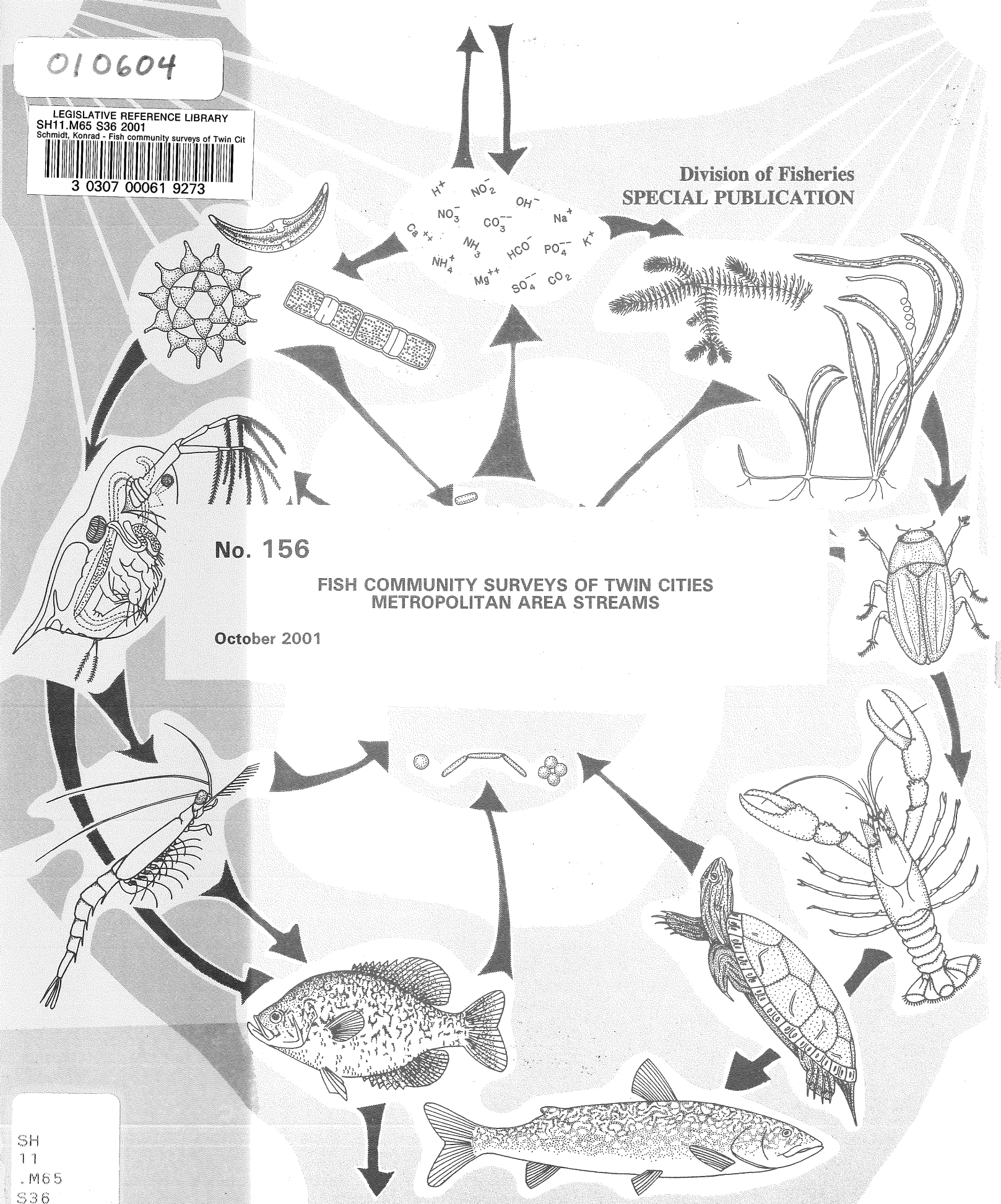

Division of Fisheries
SPECIAL PUBLICATION

No. 156

FISH COMMUNITY SURVEYS OF TWIN CITIES METROPOLITAN AREA STREAMS

October 2001

Minnesota Department of Natural Resources
Special Publication 156, October 2001

Fish Community Surveys of Twin Cities Metropolitan Area Streams

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Abstract.--One hundred thirty-three Twin Cities Metropolitan area stream stations were sampled during 1998-2000. Our goal was to gain knowledge of fish communities in these rarely studied urban streams and to document their status. Seventy-two species from 18 families were collected during the survey. Fathead minnows, central mudminnows, and green sunfish were the most frequently occurring species. Trout were collected from 26 of the 133 stations. Brook trout were present at 16 stations, while brown trout were collected from 15 stations, and rainbow trout from one station. Several warmwater game fish species were also collected. Index of biotic integrity scores of warmwater streams ranged from 0 (very poor) to 60 (good), with a median of 20 (poor). Coldwater biotic integrity scores reflected conditions more similar to reference conditions. Coldwater scores ranged from 20 (poor) to 115 (excellent), with a median of 103 (excellent). No endangered, threatened, or special concern species were sampled during this study. However, 10 species collected during this survey are rarely reported from the Twin Cities Metropolitan area. Future studies should focus on the geographical and hydrological diversity of these streams in a manner that would allow for monitoring of resource integrity over time.

Introduction

The Twin Cities Metropolitan Area (TCMA) includes portions of four major river basins: Minnesota, Upper and Lower Mississippi, and St. Croix rivers. This area encompasses approximately 1,903,435 acres and 1,897 miles of stream, and includes 7 counties (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington). Although agriculture persists on the periphery, this is the most urbanized and densely populated area of the state. Common impacts to streams include increased frequencies of flash flooding, severe bank erosion, desiccation during low and sometimes base flows, rapid and extreme temperature fluctuations, chemical spills and nutrient enrichment from streets and lawns, and internment (e.g., Bassett Creek where the last 2 miles of stream is piped under Minneapolis).

Urban streams often have altered hydrology, chemistry, habitat, and stream morphology that impacts their fish communities. Large areas of impervious surfaces in the watershed have resulted in flashy hydrographs which can alter stream habitat quality (Booth and Reinelt 1993). Urban streams tend to be wider and shallower than their unimpacted rural counterparts (Klein 1979). Ion concentrations (e.g., sodium and chloride) have been shown to be correlated to reductions in species richness and diversity (Talmage et al. 1999). The occurrence of sodium and chloride exemplify the often overlooked effects of nonpoint source pollution. Point and nonpoint source pollutants

may impair water quality of otherwise good habitat stream reaches and cause consequent impairment of the biotic communities. A study by Talmage et al. (1999) found that habitat in TCMA streams has been reduced, and this reduction in habitat was largely attributed to human disturbance. These disturbances, along with others, act together to impact the biotic communities, including the fish that inhabit TCMA streams.

The need for a TCMA wide survey was first proposed by Dr. Jay Hatch, Associate Curator of the University of Minnesota's James Ford Bell Museum of Natural History fish collection. For years, he received an increasing number of requests, from a variety of interests, for information concerning fish composition in TCMA streams. However, he discovered there was very little coverage of TCMA streams in the fish collection's holdings. This study was intended to be an initial investigation of stream resources in the TCMA. Potential applications of this information include environmental planning and review, watershed planning, and fisheries management (i.e., trout).

