Redeye River Watershed Restoration and Protection Strategies

Minnesota Pollution Control Agency

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Key Terms

Assessment Unit Identifier (AUID): The unique water body identifier for each river reach comprised of the USGS eight-digit HUC plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A Hydrologic Unit Code (HUC) is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Minnesota River Basin is assigned a HUC-4 of 0702 and the Pomme de Terre River Watershed is assigned a HUC-8 of 07020002.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

Source (or Pollutant Source): This term is distinguished from ‘stressor’ to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

Stressor (or Biological Stressor): This is a broad term that includes both pollutant sources and non-pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

Executive Summary

The Redeye River Watershed is located in northcentral Minnesota and includes all or parts of Becker, Otter Tail, Todd, and Wadena counties. It is located in the Upper Mississippi River Basin and lies almost entirely in the North Central Hardwood Forests ecoregion with just a small area in the Northern Lakes and Forests ecoregion. Nearly half the watershed's land use is agricultural, 30% is forested, 15% is wetlands, and about 4% is developed communities and industries. The Redeye River Watershed begins at Wolf Lake and joins the Leaf River, before draining into the Crow Wing River near Staples.

This Watershed Restoration and Protection Strategies (WRAPS) report summarizes water quality work in the watershed since intensive monitoring began in 2011. It culminates in a table of implementation strategies to help restore areas where pollutants violate standards and help protect those areas meeting standards.

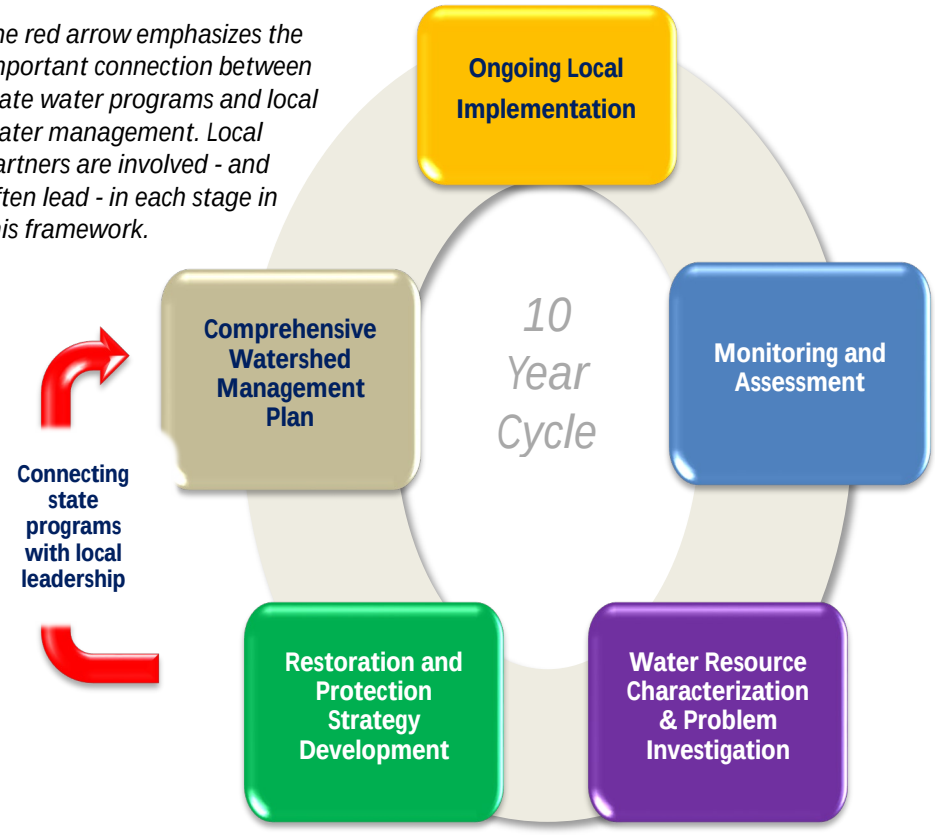
Much of the watershed is in good condition, so protection strategies will be key to maintaining water quality. Areas with identified impairments and in need of restoration strategies include South Bluff Creek, Wing River, Union Creek, and tributaries to East Leaf Lake and the Leaf River. The main concerns in these waters include low dissolved oxygen levels, excess sediment, increased drainage and flow alterations, and high bacteria levels. Providing natural buffers to these streams as well as keeping livestock and other sources of bacteria from entering the stream are key restoration strategies. There were no impaired lakes in the Redeye River Watershed.

Protection strategies were developed to help keep lakes and streams from becoming impaired. The WRAPS attempts to target and focus protection in the watershed in order to achieve results. Specific water bodies to focus strategies on include wild rice and shallow lakes, lakes with biological significance, cold water fisheries, development pressure on larger, deep lakes and lakes susceptible to decline in water quality. Establishing riparian buffers and forest habitat, protecting wetlands and monitoring groundwater withdrawals are other strategies identified to keep the watershed healthy. Maps are also included in the WRAPS that identify where to focus protection efforts as well as where to prioritize restoration efforts.

What is the WRAPS Report?

The state of Minnesota has adopted a "watershed approach" to address the state's 80 "major" watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates **water quality assessment, watershed analysis, civic engagement, planning**, **implementation**, and **measurement of results** into a 10-year cycle that addresses both restoration and protection.

The red arrow emphasizes the important connection between state water programs and local water management. Local partners are involved - and often lead - in each stage in this framework.



As part of the watershed approach, waters not meeting state standards are still listed as impaired and Total Maximum Daily Load (TMDL) studies are performed, as they have been in the past. However, the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to help state agencies, local governments and other watershed stakeholders determine how to best proceed with restoring and protecting lakes and streams. This report summarizes past assessment and diagnostic work and outlines ways to prioritize actions and strategies for continued implementation.

Purpose

- Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning
- Summarize Watershed Approach work done to date including the following reports:
  - *Redeye River 2014 Watershed Monitoring and Assessment*
  - *Redeye River 2014 Watershed Biotic Stressor Identification*
  - *Redeye River Watershed 2016 Total Maximum Daily Load*

Scope

- Impacts to aquatic recreation and impacts to aquatic life in streams
- Impacts to aquatic recreation in lakes

Audience

- Local water resource managers and users (SWCDs, local governments, watershed management groups, lake associations, sportsmens clubs, etc.)
- State agencies (BWSR, DNR, MDA, MDH, MPCA, etc.)

Users' Guide

This WRAPS Report summarizes past monitoring, water quality assessments, and other water quality studies that have been conducted in the Redeye River Watershed. It also outlines ways for local groups to prioritize projects that can be implemented in the watershed to improve water quality. The WRAPS report contains a large amount of information. The purpose of the following table is to provide a Quick Reference Guide for users to identify what information can be found in each section of the report.

Table 1. WRAPS Report Quick Reference Guide

Section	Section	Description	Pages
Summaries of Past Monitoring and Water Quality Studies			
1	Watershed Background	A brief description of the Redeye River Watershed.	8
2.1	Water Quality Assessment	A summary of how fishable, swimmable and usable the lakes and streams are in the watershed.	11
2.2	Water Quality Trends	A summary of lakes and streams with improving or declining water quality based on at least 10 years of monitoring data.	14
2.3.1	Stressors of Biological Impairments	A summary of factors that cause fish and invertebrate communities in streams to become unhealthy (also known as stressors).	15
2.3.2	Pollutant Sources	A summary of sources of pollutants (such as phosphorus, bacteria or sediment) to lakes and streams, including point sources (such as sewage treatment plants) or non-point sources (such as runoff from the land).	16
2.4	TMDL Summary	A summary of TMDL studies in the watershed. A TMDL is a calculation of how much pollutant a lake or stream can receive before it violates water quality standards.	18
2.5	Protection Considerations	A summary of lakes and streams in the watershed that are not impaired but are either close to becoming impaired or of exceptionally high quality and need to be protected.	20
Ways to Prioritize Projects that Protect or Restore Water Quality			
3.1	Civic Engagement	A summary of input meetings with local partners in the watershed on the development of the WRAPS report.	22
3.2	Targeting of Geographic Areas	A summary of the results from different tools that were used to identify, locate, and prioritize restoration and protection projects in the watershed.	24
3.3	Restoration & Protection Strategies	Tables identifying projects in the watershed that restore or protect water quality. These projects are divided into individual tables for each of the 6 smaller watersheds.	28
4	Monitoring Plan	A plan for ongoing water quality monitoring to fill data gaps, determine changing conditions, and gauge implementation effectiveness.	64
Supporting Information			
5	References	A bibliography of reports referenced in the WRAPS document.	65

1. Watershed Background and Description

The Redeye River Watershed covers 899 square miles in the northern part of the Upper Mississippi River Basin in central Minnesota. The watershed includes parts of Becker, Douglas, Otter Tail, Todd, and Wadena Counties (Figure 1). The Redeye River begins at Wolf Lake and joins the Leaf River before draining into the Crow Wing River north of Staples. The Redeye River Watershed provides habitat for aquatic life, riparian corridors for wildlife, and recreation opportunities like fishing, swimming, and canoeing. Nearly half the watershed's land use is agricultural, 30% is forested, 15% is wetlands, and about 4% is developed communities and industries.

2. Watershed Conditions

The Redeye River Watershed lies almost entirely within the North Central Hardwoods Forests ecoregion. A small portion of the watershed lies within the Northern Lakes and Forests ecoregion of Minnesota. These ecoregions have similar ecosystems based on geology, physiography, vegetation, climate, soils, land use, wildlife and hydrology.

Within the Redeye River Watershed there are approximately 633 total river miles, of which 316 miles are considered perennial. The major rivers within this watershed include the Redeye, Leaf, and Wing. There are also 11 creeks and 7 county ditches, as well as numerous smaller flowages that add to the overall total miles. A major tributary to the Redeye River is Hay Creek, which begins in Blowers Township in Otter Tail County and flows into Wadena County. The Leaf River begins in Leaf Lake Township in Otter Tail County where it flows out of East Leaf Lake. Major tributaries to the Leaf River include: Bluff Creek, Oak Creek, Union Creek, and the Wing River. The Wing River begins in Elmo Township in Otter Tail County where it flows out of Wing River Lake, through Woodside Township and into Bertha Township in Todd County, making its way to the Leaf River in Wadena County.

In addition to the rivers and creeks, lakes are also important resources. There are 73 lakes in this watershed that are greater than 10 acres in size. The main lakes include Wolf, Gourd, the chain of West, Middle and East Leaf Lakes, Donald's, Portage, Adley, Horsehead, Mary, West Annalaide, Tamarack, Edna and Bear.

Additional Redeye River Watershed Resources

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the Redeye River Watershed: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022049.pdf

Minnesota Department of Natural Resources (DNR) Watershed Assessment Mapbook for the Redeye River Watershed: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/wsmb13.pdf

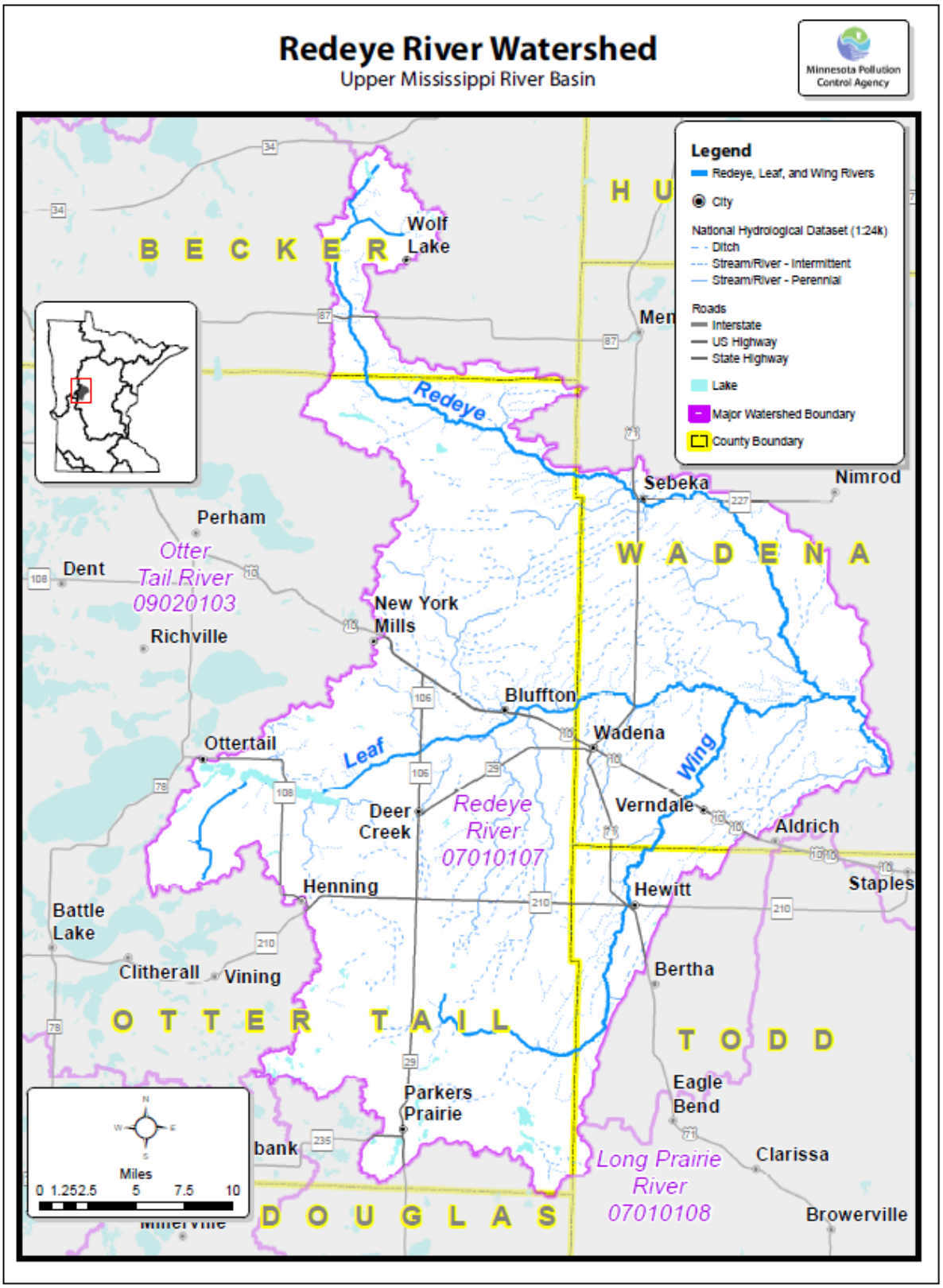


Figure 1. Redeye River Watershed

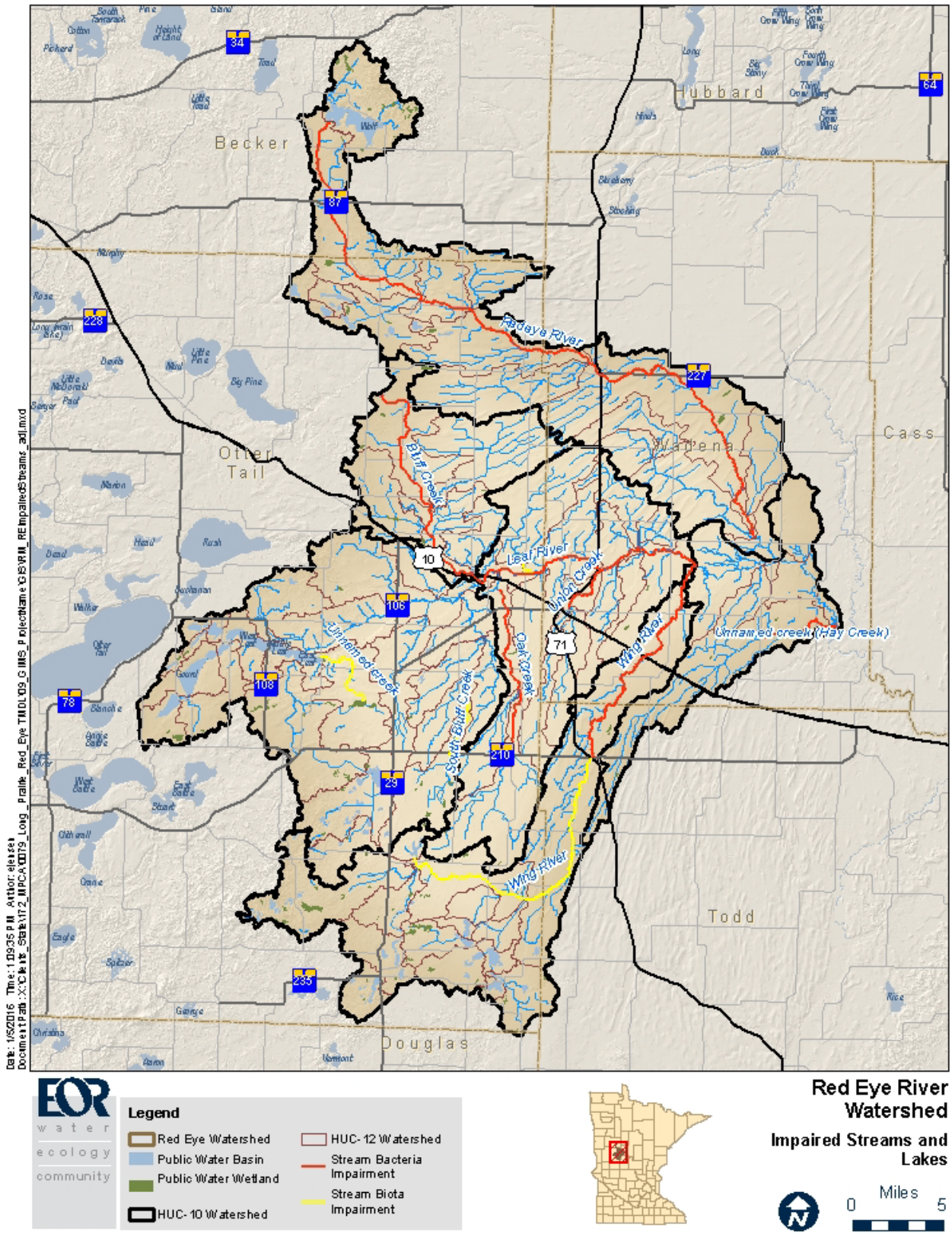


Figure 2. Redeye River Watershed Impaired Streams (no known impaired lakes)

2.1 Water Quality Assessment

This section summarizes impairment assessments for streams and lakes in the Redeye River Watershed at the HUC 10 scale. Figure 2 shows the streams in the watershed that do not meet water quality standards or are considered impaired. Waters that are not listed as impaired will be subject to protection efforts (See Section 2.5 and 3.3). Some of the waterbodies in the Redeye River Watershed are impaired by mercury; however, this report does not cover toxic pollutants. For more information on mercury impairments see the statewide mercury TMDL at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/special-projects/statewide-mercury-tmdl-pollutant-reduction-plan.html.

As part of a larger effort launched by the Minnesota Pollution Control Agency (MPCA) to intensively monitor watersheds, efforts began in 2011 to look at the Redeye River Watershed. Water quality and biological monitoring within the watershed has been occurring since the mid-1990s. Water quality conditions within the watershed vary from high quality to impaired. Primary concerns are erosion, surface and groundwater management, and changing land use patterns. Twenty-four stream sites were sampled for biology at the outlets of the subwatersheds, including the mouth of the Redeye River where it flows into the Leaf River, the outlet of the Leaf River above its confluence with the Crow Wing River, upstream outlets of major tributaries, and the headwaters of small streams. Cooperation began between MPCA, the Wadena Soil and Water Conservation District (SWCD) and the Otter Tail County Coalition of Lake Associations (COLA). This collaboration was critical in completing chemical sampling of the streams and lakes in the watershed. Monitoring data from Surface Water Assessment Grants (SWAGs) as well as data from volunteer citizen lake and stream monitors were very useful. As the watershed approach continues, additional data will be collected allowing for an increase in the number of assessed surface waterbodies. Many of the lakes in this watershed did not have historical monitoring data, except for the Leaf Lake Chain in Otter Tail County.

Streams

Beginning with the 2009 Redeye SWAG and continuing with the 2011 Redeye SWAG, 19 sites in the watershed were identified for monitoring, where chemical and field analysis was completed by trained citizen volunteers and Wadena SWCD staff (Table 2). Samples were analyzed at RMB Environmental Laboratories, Inc. in Detroit Lakes. Some of the streams had at least 10 years of historical CSMP data, but most were only assessed beginning in 2009. Most of the biology assessments were completed by MPCA in 2011. To see further trend information please reference the Redeye River Watershed Stressor Identification (SID) Report from the MPCA, which can be found online at, http://www.pca.state.mn.us/index.php/view-document.html?gid=21887.

Aquatic life use impairments include:

- Low fish index of biotic integrity (FIBI; which means an unhealthy fish community is present),
- Low macroinvertebrate IBI (MIBI; which means an unhealthy macroinvertebrate community is present),
- Dissolved oxygen (DO) levels too low to support fish or macroinvertebrate life,
- Turbidity/total suspended solids (TSS) levels too high to support fish or macroinvertebrate life,

Aquatic recreation use impairments include *Escherichia coli* (a bacteria indicator of fecal pollution) levels that are too high for safe human contact (wading or swimming).

Table 2: Assessment status of stream reaches in the Redeye River Watershed

HUC-10 Subwatershed (07010107-)	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq. Rec.
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
Upper Leaf River (-01)	511	Deer Creek	Headwaters to Leaf River	SUP	SUP	NA	NA	NA
	514	Leaf River	Bluff Creek to Oak Creek	IF	IF	IF	SUP	IMP
	525	Willow Creek	T133 R38W S11, S line to Leaf Lake	SUP	SUP	NA	NA	NA
	528	Trib. To South Bluff Creek	Unnamed Creek to South Bluff Creek	SUP	SUP	NA	NA	NA
	531	South Bluff Creek	Unnamed Creek to Leaf River	SUP	SUP	NA	NA	NA
	554	Trib. To East Leaf Lake	CD 49 to East Leaf Lake	IMP	IF	NA	NA	NA
Bluff Creek (-02)	515	Bluff Creek	Headwaters to Leaf River	SUP	SUP	NA	NA	IMP
	541	Blue Creek	Unnamed Creek to Bluff Creek	SUP	SUP	NA	NA	NA
Middle Leaf (-03)	516	Oak Creek	Unnamed Ditch to T134 R36W S3, N line	SUP	SUP	NA	SUP	IMP
	530	South Bluff Creek	Unnamed Creek to Unnamed Creek	SUP	SUP	NA	NA	NA
	553	South Bluff Creek	Unnamed Ditch to Unnamed Creek	IMP	IMP	NA	NA	NA
Wing River (-04)	559	Wing River	Wing River Lake (56-0043-00) to Hwy 210 bridge	IMP	SUP	NA	NA	NA
Wing River (-04)	560	Wing River	Hwy 210 bridge to Leaf River	SUP	SUP	IF	SUP	IMP
Redeye River (-05)	502	Redeye River	Hay Creek to Leaf River	SUP	SUP	SUP	SUP	IF
	503	Redeye River	Headwaters of Wolf Lake (03-0101-00) to Hay Creek	SUP	SUP	SUP	SUP	IMP
	513	Hay Creek	Headwaters to Redeye River	SUP	SUP	NA	SUP	IF
	539	Unnamed Creek	Unnamed Creek to Redeye River	NA	NA	NA	SUP	SUP
Lower Leaf River (-06)	501	Leaf River	Redeye River to Crow Wing River	SUP	NA	SUP	SUP	SUP
	504	Leaf River	Wing River to Redeye River	SUP	SUP	SUP	SUP	SUP

HUC-10 Subwatershed (07010107-)	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life				Aq. Rec.
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	Dissolved Oxygen	Turbidity/TSS	Bacteria
	505	Leaf River	Oak Creek to Wing River	IMP	SUP	IMP	SUP	IMP
	508	Union Creek	Whisky Creek to Leaf River	IMP	IMP	IMP	SUP	IMP
	509	Union Creek	Headwaters to Whisky Creek	SUP	IMP	NA	NA	IF
	526	Trib. To Redeye River	T134 R33W S18, W line to Leaf River	IF	IF	IF	SUP	IMP
	557	Trib. To Leaf River	Unnamed Creek to Leaf River	SUP	IMP	NA	NA	NA
SUP = found to meet the water quality standard								
IMP = does not meet the water quality standard and therefore, is impaired								
IF = the data collected was insufficient to make a finding								
NA = not assessed								

Source: Redeye River Watershed Monitoring and Assessment Report

Lakes

Lakes are assessed for aquatic recreation uses based on ecoregion specific water quality standards for TP, chlorophyll-a (chl-*a*), and secchi transparency depth. To be listed as impaired, a lake must not meet water quality standards for total phosphorus (TP) and either chl-*a* or secchi depth. The Redeye River Watershed lakes were assessed relative to the NCHF Class 2B ecoregion water quality standards (Table 3).

