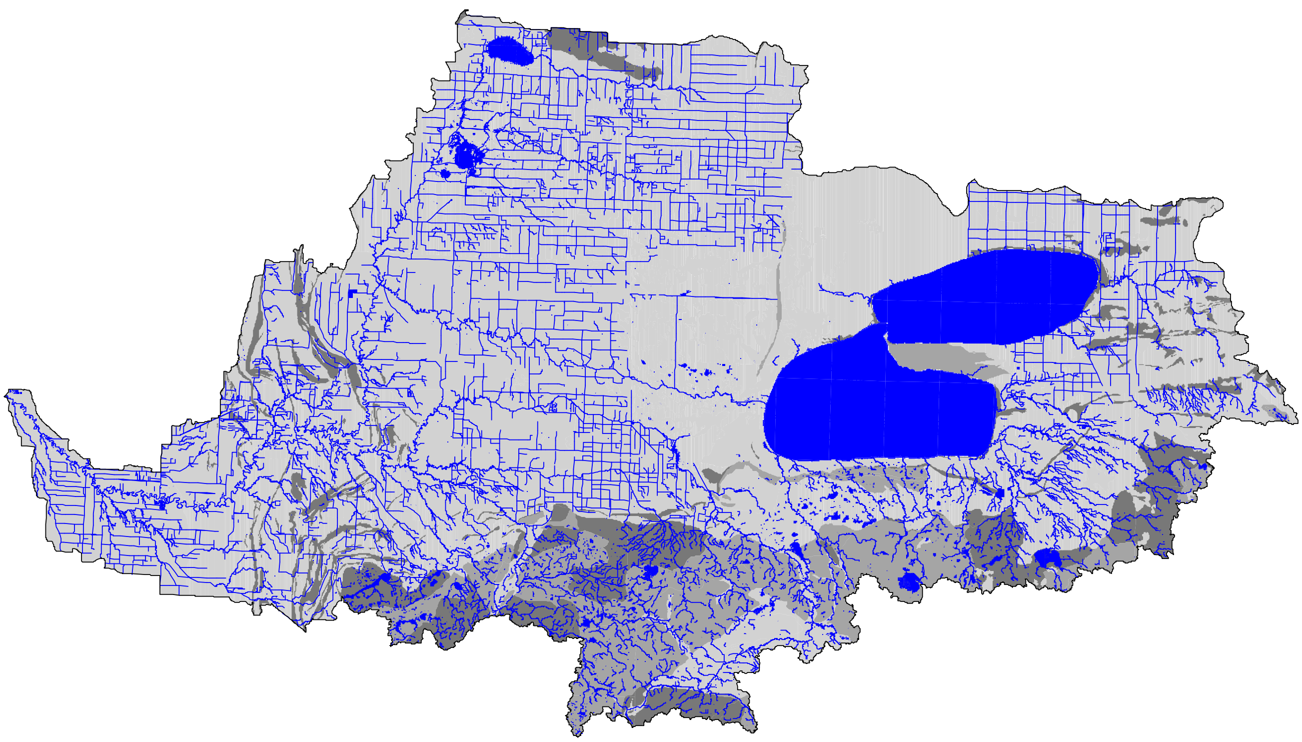
Red River Basin Stream Survey Report

Red Lake River Watershed 2004



Thomas P. Groshens

Minnesota Department of Natural Resources

Division of Fish and Wildlife

NW Region, Bemidji, MN

2005

Table Of Contents

List of Figures

List of Tables

Table | Page

List of Tables: Appendix A
Mean annual discharge data from USGS gaging stations

List of Tables: Appendix B
Fish species of the Red Lake River watershed

List of Tables: Appendix C
Fish data summary tables

List of Tables: Appendix D

Fish Index of Biotic Integrity Results

Table | Page

List of Tables: Appendix D

IBI scores from previous investigations on tributary streams to Red River

Table | Page

INTRODUCTION

The Red River of the North basin (Red River Basin) is a unique North American landscape with diverse terrestrial and aquatic natural resources. Since settlement, the landscape has been managed primarily to increase agricultural production (Stoner et al. 1993). The impacts of flooding have been a concern in Red River Basin since the early 1800's (Red River Basin Flood Damage Reduction Work Group Agreement 1998). Projects intended to lessen the impacts of flooding on agricultural lands, homes and properties have resulted in extensive development of drainage systems, modification of existing natural stream channels, and installation of various other "flood control" measures. These watershed-level changes have altered the natural hydrology and changed ecosystem function, which has generally reduced the quality of natural resources. Concern over the potential cumulative environmental effects of proposed flood control projects prompted an Environmental Impact Statement (EIS). The EIS was released in 1996 and disagreement over the outcome eventually led to the Minnesota Legislature funding a "mediation" process to resolve disputed issues. The product of this process was a 1998 agreement that details a new watershed-based management framework for both flood Damage reduction and natural resource enhancement in Red River Basin.

According to the mediation agreement, comprehensive watershed management plans that integrate flood damage reduction and natural resource enhancement are to be developed by each watershed district. Sound goals with measurable objectives will be needed for these plans. The present condition of resources must be known in order to develop and evaluate progress toward achieving natural resource enhancement goals and objectives. However, information necessary to describe present conditions exists on few streams in Red River Basin. In response to this lack of data, the fisheries management section of the Minnesota Department of Natural Resources (MN DNR) proposed watershed-level stream sampling for streams found within the Watershed Districts that were initiating new, or updating existing, watershed plans.

This report presents the results of sampling efforts conducted in the year 2004 in streams and waterways that lie within the portion of the Red Lake River watershed that is managed by the Red Lake River Watershed District, Minnesota that are located downstream of Lower Red Lake. Specifically this report describes the landscape setting, presents and discusses the results of current sampling, identifies factors impacting aquatic resources and outlines potential strategies to improve the condition of stream resources within the Red Lake River watershed downstream of Lower Red Lake and outside of the Red Lake Indian Reservation.

Watershed Description

Location and Size

The Red Lake River watershed (RLR watershed) is located in the north-central part of the Red River Basin in northwest Minnesota (Figure 1). The RLR watershed covers approximately 5,756 square miles, which makes it the second largest tributary watershed to the Red River of the North (Red River) and the largest tributary watershed located in Minnesota. Portions of the watershed lie within nine different counties (Figure 2).

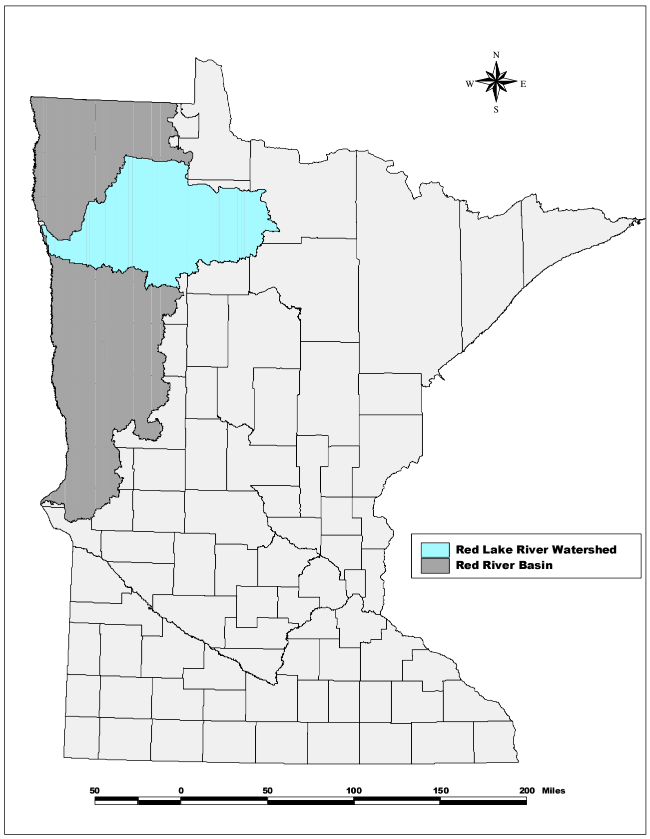


Figure 1. Location of the Red Lake River watershed in Minnesota.

The RLR watershed can be divided into four distinct subwatersheds: the Upper/Lower Red Lake subwatershed, the Clearwater River subwatershed, the Thief River subwatershed and the Red Lake River subwatershed. The characteristics of each of these subwatershed is unique and, therefore, the impact that each subwatershed has on Red Lake River and, ultimately, Red River of the North, is also unique.

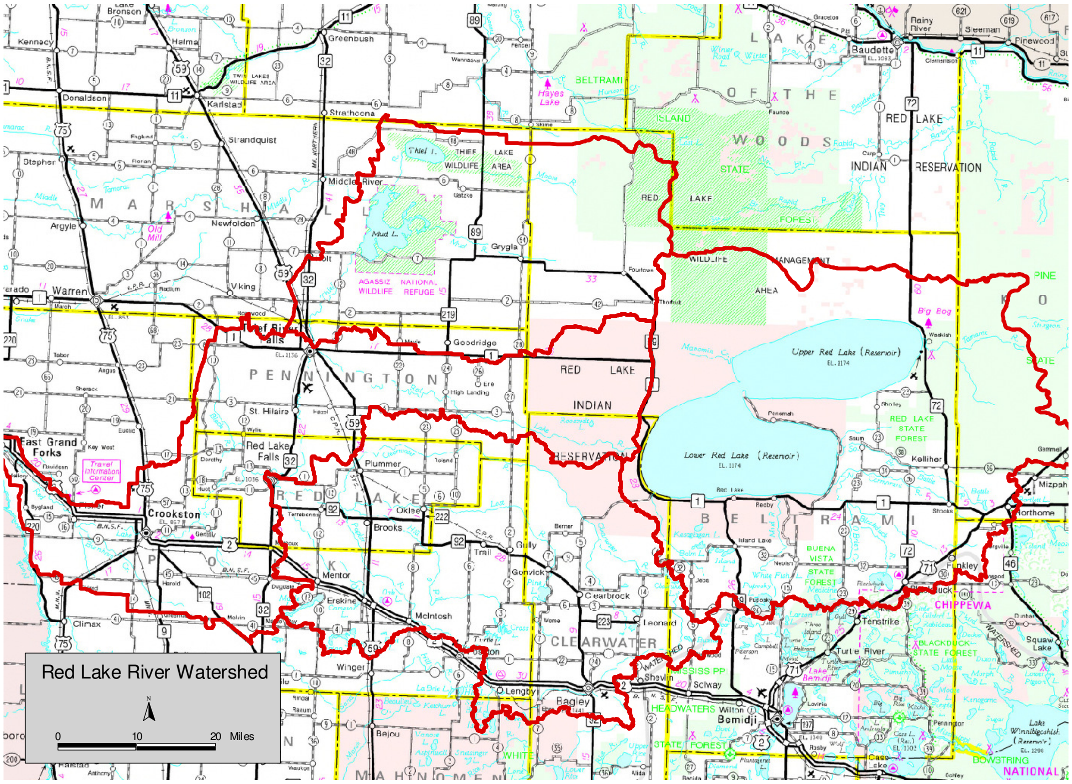


Figure 2. The Red Lake River watershed (outlined in red) overlain on the Minnesota Department of Transportation highway map.

Topography

The Red River Basin was shaped by the Red River Lobe of the Laurentide Ice Sheet, a continental glacier that occurred during the last two stages of the Wisconsin glacial age. Lake Agassiz was formed by the final melting of the continental ice sheet and disappeared from the area approximately 8,500 years ago. When Lake Agassiz receded it modified the surface topography leaving behind remnant lake bottom, beach ridge areas and upland till.

The majority (73%) of the Red Lake River watershed is relatively level (Figure 3, Table 1) and is made up of lacustrine derived materials, formed in the deeper waters of Lake Agassiz, and organic deposits. Rolling, undulating topography, found primarily along the south-central and southeastern edges of the watershed, covers approximately 9% of the watershed (Figure 3, Table 1). Hummocky topography, comprised of glacial till from the Red River Lobe of the glacier covers approximately 10% of the watershed and is found along the south-central edge of the watershed. Beach ridges from Glacial Lake Agassiz are located within an approximately 20 mile wide band ranging east-west from Crookston to Brooks, and north-south from the northern to the southern borders of the watershed.

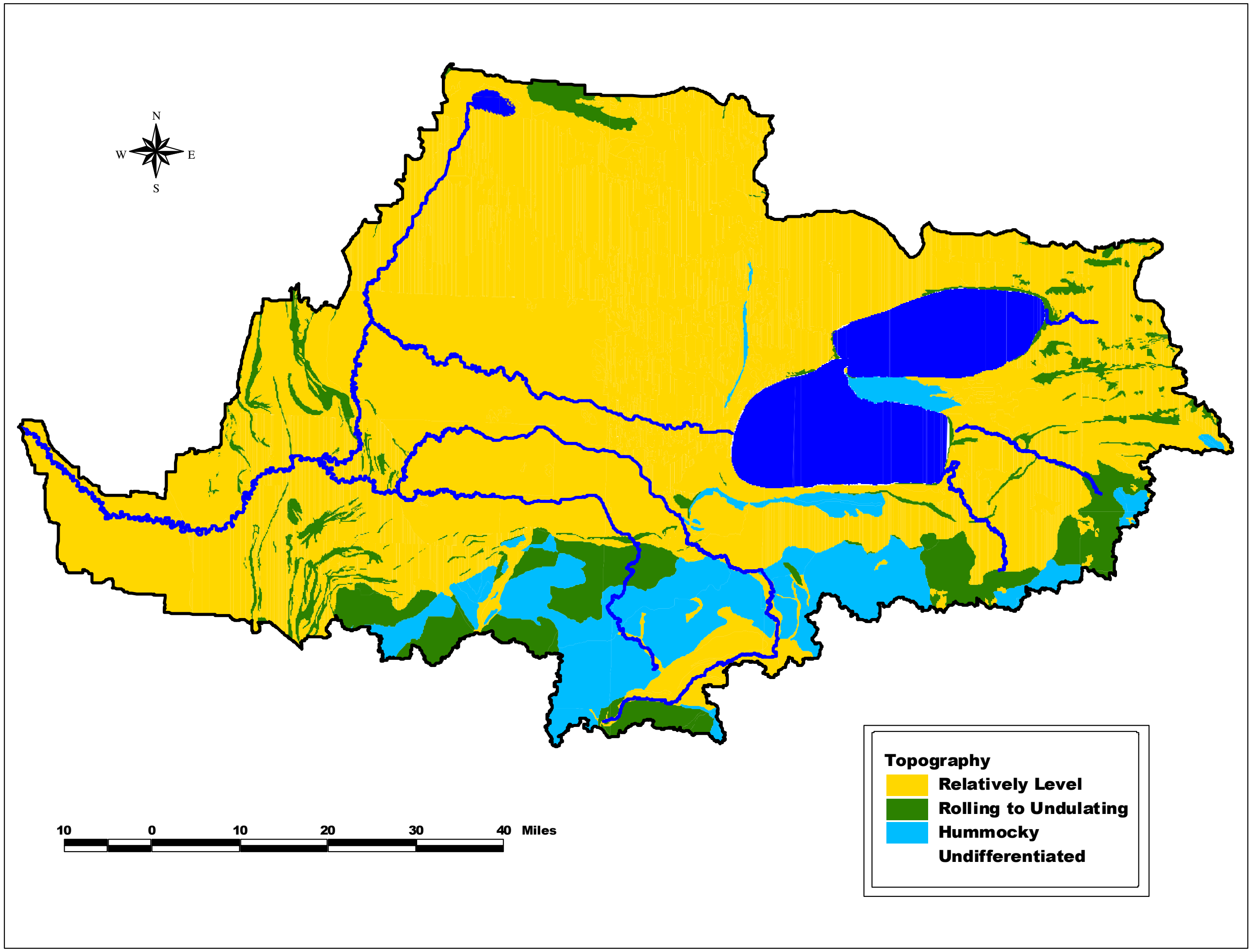


Figure 3. Topographic features of the Red Lake River watershed (MN DNR GIS dataset 2002).

Table 1. Topography of the Red Lake River watershed.

Topography description	**Area (mi^2)**	**Area (acres)**	**Percent of Total**
Hummocky. Includes areas of highly variable relief relative to adjacent topography.	560.6	358,808	9.7
Level. Includes areas of little relief relative to adjacent topography such as lake and outwash plain.	4,209.4	2,694,022	73.1
Rolling to Undulating. Areas exhibiting variable relief over broad reaches including till plains and drumlinized terrain.	542.0	346,860	9.4
Undifferentiated (Upper and Lower Red Lakes)	443.8	284,044	7.7
Total	**5,755.8**	**3,683,734**	**99.9**

Land use/land cover

Land use and cover in the Red Lake River watershed has changed dramatically since the early 1900's. Around the turn of the century, prairie and wet prairie dominated landscape on the western half of the watershed (Figure 4). Today, however, the prairie has been replaced by cultivated land, which now covers 36% of the watershed and relatively few grasslands, approximately 3.3% remain (Table2, Figures 5). Forests still cover a substantial amount of the watershed, 28.7%, primarily in the eastern half of the watershed and adjacent to larger stream segments in the western half. Water and wetlands collectively cover approximately 24.6% of the watershed (Table 2), again, primarily in the eastern half of the watershed (Figure 5). The two largest lakes in Minnesota, Upper and Lower Red lakes, are located in the eastern half of the watershed and the two lakes encompass 284,000 acres, or 7.7% of the watershed area.

Table 2. Land use and land cover in the Red Lake River watershed derived from LandSat data taken in the 1990's (MN DNR GIS dataset 2004).

Land use/ land cover type	**Area (mi^2)**	**Area (ac.)**	**Percent of Total**
Cultivated Land	2,081.0	1,331,860	36.2
Forest	1,649.7	1,055,785	28.7
Wetlands	874.4	559,604	15.2
Water	541.7	346,717	9.4
Grassland	191.7	122,718	3.3
Parks and Recreation	178.4	114,155	3.1
Grassland-shrub-tree	110.9	70,952	1.9
Transitional Agriculture	61.0	39,071	1.1
Other*	67.0	42,858	1.1

Includes: Farmsteads, urban, industrial, mining operations, bare soil and rock, and unclassified.

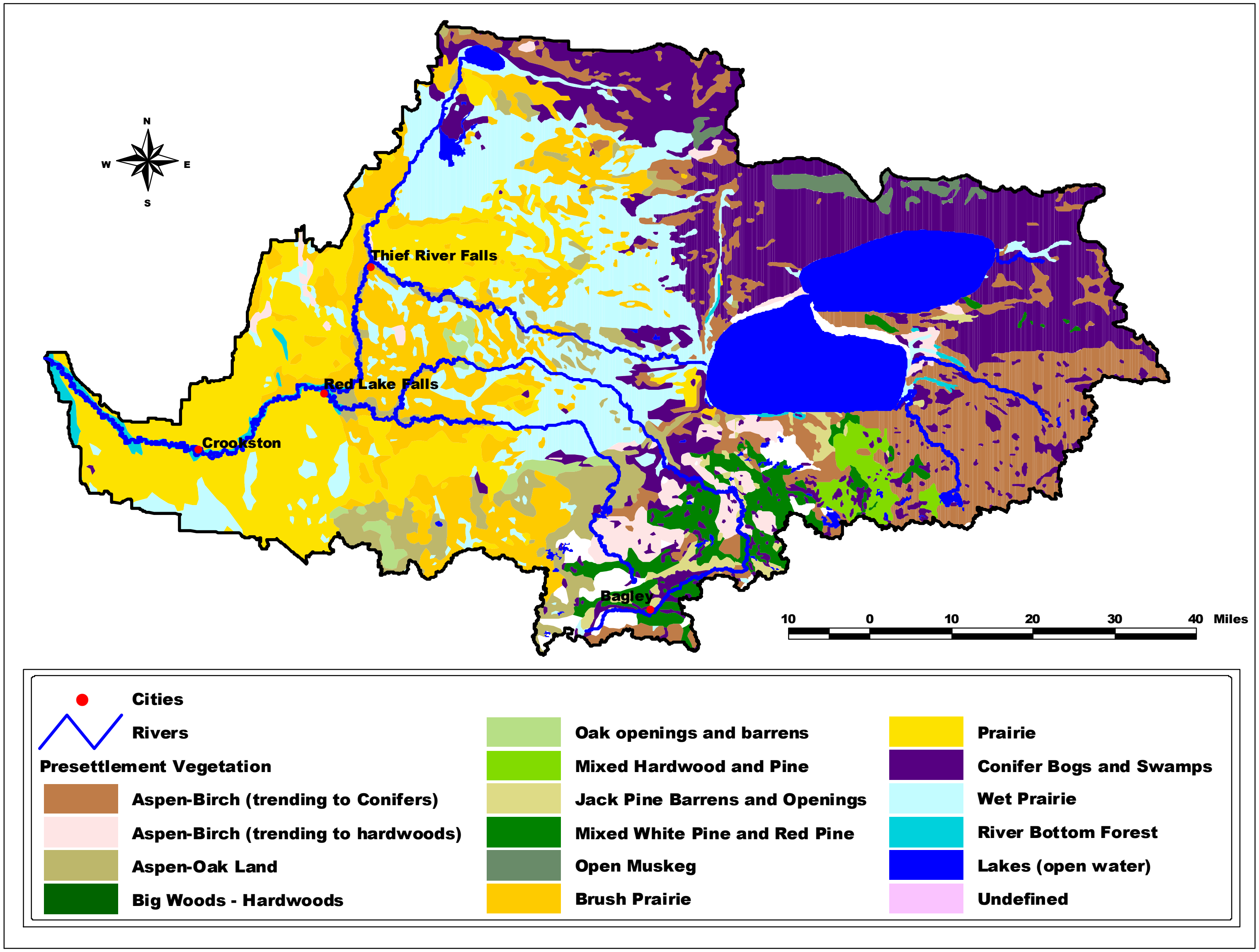


Figure 4. Historic (year 1908) vegetative cover in the Red Lake River watershed (MN DNR GIS dataset 2004).

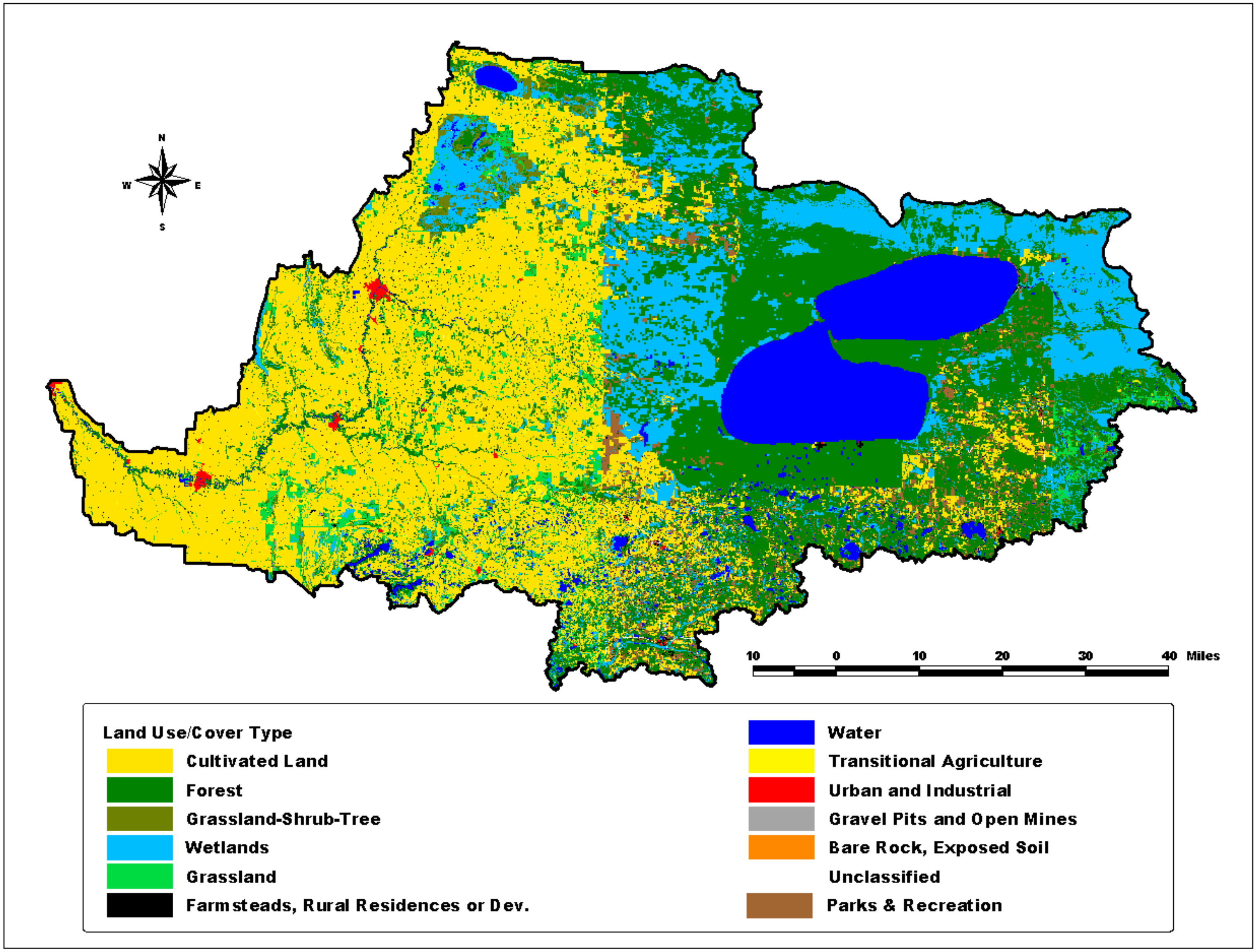


Figure 5. Land use and land cover in the Red Lake River watershed from the 1990's (MN DNR GIS dataset 2004).

Soils

Soils in the far western part of the watershed are primarily silty black loamy soils and sandy soils formed as lake bed deposits. Fine loamy soils are dominant in the north-central part of the watershed where wet prairie once dominated and in the rolling and hummocky portions in the south and southeast (Figure 6). Hemic soils are found in the north and central parts of the watershed that were historically dominated by bogs and swamps.

Wetlands

In the mid-1990s, 2,884 square miles of wetlands were identified in the Red Lake River watershed (Table 3); the majority were concentrated in the eastern and northern parts of the watershed (Figure 7). The most abundant wetland type in the watershed was bog, which covered 8.4 percent of watershed. Shrub swamp was the next most abundant habitat type covering 7.2 % of the watershed followed by shallow open water (5.7%), which included Upper and Lower Red Lakes (Figure 7, Table 3). Less than 1% of all wetland types identified were riverine systems. Much of the land that was historically covered by wetland (Figure 4) is still classified as wetland today (Figure 7), especially in the northeastern portion of the watershed. However, extensive ditching likely altered the function of some of these wetlands. Most of the wetlands in the central and western portion of the watershed have been converted to agricultural lands.

Table 3. Summary of wetland types in the Red Lake River watershed (National Wetlands Inventory, circular 39 classification, MN DNR GIS dataset 2004). Values were rounded to the nearest 0.1%.

Wetland Type	Area (mi^2)	Area (ac.)	Percent of Total Area
Bog	535.6	342,779	9.3
Shrub Swamp	477.0	305,266	8.3
Shallow Open Water	517.9	331,434	9.0
Wet Meadow	389.0	248,951	6.8
Wooded Swamp	305.0	195,185	5.3
Shallow Marsh	139.8	89,456	2.4
Municipal and Ind. Activities	23.1	14,811	0.4
Seasonally Flooded Basin	18.3	11,690	0.3
Deep Marsh	17.9	11,484	0.3
Riverine Systems	6.9	4,412	0.1
Total Wetlands	2,430.4	1,555,468	42.7
Non-wetland or unclassified	3,325.4	2,128,266	57.8

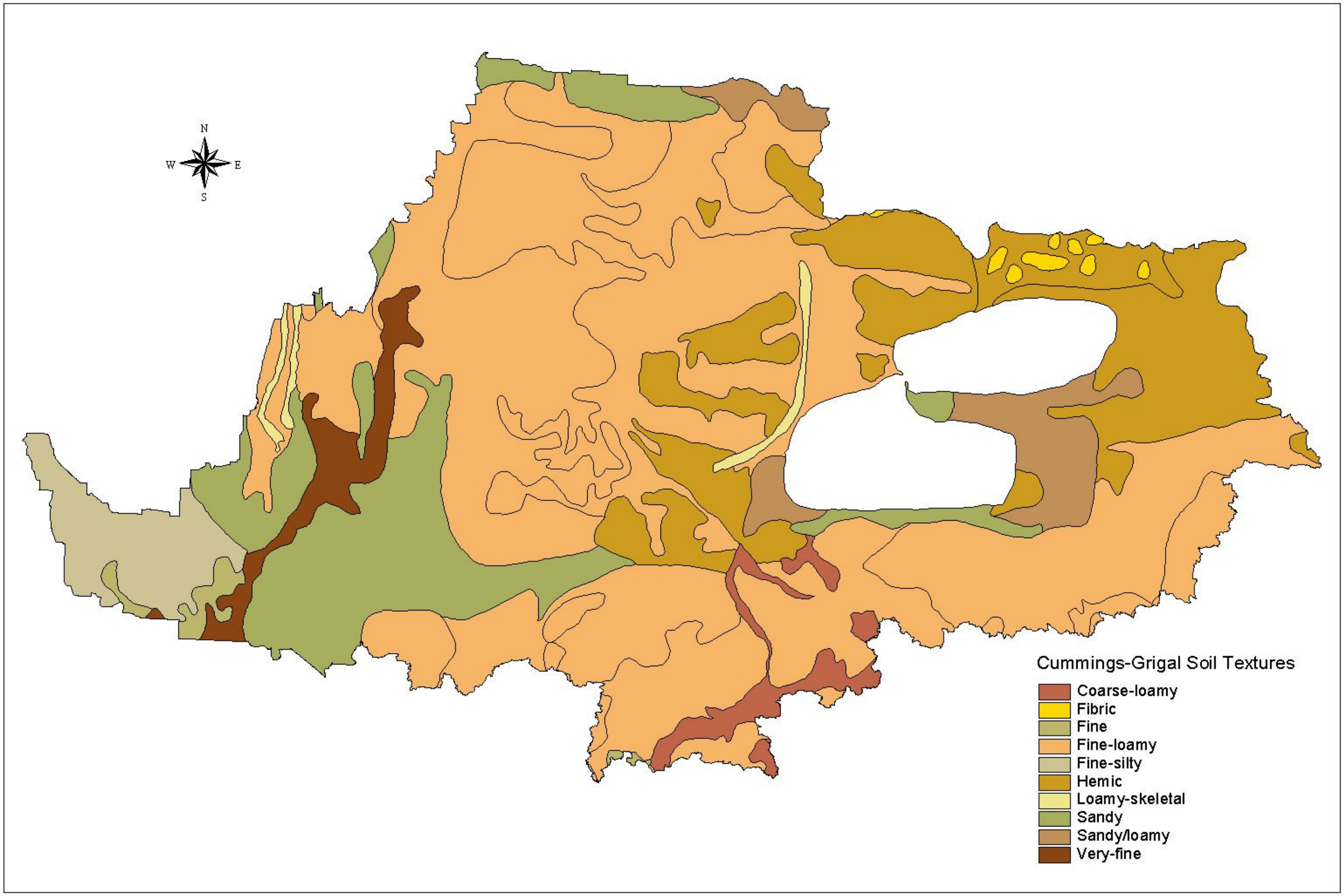


Figure 6. Soil textures in the Red Lake River watershed (MN DNR GIS dataset 2005).

