream of Nichol's Spring Road and the last section at the mouth. The trout population is currently managed using a 12-16-inch protected slot regulation with an artificial lure and flies-only gear restriction. The stream is not currently open during the winter season but discussions continue and it may be opened in the near future. Currently the angling season begins on April 1st during the spring two-week catch & release season. Angling ends September 30th at the end of the autumn two-week catch & release season. Several ethanol plants have been proposed, which is generating potential conflicts among various groups. Other localized developments may also spawn concerns.

Management Concerns for Social Aspects (at each of three spatial scales)

Watershed-scale Concerns – This watershed includes areas in three counties (Fillmore, Winona, and Olmsted). Conservation agencies, such as the Natural Resources Conservation Service and Board of Water and Soil Resources, all maintain at least rudimentary interest in the basin. However, there is no organized watershed initiative or similar interest group specific to Trout Run Creek. Proposed ethanol plants may result in future concerns. The Minnesota Pollution Control Agency is monitoring the status of these plants and MNDNR Fisheries is putting more effort into long-term monitoring at Station 8.63. Row crops continue to be a concern for maintenance of water quality and sediment load reduction in the headwaters upstream from Station 11.90. A large number of horses are pastured at the very top of the watershed with little apparent landowner concern for the stream. This area should be a priority for any watershed initiative in the future. The wet meadow upstream from County Highway 10 at mile 12.38 is getting smaller with intrusion of more row crops. This same area was auctioned off recently in a land sale. The State of Minnesota was prevented from attending the auction to acquire the acreage as a Wildlife Management Area. It is yet to be determined what will happen to this important section of Trout Run Creek.

Riparian-scale Concerns – With most of the mainstem riparian zone in conservation easement, resource concerns are few. A new house owned by a Hormel Foods executive in now completed downstream from Station 4.46, about 50 yards from the streambank and close to a spring tributary protected by an easement. Home construction was completed with caution and procedures such as silt fencing were used to minimize sediment inputs. Although resource concerns may be limited, aesthetic concerns may be more widespread. Those with cabins along Trout Run have complained about anglers disrespecting their private property. In a number of incidences, anglers bringing their dog along the stream and onto state angling easements without permission have been a recent occurrence. The Lyman Roeder property in similar reach 1 continues to be fenced off, denying access to other anglers, and includes a privately funded habitat-improvement project completed by Trout Unlimited.

Instream-scale Concerns – Dams are barriers to recreational boaters and create unsafe conditions. However, the Bucksnort Dam is a historically important feature of the area and important to local residents. Dam removal would create social conflicts such as a loss of aesthetic beauty and it may allow downstream fish and invertebrate species, including some potentially invasive species, to move upstream. There is some interest in expanding winter angling opportunities to include all of Trout Run. The existing 12-16-inch protected slot regulation has not been evaluated in either biological terms (e.g., increases in abundance of larger brown trout) or sociological terms (increases in angler catch rates of larger trout and associated increases in satisfaction).

Management Recommendations for Social Aspects:

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**	

1) Identify all stakeholders and maintain communication and coordination to manage conflicts.
2) Engage in conversations and provide information on objectives for maintaining the presence of Bucksnort Dam.
3) Actively seek angling easements in the area of Nichol's Spring and the mouth of Trout Run on the Middle Branch Root River.
4) Institute an angler creel survey to determine satisfaction, harvest, angling methods, etc., especially as related to the slot-limit regulation

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**	

References

Gallagher, A. S. 1999. Barriers. Pages 135-148 in M. B. Bain and N. J. Stevenson, editors. Aquatic habitat assessment: common methods. American Fisheries Society, Bethesda, Maryland.

MNDNR (Minnesota Department of Natural Resources). 2007. Fisheries stream survey manual. Special Publication 165, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

Mundahl, N. D., and T. P. Simon. 1999. Development and application of an index of biotic integrity for coldwater streams of the upper Midwestern United States. Pages 383-415 in T. P. Simon, editor. Assessing the sustainability and biological integrity of water resources using fish communities. CRC Press, Boca Raton, Florida.

Rosgen, D. L. 2006. Watershed Assessment of River Stability and Sediment Supply (WARSSS). Wildland Hydrology, Fort Collins, Colorado.

Snook, V. A. 2008. Resurvey report, Trout Run Creek (M-009-029). Minnesota Department of Natural Resources, Section of Fisheries, St. Paul.

Table 1. Station information on Trout Run Creek (M-009-029). Station location represents downstream UTM's. New station number is the distance from the mouth in miles.

New Station Number	Old Station Number	Station Name	Station Location (UTM's)
11.90	13	Wiskow's	574275 4859353
10.21	10	McGuire's	574834 4858364
8.63	9	Control	574555 4856663
7.35	8	Special Regulations	575981 4856233
5.95	Meyer's	Meyer's (HI Project)	575957 4854765
4.46	4	Lohman's	576092 4853572
2.50	3	Kleven's	576180 4851767
1.98	Smith's	Smith's (HI Project)	576599 4851321
1.31	Roeder's	Roeder's (HI Project)	576557 4850522
0.98	1	Hakim's/Egge's	576387 4850304

Stream Name Trout Run Creek		Kittle Number M-009-029	Total Miles in Minn. 13.11	Date of Plan (Mo.-Yr.) April 2008
Region 2	Area Fisheries Office Lanesboro (F318)	Plan Managed Segment (river miles) 0.00 – 13.11	Length (miles) Plan Managed Segment 13.11	

Table 2. Brown trout stocked in Trout Run Creek, Winona, Fillmore, and Olmsted counties.

Year	Size	Numbers
1945	Yearling	840
1946	Yearling	5,290
1947	Yearling	7,000
1948	Yearling	10,520
1949	Fingerling	1,000
	Yearling	9,275
1950	Yearling	11,424
1951	Yearling	5,304
1952	Yearling	7,060
1953	Fingerling	1,020
	Yearling	7,058
1954	Yearling	11,611
1955	Fingerling	25,216
	Yearling	2,857
	Adults	18
1956	Fingerling	15,538
	Yearling	6,795
1957	Fingerling	13,471
	Yearling	12,605
1958	Fingerling	21,540
	Yearling	3,824
1959	Fingerling	24,427
	Yearling	12,865
1960	Fingerling	14,334
	Yearling	17,360
1961	Fingerling	4,495
	Yearling	14,518
1962	Yearling	15,598
	Adult	100
1963	Yearling	15,598
	Adult	15
1964	Yearling	7,600
1965	Yearling	13,820
	Adult	300
1966	Yearling	6,175
1967	Fry	128,000
	Adult	40
	Yearling	9,598
1968	Yearling	10,964
1969	Fry	60,000

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**	

	Adult	15
	Yearling	5,360
1970	Yearling	12,288

Table 2 (continued). Brown trout stocked in Trout Run Creek, Winona, Fillmore, and Olmsted counties.

Year	Size	Numbers
1971	Yearling	9,950
1972	Fingerling	2,712
	Yearling	13,835
1973	Fingerling	2,208
	Adult	73
	Yearling	15,073
1974	Yearling	13,530
1975	Yearling	8,640
1976	Yearling	7,130
1977	Fingerling	11,250
	Yearling	6,339
1978	Yearling	5,700
1979	Yearling	5,454
1980	Fry	25,400
	Yearling	3,124
1981	Yearling	3,855
1982	Fry	200,000
	Yearling	4,087
1983	Fry	75,000
	Yearling	3,612
1984	Fry	45,486
	Yearling	2,011
1985	Fry	25,000
	Yearling	2,750
1986	Fry	24,967
	Yearling	2,800
1987	Fingerling	24,943
	Yearling	2,750
1988	Fingerling	25,000
	Yearling	3,500
1989	Fingerling	24,600
	Yearling	3,500
1990	Fingerling	50,000
1991	Fingerling	48,840
1992	Fingerling	20,000
1993	Fingerling	20,000
1994	Fingerling	20,000
1995	Fingerling	20,000
1996	Fingerling	20,000

Stream Name **Trout Run Creek**		Kittle Number **M-009-029**	Total Miles in Minn. **13.11**	Date of Plan (Mo.-Yr.) **April 2008**
Region **2**	Area Fisheries Office **Lanesboro (F318)**	Plan Managed Segment (river miles) **0.00 – 13.11**	Length (miles) Plan Managed Segment **13.11**	

1997	Fingerling	20,000
1998	Fingerling	20,000
1999	Fingerling	20,000

Table 2 (continued). Brown trout stocked in Trout Run Creek, Winona, Fillmore, and Olmsted counties.

Year	Size	Numbers
2000	Fingerling	20,000
2001	Fingerling	20,000
2002	Fingerling	20,000
2003 - 2010	No stocking	

Stream Name	Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek	**M-009-029**	**13.11**	**April 2008**

Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**

Table 3. Rainbow trout stocked in Trout Run Creek, Winona, Fillmore, and Olmsted counties.

Year	Size	Numbers
1945 - 1953	No stocking	
1954	Yearling	1,500
1955	Yearling	4,113
	Adult	29
1956	Yearling	2,505
1957	Yearling	1,085
1958	Yearling	2,971
1959	Yearling	3,640
1960	Yearling	1,080
1961	Yearling	2,400
1962	No stocking	
1963	Adult	10
1964	Yearling	5,800
	Adult	75
1965	Yearling	920
1966	Yearling	1,432
1967	Yearling	6,000
	Adult	4
1968 - 1983	No stocking	
1984	Yearling	570
1985 - 2010	No stocking	

Stream Name **Trout Run Creek**		Kittle Number **M-009-029**	Total Miles in Minn. **13.11**	Date of Plan (Mo.-Yr.) **April 2008**
Region **2**	Area Fisheries Office **Lanesboro (F318)**	Plan Managed Segment (river miles) **0.00 – 13.11**	Length (miles) Plan Managed Segment **13.11**	

Table 4. Brook trout stocked in Trout Run Creek, Winona, Fillmore, and Olmsted counties.

Year	Size	Numbers
1945	No stocking	
1946	Yearling	1,295
1947	Yearling	604
1948	Yearling	1,495
1949	Yearling	1,496
1949 - 1951	No stocking	
1952	Yearling	3,700
1953	Fingerling	1,850
1954 - 1956	No stocking	
1957	Yearling	752
1958 - 1961	No stocking	
1962	Fingerling	4,000
1963	Adults	20
1964 - 1966	No stocking	
1967	Fingerling Adults	1,600 40
1968 - 1970	No stocking	
1971	Fingerling	1,440
1972 - 1981	No stocking	
1982	Yearling	1,511
1983	Yearling	4,905
1984	Yearling	1,735
1985	Yearling	780
1986	Yearling	926
1987 - 2010	No stocking	

Stream Name Trout Run Creek		Kittle Number M-009-029	Total Miles in Minn. 13.11	Date of Plan (Mo.-Yr.) April 2008
Region 2	Area Fisheries Office Lanesboro (F318)	Plan Managed Segment (river miles) 0.00 – 13.11	Length (miles) Plan Managed Segment 13.11	

Table 5. Habitat improvement record of project on Trout Run Creek from 1958 to 2008.

Year	Type and Extent	Cost
1958-1959	Stabilize stream banks – 8,915 linear feet Build shoreline fences – 3.17 miles	No record
1960	Improve shelters and pools – 1,804 linear feet Install 20 Hewitt ramps and shelters	$4,264
1961	Install 11 flood gates Install 6 cattle crossings	$12,395
1962	Improve 5 trout-spawning areas Plant trees – 20,750	$7,567
1963	Plant trees (5,794), 30 rods of fence, 1 stile, 1 flood gate	$1,694
1964	Plant trees (4,100), 100 hours stream maintenance	$647
1965	Stream maintenance – 150 hours	$337
1966	Stream maintenance – 91 hours	$383
1967	Stream maintenance – 16 hours	$112
1968	Stream maintenance – 78 hours	$307
1969	Repair fences, flood gates, shelters, stabilize 1 bank, remove trees and debris	$3,890
1970	Restore existing improvements	$2,764
1971	Restore existing improvements	$781
1972	Restore existing improvements, improve 2 crossings	$816
1973	Restore existing improvements	$1,103
1974	Major cleanup and reconstruction after severe flood	$4,013
1975	Continue cleanup and repairs after 1974 flood	$2,582
1976	Continue cleanup and repairs after 1974 flood and remove dead elm trees	$1,856
1977	Remove dead elm trees	$2,844
1978	Restore existing improvements	$1,856
1979	Remove 4 log jams, dead elms, and install 2 stiles	$6,430
1980	Remove 40 dead elms and repair fences	$1,885
1981	Remove log jams, dead elms, and install 2 stiles	$2,301
1982	Repair fences and install 2 stiles	$740
1983	Major project	$34,970
1984	Repair fences	$380
1985	Remove log jam and repair fences	$948
1986	Major project	$9,749
1987	Major project (Sector 1A)	$14,527
1987	Major project (Sector 2C)	$10,008
1987	Inspection and repair fences	$1,010
1991	Install 4 stiles, remove 2 willow trees and 1 log jam, stream inspection for beaver dams	$1,719.84
1992	Stream inspection for beaver activity and other trout stream problems	$525.76
1992	Lyman Roeder's habitat-improvement project	~$20,922.00
1993	Repair stream fence, stream inspection	$926.32
1994	Stream inspection, remove trees from stream, repair stream fence	$2,384.84
1995	Stream inspection, install pasture pump for cattle watering, assist landowner on installing access bridge, install 2 stiles	$2,628.95

Stream Name Trout Run Creek		Kittle Number M-009-029	Total Miles in Minn. 13.11	Date of Plan (Mo.-Yr.) April 2008
Region 2	Area Fisheries Office Lanesboro (F318)	Plan Managed Segment (river miles) 0.00 – 13.11	Length (miles) Plan Managed Segment 13.11	

Table 5 (continued). Habitat improvement record of project on Trout Run Creek from 1958 to 2008.