Table 3: Minnesota's ecoregion specific lake eutrophication standards

Ecoregion	TP (ug/L)	Chl-a (ug/L)	Secchi (m)
NLF – Aquatic Rec. Use (Class 2B)	< 30	< 9	> 2.0
NCHF – Aquatic Rec. Use (Class 2B)	< 40	< 14	> 1.4
NCHF – Aquatic Rec. Use (Class 2B) Shallow lakes	< 60	< 20	> 1.0

The MPCA analyzed data from 17 lakes for aquatic recreation as part of the 2014 Monitoring and Assessment report, from which they were able to assess 14 lakes for aquatic recreation use. The Otter Tail SWCD also had lake assessments completed for East and Middle Leaf Lakes. All assessed lakes were fully supportive of aquatic recreation (Table 4).

Table 4. Assessed lakes in the Redeye River Watershed

Subwatershed	Lake ID	Lake Name	Tropic Status	Aquatic Life Use Support Status	Aquatic Recreation Support Status
Upper Leaf (-01)	56-0113-00	Unnamed	M	IF	IF
	56-0114-00	West Leaf	M	IF	FS
	56-0116-01	Middle Leaf	M	IF	FS
	56-0116-02	East Leaf	E	IF	FS
	56-0139-00	Gourd	O	NA	IF
	56-0140-01	Portage (main bay)	O	NA	FS
	56-0192-00	Tamarack	M	NA	FS
Upper Leaf (-01)	56-0200-00	Donald's	M	NA	FS
Wing River (-04)	56-0005-00	West Annalaide	M	NA	FS
	56-0010-00	Mary	M	NA	FS
	56-0022-00	Horsehead	E	NA	FS
	56-0031-00	Adley	E	NA	FS
	56-0094-00	Unnamed	H	NA	IF
Redeye River (-05)	03-0101-00	Wolf	M	IF	FS
	56-0069-00	Bear	E	NA	FS
	56-0070-00	Edna	M	NA	FS
	56-0132-00	Mud	M	NA	FS

Key:	
H = Hypereutrophic	FS = Full support
E = Eutrophic	IF = Insufficient information
M = Mesotrophic	NA = Not assessed
O = Oligotrophic	

Source: Redeye River Watershed Monitoring and Assessment Report

2.2 Water Quality Trends

Seasonal and annual Kendall trends analysis were performed using R Statistical Software to identify stream and lake sampling locations with long term datasets (minimum of 10 years) necessary to confidently establish a numerical trend. Trends were only reported that had statistical confidence of at least 95% (meaning that there is at least a 95% chance that the data are showing a true trend and at most a 5% chance that the trend is a random result of the data), contained at least 10 years of data, and were missing no more than 25% of the samples from the entire period. No statistically significant water quality trends were identified in the Redeye River Watershed.

West Leaf and East Leaf Lake show a decreasing trend in transparency; however, the decreasing trend was not statistically significant. Rainfall totals in this area of the state showed no significant trend over the last 20 years. Groundwater usage in this watershed shows a rising trend.

2.3 Stressors and Sources

Stressors and/or sources impacting or threatening stream must be identified and evaluated in order to develop appropriate strategies for restoring or protecting waterbodies. Biological Stressor Identification (SID) is done for streams with either fish or macroinvertebrate biota impairments and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors. Pollutant source assessments are done where a biological SID process identifies a pollutant as a stressor as well as for the typical pollutant impairment listings. Section 3 provides further detail on stressors and pollutant

sources. For more details on the Redeye River Watershed stressors and the process used to identify the stressors causing the biological impairments, please consult the 2014 Redeye River Watershed SID Report. This report summarizes seven candidate causes that were evaluated in each of the subwatersheds.

Stressors of Biologically-Impaired Stream Reaches

The MPCA staff conducted a SID study to identify the factors (i.e., stressors) that are causing the fish and macroinvertebrate community impairments in the Redeye River Watershed. Stressors identified include pollutants and non-pollutant-related factors. The primary stressors identified in streams with aquatic life impairments in the Redeye River Watershed include low DO concentrations due to nutrient enrichment; elevated levels of TSS (sediment); flow alteration caused by channel alteration, water withdrawals, and agricultural tile drainage; loss of habitat due to excess bedded sediment; lack of physical habitat leading to reduced habitat diversity and abundance of species requiring certain substrates and coarse debris; and loss of connectivity due to impoundments or improper placement of culverts (Table 5).

Table 5: Stressors to aquatic life in biologically-impaired reaches in the Redeye River Watershed

HUC-10 Watershed	AUID (Last 3 digits)	Reach Name	Reach Description	Biological Impairment	Stressors						
					Dissolved Oxygen	Elevated Nutrients	Increased Sediment	Bedded Sediment	Physical Connectivity	Flow Alteration	Lack of Physical Habitat
Upper Leaf River	554	Trib. to East Leaf Lake	CD 49 to East Leaf Lake	Fish	●				X		●
Upper Leaf River	557	Trib. to Leaf River	Unnamed Creek to Leaf River	Macro-invertebrates	X	X	●	X			●
	508	Union Creek	Whisky Creek to Leaf River	Fish & Macro-invertebrates	●						
	509	Union Creek	Headwaters to Whisky Creek	Fish & Macro-invertebrates	●						
Middle Leaf River	553	South Bluff Creek	Unnamed Ditch to Unnamed Creek	Fish & Macro-invertebrates	●			●		X	●
Wing River	559	Wing River	Headwaters Wing River Lake (56-0043-00) to Hwy 210 bridge	Fish	X	X			●	X	
Lower Leaf River	505	Leaf River	Oak Creek to Wing River	Fish	●						

● Primary stressor X Secondary stressor *Source: 2015 Redeye River Watershed Stressor ID Report*

Pollutant sources

This section summarizes the sources of pollutants (such as phosphorus, bacteria or sediment) to lakes and streams in the Redeye River Watershed, including point sources (such as sewage treatment plants) or non-point sources (such as runoff from the land).

Point Sources

Point sources are defined as facilities that discharge stormwater or wastewater to a lake or stream and have a National Pollutant Discharge Elimination System (NPDES) or State Disposal System (SDS) Permit. There are seven municipal wastewater facilities, four industrial stormwater facilities, and six large animal feeding operations that require NPDES permitting located in the Redeye River Watershed (Table 6).

Table 6. NPDES Permitted Point Sources in the Redeye River Watershed.

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Receiving water body
	Name	Permit #	Type		
Upper Leaf River	Deer Creek WWTP	MN0020281	Municipal wastewater	No	pond
	Henning WWTP	MN0041131	Municipal wastewater	No	pond
	Henning Transfer Station/Demo Landfill - ISW	MNR0535FF	Industrial Stormwater	No	NA
	Jennie-O Turkey Store - Henning Brood	MNG440212	Feedlot	No	NA
	Jennie-O Turkey Store - Sandridge North	MNG440212	Feedlot	No	NA
Bluff Creek	New York Mills WWTP	MNG640121	Municipal wastewater	No	pond
	Industrial Finishing Services Inc - NY Mills - SW	MNR0534CL	Industrial Stormwater	No	NA
	Wadena Asphalt Inc	MNG490041	Industrial Stormwater	No	NA
Middle Leaf River	Wadena WWTP	MN0020672	Municipal wastewater	No	Union Creek
	Wadena Hide & Fur Co Inc - SW	MNR0534HR	Industrial Stormwater	No	NA
Wing River	Hewitt WWTP	MNG580024	Municipal wastewater	No	Wing River
	Parkers Prairie WWTP	MN0024465	Municipal wastewater	No	Adley Lake
	Jennie-O Turkey Store - Verndale Farm	MNG440421	Feedlot	No	NA
Redeye River	Sebeka WWTP	MN0024856	Municipal wastewater	No	Redeye River
Redeye River	Pine Hill Ranch of Sebeka LLC	NA	Feedlot	No	NA
	Red/Eye Hogs LLC	MNG441172	Feedlot	No	NA
Lower Leaf River	Schoon Farms	NA	Feedlot	No	NA

Nonpoint Sources

Nonpoint sources of pollution, unlike pollution from industrial and sewage treatment plants come from many diffuse sources. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes and streams. The relative magnitude of common nonpoint pollutant sources in the Redeye River Watershed are shown in Table 7 , including:

- **Fertilizer and/or manure runoff**: Fertilizer and manure contains high concentrations of phosphorus, nitrogen, and bacteria that can runoff into lakes and streams when not properly managed.
- **Livestock in riparian areas**: Livestock activity can destabilize and/or erode streambanks and deliver sediment containing TSS and phosphorus to the stream. Phosphorous and E.coli can also be directly deposited in waterbodies by the grazing livestock manure.
- **Failing septic systems**: Septic systems that are not maintained or are failing near a lake or stream can contribute excess phosphorus, nitrogen, and bacteria.
- **Wildlife fecal runoff**: Dense or localized populations of wildlife, such as beavers or geese, can contribute phosphorus and bacteria pollutants to streams or ponds.
- **Poor vegetative cover:** Soils without adequate vegetative cover can erode and deliver sediment containing TSS and phosphorus to lakes and streams.
- **Upland soil erosion**: Soil erosion delivers sediment containing TSS and phosphorus to lakes and streams.

Table 7: Nonpoint Sources in the Redeye River Watershed. Relative magnitudes of contributing sources are indicated.

HUC-10 Subwatershed	Pollutant	Stream Reach (AUID)	Pollutant Sources					
			Fertilizer & manure run-off	Livestock in riparian areas	Failing septic systems	Wildlife	Poor riparian vegetation cover	Upland soil erosion
Upper Leaf River	*TSS*	Leaf River (07010107-514)	~	›	™	™		
Bluff Creek	*E. coli*	Bluff Creek (07010107-515)	~	›	™	™		
Middle Leaf River	*E. coli*	Oak Creek (07010107-516)	~	›	™	™		
Wing River	*E. coli*	Wing River (07010107-560) Hwy 210 bridge to Leaf River	~	›	™	™		
Redeye River	*E. coli*	Redeye River (07010107-503)	~	›	™	™		
	E. coli	Leaf River (07010107-505)	~	›	™	™		

HUC-10 Subwatershed	Pollutant	Stream Reach (AUID)	Pollutant Sources					
			Fertilizer & manure run-off	Livestock in riparian areas	Failing septic systems	Wildlife	Poor riparian vegetation cover	Upland soil erosion
Lower Leaf River		Union Creek (07010107-508)	˜	›	™	™		
		Tributary to Redeye River (07010107-526)	˜	›	™	™		
	TSS	Union Creek (07010107-508)					›	›

Key: ˜ = High › = Moderate ™ = Low

2.4. TMDL Summary

The MPCA is required to publish a list of waters that are determined to be impaired every two years. Examples of pollutants causing impairments include bacteria, mercury, sediment and excess nutrients, for example phosphorus or nitrogen. If a water body is classified in Category 5 it is added to the mandated impaired waters list and addressed by the TMDL process. A TMDL is the calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. A TMDL report identifies levels, or loads, of pollutants, their sources, and ways to reduce them. The Redeye River Bacterial TMDL has been developed (Table 8). The streams in Section 2.3 that have impaired aquatic life do not have a stressor pollutant that can be addressed through a TMDL. Strategies for improving the biology of the stream are found in the strategy table. In some instances, where low dissolved oxygen or sediments appear to be a stressor to the stream, not enough data was collected to actually list the stream as impaired by that parameter.

Table 8. Allocation summary for completed stream *E. coli* TMDLs in the Redeye River Watershed

Stream/ Reach (AUID)	Pollutant	Flow Zone	Allocations (*E. coli* in billions organisms/day)					Percent Reduction
			Wasteload Allocation		Load Allocation		Margin of Safety	
			WWTPs	Regulated Stormwater	Upstream Outflow	Watershed Runoff		
Redeye River (07010107-503)	*E. coli*	Very High	4.5	--	--	703.1	78.6	0%
		High	4.5	--	--	275.5	31.1	39%
		Mid	4.5	--	--	124.9	14.4	0%
		Low	4.5	--	--	55.6	6.7	0%
		Very Low	4.5	--	--	22.0	2.9	0%
Leaf River (07010107-505)	*E. coli*	Very High	0	--	1650	34.4	187.2	0%
		High	0	--	624.9	20.4	71.7	45%
		Mid	0	--	270.4	10.7	31.2	0%
		Low	0	--	114.8	4.7	13.3	0%
		Very Low	0	--	40.5	1.6	4.7	0%

Stream/ Reach (AUID)	Pollutant	Flow Zone	Allocations (*E. coli* in billions organisms/day)					Percent Reduction
			Wasteload Allocation		Load Allocation		Margin of Safety	
			WWTPs	Regulated Stormwater	Upstream Outflow	Watershed Runoff		
Union Creek (07010107-508)	*E. coli*	Very High	3.6	--	--	120.1	13.7	85%
		High	3.6	--	--	37.8	4.6	0%
		Mid	3.6	--	--	13.8	1.9	11%
		Low	3.6	--	--	4.4	0.9	29%
		Very Low	3.6	--	--	0.1	0.4	0%
Leaf River (07010107-514)	*E. coli*	Very High	2.5	--	482.4	1,076.8	173.5	0%
		High	2.5	--	111.2	538.4	72.5	21%
		Mid	2.5	--	44.8	337.8	42.8	17%
		Low	2.5	--	15.1	146.2	18.2	0%
		Very Low	2.5	--	5.8	80.0	9.8	0%
Bluff Creek (07010107-515)	*E. coli*	Very High	--	--	--	482.4	53.6	0%
		High	--	--	--	111.2	12.4	0%
		Mid	--	--	--	44.8	5.0	0%
		Low	--	--	--	15.1	1.7	44%
		Very Low	--	--	--	5.8	0.6	21%
Oak Creek (07010107-516)	*E. coli*	Very High	--	--	--	162.7	18.1	0%
		High	--	--	--	67.9	7.5	37%
		Mid	--	--	--	37.9	4.2	18%
		Low	--	--	--	18.5	2.1	0%
		Very Low	--	--	--	6.5	0.7	0%
Unnamed Creek (Hay Creek) (07010107-526)	*E. coli*	Very High	--	--	--	183.0	20.3	62%
		High	--	--	--	64.3	7.1	0%
		Mid	--	--	--	29.7	3.3	0%
		Low	--	--	--	13.0	1.4	0%
		Very Low	--	--	--	6.5	0.7	0%
Wing River (07010107-560)	*E. coli*	Very High	1.6	--	--	569.3	63.4	0%
		High	1.6	--	--	294.1	32.8	50%
		Mid	1.6	--	--	165.3	18.5	28%
		Low	1.6	--	--	101.0	11.4	32%
		Very Low	1.6	--	--	24.8	2.9	33%

2.5. Protection Considerations

This section provides a short description of the major water quality concerns in the Redeye River Watershed that were developed based on input from local partners and the public. Protection strategies are identified in Section 3.3 for each of the specific areas and/or water resources listed below and listed in table 9.

- Wild Rice and Shallow Lake Management
- Cold Water Fisheries
- Lakes of Biological Significance
- Shoreline Development on Larger, Deeper Lakes
- Risk to Water Quality Decline in Lakes

Wild Rice and Shallow Lake Management

Wild rice, an important aspect of rural Minnesotan culture, can be found within the Redeye River Watershed. Wild rice is typically found in shallow lakes and is known to be affected by turbidity, water flow, water level fluctuations, and water quality. The Redeye River Watershed contains 40 shallow lakes greater than 50 acres. Shallow lakes are especially sensitive to nutrient loading and can be affected by altered watersheds, urban development, and intensive agriculture. Shallow lakes are a critical component to wild rice and Minnesotan wildlife populations. The DNR and Ducks Unlimited began a cooperative project focused on intensive water level management in 2001 that continues to this day to help sustain the wild rice population in shallow water areas. The DNR also enacts the Shallow Lakes Program to protect and enhance wildlife habitat on shallow lakes. The DNR maintains a wild rice GIS layer to help resource managers identify wild rice lakes and rivers for wildlife habitat restoration and enhancement, and for rice management. The DNR has identified seven lakes within the Redeye River Watershed with established wild rice beds (Table 9).

Cold Water Fisheries

Cold water fish like Brown Trout (*Salmo trutta*) need cold, well oxygenated, high-quality water to survive. They usually prefer smaller streams, where water is fast-moving and full of oxygen, with stream bottom material that is rocky or gravelly for spawning beds. Increased sediment, stream temperature and low oxygen levels threaten trout habitat. Designated trout streams in the Redeye River Watershed include Union Creek near Wadena, Finn Creek west of Bluffton, Willow Creek near Henning, and Hay Creek and Whiskey Creek East of Verndale; however, Union Creek has the greatest potential to support Trout.

Lakes of Biological Significance

The DNR conducted a statewide analysis of lakes of biological significance in 2015 based on dedicated biological sampling. All lakes were rated and grouped into three biological significance classes. This analysis identified two lakes in the Redeye River Watershed that met the criteria for lakes of outstanding biological significance, Gourd and Snow, which include:

- High aquatic plant richness, high floristic quality, and a population of an endangered or threatened plant species.
- Important wild rice lakes.

- Exceptional fishery for selected game fish or an outstanding nongame fish community.
- One or more of the following: endangered or threatened colonial waterbird nesting area; presence of several endangered, threatened, or special concern lake bird species; or six or more lake bird Species of Greatest Conservation Need.

Shoreline Development on Larger, Deeper Lakes

There are only seven deep lakes in the Redeye River Watershed (Table 9). These larger, deeper lakes have mostly developed shorelines. Protection efforts will be focused on managing the impact caused by any additional development that may occur. The SWCD works with landowners to restore their shorelines to native vegetation. Shoreland management ordinances are updated to be responsive to development trends and there is potential to adopt new standards that better protect water quality on some of the high quality lakes.

Risk to Water Quality Decline in Lakes

For lakes with enough water quality data, a statewide process was developed that establishes a score for each lake based on risk factors such as proximity to the impairment threshold, long term trend data, sensitivity of the lake to future phosphorus inputs, etc. A complete description of the process can be found in the *WRAPS Protection Strategy Guidance.* Lakes with enough data to determine risk are identified in Table 9.

Table 9. Lakes with Protection Focus in the Redeye River Watershed

Lake Number	Lake Name	Wild Rice Lake	Biologically Significant	Deep Lake	Priority for Risk
56-0031-00	Adley			x	B
56-0069-00	Bear			x	A
56-0200-00	Donalds			x	
56-0116-02	East Leaf			x	C
56-0070-00	Edna				A
56-0139-00	Gourd	x	x		A
56-0115-00	Grass	x			
56-0022-00	Horsehead				B
56-0010-00	Mary				A
56-0116-01	Middle Leaf			x	B
56-0132-00	Mud	x			A
56-0013-00	North Maple	x			
56-0140-01	Portage (main bay)			x	A
56-0110-00	Snow		x		
56-0004-00	South Maple	x			
56-0192-00	Tamarack	x			A
56-0005-00	West Annalaide				A
56-0114-00	West Leaf			x	A
3-0101-00	Wolf	x			A

3. Prioritizing and Implementing Restoration and Protection

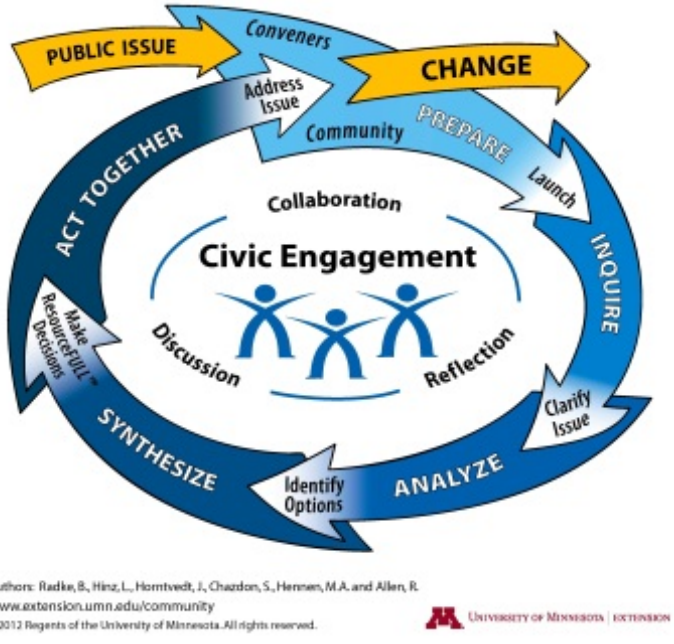
The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, and identify point sources and nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of such prioritization and strategy development. Because much of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed it is imperative to create social capital (trust, networks and positive relationships) with those who will be needed to voluntarily implement best management practices. Thus, effective ongoing civic engagement is fully a part of the overall plan for moving forward.

Restoration and protection strategies presented in this report will be refined and applied as targeted activities by local units of government and partners in the Redeye River Watershed. This information will be utilized in local water plans and by local groups to apply for state and federal grants.

3.1 Civic Engagement

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." A resourceFULL decision is one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at, http://www1.extension.umn.edu/community/civic-engagement/.



3.1.1. Steering Committee Meetings

Several work plan discussions were held over the phone and in person with local partners (Table 10).

Table 10. Redeye River Watershed Steering Committee Meetings

Date	Location	Meeting Focus
12/12/12	Wadena County Court House	Quarterly Meeting
4/10/13	MPCA office Brainerd, MN	Lake and Stream Assessments
4/23/14	Wadena County Court House	Quarterly Meeting
5/28/14	Wadena County Court House	Discuss methods for feedlot windshield survey
6/4/2015	Wadena County Court House	Quarterly Meeting

3.1.2. Public Meetings

The Redeye River WRAPS local partner team engaged with a diverse array of local groups, interested citizens, state agencies, and local government units to guide the informing and development of this restoration and protection plan. Previous and ongoing efforts were refocused into the WRAPS process. Members of the WRAPS group have provided technical assistance to local government partners and citizens, providing a watershed-wide network of connections to build from. These pre-existing civic connections provided a strong base to develop additional more non-traditional partnerships as part of the watershed protection and restoration process. A summary of public meetings hosted by the Local Partner Team is below (Table 11). The Redeye River Watershed WRAPS was on a 30-day public notice review and comment period from August 29 through September 28, 2016. The MPCA received 14 comments regarding the WRAPS, all of which were submitted by the Minnesota Department of Agriculture. All comments have been addressed in this WRAPS report.