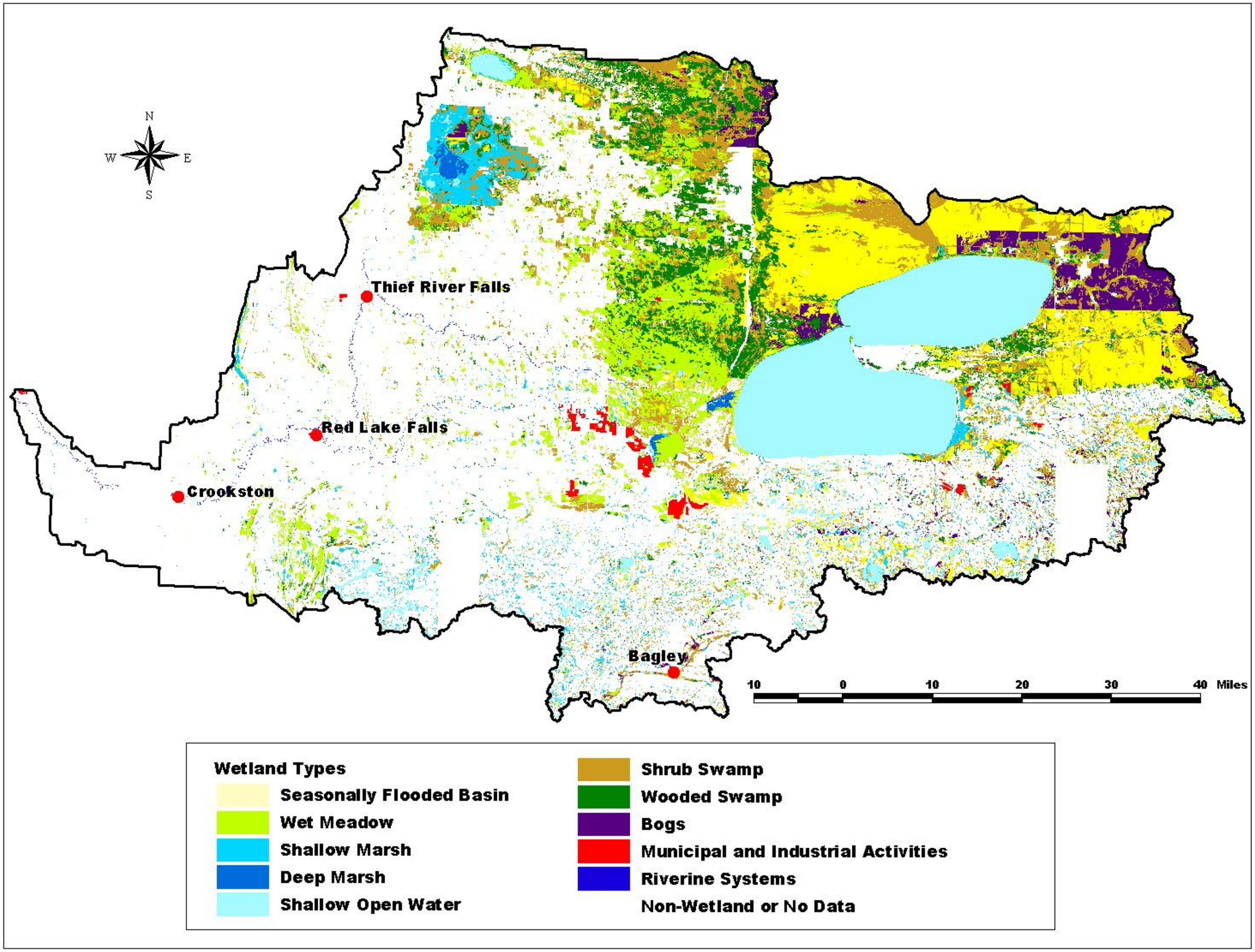


Figure 7. Wetlands in the Red Lake River watershed (MN DNR GIS dataset 2005).

Ecological Classification System

The Ecological Classification System is a hierarchical system that classifies areas in the United States into "provinces", "sections", "subsections", and "land type associations" based on climate, geology, hydrology, topography, soils, and vegetation. The Red Lake River watershed contains sections of the Prairie Parkland, Tallgrass Aspen Parklands, Laurentian Mixed Forest and Eastern Broadleaf Forest provinces (Figure 8). The portion of the Prairie Parkland province lies in the far west of the watershed and is mostly comprised of the Anthony Lake Plain land type association. The Tallgrass Aspen Parklands encompasses a large part of the northcentral and northeast sections of the watershed and contains the major beach ridges as well as several lake plain land type associations. The Eastern Broadleaf Forest Province lies in the far south-central part of the watershed and is comprised of moraine and till plain land type associations. The Laurentian Mixed Forest Province covers most of the eastern half of the watershed and contains a mix of minor beach ridge areas, peatlands, moraine and till plain.

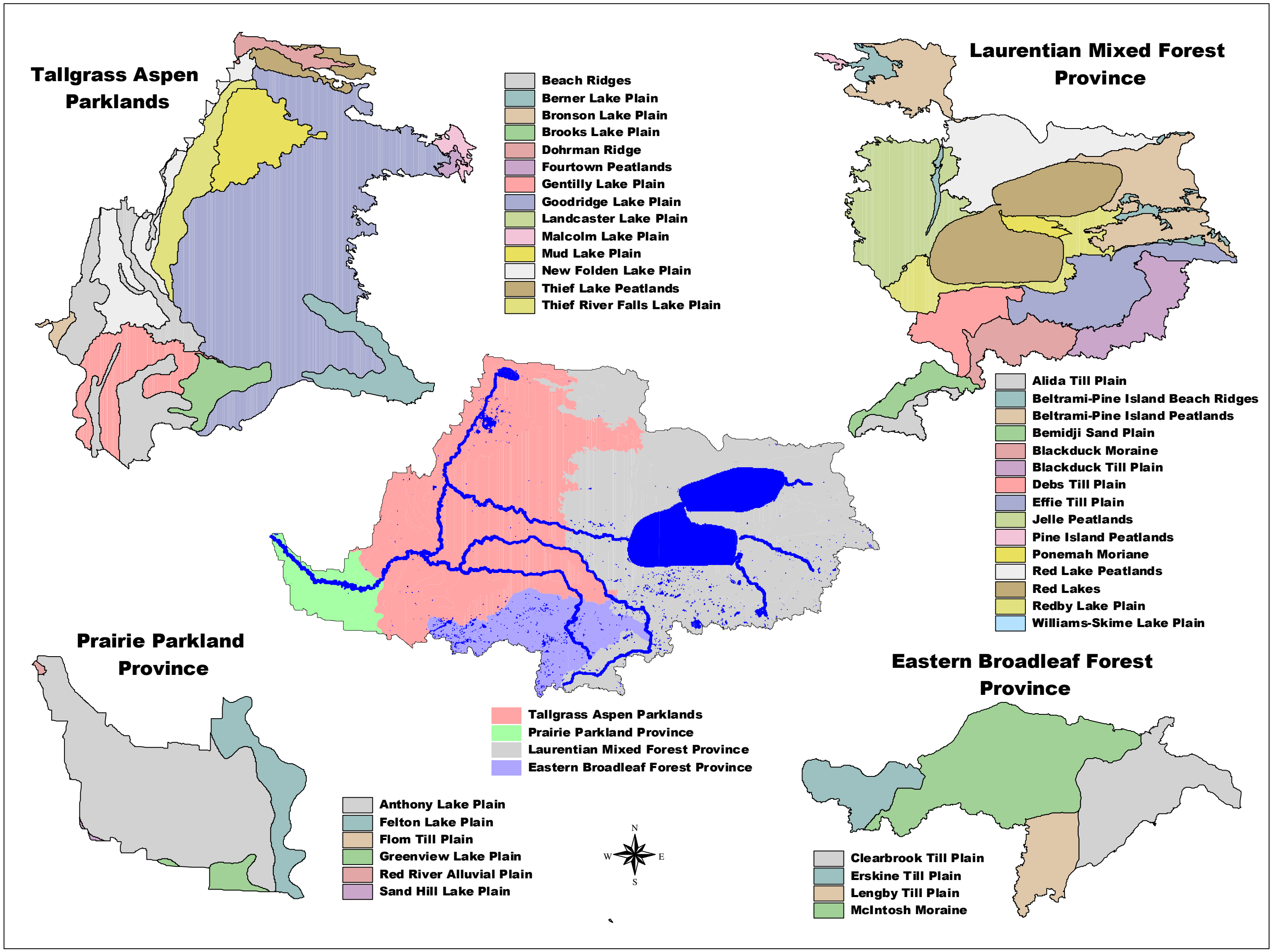


Figure 8. Ecoregion provinces and respective land type associations in the Red Lake River watershed.

Information for the remainder of this report will be focused primarily on waters lower in the watershed than the outlet of Lower Red Lake River.

Hydrology

The United States Geological Survey (USGS) currently maintains 15 active stream flow recording gages in the Red Lake River watershed (Table 4). Daily mean discharges at all gage locations are typically highest in mid-April and lowest in late December through late February (Figures 9, 10 and 11). Average annual discharge statistics for selected stations can be found Appendix A.

Table 4. Descriptions of active US Geological Survey stream surface water gage stations found in the Red Lake River watershed.

Gage Number	Years in Record	Peak Stream Flow (cfs)		Drainage Area (mi^2)	Description
05080000	5	24,500	(4/2001)	5,680	Red Lake River at Fisher, MN
05079000	104	28,400	(4/1969)	5,270	Red Lake River at Crookston, MN
05075000		4,060	(7/1975)	2,300	Red Lake River at High Landing near Goodridge, MN
05074500	67	3,600	(6/1950)	1,950	Red Lake River near Red Lake, MN
05078500	78	10,300	(4/1979)	1,380	Clearwater River at Red Lake Falls, MN
05078000	64	3,940	(4/1979)	555	Clearwater River at Plummer, MN
05076000	89	5,610	(5/1950)	985	Thief River near Thief River Falls, MN
05078230	45	3,210	(4/1969)	254	Lost River at Oklee, MN
05078770	2	67	(5/2004)	14.2	Judicial Ditch 66 near Marcoux Corners, MN
05078730	2	140	(6/2003)	11.8	County Ditch 140 near Benoit, MN
05078520	2	91	(5/2004)	11.4	Cyr Creek near Marcoux Corners, MN
05079250	2	102	(6/2003)	10.4	County Ditch 65 near Maple Bay, MN
05079200	2	41	(3/2004)	10.3	County Ditch 72 (Burnham Creek) near Maple Bay
05078470	2	50	(5/2004)	9.6	Judicial Ditch 64 near Mentor, MN
05078720	N/A	N/A		N/A	County Ditch 147 near Tilden Junction, MN

Climate is likely the most significant variable that influences the hydrology of the watershed. However, human activities such as dam and road construction, stream channelization, ditching, converting land cover from native vegetation to cropland, draining and filling wetlands, and water appropriations have changed the landscape and significantly altered the natural hydrology in the Red Lake River watershed. Streams in the watershed can be described as "flashy", where multiple peak flows occur (in addition to peak spring flows) along with periods of very low discharge.

Red Lake River. Red Lake River has a mean annual discharge of 1,199 cubic feet per second (cfs) as measured at gage station #05079000 in Crookston for the period of record from 1901 through 2004 (Table 5). The highest instantaneous peak flow recorded at Crookston was 28,400 cfs on April 29, 1969 (Table 4). A discharge of zero cfs was recorded at Crookston on July 13, 1969, which was a result of power dam operation upstream The 90% exceedance discharge for the period of record at this gage station was 120 cfs and the 10% exceedance was 2,630 cfs (Table 5).

The flows in Red Lake River at High Landing, between Lower Red Lake and Thief River Falls, do not vary as much as in other parts of the watershed (Figures 9, 10 and 11), however, frequent flooding does occur. The voluminous storage capacity of Upper and Lower Red Lakes along with the dam at the Lower Red Lake outlet are working together to produce a relatively flat hydrograph, which is generally uncharacteristic of unregulated streams.

The MN DNR is directed by Minnesota Statutes, section 103G.285 to limit consumptive appropriations of surface water under certain low flow conditions. The annual Q90 exceedance discharge for the period of record analyzed is currently used as the specified low flow value for suspending certain surface water appropriations (MN DNR Waters 2005). Red Lake River has a protected stream flow of 37 cfs measured at the USGS gage station at High Landing and a protected flow of 119 cfs measured at the gage station at Crookston (MN DNR Waters 2005).

Table 5. Discharge statistics for selected USGS gage stations in the Red Lake River watershed.

	Discharge Statistics (cfs)					
Gage Station Location	Annual Mean	Q10	Q50	Q90	Annual 7-day Minimum	
Red Lake River at Crookston (1901-04)	1,199	2,630	738	120	3.9	(9/28/1936)
Red Lake River at High Landing (1930-00)	572	1,200	500	37	0.0	(11/16/1933)
Red Lake River near Red Lake (1933-04)	478	1,020	400	43	0.0	(9/1/1934)
Thief River near Thief River Falls (1909-04)	188	588	10	0.0	0.0	(10/1/1910)
Clearwater River at Plummer (1939-04)	178	411	79	34	2.9	(5/10/1977)
Lost River at Oklee (1960-04)	74	162	20	2.8	0.0	(2/16/1963)
Clearwater River at Red Lake Falls (1909-04)	334	795	119	39	0.2	(9/12/1936)

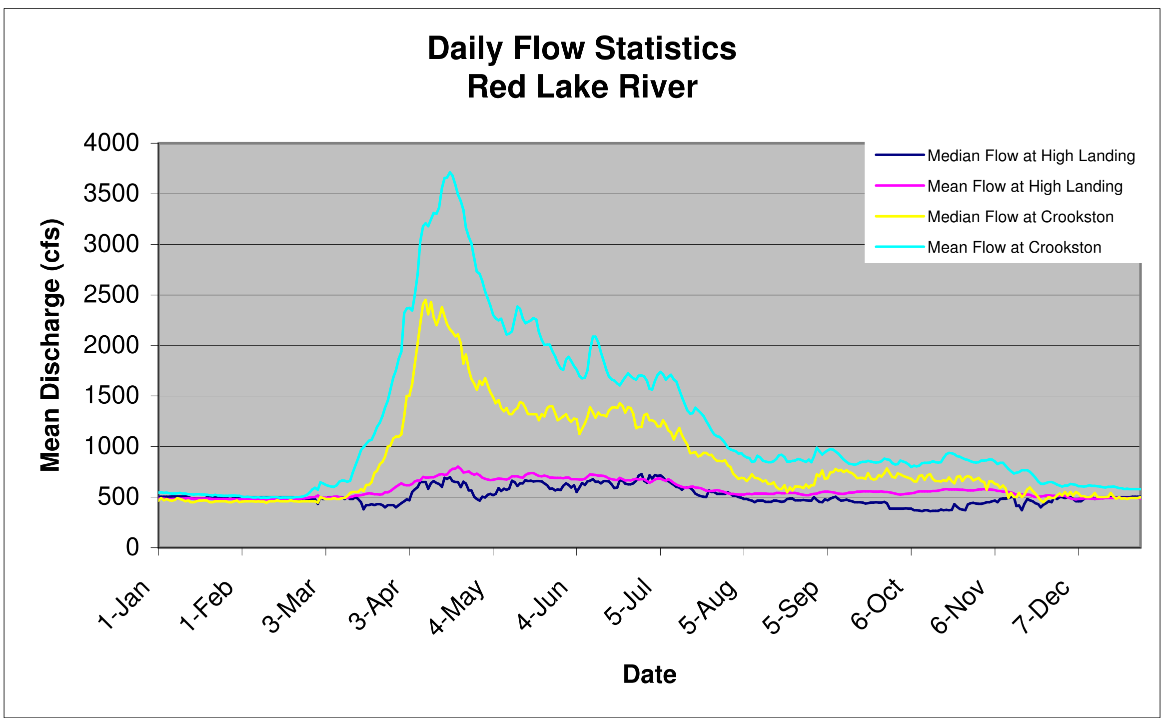


Figure 9. Mean and median daily mean discharges at USGS gage stations number 05075000 (at High Landing) and 05079000 (at Crookston) on Red Lake River.

Clearwater River. Clearwater River has a mean annual discharge of 334 cfs as measured at gage station #05078500 near the Red Lake River confluence at Red Lake Falls for the period of record from 1909 through 2004 (Table 5). The highest instantaneous peak flow recorded at Red Lake Falls was 10,300 cfs on April 25, 1979 (Table 4). A discharge of zero cfs was recorded at on September 15, 1936. The 90% exceedance discharge for the period of record at this gage station was 39 cfs and the 10% exceedance was 795 cfs (Table 5). Daily mean discharges measured at Plummer and Red Lake Falls are approximately equal from late November through early March and median daily mean flows are similar through much of the year (Figure 10). However, daily mean discharges from mid-March through November vary considerably, especially in late April where daily mean discharges measured at Red Lake Falls are near 3.5 times higher than at Plummer (Figure 10). The differences between flow patterns at Plummer and Red Lake Falls can be at least partially explained by the differences in drainage areas at the two stations (Table 4); the drainage area at Red Lake Falls includes the Lost River, Beau Gerlot Creek, Badger Creek and Terrebonne Creek watersheds whereas the gage at Plummer does not.

Wild rice operations located along Clearwater River between Clearwater Lake dam and the city of Plummer are impacting stream flows. Water withdrawal for wild rice production reduces stream flows each year as water is taken from Clearwater River and used to flood rice fields. Appropriations for wild rice irrigation have the potential to reduce stream flow in Clearwater River by 57.5 cfs (Harvey et al. 1997). Water withdrawal impacts all of Clearwater River below the rice paddies, however, the affects are more obvious upstream of the Lost River confluence. A water allocation plan was developed for wild rice growers on Clearwater River, which resulted in a protected stream flow of 36 cfs measured at the USGS gage in Plummer (MN DNR Waters 2005).

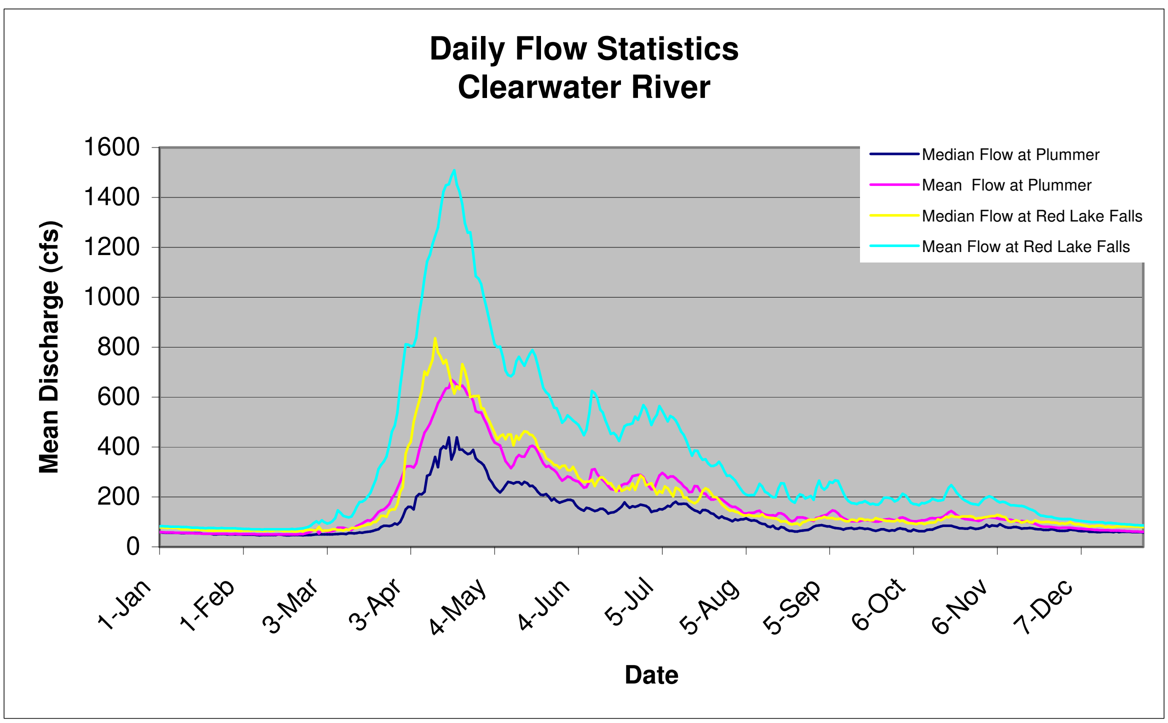


Figure 10. Mean and median daily mean discharges at USGS gage stations number 05078000 (at Plummer) and 05078500 (at Red Lake Falls) on Clearwater River.

Thief River. Thief River has a mean annual discharge of 188 cfs as measured at gage station #05076000 located Thief River Falls for the period of record from 1909 through 2004 (Table 5). The highest instantaneous peak flow recorded was 5,610 cfs on May 13, 1950 (Table 4). A discharge of zero cfs was recorded for several days around October 1, 1910. The 90% exceedance discharge for the period of record at this gage station was 0.0 cfs and the 10% exceedance was 588 cfs (Table 5). Daily mean discharges are less than 10 cfs from the first of January through late February and quickly peak at 791 cfs in late April (Figure 11).

Thief River has a protected stream flow of zero cfs (MN DNR Waters 2005). This means that permitted appropriations can draw down the entire stream at any time of the year.

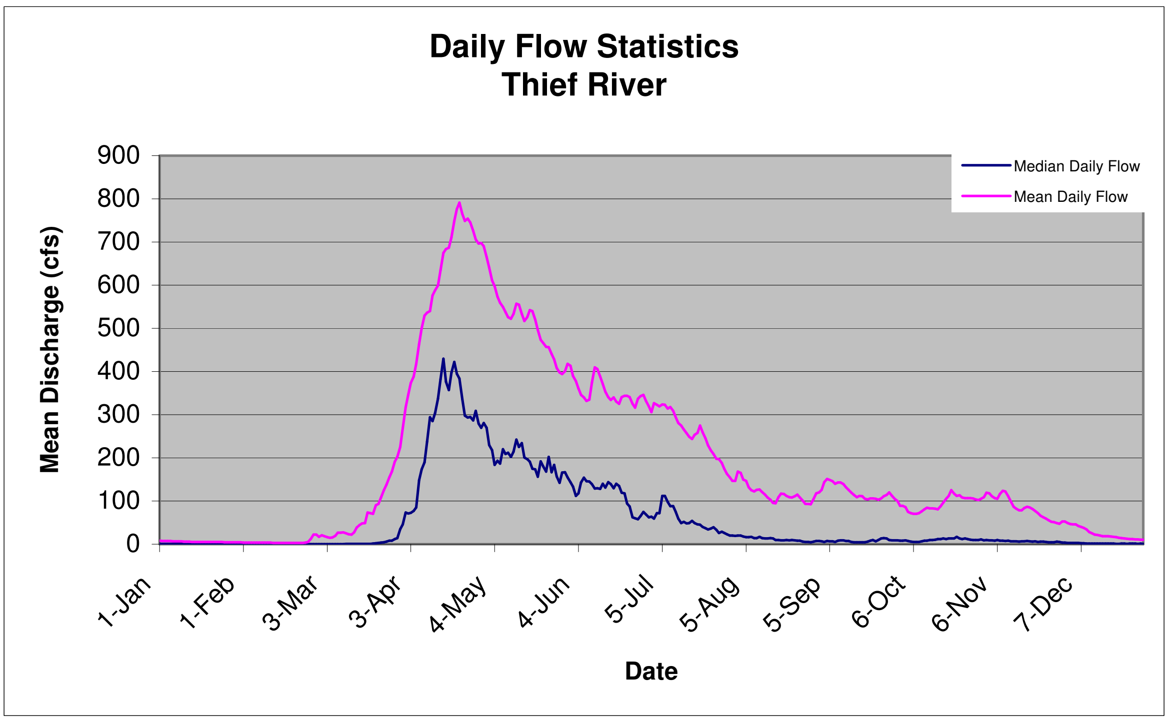


Figure 11. Mean and median daily mean discharges at USGS gage station number 05076000 on Thief River near Thief River Falls.

There are at least 51 dams located on streams and rivers in the Red Lake River watershed below Lower Red Lake, 11 of which are located on major tributaries to Red Lake River (Figure 12; USCOE dams list). All dams alter stream hydrology to one extent or another and interrupt stream connectivity. Several of the larger dams within the watershed that are affecting natural hydrology and stream connectivity include dams at East Grand Forks, Crookston, Thief River Falls, Lower Red Lake, and Clearwater Lake. The dams at East Grand Forks and Crookston have been modified to produce a riffle with a slope of approximately 5%. The dams at Thief River Falls and Lower Red Lake have drastically altered the hydrologic regime of Red Lake River and its tributaries.

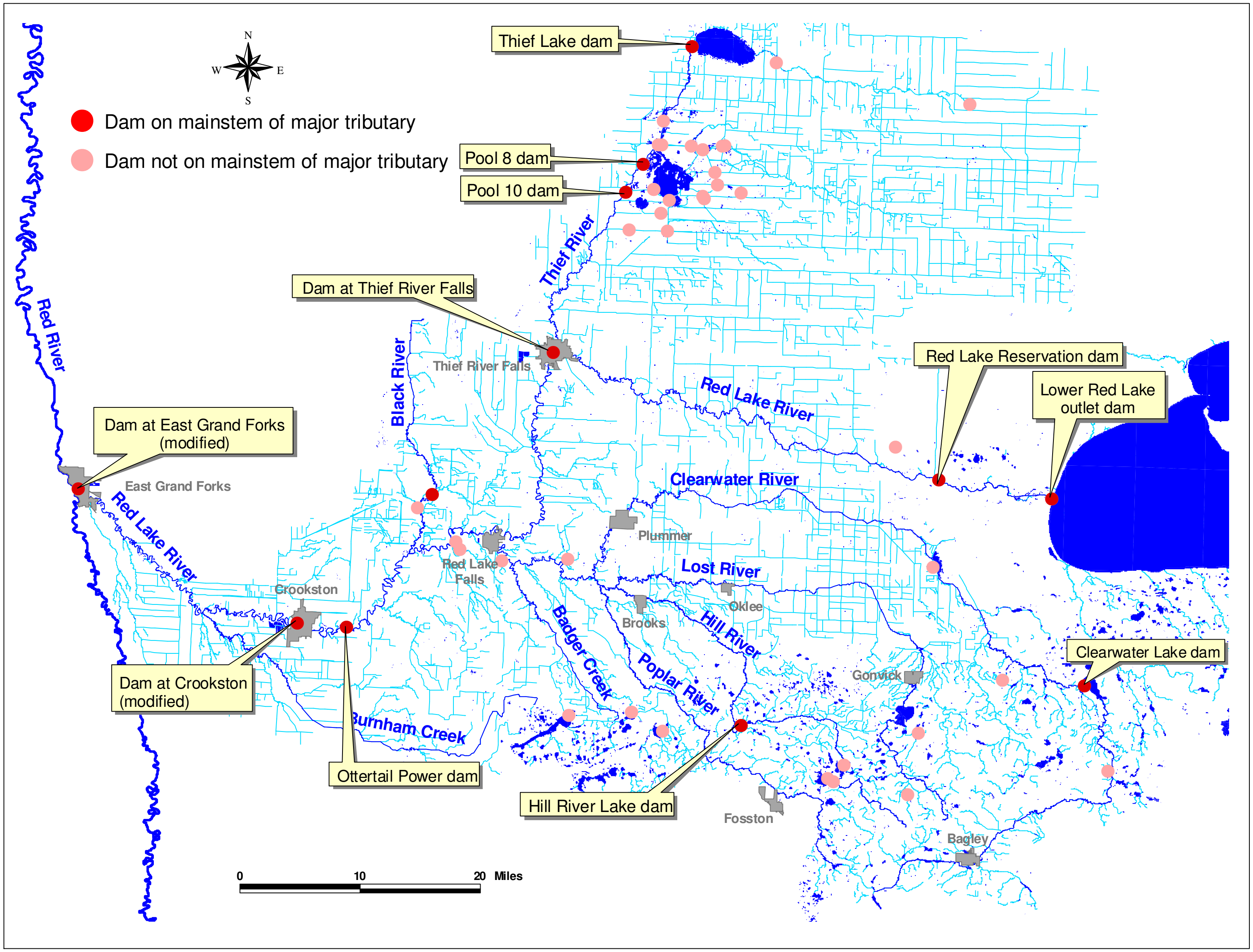


Figure 12. Location of dams in the Red Lake River watershed below Lower Red Lake as listed in the US Army Corps of Engineers' dams list.

Waterways

For this report, waterways are referenced by the name listed on USGS 1:24,000 scale topographical maps. Many of the streams within the Red Lake River watershed contain segments of named ditches along their watercourse from headwaters to confluence. The names of these ditched segments are included when referring to the stream names unless otherwise stipulated.

Numerous streams exist throughout the Red Lake River watershed including approximately 1326 miles of perennial stream and river, 1651.2 miles of intermittent stream, 1053.5 miles of perennial drainage ditch and 1,841.9 miles of intermittent drainage ditch (Table 6). Within the lands that lie lower in the watershed than the Lower Red Lake outlet there exists approximately 1,082.9 miles of perennial stream and river, 1300.1 miles of intermittent stream, 726.1 miles of perennial drainage ditch and 1,812.0 miles of intermittent drainage ditch (Table 6, Figure 13). Drainage areas, channel lengths and slopes for selected streams are listed in Table 7. The three largest streams Red Lake River watershed below Lower Red Lake are Red Lake River, Clearwater River and Thief River. Each of these streams is briefly described below.

Table 6. Lengths (miles) of waterway types lying within associated watersheds in the Red Lake River watershed.

	Red Lake River Watershed	Red Lake River Immediate Subwatershed*	Thief River Watershed	Clearwater River Watershed	Upper/Lower Red lakes Watershed
Drainage Ditch (intermittent)	1841.9	707.0	746.1	358.5	29.9
Drainage Ditch (perennial)	1053.5	484.5	69.5	172.1	327.4
Drainage (undifferentiated)	37.9	3.2	16.2	18.5	0.0
Stream (Intermittent)	1651.2	172.8	371.3	756.0	351.1
Stream (Perennial)	1032.0	63.4	100.4	312.2	556.0
River	297.0	18.8	179.3	86.6	12.3
Stream (undifferentiated)	17.5	0.0	0.1	17.1	0.3

* Land draining into Red Lake River excluding that found in the Thief River, Clearwater River and Upper/Lower Red lakes watershed.

Table 7. Characteristics of waterways within the Red Lake River watershed (MN DNR GIS dataset 2003).