Year	Type and Extent	Cost
1996	Stream inspection, maintenance for cattle waterer	$1,295.46
1997	Stream inspection, maintenance for cattle waterer, install 3 stiles	$1,572.53
1998	Stream inspection for beaver activity, maintain cattle waterer, remove tree	$2,799.95
1999	Stream inspection for beaver activity, install two stiles, maintain cattle waterer	$1,298.89
2000	Stream inspection for beaver activity	$678.39
2001	Stream inspection, maintenance of cattle waterer, install 2 stiles	$2,646.58
2002	Stream inspection, maintenance of cattle waterer	$1,460.96
2004	Stream inspection, cattle drinker maintenance, remove log jams	$4,933.51
	Meyer's TU and MNDNR cooperative habitat improvement project planning	$3,247.57
2005	Meyer's TU and MNDNR cooperative habitat improvement project	$7,472.25
2006	Smith's TU and MNDNR cooperative habitat improvement project planning	$328.23
	Smith's TU and MNDNR cooperative habitat improvement project	$19,242.05
	Bid-a-wee's MNDNR habitat improvement project	$7,490.15
2007	Lohman's TU and MNDNR habitat improvement project – SPHO, HPHO	$954.60
	Lohman's TU and MNDNR cooperative habitat improvement project	$27,840.64
	Smith's TU and MNDNR cooperative habitat improvement project	$3,048.31
	Hakim's MNDNR habitat improvement project	$128,652.12
	Hakim's MNDNR habitat improvement project – tree planting	$926.10
2008	Felding's TU and MNDNR habitat improvement project	$5,247.72

Table 6. Fish species sampled in fisheries surveys and assessments, Trout Run Creek, upstream of Bucksnort Dam. Non-game fish collected were not recorded in assessments earlier than 2003 or in 2004.

Common Name	2010	2009	2008	2007	2006	2005	2004	2003
Brown trout (*Salmo trutta*)	X	X	X	X	X	X	X	
White sucker (*Catostomus commersoni*)	X	X	X	X	X	X		X
Blacknose dace (*Rhinichthys atratulus*)						X		X
Sculpin sp. (*Cottus* sp.)	X	X				X		

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region	Area Fisheries Office	Plan Managed Segment (river miles)	Length (miles) Plan Managed Segment	
2	**Lanesboro (F318)**	**0.00 – 13.11**	**13.11**	

Table 7. Fish species sampled in fisheries surveys and assessments, Trout Run Creek, downstream of Bucksnort Dam. Non-game fish collected were not recorded in assessments earlier than 2003 or in 2004.

Common Name	2010	2009	2008	2007	2006	2005	2004	2003
Brown trout (*Salmo trutta*)	X	X	X	X	X	X	X	X
Rainbow trout (*Oncorhynchus mykiss*)				X				
White sucker (*Catostomus commersoni*)	X	X	X	X	X	X		X
Central stoneroller (*Campostoma anomalum*)					X			
Longnose dace (*Rhinichthys cataractae*)		X		X	X	X		X
Blacknose dace (*Rhinichthys atratulus*)								X
Redhorse sp. (*Moxostoma* sp.)						X		X
Shorthead redhorse (*Moxostoma macrolepidotum*)	X	X	X	X	X	X		
Golden redhorse (*Moxostoma erythrurum*)	X	X	X	X	X	X		
Silver redhorse (*Moxostoma anisurum*)		X	X	X	X			
Black redhorse (*Moxostoma duquesnei*)					X	X		
Northern hog sucker (*Hypentelium nigricans*)		X	X	X	X			
Creek chub (*Semotilus atromaculatus*)	X	X	X	X				
American brook lamprey (*Lampetra appendix*)	X		X		X	X		
Northern brook lamprey (*Ichthyomyzon fossor*)				X	X			
Lamprey sp.	X	X						
Common shiner (*Luxilus cornutus*)				X				

Stream Name		Kittle Number	Total Miles in Minn.	Date of Plan (Mo.-Yr.)
Trout Run Creek		**M-009-029**	**13.11**	**April 2008**
Region **2**	Area Fisheries Office **Lanesboro (F318)**	Plan Managed Segment (river miles) **0.00 – 13.11**	Length (miles) Plan Managed Segment **13.11**	

Table 8. Brown trout population metrics, Trout Run Creek, Fillmore, Winona, and Olmsted counties, in the Long-Term Monitoring station (Station 8.63)1972-2010.

Station number	Similar Reach	Date	No./mile (Adult)	No./mile (Recruits)	No./mile (≥ 12 in)	No./mile (≥ 14 in)	No./mile (≥ 16 in)	Biomass (lbs/acre)
8.63 (Control)	2	10/21/2010	4,817	3,892	222	22	0	376.37
8.63	2	9/23/2009	3,847	7,950	332	30	11	373.52
8.63	2	9/16/2008	2,433	4,645	138	28	11	259.84
8.63	2	9/20/2007	2,913	997	199	22	6	265
8.63	2	9/20/2006	1,409	2,135	132	39	0	160
8.63	2	9/21/2005	1,078	906	174	22	0	161
8.63	2	9/27/2004	1,489	504	79	-	-	151
8.63	2	9/23/2003	2,300	2,056	94	-	-	184
8.63	2	10/14/2002	2,239	2,933	200	-	-	236
8.63	2	9/18/2001	1,622	428	39	-	-	158
8.63	2	10/4/2000	1,806	817	50	-	-	134
8.63	2	10/6/1999	1,967	2,017	78	-	-	142
8.63	2	9/29/1998	1,744	3,317	172	-	-	186
8.63	2	10/4/1997	653	797	89	-	-	88
8.63	2	10/9/1996	1,337	607	50	-	-	118
8.63	2	10/4/1995	2,355	1,861	100	-	-	221
8.63	2	9/27/1994	1,983	2,360	56	-	-	169
8.63	2	9/23/1993	2,398	551	61	-	-	188
8.63	2	9/12/1990	1,225	63	-	-	-	-
8.63	2	9/3/1986	2,130	1,262	-	-	-	-
8.63	2	9/4/1985	2,252	465	-	-	-	-
8.63	2	9/20/1984	2,036	2,009	-	-	-	-
8.63	2	9/26/1983	1,434	1,134	-	-	-	-
8.63	2	9/9/1980	664	177	-	-	-	-
8.63	2	10/3/1977	283	149	-	-	-	-
8.63	2	10/2/1972	243	296	-	-	-	-
		Fall Mean	**1,876**	**1,705**	**126**	**27**	**5**	**198.4**
8.63	2	5/17/2005	2,565	-	146	11	0	219
8.63	2	4/2/2003	4,222	-	172	-	-	178
8.63	2	4/1/1999	3,322	-	111	-	-	167
8.63	2	4/6/1998	1,906	-	178	-	-	123
8.63	2	4/14/1997	1,667	-	28	-	-	85
8.63	2	4/8/1996	2,863	-	32	-	-	98
8.63	2	4/6/1995	2,726	-	39	-	-	139
8.63	2	4/1/1994	3,612	-	139	-	-	199
		Spring Mean	**2,860**		**106**			**151**

Stream Name Trout Run Creek	Kittle Number M-009-029	Total Miles in Minn. 13.11	Date of Plan(Mo.-Yr.) April 2008
Region 2 / Area Fisheries Office Lanesboro (F318)	Plan Managed Segment (river miles) 0.00 – 13.11	Length (miles) Plan Managed Segment 13.11	

Table 9. Brown trout population metrics, Trout Run Creek, Fillmore, Winona, and Olmsted counties, 1974-2010.

Station number	Similar Reach	Date	No./mile (Adult)	No./mile (Recruits)	No./mile (≥ 12 in)	No./mile (≥ 14 in)	No./mile (≥ 16 in)	Biomass (lbs/acre)
0.98 (Egge's)	1	4/14/2010	1,564	2,008	279	84	0	220.0
0.98	1	4/16/2009	990	668	66	5	0	119.4
0.98	1	4/17/2008	810	191	85	5	0	68.0
0.98	1	4/13/2007	820	1,554	76	0	0	112.0
0.98	1	4/6/2006	778	356	32	5	5	89.7
0.98	1	6/29/2005	1,482	21	205	-	-	167.6
0.98	1	5/27/2004	819	4	238	-	-	116.9
		Mean	**1,038**	**686**	**140**	**20**	**1**	**128.7**
1.97	1	4/29/2008	935	191	48	0	0	62.3
1.97	1	4/23/2007	1,292	423	71	5	0	73.6
1.97	1	4/20/2006	1,732	580	84	11	5	123.4
		Mean	**1,319**	**398**	**68**	**3**	**2**	**86.4**
2.50 (Kleven's)	1	10/28/2009	2,624	2,360	452	193	63	382.5
2.50	1	5/18/2005	1,387	0	32	-	-	111.0
2.50	1	9/30/2003	2,522	797	241	117	28	217.0
2.50	1	10/1/2002	2,065	3,904	333	150	33	231.8
2.50	1	9/18/2001	1,427	1,317	117	26	5	130.3
2.50	1	10/3/2000	1,207	1,683	149	24	11	99.1
2.50	1	10/7/1999	1,543	1,442	66	24	5	121.1
2.50	1	9/29/1998	1,169	4,327	103	33	28	146.0
2.50	1	10/13/1997	905	3,296	129	38	11	135.2
2.50	1	10/9/1996	1,358	1,893	104	33	11	147.12
2.50	1	10/3/1995	1,847	4,311	95	21	11	192.2
2.50	1	10/4/1993	2,534	684	59	33	21	135.2
2.50	1	10/13/1992	3,219	12,048	241	80	24	461.4
2.50	1	9/27/1990	845	541	82	37	4	91.1
2.50	1	9/8/1986	1,535	1,839	18	11	0	139.0
2.50	1	9/10/1982	774	2,345	4	0	0	68.0
2.50	1	9/27/1974	132	10	27	9	9	-
4.20	2A	4/24/2008	3,715	727	297	17	1	268.7
4.46 (Lohman's)	2A	5/23/2005	3,235	6	144	-	-	243.6
5.95 (Meyer's)	2A	4/24/2007	2,647	496	401	40	8	302.0
5.95	2A	4/13/2006	1,921	2,234	347	35	0	331.3
5.95	2A	5/16/2005	3,820	0	237	-	-	246.9
7.35 (Spec. Regs.)	2A	5/24/2005	3,121	0	40	-	-	222.0
10.21 (McGuire's)	2A	5/31/2005	2,565	0	146	-	-	218.6
11.90 (Wiscow's)	2B	6/1/2005	2,080	0	353	-	-	405.2

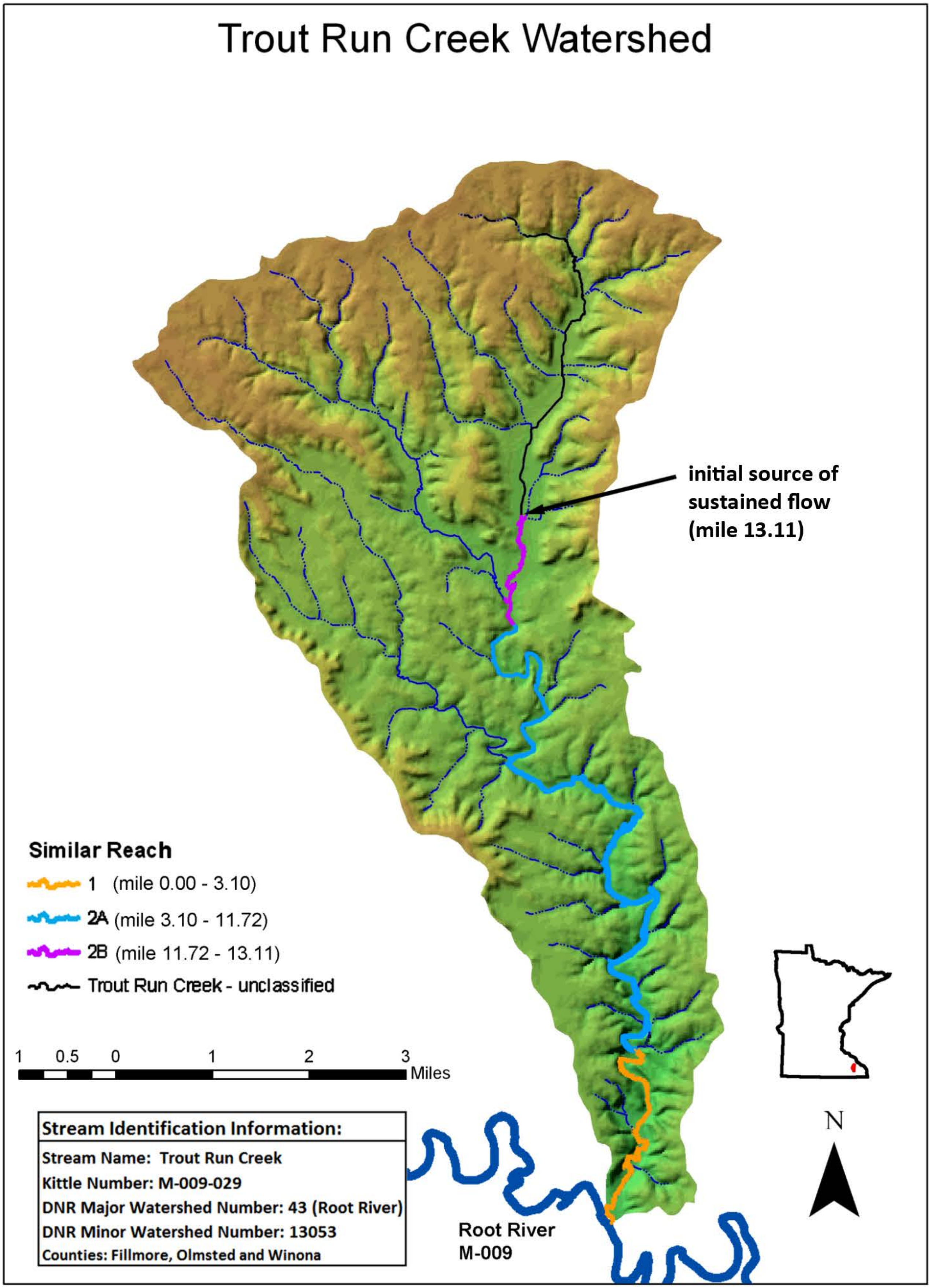

Figure 1. Map of Trout Run Creek (M-009-029) watershed with fisheries similar reaches (from Snook 2008).