Table 11. Redeye River Watershed Public Meetings

Date	Location	Meeting Focus
4/12/11	Community Center Parkers Prairie, MN	Watershed Project Kick-Off
12/17/14	County Courthouse Long Prairie, MN	TMDL status and WRAPS discussion

3.1.3. Accomplishments and Future Plans

The Central Minnesota Land Use Decision Maker Symposium was hosted by eight county SWCDs within the Redeye River and Long Prairie River Watersheds, which included Becker, Cass, Crow Wing, Douglas, Morrison, Otter Tail (West and East), Todd and Wadena on October 7, 2015, in Parkers Prairie, Minnesota. One hundred and fifty local land use decision makers and natural resource managers from eight counties in west-central Minnesota gathered to discuss preserving and enhancing water quality through available watershed tools and the use of local experts. A survey was presented to attendees as part of their packet. Groundwater, Erosion, Drinking Water and Shoreland Zoning were the top four water quality concerns of those who responded. In addition, 80% of respondents said the way they make land use decisions will be altered because of attending the event. Of the no responses, several had written in their comments they are already making these decisions with water quality in mind. This training will also help local decision makers understand how informed local choices are the basis of the Long Prairie WRAPS plan.

The Redeye River WRAPS steering committee plans to continue applying for Clean Water Legacy funds and other grants as they become available. These grants help to pay for on-the-ground practices that provide water quality and wildlife habitat benefits to all of Minnesota.

The Redeye River WRAPS steering committee feels it is important for SWCDs to continue their educational efforts towards landowners in the watersheds about water resources.

3.2 Targeting of Geographic Areas

The following section describes the specific tools that were used by the Redeye River Watershed stakeholders to identify, locate and prioritize watershed restoration and protection actions. The supporting maps found in Appendix A summarize the conclusions from each of the tools. Figure 3 shows the area in the watershed that was prioritized for restoration and protection based on HSPF data. Sections 3.2.1 and 3.2.2 provide detail on other areas in the watershed to target those that did not fit within the available tools. Follow-up field reconnaissance will be the next part of the process to validate the identified areas potentially needing work.

Six watershed modeling tools were used. All are described in more detail in Table 12 or below:

- MPCA Redeye River Watershed HSPF model (Table 12, and Appendix A, Figures 1-3)
- MPCA/DNR Lakes of Phosphorus Sensitivity Significance (Table 12 and Appendix A, Figure 4)
- BWSR Ecological Ranking Tool (Table 12 and Appendix A, Figures 5-9)
- DNR Watershed Health Assessment Framework (Table 12 and Appendix A, Figures 10-15)
    - The DNR's Watershed Health Assessment Framework tool and the Minnesota Water Table Aquifer Vulnerability data layer were used to target areas with the greatest potential for groundwater contamination (see *Groundwater Protection* for more details below).
    - The DNR's Watershed Health Assessment Framework tool was also used to target Wetland Protection areas (see *Wetland Protection* for more details below).

The DNR fisheries approach for lake protection and restoration was another tool used to categorize lake catchments (DNR 2013). This framework is based on the premise that shoreline disturbance and watershed disturbance measure physical habitat and water quality by proxy.

Figure 16 in Appendix A identifies management categories based on the degree of watershed land use disturbance and watershed protection (publicly owned land or protected by conservation easement). Areas with watershed disturbance less than 25% and watershed protection greater than 75% are considered to be sufficiently protected and vigilance is the suggested management approach. Areas with watershed disturbance less than 25% and watershed protection less than 75% are excellent candidates for protection, in order to avoid future water quality degradation. Areas with watershed disturbance between 25% to 60% are candidates for full restoration of water quality and improvement of fish communities. Areas with watershed disturbance greater than 60% are candidates for targeted, partial restoration. Catchment-wide restoration in these areas would be very expensive.

Also in Appendix A, Figure 17 shows the total amount of acres needed to reach 75% protection, while Figure 18 describes the protection/restoration approach based on the percentage of disturbed land use for the entire drainage area, including upstream catchments.

Windshield assessment of the feedlots in Todd and Wadena Counties within the Redeye River Watershed in the summer of 2014 (Appendix A, Figures 19-20), identified feedlots where livestock had

direct access to streams or lakes, and feedlots with high run-off potential. These assessments resulted in a map prioritizing implementation of best management practices (Appendix A, Figure 21).

3.2.1. Groundwater Protection

Portions of this watershed are known to have high nitrates in groundwater due to the widespread sandy soils and agricultural land use. The MDA has monitored nitrate concentrations in observation wells since 1986. The monitoring data shows that 62% of the observed wells were over the drinking water limits (MDA January 2012). Because of this, MDA found that it was important to expand nitrate monitoring to find out the extent of nitrate concentrations in private drinking water wells. The MDA began to work with the Wadena SWCD and the other counties in the Central Sands Region on the Central Sands Private Well Monitoring Network in 2011. Results showed that a much smaller percentage of private wells were over the health limit versus the observed wells.

All of the counties in the Redeye River Watershed have been identified by the MDA as containing townships vulnerable to groundwater contamination and having significant row crop production. Therefore, these counties are part of the Township Testing Program. The goal of MDA's Township Testing Program is to monitor nitrate levels in private drinking water wells. Between 2014 and 2019, the MDA will offer free nitrate tests to approximately 70,000 private well owners (within 250 to 300 townships across the state).

Crop irrigation on sandy soils has been on the rise for several years, but recently is seeing a spike in permit applications. There is not enough data to know how additional irrigation permits may change the groundwater supply, and potentially the quality of nearby lakes, streams and wetlands. The DNR's Watershed Health Assessment Framework tool was used to identify the subwatersheds with the greatest groundwater withdrawal rates based on maximum permitted water use in comparison with overland runoff. The Minnesota Water Table Aquifer Vulnerability data layer was overlaid on the Redeye HUC 10 watersheds to verify the watersheds with the greatest potential for groundwater contamination (Appendix A, Figure 22).

3.2.2. Wetland Protection

Wetlands function to filter pollutants that runoff land, trap sediment, protect shorelines, recharge groundwater, retain water during flooding and storms, provide habitat for fish and wildlife and provide public recreation. The Wetland Conservation Act (WCA) was put into law in 1991 to prevent the destruction of the quality, quantity, and biological diversity of our wetlands. All counties in the Redeye River Watershed have designated staff that administers the WCA program. Mitigation for wetland impacts follows a series of steps. Avoidance of the wetland altogether is the first step, but if the wetland cannot be avoided then minimization should be enforced. The affected land then needs to be replaced inside Bank Service Area 5 (the Bank Service Area Wadena resides in) at a 1:1 ratio because of the +80% pre-settlement wetlands that are present within this area. If no wetland credits inside of Bank Service Area 5 can be found, credits outside of the service area can be purchased for a replacement at a 1 to 1.5 ratio. This is an incentive to replace impacted wetlands within close proximity of the original impacted site. The DNR's Watershed Health Assessment Framework tool was used to identify the subwatersheds with the lowest percentage of wetlands remaining. These watersheds will be targeted for wetland restoration projects.

Figure 3. Priority areas for Restoration and Protection in the Redeye River Watershed

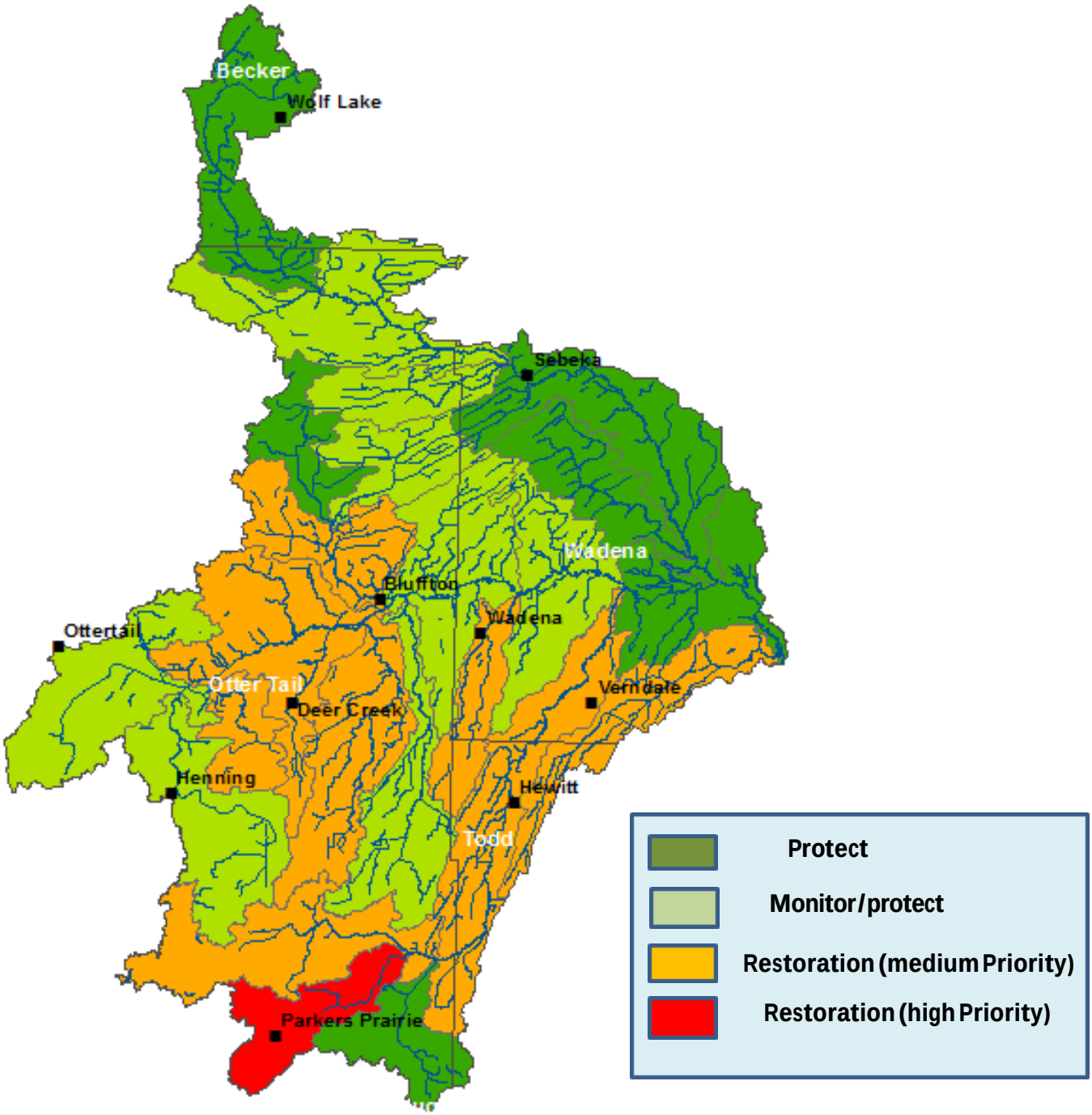


Table 12. Description of Tools used to Identify, Locate and Prioritize Watershed Restoration and Protection Actions.

Tool	Description	How can the tool be used?	Notes	
Hydrological Simulation Program – FORTRAN (HSPF) Model	Simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land. Typically used in large watersheds (greater than 100 square miles).	Incorporates watershed-scale and non-point source models into a basin-scale analysis framework. Addresses runoff and constituent loading from pervious land surfaces, runoff and constituent loading from impervious land surfaces, and flow of water and transport/ transformation of chemical constituents in stream reaches.	Local or other partners can work with MPCA HSPF modelers to evaluate at the watershed scale: 1) the efficacy of different kinds or adoption rates of BMPs, and 2) effects of proposed or hypothetical land use changes.	*EPA*
MPCA/DNR Lakes of Phosphorus Sensitivity Significance	In 2015, the MPCA and DNR completed a statewide analysis of lake sensitivity to additional phosphorus loading and the significance of that sensitivity in terms of high-quality, unimpaired lakes at risk of becoming impaired. Lakes were ranked and then assigned to one of three priority classes (high, higher, or highest).	These rankings can be used to identify and prioritize lakes that should be targeted for phosphorus reduction projects in their watersheds.	The phosphorus sensitivity significance index generally produced high values for large, oligotrophic lakes that were vulnerable to phosphorus loading and near their estimated loading threshold and low values for small, hypereutrophic lakes with high estimated phosphorus loading and watershed disturbance.	*DNR*
BWSR Ecological Ranking Tool (Environmental Benefit Index - EBI)	Three GIS layers containing: soil erosion risk, water quality risk, and habitat quality. Locations on each layer are assigned a score from 0-100. The sum of all three layer scores (max of 300) is the EBI score. This higher the score, the higher the value in applying restoration or protection.	Any one of the three layers can be used separately or the sum of the layers (EBI) can be used to identify areas that are in line with local priorities. Raster calculator allows a user to make their own sum of the layers to better reflect local values.	GIS layers are available on the BWSR website.	*BWSR*
DNR Watershed Health Assessment Framework (WHAF)	Calculates watershed health for all 80 HUC-8 watersheds based on five components: Biology, Connectivity, Geomorphology, Hydrology, and Water Quality	Statewide GIS data is used to calculate scores for each of the five components to provide an overall watershed health report. A portion of the statewide GIS data is available at a finer scale, allowing some relationships to be downscaled to the DNR catchment scale.	Suitable GIS data for each of the five components available at the DNR catchment scale can provide meaningful comparisons between individual DNR catchments within the HUC-8 watershed.	*DNR*

3.3 Restoration and Protection Strategies

The restoration and protection strategies presented in this section were drafted and compiled via interactions with local units of government over the last several years and have subsequently been incorporated in local plan updates as the WRAPS report was developed. Many of the strategies are protection-oriented given the relatively few impairments in the HUC8 watershed. The strategies can also be spatially targeted using any number of tools available, some of which are presented and discussed throughout this report. Eventually, the refined restoration and protection strategies should be incorporated into local water plans, comprehensive watershed plans, and applications for federal and state funds. Table 13 is intended to help better clarify which HUC 12 IDs and names are associated with the HUC 10 subwatersheds outlined in the strategy table in Section 3.3.1 through 3.3.6.

This section provides detailed tables identifying restoration and protection strategies to restore or protect water quality for individual lakes and streams in each HUC 10 subwatershed. These projects are divided into sections by HUC 10 subwatershed and identify the county, list the waterbody ID and the water quality parameter of concern and include the following information:

Water Quality – Current Conditions: "Current" condition is interpreted as the baseline condition over some evaluation period for the pollutant or non-pollutant stressor identified in the previous column. This should be a numeric descriptor and unit of measurement. This can be a current load (from TMDL or from the load monitoring program if pursuing a downstream goal and not a local goal), a pollutant concentration (e.g., *E. coli* geometric mean), or a score (e.g., IBI or Minnesota Stream Habitat Assessment (MSHA) score). In the interests of length and readability for unimpaired waters, professional judgment was used to determine which of the potentially many parameters to show.

Water Quality – Goals / Targets: Expressed in the same terms as applied in the previous column (Current Conditions) and will generally be a load target (could be percent reduction or a load value) or a water quality concentration target. For some parameters (e.g. phosphorus reduction in a lake watershed), typically a load target is used. For others (e.g., *E. coli*) a concentration is typically used. For protection, a numeric goal/target is used if available.

Strategies: This column is intended to provide the high-level strategies to be used for both protection and restoration. Strategies outline the method, approach, or combination of approaches that could be taken to achieve water quality goals. This field is not intended to prescribe specific projects and practices. The strategies are further described in Table 14.

Interim 10-yr Milestones: This column ties to the Estimated Scale of Adoption column and describes progress to be made toward implementing the strategy in the first 10 years. This is provided in the form of a percentage, amount, or narrative descriptor. This milestone will generally be more coincident (relative to the estimated year to achieve water quality targets) with local water planning milestones.

Stakeholder with Primary Responsibility: Identifies the stakeholder with primary responsibility. It should be noted that identifying a responsible party does not imply any newly associated or suggested authority or regulation.

Timeline/Estimated Year to Achieve Water Quality Targets: This applies to the waterbody, specifically the year it is reasonably estimated that applicable water quality targets will be achieved. Explanatory information may be included either as a footnote or in the preceding narrative providing any assumptions or caveats used in the estimate.

Table 13. HUC 10 and 12 subwatersheds within the Redeye River Watershed

HUC-10 Subwatershed	HUC 12	HUC 12 Name
Upper Leaf River	070101070101	Willow Creek
	070101070102	Co Ditch #49
	070101070103	Leaf Lake
	070101070104	South Bluff Creek
	070101070105	Deer Creek – Leaf River
Bluff Creek	070101070201	Headwaters Bluff Creek
	070101070202	Blue Creek
	070101070203	Bluff Creek
Middle Leaf River	070101070301	Oak Creek
	070101070302	City of Wadena/Leaf River
	070101070303	Union Creek
	070101070304	Co Ditch #3 – Leaf River
Wing River	070101070401	Co Ditch #13
	070101070402	Headwaters Wing River
	070101070403	West Annalaide Lake
	070101070404	Wing River
Redeye River	070101070501	Upper Redeye River
	070101070502	Middle Redeye River
	070101070503	Hay Creek
	070101070504	Town of Bluegrass/Hay Creek
	070101070505	Lower Redeye River
Lower Leaf River	070101070601	Co Ditch #5
	070101070602	Leaf River

3.3.1 Proposed general strategies and actions for all HUCs

HUC 12 Sub-water-shed	County Location and Upstream Influence Counties	Water body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Con-ditions	Water Quality Goals / Targets	Manage-ment Goals	Strategies	Stakeholder with Primary Responsibility									Timeline	Interim 10-yr Milestones
								Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits		
All	All	All	All	NA	NA	Maintain / improve existing water quality	Riparian Buffers		•		•		•	•	•	•	10 years	Full compliance with statewide buffer initiatives.
							Improve Policy on Septic Compli-ance and Ordinance Review			•		•			•		10 years	Full Compliance
							Ordinance Requiring Minimum Impact Design Standards (MIDS) on new develop-ment			•	•	•			•		10 years	Ordinance in place requiring MIDS standards on all new develop-ment.

3.3.2 (0701010701) Upper Leaf River HUC 10 Watershed: Proposed Strategies and Actions

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Willow Creek (07010107 0101)	Otter Tail	Willow Creek (0701010 7-525)	Nutrients	FS for AQL, AQR	Maintain	Maintain/ improve existing water quality	Culvert management				●	●					10 years	10-25% of culverts are replaced per year
						Conservation easement or acquisition	Protect sensitive shoreline		●	●	●				●		30 years	Identify sensitive forests or high value forests for protection in and around Inman, Elmo and Almora WMA's
						Protect riparian habitat	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
						Maintain/ improve existing water quality	Stream restoration		●		●						20 years	Complete at least one stream restoration
						Cropland Nutrient Reductions	Conservation tillage, nutrient management planning, cover crops, and other agricultural BMPs		●				●	●	●		20 years	Implement at least one agricultural BMP (cover crops) in the watershed to serve as a demonstration site.
						Monitor	Deploy data sonde to monitor DO concentrations and water temperature.		●	●							On-going	Determine if Willow Creek can be restored to a coldwater fishery.
						Protect existing upland forests	Add forest acreage focusing on high value upland forests		●		●				●		50+ years	No net loss of forest

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Co Ditch #49 (07010107 0102)	Otter Tail	Co Ditch #49 to East Leaf Lake (0701010 70-554)	Biota - Fish	NS due to low DO, habitat limited	Improve existing water quality	Conservation Easement or Acquisition	Protect sensitive shoreline		●	●	●				●		30 years	Identify sensitive forests or high value forests for protection upstream of public waters wetland 5612900
						Restore poor and fair road crossings	Culvert management				●	●					10 years	10-25% of culverts are replaced per year
						Reduce watershed P loads by 10% through cropland nutrient reductions	Conservation tillage, nutrient management planning, cover crops, and other agricultural BMPs		●				●	●	●		20 years	Implement at least one agricultural BMP (cover crops) in the Long Lake Watershed to serve as a demonstration site.
						Reduce upstream P loads by 10%	Nutrient Management		●					●	●		20 years	Develop plan to identify, target and implement nutrient BMPs
Leaf Lake (07010107 0103)	Otter Tail	Donalds Lake (5620000)	Phosphorus	Growing Season Average TP = 17 ug/L	Maintain	Conservation Easement or Acquisition	Protect sensitive shoreline		●	●					●		30 years	Identify sensitive forests or high value forests for protection
						Monitor In-Lake TP Concentrations West Leaf Lake	Collect bi-monthly TP, Chl-a, and Secchi depth measurements		●	●							On-going	No increase in mean in-lake TP concentrations.
		West Leaf (5611400)	Phosphorus	Growing Season Average TP = 21 ug/L	Maintain	Conservation Easement or Acquisition	Protect sensitive shoreline		●	●	●				●		30 years	Identify sensitive forests or high value forests for protection
						Monitor In-Lake TP Concentrations	Collect bi-monthly TP, Chl-a, and Secchi depth measurements		●	●							On-going	No increase in mean in-lake TP concentrations. Ranked by the DNR/MPCA as being

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
																		in the highest priority category of lakes in terms of lake sensitivity to increases in TP loading.
		Middle Leaf (5611400)	Phosphorus	Growing Season Average TP = 19 ug/L	Maintain	Conservation Easement or Acquisition	Protect sensitive shoreline		●	●					●		30 years	Identify sensitive forests or high value forests for protection
		East Leaf (5611400)	Phosphorus	Growing Season Average TP = 36 ug/L	Improve existing water quality	Increase Forest Acreage	Add forest acreage to get to 75% of watershed undisturbed, currently at less than 60% disturbance; restoration needed. Potential for full restoration of water quality and fish community improvement. Focus on high value uplands		●		●				●		20 years	Evaluate critical restoration opportunities, secure at least one conservation easement.
						Cropland Nutrient Reductions	Conservation tillage, nutrient management planning, cover crops, and other agricultural BMPs		●				●	●	●		20 years	Implement at least one agricultural BMP (cover crops) in the watershed to serve as a demonstration site.
		Portage Lake (5614000)	Phosphorus	Growing Season Average TP = 11 ug/L	Maintain	Conservation Easement or Acquisition	Protect sensitive shoreline		●		●				●		30 years	Identify sensitive forests or high value forests for protection
						Monitor In-Lake TP Concentrations	Collect bi-monthly TP, Chl-a,		●	●							On-going	No increase in mean in-lake TP concentrations.

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
							and Secchi depth measurements											Ranked by the DNR/MPCA as being in the highest priority category of lakes in terms of lake sensitivity to increases in TP loading.
		Gourd Lake (56013900)	Phosphorus	Growing Season Average TP = 16ug/L	Maintain	Protect riparian habitat	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
						Protect floodplain	Stream restoration		●		●						20 years	Complete at least one stream restoration
						Maintain status as lake of biological significance	Maintain status as lake of biological significance through implementation of protection measures (ordinances, voluntary BMPs, fisheries and wildlife management).		●	●	●	●			●	●	On-going	Maintain status as lake of biological significance
						Protect Wild Rice Stands on Tamarack, Gourd, and Grass Lakes	Enforce ordinances that protect wild rice stands				●	●					On-going	Protect wild rice stands by educating public regarding permit requirement for wild rice removal
						Monitor In-Lake TP Concentrations in Gourd and Tamarack Lakes	Collect bi-monthly TP, Chl-a, and Secchi depth measurements		●	●							On-going	No increase in mean in-lake TP concentrations.

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
						Protect existing upland forests through conservation easements	Prevent urbanization of floodplain through shoreland and floodplain management.		●						●	●	20 years	All shoreland residents receive shoreland BMP information. Secure at least one conservation easement in the areas around Tamarack Lake, Upstream of Gourd Lake, or Grass Lake
South Bluff Creek (07010107 0104)	Otter Tail	Unnamed Creek to Leaf River (0701010 70-531)	Nutrients	FS for AQL, AQR	Maintain & improve existing water quality	Cropland Nutrient Reductions	Ag. BMPs for erosion control, GW management to maintain stream flows, Riparian Mgmt., Cattle Exclusion		●				●	●	●		20 years	Implement at least one agricultural BMP (cover crops) in the watershed to serve as a demonstration site.
						Reduce upstream P loads by 10%	Nutrient Management		●					●	●		20 years	Develop plan to identify, target and implement nutrient BMPs
						Wetland Restoration	Wetland Restoration				●		●	●	●	●	20 years	Encourage landowners to work with Fish and Wildlife, SWCD or Public Easements to restore wetlands with focus on the upper portion of the watershed.