Stream Name	Drainage Area (mi^2)	Length (miles)	Average Slope
RED LAKE RIVER IMMEDIATE SUBWATERSHED*			
Red Lake River (at Red River of the North confluence)	**5,755.9**	193.4	0.00038
Burnham Creek	167.2	49.4	0.00136
Black River	146.5	33.8	0.00092
Kripple Creek	34.7	12.6	
Gentilly River	32.4	7.3	
Cyr Creek	24.0	11.8	
THIEF RIVER SUBWATERSHED			
Thief River (at Red Lake River confluence)	1,076.7	35.9	0.00023
Moose River	284.3	23.3	
Mud River	276.7	19.2	
CLEARWATER RIVER SUBWATERSHED			
Clearwater River (at Red Lake River confluence)	1,385.4	146.4	0.00066
Lost River (at Clearwater River confluence)	602.4	76.1	0.00123
Lost River (above Hill River confluence)	300.1		
Hill River	176.6	61.0	0.00148
Poplar River	125.7	53.9	
Beau Gerlot Creek	122.0	12.9	
Badger Creek	51.9	20.9	0.00172
Terrebonne Creek	18.5	5.9	

* All land draining into Red Lake River excluding that found in the Thief River, Clearwater River and Upper/Lower Red lakes watershed.

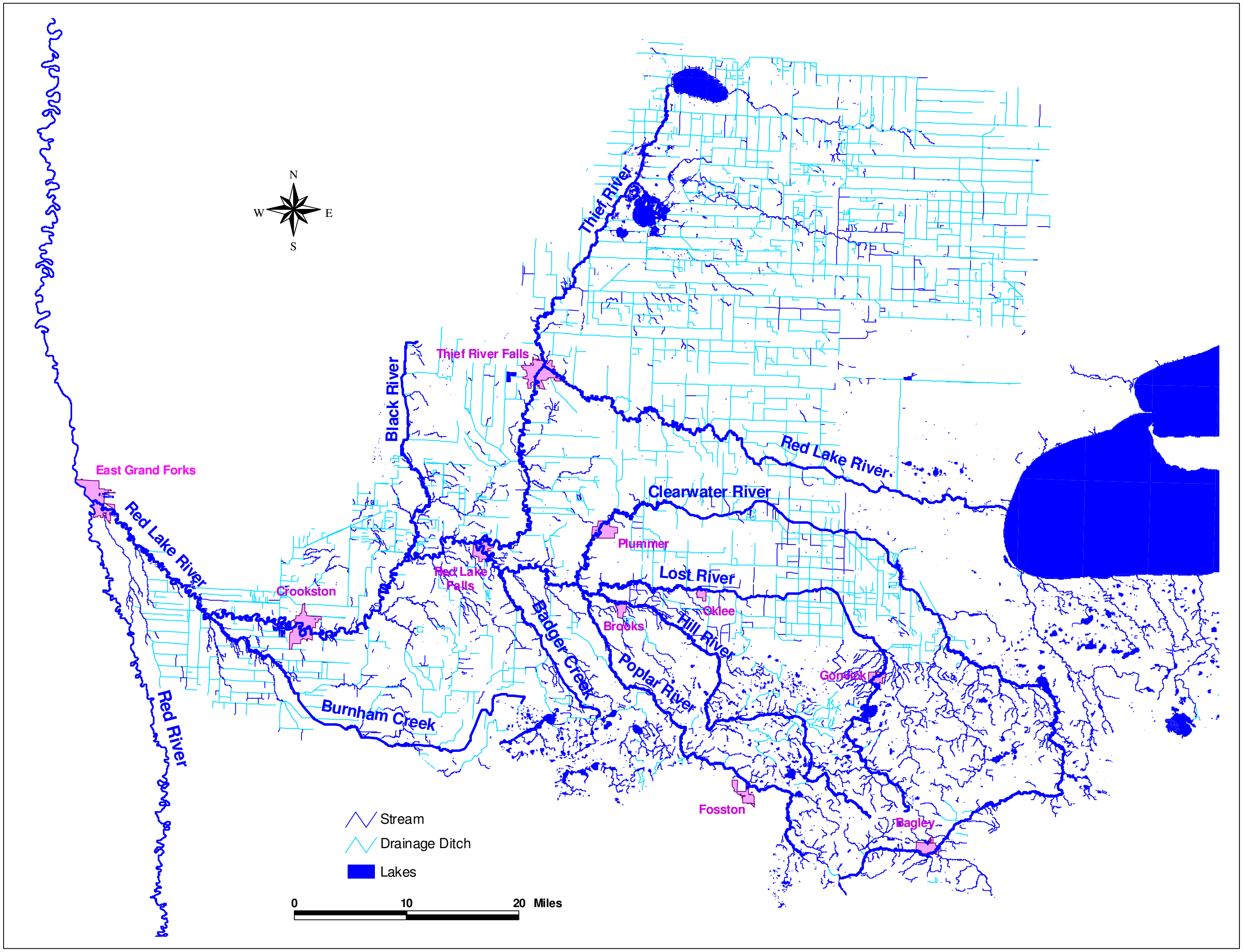


Figure 13. Waterways in the Red Lake River watershed downstream of Lower Red Lake.

Red Lake River. Red Lake River originates at the Lower Red Lake outlet control structure and ends at its confluence with Red River of the North in East Grand Forks, MN (Figure 13). Red Lake River begins as a slow moving, low gradient stream that is dominated by pools and runs as it flows through bog, wetlands and agricultural lands. Downstream of the dam at Thief River Falls, the stream changes to a higher gradient, riffle-pool systems as it flows through remnant glacial beach ridges (Figure 14). Channel gradient, as well as the frequency of riffles, decreases significantly near the Black River confluence and both continue to decrease until Red Lake River eventually empties into Red River at East Grand Forks, MN. Major tributaries to Red Lake River include Thief River, Clearwater River, Black River and Burnham Creek.

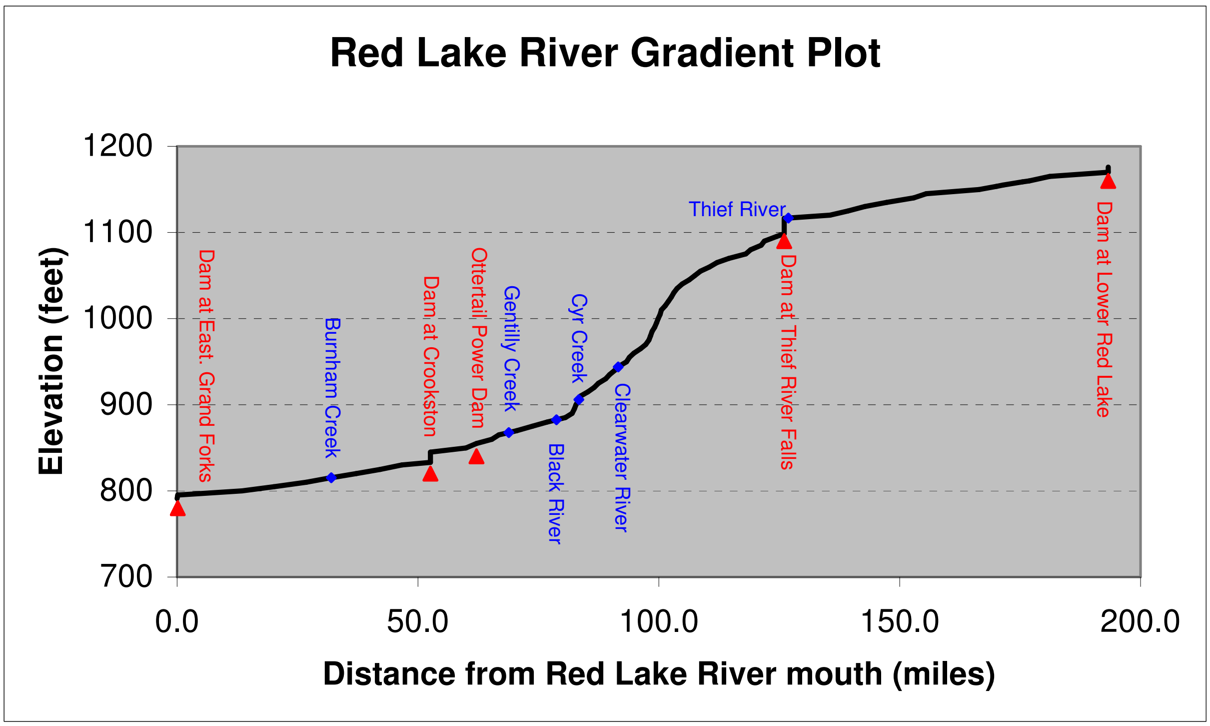
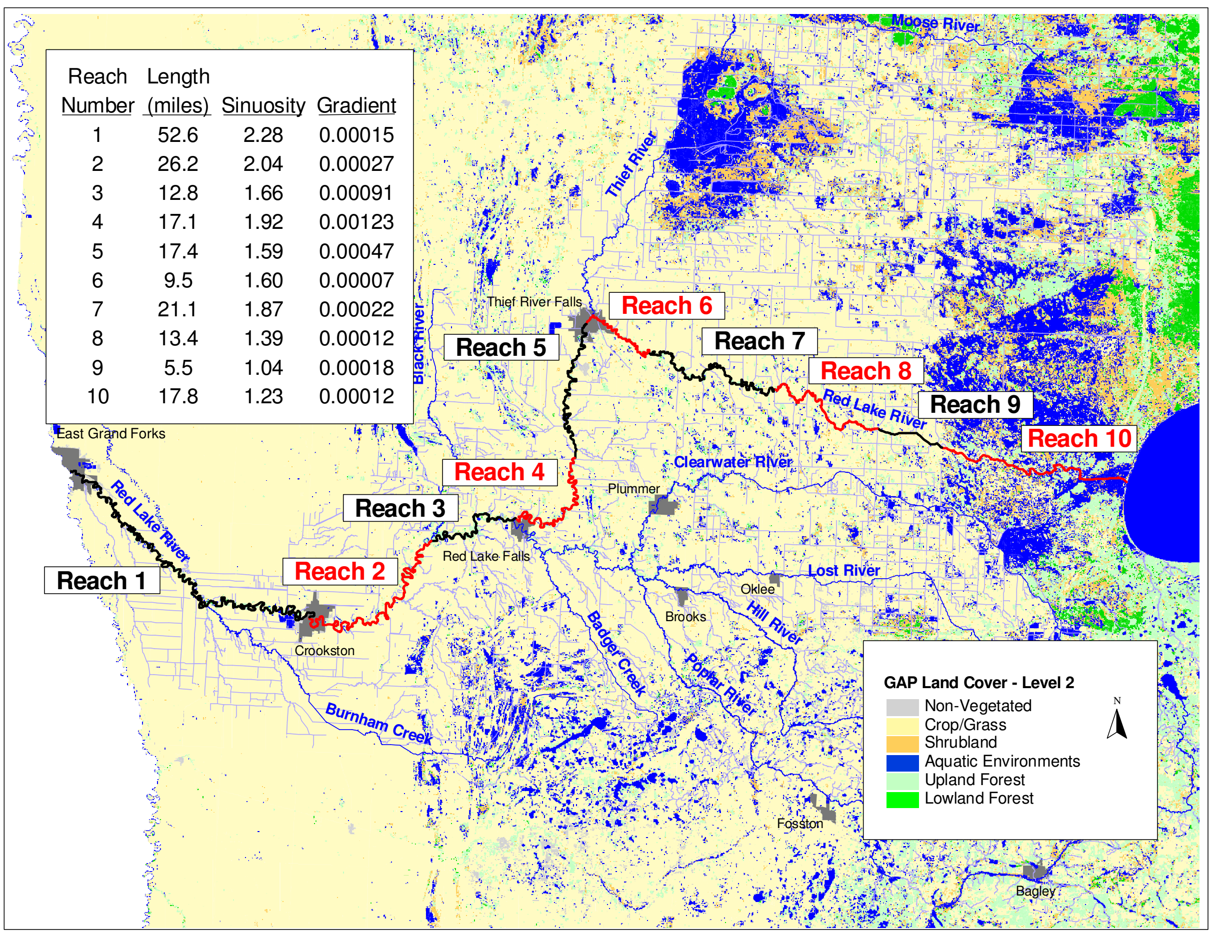


Figure 14. Gradient plot of Red Lake River.

Red Lake River was divided into 10 reaches (Table 8, Figure 15). For the purpose of this report, a reach is defined as a segment of stream with relatively consistent morphological characteristics (e.g., gradient, sinuosity, cross-section morphology) and instream habitat is assumed to be similar throughout a reach. Reach numbering began with the farthest downstream reach and progressed sequentially upstream. Reach designations for Red Lake River were based on initial work done by Renard et al. (1983) and reach boundaries for this report were either identical or closely matched those defined in that report.

Reach 1 is a low gradient, highly sinuous stream segment that meanders through flat, agricultural land. Row cropping is prominent and stream buffers are generally very narrow and are ineffective at slowing surface runoff, stabilizing stream banks, or filtering runoff. Major factors impacting this reach include: urban impacts associated with the cities of East Grand Forks and Crookston, hydrologic alterations (e.g., dams, unnatural hydrograph) and agricultural impacts (e.g., increased runoff and sedimentation). The dams at East Grand Forks and Crookston have been modified to address stream connectivity (e.g., fish passage) and safety hazard concerns. Reach 2 is also a low gradient, highly sinuous stream segment flowing through agricultural land. Noticeably more timbered stream buffer exists in Reach 2 compared to Reach 1, however, a substantial amount of ineffective stream buffer still exists. Major impacts to this reach include hydrologic alterations and agricultural impacts. A low head dam owned by the Ottertail Power Company is located within Reach 2. Reaches 3 and 4 are higher gradient stream segments that flow across a series of glacial beach ridges, and riffles and pools are common. Agricultural land dominates the landscape but wooded stream buffers are generally much more common than in Reach 1 or in upstream Reaches. Major factors impacting these reaches include: hydrologic alterations and agricultural impacts. Urban impacts associated with the city of Red Lake Falls also affect Reach 3. Reach 5 is a lower gradient reach that parallels the beach ridge. It is a relatively low gradient segment surrounded by cultivated agricultural land and has very little effective stream buffer. Major impacts to Reach 5 include hydrologic alteration and urban impacts associated with the city of Thief River Falls. Reach 6 is the reservoir formed by the dam at Thief River Falls. The dam at Thief River Falls is a known fish passage barrier.



Reach Number	Length (miles)	Sinuosity	Gradient
1	52.6	2.28	0.00015
2	26.2	2.04	0.00027
3	12.8	1.66	0.00091
4	17.1	1.92	0.00123
5	17.4	1.59	0.00047
6	9.5	1.60	0.00007
7	21.1	1.87	0.00022
8	13.4	1.39	0.00012
9	5.5	1.04	0.00018
10	17.8	1.23	0.00012

Figure 15. Delineated reaches of Red Lake River.

Table 8. Descriptions of Red Lake River delineated Reach boundaries.

Reach Number	Reach Boundary Descriptions
	Red Lake River
1	Red River upstream to the dam at Crookston. Coincides with Sector 8/7 boundary from Renard et al. (1983).
2	Dam at Crookston upstream to the confluence with Black River. Near Sector 7/6 boundary from Renard et al. (1983).
3	Confluence with Black River upstream to the confluence with Clearwater River.
4	Confluence with Clearwater River upstream 17.1 miles to a point where there is a major change in stream gradient and obvious change in stream sinuosity
5	Upstream boundary of Reach 4 to the dam at Thief River Falls. Coincides with Sector 5/4 boundary from Renard et al. (1983).
6	Dam at Thief River Falls to the upstream extent of the reservoir. Coincides with Sector 4/3 boundary from Renard et al. (1983)
7	Upstream extent of reservoir at Thief River Falls upstream 21.1 miles where there is a change in land use and stream character. Coincides with Sector 3/2 boundary from Renard et al. (1983).
8	Upstream boundary of Reach 7 to upstream boundary of channeled segment.
9	Upstream boundary of channelized segment to Red Lake Reservation boundary. Coincided with upstream boundary of Sector 1 from Renard et al (1983).
10	Red Lake Reservation boundary to Lower Red Lake outlet.

Reaches 7 through 9 are low gradient segments that flow through lake plain. Reaches 8 and 9 are largely channelized stream. Cultivated agriculture dominates the landscape and stream buffers are narrow. Major factors impacting this reach include: impacts from stream channelization and agricultural runoff and sedimentation. Reach 10 is low gradient stream that flows through the bog and peatlands of the Red Lake Indian Reservation. Two dams are located on Reach 10 (Figure 12); the dam at the outlet of Lower Red Lake is a known fish passage barrier.

Clearwater River. Clearwater River originates as a ditch at the confluence of Lower Long Lake and an unnamed lake (Minnesota Division of Waters number 44003600) in extreme northwest Mahnomen County (Figure 13). Clearwater River flows northwesterly for approximately 146 miles through glacial moraine, lake bed and beach ridge areas, and empties into Red Lake River at the city of Red Lake Falls. Major tributaries include Lost River and Badger Creek. Clearwater River has a drainage area of approximately 1,385 square miles, nearly half of which (602 square miles) is contributed by the watershed draining Lost River (Table 6).

Clearwater River was divided into 10 reaches (Figure 16, Table 9). Reaches 1,2 and 3 are situated within the Tallgrass Aspen Parklands ecoregion province where glacial lake plain and beach ridges dominate the landscape. Reach 1 is a relatively high gradient stream segment that meanders through lands affected by glacial beach ridge. Stream buffers are generally wooded, however, areas with little or no effective buffer do exist. Row cropping is prominent in lands adjacent to stream buffers. Major factors impacting this reach include: urban impacts associated with the city of Red Lake Falls, hydrologic alterations, and agricultural impacts (e.g., increased runoff and sedimentation). Reach 2 lies in the glacial lake plain and has gradient substantially lower than Reach 1 (Figure 16). Stream buffers are generally wooded, however, areas with little or no effective buffer do exist. Row cropping is prominent in lands adjacent to stream buffers.

Major factors impacting this reach include: urban impacts associated with the city of Plummer, hydrologic alterations, and agricultural impacts. Reach 3 is a long, low gradient, channelized stream segment with low sinuosity that lies in the glacial lake plain. Stream buffers are narrow and consist primarily of grasses; very little wooded corridor exists. Adjacent lands are mostly used for agriculture including row crops, pasture and wild rice production. Major factors impacting this reach include: hydrologic alterations and agricultural impacts. Agricultural impacts that originate in Reach 3 are impacts associated with wild rice production including, but not limited to: reduced stream flow from water withdrawal and reduced water quality from released paddy water. The vast majority of lateral ditch that directly connect to Clearwater River are located in Reach 3 (Figure 16). Along with these connections are associated impacts such as hydrologic alterations, stream channel destabilization and increased sedimentation.

Reaches 4 through 11 of Clearwater River lie in the southwest corner of the Laurentian Mixed Forest ecoregion province, which is dominated by till and sand plains. Reach 4 is a low gradient, relatively highly sinuous stream segment that flows through glacial till. This stream buffer is generally quite wide and mostly wooded. Land use adjacent to the stream buffer is a mix of agricultural land, wetlands and forest. The dam that forms Clearwater Lake defines the upstream boundary of this reach. This dam interrupts stream connectivity, which includes a complete barrier to fish passage and, along with Clearwater Lake, alters the hydrologic regime of the system. Major factors affecting this reach include: hydrologic alterations and, to a lesser extent, agricultural impacts.

Clearwater Lake represents Reach 5. Reach 6 is a low gradient, relatively highly sinuous segment that meanders through glacial till and sand plain. The stream buffer is generally wide and timbered through this reach as are the small tributary streams. Lands use/cover adjacent to the stream buffer is a mix of forest, row crop and pasture agricultural, and shrub lands. With the exception of impacts associated with upstream reaches, impacts to Reach 6 are relatively few. The culvert associated with the railroad crossing located near the upstream boundary of the reach is likely a fish passage barrier throughout the year. The entire length of Reach 6 is Minnesota State designated trout waters. Reach 7 is a short segment that has the highest gradient of any segment of Clearwater River. This reach has moderate sinuosity as it flows through sand plain. The stream through this reach generally has a wide, forest buffer surrounded by forest in the downstream half of the reach and a mix of row crop, pasture and forest in the upstream half. Major impacts to Reach 7 include: agricultural impacts and hydrologic alterations. Reach 7 is a designated trout stream from the Beltrami County – Clearwater County line downstream to Clearwater Lake.

Reach 8 of Clearwater River is a low gradient, highly sinuous stream segment that flows through sand plains. The stream buffer consists largely of shrubland and, to a lesser extent, agricultural grasslands. Land adjacent to the stream buffer is largely agricultural row crop and grasslands, but a substantial amount of forest and shrub are also present. Bob Melchior, professor emeritus of geology from Bemidji State University, conducted a hydrogeologic study of the Clearwater River and found that Reach 8 is a segment of losing stream. Major impacts to Reach 8 include hydrological alterations and agricultural impacts. Reach 9 is a low gradient stream segment with low sinuosity that flows through sand plains along the divide between the sand plains and glacial till; the stream has been channelized through a significant portion of this segment. The streamside buffer along Reach 9 is a mix of shrub, wetland, and agricultural grasslands and is moderately wide along most of the reach. Lands adjacent to the buffer are a mix of row crops, agricultural grasslands, forested lands and urban agricultural. Major impacts to Reach 9 include: hydrologic alterations, urban impacts from the city of Bagley, and agricultural impacts. Melchior studied found that Reach 9 is also a segment of losing stream. One significant tributary, Walker Brook, empties into Clearwater River at the southeastern edge of the city of Bagley. This stream is a state listed impaired waters by the MPCA because of low dissolved oxygen levels. John Gleason, an environmental science graduate student at Bemidji State University, concluded that this is likely a natural condition for wetland streams such as Walker Brook. Reaches 10 and 11 are low gradient, low sinuosity stream segments that flow through sand plain from the stream's origin downstream along the southern edge of the city of Bagley. The stream buffer is relatively wide along most of both reaches and consists of a mix of shrubs, forest and wetlands. Lands adjacent to the buffer are a mix of row cops, agricultural grasslands and forest. Reach 11 is entirely channelized. Major impacts to Reaches 10 and 11 include: hydrologic alteration, urban impacts from the city of Bagley and agricultural impacts.

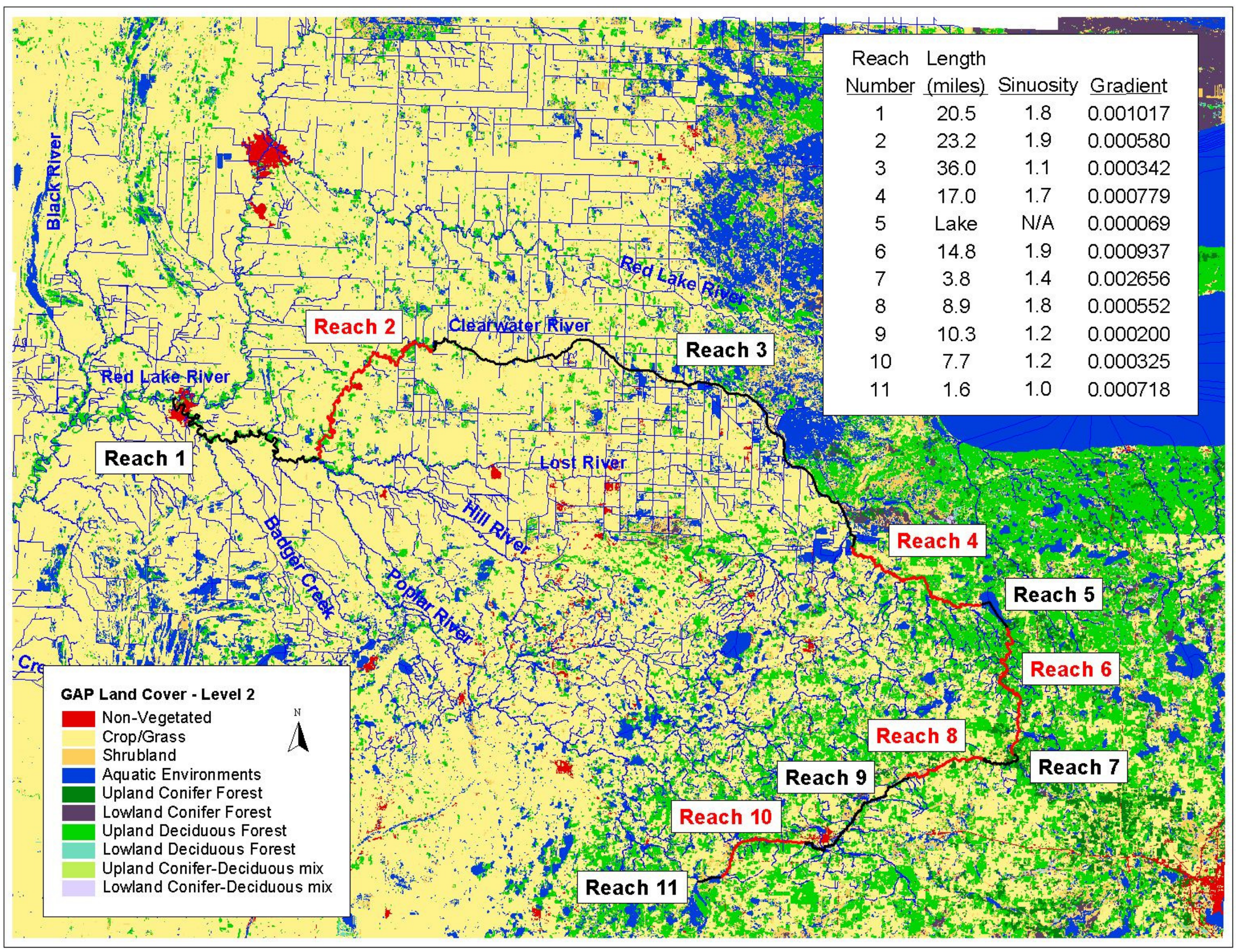


Figure 16. Delineated reaches of Clearwater River.

Table 9. Descriptions of Clearwater River delineated reach boundaries.

Reach Number	Reach Boundary Descriptions
	Clearwater River
1	Red Lake River confluence upstream to the Lost River confluence.
2	Lost River confluence upstream to the downstream boundary of channelized segment.
3	Downstream boundary of channelized segment to the upstream boundary of channelized segment.
4	Upstream boundary of channelized segment to Clearwater Lake dam.
5	Clearwater Lake
6	Upstream extent of Clearwater Lake to 0.5 miles downstream of Beltrami County Road 22 west of Pinewood
7	0.5 miles downstream of Beltrami County Road 22 west of Pinewood to 1 river mile upstream from Clearwater County road 21 (Clearwater/Beltrami county line).
8	Upstream boundary of Reach 7 to the downstream boundary of a channelized segment
9	Downstream boundary of a channelized segment to Clearwater County Road 25 on the southwest edge of Bagley approximately one stream mile downstream from First Lake.
10	Upstream boundary of Reach 9 to the downstream boundary of a channelized segment
11	Upstream boundary of Reach 10 to the stream origin located at the confluence of the Lower Long Lake and Double Lake outlets 0.8 miles west of the Mahnomen/Clearwater County line.

The MN DNR stream management plan (MN DNR 1994) has Clearwater River divided into four segments according to their ecological classification system (Sternberg 1976). Reaches 1 and 2 are classified as Class II with subclasses A and B, which is warm water stream with a significant number of game fish present; the dominant game fish species being smallmouth bass and walleye. The channelized segment (Reach 3) is classified as Class IV, which is a stream where fish populations are dominated by rough fish and forage species due to unsuitable habitat for game fish. Reaches 4, 5 and 6 are listed as Class II with subclasses B and C where the dominant game fish is walleye and northern pike. Reach 7 is classified a Class I (trout), subclass D, which is a stream capable of supporting trout where water conditions are marginal for trout, continual stocking is necessary and there is little carry over from year to year. Reaches 8-11 are classified as Class II with subclasses B and C. Reaches delineations from this report do not exactly match the stream miles listed in the management, however, any differences are inconsequential for all intents and purposes.

Thief River. Thief River originates at the outlet of Thief Lake (Figures 13 and 17) in the Thief Lake Wildlife Management Area located in northeastern Marshall County. Thief River flows south for approximately 36 miles south through glacial lake plains and empties into Red Lake River at the city of Thief River Falls. The two largest streams, Moose River and Mud River, are inlet streams to Thief Lake and Mud Lake, respectively. Thief River has a drainage area of approximately 1,077 square miles (Table 6).

Thief River was divided into three reaches (Figure 17, Table 10). Reach 1 is a low gradient stream segment of moderate sinuosity that flows through lake plain. Stream channelization is present in the upstream half of this Reach and several major ditch systems empty into this reach. The downstream end flows through northern Thief River Falls and empties into the Red Lake River reservoir at Thief River Falls. Stream buffers are generally narrow or non-existent. Wooded buffers do exist, but are usually present on one side of the stream while the opposite side has little or no buffer. Lands adjacent to the stream corridor are predominantly row crops and agricultural grasslands. Major factors affecting Reach 1 include: hydrologic alterations, agricultural impacts and urban impacts associated with the city of Thief River Falls. Reach 2 a low gradient stream segment that flows through the wetlands of Agassiz National Wildlife Refuge. Stream sinuosity is very low; the entire reach is channelized. The stream buffer consists of grasses and wetlands along the entire reach with the exception of a small portion of agricultural grasses along the downstream one-third of the reach. Lands surrounding the stream buffer are primarily wetlands along with some agricultural ground along the western edge of the downstream one-third of the reach. Major factors impacting this reach include: hydrologic alterations and agricultural impacts. Reach 3 is a low gradient stream segment of moderate sinuosity that flows through glacial lake plain. Some stream channelization is present and a substantial number of ditches empty into Reach 3. Stream buffers are mostly narrow and often non-existent. The stream corridor consists primarily of agricultural land, however, areas covered by shrubs and trees also exist. Row cropping is prominent in lands adjacent to stream buffers. Major factors affecting Reach 3 include: hydrologic alterations and agricultural impacts.