STREAM MANAGEMENT PLAN – Page 1

Stream Name		Kittle Number			Total Miles in Minn.	Date of Plan (Mo.-Yr.)
West Fork Des Moines River		**I-037**			**118.96**	**Dec 2011**
Region **4**	Area Fisheries Office **Windom Area (F418)**	Plan Managed Segment (river miles) **0.00 to 128.06**			Length (miles) Plan Managed Segment **118.96 (w/o Lake Shetek)**	
Major Watershed: **51 – West Fork Des Moines River watershed** **52 – Lower Des Moines River watershed**		Minor Watersheds (significant tributaries) **Too numerous to list (N=286)**				

Similar Reach	Similar Reach Name	Stream Miles	Length (miles)	Rosgen Channel Type	Fisheries Ecological Classification	Species of Management Interest[1]
1	**Mouth (border) to Windom**	**0.0 – 35.22**	**35.22**	**-**	**II-B,C,D**	**WAE, NOP, CCF**
2	**Windom to Heron Lake Outlet**	**35.22 – 54.96**	**19.74**	**-**	**II-B,C,D**	**WAE, NOP, CCF**
3	**Heron Lake outlet to Lime Creek**	**54.96 – 82.62**	**27.66**	**-**	**II-B,C,D**	**WAE, NOP, CCF**
4	**Lime Creek to Lake Shetek**	**82.62 – 108.29**	**25.67**	**-**	**II-B,C,D**	**WAE, NOP, CCF**
-	**Lake Shetek (DOW 51-0046-00)**	**108.29 – 117.39**	**9.10**	**-**	**-**	**-**
5	**Lake Shetek to Yankton Lake Outlet**	**117.39 – 128.06**	**10.67**	**-**	**II-B,C,D**	**WAE, NOP, CCF**

[1]WAE= walleye; NOP=northern pike; CCF=channel catfish

Long-Range Goals

Goal 1: *Similar reaches 3, 4, 5 – An accessible fishery for walleye, channel catfish, and northern pike and suitable aquatic habitat to support it.*

Objectives (Desired Future Conditions) and Operational Plans:

1. Walleye, northern pike, and channel catfish populations as defined by minimum catch rates for adults; presence of naturally reproduced young; and adequate age structure (values based on historic fisheries survey catch rates associated with anecdotal reports of angling success):
   a. Walleye – Adults 1.0/hr electrofishing; 1.0/trap net set; presence of age-0 fish; at least four age groups.
   b. Northern pike – adults 1.0/hr electrofishing; 1.5/trap net set; presence of age-0 fish; at least four age groups.
   c. Channel catfish – adults 1.0/trap net set; presence of age-0 fish; at least three age groups
      i. Conduct fish population assessments as time allows to ensure populations are being maintained as defined above.
      ii. If populations do not meet objectives, either conduct supplemental surveys of fish populations to determine factors influencing abundance or consider stocking to bolster abundance.
2. A free-flowing geomorphically stable river channel with water quantity and quality sufficient to support populations of walleye, channel catfish, and northern pike.
   a. As soon as possible, conduct a full stream survey to identify stable and unstable stream reaches and potential factors influencing stability, including road crossings, mainstem dams (e.g., Talcot Lake Dam, beaver dams), bank stability/erosion, and floodplain connectivity.
   b. Assess baseflow volume from each tributary to determine and prioritize tributaries for maintenance of low flows.
   c. Support and advocate for implementation of action items identified in the Total Maximum Daily Load Plan in part by attending relevant meetings. Implementation of action items should enhance hydrology, water quality, connectivity, and geomorphology components through better land use practices in key areas.
   d. Assist with monitoring responsibilities identified in the TMDL Plan for MNDNR staff (including Fisheries) for macrophytes, phytoplankton, zooplankton, and fish communities.

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3. A publicly accessible river resource.
    a. Ensure existing public access sites, including boat and canoe launches, remain functional.
    b. Conduct a recreational use survey to determine if the needs of all recreational users are being met (e.g., are there enough access points, is their spacing adequate).

Goal 2: *Similar Reaches 1 and 2 – There is not enough information to formulate specific management goals at this time (see Future Potential Plans).*

Survey and Assessment Schedule

Next scheduled assessment(s)	Station (river mile)	Objective	Report due
None scheduled			

Stocking Schedule

Next scheduled stocking	Species - size	Quantity	Reach	Specific location
None scheduled				

Future Potential Plans

1) Advocate for programs that seek to limit the effects of climate change, especially as it might influence precipitation patterns.
2) Develop and implement, or assist with implementation of, a monitoring program to detect improvements in hydrology, geomorphology, and water quality that could be the result of actions of conservation partners (e.g., via implementation of the TMDL Plan, climate change reduction measures, etc.)
3) Conduct a full stream survey, or at a minimum, a fish population assessment, in similar reaches 1 and 2 (river upstream from Talcot Lake) to gather baseline information to identify management options. Such a survey should include an assessment of aquatic vegetation and the presence of invasive aquatic and terrestrial species.
4) Develop monitoring protocols to detect establishment and expansion of Asian carp into this watershed.
5) Implement a recreational use and creel survey to better define current practices and desired future conditions of river recreationists, etc.

Approvals

Plan Authors			
Nate Hodgins			
Area Supervisor	***Date***	***Regional Manager***	**Date**

Stream Name West Fork Des Moines River		Kittle Number I-037	Total Miles in Minn. 118.96	Date of Plan (Mo.-Yr.) Dec. 2011
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BACKGROUND INFORMATION

Priorities – Moderate recreational importance (angling, hunting, canoeing, kayaking); designated canoe route; sportfishing for walleye, northern pike, channel catfish, black crappie, and yellow perch; dam removal; potential invasion route for Asian carp. One tributary, Sheldorf Creek, is a designated trout stream with four tributaries of its own that are also protected as such.

Description of Stream System – The Des Moines River is a tributary of the Mississippi River, approximately 525 miles (845 km) long from its mouth to its farthest headwaters in southern Minnesota. The largest river flowing across the state of Iowa, it flows across Iowa from northwest to southeast, forming part of the state boundary with Iowa and Missouri.

This management plan is for the West Fork Des Moines River in Minnesota, lying within the boundaries of MNDNR major watersheds #51 and #52. It is a hardwater eutrophic river flowing through a partially wooded agricultural area. The river flows across soils consisting of loam, clay loam, and silty clay loam on flat to gently rolling uplands. Almost the entire watershed is in private ownership with predominate uses including row crop agriculture and livestock pasture. Also present in the watershed are various state, county and city parks, wildlife management areas and game refuges. The river's source begins in southwest Lyon County, but permanent flow is generally considered to be the outlet from Lake Shetek. Most flow originates from lake outlets and tributaries. As of 2012, the most downstream 53 miles of the mainstem is considered free flowing in Minnesota (i.e., from Talcot Lake Dam downstream).

Stream Mouth Location: T.102N, R.35W, S.24 (old Jackson dam site) – stream continues to flow 12.21 miles to the MN-IA state border.

Stations used for fish surveys and assessments can be found in Table 1.

Past Surveys and Investigations – The first documented fisheries survey by a state fisheries crew was a brief survey conducted in 1953 on Kilen Creek in Kilen Woods State Park. This tributary to the West Fork Des Moines River was deemed to have no possibilities for fish or fishing due to inadequate flow. The first initial survey was conducted from 1977-1979 and included identification of three similar reaches and associated sampling stations; inventories of tributaries, springs, dams and other barriers; measurements of physical habitat and water quality; and fish community assessments. Similar, but less intensive surveys were completed in 1985, 1987, and 1994. In 2012, a fish kill investigation and a broad-level watershed mapping evaluation were completed.

1) Moyle, J. B. 1953. Stream survey report, Kilen Park Creek, Jackson County
2) Ingbritson, M. 1979. Initial stream survey report 1977-1979, West Fork Des Moines River.
3) Ingbritson, M. 1986. River fisheries survey, Des Moines River: Talcot Lake Dam to Iowa border.
4) Halverson, M. 1988. Stream population assessment, West Fork Des Moines River.
5) MNDNR. 1994. Fisheries assessment and water analysis report, West Fork Des Moines River.
6) Doorenbos, R. 2012. Des Moines River fish kill investigation.
7) Hodgins, N. 2012. Initial survey, map preparations-West Fork Des Moines River.

Past Management – The West Fork Des Moines River has been infrequently sampled for fishes since the initial stream survey was completed in 1979 (Table 1). No formal management plan has been written for this river. Most management efforts have focused on infrequent population assessments for gamefishes; occasional stocking of channel catfish, black crappie, walleye, smallmouth bass, and northern pike (Table 2); commercial fish removal (Table 3); promiscuous fishing opportunities due to poor water quality; documentation of sporadic fish kills; and, most recently, dam removals. The river has provided good opportunities for anglers fishing for northern pike, walleye, channel catfish, and crappie. It is believed that few anglers caught many smallmouth bass following an introductory stocking in 1979. No smallmouth bass have since been stocked. The river has supported large

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numbers of common carp, bigmouth buffalo, quillback carpsucker, and black bullhead. Portions of similar reaches 1, 2, and 3 were opened to promiscuous fishing at least seven times between 1952 and 1987, usually in conjunction with partial fish kills due to low dissolved oxygen levels.

ASSESSMENT OF RESOURCE CONDITION (ARC)

HYDROLOGY

General Description – The West Fork Des Moines River drains a 1,248-mi^2 watershed composed of primarily cultivated land. Occasional livestock pasture and urban land uses are also present. Major cities along the river include Windom (population 4,600 in 2010 census) and Jackson (3,300 in 2010). Several large glacial lakes and wetland complexes are present in the basin and provide some water storage. These include Heron Lake, Kinbrae lake complex, Lime Lake, and Lake Maria. Two others, Talcot Lake and Lake Shetek, are located on the mainstem river and have lake outlet structures to control lake levels primarily for wetland and waterfowl management. Drainage density is 0.10 mi/mi^2, which is relatively low. Low drainage density values are often the result of widely spaced streams associated with a watershed with good infiltration capacity. Most of the watershed is overlain by prairie soils of loams, clay loams, or silty clay loams, which likely have good infiltration capacity.

Based on the initial survey completed in 1979, most of the water in the river downstream from Talcot Lake originates as surface runoff from about 20 tributaries and ditches. Seven of these tributaries have their origins in lakes (e.g., Boot Lake WMA, Warren Lake, String Lake). Only one tributary, Scheldorf Creek, has a spring-fed water source. Consequently, hydrology of the river is heavily influenced by precipitation, especially spring-summer rainfall, and subsequent overland flow.

Total annual precipitation has been increasing slowly from about 28 inches in 1960 to just over 30 inches in 2009. Stream channels in tributaries and on the mainstem may need to be able to accommodate this increase in stream flow. Historically, within each year, precipitation generally increased gradually from March (about 2 inches) to a peak in June at about 4.5 inches, before gradually declining through November. Precipitation from 2000-2009 showed slightly higher-than-historic rainfall in April and May and again in late summer-early fall (August-October), whereas midsummer precipitation amounts were generally less, especially in July. The primarily agricultural land use practices may speed overland water delivery to the mainstem river resulting in a flashier hydrologic regime. This may also increase the magnitude and duration of low flows, a cited concern in past stream surveys and assessments.