Methods and Materials

One hundred thirty-three sites were sampled beginning with five in the fall of 1998, 80 in 1999, and 48 in 2000 (Figure 1). Twenty-seven additional stations were not sampled, primarily in the western TCMA, due to drought conditions in 2000. All sampled streams were located within or near the TCMA.

Station selection was restricted to wadeable, permanent flow sites. Generally, on small streams, one station was established in the lower watershed. On impacted and larger streams, multiple stations were established above and below barriers or waste water treatment plants. Sites were selected to represent the TCMA, this was not a full survey of the entire TCMA.

Stream survey stations were investigated twice. On the first site visit, streams were examined to determine access, flow, reach length, and appropriate sampling gear. Station lengths were a minimum of 35 times the average stream width with a minimum of 150 meters (m) for streams 3 m or less in width, and a maximum of 500 m for streams more than 14 m wide. A Garmin 12 channel global positioning system (GPS) recorded latitude/longitude coordinates at the station's midpoint. Stations were marked with flagging at the downstream, middle, and upstream points. At each stream, a camcorder was used to record instream and riparian habitat condition at a minimum of the three points, or every bend in sinuous streams.

On the second visit, data were collected on water chemistry, fish communities, and habitat. On-site water chemistry analyses included transparency recorded in centimeters (cm, using a transparency tube), turbidity in nephelometric turbidity units (ntu), pH, dissolved oxygen in milligrams/liter (mg/l), temperature in degrees centigrade (°C), and conductivity in μmhos@25°C. Additional water samples were collected for analyses of ammonia, nitrates, and nitrites by the Minnesota Department of Health. In 1998 and 2000, total phosphorous and total suspended solids were also analyzed. Water chemistry results were compiled into STORET which is a national database maintained by the Environmental Protection Agency.

Fish sampling was restricted to electrofishing gears. A 12 volt Smith-Root Type VII electrofisher was used in small streams and a custom stream electrofisher (tow barge) equipped with Coffelt VVP-15 unit was used for mid-size streams. All collected fish were identified, sorted by species, tallied, batch weighed in grams (g), smallest and largest specimens measured for a total length range in millimeters (mm), and examined for anomalies such as deformities and lesions. Up to 10 specimens of each species were preserved in formalin for later verification and final deposition in the fish collection at the James Ford Bell Museum of Natural History, University of Minnesota, St. Paul. Effort was

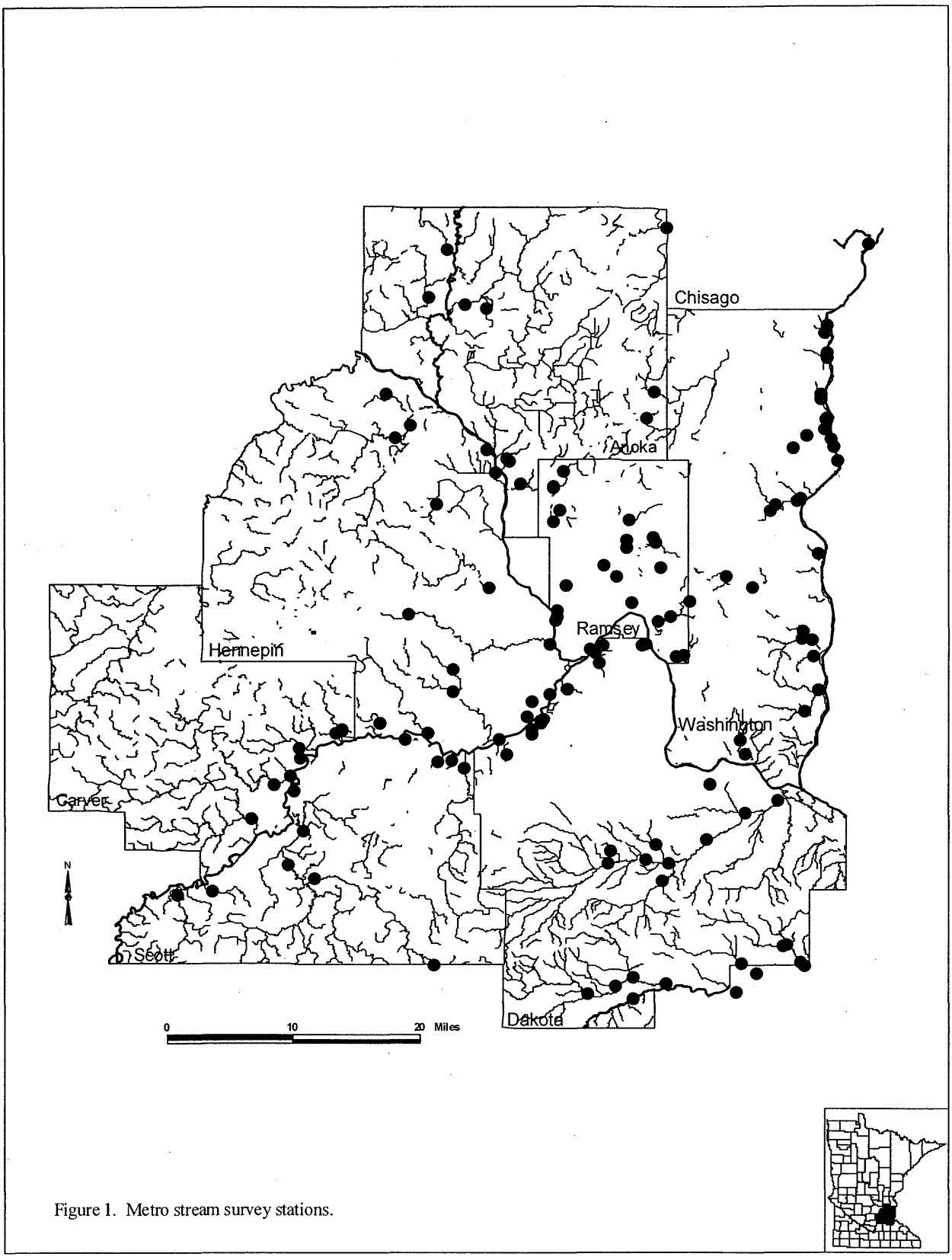

Figure 1. Metro stream survey stations.

recorded in seconds to determine catch per effort (CPE) which is a relative abundance value of species at each station, and expressed as fish sampled per hour (fish/hr).

Finally, habitat features were documented. These features included substrate, instream cover, channel morphology, riparian zone, bank erosion, pool/riffle/run quality, and gradient.

At the completion of the field work, a summary report, raw data including all field forms, and VHS video tape of stations were provided to Scott Niemela in the Minnesota Pollution Control Agency (MPCA), Environmental Outcomes Division in St. Paul.

The index of biotic integrity (IBI) was used to evaluate the status of the fish communities in these TCMA streams. The IBI evaluates various attributes (metrics) of the fish community and then scores them based on comparisons to the most pristine sites in the region. An IBI approach provides the framework to bring together the cumulative effects of various disturbances impacting streams (Karr and Chu 1999). TCMA streams with higher scores are more similar to pristine conditions, while streams with low scores have been severely impacted.