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Deer Creek – Leaf River (07010107 0105)	Otter Tail	Deer Creek (0701010 7-511)	Biota	FS for AQR	Maintain & improve existing water quality	Restore poor and fair road crossings	Culvert management				●	●					10 years	10-25% of culverts are replaced per year
						Monitor Finn Creek Tributary	Deploy data sonde to monitor DO concentrations and water temperature.		●	●							Ongoi ng	Determine if Finn Creek can be restored to a coldwater fishery.
						Reduce watershed P loads by 10%	Nutrient Management		●					●	●		20 years	Develop plan to identify, target and implement nutrient BMPs
						Conservation easements	Retain Forest Land		●		●				●	●	30 years	Identify sensitive forests or high value forests for protection with focus on Ditch 48, Leaf River corridor, Finn Creek.

3.3.3 (0701010702) Bluff Creek HUC 10 Watershed: Proposed Strategies and Actions

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Headwaters Bluff Creek (070101070201)	Otter Tail	Bluff Creek (07010107-515)	*E. coli*	Impaired by *E. coli*	Monthly geometric average *E. coli* <126 org/100 mL	Reduce watershed loading	Access control		●				●				20 years	Implement at least one cattle exclusion project
							Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure management		●						●		15 years	Conduct windshield surveys to identify problems following methods used in Todd and Wadena County
							Groundwater management		●		●						30 years	No net decline and no new contamination issues
						Conservation Easement or Acquisition	Protect sensitive shoreline		●		●		●		●		On-going	Secure 1 conservation easement on areas adjacent to Bluff Creek WMA and area downstream to Bluff Creek and area around Unnamed basin 56106000

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Blue Creek (07010107020 2)	Otter Tail, Wadena	Blue Creek (07010107-541)	Biota	FS for AQR	Maintain & improve existing water quality	Restore natural stream meander to areas impacted by ditching	Stream Restoration/ Channel Restoration				●				●		15 years	Restore degraded sections of stream with goal of improving natural channel flow.
Bluff Creek (07010107020 3)	Otter Tail	Bluff Creek (07010107-515)	*E. coli*	Impaired by *E. coli*	Monthly geometric average *E. coli* <126 org/100 mL	Reduce watershed loading	Access control		●				●				20 years	Implement at least one cattle exclusion project
							Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure management		●						●		15 years	Conduct windshield surveys to identify problems following methods used in Todd and Wadena County
							Groundwater management		●		●						30 years	No net decline and no new contamination issues
			Turbidity	NS due to elevated turbidity	Improve existing water quality	Restore poor and fair road crossings	Culvert management				●	●					10 years	10-culverts are replaced per year

3.3.4 (0701010703) Middle Leaf River HUC 10 Watershed: Proposed Strategies and Actions

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Cond-itions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Oak Creek (07010107 0301)	Otter Tail, Todd	Oak Creek (07010107 -516)	*E. coli*	Impaired by *E. coli*	Monthly geometric average *E. coli* <126 org/100 mL	Reduce watershed loading	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
							Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure manage-ment		●				●		●		15 years	Conduct windshield surveys to identify problems following methods used in Todd and Wadena County
			Nutrients	FS for AQL	Maintain existing water quality	Protect riparian habitat	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
						Restore poor and fair road crossings	Culvert manage-ment				●	●					10 years	10-25% of culverts are replaced per year
						Conservation Easement or Acquisition	Protect sensitive shoreline		●		●				●		On-going	Secure 1 conserva-tion easement on areas

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Cond-itions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
																		adjacent to the headwater areas of Oak Creek downstream of Wrights-town WMA
						Restore natural stream meander to areas impacted by ditching with goal of maintaining high biodiversity	Stream restoration		●		●						20 years	Complete at least one stream restoration-Restore degraded sections of stream with goal of improving natural channel flow. Maintain channel geometry and connectivity to floodplain and longitud-inally
						Protect existing upland forests	Add forest acreage focusing on high value upland forests		●		●						50+ years	No net loss of forest
						Reduce watershed P loads by 10%	Nutrient Manage-ment		●					●	●		20 years	Identify, target and implement nutrient BMPs

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Cond-itions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
City of Wadena/ Leaf River (07010107 0302)	Wadena, Otter Tail	Leaf River (07010107 -505)	*E. coli*	Impaired by *E. coli*	Monthly geometric average *E. coli* <126 org/100 mL	Reduce watershed loading	Access control		●				●				20 years	Implement at least one cattle exclusion project
							Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure manage-ment		●				●				15 years	Use results from windshield survey to target BMPs to priority feedlots.
			Fish IBI	NS of fish	FS of fish	Restore poor and fair road crossings, focus on deficient culvert tributary to Leaf River, T151	Culvert Manage-ment				●	●					10 years	10-25% of culverts are replace per year
			Nitrates	>10 mg/L	<10 mg/L	Wellhead Protection	Monitor Nitrate concentra-tions in ground-water		●					●	●		10 years	Declining trend in well water nitrate concentra-tions
							Monitor and reduce Nitrogen		●				●	●	●		20 years	Enforce ordinances that restrict nitrogen

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Cond-itions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
							Application Rates											application rates
			DO	Impaired by low DO	Daily Mini-mum DO >5 mg/L	Cropland Nutrient reductions	Conservat-ion tillage, nutrient manage-ment planning, cover crops, and other agricultural BMPs		●				●	●	●		20 years	Implement at least one agricultural BMP (cover crops) in the watershed to serve as a demo site.
Union Creek (07010107 0303)	Wadena, Otter Tail	Union Creek (07010107 -508)	*E. coli*	Impaired by *E. coli*	Monthly geometric average *E. coli* <126 org/100 mL	Reduce watershed loading	Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure manage-ment		●				●				15 years	Use results from windshield survey to target BMPs to priority feedlots.
							Access control		●				●				20 years	Implement at least one cattle exclusion project
							Urban Reductions		●			●			●		20 years	Implement at least one urban BMP (rain garden, shoreline buffer) in the watershed to serve as a demo site.

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Cond-itions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
																		Enforce shoreland development ordinances especially on new develop-ment to protect nearshore vegetation.
			Fish IBI	NS of fish	Meeting/ Exceeding Fish and Invert IBI	Monitor	Deploy data sonde to monitor DO concentrati ons.		●	●							5 years	Determine if Union Creek can be restored to a cold-water fishery given water temp is conducive
						Stream Restoration	Culvert manage-ment				●	●					10 years	10-25% of culverts are replaced per year
							Stream restoration with civic engage-ment		●		●						20 years	Complete at least one stream restoration Restore degraded sections of stream with goal of improving natural channel flow. High public use potential.

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Cond-itions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
			Invert IBI	NS invert		Point Source Reduction	Inspect Illicit Discharges			●		●			●		10 years	Enforce ordinances that prohibit illegal hookups to sanitary sewer
			Invert IBI	NS Inverts		Point Source Reduction	Chemical treatment of waste-water discharge			●		●			●		5 years	Continue chemical treatment to reduce phosphor-rus levels
						Protect existing upland forests	Add forest acreage focusing on high value upland forests		●		●						50+ years	No net loss of forest
						Reduce watershed P loads by 10%	Nutrient Manage-ment		●					●			20 years	Develop plan to identify, target and implement nutrient BMPs
Co Ditch #3 – Leaf River (07010107 0304)	Wadena	Trib. to Redeye River (07010107 -526)	*E. coli*	Impaired by *E. Coli*	Monthly geometric average *E. coli* <126 org/100 mL	Reduce watershed loading	Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure manage-ment		●				●				15 years	Use results from windshield survey to

HUC 12 Subwater-shed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Cond-itions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
																		target BMPs to priority feedlots.
							Access control		●				●		●		20 years	Implement at least one cattle exclusion project
		Leaf River (07010107-505)	*E. coli*	Impaired by *E. Coli*	Monthly geometric average *E. coli* <126 org/100 mL	Reduce watershed loading	Nutrient Manage-ment		●					●			20 years	Develop plan to identify, target and implement nutrient BMPs
			DO	Impaired by low DO	Daily Minimum DO >5 mg/L	Cropland nutrient reductions	Conserva-tion tillage, nutrient manage-ment planning, cover crops, and other agricultural BMPs		●				●	●	●		20 years	Implement at least one agricultural BMP (cover crops) in the watershed to serve as a demo site.

3.3.5 (0701010704) Wing River HUC 10 Watershed: Proposed Strategies and Actions

HUC 12 Subwatershed	County Location and Up-stream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Co Ditch #13 (07010107040 1)	Otter Tail	Horse-head (56002200)	Phosphorus	Growing Season Average TP = 33 ug/L	TP < 60 ug/L	In-lake management	Improve in-lake biological community and/or reduce internal loading		●	●	●						20 years	Implement shallow lake management and protection strategies.
						Protect Wild Rice Stands on North and South Maple Lakes	Enforce ordinances that protect wild rice stands				●	●					On-going	Protect wild rice stands by educating public regarding permit requirement for wild rice removal
						Reduce watershed P loads by 10%	Nutrient Management		●					●	●		20 years	Develop plan to identify, target and implement nutrient BMPs
					Improve existing water quality	Protect riparian habitat	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
						Maintain/ improve existing water quality	Stream restoration		●		●						20 years	Complete at least one stream restoration
						Increase Forest Acreage	Add forest acreage. Currently, over 60% of watershed		●	●	●	●					On-going	Evaluate critical restoration opportunities, secure at least

HUC 12 Subwatershed	County Location and Up-stream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
							disturbed; Focus on high value uplands											one conservation easement
Head-waters Wing River (070101 070402)	Otter Tail	Head-waters Wing River Lake (56-0043-00) to Hwy 210 Bridge	Biota – fish connectivity	NS for FIBI-physical connectivity	FS for FIBI	Restore poor and fair road crossings especially the dam located at Highway 210 in Hewitt, Minnesota that is likely acting as a fish barrier.	Culvert/Dam management				●	●					10 years	Prioritize beaver dams, highway 210 dam, and other culverts for replacement. Remove at least one barrier to fish migration.
						Reduce watershed P loads by 10%	Nutrient Management		●					●	●		20 years	Develop plan to identify, target and implement nutrient BMPs
						Protect riparian habitat	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
		Snow (56011 000)	Phosphorus	Growing Season Average TP = NA	Maintain & improve existing water quality	Maintain status as lake of biological significance	Maintain status as lake of biological significance through implementation of protection measures (ordinances, voluntary BMPs, fisheries and wildlife management).		●	●	●	●			●	●	On-going	Maintain status as lake of biological significance

HUC 12 Subwatershed	County Location and Up-stream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
						Protect existing upland forests	Add forest acreage focusing on high value upland forests		●		●						50+ years	No net loss of forest
West Anna-laide Lake (07010107040 3)	Otter Tail, Todd	West Anna-laide Lake (56000500)	Phosphorus	Growing Season Average TP = 19 ug/L	Maintain existing water quality	Conservation Easement or Acquisition	Protect sensitive shoreline		●		●	●					On-going	Secure 1 conservation easement on areas adjacent to Eastern WMA, and/or shallow lakes just to the south of this WMA
		Mary Lake (56001000)		Growing Season Average TP = 21 ug/L		Monitor In-Lake TP Concentrations	Collect bi-monthly TP, Chl-a, and Secchi depth measurements		●	●							On-going	No increase in mean in-lake TP concentration. Ranked by the DNR/MPCA as being in the highest priority category of lakes in terms of lake sensitivity to increases in TP loading.
Wing River (07010107040 4)	Wadena, Todd, Otter-tail	Wing River (07010107-560) Hwy 210	Nitrates	>10 mg/L	<10 mg/L	Wellhead Protection	Monitor and Reduce Nitrogen Application Rates		●					●	●		10 years	Enforce ordinances that restrict nitrogen application rates within wellhead

HUC 12 Subwatershed	County Location and Up-stream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
		bridge to Leaf River																protection area within wellhead protection area.
							Monitor Nitrate concentrations in groundwater		●					●	●		10 years	Declining trend in well water nitrate concentrations
			E. coli	Impaired by *E. coli*	Month-ly geo-metric average *E. coli* <126 org/100 mL	Reduce watershed loading	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
							Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure management		●				●				15 years	Use results from windshield survey to target BMPs to priority feedlots.
						Protect riparian habitat	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
						Restore poor and fair road crossings	Culvert management				●	●					10 years	10-25% of culverts are replaced per year

HUC 12 Subwatershed	County Location and Up-stream Influence Counties	Water-body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Townships	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
						Maintain/ improve existing quarter quality	Stream restoration		●		●						20 years	Complete at least one stream restoration
						Protect existing upland forests	Add forest acreage focusing on high value upland forests		●		●						50+ years	No net loss of forest
			Phosphorus	Growing Season Average TP = NA	TP < 30 ug\L	Quantify phosphorus loads from City of Parkers Prairie and Hewitt WWTP spray irrigation fields	Nutrient Management		●	●				●			20 years	Develop plan to identify, target and implement nutrient BMPs

3.3.6 (0701010705) Redeye River HUC 10 Watershed Proposed Strategies and Actions.

HUC 12 Subwatershed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Towns	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Upper Redeye River (07010107050501)	Becker	Wolf Lake (03010100)	Phos-phorus	Growing Season Average TP = 23 ug/L	Maintain TP < 30 ug/L	Restore poor and fair road crossings	Culvert management				●	●					10 years	10-25% of culverts are replaced per year
						Maintain/ improve existing water quality	Stream restoration		●		●						20 years	Complete at least one stream restoration
						Protect existing upland forests	Add forest acreage focusing on high value upland forests		●		●						50+ years	No net loss of forest
						Protect Wild Rice Stands on Wolf Lake	Enforce ordinances that protect wild rice stands				●	●					On-going	Protect wild rice stands by educating public regarding permit requirement for wild rice removal
						Monitor In-Lake TP Concentrations	Collect bi-monthly TP, Chl-a, and Secchi depth measurements			●	●						**2025**	No increase in mean in-lake TP concentrations. Ranked by the DNR/MPCA as being in the highest priority category of lakes in terms of lake sensitivity to increases in TP loading.

HUC 12 Subwatershed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Towns	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Middle Redeye River (07010107 0502)	Ottertail	Mud Lake (56013200)	Phos-phorus	Growing Season Average TP = 21 ug/L	Maintain TP < 30 ug/L	Conservation Easement or Acquisition	Protect sensitive shoreline		●		●	●					On-going	Secure 1 conservation easement on areas adjacent to Smokey Hills State Forest and County lands to the south at the Becker/Otter Tail County Line
						Increase Forest Acreage	Add forest acreage to get to 75% of watershed undisturbed, currently at less than 60% disturbance; restoration needed. Potential for full restoration of water quality and fish community improvement. Focus on high value uplands		●	●	●	●		●			On-going	Net Increase in undisturbed land use.
						Protect Wild Rice Stands on Mud Lake	Enforce ordinances that protect wild rice stands				●	●					On-going	Protect wild rice stands by educating public regarding permit

HUC 12 Subwatershed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Towns	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
																		requirement for wild rice removal
Hay Creek (07010107 0503)	Otter Tail, Wadena	Hay Creek (07010107-545)	Biota	FS for AQR	Maintain & improve existing water quality	Restore poor/deficient culverts. Prioritize deficient culvert at CR159	Culvert/Dam management				●	●					10 years	Replace deficient culvert at CR159 and inventory other deficient culverts.
			Nutrients	FS for AQL														
Town of Blue-grass/ Hay Creek (07010107 0504)	Wadena	Hay Creek (07010107-502)	Biota	FS for AQR	Maintain & improve existing water quality	Restore poor/deficient culverts. Prioritize deficient culvert at tributary to Hay Creek at CR135, CSAH9, on Hay Creek at CR132, T214, CSAH23, CR164, T204, CR118, T190	Culvert/Dam management				●	●					10 years	Replace deficient culverts.
			Nutrients	FS for AQL		Reduce watershed loading	Groundwater management and monitoring		●		●						30 years	No net decline in baseflow and no new contamination issues resulting from increase in irrigated agricultural lands.

HUC 12 Subwatershed	County Location and Upstream Influence Counties	Water-body (ID)	Water Quality Para-meter (incl. non-pollutant stressors)	Water Quality Current Condi-tions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Towns	NRCS	MDA	Landowners	Non Profits	Time-line	Interim 10-yr Milestones
Lower Redeye River (07010107 0505)	Wadena	Red Eye River Headwat-ers to Hay Creek (07010107-503)	*E. coli*	Impaired by *E. coli*	Monthly geo-metric average *E. coli* <126 org/100 mL	Reduce watershed loading	Access control		●				●		●		20 years	Implement at least one cattle exclusion project
							Riparian buffers		●						●	●	20 years	Increased size and amount of buffers
							Manure management		●				●				15 years	Use results from windshield survey to target BMPs to priority feedlots.
						Restore poor/deficient culverts on tribs. to Redeye R at CR131, CR133, M23, T45, CSAH7	Culvert/Dam management				●	●					10 years	Replace deficient culvert at CR159 and inventory other deficient culverts.

3.3.7 (0701010706) Lower Leaf River HUC 10 Watershed: Proposed Strategies and Actions

HUC 12 Subwatershed	County Location and Upstream Influence Counties	Water body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Towns	NRCS	MDA	Landowners	Time-line	Interim 10-yr Milestones
Co Ditch #5 (07010170601)	Wadena Todd	Hay Creek (07010107-526)	*E. coli*	Impaired by *E. coli*	Monthly geometric average *E. coli* <126 org/100 mL	Protect riparian habitat	Access control		●				●		●	20 years	Implement at least one cattle exclusion project
						Protect existing upland forests	Add forest acreage focusing on high value upland forests		●		●				●	On-going	Prevent net loss in undisturbed land use.
						Reduce watershed P loads by 10%	Manure management		●				●			15 Years	Use results from windshield survey to target BMPs to priority feedlots.
Leaf River (07010170602)	Wadena	Leaf River Wing R. to Red-eye R. (07010107-504)	Biota	FS for AQR	Maintain & improve existing water quality TP < 30 ug/L	Protect undisturbed habitat at risk for conversion due to irrigated agriculture expansion.	Add or maintain forest acreage to protect undisturbed land from being converted to irrigated agriculture		●		●				●	On-going	Prevent net loss in undisturbed land use.
						Restore natural stream meander to areas impacted by ditching	Stream Restoration / Channel Restoration				●				●	15 Years	Restore degraded sections of stream with goal of improving natural channel flow.
			Nutrients	FS for AQL		Conservation Easement or Acquisition	Protect sensitive shoreline		●		●				●	On-going	Secure at least one conservation easement on Potlach lands

HUC 12 Subwatershed	County Location and Upstream Influence Counties	Water body (ID)	Water Quality Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Management Goals	Strategies	Watershed District	SWCD	MPCA	DNR	Cities/Towns	NRCS	MDA	Landowners	Time-line	Interim 10-yr Milestones
																	at risk of conversion, potential irrigated agriculture expansion
						Reduce watershed P loads by 10%	Nutrient Manage-ment		●					●		15 Years	Develop plan to identify, target and implement nutrient BMPs

Table 14. Strategy Key

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	**Example BMPs/actions**
TSS	Improve upland/field surface runoff controls: Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Cover crops
		Water and sediment basins, terraces
		Rotations including perennials
		Conservation cover easements
		Grassed waterways
		Strategies to reduce flow- some of flow reduction strategies should be targeted to ravine subwatersheds
		Residue management - conservation tillage
		Forage and biomass planting
		Open tile inlet controls - riser pipes, french drains
		Contour farming
		Wetland restoration
		Stripcropping
	Protect/stabilize banks/bluffs: Reduce collapse of bluffs and erosion of streambank by reducing peak river flows and using vegetation to stabilize these areas.	Strategies for altered hydrology (reducing peak flow)
		Streambank stabilization
		Riparian forest buffer
		Livestock exclusion - controlled stream crossings
	Stabilize ravines: Reducing erosion of ravines by dispersing and infiltrating field runoff and increasing vegetative cover near ravines. Also, may include earthwork/regrading and revegetation of ravine.	Field edge buffers, borders, windbreaks and/or filter strips
		Contour farming and contour buffer strips
		Diversions
		Water and sediment control basin
		Terrace
		Conservation crop rotation
		Cover crop
		Residue management - conservation tillage
	Improve forestry management	Proper Water Crossings and road construction
		Forest Roads - Cross-Drainage
		Maintaining and aligning active Forest Roads

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	Example BMPs/actions
		Closure of Inactive Roads & Post-Harvest
		Location & Sizing of Landings
		Riparian Management Zone Widths and/or filter strips
	Improve urban stormwater management [to reduce sediment and flow]	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
Nitrogen (TN) or Nitrate	Increase fertilizer and manure efficiency: Adding fertilizer and manure additions at rates and ways that maximize crop uptake while minimizing leaching losses to waters	Nitrogen rates at Maximum Return to Nitrogen (U of MN rec's)
		Timing of application closer to crop use (spring or split applications)
		Nitrification inhibitors
		Manure application based on nutrient testing, calibrated equipment, recommended rates, etc.
	Store and treat tile drainage waters: Managing tile drainage waters so that nitrate can be denitrified or so that water volumes and loads from tile drains are reduced	Saturated buffers
		Restored or constructed wetlands
		Controlled drainage
		Woodchip bioreactors
		Two-stage ditch or channel restoration
	Increase vegetative cover/root duration: Planting crops and vegetation that maximize vegetative cover and capturing of soil nitrate by roots during the spring, summer and fall.	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands
		Cover crops
		Rotations that include perennials
	Implementation of the Nitrogen Fertilizer Management Plan and Minnesota Nutrient Reduction Strategy	See http://www.mda.state.mn.us/nfmp and https://www.pca.state.mn.us/sites/default/files/wq-s1-80a.pdf
Phosphorus (TP)	Improve upland/field surface runoff controls:	Strategies to reduce sediment from fields (see above - upland field surface runoff)

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	**Example BMPs/actions**
	Soil and water conservation practices that reduce soil erosion and field runoff, or otherwise minimize sediment from leaving farmland	Constructed or restored wetlands
		Pasture management
		Restored wetlands
	Reduce bank/bluff/ravine erosion	Strategies to reduce TSS from banks/bluffs/ravines (see above for sediment)
	Increase vegetative cover/root duration: Planting crops and vegetation that maximize vegetative cover and minimize erosion and soil losses to waters, especially during the spring and fall.	Conservation cover (easements/buffers of native grass & trees, pollinator habitat)
		Perennials grown on marginal lands and riparian lands
		Cover crops
		Rotations that include perennials
	Preventing feedlot runoff: Using manure storage, water diversions, reduced lot sizes and vegetative filter strips to reduce open lot phosphorus losses	Open lot runoff management to meet 7020 rules
		Manure storage in ways that prevent runoff
	Improve fertilizer and manure application management: Applying phosphorus fertilizer and manure onto soils where it is most needed using techniques which limit exposure of phosphorus to rainfall and runoff.	Soil P testing and applying nutrients on fields needing phosphorus
		Incorporating/injecting nutrients below the soil
		Manure application meeting all 7020 rule setback requirements
		Sewering around lakes

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	**Example BMPs/actions**
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Eliminating straight pipes, surface seepages
	Reduce in-water loading: Minimizing the internal release of phosphorus within lakes	Rough fish management
		Curly-leaf pondweed management
		Alum treatment
		Lake drawdown
		Hypolimnetic withdrawal
	Improve forestry management	See forest strategies for sediment control
	Reduce Industrial/Municipal wastewater TP	Municipal and industrial treatment of wastewater P
		Upgrades/expansion. Address inflow/infiltration.
	Treat tile drainage waters: Treating tile drainage waters to reduce phosphorus entering water by running water through a medium which captures phosphorus	Bioreactor
	Improve urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
E. coli	Reducing livestock bacteria in surface runoff: Preventing manure from entering streams by keeping it in storage or below the soil surface and by limiting access of animals to waters.	Strategies to reduce field TSS (applied to manured fields, see above)
		Improved field manure (nutrient) management
		Adhere/increase application setbacks
		Improve feedlot runoff control
		Animal mortality facility
		Manure spreading setbacks and incorporation near wells and sinkholes
		Rotational grazing and livestock exclusion (pasture management)
		Pet waste management