A United States Geological Survey stream gage (05476000) is located near the mouth of the river at Jackson. Historic data indicate that the river's hydrology is typified by a spring flood in April, likely the result of melting snow and spring rains, followed by a gradual decline through August and September. River flows since 1960 have been higher than flows recorded from 1930-1959. In the last decade (2000-2009) the April flood has maintained its magnitude but has extended into May. Also, the flood recession has dipped lower than averaged flows in June, July, and August. This likely re-illustrates the relationship between precipitation and stream flow, because recent precipitation patterns have suggested a similar pattern of lower-than-average rainfall amounts in June and July in 2000-2009. Dams exist at the outlets of Talcot Lake and Lake Shetek, but their influence on hydrology is unknown. Two other mainstem dams existed at Windom and Jackson but were recently removed in 2012. Ditching, tiling, and channelization of tributaries likely also speed water delivery to the stream, but these issues have not been quantified in past stream surveys.

Management Concerns for Hydrology (at each of three spatial scales)

Watershed-scale Concerns – The two most important factors influencing hydrology of the West Fork Des Moines River likely occur at the watershed scale. They are precipitation events that contribute flow volume and land use practices that move this water to the stream. Precipitation influences all five elements of hydrology: the magnitude (how much water), timing (when that water comes), frequency (how often the water rises), duration (how long it lasts), and rate of change (how rapidly it rises and then falls). Land use practices also influence these five but have a greater influence on duration (how quickly the water gets to the stream, e.g., via drain tiles or ditches) and consequently how rapidly the water rises and falls (rate of change). Because precipitation and land use practices generally fall outside the management authority of MNDNR Fisheries, proper management

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of hydrology for this river will depend on involvement of other agencies and conservation partners. However, MNDNR Fisheries may have a role in identification of important land areas to target for conservation efforts by partners and to monitor fish and instream habitat benefits in response to changes in land use practices and climate.

Riparian-scale Concerns – Specific riparian scale concerns have not been identified. Presence of levees and, more generally, the importance of floodplain access to mediate flood peaks is unknown. Further investigation may be warranted.

Instream-scale Concerns – Dams and road crossings are likely the two greatest instream concerns for hydrology. Alterations to the hydrologic regime on this river due to the two remaining dams (Talcot Lake and Lake Shetek) are unknown. Historically, active beaver dams have also been identified on the mainstem but their hydrologic impacts were not quantified. In addition, there are many instream road crossings located at several locations (hundreds of locations) on the mainstem and tributaries. Whether these crossings influence the magnitude, timing, duration, frequency, and rate of change of high and low flow pulses is unknown. Additional data may need to be acquired to ensure these structures are not having an impact. To accomplish this, stream stage- or discharge-recording equipment could be established upstream and downstream from these structures to assess impacts. Alternatively, differences in geomorphology (i.e., channel dimension, pattern, and profile) could also be collected and used as a surrogate assessment. If dimension, pattern, and profile differ between upstream and downstream stations, this might also suggest concerns (however, such differences may be more related to geomorphology concerns such as improper sediment movement than to primarily hydrology concerns).

Management Recommendations for Hydrology:

1) Successful direct management of precipitation seems unlikely other than through advocation of programs designed to reduce effects of climate change. Most such programs will be developed and implemented by others. MNDNR Fisheries can contribute to such efforts mostly as an advocate and through monitoring efforts to demonstrate either continued alterations or perhaps re-establishment of preferred conditions.
2) More direct management of hydrology may be accomplished through better management of land use practices in the basin. Flows should be measured near the mouth of each tributary to determine which tributaries contribute the most surface water to the mainstem. Land use practices in the watersheds of the primary contributing tributaries should be targeted for enhancement by partners such as NRCS, SWCD, etc.
3) The influence of Talcot Lake Dam, Lake Shetek Dam, beaver dams, and road crossings on stream hydrology is unknown and should be investigated.

CONNECTIVITY

General Description – The three primary connectivity dimensions are longitudinal, lateral, and vertical. Longitudinally, the mainstem West Fork Des Moines River has two man-made dams at the outlets of Talcot Lake and Lake Shetek, historical presence of beaver dams, and several road crossings. In addition, there are also hundreds of road crossings scattered throughout the watershed on many tributaries. With dam removals at Windom and Jackson, the most downstream 53 river miles are considered to be free flowing. There are also water-quality barriers, in terms of river sections with low dissolved oxygen, which result in occasional barriers for fishes and other aquatic biota. Lateral and vertical (i.e., groundwater flow) connectivity has never been evaluated.

Management Concerns for Connectivity (at each of three spatial scales)

Watershed-scale Concerns – The extensive number and scope of road crossings in the basin may be considered a watershed-scale concern. However, the impact of such crossings on movement of water, sediment, or biota has not been determined. The importance of water movement to the stream from subsurface sources is unknown as well.

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Riparian-scale Concerns – Lateral riparian connectivity concerns are unknown. Although not completely inventoried, it is believed that riparian zone levees are either uncommon or absent along the West Fork Des Moines River. Entrenched river channels may result in a decreased connection between a river and its floodplain as well, but no geomorphic surveys have been conducted to assess this on the West Fork.

Instream-scale Concerns – The existing mainstem dams (Talcot Lake, Lake Shetek), road crossings, and unknown beaver dams may be cause for concern as barriers to movement of fishes or other aquatic biota, or as impediments to proper movement of water and sediment. However, none of these factors has been examined for this river since at least the initial survey in 1979. Therefore, concern for these factors cannot be determined at this time. Low dissolved oxygen levels in some river sections continue to plague this river, as evidenced by a moderate fish kill in summer 2012. These episodic water-quality barriers are intimately linked with hydrology as they are most common during low flows.

Management Recommendations for Connectivity:

1) Almost nothing is known about connectivity concerns either along the mainstem river or its many tributaries. Thus, a full stream survey should be completed. The connectivity survey should specifically assess subsurface connections to groundwater flow, and potential interruptions to water, sediment, and aquatic biota movements through road crossings and over mainstem dams.
2) To alleviate chronic instream water-quality barriers, augmentation of low instream flows may need to be implemented. This will most likely be accomplished through better land use practices, especially in priority sub-watersheds of tributaries that contribute substantial flows (see management recommendation 2 for Hydrology above).

GEOMORPHOLOGY AND FISH HABITAT

General Description – Almost no geomorphic surveys have been completed on this river, making a broad-level description difficult. Watershed measures indicate that the length of the basin is about 66 miles with an overall drop in elevation of 641 feet. Overall slope of the watershed (i.e., basin relief ratio = 0.0018) is steeper than the slope of the mainstem river channel (0.000314). The mainstem is a 6th-order stream from its confluence with the Heron Lake outlet tributary downstream to Jackson (similar reaches 1 and 2). It is a 5th-order stream upstream to Lake Shetek (similar reaches 3 and 4). In 1979, channel width averaged about 60 feet in similar reaches 1 and 2. A watershed-scale longitudinal profile depicts several sections of little or no slope interspersed with rapid changes in stream slope. Some sections lacking slope can be explained by known lakes and impoundments such as Talcot Lake and Lake Shetek, whereas others cannot be similarly explained. Other areas with steep stream slopes could be nick points, improperly designed road crossings, historic stream obstructions such as beaver dams, or some other feature. It is not currently possible to determine if the mainstem river channel is geomorphically stable or not, although most former prairie streams in southwestern Minnesota are believed to be unstable. The presence of a large number of road crossings may interrupt proper sediment and water transport.

Similarly, almost no assessment of fish habitat has been completed since the initial survey in 1979. That survey noted that fish cover included occasional log jams and overhanging vegetation. Boulders, instream vegetation, and undercut banks were usually rated as scare or occasional cover types. Nevertheless, the entire river downstream from Talcot Lake was considered to provide suitable habitat for gamefishes in 1979.

Management Concerns for Geomorphology and Fish Habitat (at each of three spatial scales)

Watershed-scale Concerns – The primary factors that influence stream geomorphology from watershed sources are amounts of water and sediment. Average annual precipitation has increased over the past 50 years, suggesting that water volume has increased. The West Fork Des Moines River would have had to (and may continue to) change in response to an increase in water volume. Land use practices may ameliorate or increase the effects of this increase in water volume. Similarly, excessive sediment may fill stream channels either from erosion as water rushes overland, or by instream bank erosion due to higher

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stream flows. The 1979 survey noted several instances of severe bank erosion which would have supported this notion 30 years ago. However, current conditions are unknown. Because most of the watershed is in agriculture, land use practices are likely important regulators of water and sediment delivery to the river.

Riparian-scale Concerns – Streambank erosion is present at some sites, which will increase sediment delivery to the stream channel. Availability of adequate floodplains that allow dissipation of stream power during high flows has not been determined. Perhaps the greatest concern is a lack of geomorphic information.

Instream-scale Concerns – Lack of recent information on instream geomorphic conditions and fish habitat is the primary concern.

Management Recommendations for Geomorphology and Fish Habitat:

1) Schedule a full stream survey to gather information on the current geomorphic state and instream habitat of each similar reach and priority tributaries.
2) As opportunities arise, continue working with conservation partners on implementation of better land use practices as a general approach to improving geomorphology.
3) Conduct a comprehensive inventory and evaluation of road crossings. Consider prioritizing this inventory, perhaps by identifying important tributaries (see recommendation 2 above).

WATER QUALITY

General Description – Water quality in the West Fork Des Moines River has been infrequently assessed by grab samples conducted by MNDNR Fisheries since at least the 1970s. These samples have suggested a nutrient-rich river with occasional excessive algae blooms and periods of low dissolved oxygen. The initial survey in 1979 noted non-point-source pollution problems of turbidity, nutrient enrichment from agricultural activities including livestock pasturing, and general agricultural runoff. Point-source pollution problems associated with discharge from the Windom treatment plant included suds and organic discharge. Nutrient enrichment often coupled with low flows in summer or winter has led to occasional fish kills. The Minnesota Pollution Control Agency (MPCA) listed similar reach 1 as impaired in 1994 for ammonia and low dissolved oxygen. Some point-source pollution may have been addressed by an upgrade to the Windom wastewater treatment plant in 1995 at a cost of $4.1 million. Most subsequent impairment listings by MPCA may represent a shift to non-point-source pollution concerns. For example, subsequent impairment listings included similar reach 1 turbidity in 1998, fecal coliform in 2004, and similar reaches 3 and 4 turbidity and fecal coliform in 2004.

A Total Maximum Daily Load (TMDL) study was completed and approved for the entire basin in December 2008 (MPCA 2008; Heron Lake Watershed District 2009). This project noted that various reaches and lakes in the basin were listed as impaired for bacteria, turbidity, and phosphorus. To meet water-quality goals, bacteria levels would need to be reduced by 10-86 percent (depending on specific water body or stream reach); turbidity by 20-90 percent, and phosphorus by 79 percent. Primary sources of fecal coliform bacteria included livestock on overgrazed pasture, surface-applied manure, runoff from feedlots, and inadequate septic systems. Turbidity sources included streambank erosion, row-cropping practices, and algae. Phosphorus impairments were primarily located within the Heron lakes and were due to wastewater treatment facilities, cropland/pasture runoff, and streambank erosion. Specific projects to address these pollutant sources have been developed (see Heron Lake Watershed District 2009). The estimated cost for implementation of all identified projects was $63 million dollars. This equates to a cost of about $47,000/mi^2 or about $74/acre in the watershed.

Perhaps the most important water-quality factor for fish management is continued episodic periods of low dissolved oxygen, with the last occurring in summer 2012 during low flows and an extremely warm summer.

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Management Concerns for Water Quality (at each of three spatial scales)

Watershed-scale Concerns – As identified in the TMDL, the most important water-quality pollutants include bacteria, turbidity, and phosphorus. A total of 123 specific action items were initially identified to address these pollutants, but a final subset of 38 were prioritized for implementation. Some examples include providing a $15/acre incentive for variable-rate fertilizer application, replace open tile intakes with alternative tile intakes by providing 75% cost share, provide a $2,500-per-acre incentive for restoring wetlands through the Wetland Reserve Program, and obtain a feedlot inventory by conducting Level III feedlot inspections. The agencies responsible for implementation of most actions items were conservation partners such as the seven county SWCD and NRCS offices, county environmental offices, and the Heron Lake Watershed District. Fisheries staff may have little direct involvement in these action items, but should at a minimum serve as an advocate to these conservation partners. As time allows, fisheries staff should continue to attend informational meetings associated with these processes. Also, fisheries staff should continue monitoring of selected riverine components in the West Fork Des Moines River to help document benefits of these programs to the fishery of this river. The TMDL implementation plan does list one specific action item for MNDNR. That item (Action F, under Objective 9-Effectiveness Monitoring), directs the MNDNR Shallow Lakes and Fisheries units to conduct thorough macrophyte, phytoplankton, zooplankton, and fishery surveys. Fisheries staff should attempt to complete their part of this work.

Riparian-scale Concerns – The TMDL implementation plan offers several action items specific to riparian-scale issues of bank erosion, control of runoff, overgrazing, and other non-point sources of impairment. Many suggest monetary incentives for establishment of buffer strips, perpetual easements, and other actions. Fisheries should aid these efforts in an advocacy role and perhaps through implementation of more surveys to help identify specific locations where these action items may be most effective.