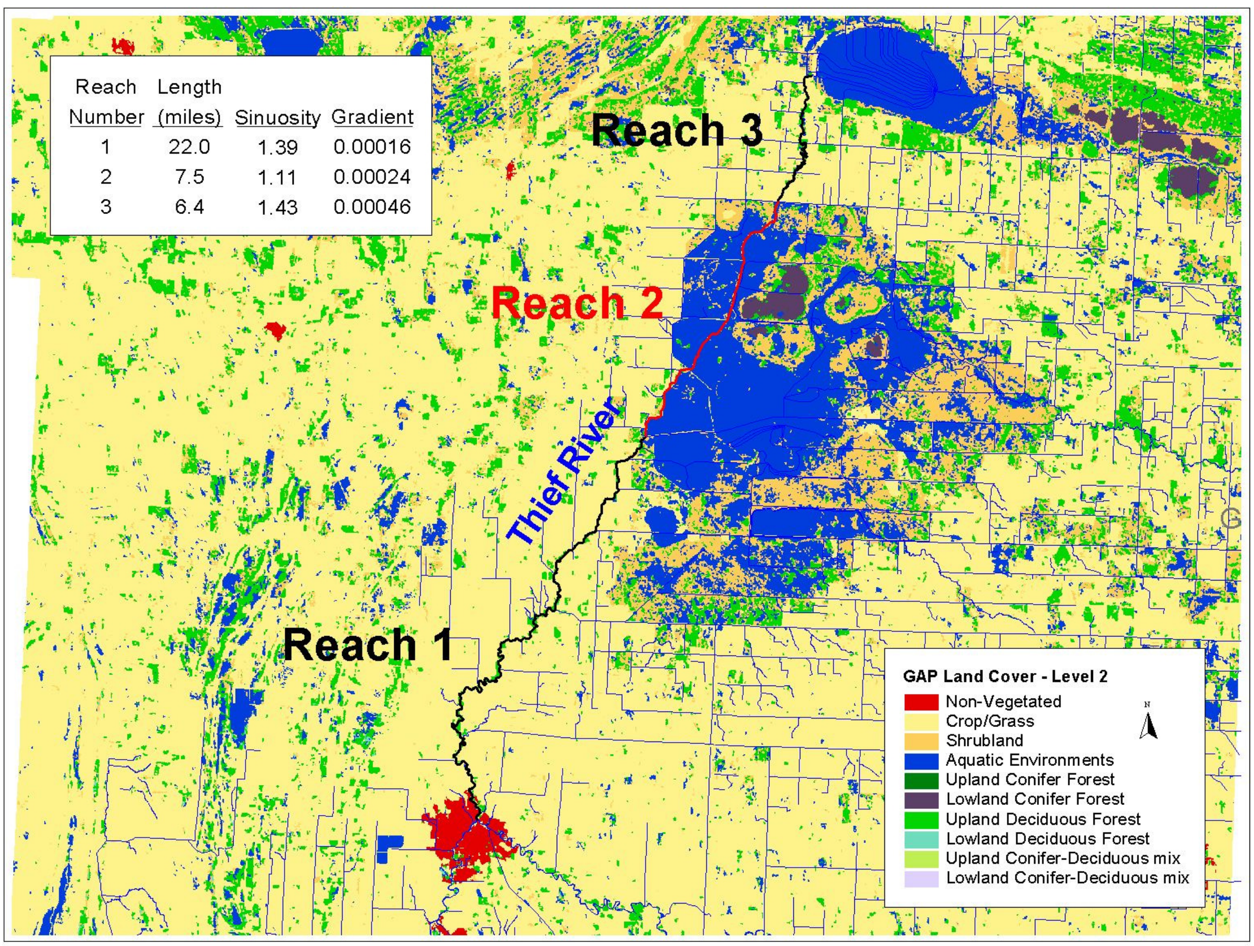


Figure 17. Delineated reaches of Thief River.

Table 10. Descriptions of Thief River delineated reach boundaries.

Reach Number	Reach Boundary Descriptions
	Thief River
1	Red Lake River confluence to the outlet of Mud Lake
2	Outlet of Mud Lake to the inlet to Mud Lake
3	Inlet to Mud Lake to the outlet of Thief Lake.

Other Streams

Red Lake River, Clearwater River and Thief River are the major streams in the watershed and of primary interest from a fisheries perspective. Notable tributaries to these major streams include: Burnham Creek, Lost River, Black River, Poplar River, Hill River and Badger Creek (Figure 13). Many of these tributary streams provide important habitat for a variety of aquatic organisms at various life history stages. The contribution to the cumulative impacts of downstream waterways, including Red River of the North, resulting from channel and watershed disturbances associated with these smaller tributary streams cannot be understated.

Designated Trout Waters

Several stream segments located in the Red Lake River watershed below Lower Red Lake are State of Minnesota designated trout waters according to Minnesota Rule 6264.0050.

Beltrami County. The segment Clearwater River designated as trout waters includes portions located in Township 148, Range 35, sections 5, 6, 8, 17, 20, 29, 31, and 32, and in Township 149, Range 35, sections 20, 29, 31 and 32. This ranges from the inlet of Clearwater Lake to the Beltrami/Clearwater county line (Reaches 6 and 7, Figure 15). This stream segment is marginally suitable for trout and is managed by the MN DNR Bemidji area fisheries office as an annually stocked put-and-take trout stream.

A one-mile segment of Spring Lake Creek located in Township 148, Range 35, sections 34 and 35, or 1.5 miles east of the town of Pinewood, is also trout waters. This is the headwater portion of a stream that connects Whitefish Lake, Little Buzzle Lake and Buzzle Lake before emptying into Clearwater River approximately 2 miles downstream from the upstream boundary of Clearwater River Reach 6. Although these are designated trout waters, there is currently no active trout management occurring.

Clearwater County

A 5.3 mile segment of Lost River located Township 148, Range 38, sections 20, 21, 22, 27 and 28, or approximately 6 miles NNE of the city of Bagley, and Nasset Creek, a small tributary to Lost River located (T148, R38, sec. 20, 28 and 29) are designated trout waters. Although these are designated trout waters, there is currently no active trout management occurring.

Polk County

A 1.5 mile segment of Lengby Creek located T147 R39, sec. 33 and 34 is designated trout waters. This stream segment empties into the east side of Spring Lake, which is situated on the southern edge of the city of Lengby. Although these are designated trout waters, there is currently no active trout management occurring.

METHODS

Fish sampling was a coordinated effort between the Minnesota Department of Natural Resources' Red River fisheries staff (DNR-RR) and the Red Lake Watershed District (RLWD). Fish data supplied by RLWD was collected by Red Lake Indian Reservation fisheries staff. Raw data from Clearwater River was supplied by the RLWD and analyzed for this report.

Sample Stations

Sampling was conducted at 36 stations in streams within the Red Lake River watershed in the summers of 2003 and 2004 (Table 11, Figure 18).

Physical and biological stream characteristics investigated at various stations included:

- ***Fish community assessment***: Fish community assessments provide quantitative information describing the species and numbers of fish at locations throughout the watershed. The condition of fish communities reflects the condition of a stream.
- ***Fish habitat evaluation***: The characteristics of instream habitat play a key role in determining the numbers, sizes, and species of fish that a stream can support. Information on fish habitat is vital to stream fisheries management.
- ***Stream morphology and classification***: Stream morphology descriptions provide information that can be used to assess current stream condition and stability, monitor changes over time and allow comparisons to other streams.
- ***Stream bank stability assessment***: Stream bank stability reflects whether or not a stream is functioning naturally. A stable stream will maintain a consistent dimension, pattern and profile over time and the stream bank stability assessment provides information to determine if these characteristics are consistent or if they are changing.

Fish Community Assessment

Fish communities were sampled at nine stations by DNR-RR during low flow conditions (Table 11, Figure 19). Station lengths were 35 times the mean stream width. Backpack, tow barge or boat, electrofishing gear was used depending on stream width and water depth at the time of sampling. Fish communities were sampled at 15 stations (Table 11, Figure 19) in Clearwater River by RLWD following the rapid bioassessment procedures developed by the U.S. Environmental Protection Agency (Barbour et al. 1999).

After capture, fish were identified, measured for length, weighed, examined for diseases and anomalies (e.g., tumors) and released. Fish species that could not be identified in the field were preserved and identified in the laboratory.

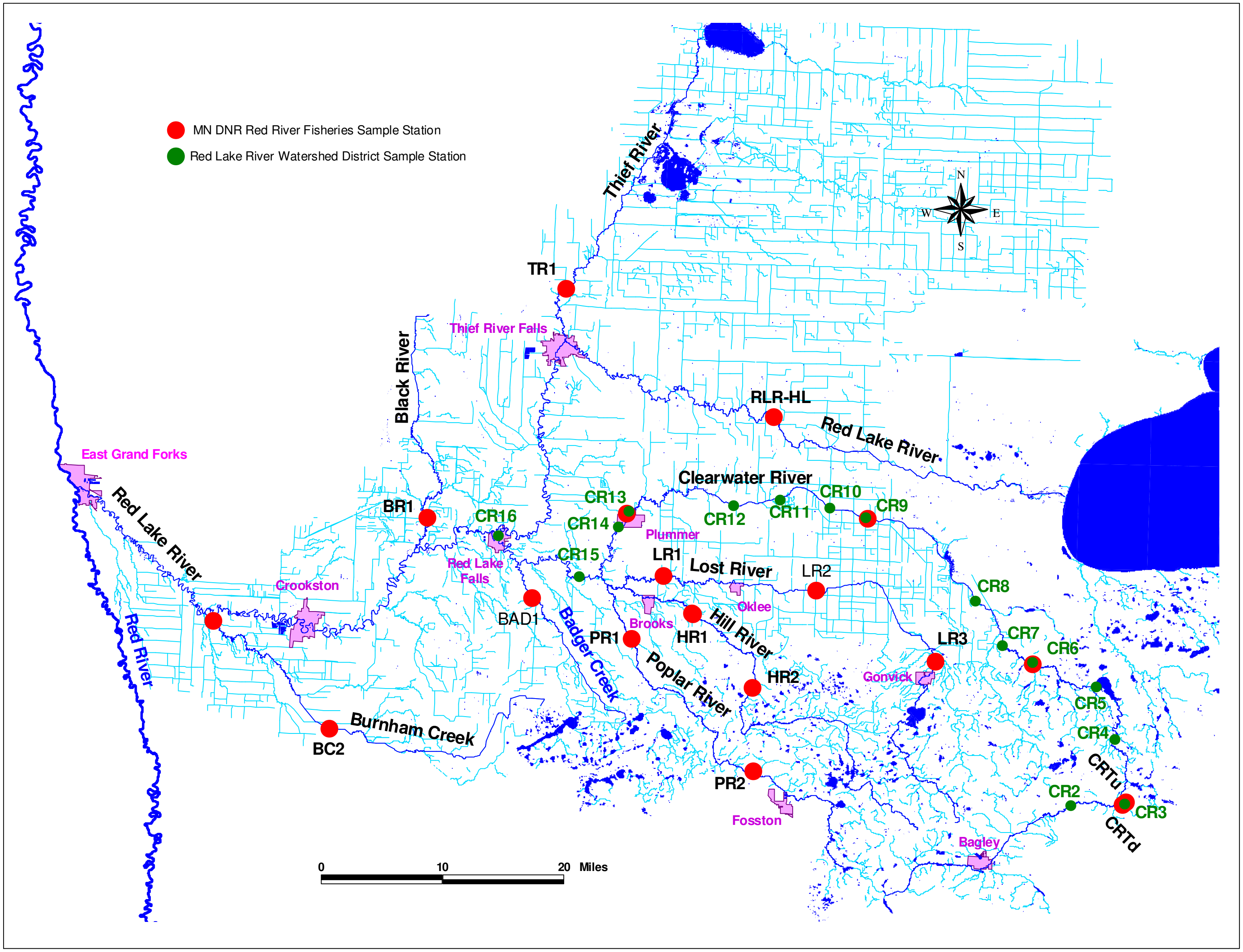


Figure 18. Sample station locations in the Red Lake River watershed during the summers of 2003 and 2004.

Table 11. Types of sampling completed at stations in the Red Lake River watershed in 2003 and 2004 conducted by MN DNR Red River fisheries staff (DNR-RR) and the Red Lake Watershed District (RLWD).

Station	Stream/Waterway	Fish Assessment	Fish Habitat Evaluation	Stream Morphology	Stream Bank Stability
LR1	Lost River	DNR-RR	DNR-RR	DNR-RR	DNR-RR
LR3	Lost River	DNR-RR	DNR-RR	DNR-RR	DNR-RR
LR2	Lost River		DNR-RR	DNR-RR	DNR-RR
RLR-HL	Red Lake River	DNR-RR			
HR1	Hill River		DNR-RR	DNR-RR	DNR-RR
HR2	Hill River	DNR-RR	DNR-RR	DNR-RR	DNR-RR
PR1	Poplar River	DNR-RR	DNR-RR	DNR-RR	DNR-RR
PR2	Poplar River	DNR-RR	DNR-RR	DNR-RR	DNR-RR
BAD1	Badger Creek		DNR-RR	DNR-RR	
BC1	Burnham Creek		DNR-RR	DNR-RR	DNR-RR
BC2	Burnham Creek	DNR-RR	DNR-RR	DNR-RR	DNR-RR
BR1	Black River	DNR-RR	DNR-RR	DNR-RR	DNR-RR
TR1	Thief River	DNR-RR			
CR2	Clearwater River	RLWD			
CRTd	Clearwater River		DNR-RR	DNR-RR	DNR-RR
CRTu	Clearwater River		DNR-RR	DNR-RR	DNR-RR
CR3	Clearwater River	RLWD	RLWD		
CR4	Clearwater River	RLWD	RLWD		
CR5	Clearwater River	RLWD	RLWD		
CR6	Clearwater River	RLWD	RLWD	DNR-RR	
CR7	Clearwater River	RLWD	RLWD		
CR8	Clearwater River	RLWD	RLWD		
CR9	Clearwater River	RLWD	RLWD	DNR-RR	
CR10	Clearwater River	RLWD	RLWD		
CR11	Clearwater River	RLWD	RLWD		
CR12	Clearwater River	RLWD	RLWD		
CR13	Clearwater River	RLWD	RLWD		
CR14	Clearwater River	RLWD	RLWD		
CR15	Clearwater River	RLWD	RLWD		
CR16	Clearwater River	RLWD	RLWD		

Fish species index of biotic integrity (IBI) scores were calculated for each station using methods developed for the Lake Agassiz Plain (Niemela et al. 1998). Two different sets of twelve metrics were used: one a set for stations with drainage areas less than 200 square miles and the other was a set for stations with drainage areas of 200 to 1500 square miles. Metrics used were related to species richness and composition, trophic composition, reproductive guild, functional guild, and fish abundance and condition. According to Niemela et al. (1998), stream stations with scores from 12 through 20 are considered to have "very poor" biotic integrity, scores of 21 through 30 have "poor" integrity, scores of 31 through 40 have "fair" integrity, scores of 41-50 have "good" integrity and scores greater than 50 are determined to have "excellent" biotic integrity.

Fisheries data for each station was summarized into species composition and species catch per unit of effort tables. Standard length-weight regressions for Red River basin streams (MN DNR, unpublished data) were used to estimate biomass when fish were not weighed.

Instream Habitat

Instream habitat evaluations by DNR-RR were conducted at 13 stations following procedures outlined by Simonson et al. (1994; Table 11). Eighteen cross-section transects were established within each sample station. The first transect was located 0.5 mean stream width from the downstream boundary of the station and subsequent transects were positioned 2 mean stream widths apart. Stream habitat measurements of mesohabitat types (i.e., pool, riffle, run), water depth, depth of fines, substrate embeddedness, stream shading, substrate composition, and fish cover, as well as stream bank erosion, streamside land use and riparian buffer widths were taken along each transect. Data from all transects were pooled, and the mean value calculated for each numerical variable or the frequency of occurrence divided by total counts calculated for categorical data. Stream substrate and mesohabitat type information by RLWD was collected on 15 stations following procedures outlined in Barbour et al. (1999).

Stream Morphology and Classification

Stream morphology evaluation procedures were conducted on 15 stations (Table 11) following methods described in Rosgen (1996). Channel cross-section, longitudinal profile and substrate particle composition were surveyed at each sample stations. Survey data were used to estimate bankfull cross sectional areas and dimensionless ratios (i.e., width to depth ratio, slope, sinuosity, riffle: pool ratio, etc) needed to describe stream morphology and classify the stream segments according to Rosgen (1996). Surveys were conducted using laser levels, and cross-sections and station boundaries were geo-referenced using Garmin XL12 global positioning receivers.

Stream Bank Stability

Twelve sample stations were evaluated for stream bank stability (Table 11). Methods to evaluate stream bank stability followed those described in Pfankuch (1975) with modifications recommended in Rosgen (1996). Station lengths of 35 times the mean stream width were used to rate 15 data categories describing various characteristics of the stream bottom (wetted width), lower stream bank (water's edge to the bankfull height) and upper banks (bankfull height to flood prone height). Pfankuch's stream channel rating system was developed before stream classifications were invented and originally returned an average stability rate regardless of the stream type to which it was applied. Rosgen (1996) developed a conversion that, when applied to the Pfankuch system, adjusted the rating system account for different stream types.

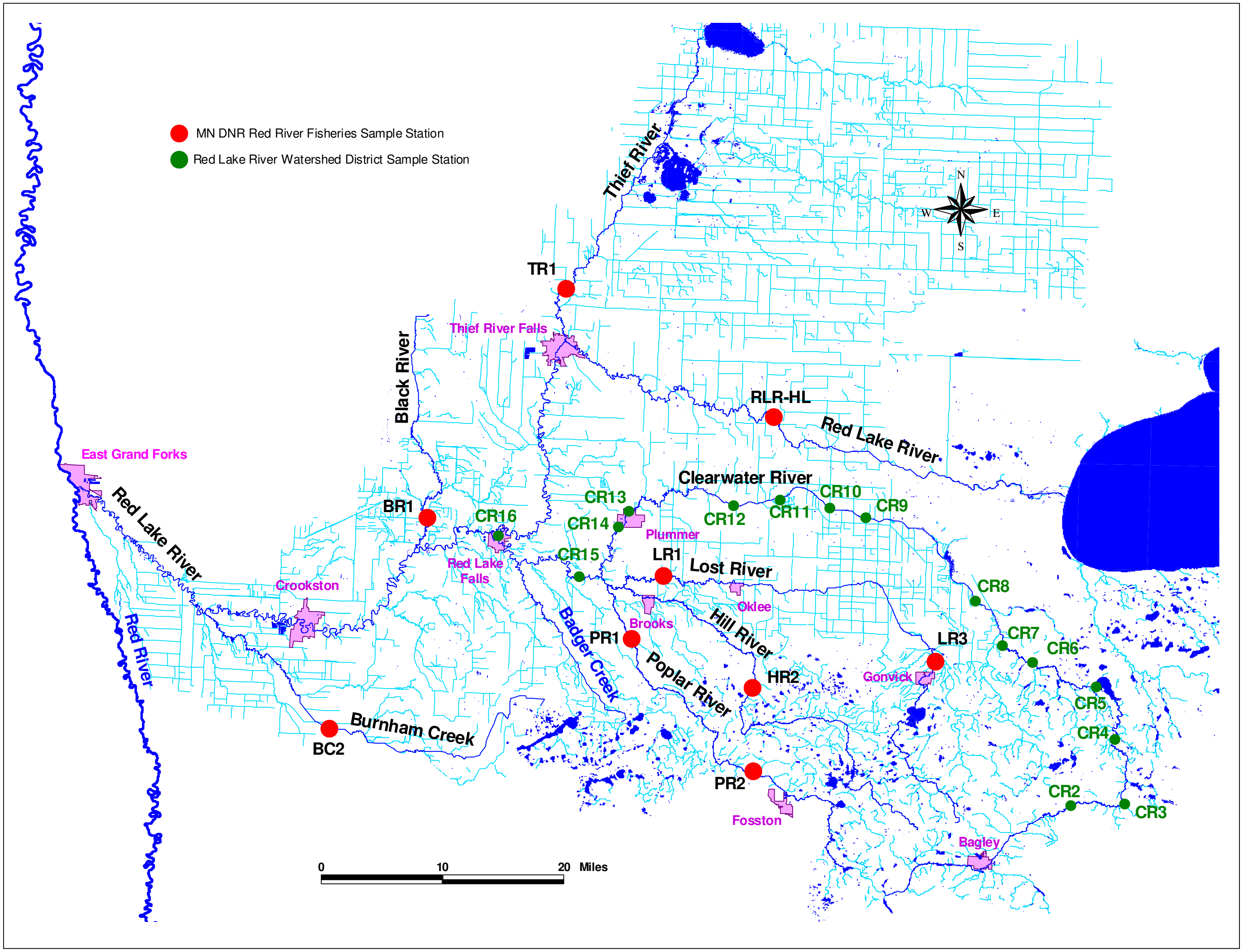


Figure 19. Fish sampling station locations within the Red Lake River watershed during the summers of 2003 and 2004.

RESULTS

The following results are a combination of sampling by DNR-RR and RLWD. Sampling by RLWD was designed for a rapid bioassessment and not to provide a complete fish community description at each individual station, this data was omitted from various analyses when appropriate.

Fish Community

Forty-nine fish species were sampled in the Red Lake River watershed in the summers of 2003 and 2004 (Tables 12 and 13). Fish species richness was positively correlated with drainage area (r=0.69) at stations sampled by DNR-RR. Species richness was highest (22 species) at Lost River stations LR1 and Black River station BR1. Species of special interest sampled at both stations included the carmine shiner and smallmouth bass. Carmine shiners were also found at one other station (LR3) in the watershed. Only two fish species, northern redbelly dace and central mudminnow, were found at station PR2 (Table 12). The unusually low species diversity at this station was likely due to an upstream point source discharge. Removing PR2 resulted in a correlation between species richness and drainage increase to r=0.79. Species richness at other stations varied from 8 at Clearwater River stations CR7, CR8 and CR11, to 18 at Thief River station TR1.

White sucker were found at 21 of the 24 stations sampled (Tables 12 and 13). Seven species sampled were found at only one station, and only one individual fish was sampled of each of the following species: golden shiner, blacknose shiner, silver redhorse and freshwater drum. Sampling by RLWD found mottled sculpin only at stations CR3 and CR4, which are both located within the designated trout waters.

Nineteen fish species that are considered to be sensitive to environmental disturbances, such as water quality and habitat degradation are known to occur in the Red Lake River watershed (Niemela et al. 1998; Appendix B, Table B2). Fifteen of these 19 sensitive species were sampled during the summers of 2003-04 in the Red Lake River watershed including: hornyhead chub, blackchin shiner, blacknose shiner, carmine shiner, sand shiner, mimic shiner, northern redbelly dace, finescale dace, longnose dace, silver redhorse, golden redhorse, shorthead redhorse, stonecat, rock bass and smallmouth bass. Sensitive species were widespread through out the watershed; at least one environmentally sensitive species was sampled at each station except CR7. Ten sensitive species were found in Black River station BR1 and nine were found at LR1. The number of sensitive species found at a station was positively correlated to the final IBI score (r=0.624).

Table 12. Fish species sampled by DNR-RR at stations in Lost River (LR), Red Lake River (RLR), Hill River (HR), Poplar River (PR), Burnham Creek (BC), Black River (BR) and Thief River (TR).

	Sample Station								
Species	**LR1**	**LR3**	**RLR-HL**	**HR2**	**PR1**	**PR2**	**BC2**	**BR1**	**TR1**
Chestnut lamprey	X								
Silver lamprey	X								
Brassy minnow					X				
Common shiner	X	X	X	X	X		X	X	X
Hornyhead chub	X	X	X	X				X	X
Golden shiner					X				
Emerald shiner	X							X	
Bigmouth shiner					X		X	X	X
Blackchin shiner								X	
Blacknose shiner			X						
Spottail shiner			X						X
Carmine shiner	X	X						X	
Sand shiner	X							X	
Mimic shiner	X		X		X		X		X
Northern redbelly dace				X	X	X		X	X
Finescale dace									X
Bluntnose minnow								X	
Fathead minnow	X				X		X	X	X
Western blacknose dace	X	X			X			X	
Longnose dace	X	X			X			X	
Creek chub	X	X		X	X		X	X	X
White sucker	X		X	X	X		X	X	X
Silver redhorse			X						
Golden redhorse	X	X	X						
Shorthead redhorse	X		X					X	X
Black bullhead				X			X		
Stonecat								X	
Tadpole madtom				X			X		
Northern pike	X		X	X					X
Central mudminnow	X	X		X	X	X	X	X	X
Brook stickleback				X	X			X	X
Rock bass	X		X	X				X	X
Pumpkinseed		X		X					
Bluegill	X	X							
Smallmouth bass	X				X			X	
Black crappie				X					
Iowa darter		X		X					
Johnny darter	X	X		X	X			X	X
Yellow perch			X						X
Blackside darter	X	X	X	X	X		X	X	X
Walleye			X						
Freshwater drum			X						
Total Number of Species	22	13	15	16	16	2	10	22	18
Total Number of Individuals	2,113	142	252	200	755	154	60	382	649

Table 13. Fish species sampled by RLWD at stations in Clearwater River. The total number of species found at some stations was not listed when more than one unidentified fish was reported in any single taxonomic category (e.g., "unidentified shiner").

	Sample Station														
Species	**CR2**	**CR3**	**CR4**	**CR5**	**CR6**	**CR7**	**CR8**	**CR9**	**CR10**	**CR11**	**CR12**	**CR13**	**CR14**	**CR15**	**CR16**
Chestnut lamprey					X								X		
Silver lamprey			X												X
Common shiner	X	X			X	X	X	X	X	X	X				
Hornyhead chub	X				X					X		X			
Unidentified shiner	X										X		X		X
Northern redbelly dace													X		
Finescale dace					X		X		X		X	X	X	X	X
Bluntnose minnow													X	X	X
Fathead minnow					X	X	X	X	X	X	X	X			
Western blacknose dace	X	X	X		X						X		X	X	X
Longnose dace		X	X											X	X
Creek chub	X	X	X	X	X	X					X	X	X	X	X
Quillback					X										
White sucker	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Unidentified redhorse								X	X						
Black bullhead				X				X							
Yellow bullhead				X		X							X	X	X
Stonecat							X								X
Northern pike				X								X			
Central mudminnow	X	X	X	X			X	X	X	X	X			X	X
Brook stickleback	X					X	X	X	X	X	X	X	X		
Rock bass				X	X							X		X	
Pumpkinseed				X											
Bluegill				X		X		X		X		X		X	
Smallmouth bass														X	X
Largemouth bass	X		X	X											
Black crappie	X			X											
Iowa darter			X	X	X			X	X	X	X	X	X	X	X
Johnny darter		X	X		X		X	X	X		X	X	X	X	
Yellow perch			X	X		X			X		X		X		
Mottled sculpin		X	X												
Brown Trout		X													
Total Number of Species		9	11	13	12	8	8	10	9	8		11		13	
Total Number of Individuals	78	59	52	155	85	115	128	48	146	43	125	96	127	132	285

Fifteen fish species considered to be to be highly tolerant to environmental disturbances including water quality and habitat degradation are known to occur in the Red Lake River watershed (Niemela e al. 1998; Appendix B, Table B3). Of these 15 tolerant species 10 were sampled during the summers of 2003-04 in the Red Lake River watershed including: golden shiner, bluntnose minnow, fathead minnow, western blacknose dace, creek chub, white sucker, central mudminnow, brook stickleback and quillback. Tolerant fish species were found at all stations and comprised more than 50% of the total individuals sampled at nine stations, which included eight of the 10 downstream-most stations on Clearwater River (i.e., CR7 through CR16). The percentage of the total number of fish sampled that were of a tolerant species was negatively correlated with IBI scores (r = -0.722).

No Minnesota State or Federally listed endangered or threatened species are known to inhabit streams in the Red Lake River watershed. The lake sturgeon, a Minnesota State listed species of special concern, was not sampled but is known to be present in Red Lake River as a result of ongoing population restoration efforts.

Fish Abundance. A total of 6,380 fish were sampled across the watershed; 4,707 by DNR-RR and 1,673 by RLWD. Common shiner was the most numerically abundant species found comprising 20.3% of all fish sampled in the watershed, followed by white sucker (14.5%) and creek chub (14.5%). The relative abundance of fish within a sample station, expressed as the number of fish caught per hour of effort (CPUE), varied greatly among sampling stations (Appendix A, Table A21). The two highest CPUE were from Lost River station LR1 (1,427.7 fish/hour) and Poplar River station PR1 (1126.9). The two lowest CPUEs were from Clearwater River station CR11 (120.7 fish/hour) and Burnham Creek station BC2 (125.0). CPUE for Hill River station HR2 was not available due to equipment failure.

Fish Biomass. The total fish biomass in the watershed was dominated by catastomids, which accounted for 67.7% of the 117.5 kg sampled and dominated the catch at 14 of the 24 stations. White sucker comprised the highest percentage (37.5%) of the total biomass and dominated the catch at 10 of the 24 stations. Shorthead redhorse made up the next highest proportion of the biomass (24.0%) followed by greater redhorse (14.6%) at stations sampled by DNR-RR; redhorse species were not identified to species by RLWD. Northern pike dominated the fish biomass at stations CR5 and CR13 and no other species was dominant at more than one station.

Summaries of fish sampling efforts can be found in Appendix C, Table C1. Summaries of fish species composition and species catch rates associated with each sample station can be found in Appendix C, Tables C2 through C14. Catch rates (cpue) for each fish species at each sample station can be found in Appendix C, Table C15.

<u>Fish Species Index of Biotic Integrity (IBI)</u>

IBI scores ranged from 16 at Poplar River station PR2 to 48 at Thief River station TR1 (Table 14, Figure 20). Biotic integrity was good at six of the 20 stations where IBI was calculated, fair at five stations, poor at seven stations and very poor at two stations (Table 14). IBI scores were positively correlated with drainage area but the correlation was very weak (r =0.13).

Individual metric scores varied between stations. The species richness index scored the highest possible value of five at 11 stations. A species richness value of three was scored at eight stations including all seven IBI stations on Clearwater River from CR7 downstream up to and including CR15. Only one station, Poplar River P2, scored the lowest possible species richness value of one. Headwater fishes were under-represented in smaller streams.

Only two of the 10 stations with drainage areas less than 200 mi^2, BR1 and CR6, had a percent headwater individual metric score higher than one. Large river fishes were under-represented at station RLR-HL, the only station with a drainage area larger than 1500 mi^2; where the metric associated with the proportion of larger river individuals scored the lowest possible value of l.

IBI scores were positively correlated with the number of sensitive species present (r = 0.624). Four or more sensitive species were found at six of the eight stations with IBI scores 40 or greater. Similarly, stations where tolerant species comprised the highest percentage of the total number of fish sampled was negatively correlated with IBI scores (r = -0.72). Twelve stations had IBI scores less than 40, which included all 10 stations that were comprised of more than 60% tolerant individuals

The fish abundance metric was scored a one at all stations except LR1 and TR1, which each scored a 3. A substantial number (4.6%) of the fish collected at station LR1 had tumors, so this metric scored the lowest value of 1 for this station. The tumors were found in common shiners and identified by Don Cloutman (Bemidji State University) as *Thelohanellus notatus*, a myxosporidan parasite with the potential to cause harm to host fish including weight loss and mortality. Few deformities, eroded fins, lesions or tumors (DELT) were found at the remaining stations. IBI metrics and scores associated with each station can be found in Appendix D, Tables B1, B2 and B3.

Table 14. Fish IBI scores (Niemela et al. 1998) calculated for stations in the Red Lake River watershed sampled in the summers of 2003 and 2004.