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	**Example BMPs/actions**
	Reduce urban bacteria: Limiting exposure of pet or waterfowl waste to rainfall	Filter strips and buffers
		See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
	Address failing septic systems: Fixing septic systems so that on-site sewage is not released to surface waters. Includes straight pipes.	Replace failing septic (SSTS) systems
		Maintain septic (SSTS) systems
	Reduce Industrial/Municipal wastewater bacteria	Reduce straight pipe (untreated) residential discharges
		Reduce WWTP untreated (emergency) releases
Dissolved Oxygen	Reduce phosphorus	See strategies above for reducing phosphorus
	Increase river flow during low flow years	See strategies above for altered hydrology
	In-channel restoration: Actions to address altered portions of streams.	
Chloride	Road salt management	[Strategies currently under development within Twin Cities Metro Area Chloride Management Plan]
Altered hydrology; peak flow and/or low base flow (Fish/Macroinvertebrate IBI)	Increase living cover: Planting crops and vegetation that maximize vegetative cover and evapotranspiration especially during the high flow spring months.	Grassed waterways
		Cover crops
		Conservation cover (easements & buffers of native grass & trees, pollinator habitat)
		Rotations including perennials
		Treatment wetlands

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	Example BMPs/actions
	Improve drainage management: Managing drainage waters to store tile drainage waters in fields or at constructed collection points and releasing stored waters after peak flow periods. Protect existing wetlands and restore drained wetlands.	Restored wetlands
	Reduce rural runoff by increasing infiltration: Decrease surface runoff contributions to peak flow through soil and water conservation practices.	Conservation tillage (no-till or strip till w/ high residue)
		Water and sediment basins, terraces
	Improve urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
	Improve irrigation water management: Increase groundwater contributions to surface waters by withdrawing less water for irrigation or other purposes. Restore channel meanders to reduce slope and stabilize hydrograph.	Groundwater pumping reductions and irrigation management
Poor Habitat (Fish/Macroinvertebrate IBI)	Improve riparian vegetation: Planting and improving perennial vegetation in riparian areas to stabilize soil, filter pollutants and increase biodiversity	50' vegetated buffer on protected of waterways
		One rod ditch buffers
		Lake shoreland buffers
		Increase conservation cover: in/near water bodies, to create corridors
		Improve/increase natural habitat in riparian, control invasive species

Parameter (incl. non-pollutant stressors)	Strategy Key	
	Description	**Example BMPs/actions**
		Tree planting to increase shading
		Streambank and shorline protection/stabilization
		Wetland restoration
		Accurately size bridges and culverts to improve stream stability
	Restore/enhance channel: Various restoration efforts largely aimed at providing substrate and natural stream morphology.	Retrofit dams with multi-level intakes
		Restore riffle substrate
		Two-stage ditch
		Dam operation to mimic natural conditions
		Restore natural meander and complexity
Water Temperature	Urban stormwater management	See MPCA Stormwater Manual: http://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
	Improve riparian vegetation Actions primarily to increase shading, but also some infiltration of surface runoff.	Riparian vegetative buffers
		Tree planting to increase shading
		Manage groundwater withdrawls
Connectivity (Fish IBI)	Removal fish passage barriers: Identify and address barriers longitudinally and laterally.	Dam removal
		Properly size and place culverts for flow and fish passage and sediment delivery.
		Construct nature-like fish passage
		Restore connectivity between the channel and the floodplain

4. Monitoring Plan

Specific monitoring strategies related to certain waterbodies are identified in the strategy table. General data from three monitoring programs will continue to be collected and analyzed for the Redeye River Watershed. These monitoring programs are summarized below:

1. ***Intensive Watershed Monitoring*** collects water quality and biological data throughout each major watershed once every 10 years. This work is scheduled for its second iteration in the Redeye River Watershed in 2021. This data provides a periodic but intensive "snapshot" of water quality throughout the watershed.
2. The ***Watershed Pollutant Load Monitoring Network*** intensively collects pollutant samples and flow data to calculate sediment and nutrient loads and flow-weighted mean concentrations. In the Redeye River Watershed, there is one subwatershed pollutant load monitoring site on the Leaf River where it flows under CSAH 29 in section 34 of Bullard Township, Wadena County.
3. The ***Citizen Lake and Stream Monitoring Programs*** are a network of volunteers who take monthly lake and river transparency readings. Several data collection locations exist in the Redeye River Watershed. Only one lake is monitored through the lake monitoring program: Middle Leaf. Thirteen streams are monitored through the stream monitoring program (three in Otter Tail County, one in Todd County, one that shares a border with Todd and Wadena Counties, and eight in Wadena County), with one in Wadena County being a high priority stream site. This data provides a continuous record of one water quality parameter throughout much of the watershed.

In addition to the monitoring conducted in association with the WRAPS process, each local unit of government associated with water management may have their own monitoring plan. Furthermore, there are many citizen monitors throughout the watershed collecting both stream and lake data. All data collected locally should be submitted regularly to the MPCA for entry into the EQuIS database system.

5. References and Further Information

Emmons & Olivier Resources, Inc. Draft 2015. Redeye River Watershed TMDL Study. Prepared for the Minnesota Pollution Control Agency.

Minnesota Department of Agriculture (MDA). January 2012. Central Sands Private Well Network 2011 Current Nitrate Conditions Summary.

Minnesota Pollution Control Agency (MPCA). May 2014. Redeye River Watershed Monitoring and Assessment Report.

Minnesota Pollution Control Agency (MPCA). October 2014. Redeye River Watershed Stressor Identification Report.

Redeye River Watershed Reports

All Redeye River Watershed reports referenced in this watershed report are available at the Redeye River Watershed webpage: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/redeye-river.html

Appendix A Maps and Tools to Target Restoration and Protection Strategies

This map illustrates the magnitude of TP pollution generated in each subwatershed based on the HSPF model results. Subwatersheds are coded along a color gradient, with red subwatersheds having greater pollutant yields than blue subwatersheds.

The areas of primary focus will be the regions of highest TP loads shown in red, where Parkers Prairie resides, and in the dark orange regions that include Deer Creek, Hewitt, and Verndale.

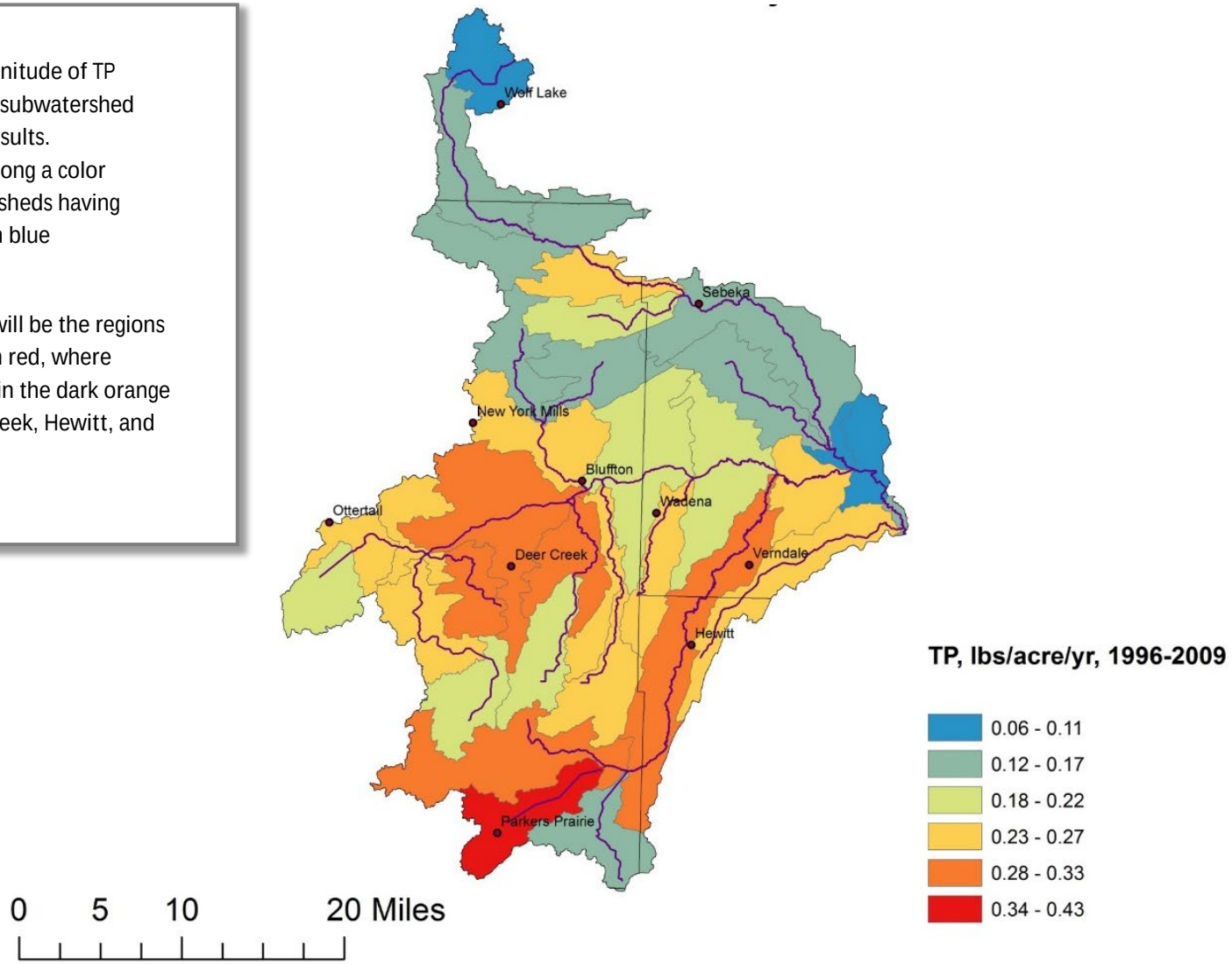


Figure 1. Redeye River Watershed HSPF Subwatershed Total Phosphorus Loads (pounds/acre/year).

Appendix A Maps and Tools to Target Restoration and Protection Strategies

This map illustrates the magnitude of **total nitrogen** (TN) pollution generated in each subwatershed based on the HSPF model results. Subwatersheds are coded along a color gradient, with red subwatersheds having greater pollutant yields than blue subwatersheds.

The areas of primary focus will be within the regions of highest Total Nitrogen (TN) loads shown in red, where Parkers Prairie, Hewitt, Verndale, and Wadena reside, and in the dark orange regions that include Ottertail.

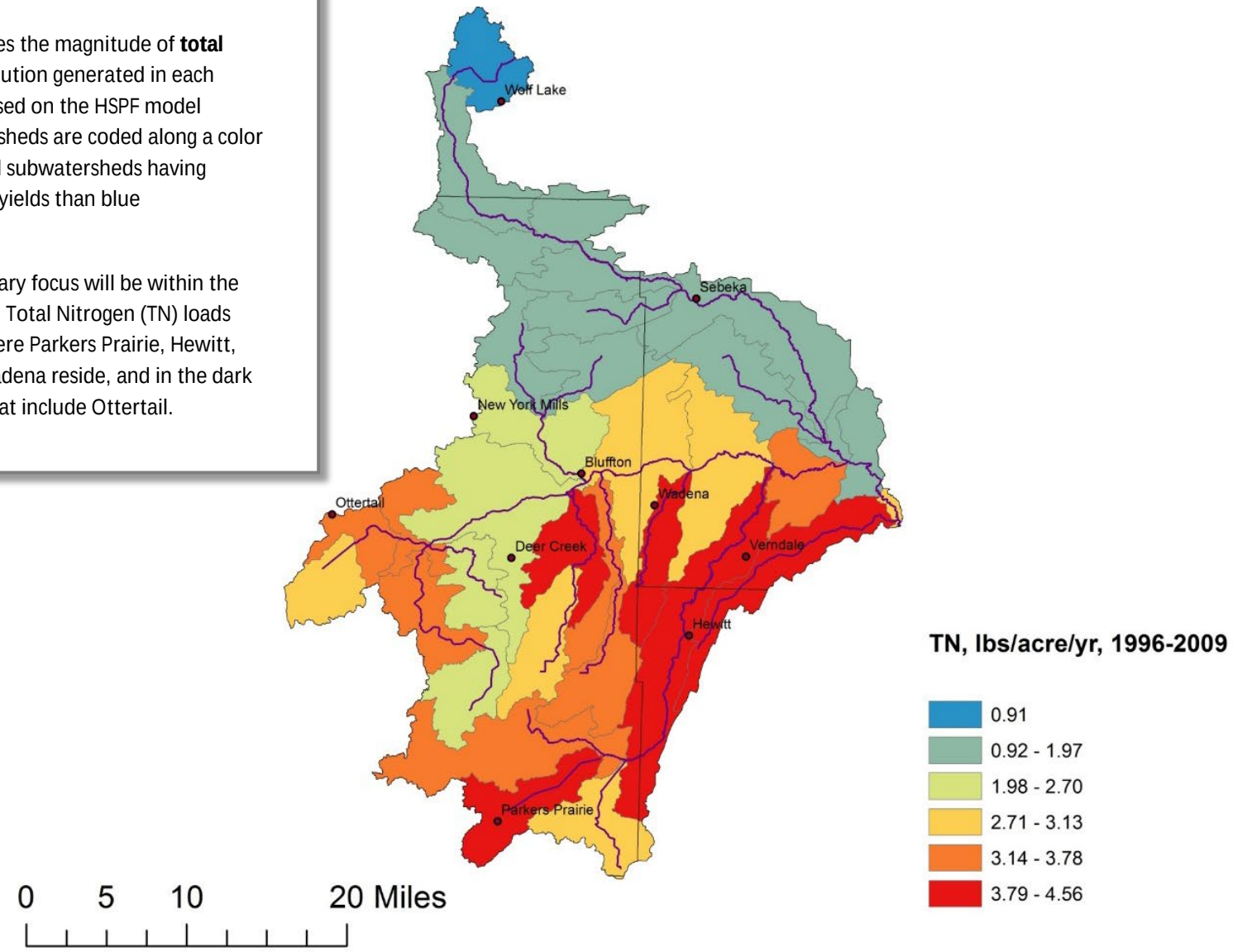


Figure 2. Redeye River Watershed HSPF Subwatershed Total Nitrogen Loads (pounds/acre/year).

Appendix A Maps and Tools to Target Restoration and Protection Strategies

This map illustrates the magnitude of **total suspended solids** (TSS) pollution generated in each subwatershed based on the HSPF model results. Subwatersheds are coded along a color gradient, with darker subwatersheds having greater pollutant yields than lighter subwatersheds.

The areas of primary focus will be within the regions of highest concentration which are shown in dark brown, where Parkers Prairie resides, and in the lesser dark brown regions of Deer Creek, Bluffton, Verndale, New York Mills, etc.

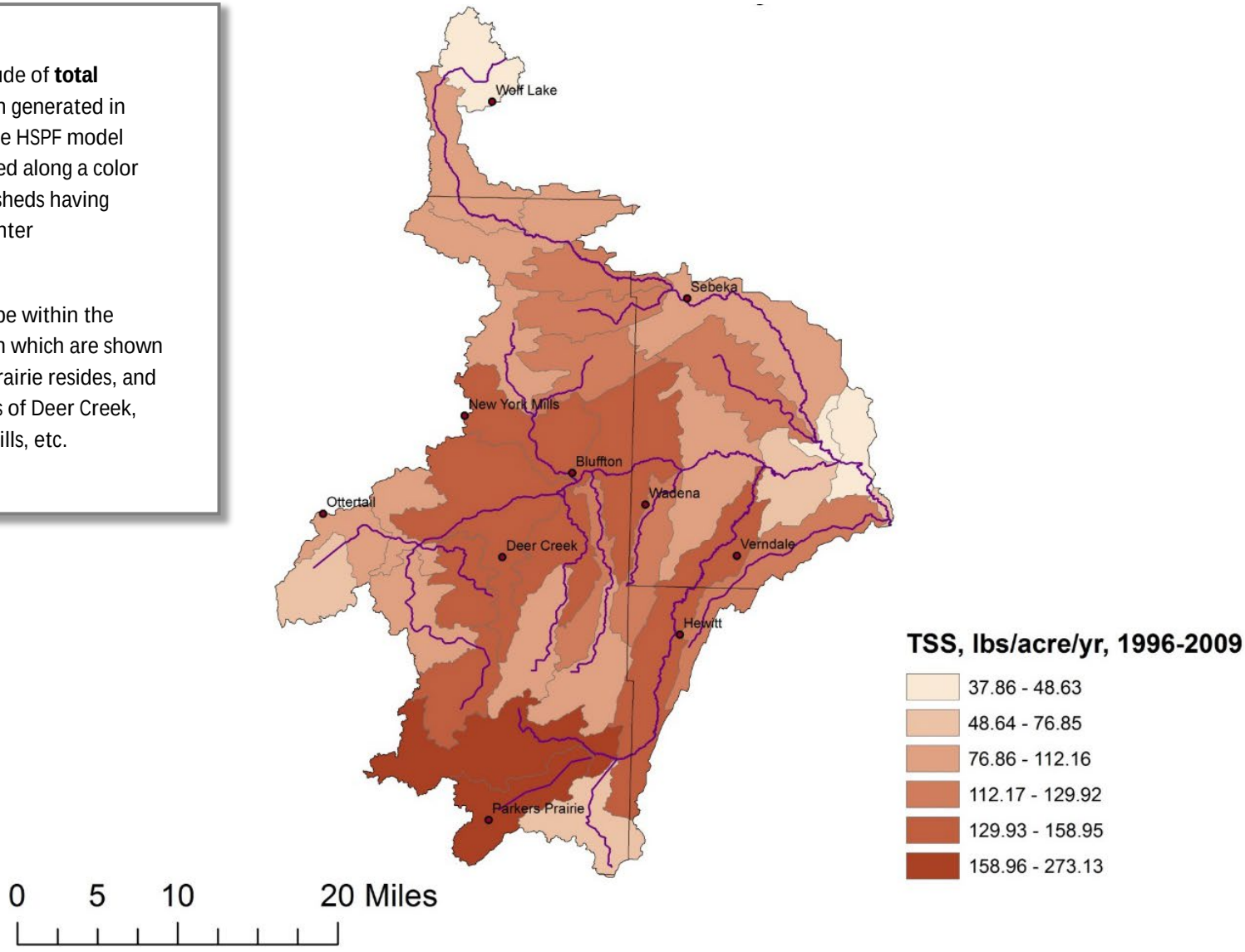


Figure 3. Redeye River Watershed HSPF Subwatershed Total Suspended Solids Loads (pounds/acre/year).

Appendix A Maps and Tools to Target Restoration and Protection Strategies

This map illustrates the magnitude of **overland runoff** in each subwatershed based on the HSPF model results. Subwatersheds are coded along a color gradient, with more blue subwatersheds having greater runoff than more green subwatersheds.

The areas of primary focus will be within the regions of highest concentration which are shown in dark blue, near Hewitt, Verndale, Wadena, and Bluffton, and in the lesser dark blue regions.

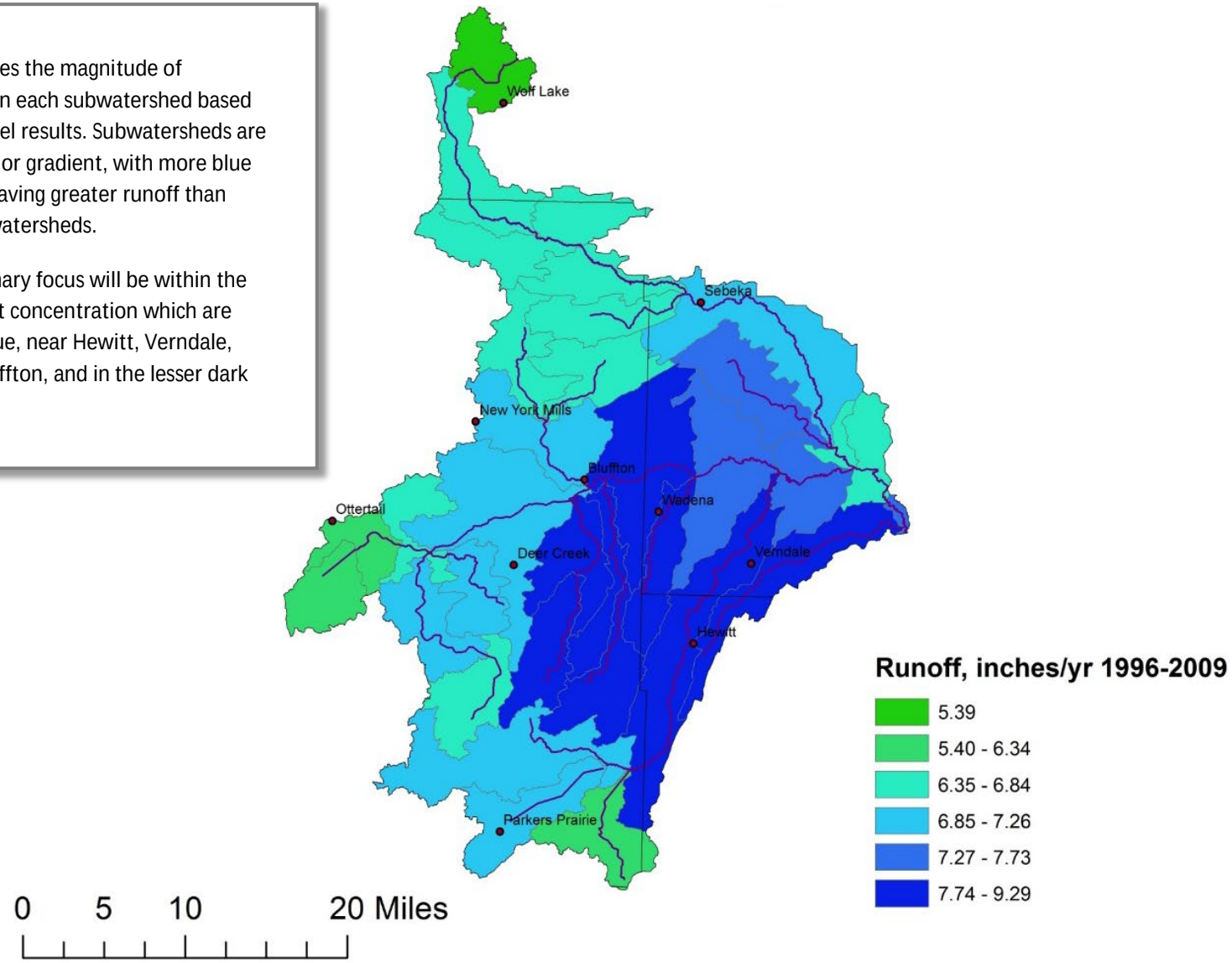


Figure 4. Redeye River Watershed HSPF Subwatershed Overland Runoff Volume (inches/year).