Instream-scale Concerns – Continued low dissolved oxygen levels and associated fish kills remain the primary instream water-quality concern. These problems appear to be related to combinations of flow volume, water temperature, and biological oxygen demand associated with nutrient enrichment. As such, low instream dissolved oxygen levels are the result of larger-scale concerns. Flow volume may be partially addressed by management recommendations for hydrology. Nutrient enrichment is likely due to non-point sources that can be best addressed by better land use practices in the watershed and riparian zones as directed by the TMDL Implementation Plan.

Management Recommendations for Water Quality:

1) Continue to support conservation measures in the watershed and associated monitoring efforts identified in the TMDL Implementation Plan.
2) Conduct a full stream survey that includes an inventory of riparian areas with heavy livestock use or row crop agriculture near the shoreline to identify areas of potential bank erosion and non-point sources of pollution.
3) Assist with specific monitoring efforts identified in the TMDL Plan for macrophytes, phytoplankton, zooplankton, and fisheries resources.

BIOLOGY

General Description – Biota in the West Fork Des Moines River have been infrequently assessed in similar reaches 1 and 2, and similar reach 3 downstream from Talcot Lake (Table 1). Fish stocking and removals are summarized in Tables 2 and 3. A total of 23 fish species have been sampled by fisheries staff between 1979 and 1994. Those past assessments indicated sport fishery potential for northern pike, walleye, channel catfish, black crappie, and yellow perch. Natural reproduction was documented for all five species at least once (Table 4). Growth rates in 1987 were at least average for most sportfishes with walleye and northern pike reaching 16 to 17 inches by age 4. The largest walleye collected in 1987 was just longer than 28 inches. Fisheries assessments also noted populations of some commercial species including common carp, bigmouth buffalo, black bullhead, and quillback carpsucker.

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Region **4**	Area Fisheries Office **Windom Area (F418)**	Plan Managed Segment (river miles) **0.00 to 128.06**	Length (miles) Plan Managed Segment **118.96 miles (w/o Lake Shetek)**	

No state-listed species of special concern were collected in these assessments. More recent fish surveys have not been conducted since 1987 but walleye, channel catfish, redhorse spp., white sucker and quillback carpsucker were noted in a 2012 fish kill.

Fishes have not been sampled upstream of Talcot Lake in the West Fork Des Moines River (i.e., similar reaches 4 and 5), but fisheries assessments have been conducted in Lake Shetek. The last survey in that lake was in 2010 and found most of the same fishes present as in the river downstream from Talcot Lake.

Other biota have not been assessed since the initial survey in 1979. That survey noted the presence of 31 beaver dams (24 considered active dams) between Jackson and Talcot Lake, suggesting beaver were abundant at that time. Other vertebrates were not noted. Aquatic plants present in 1979 included algae, arrowhead, lesser duckweed, common cattail, softstem bulrush, sago pondweed, and *Potamageton* spp. Most aquatic plants were found along river margins in waters with little or no velocity. Macroinvertebrates were not assessed.

Management Concerns for Biology (at each of three spatial scales)

Watershed-scale Concerns **–** Based on information available, there doesn't appear to be any high priority watershed-scale concerns for the biology component, although a complete inventory of invasive species, especially invasive plants, has not been completed.

Riparian-scale Concerns **–** Specific concerns for fishery management are not presently known because of a lack of recent information, especially of potential terrestrial invasive species such as reed canary grass.

Instream-scale Concerns **–** Based on anecdotal angling reports and observations during the 2012 fish kill, the river in similar reaches 1, 2, and 3 is believed to continue to support fishable populations for northern pike, channel catfish, and walleye. However, the current status of those populations is unknown due to a lack of information. Invasive Asian carp are known to be present in an adjacent watershed. Periodic hydrologic connections, such as in conjunction with high-water events, may allow entry into the West Fork Des Moines River watershed. Presence and status of other invasive species is unknown.

Management Recommendations for Biology:

1) Complete a full stream survey that includes assessment of sportfish populations and the broader fish community in all five reaches, aquatic vegetation, and presence of invasive aquatic and riparian terrestrial species.
2) Consider development of monitoring protocols to detect expansion of Asian carp into this watershed.

SOCIAL ASPECTS

General Description – Because most of the surrounding land use in the 1,300-mi^2 watershed is primarily agricultural, watershed land owners and conservation agencies likely have the strongest influence on aquatic habitat and fisheries resources in the West Fork Des Moines River. The development of the TMDL plan identified many of the important conservation partners in the watershed. Two committees were formulated during this process: an advisory committee and a technical committee. The advisory committee included representatives from the cities of Currie and Brewster, the Taylor Co-op, Pheasants Forever, Minnesota Soybean Growers, Martin County SWCD, Cottonwood County, and the MNDNR-Windom. The technical committee included members from MPCA; Heron Lake Watershed District; county staff from Nobles, Jackson, Murray, Martin, and Lyon counties; SWCD staff from Pipestone, Nobles, Jackson, Murray, Cottonwood, Lyon, and Martin counties; cities of Jackson, Windom, Lakefield, Okabena, and Worthington; Swift Brands Inc.; U.S. Fish and Wildlife Service; MNDNR Marshall, Windom, Mankato, and Talcot Lake WMA staff members; BWSR; NRCS staff from Nobles, Jackson, Murray, Cottonwood, Martin, Pipestone, and Lyon counties; and the Silver Lake Watershed coordinator. Of course, all the anglers who fish the West Fork Des Moines River represent another key stakeholder group, but there is no formal organization representing them. River canoeists and kayakers represent another informal stakeholder group. The 1979 survey noted the presence of eight city-, county-, or state-owned parks or lands that afford access to

Stream Name West Fork Des Moines River		Kittle Number I-037	Total Miles in Minn. 118.96	Date of Plan (Mo.-Yr.) Dec. 2011
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recreational users, including anglers. An additional 22 road crossings also afford public access to the river downstream from Talcot Lake. The 2012 Water Trail Guide notes five canoe access points and two boat landings on the river downstream from Talcot Lake.

Management Concerns for Social Aspects (at each of three spatial scales)

Watershed scale Concerns – Because land use in the basin has such an important influence on the aquatic habitat and fisheries resources, maintenance of effective cooperation and collaboration among all the land owners and associated conservation agencies remains a high priority for management of this river. The TMDL Implementation Plan identifies several of these partners and suggests action items to ensure that effective cooperation and communication is maintained in this watershed. In particular, the hiring of a Watershed Coordinator and associated technical staff will help facilitate collaboration among these varied stakeholder groups.

Riparian scale Concerns – Same concerns as above in the Watershed-scale section.

Instream scale Concerns – Instream-scale concerns are unknown at present. No formal creel or human dimensions surveys have been initiated so there is no information on whether current recreational users are satisfied or dissatisfied with current management practices such as adequacy of existing angling regulations, river access, quality of the fishery, etc. Based on a lack of angler comments, it is assumed that no high-priority concerns currently exist.

Management Recommendations for Social Aspects:

1) Continue to support implementation of action items identified in the TMDL Plan.
2) Consider implementing a recreational use and creel survey to better define desired future conditions and current practices of river recreationists.

References

Heron Lake Watershed District. 2009. West Fork Des Moines River and Heron Lake TMDL Implementation Plan. Available: http://www.hlwdonline.org/hlwd/images/pdf/Implementation_Plan.pdf (Accessed 3-1-13).

MPCA (Minnesota Pollution Control Agency). 2008. West Fork Des Moines River Watershed Total Maximum Daily Load Final Report: excess nutrients (North and South Heron Lakes), turbidity, and fecal coliform bacteria impairments. Minnesota Pollution Control Agency, St. Paul. Available: http://www.pca.state.mn.us/index.php/view-document.html?gid=8223 (Accessed 3-1-13).

Stream Name **West Fork Des Moines River**		Kittle Number **I-037**	Total Miles in Minn. **118.96**	Date of Plan (Mo.-Yr.) **Dec. 2011**
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Table 1. Fish-sampling stations used historically on the West Fork Des Moines River (I-037). Old river-mile location is the distance from the old Jackson Dam site (i.e., old river "mouth").

Old River-mile Location	Old Station Number	Station Description	Years Sampled	Station Location (T/R/Sec)
52.8	5	Talcot Lake WMA	1979, 1985, 1987	T-105/R-38/Sec-20
38.5	4	none	1979, 1987	T-105/R-37/Sec-15
23.5	3	Windom city park	1979, 1987	T-105/R-36/Sec-26, 35
15.7	2	none	1979, 1987, 1994	T-104/R-35/Sec-19
0.1	1	Jackson Dam impoundment	1979, 1987, 1994	T-102/R-35/Sec-23

Table 2. Fishes stocked in the West Fork Des Moines River downstream from Talcot Lake, Cottonwood and Jackson counties.

Year(s)	Species	Numbers
1970	Channel catfish fingerlings	6,920
1971	Channel catfish fingerlings	10,000
1978	Channel catfish fingerlings	24,301
1980-1982	Channel catfish	10,270
1976	Black crappie adults	2,475
1977	Black crappie adults	775
1978	Black crappie adults	1,960
1980-1982	Black crappie	8,474
1978	Walleye fingerlings	4,313
1979	Walleye fingerlings	5,886
1980-1985	Walleye	13.740
1979	Smallmouth bass fingerlings	11,500
1986	Northern pike	15,390

Table 3. Fishes removed from the West Fork Des Moines River downstream from Talcot Lake, Cottonwood and Jackson counties.

Year	Species	Pounds
1946-1984	Common carp	55,610
1946-1984	Buffalo spp.	15,177
1957-1971	Bullhead spp.	12,900

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Table 4. Fish species sampled in fisheries surveys and assessments, West Fork Des Moines River, Talcot Lake and downstream, Cottonwood and Jackson counties.

Common Name	1979	1985	1987	1994
Channel catfish	X		X	X
Tadpole madtom	X			
Black bullhead	X	X	X	X
Yellow bullhead	X	X	X	
Black crappie		X	X	
White crappie			X	
Bluegill		X	X	
Pumpkinseed		X		
Orangespotted sunfish			X	
Green sunfish			X	X
Northern pike	X	X	X	X
Walleye	X	X	X	X
Yellow perch	X	X		
Bigmouth buffalo	X	X	X	
Quillback carpsucker	X	X		X
River carpsucker			X	
Shorthead redhorse				X
White sucker	X		X	X
Common carp	X	X	X	X
Fathead minnow	X			
Bluntnose minnow	X			
Common shiner	X			
Spotfin shiner	X			
Young-of-year observed				
Channel catfish			X	
Black crappie	X		X	
Northern pike	X			
Walleye	X			
Yellow perch	X			

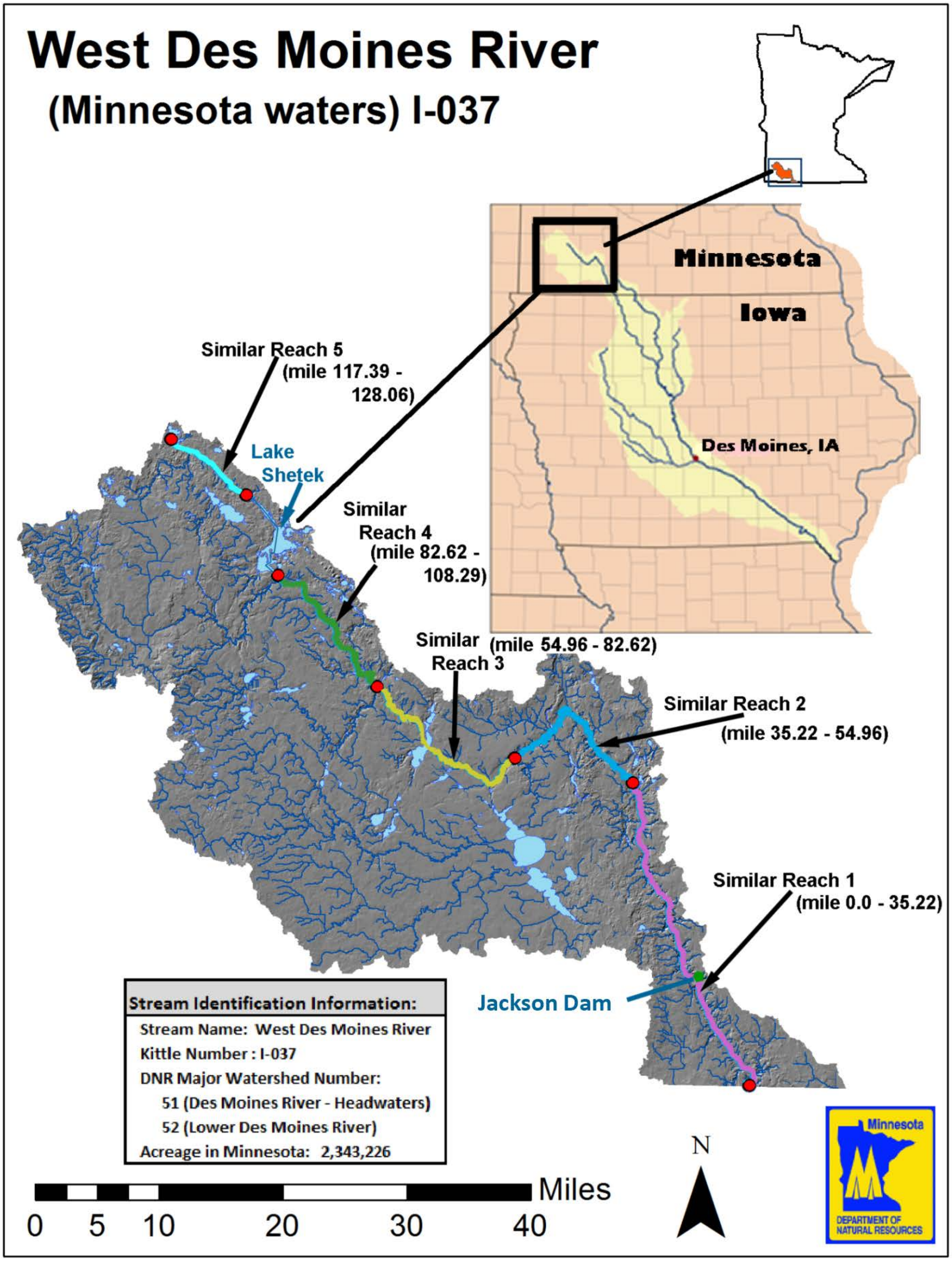

Figure 1. Map of West Fork Des Moines River (I-037) watershed with fisheries similar reaches.