Stream	Station Number	Gear	IBI Score	Biotic Integrity Classification
Burnham Creek	BC2	Backpack	30	Poor
Black River	BR1	Backpack	42	Good
Clearwater River	CR3	Backpack	40	Fair
Clearwater River	CR4	Backpack	34	Fair
Clearwater River	CR5	Backpack	32	Fair
Clearwater River	CR6	Backpack	44	Good
Clearwater River	CR7	Backpack	26	Poor
Clearwater River	CR8	Backpack	24	Poor
Clearwater River	CR9	Backpack	22	Poor
Clearwater River	CR10	Backpack	28	Poor
Clearwater River	CR11	Backpack	20	Very Poor
Clearwater River	CR13	Backpack	24	Poor
Clearwater River	CR15	Backpack	30	Poor
Lost River	LR1	Tow Barge	42	Good
Lost River	LR3	Backpack	44	Good
Poplar River	PR1	Tow Barge	42	Good
Poplar River	PR2	Tow Barge	16	Very Poor
Hill River	HR2	Tow Barge	38	Fair
Thief River	TR1	Tow Barge	48	Good
Red Lake River	RLR-HL	Boat	40	Fair

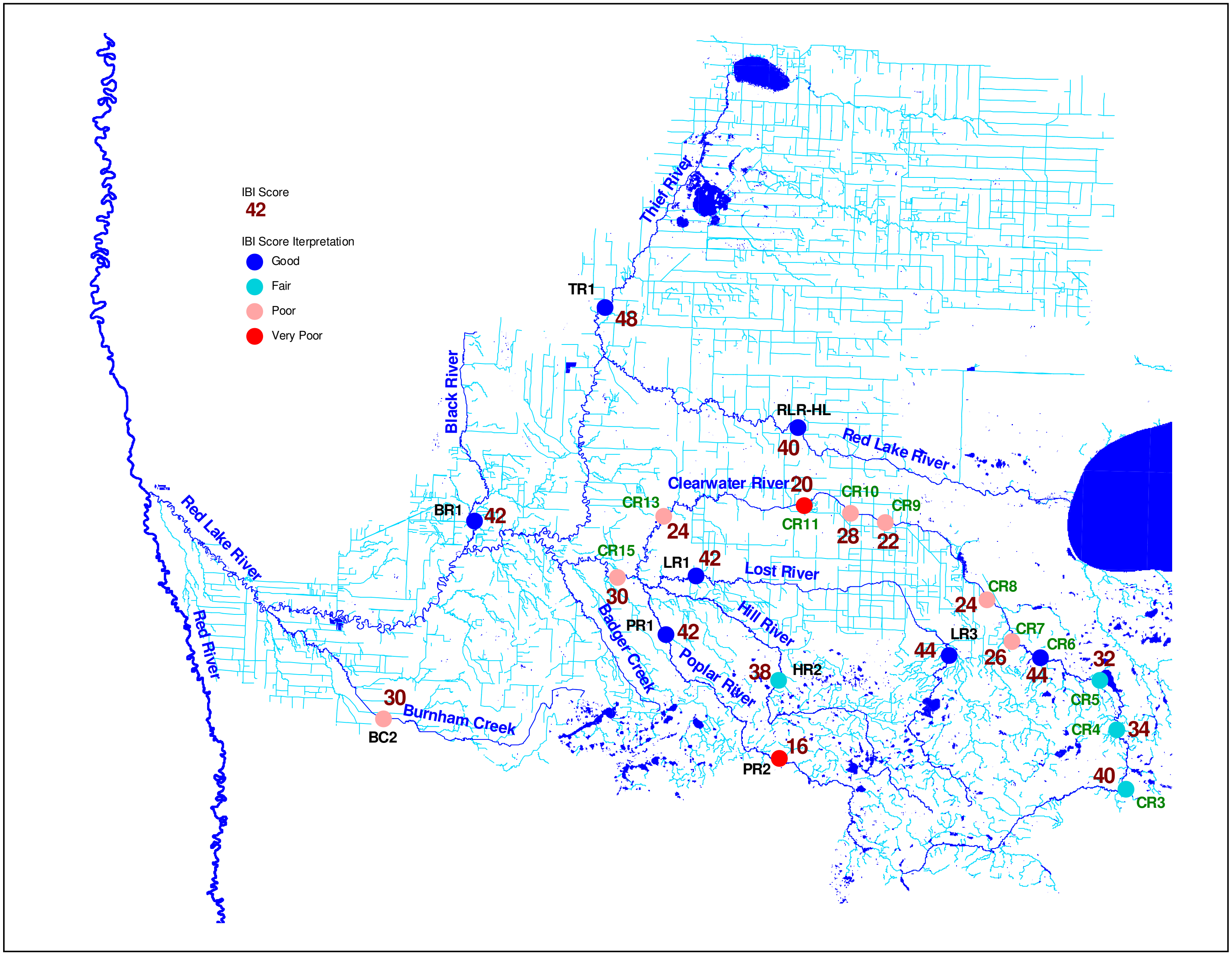


Figure 20 Distribution of IBI scores (Niemela et al. 1998) at Red Lake River watershed sample stations.

Game Fish

Major game fish species sampled were northern pike, walleye, smallmouth bass and largemouth bass. Channel catfish, brown trout and rainbow trout are also known to be present in the watershed.

Northern pike. Northern pike were sampled at six stations in the watershed (Figure 21). DNR-RR sampled five northern pike ranging in length from 138 to 201 mm total length at the Red Lake River station RLR-HL and six northern pike at Thief River station TR1 ranging from 224 to 395 mm total length. Seven northern pike, ranging from 224 to 510 mm total length were sampled at Lost River station LR1 and one 170 mm northern pike was sampled at Hill River station HR2. RLWD sampled one 590 mm northern pike at Clearwater River station CR5 and one 319 mm northern pike at CR13.

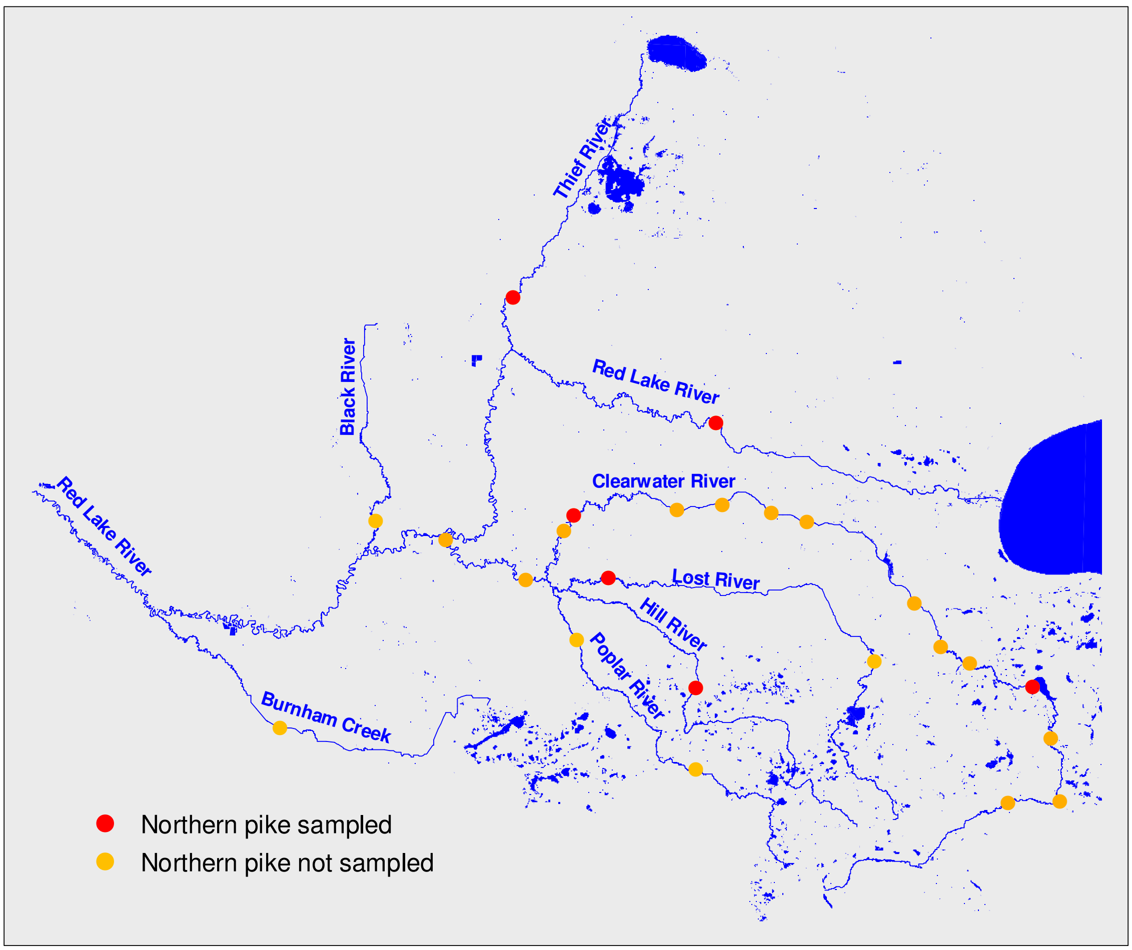


Figure 21. Distribution of northern pike sampled in the Red Lake River watershed in 2003-04.

Walleye. Walleye were found at stations located in Thief River and Red Lake River. Walleye are likely scattered in low numbers throughout the watershed in isolated pockets where there is adequate habitat but they are primarily found in Red Lake River, Thief River and, likely, the downstream reaches of major tributaries (Figure 22). The MN DNR stocks walleye in several lakes throughout the watershed, however, it appears that many of the streams that potentially receive walleye emigrating from these lakes do not have the ability to support resident populations.

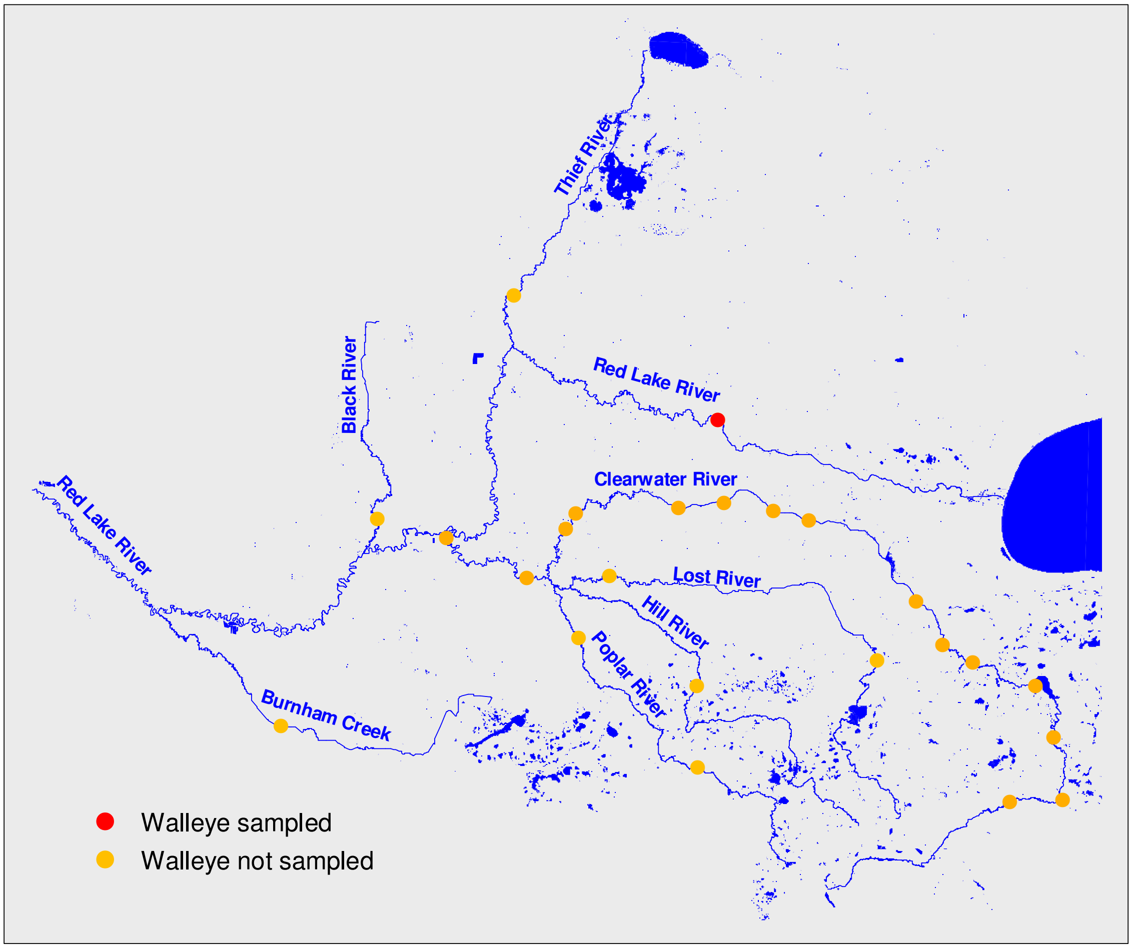


Figure 22. Distribution of walleye sampled in the Red Lake River watershed in 2003-04.

Smallmouth bass. Smallmouth bass were originally stocked in lower Red Lake River by MN DNR in 1985. Since then, this species has become well established in the watershed and has become a popular sport fish among anglers. Smallmouth bass distribution during the sample period was limited to stations located in downstream segments of Clearwater River, the downstream segments of tributaries to Clearwater River, and Black River near the Red Lake confluence (Figure 23).

Two hundred thirty two (232) smallmouth bass ranging from 35 to 175 mm, including only 3 over 80 mm, were sampled at Lost River P1. Large adult smallmouth bass were observed at P1 but not sampled, as were several groups of recently hatched young-of-year smallmouth bass. Twenty-five (25) SMB ranging from 46 to 82 mm were sampled at Poplar P1 and 37 ranging from 41 to 52 mm total length were sampled from Black River. In Clearwater River, three smallmouth bass ranging from 87 to 241 mm were sampled at CR15 and two (80 and 87 mm) were sampled at CR16. No smallmouth bass were found in either Thief River or Red Lake River upstream from the Red Lake River dam at Thief River Falls.

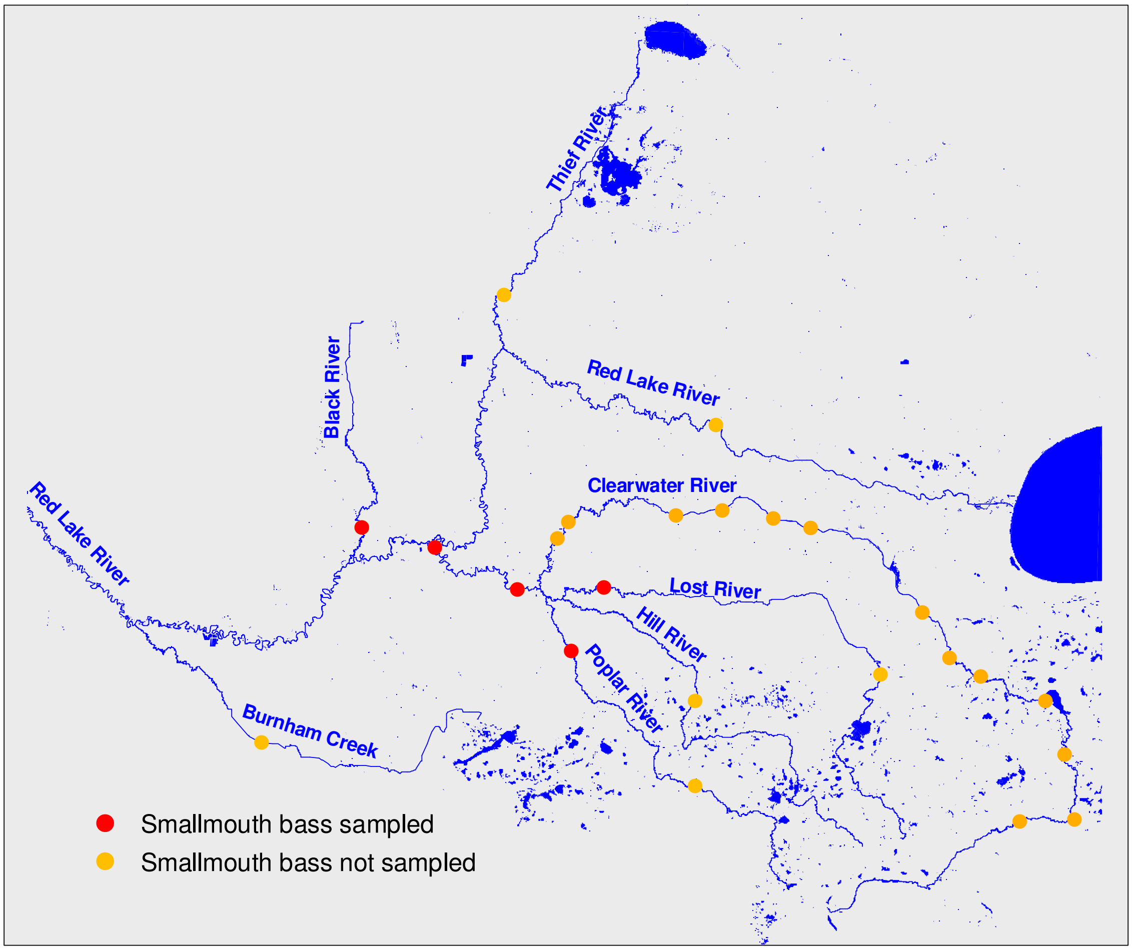


Figure 23. Distribution of smallmouth bass sampled in the Red Lake River watershed in 2003-04.

Stream Morphology and Classification

Stream morphology data was collected at 15 stations in the Red Lake River watershed (Table 15).

Bankfull Width and Depth: The narrowest bankfull width estimate was 17.5 feet at station BC 2 in the County Ditch 12 segment of Burnham Creek and the widest was 46.1 feet at CR9 on Clearwater River. Bankfull widths were correlated to drainage area (r=0.63). Bankfull cross-sectional areas ranged from 30.9 ft^2 at Lost River station LR3 to 216.6 ft^2 at CR9. Bankfull cross-sectional areas were correlated with drainage area (r= 0.79) and comparable to those of other streams in Red River Basin (Figure 24; MN DNR, unpublished data). Stream channel width-to-depth ratios ranged from 8.8 at BC2 to 28.5 at CRTd. Mean bankfull depths ranged from 1.3 ft at CRTu and CRTd, to 4.7 ft at CR9.

Table 15. Stream morphology (Rosgen 1996) summary statistics for streams sampled in the Red Lake River watershed**.**

Stream	Station Number	Drainage Area (mi^2)	Bankfull Width (ft)	Mean Depth (ft)	Bankfull XS Area (ft^2)	Width/Depth Ratio	Flood Prone Width (ft)	Entrenchment Ratio	D50 Substrate Type	Water Surface Slope	Sinuosity	Rosgen Stream Type
Burnham Creek	BC1	166.9	40.5	4.2	169.9	9.7	120	3.0	silt/clay	0.00520	2.2	E6
Burnham Creek	BC2	73.9	17.5	2.0	35.5	8.8	50.0	2.9	silt/clay	0.00031	1.2	E5
Poplar River	PR1	113.0	25.9	2.9	60.0	8.9	163.4	6.3	sand	0.00262	1.9	E5
Poplar River	PR2	77.0	20.6	1.8	37.7	11.2	218	10.6	silt/clay	0.00060	1.8	E6
Hill River	HR1	143.4	19.5	3.4	46.9	8.1	627	27.0	sand	0.00052	2.1	E5
Hill River	HR2	103.7	41.8	1.5	63.2	27.7	231	5.5	silt/clay	0.00064	1.5	C6c
Lost River	LR1	289.2	43.5	3.0	131.0	14.4	91.7	2.1	gravel	0.00105	2.5	C4c-
Lost River	LR2	195.2	34.5	4.2	120.6	9.9	74.3	2.2	silt/clay	0.00002	1.1	B6
Lost River	LR3	75.8	24.0	1.6	30.9	18.6	36.0	1.5	sand	0.00151	1.5	F5
Clearwater River	CRTu	124.7	37.4	1.3	55.8	27.9	141.6	3.8	gravel	0.00353	1.4	C4
Clearwater River	CRTd	126.9	37.0	1.3	47.2	28.5	56.4	1.5	gravel	0.00351	1.3	B4c
Clearwater River	CR6	196.6	43.3	2.9	127.4	14.7	123.0	2.8	gravel	0.00055	1.8	C4c-

Table 15 (continued).

Stream	Station Number	Drainage Area (mi^2)	Bankfull Width (ft)	Mean Depth (ft)	Bankfull XS Area (ft^2)	Width/Depth Ratio	Flood Prone Width (ft)	Entrenchment Ratio	D50 Substrate Type	Water Surface Slope	Sinuosity	Rosgen Stream Type
Clearwater River	CR9	404.1	46.1	4.7	216.6	9.8	88	1.9	sand	0.00300	1.1	B5c
Black River	BR1	142.1	26.2	1.8	48.2	14.6	34.7	1.3	gravel	0.00794	2.0	F4
Badger Creek	BAD1	47.8	34.5	3.3	112.7	10.6	132	3.8	sand	0.00065	1.7	E5

Entrenchment: Flood prone widths ranged from 36.0 feet at LR3 to 627.0 feet at Hill River station HR1. The stream was either entrenched or moderately entrenched (entrenchment ratios ≤2.2) at six stations and only slightly entrenched at nine stations (entrenchment ratios >2.2; Table 15). The lowest entrenchment ratio (1.3) was found at Black River station BR1 while that highest (27.0) was found at Hill River station HR1.

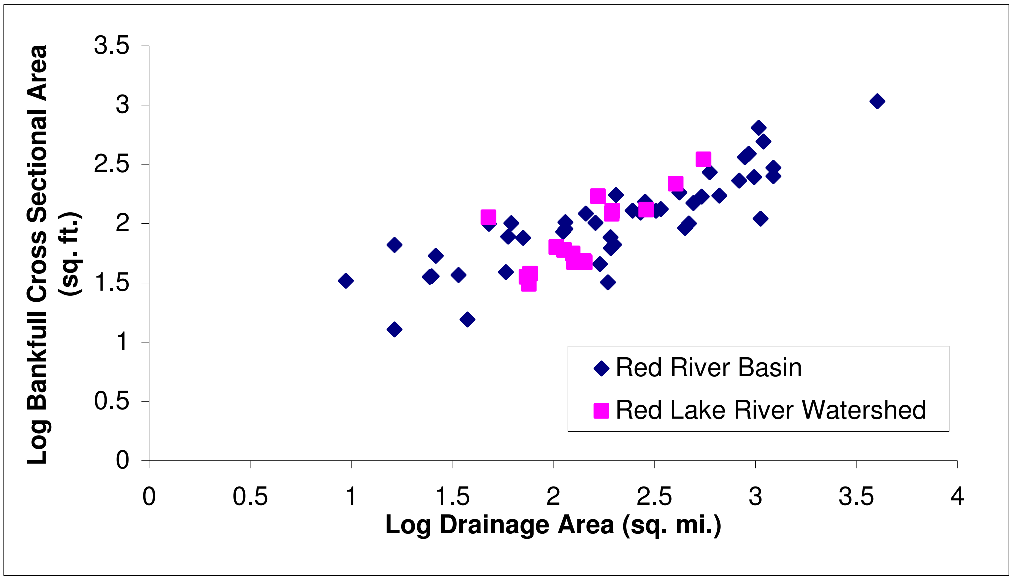


Figure 24. Relationship between drainage area and bankfull cross-sectional area for sample stations in the Red Lake River watershed and other stations throughout Red River Basin.

Sinuosity: Stream sinuosity was high (sinuosity >1.5) at 10 of the 15 stations, moderate (≥1.2 – 1.5) at three stations, and low (<1.2) at two stations. Stream sinuosity ranged from 1.1 at stations LR2 and CR9, to 2.5 at LR1.

Stream classification. Rosgen (1996) stream classification was determined at fourteen stations in the Red Lake River watershed (Table 15). Three stations were classified as B channels and four were C type channels. Six stations were classified at E channels including both stations on Burnham Creek and both stations on Poplar River. Two stations were F type channels. General characteristics of channel types identified in the Red Lake River watershed are shown in Table 16.

Table 16. General characteristics of channel types found in the Red Lake River watershed (Rosgen 1996).

Channel Type	Entrenchment	Width to Depth	Sinuosity
B	Moderately entrenched	Moderate	Moderate
C	Slightly entrenched	Moderate to high	High
E	Slightly entrenched	Very low	Very High
F	Entrenched	Moderate to high	Moderate

Stream Channel Stability

Stream channel stability was evaluated at 12 stations in the Red Lake River watershed (Table 8). Channel stability was good at Lost River station LR3 and Clearwater River station CRTu and fair at Burnham Creek station BC2 and Lost River station LR1. The remaining eight stations had poor channel stability (Table 17).

Channel stability was poor at both stations located on B type channels (LR2 and CRTd). The lack of upper stream bank protection provided by dense, multi-species vegetation with deep, soil binding root masses was a major contribution factor at both stations. In addition, the stream bottom at LR2 was comprised of a loosely consolidated stream bottom with few, if any, stable materials present.

Of the three C type channels, stability was good at CRTu, fair at LR1 and poor at HR2. Prevalent lower stream bank erosion, extensive deposits of predominantly fine substrate particles containing few stable materials, and the presence of a continually shifting stream bottom were the primary reasons for rating channel stability poor at HR2.

Channel stability was poor at four of the five E type channels (HR1, BC1, PR1, PR2) and fair at BC2. Prevalent lower bank erosion, extensive deposits of predominantly fine substrate particles, and a lack of stable stream bottom materials were factors at all stations with poor channel stability. Burnham Creek station BC1 had large areas of mass wasting on the upper stream banks.

Of the two F type channels, channel stability was good at LR3 and poor at BR1. Frequent and large areas of mass wasting on the upper stream banks and extensive lower bank erosion were primary factors contributing to the poor channel stability rating.

Table 17. Results of stream bank stability assessments (Pfankuch 1975) conducted at Red Lake River watershed sample stations in the summer of 2004.

Stream	Station ID	Stream Channel Stability Score	Stream Type (Rosgen 1996)	Interpretation
Black River	BR1	133	F4	Poor
Burnham Creek	BC1	129	E6	Poor
Burnham Creek	BC2	94	E5	Fair
Clearwater River	CRTu	80	C4	**Good**
Clearwater River	CRTd	93	B4	Poor
Hill River	HR1	122	E5	Poor
Hill River	HR2	113	C6	Poor
Lost River	LR1	103	C4	Fair
Lost River	LR2	107	B6	Poor
Lost River	LR3	90	F5	**Good**
Poplar River	PR1	129	E5	Poor
Poplar River	PR2	115	E6	Poor

Instream Habitat

Mesohabitat Types. Instream habitat was evaluated at 13 stations by DNR-RR and 15 stations by RLWD (Tables 18 and 19). The relative amounts of pool, riffle and run habitats present varied widely among sample stations, however, run habitat was by far the most common habitat present in the watershed. Run dominated nine of the 13 stations evaluated by DNR-RR including stations LR2, PR2 and BC2, which were comprised entirely of run habitat. Similarly, all 15 stations evaluated by RLWD were dominated by run habitat including stations CR4, CR5, CR10 and CR11, which were more than 90% run. Stations LR1, HR1, BR1, CRTd and BAD1 each contained a mix of pool, riffle and run mesohabitats, as did stations CR2, CR6, CR7, CR14 and CR15.

Water Depth. Water greater than 3 feet deep was generally limited within sample stations evaluated by DNR-RR (Table 18). Exceptions were Lost River station LR2 where more than half of the depth observations ranged from three to five feet, and Burnham Creek station BC1 where just over 24% of the observations exceeded 3 feet deep including one observation deeper than 5 feet. The distribution of water depths was not evaluated by RLWD.

Substrate particle composition. Silt was dominant at three stations including both stations located on Burnham Creek. The substrate at Burnham Creek station BC1 was comprised of the highest percentage of silt (100%) and Clearwater River station CRTd had the lowest (5%). Sand was the predominant substrate particle type present at eight of the 13 stations where instream habitat was evaluated by DNR-RR. Gravel was present at all stations except station BC1 and was the dominant particle substrate size at stations BR1 (53%) and CRTd (57%). Cobble/rubble was present at all stations except BC1; the highest percentage (28%) was found at CRTu. Boulders were present at nine stations but quantities were generally limited. No boulders were found at either station in Burnham Creek, HR1 or PR1 and the highest percentage of boulder (7%) was found at CRTu.

RLWD found a mix of substrate types throughout the sample stations located on Clearwater River (Table 19). Four of the five stations located within the channelized Reach 3 (CR8, CR9, CR10 and CR11), as well as station CR7 in Reach 4, had substrates comprised of at least 30% silt/clay. Four of the five stations located downstream of CR11 also had substantial amounts of silt/clay, however, only one station located upstream of CR7 (station CR5) had more than 6% silt/clay. Gravel was present at all stations; stations upstream of CR7 had noticeably more gravel than others. Cobble and boulder were present in all stations. Seven of the 15 stations on Clearwater River had cobble sized particles comprising 20% or more of the substrate; 6 or these seven were located in Reaches 1, 2, or 3 below Clearwater Dam. Stations CR7 contained 30% boulder and CR16 contained 20%. The remaining stations had 10% or less of boulder substrate including CR2, CR4, CR5 and CR10, all of which had 1%.

Fish Cover. Fish cover is reported as the percentage of a station's total surface area covered by each cover type. The least amount of fish cover was found at Lost River station LR3 (6.7%) and the highest amount was found at Poplar River station PR2 (75%). Three sample stations, LR3, HR1 and BC1, contained less than 10% fish cover and two stations, HR2 and PR2, had more than 60% fish cover.

Submerged vegetation provided the most fish cover at stations LR1, LR2, HR2, PR2 and CRTd, including 57.6% at PR2 and 53.1% at HR2. No submergent vegetation was found at either Burnham Creek station at Badger Creek station BAD1. Overhanging vegetation was the dominant fish cover at stations PR1, BR1, CRTu and BAD1. The amount of cover provided by woody material was less than 3% at 10 of the 13 stations, including station BC2 that had no woody fish cover. Burnham Creek station BC1 contained the most woody fish cover comprising 4.6% of the station.

Table 18. Summary of instream habitat characteristics within Red Lake River watershed sampling stations. Substrate composition values may not sum to 100% as a result of value rounding.

	Lost River			Hill River		Poplar River		Burnham Creek		Black River	Clearwater River		Badger Creek
	LR1	**LR2**	**LR3**	**HR1**	**HR2**	**PR1**	**PR2**	**BC1**	**BC2**	**BR1**	**CRTu**	**CRTd**	**BAD1**
Mesohabitat Types (%)													
Pool	11			22	22			28		11		17	28
Riffle	22		39	44		17				56	72	78	33
Run	67	100	61	33	78	83	100	72	100	33	28	6	39
Water Depth Distribution (No. of observations)													
0-1	43		48	20	16	18	18	9	7	51	12	20	23
>1-2	44	4	42	52	53	55	62	27	75	33	63	47	48
Depth >2-3	3	35		14	14	15	10	32	6	5	15	15	18
(ft) >3-4		46		4	5	2		10		1		5	1
>4-5		5			2			11				1	
>5								1					
Depth of Fine Materials* (ft)													
Minimum	0	>0.1	0	>0.1	0	>0.1	0	>0.1	>0.1	>0.1	0	0	0
Mean	0.2	0.6	0.1	0.4	0.5	0.5	0.5	0.7	0.3	0.3	0.1	0.3	0.3
Maximum	1.3	1.5	0.8	1.5	2.1	2.3	1.9	1.8	1.0	1.3	1.3	1.3	1.4
Substrate Particle Composition (%)													
Silt	14	32	23	29	46	18	65	100	77	12	11	5	22
Sand	49	57	42	51	50	62	20		6	31	34	35	49
Gravel	33	8	25	20	4	19	11		7	53	20	57	20
Cobble/rubble	3	2	9	0.1	0.1	0.3	4		10	3	28	3	6
Boulder	0.4	0.2	0.4	0	0.3	0	1		0	2	7	1	4
Fish Cover (%)													
Undercut Bank	0.3	2.9	0.8	2.0	2.4	2.6	5.5		5.6	3.2	0.9	1.8	0.8
Boulders		0.5	1.7		0.7	0.4	3.0			2.7	6.3	1.4	3.2
Overhang Veg.	3.1	4.6		1.5	0.2	19.0	3.0	0.2	2.1	3.7	13.1	2.9	10.1
Submerged Veg.	17.9	12.3	0.5	2.0	53.1	2.5	57.6			0.3	3.9	8.0	
Emergent Veg.	0.7	1.0	1.7	0.1	5.0	0.1	4.9	2.6	2.4	0.5	0.4	0.1	
Woody Material	0.3	1.5	2.0	2.2	0.9	2.5	1.0	4.6		3.5	0.7	1.7	3.1
Total Cover	22.3	22.8	6.7	7.8	62.3	27.1	75.0	7.4	10.1	13.9	25.3	15.9	17.2

* Depth of fine materials should only be used as a relative measure of fine particle deposition between sites in this study.