Using an IBI requires a modification specific to regional conditions (Fausch et al. 1984; Steedman 1988). The TCMA does not have a regionally developed IBI specific to the entire area. Therefore, two IBI versions were considered for rating TCMA warmwater streams because their development was done in or near the TCMA: one developed for wadeable warmwater streams of Wisconsin (Lyons 1992); and the other developed for coolwater streams of the St. Croix River basin (Niemela and Feist 2000). Each IBI was used to score the entire warmwater data set. Then individual sites and metrics were compared. The Wisconsin Department of Natural Resources (WDNR) version (Lyons 1992) was consistently able to account for and adequately score the uncharacteristic conditions found in the numerous headwater sites in this study. Both modifications gave scores that were similar for non-headwater streams, however, the St. Croix River IBI (Niemela and Feist 2000) was consistently higher. The St. Croix River IBI higher scoring at non-headwater streams was likely due to differential scoring of the "abundance" and "health condition" metrics. The St. Croix River IBI scores a positive 20 points as long as enough fish are present and not demonstrating high percentages of deformities, regardless of species, while the Wisconsin version deducts from the IBI score only if fish quantities and percentage of deformities are sub-standard.

For the assessment of warmwater streams, the IBI developed by the WDNR was employed (Lyons 1992). This IBI evaluates 10 metrics, has total scores ranging from 0 to 100, and rates fish communities from very poor to excellent (Table 1). Because this modification of the IBI was not specifically developed for use on TCMA streams, there are caveats to its use. First, the WDNR IBI was developed for use on moderate sized wadeable streams, not "headwater" streams that are common in the TCMA. However, while many of the sites sampled in this survey are considered "headwater" streams, they do not function as such. TCMA streams generally demonstrated species richness and composition of moderate sized streams. Additionally, TCMA streams typically have a close proximity (within 1-2 miles) to larger streams, rivers, and lakes. In summary, this particular version of the IBI may have scored headwater streams low; however, when compared to other regional modifications it provided the most accurate results. Second, although the WDNR IBI was developed for warmwater streams of Wisconsin, fish communities in TCMA streams are zoogeographically similar to the streams of central Wisconsin. Additionally, TCMA streams are more geomorphologically and hydrologically similar to central Wisconsin streams than to the St. Croix River basin.

For the coldwater streams in the TCMA, we used an IBI developed by Mundahl and Simon (1999) for Midwestern coldwater streams. This version of the IBI evaluates 12 metrics, and scores range from 0 to 120 (Table 2). Warmwater streams were common

Table 1. Guidelines for interpreting overall warmwater IBI scores (from Lyons 1992).

Overall IBI Score	Biotic integrity rating	Fish community attributes
100-65	Excellent	Comparable to the best situations with minimal human disturbance; all regionally expected species for habitat and stream size, including the most intolerant forms, are present with a full array of age and size classes; balanced trophic structure.
64-50	Good	Species richness somewhat below expectation, especially due to the loss of intolerant forms; some species, especially top carnivores, are present with less optimal abundances or size/age distributions; trophic structure shows some signs of imbalance.
49-30	Fair	Signs of additional deterioration include decreased species richness, loss of intolerant forms, reduction in simple lithophils, increased abundance of tolerant species, and/or highly skewed trophic structure (i.e., increasing frequency of omnivores and decreased frequency of more specialized feeders); older age classes of top carnivores rare and absent.
29-20	Poor	Relatively few species; dominated by omnivores, tolerant forms, and habitat generalists; few or no top carnivores or simple lithophilous spawners; growth rates and condition factors sometimes depressed; hybrids sometimes common.
19-0	Very Poor	Very few species present, mostly exotics or tolerant forms or hybrids; few large or old fish; DELT fish (fish with deformities, eroded fins, lesions, or tumors) sometimes common.
No score	Very Poor	Thorough sampling finds few or no fish; impossible to calculate IBI.

Table 2. Guidelines for interpreting overall coldwater IBI scores (from Mundahl and Simon 1999).

Overall IBI Score	Biotic Integrity Rating	Fish community attributes
105-120	Excellent	Comparable to the best situations with little human disturbance; 3 or 4 coldwater species present; dominated (>75%) by brook trout; exotic salmonids absent or limited to few individuals; sculpin present; lampreys often present; white suckers absent; warmwater species absent or very uncommon.
70-100	Good	Some impairment present; coldwater intolerant species (sculpin, brook trout) reduced in abundance; white suckers present in low numbers; often dominated by brown trout or other salmonids; higher species richness resulting from presence of more tolerant warmwater minnows and darters.
35-65	Fair	Moderate impairment; coldwater intolerant species rare or absent; brown trout and more tolerant coldwater species (e.g., brook stickleback) may be common; relatively high species richness; warmwater species relatively common.
10-30	Poor	High impairment; more tolerant warmwater species usually dominant; white suckers often abundant; salmonids very rare or absent; relatively high species richness.
0-5	Very Poor	Severe impairment; coldwater fish absent; only warmwater species present.
No score	No Score	Too few fish (<25 individuals) to calculate IBI score.

throughout the entire TCMA, while coldwater/trout streams were located primarily in the St. Croix River basin (Washington County). Some of these coldwater streams are managed for trout, while others have remnant populations from historic stocking. It was evident that natural reproduction is also taking place in many of these coldwater/trout streams.

Results and Discussion

The three year study sampled over 50,000 fish representing 72 species in 18 families (Table 3). Overall, the emerald shiner was the most abundant species and comprised 28.8 % of the total catch but occurred at only 14.4% of the stations. Fathead minnows, central mudminnows, and green sunfish were the most frequently occurring species which were present at 61.6, 52.8, and 61.6 % of the stations, respectively. Mooneye, goldfish, silver chub, spottail shiner, mimic shiner, smallmouth buffalo, bigmouth buffalo, brown bullhead, rainbow trout, tiger trout (hybrid), brook silverside, mottled sculpin, slimy sculpin, white bass, rock bass, banded darter, and river darter were the rarest fishes which each comprised 0.1 % or less of the total catch and were present at only one or two stations (0.8 - 1.6 % occurrence).

Eighty-eight of the 133 stations exhibited low species richness. No fish were found at 9 stations, 1-5 species at 49 stations, and 6-10 species at 30 stations. Species diversity was higher at other stations with 11 to 14 species at 23 stations, 16 to 20 species at 15 stations, and more than 20 species at 7 stations. The greatest species richness occurred in moderate to large streams which include Bevens and Carver creeks (Carver County), Chub Creek and Vermillion River (Dakota County), Cannon River (Goodhue County), and Credit River and Sand Creek (Scott County) at 28, 31, 29, 31, 22, 23, 29 species, respectively. Several smaller streams also had diverse communities, but generally were in close proximity to a lake or river which provided access for species not typically found in streams of this size on a permanent basis. However, Seelye Brook (Anoka County) was one exception where 19 species were sampled.