Appendix A Maps and Tools to Target Restoration and Protection Strategies

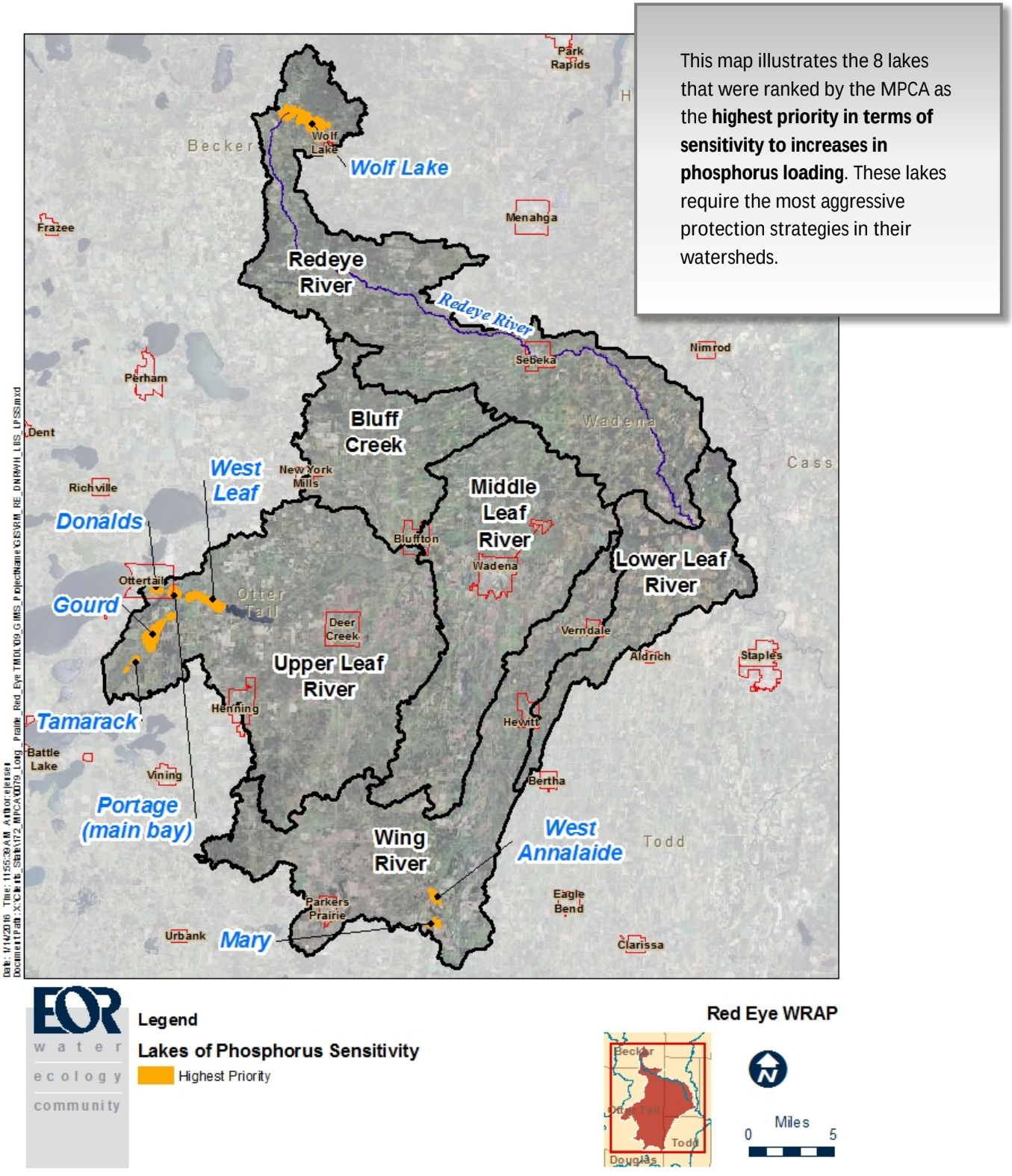
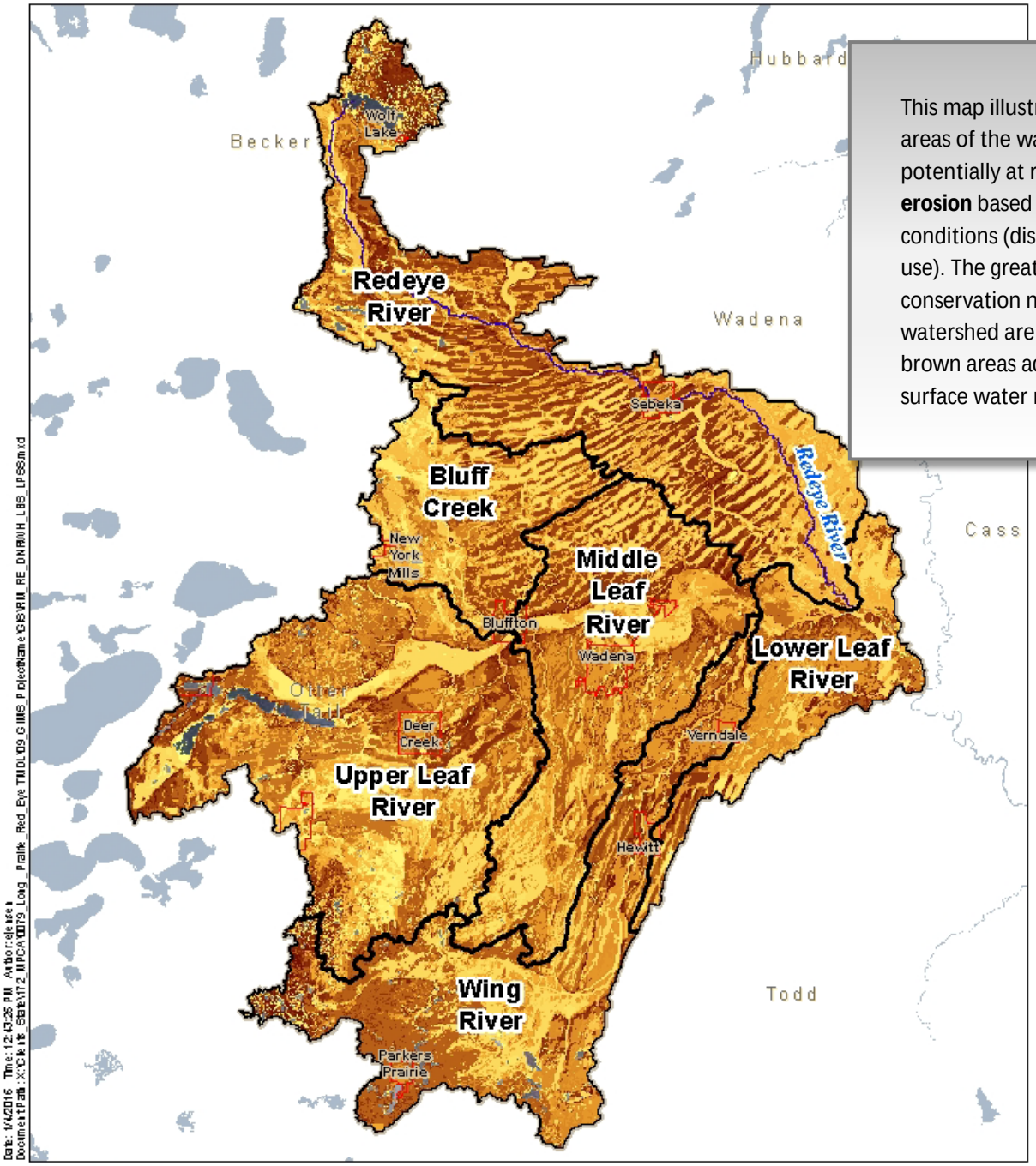


Figure 5. Redeye River Watershed Lakes of Phosphorus Sensitivity.

Appendix A Maps and Tools to Target Restoration and Protection Strategies



This map illustrates the areas of the watershed potentially at risk for **soil erosion** based on bare soil conditions (disregards land use). The greatest conservation needs in the watershed are the dark brown areas adjacent to surface water resources.

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EOR water ecology community

Legend

BWSR Ecological Ranking Tool Soil Erosion

Value

High Risk: 100

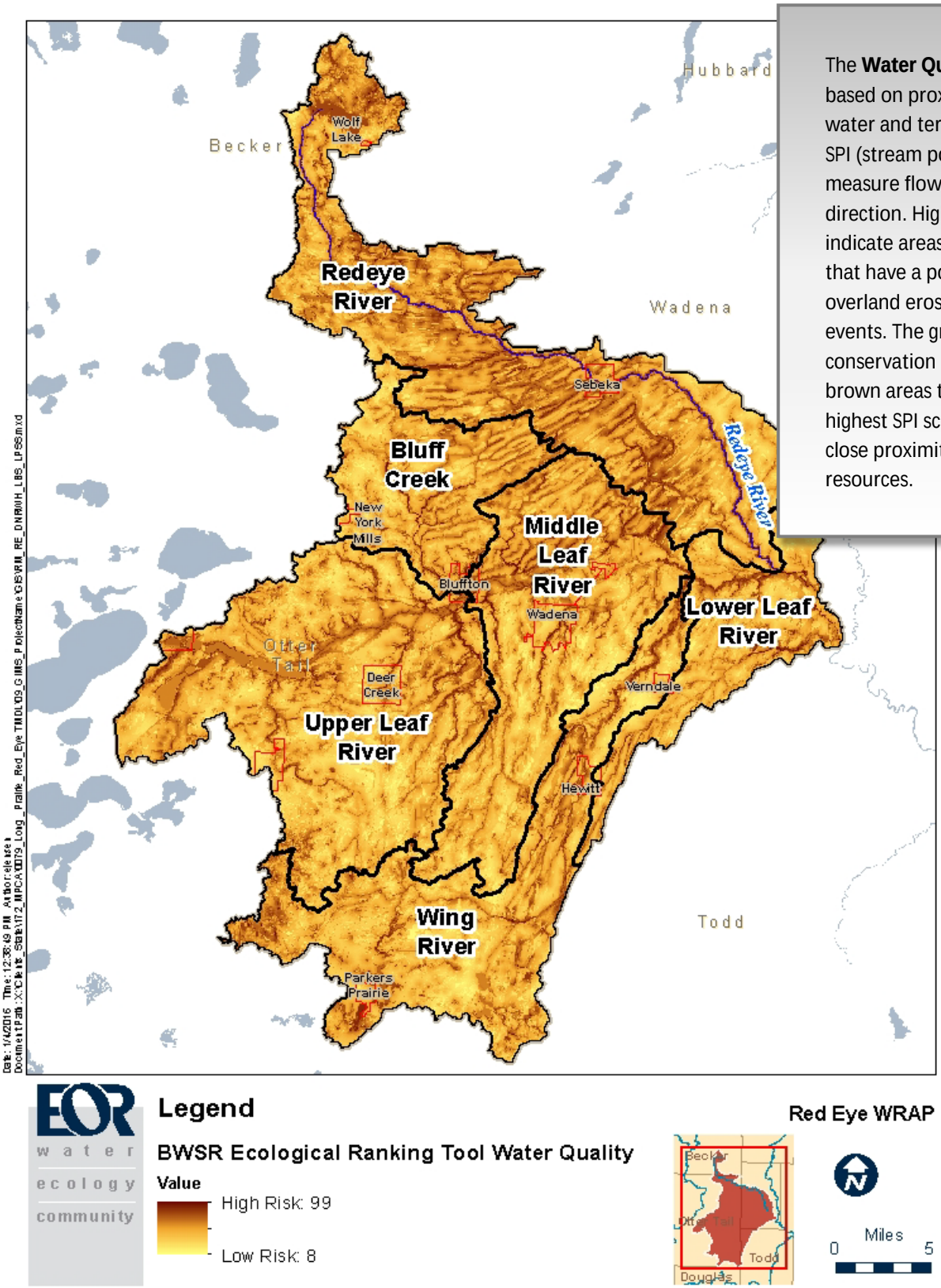
Low Risk: 0

Red Eye WRAP

Miles

0 5

Figure 6. Redeye River Watershed Predicted Soil Erosion Risk.



The **Water Quality** layer is based on proximity to surface water and terrain attributes or SPI (stream power index) that measure flow accumulation and direction. High SPI values indicate areas on the landscape that have a potential for overland erosion during runoff events. The greatest conservation needs are the dark brown areas that have the highest SPI scores and are in close proximity to water resources.

Figure 7. Redeye River Watershed Water Quality Degradation Risk.

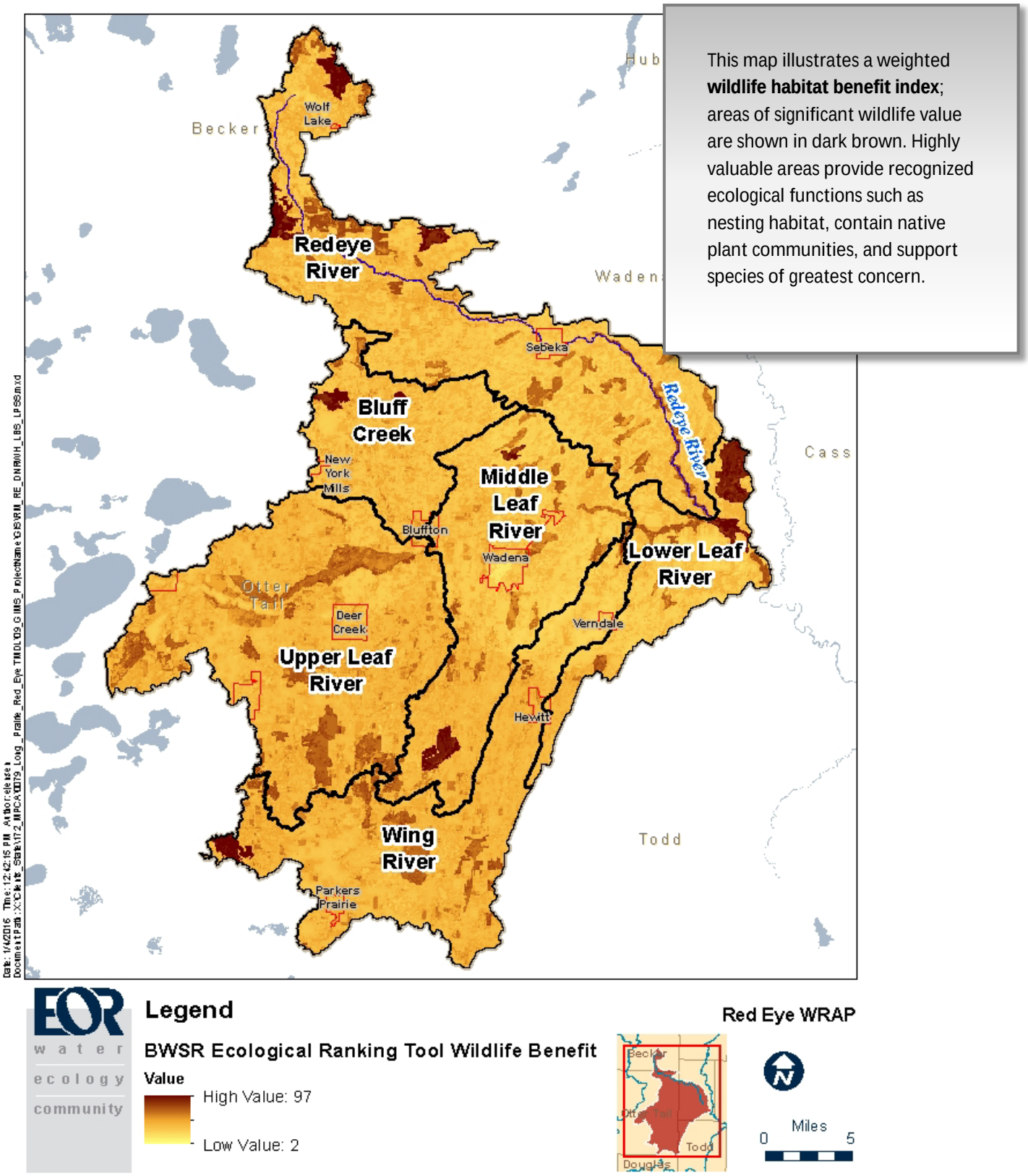
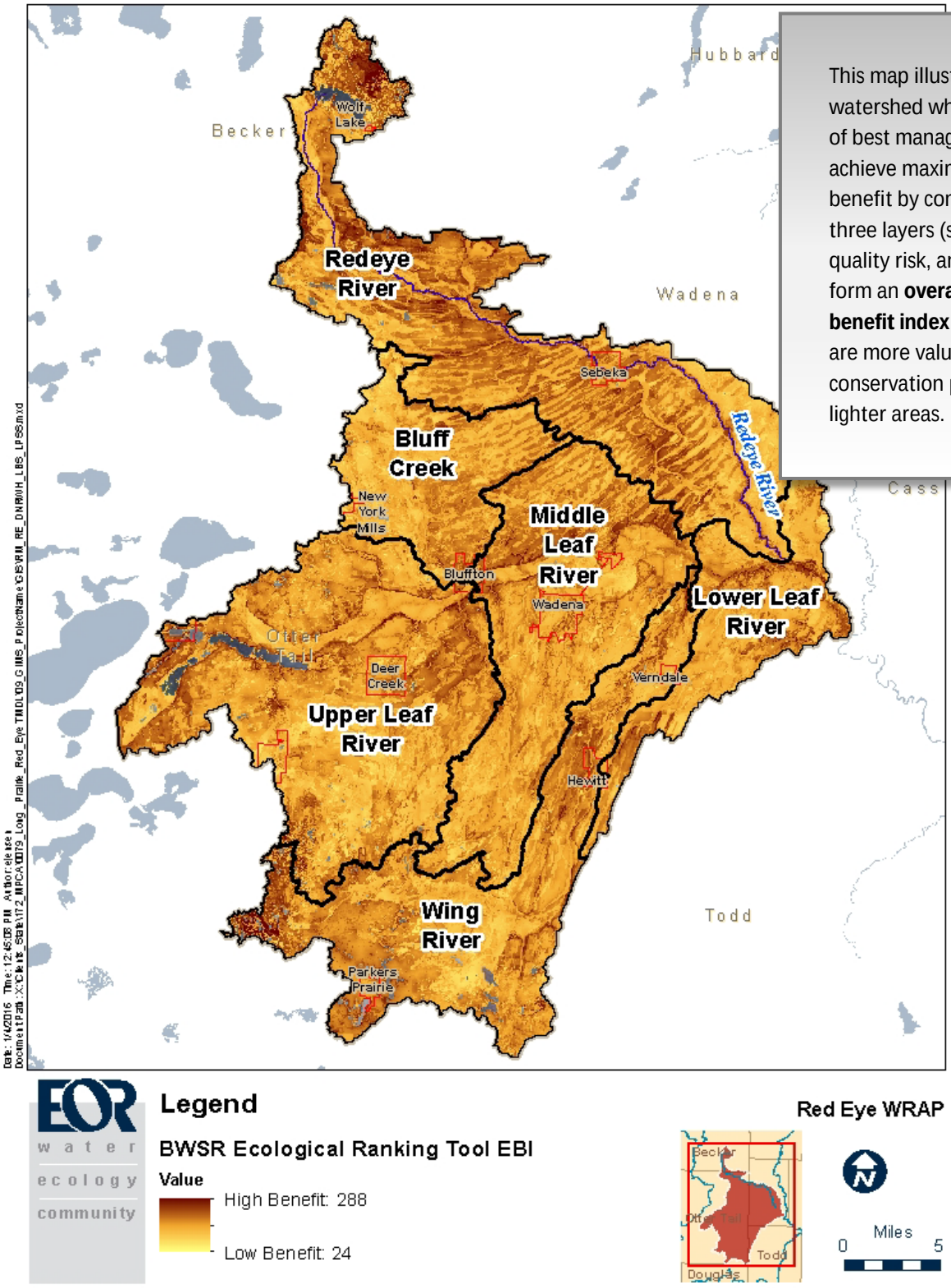


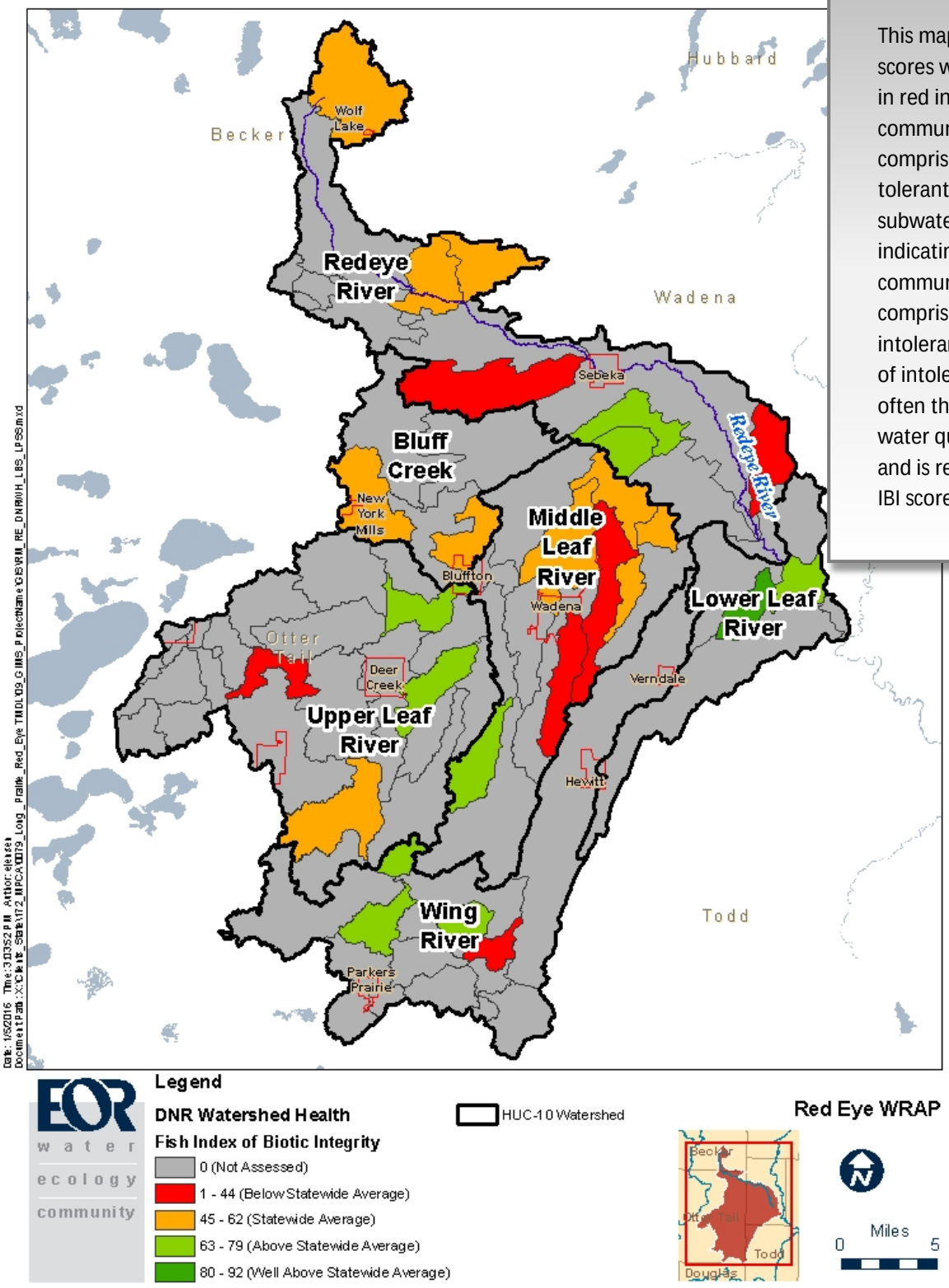
Figure 8. Redeye River Watershed Wildlife Habitat Benefit Index.



This map illustrates areas within the watershed where implementation of best management practices will achieve maximum ecological benefit by combining the previous three layers (soil erosion risk, water quality risk, and wildlife benefit) to form an **overall environmental benefit index (EBI)**. Darker areas are more valuable from a conservation perspective than lighter areas.

Figure 9. Redeye River Watershed Environmental Benefit Index.

Appendix A Maps and Tools to Target Restoration and Protection Strategies



This map illustrates FIBI scores with subwatersheds in red indicating fish communities that are comprised of pollutant tolerant species and subwatersheds in green indicating fish communities that are comprised of pollutant intolerant species. The loss of intolerant species is often the direct result of water quality degradation and is reflected in the fish IBI scores.

Figure 10. Redeye River Watershed Fish Index of Biotic Integrity.