Table 19. Mesohabitat distribution (percent of station), stream substrate composition (percent of station) estimates, and habitat scores (Barboura et al. 1999) at RLWD sample stations on Clearwater River in 2003.

	Reach 7	Reach 6	Reach 5	Reach 4			Reach 3					Reach 2		Reach 1	
	CR2	**CR3**	**CR4**	**CR5**	**CR6**	**CR7**	**CR8**	**CR9**	**CR10**	**CR11**	**CR12**	**CR13**	**CR14**	**CR15**	**CR16**
Mesohabitat Distribution															
Pool	20	10	5	1	20	20	10	10	5	5	10	10	10	10	10
Riffle	10	10	5	2	10	20	10	10	5	5	10	10	20	20	10
Run	70	80	90	97	70	60	80	80	90	90	80	80	70	70	80
Substrate Composition															
Silt/Clay	3	6	6	24	6	30	30	30	70	30	20	25	20	0	20
Sand	42	30	44	10	33	20	15	15	14	25	25	25	25	25	20
Gravel	42	50	44	50	35	5	15	15	10	25	25	30	25	25	20
Cobble/rubble	12	11	5	15	20	5	30	30	5	10	25	15	25	40	20
Boulder	1	3	1	1	5	30	10	10	1	10	5	5	5	10	20
Habitat Score	162	194	162	168	167	150	127	107	101	152	164	154	176	164	155

DISCUSSION

The Red Lake River watershed contains a wide variety of lakes and streams with a vast network of tributaries. These waters provide habitat for all life stages of fish species found in the watershed. Significant aquatic resources in the Red Lake River watershed downstream of Lower Red Lake include, but are not limited to: Red Lake River, Red Lake River reservoir at Thief River Falls, Thief River, Clearwater River, Clearwater Lake, Pine Lake, and Lost River.

Fish Community
A diverse fish species assemblage exists across the Red Lake River watershed. Forty-nine of the 69 species known to have been sampled from waters in the Red Lake River watershed between 1962 and 2000 (Appendix B, Table B1; Aadland et al. 2005; Koel 1997) were sampled during this investigation. Many of the fish species known to occur but not sampled in this study were those that are more commonly found in larger river segments, such as bigmouth buffalo, goldeye and mooneye. Previous surveys (Huberty 1996; Huberty 2001) have found many of theses species in the Red Lake River reaches located downstream of Thief River Falls. These reaches were not sampled for this report.

A healthy stream fish community is comprised of a relatively high number of different fish species, a variety of year classes and life stages, and an abundance of fish. Based on these criteria, fish populations in the Red Lake River watershed range from healthy (e.g., LR1, TR1) to severely impaired (e.g. PR2). Fish communities are being negatively affected by stream channel alterations; instream habitat within these segments is homogeneous and fish cover is limited. Fish communities found in stream segments impacted by channelization, altered hydrology, and/or excessive sedimentation were characterized by low species diversity, low fish abundance, low IBI scores and fish biomass dominated by species that are tolerant of poor water and habitat quality. For example, stations CR2, 3, 4, 5 and CR6 in upper Clearwater River had IBI scores ranging from 32 to 44 (fair to good). However, stations CR7 through CR11, all located in a stream segment where the combination of channelization and intense water appropriation has severely degraded instream habitat conditions, had IBI scores ranging from 20 to 30. Stations CR13 and CR15 also had poor biotic integrity, which was likely caused by impacts related to changes in hydrology and sediment supply upstream.

Fish species diversity and IBI scores were highest at stations BR1 and LR1 (Table 14) where a mix of mesohabitat types was present. Habitat evaluation was not conducted at TR1 in Thief River, however, habitat was relatively complex and the third highest number of species, along with the highest IBI score, was found at that station.

With the exception of PR2, biotic integrity was fair to good at stations located in the rolling lands of the morainal area where there is relatively less ditching and stream channelization, streams are of higher gradient, and there is less cultivated land compared to the glacial lake bed. Fish communities located within the glacial lake bed were in relatively poor condition as a result of the negative impacts of ditching, channelization and land use practices in this highly cultivated area. Habitat complexity increases as streams flow through lands near the beach ridges; stream gradients increase and rocky habitat with riffles and pools becomes more available. The highest number of species was generally found in stations near the beach ridge areas of lower Black

River, lower Thief River and lower Lost River, and biotic integrity in these stream segments was generally good.

The biotic integrity of fish communities varied considerably between sample stations throughout the watershed. Six stations had IBI scores that rated them at "good", five stations were "fair", seven stations were "poor" and two stations were determined to have "very poor" biotic integrity. This variation in scores within a watershed is similar to what was found in the Wild Rice River, Bois de Sioux River, Roseau River, Buffalo River and Two Rivers watersheds during the summers of 2000 and 2001 (Appendix E, Table E1) and to what was found by Niemela et al. (1998). IBI scores were calculated for three stations (LR1, PR1 and BR1) that were located in the same general vicinities as stations used in the IBI study by Niemela et al. (1998). The scores calculated for this study were 6 points higher at LR1 and PR1 and 4 points higher at BR1 than was calculated by Niemela et al. (1998). Reasons for the differences in scores are unknown.

Game Fish

Numerous angling opportunities exist in the lakes and streams located throughout the Red Lake River watershed. Popular game fish in the watershed include channel catfish, smallmouth bass, walleye, and northern pike. There is also an opportunity to catch brown and rainbow trout in Clearwater River.

The combination of abundant fish and a good size distribution provides excellent channel catfish angling opportunities in Red Lake River. MN DNR surveys conducted 1994 (Huberty 1996) and 2000 (Huberty 2001) both found high numbers of catfish downstream of Crookston. The average catfish length at the time of sampling was 15.2 inches in 1994 and 18.7 inches in 2000. Channel catfish up to approximately 30 inches were caught each year . An angler survey conducted in 2001 on Red Lake River downstream of the Crookston dam estimated that 47.5% of the anglers fishing this stream segment from May 1 to September 30 were targeting channel catfish (Topp 2003). Further, the survey estimated that anglers in this 52.6 mile segment of Red Lake River harvested 62% more channel catfish than were harvested from the 95 mile segment of Red River ranging from Grand Forks to Drayton for the same time period, even though the segment of Red River received approximately 30% more hours of fishing pressure.

Conversely, only one catfish was sampled in Red Lake River between Crookston and Thief River Falls in each of the previously mentioned surveys (Huberty 1996; Huberty 2001). Huberty suggested that channel catfish numbers upstream of the dam have experienced a steady decline since at least 1971. He concluded in both the 1996 and 2001 reports that the fish passage barrier posed by the dam at Crookston was primarily responsible for the differences in catfish populations upstream and downstream of the dam. Modifications to the dam at Crookston began in 2004 and were completed in 2005, allowing fish passage to habitats located higher in the watershed. Data for this survey have not yet been analyzed but preliminary results suggest that channel catfish are already responding to the elimination of the passage barrier (MN DNR unpublished data). Sampling conducted in May 2005, using identical stations and methods to the 1994 and 2000 surveys, resulted in 220 channel catfish ranging from 10.4 to 27.8 inches long being sampled between Crookston and Thief River Falls. The dramatic increase in the number of catfish sampled clearly demonstrates the positive effect that reestablishment of stream connectivity is having on the catfish population within this segment of Red Lake River. Channel catfish distribution is likely to expand into portions of other streams as well, particularly in the Clearwater River watershed. Efforts to monitor changes in Red Lake River catfish populations upstream of Crookston and population expansion into other streams within the watershed, should be planned and implemented.

There have been no known documented occurrences of channel catfish being found in Red Lake River or Thief River upstream of Thief River Falls. The only documented report of channel catfish being sampled in streams other than Red Lake River was in Clearwater River in 1979 when one approximately 28 inch fish was sampled in the downstream portion of Reach 3 (Johnson 1980); no channel catfish have been found in subsequent surveys conducted in Clearwater River. No channel catfish were sampled during this investigation; however, the methods used were not likely to capture catfish.

Smallmouth bass is a popular sportfish in the watershed and its distribution has expanded since the MN DNR first introduced smallmouth bass into Red Lake River in 1985. Smallmouth bass are present in Red Lake River Reaches 1 through 5, from its confluence with Red River of the North upstream to Thief River Falls, and in the downstream segments of tributary streams. Clearwater River Reaches 1 and 2 are known to contain smallmouth bass but none have yet been sampled above the Clearwater River/Lost River confluence. Smallmouth bass are most abundant in Red Lake River Reaches 2 through 5, between Crookston and Thief River Falls (Huberty 2001). Only juvenile smallmouth bass were found at Black River station BR1 whereas adult, juvenile and young-of-the-year smallmouth bass were all found at Lost River station LR1. The stream channel in lower Black River is unstable (Table 17) and highly entrenched (Table 15), and stream flows vary widely from spring through fall. It is likely that the lower section of Black River, and possibly other tributaries as well, is being used by smallmouth bass primarily for spawning and rearing. In contrast, it appears that there is a reproducing resident population of smallmouth bass in lower Lost River. The stream channel at LR1 was only slightly to moderately entrenched (Table 15), and both base flows and habitat conditions appear to be sufficient to support a resident smallmouth bass population.

Walleye are primarily found in Red Lake River, Thief River and Clearwater River. The MN DNR currently stocks walleye in a number of lakes in the watershed including Clearwater Lake on Clearwater River, Pine Lake on Lost River, as well as numerous other smaller lakes that may be connected to the stream network via tributaries. Walleye are likely located in smaller streams throughout the watershed, but suitable habitat in these streams is limited to widely scattered deeper pool areas. Some streams and segments, especially those of higher gradient containing coarse substrate materials, are used only seasonally for walleye spawning. Fishable populations are limited to Red Lake River, lower Thief River and in larger impounded waters (e.g., Clearwater and Pine lakes).

Walleye numbers in Red Lake River, especially upstream from Thief River Falls, are likely being influenced by the population status within Upper and Lower Red lakes. A cooperative effort to revive the collapsed Red lakes walleye population(s) began in 1999 and walleye numbers have grown dramatically within both Upper and Lower Red lakes. Walleye fry probably emigrate from Lower Red Lake into Red Lake River in the springtime shortly after hatching. An increase in fry production within the Red lakes as a result of restoration efforts should increase fry immigration into Red Lake River. Whether or not significant numbers of fry will survive and, eventually, increase the size of the walleye population in Red Lake River is unknown.

Walleye spawning movement upstream from Red River and lower Red Lake River will likely increase because of the Crookston dam modification. The highest quality walleye spawning habitat is found in stream sections within the beach ridge area, which includes the segment of Red Lake River between Crookston and Thief River Falls and in the downstream portions of associated tributaries. Prior to modification, the dam at Crookston was barrier to upstream fish migration. Now that the barrier has been alleviated, walleye from Red River and lower Red Lake River have access to the best spawning habitat in the watershed.

Northern pike are distributed in streams throughout the Red Lake River watershed downstream from Lower Red Lake, however, few fish greater than 24 inches have been collected. Large northern pike are found primarily in Red Lake River upstream from Crookston, especially in the reservoir at Thief River Falls. Smaller tributary streams are used primarily for northern pike spawning and rearing.

Trout angling is available Reaches 6 and 7 of Clearwater River. The MN DNR annually stocks 1500 rainbow and 1500 brown trout in these designated trout waters. This is currently a put-and-take trout fishery. The lack of fish surviving over the winter warrants yearly stocking in order for there to be sufficient number so trout to support a fishery. Other designated trout waters exist in the watershed; however, these waters have not been actively managed for trout in a number of years.

Fish Species of Special Interest

Common Carp. Common carp have been well established in the Red River Basin since the 1930's (Aadland et al. 2005). Two common carp were sampled by the MN DNR in the reservoir upstream of the Red Lake River dam at Thief River Falls in the summer of 2004 (Standera 2005c) but no carp were found in any waters upstream of the reservoir, either in Red Lake River or in Thief River, during this investigation. This is consistent with previous investigations that reported finding common carp in Red Lake River from its confluence with Red River upstream to the dam in Thief River Falls and in the reservoir but not above this point (Renard et al. 1983; Huberty 2001; Koel 1997). A literature review for this document could find no documented sources of common carp occurring upstream of the reservoir at Thief River Falls. The expansion of carp distribution is of concern in the Red Lake River because of the possibility of carp moving upstream into Lower and Upper Red lakes, Agassiz National Wildlife Refuge and MN DNR Thief Lake Wildlife Management Area.

No carp were sampled in the Clearwater River (Table 13) or other Red Lake River tributary streams (Table 12) and only two documented reports of carp being sampled in waters within the Clearwater River watershed were found. Bell Museum of Natural History records document that seven (7) common carp were sampled from Lost River Reach 4 (Figure 16) approximately 8.3 miles NNE of Gonvick, or 4.6 river miles upstream of station LR2. Also, a 1979 MNDNR stream survey (Johnson 1980) reported sampling 4 carp in the lower portion of Clearwater River

Reach 3 (Figure 16). Common carp are well established in Red Lake River both upstream and downstream of the Clearwater River confluence (Huberty 1996; Huberty 2001). The rarity of carp occurrence in the Clearwater River watershed suggests that habitat conditions in these waters may not be suitable for carp to inhabit as a resident species.

Lake Sturgeon. Lake sturgeon are native to the Red River Basin and historical accounts suggest that they were abundant until the late 1800's (MN DNR 2002). By the mid-1900's, lake sturgeon had been essentially extirpated from the basin due to a combination of over exploitation, dam construction and declines in water quality.

Dam construction had a large influence on lake sturgeon in the Red Lake River watershed. One of the largest known historical lake sturgeon spawning sites was located at the confluence of Clearwater River and Red Lake River. The construction of two dams on lower Red Lake River, Point Dam at East Grand Forks and the dam at Crookston (Figure 25) historically have prevented lake sturgeon from reaching this important spawning site during spring spawning migrations. As of this writing, Point Dam in East Grand Forks and the dam at Crookston have both been modified to emulate a rock-riffle and are no longer a fish passage barriers. A third dam, owned by Ottertail Power, is located between Crookston Dam and the Clearwater River / Red Lake River confluence, however, this is likely a barrier for lake sturgeon spawning runs only during years with low spring flows (Mike Larson, MN DNR, Fisheries Division, pers. comm.).

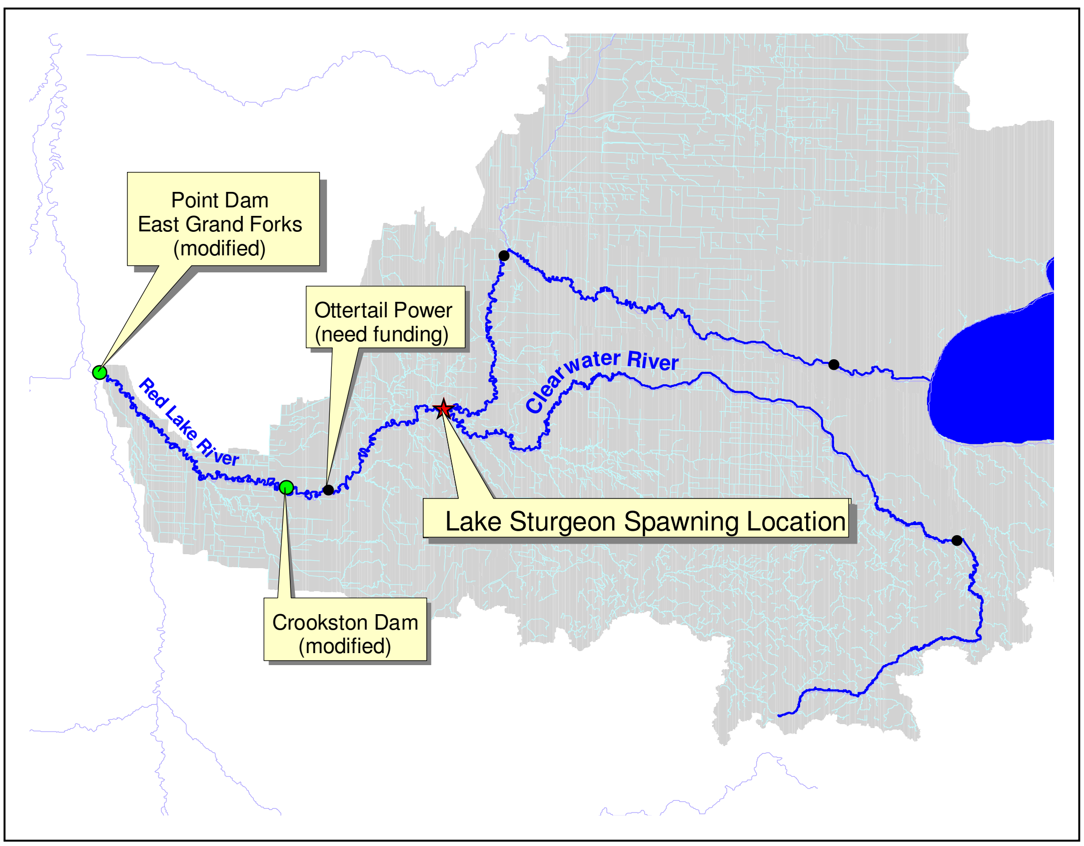


Figure 25. Locations of dams downstream of a major historic lake sturgeon spawning location on Red Lake River.

Sturgeon population restoration efforts currently underway include: protection through harvest restrictions, fry and fingerling stocking and restoring river connectivity through dam removal or modification (MN DNR 2002). Lake sturgeon harvest is currently not allowed and lake sturgeon fry are stocked annually in Red Lake River at the confluence of Red Lake River and Clearwater River.

Stream Morphology And Stream Stability

Twelve of the 15 stream morphology sites in the Red Lake River watershed are very sensitive to disturbance (i.e., changes in hydrology and sediment supply), 11 of these 12 have high erosion potential (Table 20). The role of vegetation in controlling stream width-to-depth ration stability was most important on the less entrenched streams with wider floodplains. Vegetative influence tended to have the least affect on unstable, channelized stream segments where other factors (e.g., altered stream flows) are having a greater affect of the channel than the streamside vegetation.

Table 20. Management interpretations of various stream types (*from:* Rosgen 1996)

Stream Type	Sample Stations	Sensitivity to Disturbance	Recovery Potential	Sediment Supply	Stream bank Erosion Potential	Vegetation Controlling Influence*
B4	CRTd	Moderate	Excellent	Moderate	Low	Moderate
B5	CR9	Moderate	Excellent	Moderate	Moderate	Moderate
B6	LR2	Moderate	Excellent	Moderate	Low	Moderate
C4	LR1, CRTu, CR6	Very high	Good	High	Very high	Very high
C6	HR2	Very high	Good	High	High	Very high
E5	BC2, PR1, HR1, BAD1	Very high	Good	Moderate	High	Very high
E6	BC1, PR2	Very high	Good	Low	Moderate	Very high
F4	BR1	Extreme	Poor	Very high	Very high	Moderate
F5	LR3	Very high	Poor	Very high	Very high	Moderate

* vegetation that influences width to depth ratio-stability

Stream channel manipulation and land use practices have altered and destabilized many waterways in the Red Lake River watershed. According to MN DNR's hydrography data (MN DNR GIS dataset 2005), approximately 54% of the waterways located downstream of Lower Red Lake are ditches and substantial amounts of channelized stream segments also exist. The least amount of ditching has occurred in the streams lying in the Eastern Broadleaf Forest Province ecoregion where only 13% of the waterways are ditches, likely because of the rolling, hummocky topography associated with glacial moraine in that portion of the watershed. Many stream tributaries have been directly modified and have been farmed in smaller drainage areas.

Channelization is negatively affecting both the physical and biological properties of the streams in the watershed. For example, biotic integrity was generally fair to good above channelized stream segments but poor within the channelized segments. In Clearwater River, biotic integrity remained poor downstream of the channelized segment as well. This was likely a result of the hydrologic changes caused by channelization and the associated impacts on instream habitat.

Burnham Creek is another example of a stream that has been substantially altered by ditching and channelization. Habitats are in poor condition throughout the stream and biotic integrity was found to be poor in the channelized segment. Fish sampling was not possible in the downstream portions of Burnham Creek because stream conditions were too hazardous for back-pack or tote barge sampling (e.g., trapezoidal channel, steep banks, deep water and deep sediment on stream bottom) and there was no adequate access points for a boat electrofisher. However, given the condition of the streams, biotic integrity is no doubt poor there as well. The waterway emptying into Burnham Creek from the south near Girard, MN, or approximately 2.5 miles southwest of Crookston, appears be having especially significant negative affects on lower Burnham Creek. This waterway carries the water that has been accumulated from a number of different county ditches and stream banks are heavily eroded at its confluence with Burnham Creek. Sediment loading appears to be significant. Most of the stream channel below this confluence is unstable.

The channelized stream segments of Lost River and Clearwater River flow through the part of the watershed that was historically a wet prairie but has now been converted to mostly cropland. This undoubtedly changed stream hydrology and sediment supplies and, coupled with intense water appropriations, has severely degraded both the physical and biological characteristics of the affected streams and their tributaries. The channelized segment of Red Lake River lying north of Clearwater River also flowed through this wet prairie, however, it appears to be in somewhat better condition. Fewer miles of ditching enter into this portion of the stream, compared to Clearwater and Lost rivers, and the flattened hydrograph resulting from the outlet of Lower Red Lake may be stabilizing the stream somewhat. However, the habitat value of this portion of Red Lake River has been substantially reduced as evidenced by the lack of habitat diversity in this portion of Red Lake River.

Reduction or removal of riparian areas is also common in the Red Lake River watershed. Little or no buffer exists between many waterways and agricultural land. Healthy riparian areas can reduce the impacts of agricultural activities on stream stability by reducing sediment inputs, reducing bank erosion and slowing stormwater runoff. Stream segments without functional riparian “buffers” are more susceptible to erosion and sediment yields are generally higher compared to those with functional buffers.

Instream Habitat

The Red Lake River watershed has important spawning and rearing habitat for both migratory and resident fish populations. Red River of the North lacks quality spawning habitat for those species that require clean gravel or rocky substrates such as walleye or lake sturgeon. Several streams in the watershed provide such habitats, especially where streams pass through the beach ridge area of glacial Lake Agassiz. Red Lake River, lower Thief River, lower Black River, lower Badger Creek, Clearwater River, lower Lost River, and in Poplar and Hill rivers near their confluence with Lost River have the most potential to provide gravel substrates. Habitats for species that require larger rock substrates are most likely to be found in Red Lake River between Crookston and Thief River Falls and in lower Clearwater River have the most potential to provide rocky habitats. Although these streams have the potential to provide high quality habitat for species that require coarser substrates, stream channel instability and high sediment loads are reducing both habitat quality and quantity.

Newly hatched young-of-the-year (YOY) smallmouth bass were seen in Lost River, and juvenile smallmouth bass and northern pike were sampled at several stations. This confirms that successful natural reproduction of these predatory species does occur in tributary streams, therefore, there is some spawning and rearing habitat available. Lowland areas susceptible to flooding and seasonal watering provide northern pike spawning habitat, riffle areas provide potential walleye spawning habitat, and the higher gradient stream segments with mixed substrates and variable depths that include shallow riffle areas provide good spawning and rearing habitat for smallmouth bass.

Little is known about natural reproduction of channel catfish in Red Lake River watershed streams and no evidence of channel catfish reproduction was found during this survey. Channel catfish are known to occur in substantial numbers in Red Lake River below Thief River Falls, which indicates that natural reproduction is likely good there although that segment was not sampled for this study. Long term monitoring of fish populations in Red Lake and Thief River is presently underway and should continue. Efforts to describe natural reproduction trends for walleye, smallmouth bass, northern pike, and channel catfish and to identify factors limiting natural reproduction of these important game species should be undertaken.

Hydrology

The annual hydrograph of a stable, natural stream exhibits a peak spring discharge and relatively stable base flows. These characteristics, along with a floodplain sufficient to attenuate high discharges during storm events, provide a variety of conditions and habitats throughout the year, which promotes healthy fish communities. Hydrology throughout the Red Lake River watershed has been altered by changes in land use and drainage patterns. Extensive ditching and channelization, and intensive agricultural activities have altered the natural hydrograph of most streams in the watershed. The typical result of these activities is to make stream flows more "flashy." That is, accelerated runoff causes peak discharges from storm events to arrive faster and have a higher discharge than would occur naturally occur. Also, the amount of water available to maintain base flows during the drier times of the year is reduced because the water leaving the system as runoff is no longer available to percolate into the soil and recharge the groundwater resources. Altering a hydrologic regime in this way reduces instream habitat quality by destabilizing stream channels, reduces base flows and changes the availability of different habitat types, which adversely affects aquatic communities. The bankfull discharge is the stage at which a stream begins to access its floodplain and it is at these flow levels where the major channel forming processes occur. Bankfull flows are important for maintaining channel stability and for providing habitat diversity (Harvey et al. 1997). Restoring the flow regimes of many of the streams in the watershed to more natural conditions would, eventually, stabilize stream channels and provide instream conditions conducive to healthy stream communities.

The current method for determining the protected low flow value is to use the Q90, defined as the stream discharge that statistically is exceeded 90% of the time during the period of record analyzed. The Q90 is an extremely low flow and offers inadequate instream flow protection (MN DNR Waters 2005, Olson et al. 1988, Harvey et al. 1997). The protected flow value of zero cfs in Thief River allows the entire stream flow to be withdrawn and, obviously, provided no stream protection. Similarly, the protected flow in Clearwater River at Plummer (36 cfs) offers very little protection for the aquatic community and provides little habitat diversity.

Stream flow recommendations were developed for the Red Lake River watershed by Harvey et al. (1997) using the Instream Flow Incremental Methodology (IFIM; Bovee 1982). IFIM is a widely used method for addressing instream flow issues that combines hydraulic simulation procedures with the habitat requirements of the aquatic community. The results provide quantitative relationships between stream flow and habitat, and these relationships are used to determine appropriate stream flows for protecting aquatic resources. The minimum flow recommendations provided by Harvey et al. (1997) should be used to replace current protected flow values and IFIM methodologies used to determine future designated minimum flow values.

Dams

Dams interrupt stream connectivity and often times act as fish passage barriers. There are at least 51 dams in the Red Lake River watershed below Lower Red Lake (USCOE dams list). Of primary interest here are dams that act as fish passage barriers, which include: Ottertail Power dam, the dam at Thief River Falls, the Lower Red Lake outlet dam, the dam on Red Lake River located 11.6 miles downstream of the Lower Red Lake outlet dam, and Clearwater Lake dam (Figure 12). Point Dam, located on Red Lake River in East Grand Forks, and the dam at Crookston have been modified to emulate a riffle with a 5% slope and no longer act as a fish passage barriers.

The dam at Crookston was shown to be an effective fish passage barrier to a number of species. Huberty (2001) sampled upstream and downstream of Crookston dam using trap nets, trotlines and electrofishing, and reported catching a combined total of 581 channel catfish downstream of the dam but only one (1) upstream. Other differences were also seen between fish assemblages upstream and downstream of Crookston dam. Huberty acknowledged that some fish assemblage differences were likely due to stream channel morphology differences but he concluded that some were due to the fish passage barrier. The modification of this dam has restored river connectivity, including fish passage. The completion of the Crookston dam modification has opened hundreds of miles of tributary streams, from Red River of the North upstream to the dam at Thief River Falls including the entire Clearwater River watershed, to migration of fishes from the Red River of the North.

The Ottertail Power dam is located 9.7 river miles upstream of the Crookston Dam and forms a fish passage barrier during low flows (Mike Larson, MNDNR, pers. comm.). The dam at Thief River Falls is a fish passage barrier at all flows and it, along with the two dams immediately downstream of Lower Red Lake prevent migration of fishes into the upper-most portions of the Red Lake River upstream of and including Lower Red Lake.

The dam at Clearwater Lake is also a fish passage barrier at all flows. A combined total of 21 fish species were found in the three sample stations in Reach 3, located immediately downstream of Clearwater Lake dam (CR5, CR6 and CR7), whereas only 12 species (excluding brown trout, a non-native species that is stocked annually) were found in Reach 2 (CR3 and CR4) located immediately upstream of the dam. Fish passage barrier removal is a key component to the restoration and/or enhancement of fish populations in the Red Lake River watershed.

Impaired Waters
Although it is not typically thought of as "habitat", water quality is an integral component of instream habitat and can have a profound affect on the health of a fish community. Several stream segments in the watershed are listed as impaired waters by the MPCA. Of particular interest here are those that are most likely to impact fish populations. Poplar River, Lost River and Clearwater River all contain substantial lengths of stream that are listed as impair because of low oxygen. The Red Lake River Watershed District has been monitoring quality in the lakes and streams within the watershed for a number of years. In 2004 the RLWD conducted a water quality assessment based on its long-term monitoring data through the year 2003. The assessment was based on MPCA methods to evaluate surface waters and gave a preview of waters that are likely to be listed as impaired by the MPCA in the future. Results of this assessment showed dissolved oxygen problems at a number of sample sites that could lead to impaired waters listings. Streams where DO problems were found include sites on Moose River, Thief River, Clearwater River, Poplar River, Lost River and Badger Creek.

The difference in fish communities between Poplar River stations PR1 and PR2 could be a result of low dissolved oxygen. Sixteen species were sampled at station PR2, whereas only two species were found at PR1, and biotic integrity was good at PR1 (IBI score of 42) compared to poor (IBI score of 16) at PR2. Although some physical differences were seen between the two stations, there were many similarities between the two sites: they were both located in E channel types, and mesohabitat and water depth distributions were similar. Probably the biggest difference between the two stations was that the stream segment where PR2 was located is listed as a Minnesota state impaired water due to low dissolved oxygen, whereas the segment where PR1 is located is not listed. PR2 was positioned approximately 4 miles downstream of Fosston's wastewater treatment facility where, in 2002, the city of Fosston and Minnesota Dehydrated Vegetables (MDV) were cited for environmental violations that resulted in a fish kill in Poplar River in 1999. It is likely that addressing the low dissolved oxygen issue in Poplar River would benefit the aquatic community in that stream substantially. Identifying and addressing dissolved oxygen problems throughout the watershed would likely benefit aquatic communities in other stream segments as well.

Goals of this survey were to evaluate the general health and condition of streams and stream fish populations, and to identify opportunities to restoration and/or enhancement. The potential exists to greatly enhance the fisheries resources in the watershed. A number of factors relating to land use and stream channel alteration (e.g., row crop agriculture, channelization, ditching) have been responsible for decreased fish community health, lower quality instream habitat and stream instability problems. There is likely a multitude of opportunities to improve the condition of the stream resources in the Red Lake River watershed. Restoring the hydrograph to of a more natural shape is likely the most effective approach to improving stream stability, instream habitat and the health of the biological community. Bankfull discharges are the primary channel forming flows and are critical to the maintenance of restored channels. Restoration of natural bankfull discharges into the original channels would not only benefit fisheries and wildlife, but would help to stabilize the overall hydrology of the entire system as well.