Trout Streams

Trout species were sampled at 26 stations on 20 streams (Table 4 and Figure 2). Brook trout were present at 16 stations, brown trout at 15 stations, and rainbow trout at one station. However, brook and brown trout were sampled together at only five stations. One tiger trout, which is a hybrid between a brown and brook trout, was collected at station 99TC025 in Valley Branch (Washington County). Brook trout are the only native stream trout in Minnesota and require near pristine conditions for survival. With the exception of Trout Brook in the Cannon River watershed, all streams which had brook trout were in the St. Croix River drainage in Chisago and Washington counties. Stream sampling stations with the highest CPE rates include Falls Creek, Gilbertson Creek, Lawrence Creek, Old Mill Stream, two unnamed tributaries to the St. Croix River (99TC066 and 00TC059), and Spring Creek. Catch rates at these stations ranged from 237 to 747 brook trout per hour. However, most of these populations were dominated by young of the year and juvenile fish. Notable exceptions include Falls Creek, Gilbertson Creek, Lawrence Creek, Old Mill Stream, and Willow Creek which had numbers in catchable size classes that would attract anglers, but can likely support only a very limited or catch and release fishery. Two stations on Trout Brook (Dakota County) in the Cannon River watershed had CPE rates ranging from 152 to 274 brook trout per hour, and size classes which also would support a limited sport fishery.

Brown trout are native to Europe and can tolerate warmer water temperatures and poorer water quality than brook trout. This species was most abundant in Pine Creek (Dakota County) and Valley Branch (Washington County) where CPE rates ranged from 199 to 330 fish/hr with size classes in sufficient numbers to support a sport fishery. Brown trout were also sampled in Eagle Creek (Scott County), which is the only western

Table 3. Catch data for TCMA streams, 1998-2000.

Common Name	Scientific Name	No. survey stations	Total catch	% Comp	% Occur
LAMPREY	PETROMYZONTIDAE				
American brook lamprey	*Lampetra appendix*	5	23	<0.1	4.0
BOWFIN	AMIDAE				
Bowfin	*Amia calva*	3	3	<0.1	2.4
MOONEYE	HIODONTIDAE				
Mooneye	*Hiodon tergisus*	1	1	<0.1	0.8
HERRING	CLUPEIDAE				
Gizzard shad	*Dorosoma cepedianum*	3	29	<0.1	2.4
MINNOWS	CYPRIDNIDAE				
Central stoneroller	*Campostoma anomalum*	21	873	1.7	16.8
Goldfish	*Carassius auratus*	2	19	<0.1	1.6
Spotfin shiner	*Cyprinella spiloptera*	29	2,975	5.9	23.2
Common carp	*Cyprinus carpio*	33	792	1.6	26.4
Brassy minnow	*Hybognathus hankinsoni*	25	303	0.6	20.0
Common shiner	*Luxilus comutus*	14	295	0.6	11.2
Silver chub	*Macrhybopsis storeriana*	1	1	<0.1	0.8
Pearl dace	*Margariscus margarita*	6	223	0.4	4.8
Hornyhead chub	*Nocomis biguttatus*	8	102	0.2	6.4
Golden shiner	*Notemigonus crysoleucas*	13	113	0.2	10.4
Emerald shiner	*Notropis atherinoides*	18	14,547	28.8	14.4
Bigmouth shiner	*Notropis dorsalis*	31	498	1.0	24.8
Blackchin shiner	*Notropis heterodon*	2	214	0.4	1.6
Blacknose shiner	*Notropis heterolepis*	3	10	<0.1	2.4
Spottail shiner	*Notropis hudsonius*	2	3	<0.1	1.6
Sand shiner	*Notropis stramineus*	11	1,518	3.0	8.8
Mimic shiner	*Notropis volucellus*	2	39	0.1	1.6
Northern redbelly dace	*Phoxinus eos*	7	69	0.1	5.6
Bluntnose minnow	*Pimephales notatus*	31	806	1.6	24.8
Fathead minnow	*Pimephales promelas*	77	4,519	8.9	61.6

Table 3. Continued

Common Name	Scientific Name	No. Survey Stations	Total Catch	% Comp	% Occur
Blacknose dace	*Rhinichthys atratulus*	36	1,583	3.1	28.8
Longnose dace	*Rhinichthys cataractae*	7	120	0.2	5.6
Creek chub	*Semotilus atromaculatus*	47	3,239	6.4	37.6
SUCKERS	CATOSTOMIDAE				
Quillback	*Carpiodes cyprinus*	3	5	<0.1	2.4
White sucker	*Catostomus commersoni*	53	3,398	6.7	42.4
Northern hog sucker	*Hypentelium nigricans*	8	33	0.1	6.4
Smallmouth buffalo	*Ictiobus bubalus*	2	26	0.1	1.6
Bigmouth buffalo	*Ictiobus cyprinellus*	1	31	0.1	0.8
Silver redhorse	*Moxostoma anisurum*	4	14	<0.1	3.2
Golden redhorse	*Moxostoma erythrurum*	5	154	0.3	4.0
Shorthead redhorse	*Moxostoma macrolepidotum*	8	140	0.3	6.4
BULLHEAD/CATFISH	ICTALURIDAE				
Black bullhead	*Ameiurus melas*	43	281	0.6	34.4
Yellow bullhead	*Ameiurus natalis*	16	77	0.2	12.8
Brown bullhead	*Ameiurus nebulosus*	2	2	<0.1	1.6
Channel catfish	*Ictalurus punctatus*	7	38	0.1	5.6
Stonecat	*Noturus flavus*	5	30	0.1	4.0
Tadpole madtom	*Noturus gyrinus*	8	65	0.1	6.4
PIKE	ESOCIDAE				
Northern pike	*Esox lucius*	13	77	0.2	10.4
MUDMINNOW	UMBRIDAE				
Central mudminnow	*Umbra limi*	66	3,059	6.1	52.8
TROUT	SALMONIDAE				
Rainbow trout	*Oncorhynchus mykiss*	1	11	<0.1	0.8
Brown trout	*Salmo trutta*	14	534	1.1	11.2
Brook trout	*Salvelinus fontinalis*	16	1,341	2.7	12.8
Tiger trout	*S. trutta x S. fontinalis*	1	1	<0.1	0.8

Table 3. Continued

Common Name	Scientific Name	No. Survey Stations	Total Catch	% Comp	% Occur
CODFISH	GADIDAE				
Burbot	*Lota lota*	7	24	<0.1	5.6
SILVERSIDES	ATHERINIDAE				
Brook silverside	*Labidesthes sicculus*	2	6	<0.1	1.6
STICKLEBACK	GASTEROSTEIDAE				
Brook stickleback	*Culaea inconstans*	56	1,201	2.4	44.8
SCULPINS	COTTIDAE				
Mottled sculpin	*Cottus bairdi*	1	1	<0.1	0.8
Slimy sculpin	*Cottus cognatus*	1	56	0.1	0.8
TEMPERATE BASS	PERCICHTHYIDAE				
White bass	*Morone chrysops*	2	2	<0.1	1.6
SUNFISH	CENTRARCHIDAE				
Rock bass	*Ambloplites rupestris*	2	4	<0.1	1.6
Green sunfish	*Lepomis cyanellus*	77	2,675	5.3	61.6
Pumpkinseed	*Lepomis gibbosus*	41	432	0.9	32.8
Orangespotted sunfish	*Lepomis humilis*	14	42	0.1	11.2
Bluegill	*Lepomis macrochirus*	34	998	2.0	27.2
Sunfish (young of the year)	*Lepomis species*	2	5	<0.1	1.6
Hybrid sunfish	*Lepomis sp. x Lepomis sp.*	37	337	0.7	29.6
Smallmouth bass	*Micropterus dolomieu*	6	27	0.1	4.8
Largemouth bass	*Micropterus salmoides*	31	307	0.6	24.8
Black crappie	*Pomoxis nigromaculatus*	21	66	0.1	16.8
PERCH	PERCIDAE				
Rainbow darter	*Etheostoma caeruleum*	3	26	0.1	2.4
Iowa darter	*Etheostoma exile*	25	290	0.6	20.0
Fantail darter	*Etheostoma flabellare*	5	93	0.2	4.0
Johnny darter	*Etheostoma nigrum*	49	1,285	2.5	39.2