12. Appendices

Content of Appendices

Appendix 1–Suggestions to Enhance Stream Management in Minnesota

There are many reasons hindering enhanced and effective management of stream and river resources across the state of Minnesota. The Stream Management Planning Guide Committee attempted to identify several of these during the development of this planning guide. The Committee also discussed potential options to alleviate some of these concerns. This Appendix provides a summary of these discussions.

(1) Streams and rivers are a BIG RESOURCE. There are over 15,000 miles of stream and river resources supporting recreational fisheries in Minnesota and almost 69,000 miles overall. These systems are often long and cross multiple Fisheries Area and Regional boundaries and obviously drain a large land area in each watershed. There are too few resources, including fisheries staff, time, and money. Options to consider:

- *Manage (i.e., management plans) all streams and their designated similar reaches*. This is likely physically and logistically impossible.

- *Prioritize and manage a select few, key or important, streams and rivers.* Priority reasons can vary substantially depending on Area and Regional needs. This is the current practice of MNDNR Fisheries. See Prioritization Sections (Appendix 3) in this guide for additional suggestions.

- *Manage larger spatial scales.* For example, develop a single management plan for all the streams and rivers within a Major- or HUC-8 level watershed and not necessarily for each individual stream. This also helps foster the importance of managing for connectivity across a river system. The example Rum River management plan is a good example of at least moving in this direction.

- *Engage partners in the development and management of streams to broaden management responsibility and help ensure that enough resources (staff, time, and money) are available*.

- Stream management is presently piecemeal and happens at an Area-specific scale resulting in occasional disparate approaches to managing the same resource. *Development of a Statewide Strategy or Plan (e.g., MPCA approach) for the state might improve coordination, communication, and implementation of a stream management program.*

(2) Most of the Resource is in PRIVATE OWNERSHIP. Land use in the watershed, most riparian areas, and consequently most instream habitat, is in private ownership or under private influence. Thus access is limited. MNDNR Fisheries has no legislative or regulatory authority to access and manage streams. Trespass law is based on case law opinions.

- Perhaps the only option is to identify important sites (at watershed, riparian, or instream scales) to target for acquisition, easement, or publicly funded conservation assistance (e.g., CREP, WHIP), work with partner agencies to implement best management practices (either agricultural or forestry) on these parcels.

(3) Stream Management can be COMPLEX, TIME CONSUMING, and EXPENSIVE. Active stream management techniques include resource assessment and monitoring, bank stabilization, dam removal/modification, channel modification/restoration, instream habitat improvement, resource protection (i.e., environmental review), and more. Special training is required and few staff have it (or sufficient amounts of it) and even fewer staff have experience applying it. This inexperience is manifested in staff confusion with some techniques in the Stream Survey Manual, resulting in extra time needed to learn and apply management techniques (extra time that most staff do not have, given other responsibilities), and consequently occasional staff disinterest. Most staff currently lack knowledge of how to interpret and use stream survey information to manage streams. Options to consider include:

- Need to decide which staff will develop and apply these skills:
  - All Fisheries staff (e.g., Specialists).
  - Select few Fisheries staff, if select few, these might be organized into Regional or Statewide stream management teams (with 80% or more of time dedicated to stream management. This time commitment might be critical to develop an effective staff and efficient stream management program).
  - Contract stream management work to non-MNDNR Fisheries agencies/groups (e.g., MNDNR-Ecological Resources staff, universities, private consultants).

- Acquire sufficient funding to accomplish stream management.
  - Dedicate staff to pursuing, acquiring, and using multiple funding sources.
  - If stream management teams are instituted, ensure that at least one staff on each team is versed in acquiring and using multiple funding sources.
  - Majority of Fisheries funding comes from angler licenses and this constituent group may resist expenditures on aquatic habitat for non-game fishes or in small streams with little recreational potential. However, these same small streams may be important to manage to alleviate excess transport of water, sediment, or nutrients that degrade downstream rivers with recreational fisheries.
- Develop stream-lined guidance documents to expedite stream management actions. Appendix 2, "Checklist for Stream Habitat Improvement Projects," is an excellent initial attempt at such a guidance document.

(4) <u>MULTIPLE AGENCIES and GROUPS (some with differing mission statements) effect aquatic habitat and stream biota.</u>

- Identify all interested parties-private landowners, competing agencies/groups, collaborative agencies/groups (MPCA, MNDNR-Waters and Ecological Resources, etc.) and identify and understand their Mission Statements, Goals and current Programs that either enhance or impede stream management.

- Coordinate and communicate management plan development and implementation with these parties. (Such coordination and communication may be best facilitated by a dedicated stream management team.)

(5) <u>Lack of a STREAM SURVEY DATABASE and a STREAM SURVEY REPORT FORMAT.</u>
A stream database physical data model (Version 2.6) has been under development and as of spring 2013 is in the process of being incorporated into the existing MNDNR Fisheries lakes information system. A prototype stream survey report format for the updated survey methods is available for use (example plan, Trout Run Creek, and a blank form).

- see public network drive:
  \\P:\FAW\Fisheries Information System\Stream Surveys\Reports\Examples

This report format will likely be modified and incorporated into the Fisheries Stream Database when the first working version of the MNDNR Fisheries Stream Survey database is made available (likely in 2014).

Appendix 2 – Checklist for Stream Habitat Improvement Projects

Objectives and Intent:

This checklist is intended for work with cooperative partners using Lessard-Sams Outdoor Heritage Council (LSOHC) funds to do instream habitat improvements on MNDNR-administered lands. Additionally, this checklist could assist with smaller projects with these cooperative partners using LSOHC funds such as fencing, riparian vegetation management, etc. If this checklist were to be used for those smaller projects, many or some of the permits and procedures would not be required. This checklist is simply a tool to assist MNDNR Fisheries staff and cooperative partner project leaders through the process and to make this process consistent throughout MNDNR Fisheries Regions.

The checklist contains the following:

- Deliverables – Pre-project
- Deliverables – Design
- Deliverables – Installation
- Deliverables – Completion

Minnesota Department of Natural Resources – Section of Fisheries

Checklist for Stream Habitat Improvement Projects

Version 18, December 29, 2010 (For MNDNR internal and external use)

Check as completed	**Deliverables – Pre-project**	**Time Line (months)**
✓	**Cooperative project partner will…** 1) Schedule an appointment with the MNDNR Area Fisheries Supervisor in respective management area to inform of purpose and intent.	-24
	MNDNR Area Fisheries Supervisor will… 2) Advise cooperative project partner a) Provide the cooperative partner with suggestions for habitat improvement work based on management plans and current MNDNR Fisheries Area Office management goals. If a specific project is already proposed, suggest management direction. b) Check that the project is within MNDNR Area Fisheries Aquatic Management Area Easement or other public property that guarantees public access as required by LSOHC. c) Check that cooperative partner has the appropriate information (see Appendix 2A). The project will not move forward without this information.	-24 -24 -24
	3) MNDNR Area Fisheries Supervisor must contact landowner (if applicable) to facilitate project with cooperative partner.	-9

Project stream: ______________________

Kittle number: ______________________

UTM's upstream boundary: ______________________

UTM's downstream boundary: ______________________

Cooperative Project Partner signature and date: ______________________

MNDNR Area Fisheries Supervisor signature and date: ______________________

Check as completed	**Deliverables – Design**	**Time Line (months)**
	Cooperative project partner will… 4) Provide pre-survey and design documentation (see Appendix 2B) to MNDNR Area Fisheries Supervisor and demonstrate that the criteria for trout stream management have been met and are compatible with other planned and applied practices (large trout management, brook trout management, wild trout management, etc.).	-6
	5) Draft specific habitat improvement project objective(s). Ex. *Rehabilitate/improve/increase degraded adult trout habitat and increase trout abundance/biomass.*	-6
	6) Create an adequate plan <u>with</u> the MNDNR Area Fisheries Supervisor (using Appendix 2C or something similar), <u>on site</u> to ensure that the project can be properly constructed.	-6
	7) Determine if an Environmental Assessment Worksheet (EAW) is required. The MNDNR Area Fisheries Supervisor can assist the cooperative project partner in this determination. This could require a change in design and therefore a change in the time table. (See Appendix 2D for details.)	-6

Checklist for Stream Habitat Improvement Projects

Check as completed	Deliverables – Design (continued)	Time Line (months)
	8) Successfully apply for any required local permits such as county shoreland zone grading permits, floodplain fill, city grading permits, etc.	-6
	9) Successfully apply for State Historic Preservation Office (SHPO) review and Tribal Historic Preservation Office (THPO) review on projects that involve disturbing the soil. (Contact: MNDNR Forestry, Fish & Wildlife Archaeologist) a) Provide project information (GPS location in UTM's of upstream and downstream boundaries, copy of quad map [8.5" x 11"] showing project location, project description including enough detail of all excavation and stock pile areas) to above contact. b) The MNDNR Forestry, Fish & Wildlife Archaeologist comments back to the cooperative partner within 3 months that the SHPO either reported that there are no historic properties that may be affected by the undertaking (review process ends) OR requests that an archaeological review of the project corridor be completed. c) If an archaeological review is necessary, the cooperative partner will be notified by the MNDNR Forestry, Fish & Wildlife Archaeologist and the cooperative partner must contract with a cultural resource consultant to complete the archaeological review. d) Cooperative partner provides the results from the cultural resource consultant to the MNDNR Forestry, Fish & Wildlife Archaeologist. e) SHPO comments on the results of the review within 30 days. It is possible that these comments will include an expectation of additional archaeological investigations.	-6
	10) Submit a Minnesota Natural Heritage Information System Data Request Form (available at http://files.dnr.state.mn.us/eco/nhnrp/nhis_data_request.pdf). If you have questions, contact Lisa Joyal, 651-259-5109 or lisa.joyal@state.mn.us	-6
	11) Apply for Minnesota Pollution Control Agency (MPCA) General Stormwater Permit for Construction Activity (NPDES/SDS). (www.pca.state.mn.us/water/stormwater/stormwater-c.html). Contract with an environmental consulting firm if needed to complete this requirement. a) Training is required to write the stormwater pollution prevention plan, supervise construction site monitoring and maintenance of erosion control, and supervise installation of erosion control practices. b) Provide documentation of above training to MNDNR Area Fisheries Supervisor. c) Provide payment to MPCA ($400 application fee as of June 11, 2010).	-6
	12) Successfully apply for MNDNR – Division of Ecological and Water Resources Protected Waters Permit (MNDNR Area Hydrologist) a) Wetland Conservation Act review is included here. If potential wetland impacts are identified, a Technical Evaluation Panel must be convened to determine if mitigation or changes to project design are required.	-6
	MNDNR Area Fisheries Supervisor will… 13) Approve design with intent to continue project proposal OR deny authorization to continue and provide explanation with suggestions on how to proceed.	-3

Cooperative Project Partner initials and date: ______________________

MNDNR Area Fisheries Supervisor initials and date: ______________________

Minnesota Department of Natural Resources – Section of Fisheries

Checklist for Stream Habitat Improvement Projects

Check as completed	**Deliverables – Installation**	**Time Line (months)**
	Cooperative partner will…	
	14) Verify to MNDNR Area Fisheries Supervisor regarding pre-construction conference with contractor and that the contractor has liability insurance.	-1/4
	15) Verify to MNDNR Area Fisheries Supervisor that cooperative partner has obtained the necessary permits.	-1/4
	16) Verify to MNDNR Area Fisheries Supervisor that on-site staking and layout was accomplished according to plans and specifications. Applicable layout notes will be provided to MNDNR Area Fisheries Supervisor.	-1/4
	17) Verify to MNDNR Area Fisheries Supervisor that the installation process and materials meet design and permit requirements (erosion control blanket containing monofilament mesh is not permitted).	-1/4
	18) Begin habitat improvement project (no later than August 1st, which will provide for the maximum vegetative cover on exposed soil before the first freeze and allow for any minor repairs before winter. Instream work on designated trout streams is not allowed after October 15th).	0

Cooperative Project Partner signature and date: ____________________

MNDNR Area Fisheries Supervisor initials and date: ____________________

Check as completed	**Deliverables – Completion**	**Time Line (months)**
	Cooperative partner will…	
	19) Meet on site with MNDNR Area Fisheries Supervisor and show that the installation meets MNDNR Area Fisheries Supervisor approval and is in compliance with permits. Provide post-survey materials and data (Appendix 2D) to MNDNR Area Fisheries Supervisor for inclusion in MNDNR database.	-1/4
	20) Terminate any required permits (Be aware of the constraints surrounding the NPDES permit).	-1/4
	21) Provide a completion report that describes what work was done, the amount of materials used, number and type of structures installed, and a list of volunteer names and volunteer hours, and total cost of the project. A blank completion report form is included below. (Contact: MNDNR Fisheries Stream Habitat Program Consultant – Brian Nerbonne, 651-259-5205, brian.nerbonne@state.mn.us)	+4

Cooperative Project Partner signature and date: ____________________

MNDNR Area Fisheries Supervisor signature and date: ____________________

Appendix 2A – Information necessary to successfully begin a stream habitat improvement project

Understand and follow these documents:

1) *MNDNR Operational Order 113*
   http://files.dnr.state.mn.us/assistance/grants/habitat/heritage/oporder_113.pdf

   MNDNR Operational Order 113 Division Fish & Wildlife Guidelines
   http://files.dnr.state.mn.us/areas/fisheries/lanesboro/oporder113_guidelines.pdf

2) See specifically:
   Section III "Detailed Aquatic Activities, Category of Activity: Habitat Improvement and Shoreland Restoration" (pages 12-13).
   - Other details within this document may apply.