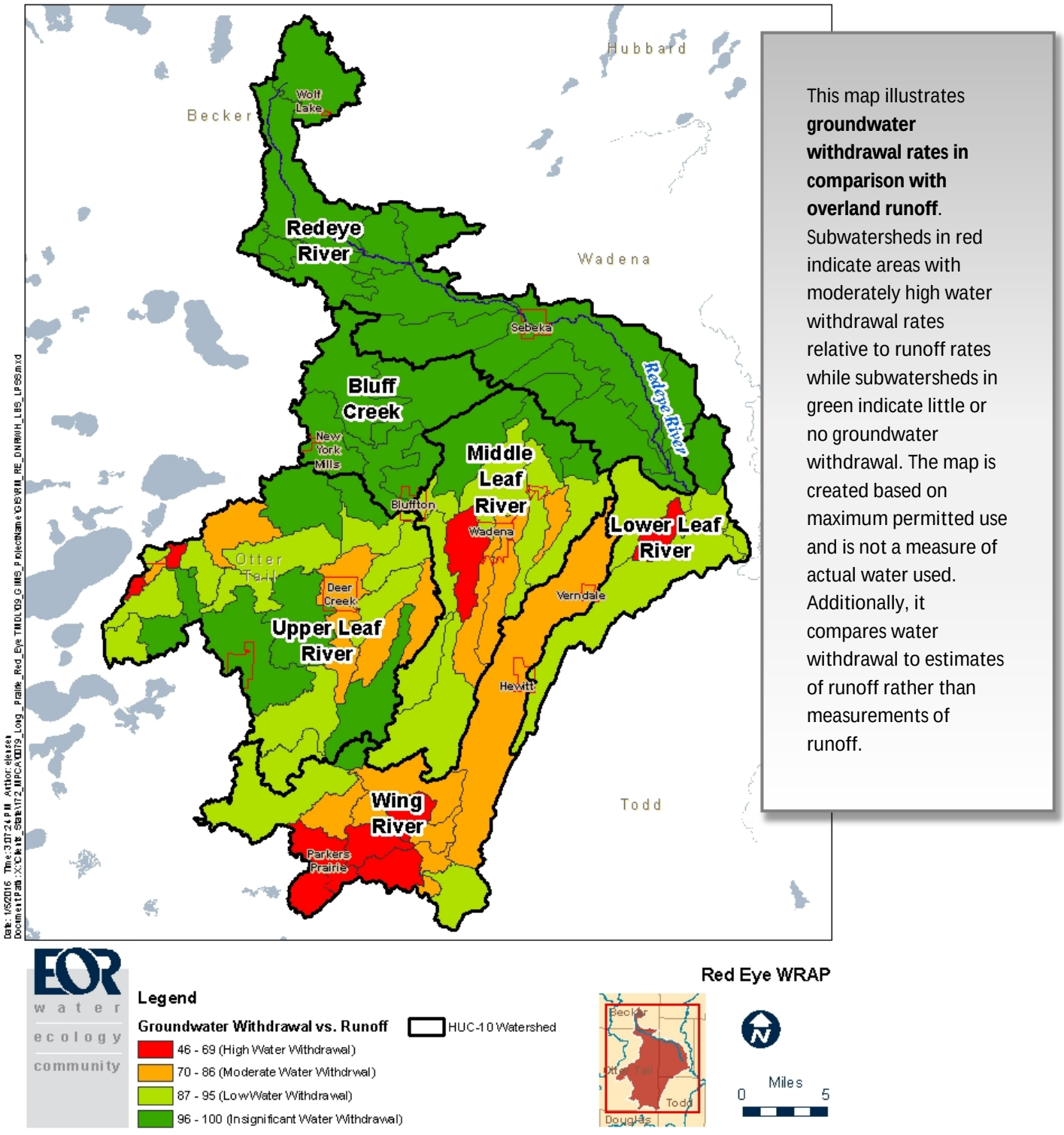


Figure 11. Redeye River Watershed Groundwater Withdrawal Comparison.

Appendix A Maps and Tools to Target Restoration and Protection Strategies

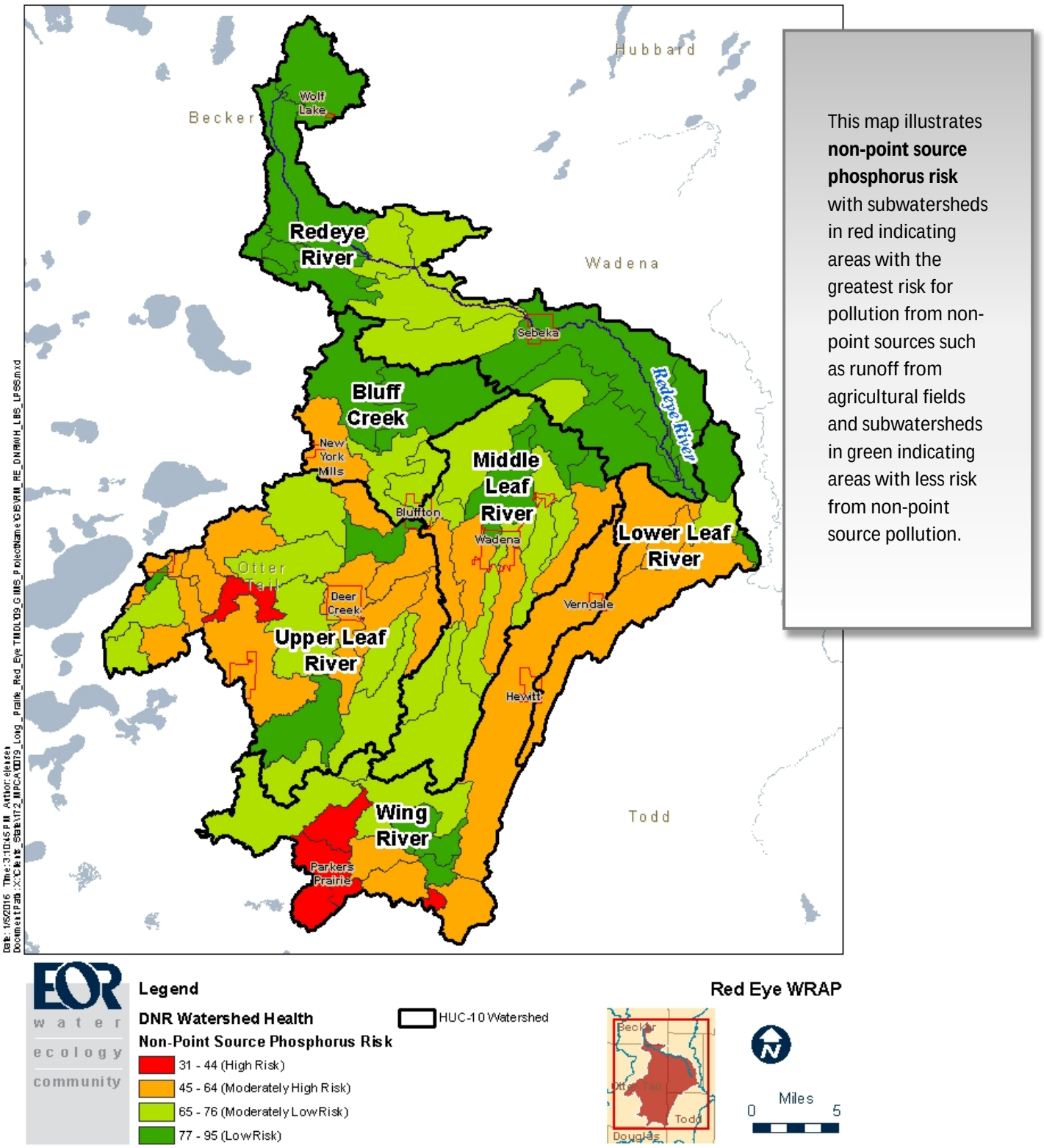
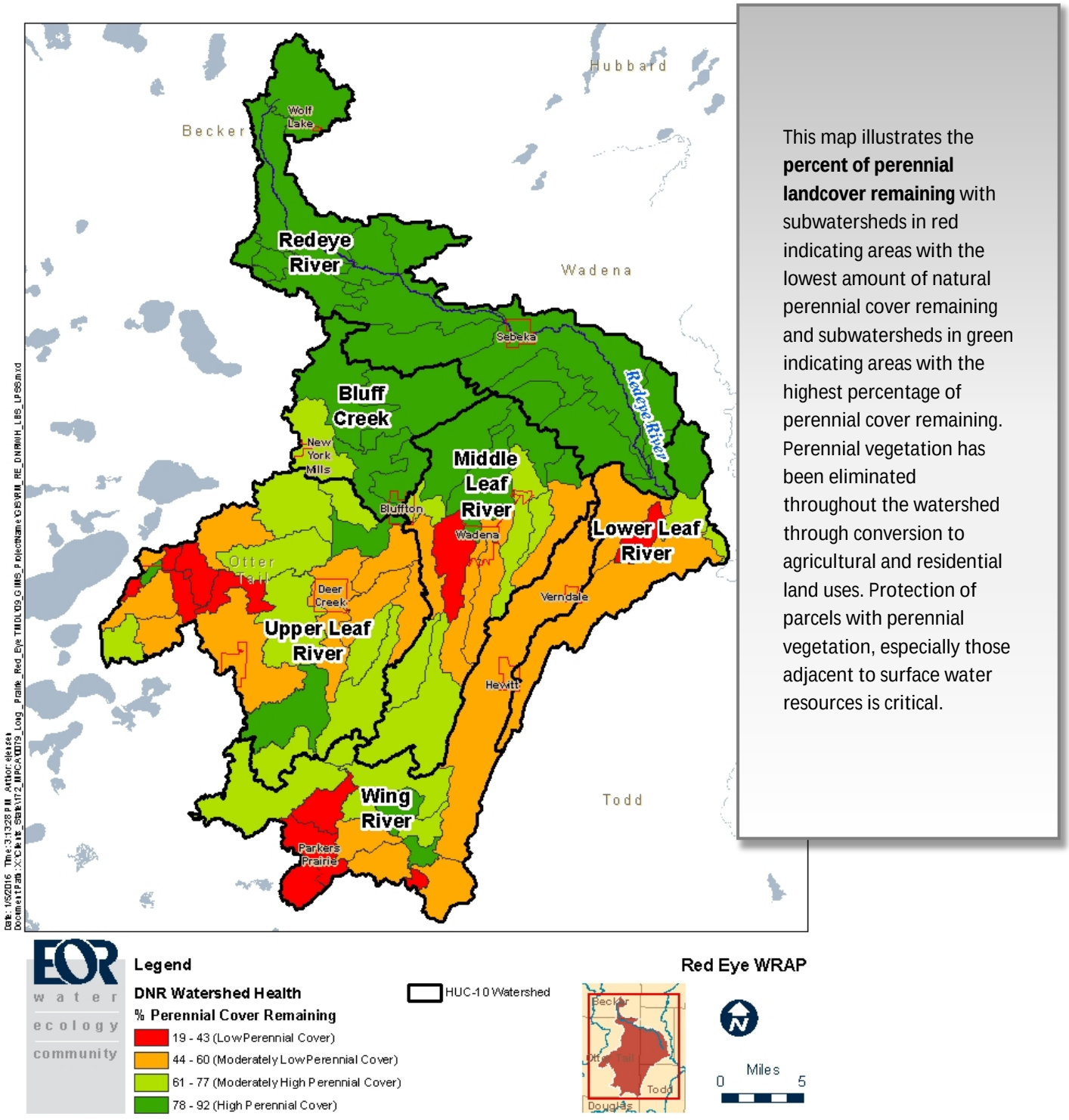
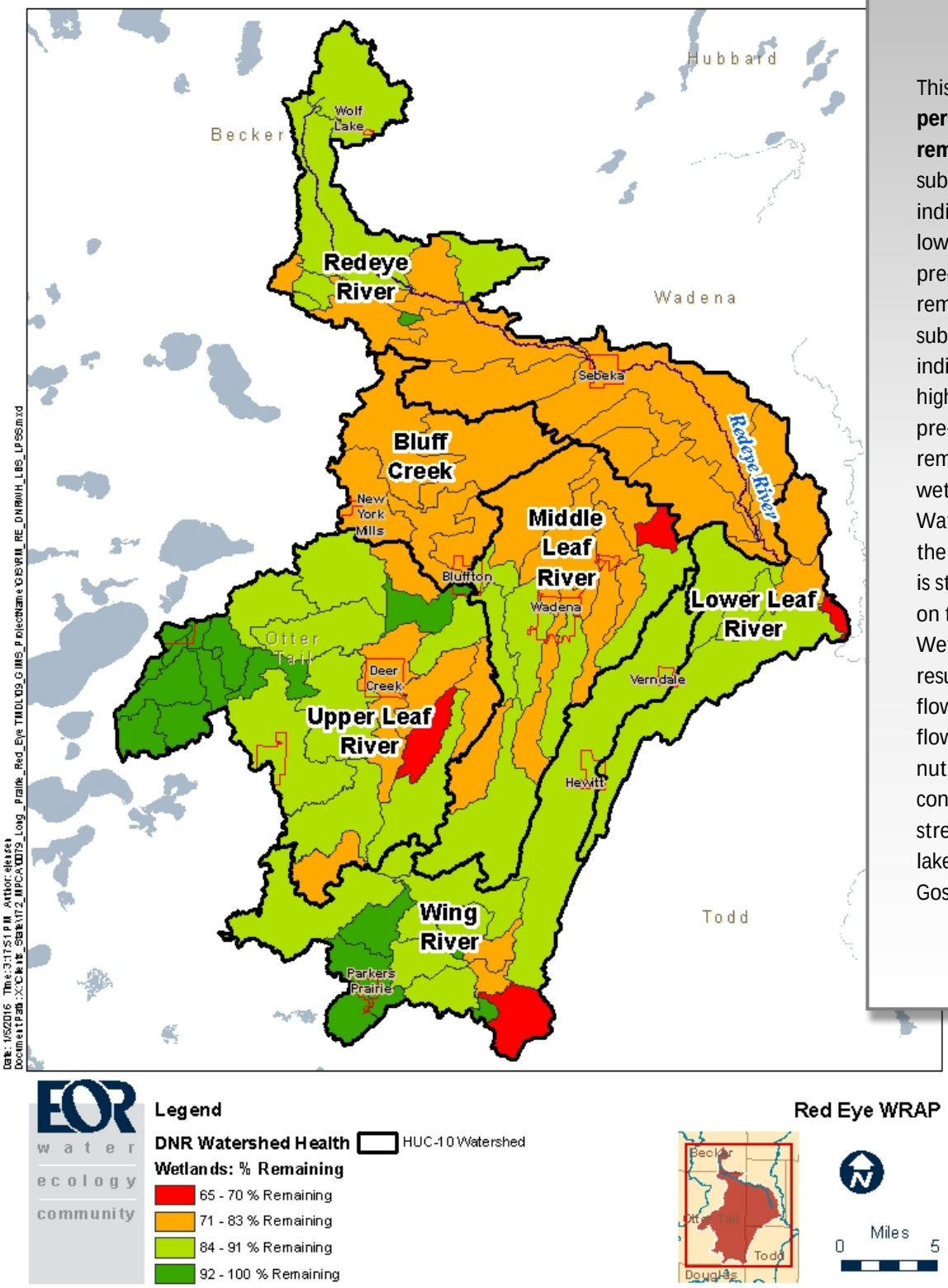


Figure 12. Redeye River Watershed Non-Point Source Phosphorus Risk.



This map illustrates the **percent of perennial landcover remaining** with subwatersheds in red indicating areas with the lowest amount of natural perennial cover remaining and subwatersheds in green indicating areas with the highest percentage of perennial cover remaining. Perennial vegetation has been eliminated throughout the watershed through conversion to agricultural and residential land uses. Protection of parcels with perennial vegetation, especially those adjacent to surface water resources is critical.

Figure 13. Redeye River Watershed Perennial Landcover Remaining.



This map illustrates the **percent of wetlands remaining** with subwatersheds in red indicating areas with the lowest percentage of pre-settlement wetlands remaining and subwatersheds in green indicating areas with the highest percentage of pre-settlement wetlands remaining. The loss of wetlands in the Redeye Watershed has affected the way in which water is stored and released on the landscape. Wetland loss most often results in increased peak flows and lower base flows, and increased nutrient and sediment concentrations in streams, rivers, and lakes (Mitch and Gosselink, 2007).

Figure 14. Redeye River Watershed Remaining Wetlands.

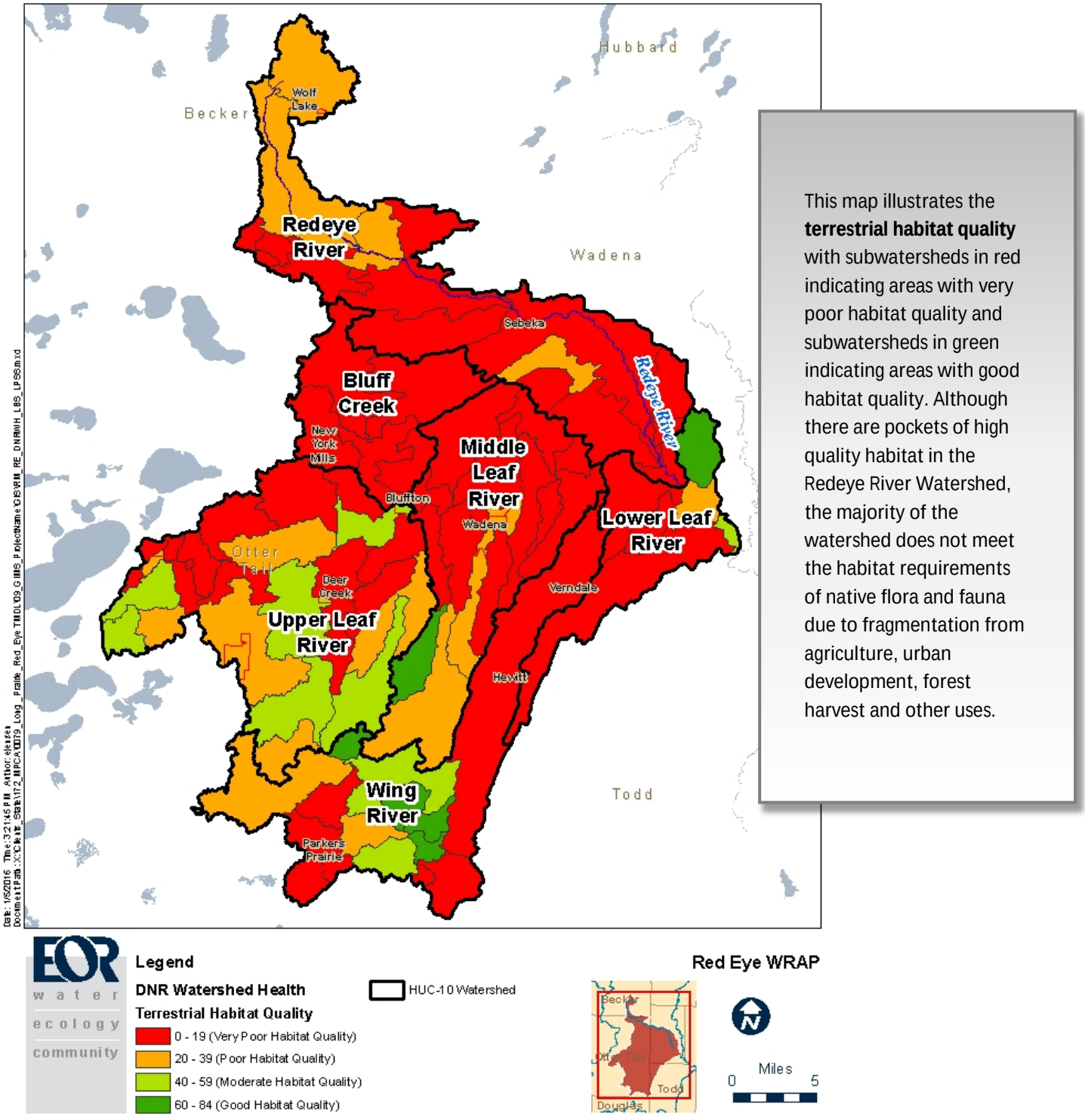
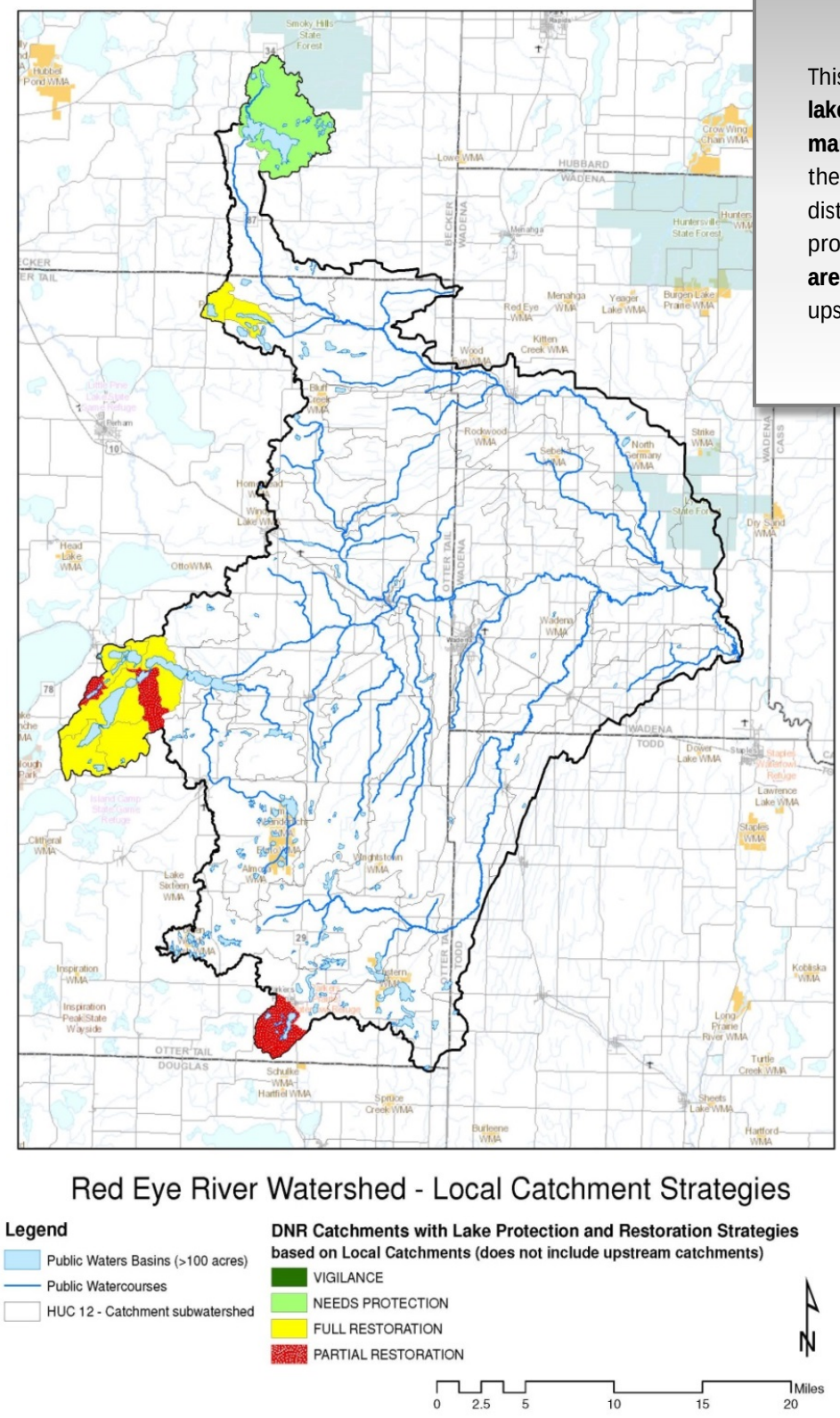


Figure 15. Redeye River Watershed Terrestrial Habitat Quality.