RECOMMENDATIONS

The rivers and streams in the Red Lake River watershed have the capacity to provide a variety of high quality habitats for fish and other animals. Hydrologic conditions and unstable channels limit many reaches of streams from achieving their potential. Activities listed below will help improve the quality of waterways and the condition of aquatic communities in the Red Lake River watershed Priority areas for implementing these recommendations are (in no particular order):

1. Clearwater River including the channelized and upstream reaches
2. Burnham Creek watershed
3. Middle and lower reaches of Poplar River
4. Thief River
5. Lost River including the channelized and upstream reaches to Pine Lake
6. Red Lake River main stem

The recommended activities listed below should be implemented progressing from upstream to downstream whenever possible.

Habitat Protection and Enhancement

- Establish and/or protect riparian corridors along all waterways, including ditches, using native vegetation whenever possible.
- Implement seasonal aquatic community based instream flow protection recommendations provided by Harvey et al. (1997) for Clearwater River and Red Lake River.
- Use seasonal aquatic community based IFIM methodologies to develop protected flow levels on remaining streams within the Red Lake River watershed.
- Stop or mitigate future activities that will continue to disrupt the hydrology (e.g., drainage, tiling, etc).
- Identify and take actions to correct the source(s) of biotic impairments.
- To the extent possible, augment base flows and attenuate peak flows in streams throughout the watershed to attain more natural hydrographs.
- Protect and enhance the quality and accessibility of lake sturgeon spawning habitat on Red Lake River.
- Remove or modify dams and culverts that are acting as fish passage barriers including, but not limited to: the dam at Thief River Falls and the Ottertail Power dam upstream from Crookston.
- Re-establish natural functioning stream channels wherever possible using natural channel design principles.
- Rehabilitate the channelized reaches, especially Clearwater River, Lost River, Red Lake River and Burnham Creek.
- Define areas critical for sustaining base stream flows.
- Include stream protection measures during land use planning efforts to reduce impacts from urban sprawl, especially in the more populated centers such as East Grand Forks and Crookston.
- Implement agricultural Best Management Practices (BMPs) to reduce erosion and sedimentation, and to facilitate natural channel evolution.

- Work with appropriate entities to alleviate water quality problems that are affecting aquatic communities
- Encourage the accumulation of woody material in streams to enhance habitat. Recommend following American Fisheries Society guidelines.

Data and Monitoring

- Monitor the potential expansion of smallmouth bass populations throughout the watershed.
- Monitor the potential expansion of common carp populations throughout the watershed.
- Monitor lake sturgeon recovery efforts in the watershed.
- Monitor the effects of dam removal projects on fish communities and individual species populations.
- Identify and protect important stream spawning locations and enhance the quality of habitat in these locations when possible.
- Monitor the fish community in Popular River immediately downstream of Fosston.
- Track land use changes in the watershed, particularly the continuous sign-up CRP and CREP lands.
- Survey culverts in the basin (dimensions and slope).
- Spring trap net surveys in the watershed to assess northern pike and walleye spawning runs.
- Conduct pre- and post-monitoring of approved natural resource enhancement and flood damage reduction projects.

REFERENCES

Aadland, L.P., T.M. Koel, W.G. Franzin, K.W. Stewart, and P. Nelson. 2005. Changes in fish assemblage structure of the Red River of the North. American Fisheries Society Symposium 45:293-321.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish, second edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington. D.C.

Bovee, K.D. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. Instream flow information paper no. 12. US Fish and Wildlife Service FWS/OBS-82/26. Ft. Collins, CO.

Groshens, T.P., B. Evarts, H. Van Offelen and M. Johnson. 2003. Red River basin stream survey report: Buffalo River watershed 2001. Minnesota Department of Natural Resources, Division of Fisheries, Region I, Bemidji, MN.

Groshens, T.P., B. Evarts, H. Van Offelen, and M. Johnson. 2003. Red River basin stream survey report: Two River watershed 2001. Minnesota Department of Natural Resources, Division of Fisheries, Region I, Bemidji, MN.

Harvey, J., L.P. Aadland, S.L. Johnson, A. Kuitunen, and K.L. Terry. 1997. Red Lake River watershed: recommendations for stream flow and habitat protection; report to the Legislative Commission on Minnesota Resources.

Huberty, G. 1996. Stream fish population assessment of the red lake river from it's mouth upstream to Thief River Falls; Reaches one, two and three; Polk, Red Lake, and Pennington counties, June 6-10 and September 6-12, 1994. Minnesota Department of Natural Resources, Detroit Lakes, MN.

Huberty, G. 2001. Red Lake River fisheries population assessment, summer 2000; reaches 1 & 2 report, river mile 0.0 to 125.7. Minnesota Department of Natural Resources, Division of Fisheries, Project F-29-R(P) Study III, St. Paul, MN

Johnson, D. 1993. Stream resurvey: Clearwater River; July 20, 1992 to August 13, 1992. Minnesota Department of Natural Resources, Bemidji, MN.

Johnson, D. 1980. Stream survey 1980: Clearwater River. Minnesota Department of Natural Resources, Bemidji, MN.

Koel, T.M. 1997. Distribution of fishes in the Red River of the North basin on multivariate environmental gradients. Doctoral dissertation. North Dakota State University, Fargo, ND.

MN DNR. 1994. Stream management plan: Clearwater River. Minnesota Department of Natural Resources, Bemidji, MN.

MN DNR. 2002. Restoration of extirpated lake sturgeon (*Acipenser fulvescens*) in the Red River of the North watershed. Minnesota Department of Natural Resources, Division of Fisheries, St. Paul, MN.

MN DNR DOW. 2005. Guidelines for suspension of surface water appropriation permits; Revised: July 18, 2005. Minnesota Department of Natural Resources, Division of Waters, St. Paul, MN.

Niemela, S., E. Pearson, T.P. Simon, P.M. Goldstein, and P.A. Bailey. 1998. Development of index of biotic integrity expectations for the Lake Agassiz plain ecoregion.

Olson, P.L., H. Drewes, and D. Desotelle. 1988. Statewide instream flow assessment, Technical Report 1985-1987. Minnesota Department of Natural Resources, St. Paul, MN.

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation: a watershed management procedure. USDA Forest Service, R1-75-002, Washington, D.C.

Renard, P.A., S.R. Hanson, and J.W. Enblom. 1983. Biological survey of the Red Lake River. Minnesota Department of Natural Resources, Ecological Services Section, Special Publication No. 134, St. Paul, MN.

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

Simonson, T.D., J. Lyons, and P.D. Kanehl. 1994. Guidelines for evaluating fish habitat in Wisconsin streams. Gen. Tech. Rep. NC-164, U.S. Department of Agriculture, Forest Service, St. Paul, MN.

Stoner, J., D.L. Lorena, G.J. Wiche and R.M. Goldstein. 1993. Red River of the North Basin, Minnesota, North Dakota, South Dakota. Water Resources Bulletin, American Water Rsources Association. 29(4):575-615.

Standera, T. 2005a. Stream population assessment 2004: Red Lake River. Minnesota Department of Natural Resources, Section of Fisheries, Baudette, MN.

Standera, T. 2005b. Stream population assessment, 2004: Thief River. Minnesota Department of Natural Resources, Section of Fisheries, Baudette, MN.

Standera, T. 2005c. Lake survey 2004: Red Lake River (reservoir at Thief River Falls). Minnesota Department of Natural Resources, Section of Fisheries, Baudette, MN.

Topp, D. 2003. Completion Report: Red River of the North Creel Survey; May 1 – September 30, 2001. Minnesota Department of Natural Resources, Project F-29-R(P)-22, Area 110, Study 4, Job 592, St. Paul, MN.

Van Offelen, H., B. Evarts, M. Johnson, T.P. Groshens and G. Berg. 2002. Red River Basin stream survey report: Bois de Sioux watershed 2000. Minnesota Department of Natural Resources, Division of Fisheries, Region I, Bemidji, MN.

Van Offelen, H., B. Evarts, M. Johnson, T.P. Groshens and G. Berg. 2002. Red River basin stream survey report: Wild Rice watershed 2000. Minnesota Department of Natural Resources, Division of Fisheries, Region I, Bemidji, MN.

Van Offelen, H., T.P. Groshens, B. Evarts, M. Johnson and G. Berg. 2003. Red River basin stream survey report: Roseau River watershed 2000. Minnesota Department of Natural Resources, Section of Fisheries, Region I, Bemidji, MN.

APPENDIX A

Mean annual discharge data from USGS gaging stations

Table A1. Mean annual discharge for the period of record at gage station 05074500 on Red Lake River near Red Lake, MN (US Geological Survey).

Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)
1934	7.95	1952	786	1970	769	1988	69.1
1935	13.1	1953	243	1971	582	1989	62
1936	5.41	1954	310	1972	754	1990	63.7
1937	13.7	1955	238	1973	458	1991	67.6
1938	95.1	1956	172	1974	955	1992	133
1939	193	1957	635	1975	969	1993	587
1940	231	1958	345	1976	697	1994	
1941	239	1959	71.8	1977	155	1995	
1942	373	1960	68.1	1978	494	1996	
1943	584	1961	53	1979	756	1997	
1944	650	1962	632	1980	395	1998	
1945	761	1963	803	1981	296	1999	
1946	567	1964	243	1982	750	2000	791
1947	780	1965	681	1983	590	2001	873
1948	596	1966	925	1984	614	2002	797
1949	435	1967	691	1985	752	2003	92.2
1950	4349	1968	360	1986	852		
1951	1007	1969	983	1987	277		

Table A2. Mean annual discharge for the period of record at gage station 05075000 on Red Lake River at High Landing near Goodridge, MN (US Geological Survey).

Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)
1930	223	1948	707	1966	1146	1984	729
1931	76.1	1949	505	1967	852	1985	968
1932	19.1	1950	1559	1968	496	1986	1003
1933	7.21	1951	1130	1969	1135	1987	321
1934	7.73	1952	858	1970	928	1988	92.4
1935	16.4	1953	280	1971	719	1989	91.2
1936	8.38	1954	349	1972	926	1990	71.8
1937	31.6	1955	274	1973	543	1991	69.4
1938	154	1956	234	1974	1215	1992	173
1939	188	1957	724	1975	1329	1993	710
1940	241	1958	367	1976	794	1994	638
1941	284	1959	77.8	1977	168	1995	796
1942	447	1960	87	1978	626	1996	1114
1943	661	1961	59.6	1979	927	1997	1152
1944	780	1962	767	1980	443	1998	940
1945	867	1963	839	1981	343	1999	1150
1946	644	1964	306	1982	945		
1947	910	1965	794	1983	782		

Table A3. Mean annual discharge for the period of record at gage station 05079000 on Red Lake River at Crookston, MN (US Geological Survey).

Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)
1930	457	1949	1227	1968	1281	1987	735
1931	140	1950	3430	1969	2058	1988	297
1932	179	1951	1782	1970	1889	1989	530
1933	96.3	1952	1277	1971	1439	1990	187
1934	84.8	1953	640	1972	1660	1991	249
1935	135	1954	666	1973	1004	1992	631
1936	172	1955	588	1974	2279	1993	1466
1937	361	1956	933	1975	2606	1994	1490
1938	544	1957	1618	1976	1106	1995	1636
1939	265	1958	580	1977	394	1996	2587
1940	429	1959	367	1978	1409	1997	2945
1941	878	1960	453	1979	2057	1998	1876
1942	1017	1961	219	1980	745	1999	3000
1943	1354	1962	2197	1981	780	2000	1675
1944	1261	1963	1286	1982	1836	2001	2326
1945	1597	1964	988	1983	1671	2002	2029
1946	1237	1965	2135	1984	1363	2003	473
1947	1864	1966	2482	1985	2183		
1948	1377	1967	1828	1986	1828		

Table A4. Mean annual discharge for the period of record at gage station 05076000 on Thief River near Thief River Falls, MN (US Geological Survey).

Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)
1930	28.7	1949	163	1968	306	1987	84.2
1931	2.64	1950	602	1969	276	1988	26.5
1932	30.4	1951	181	1970	282	1989	101
1933	15.6	1952	66	1971	160	1990	7.92
1934	4.48	1953	44.9	1972	162	1991	7.57
1935	14.3	1954	63.8	1973	80.9	1992	158
1936	28	1955	63.6	1974	337	1993	342
1937	129	1956	294	1975	441	1994	193
1938	164	1957	347	1976	57.8	1995	200
1939	1.28	1958	54.3	1977	10.3	1996	482
1940	12.4	1959	89.8	1978	240	1997	503
1941	107	1960	104	1979	336	1998	323
1942	196	1961	18.1	1980	N/A	1999	768
1943	171	1962	391	1981	N/A	2000	213
1944	133	1963	180	1982	313	2001	446
1945	193	1964	323	1983	298	2002	454
1946	111	1965	483	1984	148	2003	45.9
1947	182	1966	533	1985	555		
1948	191	1967	369	1986	281		

Table A5. Mean annual discharge for the period of record at gage station 05078000 on Clearwater River at Plummer, MN (US Geological Survey).

Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)
1940	76.3	1956	126	1972	211	1988	77.3
1941	159	1957	239	1973	178	1989	106
1942	146	1958	79.5	1974	244	1990	55.7
1943	202	1959	90.3	1975	294	1991	71.5
1944	182	1960	85.3	1976	87	1992	124
1945	209	1961	77.1	1977	92.5	1993	162
1946	162	1962	338	1978	172	1994	196
1947	262	1963	124	1979	N/A	1995	192
1948	128	1964	137	1980	N/A	1996	278
1949	200	1965	255	1981	N/A	1997	328
1950	359	1966	254	1982	N/A	1998	175
1951	196	1967	209	1983	180	1999	326
1952	178	1968	185	1984	138	2000	215
1953	163	1969	223	1985	227	2001	289
1954	143	1970	203	1986	184	2002	188
1955	109	1971	191	1987	122	2003	81.6

Table A6. Mean annual discharge for the period of record at gage station 05078500 on Clearwater River at Red Lake Falls, MN (US Geological Survey).

Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)	Year	Annual Mean Streamflow (cfs)
1935	80.8	1952	308	1969	427	1986	408
1936	92.1	1953	265	1970	441	1987	232
1937	121	1954	224	1971	433	1988	158
1938	191	1955	182	1972	469	1989	218
1939	68.9	1956	254	1973	352	1990	94.9
1940	143	1957	469	1974	488	1991	140
1941	341	1958	124	1975	560	1992	231
1942	287	1959	157	1976	162	1993	360
1943	404	1960	177	1977	151	1994	445
1944	337	1961	122	1978	404	1995	466
1945	420	1962	779	1979	511	1996	591
1946	328	1963	215	1980	140	1997	766
1947	593	1964	271	1981	N/A	1998	416
1948	275	1965	587	1982	N/A	1999	755
1949	361	1966	536	1983	373	2000	419
1950	862	1967	382	1984	292	2001	540
1951	383	1968	282	1985	587		

APPENDIX B

Fish Species of the Red Lake River Watershed

Table B1. Fish species reported to have been sampled in the Red Lake River watershed (Aadland et al. 2005, Koel 1997). Common names followed by (E) are species that have been extirpated from the Red Lake River watershed and those followed by (L) are species that have been found only in headwater lakes.

Family	Common name	*Genus species*
Petromyzontidae	Chestnut lamprey	*Ichthyomyzon castaneus*
	Silver lamprey	*Ichthyomyzon unicuspis*
Acipenseridae	Lake sturgeon (E)	*Acipenser fulvescens*
Hiodontidae	Goldeye	*Hiodon alosoides*
	Mooneye	*Hiodon tergisus*
Cyprinidae	Spotfin shiner	*Cyprinella spiloptera*
	Common carp	*Cyprinus carpio*
	Brassy minnow	*Hybognathus hankinsoni*
	Common shiner	*Luxilus cornutus*
	Silver chub	*Macrhybopsis storeriana*
	Pearl dace	*Margariscus margarita*
	Hornyhead chub	*Nocomis biguttatus*
	Golden shiner	*Notemigonis crysoleucas*
	Emerald shiner	*Notropis atherinoides*
	River shiner (E)	*Notropis blennius*
	Bigmouth shiner	*Notropis dorsalis*
	Blackchin shiner	*Notropis heterodon*
	Blacknose shiner	*Notropis heterolepis*
	Spottail shiner	*Notropis hudsonius*
	Carmine shiner[1]	*Notropis percobromus*
	Sand shiner	*Notropis stramineus*
	Weed shiner	*Notropis texanus*
	Mimic shiner	*Notropis volucellus*
	Northern redbelly dace	*Phoxinus eos*
	Finescale dace	*Phoxinus neogaeus*
	Bluntnose minnow	*Pimephales notatus*
	Fathead minnow	*Pimephales promelas*
	Western blacknose dace[2]	*Rhinichthys obtusus*
	Longnose dace	*Rhinichthys cataractae*
	Creek chub	*Semotilus atromaculatus*
Catastomidae	Quillback	*Carpiodes cyprinus*
	White sucker	*Catostomus commersoni*
	Bigmouth buffalo	*Ictiobus cyprinellus*
	Silver redhorse	*Moxostoma anisurum*
	Golden redhorse	*Moxostoma erythrurum*
	Shorthead redhorse	*Moxostoma macrolepidotum*
Ictaluridae	Black bullhead	*Ameiurus melas*
	Yellow bullhead	*Ameiurus natalis*

Table B1 (continued)

Family	Common name	*Genus species*
Ictaluridae	Brown bullhead	*Ameiurus nebulosus*
	Channel catfish	*Ictalurus punctatus*
	Stonecat	*Noturus flavus*
	Tadpole madtom	*Notorus gyrinus*
Esocidae	Northern pike	*Esox lucius*
Umbridae	Central mudminnow	*Umbra limi*
Salmonidae	Cisco (L)	*Coregonus artedi*
	Lake whitefish (L)	*Coregonus clupeaformis*
	Rainbow trout	*Onchorhyncus mykiss*
	Brown trout	*Salmo trutta*
	Brook trout	*Salvelinus fontinalis*
Gadidae	Burbot	*Lota lota*
Percopsidae	Trout-perch	*Percopsis omiscomaycus*
Cyprinodontidae	Banded Killifish	*Fundulus diaphanus*
Gasterosteidae	Brook stickleback	*Culaea inconstans*
Cottidae	Mottled sculpin	*Cottus bairdi*
Centrarchidae	Rock bass	*Ambloplites rupestris*
	Pumpkinseed	*Lepomis gibbosus*
	Bluegill	*Lepomis macrochirus*
	Smallmouth bass	*Micropterus dolomieu*
	Largemouth bass	*Micropterus salmoides*
	Black crappie	*Pomoxis nigromaculatus*
Percidae	Iowa darter	*Etheostoma exile*
	Johnny darter	*Etheostoma nigrum*
	Yellow perch	*Perca flavescens*
	Logperch	*Percina caprodes*
	Blackside darter	*Percina maculata*
	River darter	*Percina shumardi*
	Sauger	*Sander canadense*
	Walleye	*Sander vitreus*
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*

[1] recently changed from rosyface shiner, *Notropis rubellus*
2 recently changed from blacknose dace, *Rhynichthys atratulus*

Table B2. Fish species found in the Red Lake River watershed that were considered by Niemela et al. (1998) to be sensitive to environmental disturbances including water quality and habitat degradation.

Family	Common name	*Genus species*
Hiodontidae	Goldeye	*Hiodon alosoides*
	Mooneye	*Hiodon tergisus*
Cyprinidae	Hornyhead chub	*Nocomis biguttatus*
	Blackchin shiner	*Notropis heterodon*
	Blacknose shiner	*Notropis heterolepis*
	Carmine shiner	*Notropis percobromus*
	Sand shiner	*Notropis stramineus*
	Mimic shiner	*Notropis volucellus*
	Northern redbelly dace	*Phoxinus eos*
	Finescale dace	*Phoxinus neogaeus*
	Longnose dace	*Rhinichthys cataractae*
Catastomidae	Silver redhorse	*Moxostoma anisurum*
	Golden redhorse	*Moxostoma erythrurum*
	Shorthead redhorse	*Moxostoma macrolepidotum*
Ictaluridae	Stonecat	*Noturus flavus*
Percopsidae	Trout-perch	*Percopsis omiscomaycus*
Centrarchidae	Rock bass	*Ambloplites rupestris*
	Smallmouth bass	*Micropterus dolomieu*
Percidae	Logperch	*Percina caprodes*

Table B3. Fish species found in the Red Lake River watershed that were considered by Niemela et al. (1998) to be highly tolerant to environmental disturbances including water quality and habitat degradation.

Family	Common name	*Genus species*
Cyprinidae	Common carp	*Cyprinus carpio*
	Golden shiner	*Notemigonis crysoleucas*
	Bluntnose minnow	*Pimephales notatus*
	Fathead minnow	*Pimephales promelas*
	Western blacknose dace	*Rhinichthys obtusus*
	Creek chub	*Semotilus atromaculatus*
Catastomidae	Quillback	*Carpiodes cyprinus*
	White sucker	*Catostomus commersoni*
	Bigmouth buffalo	*Ictiobus cyprinellus*
Ictaluridae	Black bullhead	*Ameiurus melas*
	Channel catfish	*Ictalurus punctatus*
Umbridae	Central mudminnow	*Umbra limi*
Gasterosteidae	Brook stickleback	*Culaea inconstans*
Centrarchidae	Green sunfish	*Lepomis cyanellus*
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*

APPENDIX C

Fish Data Summary Tables

Table C1. Sample date, station length, electrofishing gear type used and sampling effort statistics for fish sample stations in the Red Lake River watershed.

Stream	Station ID	Sample Date	Station Length (ft)	Mean Stream Width (ft)	Gear Type Used	Sampling Effort (sec)
Burnham Creek	BC2	7/26/04	375	11	Backpack	1,714
Black River	BR1	7/27/04	910	26	Backpack	2,522
Clearwater River	CR2	8/12/03	328	36	Backpack	1,425
Clearwater River	CR3	8/18/03	328	33	Backpack	1,406
Clearwater River	CR4	8/18/03	328	33	Backpack	1,170
Clearwater River	CR5	8/18/03	328	69	Backpack	2,018
Clearwater River	CR6	8/12/03	328	43	Backpack	1,481
Clearwater River	CR7	8/12/03	328	59	Backpack	1,251
Clearwater River	CR8	8/13/03	328	66	Backpack	1,263
Clearwater River	CR9	8/13/03	328	46	Backpack	1,333
Clearwater River	CR10	8/13/03	328	49	Backpack	1,156
Clearwater River	CR11	8/14/03	328	43	Backpack	1,283
Clearwater River	CR12	8/14/03	328	43	Backpack	1,808
Clearwater River	CR13	8/14/03	328	59	Backpack	1,866
Clearwater River	CR14	8/14/03	328	82	Backpack	967
Clearwater River	CR15	8/15/03	328	118	Backpack	1,484
Clearwater River	CR16	8/15/03	328	66	Backpack	1,143
Lost River	LR1	8/19/04	1,500	43	Tote Barge	5,341
Lost River	LR3	7/22/03	500	22	Backpack	2,493
Poplar River	PR1	9/30/04	910	21	Tote Barge	2,409
Poplar River	PR2	7/7/04	455	13	Tote Barge	1,729
Hill River	HR2	7/22/04	910	26	Tote Barge	N/A
Thief River	TR1	8/17/04	860	43	Tote Barge	2,834
Red Lake River	RLR_HL	8/16/04	2,310	66	Boat (12 ft)	1,439

Table C2. Number and weight of each fish species captured by DNR-RR using conventional electrofishing gear in the Red Lake River watershed in 2004.

Stream	Lost River		Lost River		Red Lake River		Hill River		Poplar River	
Station ID	LR1		LR3		RLR-HL		HR2		PR1	
Species	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)
Chestnut lamprey	1	31.8								
Silver lamprey	1	39.1								
Brassy minnow									4	7.6
Common shiner	611	3,093.2	6	87.0	36	160.2	12	266.2	90	889.9
Hornyhead chub	192	1,040.5	25	260.8	14	140.9	1	34.4		
Golden shiner									1	
Emerald shiner	1	1.6								
Bigmouth shiner									93	189.0
Blackchin shiner										
Blacknose shiner					1	1.5				
Spottail shiner					1	0.5				
Carmine shiner	3	4.2	5	9.8						
Sand shiner	25	49.2								
Mimic shiner	1	2.1			71	105.7			12	6.7
Northern redbelly dace							1	1.9	8	20.1
Finescale dace										
Bluntnose minnow										
Fathead minnow	1	5.0							7	26.9
Western blacknose dace	13	52.2	10	24.1					15	39.4
Longnose dace	12	54.3	7	25.2					41	47.0
Creek chub	305	2,213.8	27	687.1			34	518.8	178	1,159.3
White sucker	337	6,745.0			31	12,563.9	75	2,189.4	221	2,747.0
Silver redhorse					1	26.4				
Golden redhorse	2	95.5	2	165.2	31	14,890.3				
Shorthead redhorse	22	352.6			32	10,758.7				
Black bullhead							1	71.0		
Stonecat										
Tadpole madtom							1	10.0		
Northern pike	7	2775.6			5	146.4	1	29.1		
Central mudminnow	1	6.1	11	45.0			45	664.6	8	40.1
Brook stickleback							2	3.2	20	18.5
Rock bass	41	765.9			3	323.0	1	118.4		
Pumpkinseed			1	10.0			1	27.4		
Bluegill	14	322.5	8	29.7						
Smallmouth bass	232	1175.4							25	116.4
Black crappie							15	105.8		
Iowa darter			5	5.7			1	2.2		
Johnny darter	77	161.4	31	24.1			7	16.2	24	21.0
Yellow perch					1	1.0				
Blackside darter	214	813.1	4	9.6	19	61.2	2	15.5	8	14.4
Walleye					5	1874.0				
Freshwater drum					1	1175.0				
Total	**2,113**	**19,800.1**	**142**	**1,383.3**	**252**	**42,228.7**	**200**	**4,074.1**	**755**	**5,343.3**

Table C2 (continued).

Stream	Poplar River		Burnham Creek		Black River		Thief River	
Station ID	PR2		BC2		BR1		TR1	
Species	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)	No.	Wt. (g)
Chestnut lamprey								
Silver lamprey								
Brassy minnow								
Common shiner			1	9.1	44	398.2	285	1,698.6
Hornyhead chub					8	112.4	15	152.7
Golden shiner								
Emerald shiner					1	0.3		
Bigmouth shiner			2	1.6	25	48.7	16	22.2
Blackchin shiner					11	9.8		
Blacknose shiner								
Spottail shiner							49	23.0
Carmine shiner					10	15.8		
Sand shiner					4	9.5		
Mimic shiner			1	3.4			1	1.4
Northern redbelly dace	21	26.8			42	70.4	7	5.6
Finescale dace							1	8.0
Bluntnose minnow					1	0.2		
Fathead minnow			3	4.7	3	10.4	13	14.8
Western blacknose dace					61	209.8		
Longnose dace					12	52.0		
Creek chub			14	6.5	61	1095.3	4	4.7
White sucker			25	324.5	17	6796.8	9	2,465.5
Silver redhorse								
Golden redhorse								
Shorthead redhorse					1	19.4	27	13,720.1
Black bullhead			2	37.7				
Stonecat					2	59.3		
Tadpole madtom			1	7.5				
Northern pike							5	618.0
Central mudminnow	133	497.3	5	31.2	2	15.1	2	8.4
Brook stickleback					4	1.9	1	0.7
Rock bass					1	0.3	9	1,330.8
Pumpkinseed								
Bluegill								
Smallmouth bass					37	58.4		
Black crappie								
Iowa darter								
Johnny darter					24	100.5	42	62.6
Yellow perch							18	14.9
Blackside darter			6	15.7	11	43.0	145	446.3
Walleye								
Freshwater drum								
Total	**154**	**524.1**	**60**	**441.9**	**382**	**9,127.5**	**649**	**20,598.3**

Table C3. Number and total weight of each fish species sampled by RLWD in Clearwater River using backpack electrofishing gear in 2003.

Stream Station ID	CR2		CR3		CR4		CR5		CR6	
Species	**No.**	**Wt. (g)**	**No.**	**Wt. (g)**	**No.**	**Wt. (g)**	**No.**	**Wt. (g)**	**No.**	**Wt. (g)**
Chestnut lamprey									2	23.5
Silver lamprey					4	19.8				
Brassy minnow										
Common shiner	3	9.0	1	10.9					4	15.1
Hornyhead chub	1	1.3							8	69.6
Golden shiner										
Emerald shiner										
Bigmouth shiner										
Blackchin shiner										
Blacknose shiner										
Spottail shiner										
Carmine shiner										
Sand shiner										
Mimic shiner										
Unidentified shiner	1	2.9								
Northern redbelly dace										
Finescale dace	4	5.3							24	23.3
Bluntnose minnow										
Fathead minnow									2	0.5
Western blacknose dace	51	84.3	13	84.5	4	1.4			24	59.9
Longnose dace			26	134.2	1	3.1				
Creek chub	3	11.7	5	27.4	4	6.5	3	3.6	6	21.8
Quillback									1	53.1
White sucker	6	525.3	1	24.9	8	12.4	25	959.6	8	111.7
Silver redhorse										
Golden redhorse										
Shorthead redhorse										
Unidentified redhorse										
Black bullhead							5	271.2		
Yellow bullhead							4	122.0		
Stonecat										
Tadpole madtom										
Northern pike							1	1,285.0		
Central mudminnow	2	0.2	1	7.1	1	5.2	3	14.7		
Brook stickleback	2	0.2								
Rock bass							2	28.1	1	11.5
Pumpkinseed							4	118.6		
Bluegill							27	516.2		
Smallmouth bass										
Largemouth bass	3	35.7			4	18.0	5	396.0		
Black crappie	1	24.3					1	147.4		
Iowa darter					3	14.3	8	43.2	3	3.6
Johnny darter			3	6.3	19	16.0			2	0.2
Yellow perch					2	31.9	67	375.3		
Blackside darter										
Walleye										
Mottled sculpin			4	28.2	2	2.8				
Brown trout			5	789.0						
Total	**77**	**700.2**	**59**	**1,112.5**	**52**	**131.4**	**155**	**4,280.9**	**85**	**393.8**

Table C3 (continued).