3) *MNDNR Operational Order 113 Division of Ecological Resources Guidelines*
   http://files.dnr.state.mn.us/assistance/grants/habitat/lessard_sams/oporder113_eco.pdf
   a. This document is referenced in the Guidelines for MNDNR Division of Fish & Wildlife.
   b. See specifically "*Detailed Aquatic Activities, Category of Activity: Stream Restoration" (pages 25-26).*

4) Source of funds should be determined before projects begin.

5) Each project will have one project supervisor/contact.

6) The *Deliverables – Pre-project* section must be checked off and signed before the Area Fisheries Supervisor (representing the MNDNR Commissioner) will approve of the project for cooperative partners.

Appendix 2B – Pre-Project Survey Requirements for Habitat Improvement Projects

As stated in the MNDNR Fisheries Stream Survey Manual (2007):

> *"Geomorphic data help us understand the processes and characteristics of stream systems, provide fish habitat information, facilitate stream comparisons within a watershed and between regions, and provide a common framework for communication."*

- More work is needed to understand what effects habitat improvements have on fish populations (Steen and Wehrly 2005), and collecting this information will aid in this objective.

- Other values to the completion of this survey are:
  1) To aid in drafting habitat improvement design (pre-survey)
  2) To add to MNDNR stream files as information for full survey write-up, management plan updates, and/or database of regional long-term or status and trend monitoring
  3) To illustrate relative change from pre- and post-project to justify cost to grantor and constituency
  4) To make clear any geomorphological characteristics that could jeopardize the project and/or design
  5) To evaluate project design
  6) To confirm project objectives
  7) To use in "as-built" justification (post-survey)

- The following are standardized survey methodologies and should be considered a minimum for habitat improvement project designs. Contract with a qualified environmental consulting firm if needed to complete this requirement. If additional information is needed to address a specific management question or objective, then collection of that information is also required (discuss with MNDNR Area Fisheries Supervisor).

A. Longitudinal Profile Survey – Required

The longitudinal profile should include the entire project area and extend to the first riffles upstream and downstream outside of the project area. If the project begins or ends at the boundary of an aquatic management area (angling easement corridor), the longitudinal profile survey can begin at this boundary. Do not leave the easement corridor to complete this survey unless given permission by the landowner.

Collect elevations along the longitudinal profile at a sufficient number of points in the thalweg to accurately describe the shape, depth, and lengths of bed features along the profile (Figure 1). Bed features are those features that dictate the boundaries of mesohabitat types (e.g., pools, riffles, runs, and glides). At a minimum, take thalweg elevations at the top, middle, and bottom of each bed feature and be sure to include the deepest point in each pool. Collect water surface elevations at each thalweg elevation measurement. Bankfull elevations (described below) should also be included in the longitudinal profile.

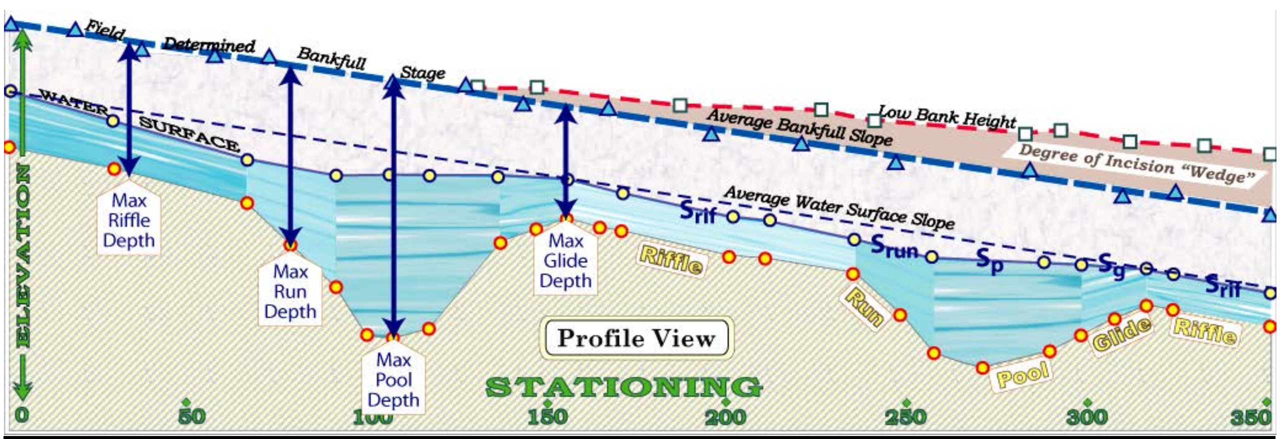

Figure 1. Longitudinal profile showing thalweg bed features, water surface and bankfull elevations (© Wildland Hydrology, Rosgen 2006)

B. Channel Cross-Section Survey – Required

Channel cross-sections should be measured on a minimum of two or three riffles and two or three pools within the habitat improvement area. If riffles are not present in the area, position the cross-section within a run.

Record the cross-section location on the longitudinal profile. Lay the channel cross-section perpendicular to the stream flow. Make sure that the cross-sectional end points are far enough away from the stream bank to identify floodplain features. This is typically 40 to 50 feet from the wetted perimeter on either stream bank in southeast Minnesota streams but could be more than 1,000+ feet in some low-gradient streams. If floodplain features are an excessive distance from the wetted stream perimeter, it may be appropriate to identify these features via a topographical map. Measure elevations along the cross section to include any terraces on the stream banks, bankfull stage (see below), water edge, thalweg, and water surface elevation.

Determining bankfull stage (bankfull height) is the water surface elevation at flows primarily responsible for channel formation (Dunne and Leopold 1978). It is typically the water height at which the stream channel begins to access its flood plain. Bankfull stage can only be determined in the field. Indicators of bankfull height or stage can be found in Harrelson et al. (1994) and are as follows:

1. The height of depositional features (top of point bar),
2. A change of vegetation (especially the lower limit of perennial species),
3. A change in the size distribution of substrate or bank particles,
4. A break in the slope of the stream bank,
5. Stains on rocks,
6. Root hairs exposed below an intact soil layer.

It is advised that the surveyors walk the project area prior to beginning the survey and mark indicators of bankfull with flagging so that they can be easily included in the longitudinal and cross-sectional survey. Correct identification of bankfull is critical, as much of the analysis of stream stability and habitat quality is based on the analysis of this measurement. Most people tend to underestimate bankfull elevation as a lower terrace. These terraces are remnant bankfull features formed under different hydrologic conditions.

Pages 5-8 and 5-9 in Rosgen (1996) and USDA Forest Service (2005) reference CD provide additional direction for determining bankfull stage.

Because these cross sectional surveys will be conducted again post-project in the same locations, it would be wise to install temporary (or permanent) markers or stakes indicating their location.

C. Substrate Particle Composition at Channel Cross-Sections – Required

Stream channel substrate particle compositions are conducted using the Wolman pebble count procedure (1954). Methods are as follows:

1) Begin at either side of the wetted perimeter of the stream.
2) Without looking, reach down to the substrate and pick up the first particle the tip of your finger touches.
3) Measure the width of the particle along the intermediate axis. The intermediate access is neither the widest axis nor the shortest axis, rather the axis which is intermediate (see Figure 46 in Stream Survey Manual if necessary).
4) Tally each measurement in the appropriate category on the Pebble Count Recording Sheet.
5) Be sure to indicate whether this is a riffle or pool substrate particle count on the data sheet.
6) Proceed across the cross-section, measuring a total of no less than 100 individual substrate particles.
7) Conclude the count at the opposite end of the cross-section you began within the wetted perimeter.

D. Channel Geometry Measurements (Pattern) – Recommended

Measurements to determine channel geometry should be taken directly in the field. On occasion a relatively new aerial photograph can be used and measurements can be taken directly from this. Geometry is used to describe reachwide characteristics, so measurements should reflect an area larger than the habitat improvement project area (Figure 2).

Sinuosity – Valley length measurements should be measured following the valley centerline, not simply following the stream meander centerline.

Sinuosity = stream length / valley length

Linear Wavelength *(λ)* – The longitudinal distance parallel with the fall line of the between the apex of two sequential meanders.

Stream Meander Length (L_m) – Meander length is the longitudinal distance between the apexes of two sequential meanders.

Radius of Curvature (R_c) – The radius of the circular arc portion of a meander, measured from a center point on the inside of the curve to the center of the channel. On compound bends there will be two Rc's, one in each corner.

Belt Width (W_{blt}) – Belt width is a measure of lateral containment of the channel within its valley. Measure the longest distance perpendicular to the valley slope from outside bend to outside bend.

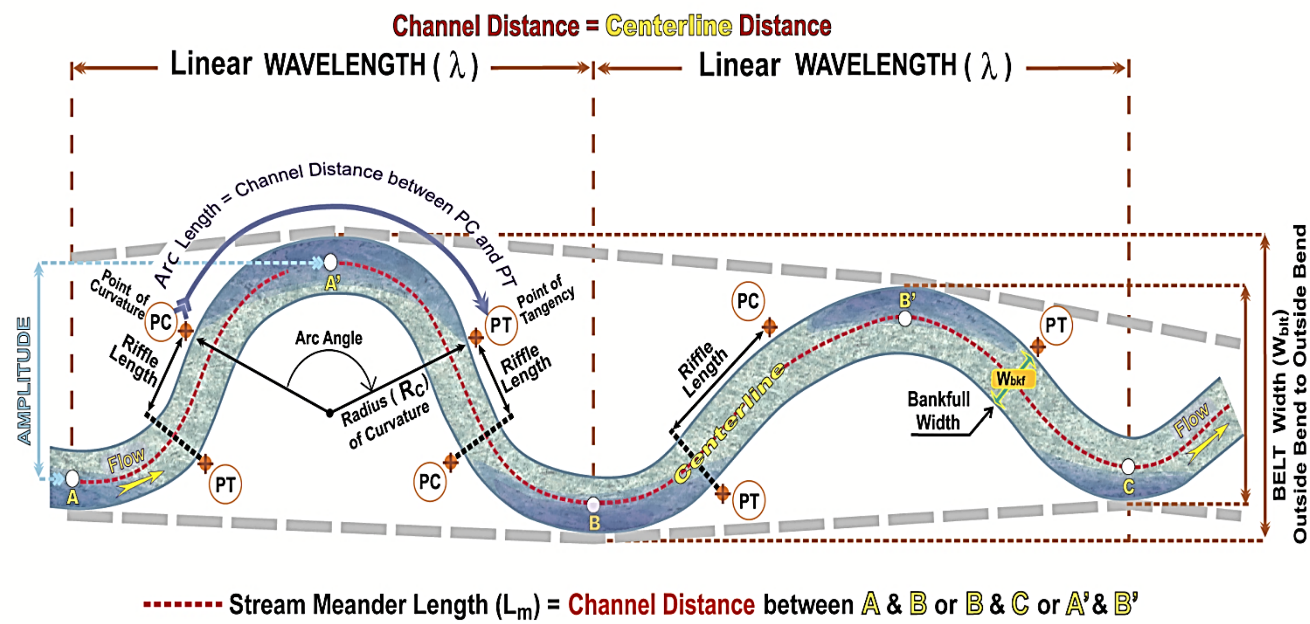

Figure 2. Channel geometry measurements (© Wildland Hydrology, Rosgen 2006).

E. Post-Project Survey Requirements for Habitat Improvement Projects

Repeat procedures for Pre-Project Survey above. Be sure to include cross-section surveys in the same locations as was completed in the Pre-Project Survey.