Table 3. Continued

Common Name	Scientific Name	No. Survey Stations	Total Catch	% Comp	% Occur
Banded darter	*Etheostoma zonale*	2	6	<0.1	1.6
Yellow perch	*Perca flavescens*	24	100	0.2	19.2
Logperch	*Percina caprodes*	8	28	0.1	6.4
Blackside darter	*Percina maculata*	6	62	0.1	4.8
Slenderhead darter	*Percina phoxocephala*	6	33	0.1	4.8
River darter	*Percina shumardi*	1	10	<0.1	0.8
Walleye	*Stizostedion vitreum*	9	30	0.1	7.2
DRUMS	SCIAENIDAE				
Freshwater drum	*Aplodinotus grunniens*	6	13	<0.1	4.8
TOTALS		135	50,393	100.0	

Table 4. Catch rate and lengths for TCMA Trout Stations, 1998-2000.

Station	Stream	Brook trout No./CPE	Length Range (mm)	Brown trout No./CPE	Length Range (mm)	Rainbow trout No./CPE	Length Range (mm)
99TC031*	Assumption Creek						
99TC015*	Browns Creek			15/31	72-340		
00TC030	Cannon River			1/1	250		
99TC030*	Eagle Creek			13/45	75-515		
99TC056*	Falls Creek	204/287	63-248				
99TC053*	Gilbertson Creek	120/385	62-240	2/6	269-273		
99TC029*	Harnack Creek						
99TC019*	Kennaley's Creek						
00TC057*	Lawrence Creek	252/747	45-260				
99TC041*	Old Mill Stream	91/400	70-219	1/4	280		
99TC020*	One Mile Creek						
99TC020*	One Mile Creek						
00TC004*	One Mile Creek trib						
99TC017*	Pine Creek			120/257	53-340		
99TC035*	Pine Creek			51/199	51-434		
99TC057	St. Croix River trib	21/186	72-231				
99TC062	St. Croix River trib	4/55	128-202				
99TC066	St. Croix River trib	19/335	90-130				
00TC059	St. Croix River trib	62/261	82-272				
00TC053	Spring Creek	118/339	64-309				
00TC054	Spring Creek	82/237	63-301				
99TC014	Trout Brook			5-N/A	185-305		
99TC018*	Trout Brook	67/152	87-306	23/52	73-439		
99TC033*	Trout Brook	70/274	65-226				
99TC034	Trout Brook trib	5/42	76-209				
99TC025*	Valley Branch			97/299	50-282		
99TC027*	Valley Branch	19/138	32-208	8/58	65-321		
99TC026*	Valley Branch trib	21/52	39-193	132/330	33-304	11/27	57-233
98RM001	Vermillion River			2/1	104-130		
98RM003	Vermillion River			8/3	129-522		
98RM004	Vermillion River			61/37	105-478		
99TC044*	Willow Brook	186/473	70-279				

*Designated Trout Stream

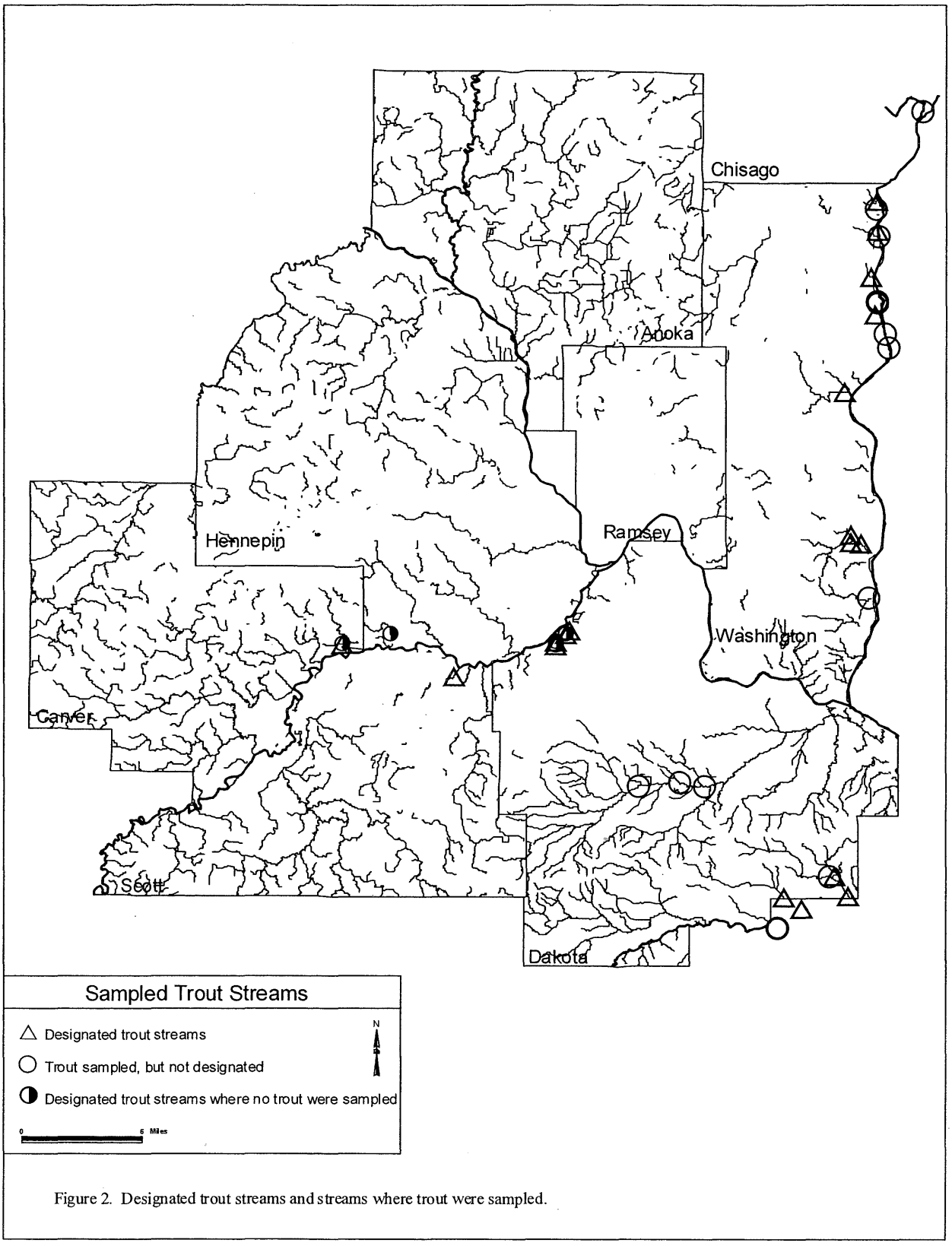

Figure 2. Designated trout streams and streams where trout were sampled.