Stream Station ID Species	CR7 No.	 Wt. (g)	CR8 No.	 Wt. (g)	CR9 No.	 Wt. (g)	CR10 No.	 Wt. (g)	CR11 No.	 Wt. (g)
Chestnut lamprey										
Silver lamprey										
Brassy minnow										
Common shiner	1	1.2	5	10.0	9	57.2	3	1.6	5	53.3
Hornyhead chub									1	15.4
Golden shiner										
Emerald shiner										
Bigmouth shiner										
Blackchin shiner										
Blacknose shiner										
Spottail shiner										
Carmine shiner										
Sand shiner										
Mimic shiner										
Unidentified shiner										
Northern redbelly dace										
Finescale dace			1	0.1			5	1.9		
Bluntnose minnow										
Fathead minnow	1	1.4	67	20.8	12	11.9	31	10.1	18	13.8
Western blacknose dace										
Longnose dace										
Creek chub	6	4.2								
Quillback										
White sucker	6	3.5	1	0.1	5	56.2			6	2,866.9
Silver redhorse										
Golden redhorse										
Shorthead redhorse										
Unidentified redhorse					2	215.6	1	628.4		
Black bullhead					1	17.8				
Yellow bullhead	1	18.4								
Stonecat			1	0.1						
Tadpole madtom										
Northern pike										
Central mudminnow			3	1.3	1	0.1	68	91.1	2	5.9
Brook stickleback	85	37.0	49	10.0	11	4.9	33	9.1	2	0.9
Rock bass										
Pumpkinseed										
Bluegill	6	111.7			2	11.6			1	27.1
Smallmouth bass										
Largemouth bass										
Black crappie										
Iowa darter					1	4.9	2	2.8	8	19.1
Johnny darter			1	0.1	4	2.1	1	2.7		
Yellow perch	9	82.8					2	4.6		
Blackside darter										
Walleye										
Mottled sculpin										
Brown trout										
Total	**115**	**260.2**	**128**	**42.5**	**48**	**382.3**	**146**	**752.3**	**43**	**3,002.4**

Table C3 (continued).

Stream Station ID / Species	CR12 No.	CR12 Wt. (g)	CR13 No.	CR13 Wt. (g)	CR14 No.	CR14 Wt. (g)	CR15 No.	CR15 Wt. (g)	CR16 No.	CR16 Wt. (g)
Chestnut lamprey					1	17.7				
Silver lamprey									2	7.1
Brassy minnow										
Common shiner	10	57.2								
Hornyhead chub			2	7.2						
Golden shiner										
Emerald shiner										
Bigmouth shiner										
Blackchin shiner										
Blacknose shiner										
Spottail shiner										
Carmine shiner										
Sand shiner										
Mimic shiner										
Unidentified shiner	7	2.1			6	2.1			74	29.8
Northern redbelly dace					1	2.2				
Finescale dace	3	2.2	20	8.2	47	20.2	11	6.2	26	28.3
Bluntnose minnow					1	11.7	2	N/A	10	23.0
Fathead minnow	42	21.9	56	11.3						
Western blacknose dace	6	2.0			2	4.4	2	2.0	11	21.8
Longnose dace							1	2.2	23	93.0
Creek chub	7	26.2	2	2.8	39	49.6	85	54.2	39	111.0
Quillback										
White sucker	7	1,019.6	5	1.3	11	62.9	1	1.4	9	25.2
Silver redhorse										
Golden redhorse										
Shorthead redhorse										
Unidentified redhorse										
Black bullhead										
Yellow bullhead					1	19.3	6	207.3	8	179.2
Stonecat									1	24.9
Tadpole madtom										
Northern pike			1	197.5						
Central mudminnow	2	17.1					9	4.9	68	40.1
Brook stickleback	21	9.0	3	0.1	4	0.1				
Rock bass			1	63.3			1	74.0		
Pumpkinseed										
Bluegill			2	14.8			1	13.0		
Smallmouth bass							3	215.4	2	16.1
Largemouth bass										
Black crappie										
Iowa darter	12	34.5	1	2.1	7	22.8	6	20.5	12	34.0
Johnny darter	6	0.2	3	0.8	6	6.3	4	4.4		
Yellow perch	2	10.9			1	1.0				
Blackside darter										
Walleye										
Mottled sculpin										
Brown trout										
Total	**125**	**1,202.9**	**96**	**309.4**	**127**	**220.3**	**132**	**605.5**	**285**	**633.5**

Table C4. Fish species composition at station LR1 in Lost River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Chestnut lamprey	1	*	31.8	0.2
Silver lamprey	1	*	39.1	0.2
Common shiner	611	28.9	3,093.2	15.6
Hornyhead chub	192	9.1	1,040.5	5.3
Emerald shiner	1	*	1.6	*
Carmine shiner	3	0.1	4.2	*
Sand shiner	25	1.2	49.2	0.2
Mimic shiner	1	*	2.1	*
Fathead minnow	1	*	5.0	*
Western blacknose dace	13	0.6	52.2	0.3
Longnose dace	12	0.6	54.3	0.3
Creek chub	305	14.4	2,213.8	11.2
White sucker	337	15.9	6,745.0	34.1
Golden redhorse	2	0.1	95.5	0.5
Shorthead redhorse	22	1.0	352.6	1.8
Northern pike	7	0.3	2,775.6	14.0
Central mudminnow	1	*	6.1	*
Rock bass	41	1.9	765.9	3.9
Bluegill	14	0.7	322.5	1.6
Smallmouth bass	232	11.0	1,175.4	5.9
Johnny darter	77	3.6	161.4	0.8
Blackside darter	214	10.1	813.1	4.1
Total	**2,113**	**100.0**	**19,800.**	**100.0**

Table C5. Fish species composition at station LR3 in Lost River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Common shiner	6	4.2	87.0	6.3
Hornyhead chub	25	17.6	260.8	18.9
Carmine shiner	5	3.5	9.8	0.7
Western blacknose dace	10	7.0	24.1	1.7
Longnose dace	7	4.9	25.2	1.8
Creek chub	27	19.0	687.1	49.7
Golden redhorse	2	1.4	165.2	11.9
Central mudminnow	11	7.7	45.0	3.3
Pumpkinseed	1	0.7	10.0	0.7
Bluegill	8	5.6	29.7	2.1
Iowa darter	5	3.5	5.7	0.4
Johnny darter	31	21.8	24.1	1.7
Blackside darter	4	2.8	9.6	0.7
Total	**142**	**100.0**	**1,383.3**	**100.0**

Table C6. Fish species composition at station RLR-HL in Red Lake River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Common shiner	36	14.3	160.2	0.4
Hornyhead chub	14	5.6	140.9	0.3
Blacknose shiner	1	0.4	1.5	0.0
Spottail shiner	1	0.4	0.5	0.0
Mimic shiner	71	28.2	105.7	0.3
White sucker	31	12.3	12,563.9	29.8
Silver redhorse	1	0.4	26.4	0.1
Golden redhorse	31	12.3	14,890.3	35.3
Shorthead redhorse	32	12.7	10,758.7	25.5
Northern pike	5	2.0	146.4	0.3
Rock bass	3	1.2	323.0	0.8
Yellow perch	1	0.4	1.0	0.0
Blackside darter	19	7.5	61.2	0.1
Walleye	5	2.0	1,874.0	4.4
Freshwater drum	1	0.4	1,175.0	2.8
Total	**252**	**100.0**	**42,228.7**	**100.0**

Table C7. Fish species composition at station HR2 in Hill River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Common shiner	12.0	6.0	266.2	6.5
Hornyhead chub	1.0	0.5	34.4	0.8
Northern redbelly dace	1.0	0.5	1.9	*
Creek chub	34.0	17.0	518.8	12.7
White sucker	75.0	37.5	2,189.4	53.7
Black bullhead	1.0	0.5	71.0	1.7
Tadpole madtom	1.0	0.5	10.0	0.2
Northern pike	1.0	0.5	29.1	0.7
Central mudminnow	45.0	22.5	664.6	16.3
Brook stickleback	2.0	1.0	3.2	0.1
Rock bass	1.0	0.5	118.4	2.9
Pumpkinseed	1.0	0.5	27.4	0.7
Black crappie	15.0	7.5	105.8	2.6
Iowa darter	1.0	0.5	2.2	0.1
Johnny darter	7.0	3.5	16.2	0.4
Blackside darter	2.0	1.0	15.5	0.4
Total	200.0	100.0	4,074.1	100.0

Table C8. Fish species composition at station PR1 in Poplar River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Brassy minnow	4	0.5	7.6	0.2
Common shiner	90	11.9	889.9	20.0
Golden shiner	1	0.1		
Bigmouth shiner	93	12.3	189.0	4.3
Mimic shiner	12	1.6	6.7	0.2
Northern redbelly dace	8	1.1	20.1	0.5
Fathead minnow	7	0.9	26.9	0.6
Western blacknose dace	15	2.0	39.4	0.9
Longnose dace	41	5.4	47.0	1.1
Creek chub	178	23.6	1,159.3	26.1
White sucker	221	29.3	2,747.0	61.8
Central mudminnow	8	1.1	40.1	0.9
Brook stickleback	20	2.6	18.5	0.4
Smallmouth bass	25	3.3	116.4	2.6
Johnny darter	24	3.2	21.0	0.5
Blackside darter	8	1.1	14.4	0.3
Total	**755**	**100.0**	**4,445.8**	**100.0**

Table C9. Fish species composition at station PR2 in Poplar River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Northern redbelly dace	21	13.6	26.8	5.1
Central mudminnow	133	86.4	497.3	94.9
Total	**154**	**100.0**	**524.1**	**100.0**

Table C10. Fish species composition at station BC2 in Burnham Creek.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Common shiner	1	1.7	9.1	2.1
Bigmouth shiner	2	3.3	1.6	0.4
Mimic shiner	1	1.7	3.4	0.8
Fathead minnow	3	5.0	4.7	1.1
Creek chub	14	23.3	6.5	1.5
White sucker	25	41.7	324.5	73.4
Black bullhead	2	3.3	37.7	8.5
Tadpole madtom	1	1.7	7.5	1.7
Central mudminnow	5	8.3	31.2	7.1
Blackside darter	6	10.0	15.7	3.6
Total	**60**	**100.0**	**441.9**	**100.0**

Table C11 Fish species composition at station BR1 in Black River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Common shiner	44	11.5	398.2	4.4
Hornyhead chub	8	2.1	112.4	1.2
Emerald shiner	1	0.3	0.3	0.0
Bigmouth shiner	25	6.5	48.7	0.5
Blackchin shiner	11	2.9	9.8	0.1
Carmine shiner	10	2.6	15.8	0.2
Sand shiner	4	1.0	9.5	0.1
Northern redbelly dace	42	11.0	70.4	0.8
Bluntnose minnow	1	0.3	0.2	0.0
Fathead minnow	3	0.8	10.4	0.1
Western blacknose dace	61	16.0	209.8	2.3
Longnose dace	12	3.1	52.0	0.6
Creek chub	61	16.0	1,095.3	12.0
White sucker	17	4.5	6,796.8	74.5
Shorthead redhorse	1	0.3	19.4	0.2
Stonecat	2	0.5	59.3	0.6
Central mudminnow	2	0.5	15.1	0.2
Brook stickleback	4	1.0	1.9	0.0
Rock bass	1	0.3	0.3	0.0
Smallmouth bass	37	9.7	58.4	0.6
Johnny darter	24	6.3	100.5	1.1
Blackside darter	11	2.9	43.0	0.5
Total	**382**	**100.0**	**9,127.5**	**100.0**

Table C12. Fish species composition at station TR1 in Thief River.

Species Present	Number	Percent of Total Number	Weight (g)	Percent of Total Weight
Common shiner	285	34.3	1,698.6	8.2
Hornyhead chub	15	1.8	152.7	7.4
Bigmouth shiner	16	1.9	22.2	0.1
Spottail shiner	49	5.9	23.0	0.1
Mimic shiner	1	0.1	1.4	>0.1
Northern redbelly dace	7	0.8	5.6	>0.1
Finescale dace	1	0.1	8.0	>0.1
Fathead minnow	13	1.6	14.8	>0.1
Creek chub	4	0.5	4.7	>0.1
White sucker	9	1.1	2,465.5	12.0
Shorthead redhorse	27	3.3	13,720.1	66.6
Northern pike	5	0.6	618.0	3.0
Central mudminnow	2	0.2	8.4	>0.1
Brook stickleback	1	0.1	0.7	>0.1
Rock bass	9	1.1	1,330.8	6.5
Johnny darter	42	5.1	62.6	0.3
Yellow perch	18	2.2	14.9	>0.1
Blackside darter	145	17.5	446.3	2.2
Total	**649**		**20,598.3**	

Table C13. Number of fish caught per electrofishing hour (CPUE) at stations within the Red Lake River watershed in 2004.

Station ID **Sampling Effort (sec)**	**LR1** **5341**	**LR3** **2493**	**RLR** **1439**	**PR1** **2409**	**PR2** **1429**	**BC2** **1714**	**BR1** **2522**	**TR1** **2834**
Species								
Chestnut lamprey	0.7							
Silver lamprey	0.7							
Brassy minnow				6.0				
Common shiner	412.8	8.7	90.0	134.3		2.1	62.9	362.1
Hornyhead chub	129.7	36.2	35.0				11.4	19.1
Golden shiner				1.5				
Emerald shiner	0.7						1.4	
Bigmouth shiner				138.8		4.2	35.7	20.3
Blackchin shiner							15.7	
Blacknose shiner			2.5					
Spottail shiner			2.5					62.3
Carmine shiner	2.0	7.2					14.3	
Sand shiner	16.9						5.7	
Mimic shiner	0.7		177.5	17.9		2.1		1.3
Northern redbelly dace				11.9	43.8		60.0	8.9
Finescale dace								1.3
Bluntnose minnow							1.4	
Fathead minnow	0.7			10.4		6.3	4.3	16.5
Western blacknose dace	8.8	14.5		22.4			87.1	
Longnose dace	8.1	10.1		61.2			17.1	
Creek chub	206.1	39.1		265.7		29.2	87.1	5.1
White sucker	227.7		77.5	329.9		52.1	24.3	11.4
Silver redhorse			2.5					
Golden redhorse	1.4	2.9	77.5					
Shorthead redhorse	14.9		80.0				1.4	34.3
Black bullhead						4.2		
Stonecat							2.9	
Tadpole madtom						2.1		
Northern pike	4.7		12.5					6.4
Central mudminnow	0.7	15.9		11.9	277.1	10.4	2.9	2.5
Brook stickleback				29.9			5.7	1.3
Rock bass	27.7		7.5				1.4	11.4
Pumpkinseed		1.4						
Bluegill	9.5	11.6						
Smallmouth bass	156.8			37.3			52.9	
Black crappie								
Iowa darter		7.2						
Johnny darter	52	44.9		35.8			34.3	53.4
Yellow perch			2.5					22.9
Blackside darter	144.6	5.8	47.5	11.9		12.5	15.7	184.2
Walleye			12.5					
Freshwater drum			2.5					
Total	**1427.7**	**205.8**	**630.0**	**1126.9**	**320.8**	**125.0**	**545.7**	**824.7**

Table C14. Number of fish caught per electrofishing hour (CPUE) at stations within the Clearwater River in 2003.

Station ID **Sampling Effort (sec)**	**CR2** **1425**	**CR3** **1406**	**CR4** **1170**	**CR5** **2018**	**CR6** **1481**	**CR7** **1251**	**CR8** **1263**	**CR9** **1333**	**CR10** **1156**
Species									
Chestnut lamprey					4.9				
Silver lamprey			12.3						
Brassy minnow									
Common shiner	7.6	2.6			9.7	2.9	14.3	24.3	9.3
Hornyhead chub	2.5				19.4				
Golden shiner									
Emerald shiner									
Bigmouth shiner									
Blackchin shiner									
Blacknose shiner									
Spottail shiner									
Carmine shiner									
Sand shiner									
Mimic shiner									
Unidentified shiner	2.5								
Northern redbelly dace									
Finescale dace	10.1				58.3		2.9		15.6
Bluntnose minnow									
Fathead minnow					4.9	2.9	191.0	32.4	96.5
Western blacknose dace	128.8	33.3	12.3		58.3				
Longnose dace		66.6	3.1						
Creek chub	7.6	12.8	12.3	5.4	14.6	17.3			
Quillback					2.4				
White sucker	15.2	2.6	24.6	44.6	19.4	17.3	2.9	13.5	
Silver redhorse									
Golden redhorse									
Shorthead redhorse									
Unidentified redhorse								5.4	3.1
Black bullhead				8.9				2.7	
Yellow bullhead				7.1		2.9			
Stonecat							2.9		
Tadpole madtom									
Northern pike				1.8					
Central mudminnow	5.1	2.6	3.1	5.4			8.6	2.7	211.8
Brook stickleback	5.1					244.6	139.7	29.7	102.8
Rock bass				3.6	2.4				
Pumpkinseed				7.1					
Bluegill				48.2		17.3		5.4	
Smallmouth bass									
Largemouth bass	7.6		12.3	8.9					
Black crappie	2.5			1.8					
Iowa darter			9.2	14.3	7.3			2.7	6.2
Johnny darter		7.7	58.5		4.9		2.9	10.8	3.1
Yellow perch			6.2	119.5		25.9			6.2
Blackside darter									
Walleye									
Mottled sculpin		10.2	6.2						
Brown trout		12.8							
Total	**194.5**	**151.1**	**160.0**	**276.5**	**206.6**	**330.9**	**364.8**	**129.6**	**454.7**

Table C14 (continued).

Station ID Sampling Effort (sec)	CR11 1283	CR12 1808	CR13 1866	CR14 967	CR15 1484	CR16 1143
Species						
Chestnut lamprey				3.7		
Silver lamprey						6.3
Brassy minnow						
Common shiner	14.0	19.9				
Hornyhead chub	2.8		3.9			
Golden shiner						
Emerald shiner						
Bigmouth shiner						
Blackchin shiner						
Blacknose shiner						
Spottail shiner						
Carmine shiner						
Sand shiner						
Mimic shiner						
Unidentified shiner		13.9		22.3		233.1
Northern redbelly dace				3.7		
Finescale dace		6.0	38.6	175.0	26.7	81.9
Bluntnose minnow				3.7	4.9	31.5
Fathead minnow	50.5	83.6	108.0			
Western blacknose dace		11.9		7.4	4.9	34.6
Longnose dace					2.4	72.4
Creek chub		13.9	3.9	145.2	206.2	122.8
Quillback						
White sucker	16.8	13.9	9.6	41.0	2.4	28.3
Silver redhorse						
Golden redhorse						
Shorthead redhorse						
Unidentified redhorse						
Black bullhead						
Yellow bullhead				3.7	14.6	25.2
Stonecat						3.1
Tadpole madtom						
Northern pike			1.9			
Central mudminnow	5.6	4.0			21.8	214.2
Brook stickleback	5.6	41.8	5.8	14.9		
Rock bass			1.9		2.4	
Pumpkinseed						
Bluegill	2.8		3.9		2.4	
Smallmouth bass					7.3	6.3
Largemouth bass						
Black crappie						
Iowa darter	22.4	23.9	1.9	26.1	14.6	37.8
Johnny darter		11.9	5.8	22.3	9.7	
Yellow perch		4.0		3.7		
Blackside darter						
Walleye						
Mottled sculpin						
Brown trout						
Total	**120.7**	**248.9**	**185.2**	**472.8**	**320.2**	**897.6**

Appendix D

Fish Index of Biotic Integrity Results

Table D1. Fish species IBI ratings for stations in the Red Lake River watershed with drainage areas less than 200 square miles.

Station Number	**LR3**		**HR2**		**PR1**		**PR2**	
Date								
Drainage Area (sq miles)	**75.8**		**103.7**		**113.0**		**77.0**	
Length of Station (m)	**152.4**		**277.3**					
Gear	**Backpack**		**Tow Barge**		**Tow Barge**		**Tow Barge**	
Sample Size	**142**		**200**		**755**			
Metric	**Observed**	**Score**	**Observed**	**Score**	**Observed**	**Score**	**Observed**	**Score**
Sp. Richness and Composition								
Number of species	13	5	16	5	16	5	2	1
Evenness	0.863	5	0.645	3	0.7418	3	0.570	1
Number of minnow species	6	5	4	3	10	5	1	1
Percent pioneer individuals	41.0	3	20.5	5	27.0	5	0	1
Percent headwater individuals	7.0	1	1.5	1	5.6	1	0.14	1
Trophic Composition								
Percent omnivore biomass	0	5	55.5	3	51.9	3	0	1
Percent insectivore biomass	100	5	38.3	3	45.8	3	100	1
Reproductive Guild								
Percent simple lithophilic	19.7	1	39.0	3	37.8	3	14	1
Functional Guild								
Percent tolerant individuals	33.8	3	78.5	1	58.1	3	86	1
Number of sensitive species	4	5	3	5	4	5	1	1
Abundance and Condition								
Number per meter	0.93	1	0.72	1	3.4	1	0.83	1
Percent DELT	0	5	0	5	0	5	0	5
Total IBI Score		**44**		**38**		**42**		**16**

Table D1 (cont'd).

Station Number	BC2		BR1	
Date				
Drainage Area (sq miles)	73.9		142.1	
Length of Station (m)	111		277.4	
Gear	Backpack		Backpack	
Sample Size	60		382	
Metric	**Observed**	**Score**	**Observed**	**Score**
Sp. Richness and Composition				
Number of species	10	5	22	5
Evenness	0.748	3	0.82	5
Number of minnow species	5	3	13	5
Percent pioneer individuals	28.3	5	23	5
Percent headwater individuals	0	1	28	3
Trophic Composition				
Percent omnivore biomass	83.0	1	75.0	1
Percent insectivore biomass	16.9	1	25.0	1
Reproductive Guild				
Percent simple lithophilic	51.7	3	40.0	3
Functional Guild				
Percent tolerant individuals	81.7	1	39.0	3
Number of sensitive species	1	1	10	5
Abundance and Condition				
Number per meter	0.541	1	1.38	1
Percent DELT	0	5	0	5
Total IBI Score		**30**		**42**

Table D1 (continued).

Station Number	CR3		CR4		CR5		CR6	
Date	8/18/03		8/18/03		8/18/03		8/12/03	
Drainage Area (sq miles)	104.1		136.2		150.6		196.6	
Length of Station (m)	100		100		100		100	
Gear	Backpack		Backpack		Backpack		Backpack	
Sample Size	59		52		155		85	
Metric	**Observed**	**Score**	**Observed**	**Score**	**Observed**	**Score**	**Observed**	**Score**
Sp. Richness and Composition								
Number of species	9	5	11	5	13	5	12	5
Evenness	0.753	3	0.839	5	0.701	3	0.796	3
Number of minnow species	4	3	3	1	1	1	6	3
Percent pioneer individuals	13.6	5	44.2	3	1.9	5	11.8	5
Percent headwater individuals	22.0	1	7.7	1	0	1	56.5	5
Trophic Composition								
Percent omnivore biomass	2.0	5	9.4	5	31.6	5	28.5	5
Percent insectivore biomass	31.1	3	59.7	3	23.8	1	49.1	3
Reproductive Guild								
Percent simple lithophilic	67.8	5	25.0	1	16.1	1	37.7	3
Functional Guild								
Percent tolerant individuals	33.9	3	32.7	3	23.2	5	40.1	3
Number of sensitive species	1	1	1	1	1	1	3	3
Abundance and Condition								
Number per meter	0.59	1	0.52	1	1.55	1	0.85	1
Percent DELT	0	5	0.5		0	5	0	5
Total IBI Score		**40**		**34**		**32**		**44**

Table D2. Fish species IBI ratings for stations in the Red Lake River watershed with drainage areas from 200 to 1500 square miles.

Station Number	**LR1**		**TR1**	
Date				
Drainage Area (sq miles)	**289.2**		**1,045.3**	
Length of Station (m)	**457**		**196.6**	
Gear	**Tow Barge**		**Tow Barge**	
Sample Size	**2,113**		**639**	
Metric	**Observed**	**Score**	**Observed**	**Score**
Sp. Richness and Composition				
Number of species	22	5	18	5
Evenness	0.670	3	0.624	3
Number of minnow sp	10	5	8	5
Number of benthic insectivore sp	7	3	5	3
Trophic Composition				
Percent piscivore biomass	24.2	5	7.1	1
Percent omnivore biomass	34.1	3	9.1	5
Percent insectivore biomass	41.7	3	83.8	5
Reproductive Guild				
Percent simple lithophilic	31.1	3	31.0	3
Functional Guild				
Percent tolerant individuals	31.1	3	4.5	5
Number of sensitive species	9	5	6	5
Abundance and Condition				
Number per meter	4.61	3	2.4	3
Percent DELT	4.6	1	0	5
Total IBI Score		**42**		**48**

Table D2 (continued).

Station Number	CR7		CR8		CR9		CR10	
Date	8/12/03		8/13/03		8/13/03		8/13/03	
Drainage Area (sq miles)	201.5		309.7		404.1			
Length of Station (m)	100		100		100		100	
Gear	Backpack		Backpack		Backpack		Backpack	
Sample Size	115		120		48			
Metric	**Observed**	**Score**	**Observed**	**Score**	**Observed**	**Score**	**Observed**	**Score**
Sp. Richness and Composition								
Number of species	8	3	8	3	10	3	9	3
Evenness	0.485	1	0.516	3	0.846	5	0.611	3
Number of minnow sp	3	1	3	1	2	1	3	1
Number of benthic insectivore sp	0	1	2	1	3	1	3	1
Trophic Composition								
Percent piscivore biomass	0	1	0	1	0	1	0	1
Percent omnivore biomass	9.0	5	50.6	3	23.4	1	1.3	5
Percent insectivore biomass	91.0	5	49.4	3	21.1	1	98.7	5
Reproductive Guild								
Percent simple lithophilic	5.2	1	0.8	1	14.6	1	0.69	1
Functional Guild								
Percent tolerant individuals	85.2	1	93.8	1	62.5	1	90.4	1
Number of sensitive species	0	1	2	1	1	1	2	1
Abundance and Condition								
Number per meter	1.15	1	1.28	1	0.48	1	1.46	1
Percent DELT	0	5	0	5	0	5	0	5
Total IBI Score		**26**		**24**		**22**		**28**

Table D2 (continued).

Station Number	CR11		CR13		CR15	
Date	8/14/03		8/14/03		8/15/03	
Drainage Area (sq miles)	440.3		540.9		1160.0	
Length of Station (m)	100		100		100	
Gear	Backpack		Backpack		Backpack	
Sample Size	43		96		132	
Metric	**Observed**	**Score**	**Observed**	**Score**	**Observed**	**Score**
Sp. Richness and Composition						
Number of species	8	3	11	3	13	3
Evenness	0.800	3	0.582	1	0.554	1
Number of minnow sp	3	1	4	1	5	3
Number of benthic insectivore sp	1	1	2	1	4	3
Trophic Composition						
Percent piscivore biomass	0.0	1	84.1	1	29.1	5
Percent omnivore biomass	70.8	1	4.0	5	41.6	3
Percent insectivore biomass	29.2	1	10.4	1	21.4	1
Reproductive Guild						
Percent simple lithophilic	14.0	1	5.2	1	30.1	1
Functional Guild						
Percent tolerant individuals	65.1	1	68.8	1	75.0	1
Number of sensitive species	1	1	3	3	4	3
Abundance and Condition						
Number per meter	0.43	1	0.96	1	1.32	1
Percent DELT	0	5	0	5	0	5
Total IBI Score		**20**		**24**		**30**

Table D3. Fish species IBI ratings for stations in the Red Lake River watershed with drainage areas greater than 1500 square miles.

Station Number	**RLR-HL**	
Date		
Drainage Area (sq miles)	**2,297.6**	
Length of Station (m)	**704**	
Gear	**Boat**	
Sample Size	**252**	
Metric	**Observed**	**Score**
Sp. Richness and Composition		
Number of species	15	3
Evenness	0.770	3
Percent large river individuals	2.8	1
Percent round bodied suckers	25.4	3
Trophic Composition		
Percent piscivore biomass	5.5	1
Percent omnivore biomass	29.8	5
Percent insectivore biomass	64.7	5
Reproductive Guild		
Percent simple lithophilic	47.2	3
Functional Guild		
Percent tolerant individuals	12.7	5
Number of sensitive species	7	5
Abundance and Condition		
Number per meter	0.358	1
Percent DELT	0.	5
Total IBI Score		**40**

APPENDIX E

IBI Scores from Previous Investigations on Tributary Streams to Red River

Table E1. Index of Biotic Integrity (IBI) scores for watersheds in the Red River Basin sampled in 2000 and 2001.

Watershed Stream	IBI Score	IBI Score Interpretation
Bois de Sioux Watershed		
Bois de Sioux River	**24**	**Poor**
Bois de Sioux River	**18**	**Very poor**
Twelvemile Creek	**20**	**Very poor**
W. Branch Twelvemile Creek	**16**	**Very poor**
Mustinka River	**23**	**Poor**
Five Mile Creek	**26**	**Poor**
Wild Rice Watershed		
Wild Rice River	**24**	**Poor**
Wild Rice River	**42**	**Good**
Wild Rice River	**32**	**Fair**
Wild Rice River	**44**	**Good**
Wild Rice River	**40**	**Fair**
Wild Rice River	**32**	**Poor**
Wild Rice River	**42**	**Good**
Wild Rice River	**38**	**Fair**
White Earth River	**38**	**Fair**
White Earth River	**40**	**Fair**
White Earth River	**34**	**Fair**
So. Branch Wild Rice River	**32**	**Fair**
So. Branch Wild Rice River	**38**	**Fair**
Marsh Creek	**36**	**Fair**
Mashaug Creek	**40**	**Fair**
Roseau River Watershed		
Buffalo River	**32**	**Fair**
Buffalo River	**38**	**Fair**
Buffalo River	**38**	**Fair**
Buffalo River	**38**	**Fair**
Buffalo River	**44**	**Good**
Buffalo River	**42**	**Good**
Buffalo River	**28**	**Poor**
So. Branch Buffalo River	**32**	**Fair**
So. Branch Buffalo River	**34**	**Fair**
So. Branch Buffalo River	**28**	**Poor**
Stony Creek	**22**	**Poor**
Stony Creek	**38**	**Fair**
Stony Creek	**28**	**Poor**
Spring Creek	**40**	**Fair**
Hay Creek	**30**	**Poor**
Hay Creek	**24**	**Poor**
County Ditch 38	**38**	**Fair**
Deerhorn Creek	**38**	**Fair**
Whiskey Creek	**30**	**Poor**
Whiskey Creek	**28**	**Fair**
Whiskey Creek	**20**	**Very Poor**
Whiskey Creek	**34**	**Fair**
Roseau River Watershed		
Roseau River	**38**	**Fair**
Roseau River	**16**	**Very poor**
Roseau River	**24**	**Poor**
Roseau River	**14**	**Very poor**
Roseau River	**26**	**Poor**
Roseau River	**44**	**Good**
Roseau River	**34**	**Fair**
Roseau River	**40**	**Fair**
Roseau River	**40**	**Fair**
So. Fork Roseau River	**38**	**Fair**
So. Fork Roseau River	**46**	**Good**
Hay Creek	**32**	**Fair**
Hay Creek	**24**	**Poor**
Hay Creek	**30**	**Poor**
Bear Creek	**38**	**Fair**
Bear Creek	**40**	**Fair**
Sprague Creek	**40**	**Fair**
Two Rivers Watershed		
So. Branch Two Rivers	**28**	**Poor**
So. Branch Two Rivers	**22**	**Poor**
So. Branch Two Rivers	**24**	**Poor**
County Ditch 49	**30**	**Poor**
County Ditch 48	**36**	**Fair**
So. Branch Two Rivers	**46**	**Good**
So. Branch Two Rivers	**38**	**Fair**
So. Branch Two Rivers	**36**	**Fair**
County Ditch 13	**16**	**Very Poor**
Middle Branch Two Rivers	**36**	**Fair**
Middle Branch Two Rivers	**32**	**Fair**
Two Rivers	**38**	**Fair**
No. Branch Two Rivers	**42**	**Good**
No. Branch Two Rivers	**40**	**Fair**
No. Branch Two Rivers	**40**	**Fair**
No. Branch Two Rivers	**34**	**Fair**
No. Branch Two Rivers	**26**	**Poor**