Appendix 2C – Habitat Improvement Summary Sheet

Habitat Improvement Plan Summary

Stream/project name:	Date:	Stream mile:

Upstream UTM's:	Downstream UTM's:	Length of project:

Bank	Side	Distance (ft)	Rock (yds)	HI Technique	Comments

Key

Location description	Rock type	Structure or Technique type	Structure or Technique type
LB – Left descending bank	BR – Breaker rock	LS – Lunker structure	SS – Slope and seed
RB – Right descending bank	CR – Cover rock	SH – Sky hook	SC – Stream crossing
Both – Both banks	SRR – Small road rock	RW – Rock weir	CN – Channel narrowing
POR – Point of reference	RR – Rip rap	RV – Rock vein	RSH – Rock sky hook
SC – Stream crossing	FR – Flat rock	RD – Rock deflector	RLS – Rock lunker structure
		RWD – Root wad	WD – Woody debris

Appendix 2D – Habitat Improvement Completion Report

Rev 04/09

STATE OF MINNESOTA DEPARTMENT OF NATURAL RESOURCES

___ Development
___ Maintenance

Completion Report

(Habitat Development & Maintenance)

Stream	Project	Project Number	Cooperative Partner

Region	Area	County	Section	Township	Range

Upstream UTM	Downstream UTM

Date Work Started	Date Work Completed	Contact person & phone number

Instructions:

1) The Project Coordinator in charge of the work is responsible for the preparation of Completion Reports and the submission of four (4) copies to the MNDNR Area Fisheries Office.
2) The Regional Fisheries Manager and Area Fisheries Supervisor are responsible for the review, approval, and distribution.
3) Distribution of copies: original plus one (1) copy to the St. Paul Office, one (1) copy to be retained at the Regional Office, and one (1) copy returned to the Area Office.

FINAL PROJECT COSTS (based on field records only)

Source of Funds

Aid (LSOHC, TUDARE, etc.)				Total
Salaries - Labor				
Salaried - Supervision				
Equipment Rental				
Travel & Subsistence				
Materials & Supplies				
Work Agreement				
Contract				
Totals				

Appendix 2D – Habitat Improvement Completion Report

Completion Report (Habitat Development & Maintenance)
DESCRIPTION OF WORK ACCOMPLISHED *(additional space provided on following pages)*

Work Item (key codes on following pages)	Description of Development or Maintenance	Cost

Report completed by:
Name: **Title:** **Date:**

Approved by:
Name: *Title:* *Date:*

Approved by:
Name: *Title:* *Date:*

MNDNR Area Fisheries Supervisor

Appendix 2D – Habitat Improvement Completion Report

Completion Report (Habitat Development & Maintenance)

DESCRIPTION OF WORK ACCOMPLISHED *(Continued from previous page)*

Work Item	Description of Development or Maintenance	Cost

Key Codes for Work Items

(See directive 3-202)

The following key codes require Minnesota Department of Natural Resources (MNDNR) approval and are required in any pre-project design planning. The work associated with many key codes are for MNDNR use only and this list should not be considered as acceptable for cooperative partner implementation without prior MNDNR approval.

1) Buildings
2) Dams, Dikes & Levees (permit required)
3) Canals, Channels or Ditches (permit required)
4) Bridges (permit required)
5) Roads & Trails
6) Telephone or Electric Lines
7) Fences
8) Public Use Facilities (MNDNR only)
9) Fishways, Screens & Barriers (MNDNR only)
10) A. Stream Improvements, B. Lake Improvements, C. Lake Rehabilitation
11) Signs & Boundary Markers (MNDNR only)
12) Planting Trees, Shrubs & Aquatics
13) Herbaceous Seeding
14) Thinning or Clearing
15) Noxious Vegetation Control
16) Population Control
17) Firebreaks (Method)
18) Fish or Wildlife Stocking
19) Crop Leasing
20) Rearing Ponds
21) Pothole Blasting & Dugouts
22) Fish Rescue Sites
23) Rough Fish Traps
24) Nesting Structures
25) Northern Pike Spawning Areas
26) Goose Management
27) Surveys & Inventories
28) Miscellaneous Cooperative Land Management Activities

Appendix 2D – Habitat Improvement Completion Report

Completion Report (Habitat Development & Maintenance)
DISCUSSION OF WORK ACCOMPLISHED (Objectives met, area of project benefits, etc.):

Appendix 2E – Determining the Need for an Environmental Assessment Worksheet (EAW)

- Minnesota Administrative Rules – 4410.1000 Projects Requiring an EAW
  https://www.revisor.mn.gov/rules/?id=4410.1000

- Minnesota Administrative Rules – 4410.4300 Mandatory EAW categories
  https://www.revisor.mn.gov/rules/?id=4410.4300

  Subp. 26. Stream diversion.
  Subp. 27. Wetlands and public waters.

- Other sources of information may be available through the MNDNR Fisheries Supervisor or the MNDNR Hydrologist.

Appendix 3 – Stream Management Planning Prioritization

This Appendix was developed during committee discussions as a potential questionnaire for Fisheries Areas to complete to help prioritize streams for internal Area-specific planning purposes and simultaneously providing a standardized set of information that could be placed in a statewide Stream Management Planning Database. Such statewide information might be useful to guide allocation of resources and to better track statewide implementation and progress of stream management projects (e.g., stream survey schedule, fish stocking, stream channel enhancement and restoration, land acquisition and easement, TMDL implementation, etc.). Completing a Stream Management Planning Prioritization Matrix will allow managers to determine where to put their focus, based on needs and the resource. In addition to providing prioritization to the Area, this exercise should reduce the B work-unit/Study 4 proposal workload.

Stream Management Planning Prioritization Matrix – Step-by-step completion.

1) Stream Name; List name of stream, use the highest order name of the referenced reach.
2) Kittle Number; Provide the Kittle number for the stream main stem.
3) Stream Type; Identify the type of fishery that you wish to manage the stream for (coldwater / warmwater / warmwater with sport fishery).
4) Resource Quality; Rate the resource value to your Area; this should also reflect the priority you wish to put on this stream. When considering Resource Quality, consider the following three items;
    a) Assessment of condition (baseline surveys, etc.)
    b) Identification of stressors (e.g., reaches identified as being problematic, TMDL support)
    c) Measuring effectiveness of management activities (stocking evaluation, post BMP or habitat improvement, etc.)
5) Location; Provide finer details of the reaches and streams this management plan pertains to.
6) Watershed Size; Square-mile area of entire watershed for which this plan pertains.
7) Existing Management Plan (Date); The date of the last stream management plan. If none exists, enter NA.
8) Last Survey Date; The date of the last stream survey (can be initial, full, or even a population assessment).
9) Next Proposed Survey; The year you intend to next survey the river/stream.

10) Sampling Frequency; The frequency at which you plan to survey/sample at the stream.
11) Public Access; Yes or no. Then list types of access (Federal, State, County, fee).
12) Rare Species; List the 3-letter species code for each of the listed species historically found in this stream.
13) Invasive Species; List all the invasive species found in the stream and its upstream watershed.
14) Sportfish; List the managed sportfish species.
15) Natural Reproduction; Do the managed game fish species naturally reproduce in the system? Yes or no.
16) Stocking; Do you, or do you plan on, stocking this stream? Yes or no.
17) Primary Management Direction; From a perspective of habitat and resource quality, does the stream and its watershed need protection, restoration, or enhancement?
18) Protection;
    18a) From a protection standpoint, how much money is needed to protect unique habitats?
    18b) From a protection standpoint, how much money is needed to protect the watershed?
    18c) From a protection standpoint, how much money is needed to make key land acquisitions?
19) Restoration;
    19a) From a restoration standpoint, how much money is needed to restore unique habitats?
    19b) From a restoration standpoint, how much money is needed to restore key components of the watershed?
    19c) From a restoration standpoint, how much money is needed to make key land acquisitions?
20) Enhancement;
    20a) From an enhancement stand point, how much money is needed to enhance desired habitats?
    20b) From an enhancement stand point, how much money is needed for the desired enhancements to the watershed?
    20c) From an enhancement stand point, how much money is needed to make key land acquisitions?
21) Summarize the habitat, watershed, and land acquisition needs.
22) Survey Needs?; Are there specific survey needs for this stream? Or additional data needed to make sound management decision?
23) Type; What type of survey needs exist?
24) Cost; How much additional funding is needed to address the survey needs you have for the resource?

25) Creel Survey Needed?; Is a creel survey needed or recommended?
26) Creel Survey Cost; How much would it cost to conduct a creel survey on the stream/river?
27) Potential Partners; List potential partners and cooperators who have interest in the resource and its management.

Appendix 4 – Fisheries Ecological Classification of Minnesota Streams

Fisheries Ecological Classification of Minnesota Streams (MNDNR 1978)

Class	**I**	**Coldwater**
	I-A	Wild trout
	I-B	Coldwater feeder
	I-C	Semi-wild trout
	I-D	Marginal trout
Class	**II**	**Warmwater gamefish**
	II-A	Smallmouth bass
	II-B	Walleye
	II-C	Northern pike
	II-D	Channel catfish
	II-E	Cosmopolitan
	II-F	Other (list)
Class	**III**	**Warmwater feeder**
Class	**IV**	**Rough fish - forage fish**
Class	**V**	**Intermittent**

See the following page for class definitions

Class I (Coldwater) – Streams capable of supporting trout are divided into the following four subclasses:

IA. Wild trout – Good water conditions, high natural reproduction and adequate density of wild trout; no stocking of hatchery fish necessary.

IB. Coldwater feeder – Small shallow streams that flow throughout the year. The water temperature is usually less than 60^{o}F and they may contain resident populations of small trout and certain minnow species. They are normally less than five feet wide and are about one foot in depth with heavy shade and stream bank cover. They are usually an important source of water for a larger trout stream.

IC. Semi-wild trout – Usually has some natural reproduction but not enough to maintain a fishable population or utilize available habitat; moderate to heavy stocking necessary; stream is capable of substantial carry-over to subsequent years.

ID. Marginal trout – Marginal water conditions for trout; continual stocking necessary; little carry-over to subsequent years.

Class II (Warmwater Gamefish) – Streams usually dominated by forage and rough fish but with significant numbers of gamefish should be divided into the following subclasses based on the dominant gamefish species. The subclass cosmopolitan applies to large streams or river lakes with a diverse species composition. List more than one species if they are of approximately equal importance, e.g., Class II-A,B.

IIA. Smallmouth bass
IIB. Walleye
IIC. Northern pike
IID. Channel catfish
IIE. Cosmopolitan
IIF. Other (list)

Class III (Warmwater Feeder) – Small shallow streams that flow throughout the year. Water temperatures during midsummer exceed the maximum tolerated by trout and they usually have resident populations of suckers, minnows, and small gamefish. They may be used for spawning by northern pike, walleyes, and suckers during springtime. They are usually less than 20 feet wide.

Class IV (Rough Fish – Forage Fish) – Populations completely dominated by rough fish and forage species due to unsuitable habitat for gamefish.

Class V (Intermittent) – Small shallow streams that usually flow with the spring runoff or during periods of heavy rainfall. They do not have resident fish populations but may be used by spring-spawning fish such as northern pike.

Appendices – Literature Cited and References

Dunne, T., and L. B. Leopold. 1978. Water in environmental planning. W. H. Freeman, New York.

Harrelson, C. C., C. L. Rawlins, and J. P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field techniques. Gen. Tech. Rep. RM-245. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

MNDNR (Minnesota Department of Natural Resources). 1978. Fisheries stream survey manual. Special Publication 120, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

MNDNR (Minnesota Department of Natural Resources). 2007. Fisheries stream survey manual. Special Publication 165, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

Mossop, B., and M. J. Bradford. 2006. Using thalweg profiling to assess and monitor juvenile salmon (*Oncorhynchus* spp.) habitat in small streams. Canadian Journal of Fisheries and Aquatic Sciences 63:1515-1525.

Rosgen, D. L. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Rosgen, D. L. 2006. Watershed Assessment of River Stability and Sediment Supply (WARSSS). Wildland Hydrology, Fort Collins, Colorado.

Steen, P. J., and K. Wehrly. 2005. History and inventory of stream habitat improvements for the state of Michigan. University of Michigan, Ann Arbor.

Thorn, W. C., and C. S. Anderson. 2001. Evaluating habitat quality from stream survey variables. Fish Management Report 35, Section of Fisheries, Minnesota Department of Natural Resources, St. Paul.

USDA Forest Service. 2005. Guide to identification of bankfull stage in the northeastern United States. Gen. Tech. Rep. RMRS-GTR-133-CD. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado. 4 CD-ROM set. Sandy Verry, Author and Principal Technical Presenter.

Verry, E. S. 2005. The how and why of pebble counts to characterize stream channel sediment. Elon River Partners, Grand Rapids, Minnesota.

Whiteway, S. L., P. M.Biron, A. Zimmermann, O.Venter, and J. W. A. Grant. 2010. Do in-stream restoration structures enhance salmonid abundance? A meta-analysis. Canadian Journal of Fisheries and Aquatic Sciences 67:831-841.

Wolman, M.G. 1954. A method of sampling coarse river-bed material. Transactions of the American Geophysical Union 35:951-956.