TCMA stream where the species is currently found. Large adults comprised the small catch, but all appeared emaciated and only one young of the year was sampled in the entire station.

Rainbow trout are native to the western slope of the continental divide in North America. The only occurrence of this species was in a tributary to Valley Branch (Washington County) where it was the least common of the three trout species sampled.

The Minnesota Department of Natural Resources (MDNR) maintains a listing of officially designated trout waters. These designated streams are managed to provide a recreational fishery. However, due to the connectivity of streams and historical stocking, many non-designated streams also contain trout populations. Brook trout were collected in six non-designated streams, including five streams in the St. Croix River basin and one in the Cannon River basin. Topographical maps show a possible 5-10 additional non-designated streams along the St. Croix that may hold small populations, in southern Chisago and northern Washington counties. Brown trout were found for the first time in Trout Brook (Washington County) within the boundaries of Afton State Park, and at three localities downstream of the designated trout water in the Vermillion River (Dakota County).

No trout were found in five designated trout streams in the western TCMA (Figure 2). MDNR Fisheries stream survey reports indicate that the brook trout have not been sampled in One Mile or Harnack creeks (Dakota County) since 1980. Brook trout were last reported from Kennaley's Creek in 1982, but the population survived until 1990 when the stream was dewatered during an expansion of the Seneca Wastewater Treatment Plant. MDNR Fisheries conducted a stream survey of Assumption Creek (Carver County) in 1999 and also did not sample brook trout, but observed one adult in an impoundment upstream of Highway 212. There is no evidence that brook trout were indigenous to any part of the Minnesota River drainage (Underhill 1989), although MDNR stream files for Dakota County streams cite interviews with landowners who reported stocking ponds and streams on their property.

The historical occurrence of brook trout in TCMA streams can rarely be proven and is generally based on anecdotal accounts, but include: Golden Valley Creek (Hennepin County), Vermillion River (Dakota County), Browns and Perro creeks (Washington County); and Trout Brook, Phalen Creek, and an unnamed tributary to the Mississippi River flowing through Town and Country Golf Course (Ramsey County). Brook trout reportedly existed in the headwaters of Browns Creek until the 1970s (landowner personal comm.) and into the 1930s in the golf course stream (William Larson - Grounds Superintendent personal comm.). The trout population in Perro Creek was eliminated soon after the state prison in Stillwater constructed a dam on the stream to create a water supply for the facility (Scott Nelson - Corrections Department personal comm.).

Other Sport Fishes

Eleven additional species which anglers often pursue were sampled during the surveys. Although small warmwater streams rarely support large and harvestable populations of any game species, these streams do play a vital role in providing spawning habitat for adults and rearing habitat for young of the year and juveniles. Overall, game fish were sampled at 74 stations with the most diverse assemblages occurring in Clearwater Creek (Anoka County), Rice Creek (Ramsey County), and the Vermillion River (Dakota County) at 7, 8, and 8 species respectively.

Six species of the sunfish family comprised the bulk of the game fish population in the warmwater streams. Pumpkinseed, bluegill, and largemouth bass were the most widespread species occurring at 40, 33, and 31 stations respectively.

The perch family included the yellow perch and walleye. Yellow perch were collected at 24 stations with larger fish coming from a Gun Club Lake tributary (Dakota County) at 7.7 inches and Clearwater Creek

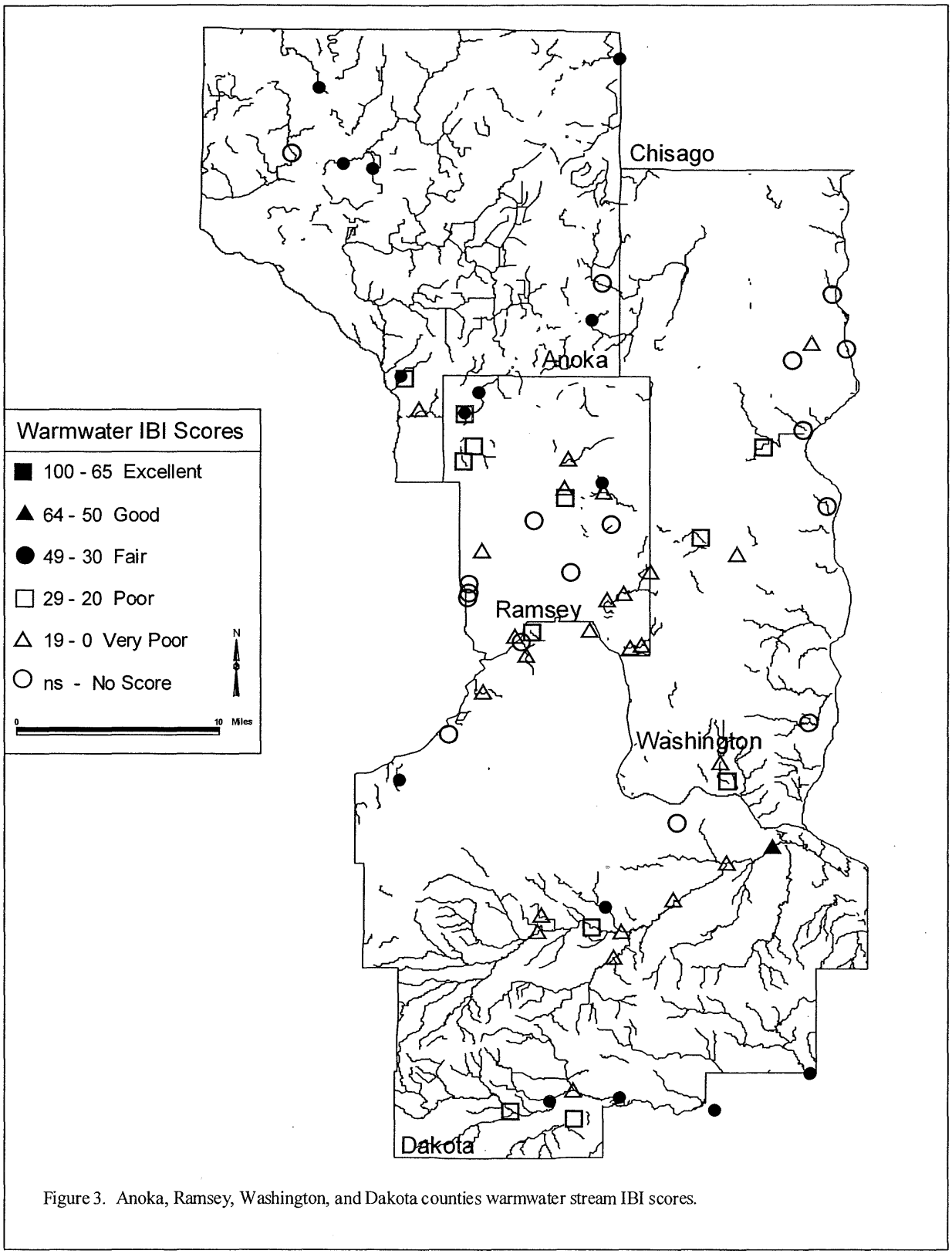

Figure 3. Anoka, Ramsey, Washington, and Dakota counties warmwater stream IBI scores.