Appendix A Maps and Tools to Target Restoration and Protection Strategies



This map illustrates **DNR fisheries lake protection and restoration management categories** based on the degree of watershed disturbance and watershed protection in the **direct drainage area** of the lake (does not include upstream catchments).

Figure 16. Redeye River Watershed Lake Protection and Restoration Strategies Based on Local Catchments.

Appendix A Maps and Tools to Target Restoration and Protection Strategies

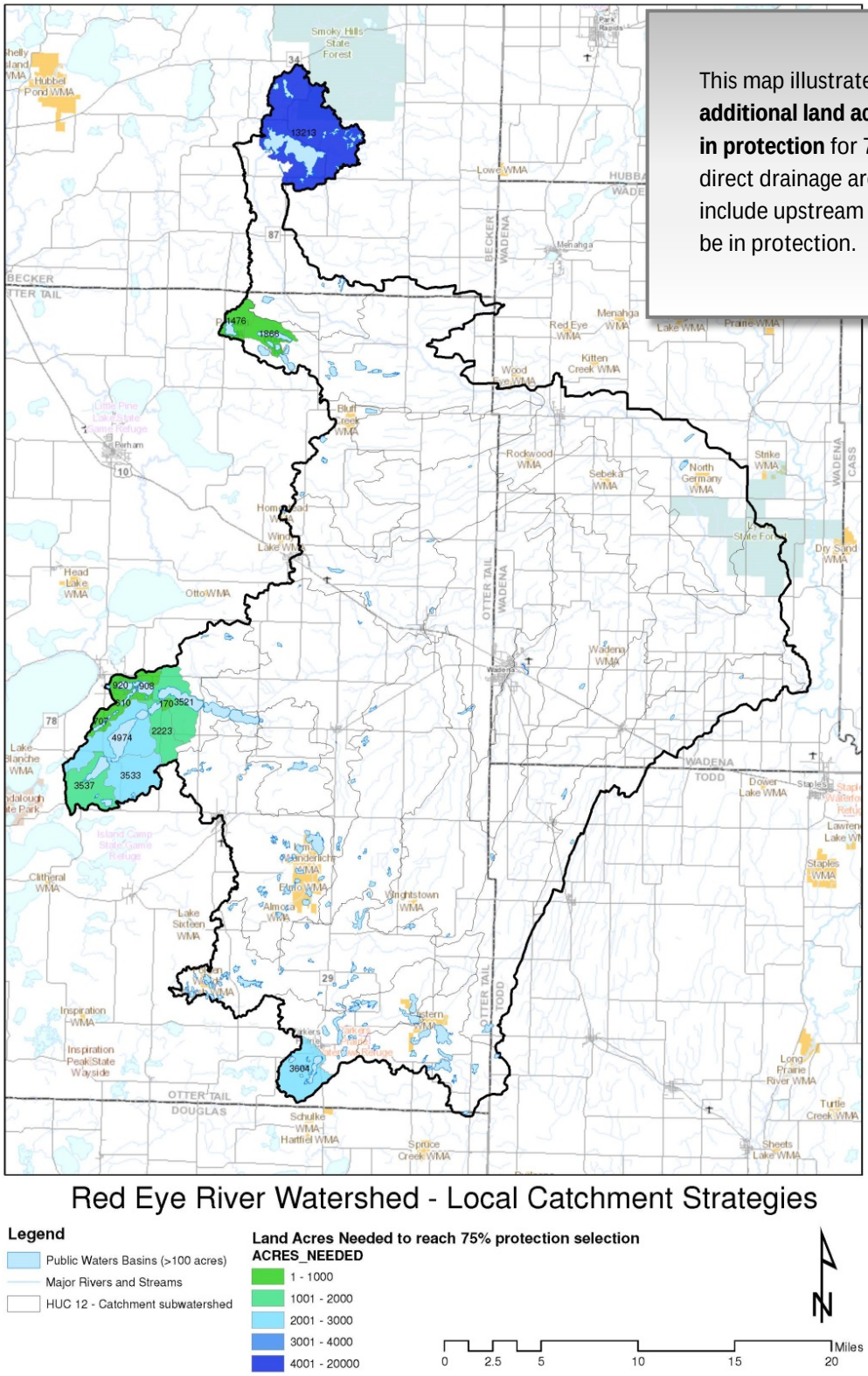


Figure 17. Redeye River Watershed Land Acres Needed to Reach 75% Protection.

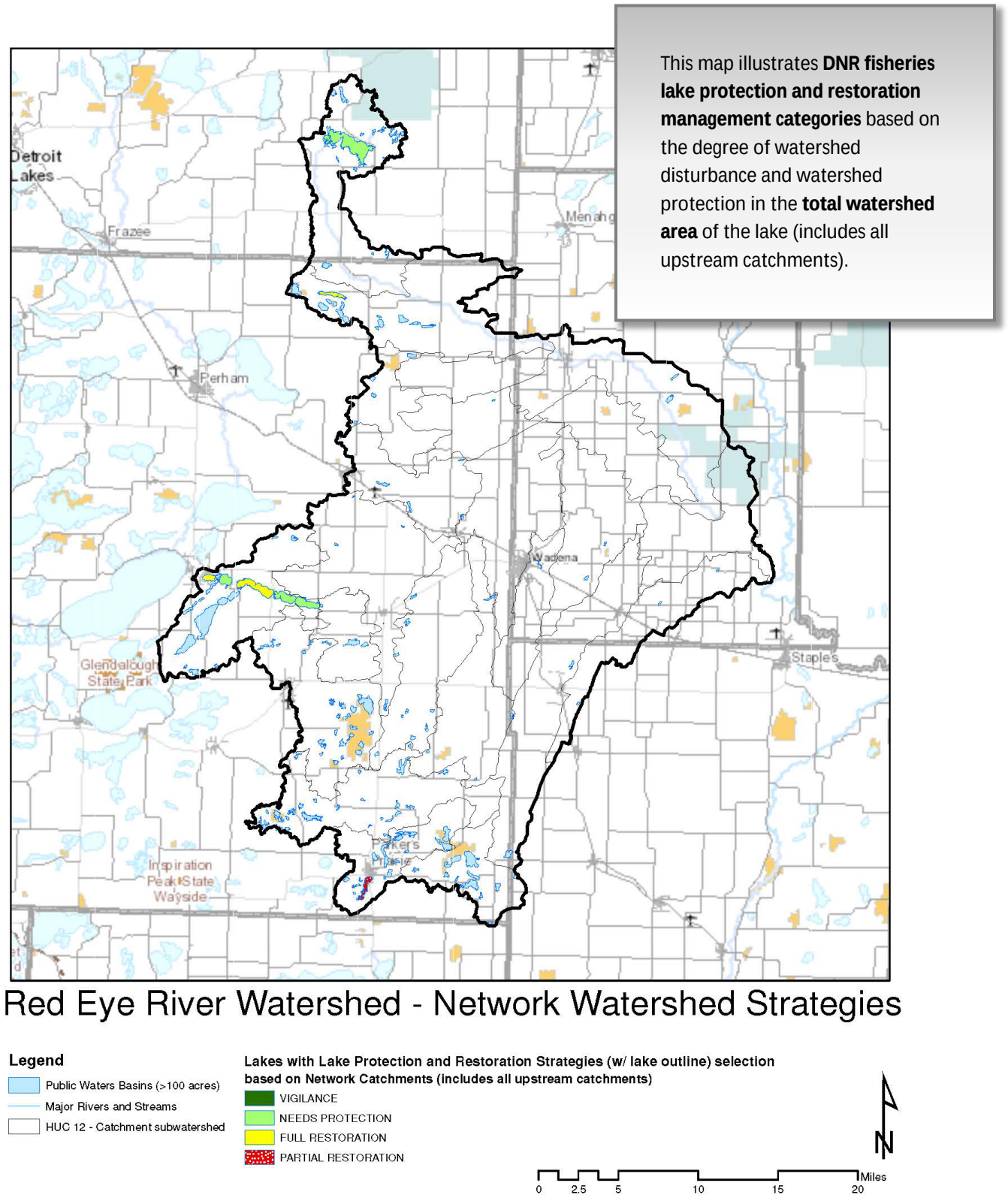


Figure 18. Redeye River Watershed Lake Protection and Restoration Strategies Based on Network Catchments.

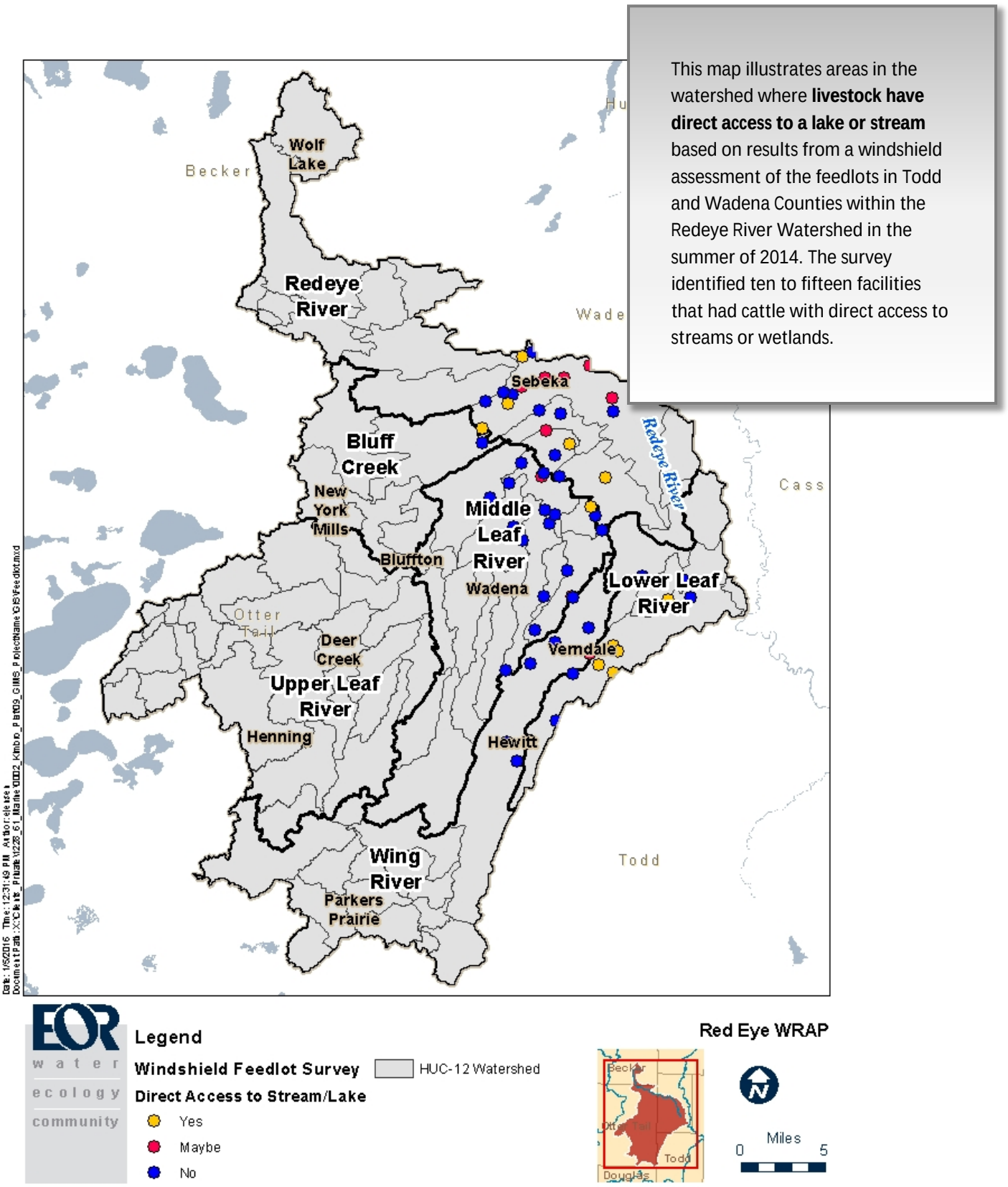
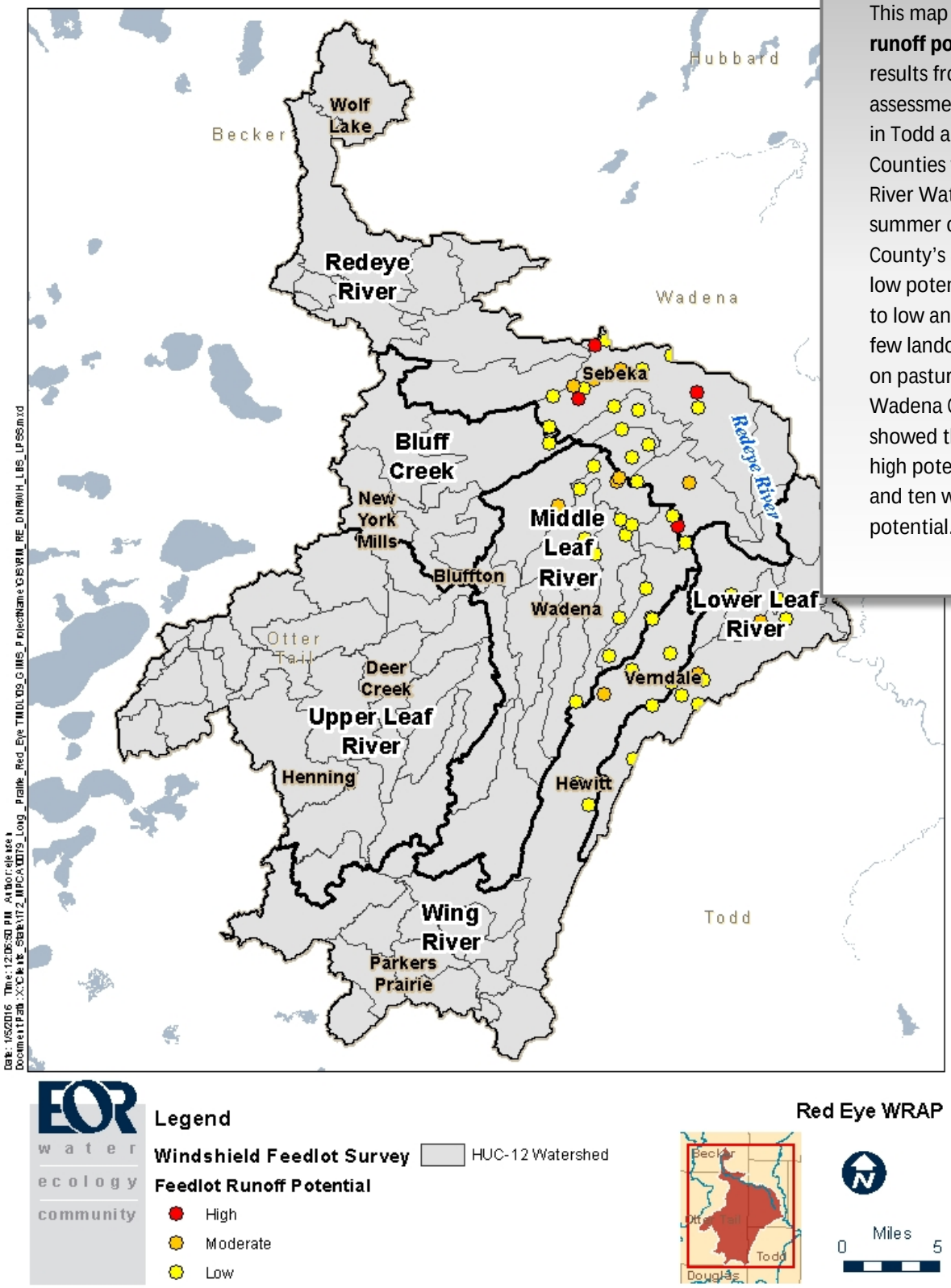


Figure 19. Redeye River Watershed Feedlots with Direct Access to Water Resources.



This map illustrates **feedlot runoff potential** based on results from a windshield assessment of the feedlots in Todd and Wadena Counties within the Redeye River Watershed in the summer of 2014. Todd County's analysis showed low potential for runoff due to low animal units and a few landowners with cattle on pasture at the time. Wadena County's analysis showed three facilities with high potential for runoff and ten with moderate potential.

Figure 20. Redeye River Watershed Feedlots with High Runoff Potential.

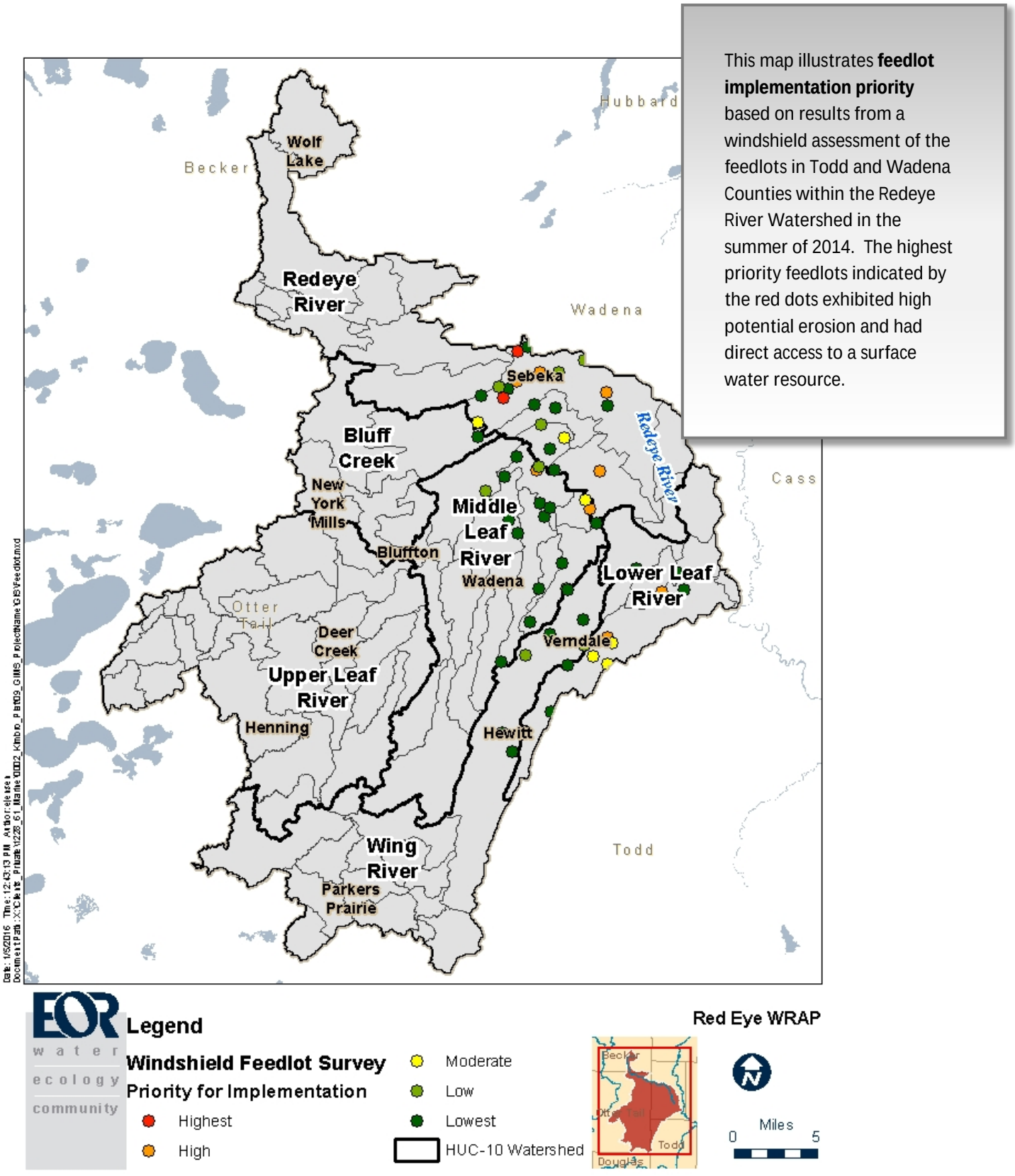


Figure 21. Redeye River Watershed Feedlots BMP Implementation Priority.

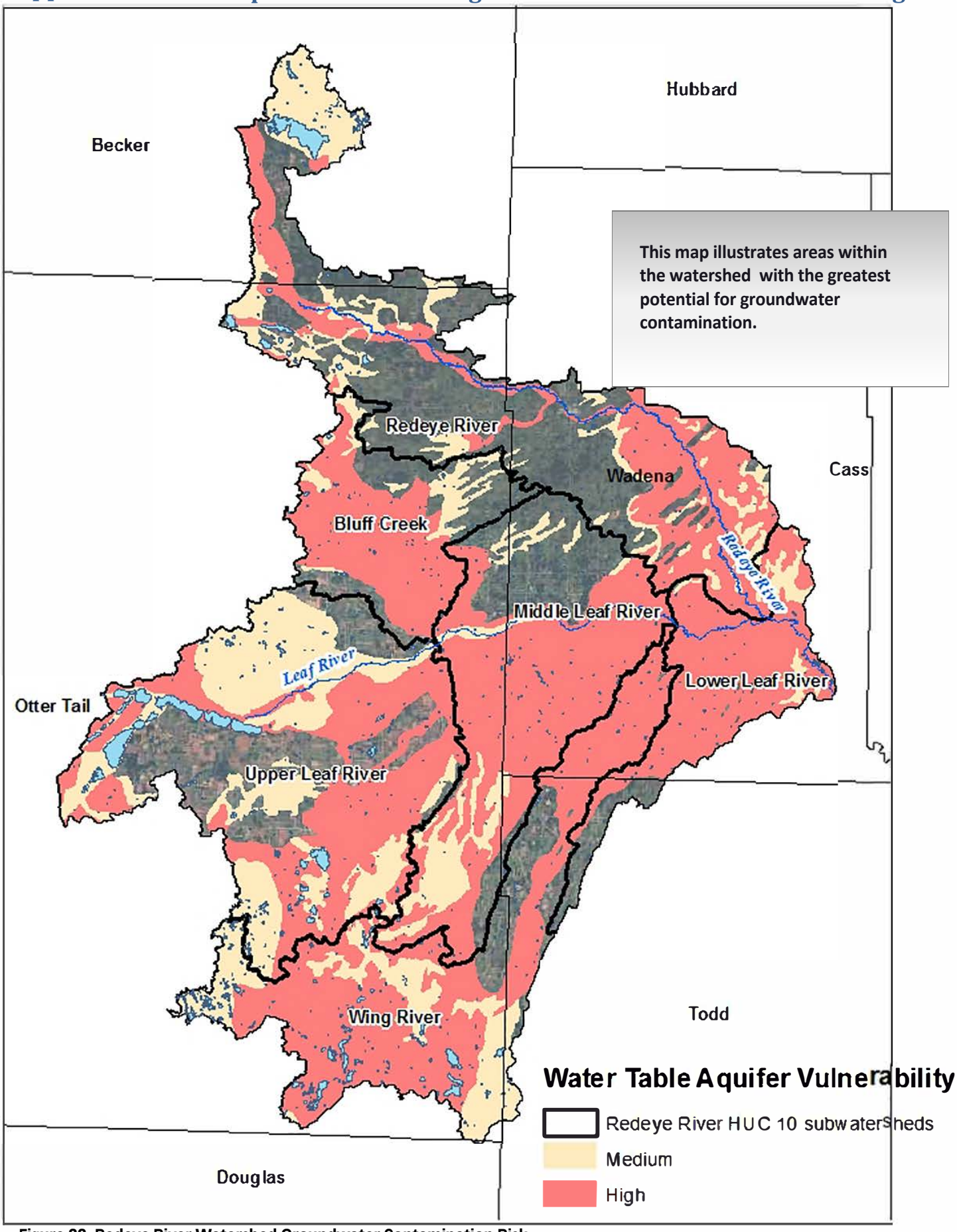


Figure 22. Redeye River Watershed Groundwater Contamination Risk.