(Anoka County) at 6.7 inches. Walleye were sampled at 9 stations with the largest fish coming from the Vermillion River (Dakota County) at 19.4 inches.

Several other game fish species were captured. Channel catfish were sampled at 7 stations with the largest individuals in Bevens Creek (Carver County), Vermillion River (Dakota County), and Sand Creek (Scott County) at 17.1, 17.8, and 27.7 inches respectively. Northern pike were present at 13 stations and the largest fish came from Chub Creek (Dakota County) at 28.8 inches. White bass were found at two stations in Sand Creek (Scott County) where one juvenile was collected at each location.

Biotic integrity

--Warmwater Streams

IBI scores in TCMA warmwater streams ranged from zero (11 sites, see Appendix 1, Figures 3-4) to 60 (Carver Creek). The mean IBI score for warmwater streams was 20.9 (standard deviation = 14.6, median = 20) out of a maximum possible score of 100. Twenty-one of the 103 warmwater streams sampled were not scored because they had too few fish. These sites were consequently scored a zero and described as very poor (Table 1). Twenty-six sites, out of the 82 sites with a score, had IBI scores greater than or equal to 30, indicating fair to good biotic integrity (Lyons 1992). The other 56 sites scored below 30, indicating poor to very poor conditions. It is important to remember that this version of the IBI may underestimate the actual condition of headwater streams. However, these scores are relative to each other and demonstrate the general trend and status of the warmwater stream resources of the TCMA.

Specific metric values were variable throughout the TCMA. The number of native species ranged from 1 to 33 with a mean of 10.8 (s.d.(standard deviation) = 7.2). With consideration to drainage area, many of these sites had relatively high species richness. This characteristic may reflect the connectivity of these sites to larger rivers, lakes, and streams. Intolerant species were noticeably absent/rare from TCMA streams (mean=0.6 species per site, s.d. = 0.88, median = 0). The scarcity of these species indicates that some type of impacts have occurred to the stream. The metric that examines the percentage of tolerant individuals demonstrates the overall condition of species composition in many of these warmwater streams. Mean percent tolerant individuals was 57% (s.d. = 32%) with a median of 65%. This metric is inversely related to IBI scores, as degradation occurs more resilient/tolerant species are able to reside as the less tolerant species are driven away or extirpated. Percent simple lithophilic spawners is another metric that demonstrated degradation with many sites having low percentages and a median of 6%. Simple lithophilic spawners are fish that require clean coarse substrates for spawning. Their absence or low numbers indicates the quality of the substrates is degraded, likely due to siltation (Berkman and Rabeni 1987).

--Coldwater Streams

Using an IBI to assess the ecological status of coldwater streams is a relatively new development (Lyons et al. 1996; Mundahl 1999). Due to the functional attributes of coldwater streams, species richness generally increases (i.e., warmwater species begin to thrive) as impairment occurs to the stream. The median species richness was four, indicating that many of these coldwater/trout streams have avoided serious degradation (see Appendix 2 and Figure 5). However, the number of species ranged from zero to 12 species. While the exotic brown and rainbow trout serve as important game fish species, they are generally considered capable of dealing with degraded conditions better than the very intolerant brook trout. One of the metrics that examines this facet of the community is a metric that scores the percentage of salmonids (trout) as brook trout. This metric was quite variable in the TCMA trout streams ranging from zero to 100% with a median of 70.4%. Species composition generally consisted of coldwater preferring individuals making up

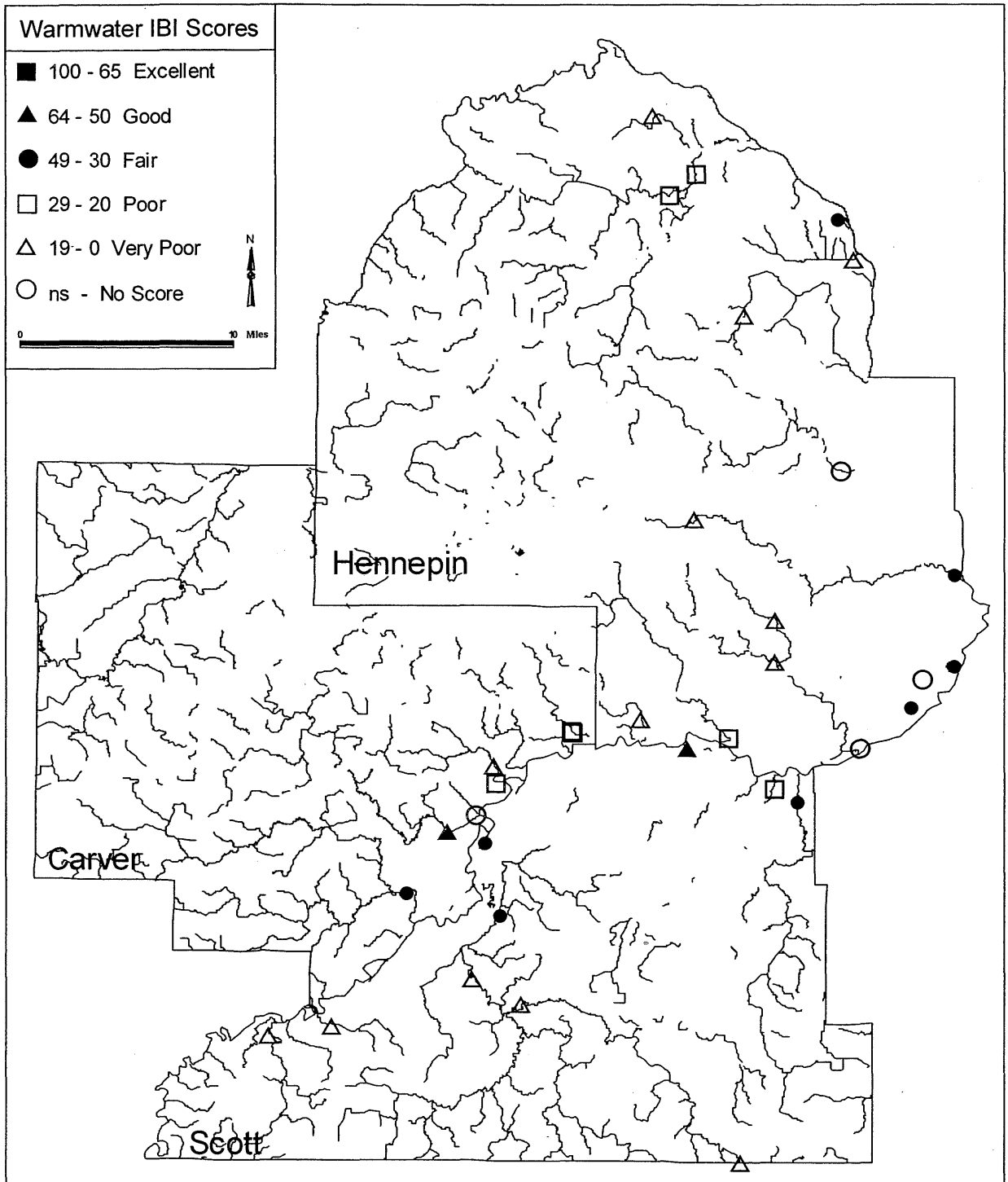

Figure 4. Hennepin, Carver, and Scott counties warmwater stream IBI scores.

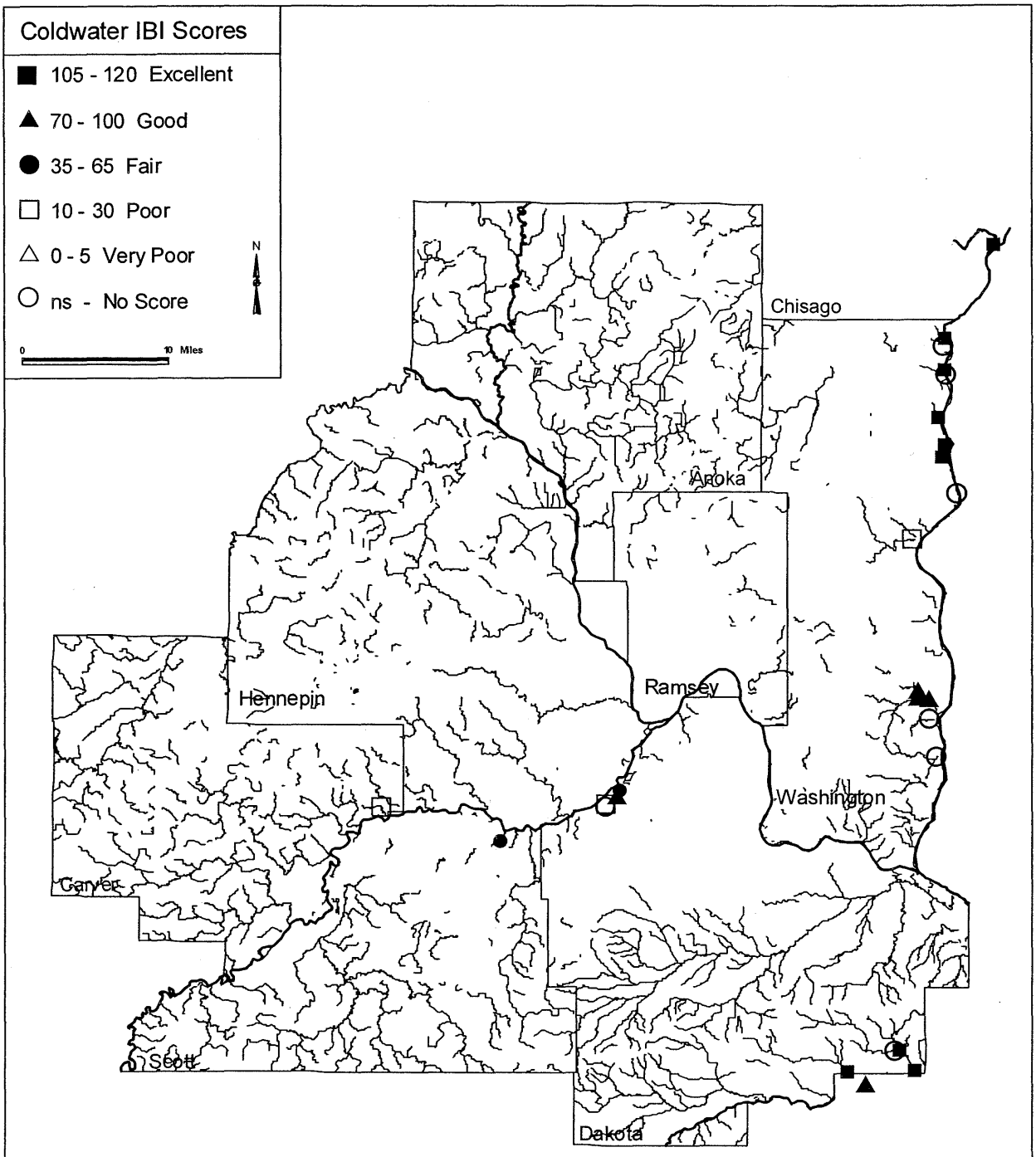

Figure 5. Coldwater stream IBI scores.

nearly 75% of the community with warmwater individuals being less abundant or absent in many streams. IBI scores ranged from 20 at Assumption Creek to a high of 115 at Trout Brook, Pine Creek, Gilbertson Creek, and Falls Creek (Figure 5). The average IBI score was 87.4 while the median score was 103. Fifteen of the 20 streams scored were rated "good" to "excellent." Seven streams had no or too few fish to evaluate with an IBI (<25 individual collected). Three streams rated as "poor" Browns Creek, One Mile Creek, and Assumption Creek. Overall, coldwater/trout streams in the TCMA area were in relatively good condition compared to their warmwater counterparts. This may largely be attributed to their protection associated with the highly protected St. Croix River and their designation as "trout streams" by the Minnesota Department of Natural Resources.

Rare and Unusual Occurrences Reported in the TCMA

Natural Heritage Program EORs (Element Occurrence Records) of Tracked Fishes Reported in the TCMA and Rare, Intolerant, Exotic, and Range Extensions Reported in the TCMA (Appendix 3 and 4) were compiled to serve as a guide and checklist for biologists and resource managers to identify and rank sites for future surveys and restoration efforts. It is also important that survey specimens are deposited in the Bell Museum fish collection for verification, particularly if these species are unusual, rare, or taxonomically difficult to identify.

The Minnesota Natural Heritage Program tracks element occurrence records (EORs) for 1 threatened, 20 special concern, and 4 delisted fish species. Fourteen of these species have been reported from the seven county TCMA (Appendix 3). Most have been reported recently in area lakes and streams. However, the skipjack herring and pallid shiner have been absent since the 1920s. The pugnose shiner and least darter, which are both extremely intolerant species, have not been reported from eight localities for the shiner since 1926 - 1948 and two localities for the darter since 1931 - 1935.

Thirty-eight additional species of note have been listed in Appendix 4. These include species rarely reported in the TCMA, those that are extremely intolerant and serve as environmental indicators, exotics, or those that represent range extensions. Again, most species have been reported recently at least once in the TCMA. Exceptions include: silvery minnow (1899), channel shiner (1947), and lake whitefish (1967).

No endangered, threatened, or special concern species were sampled during the study. However, the American brook lamprey was delisted from special concern status in 1996. This non-parasitic species is frequently found in trout streams. Lampreys were collected at five stations including new localities in a Minnesota River tributary (Scott County), Assumption Creek (Carver County), and Trout Brook (Dakota County). The first two localities are significant because this lamprey had only been reported once from the Minnesota River drainage since the 1940s. Additional collections were made at two stations near historical localities in Valley Branch (Washington County), which is one of two streams the species inhabits in the entire St. Croix River drainage.

Ten species collected during the surveys are rarely reported in the TCMA (Figures 6 and 7). Most are on the periphery of their range in Minnesota and may have never been common. However, some are intolerant or indicator species, which are the first to decline or disappear when stream habitat and water quality degrade.

The silver chub was collected at one station in the Cannon River and is more common south of the Twin Cities in the Mississippi River, where it generally inhabits deep water during the day and is difficult to sample. However, based on personal experience, the species appears to seek out shallower depths at night when seining has been successful, while sampling the same areas during the day has not.

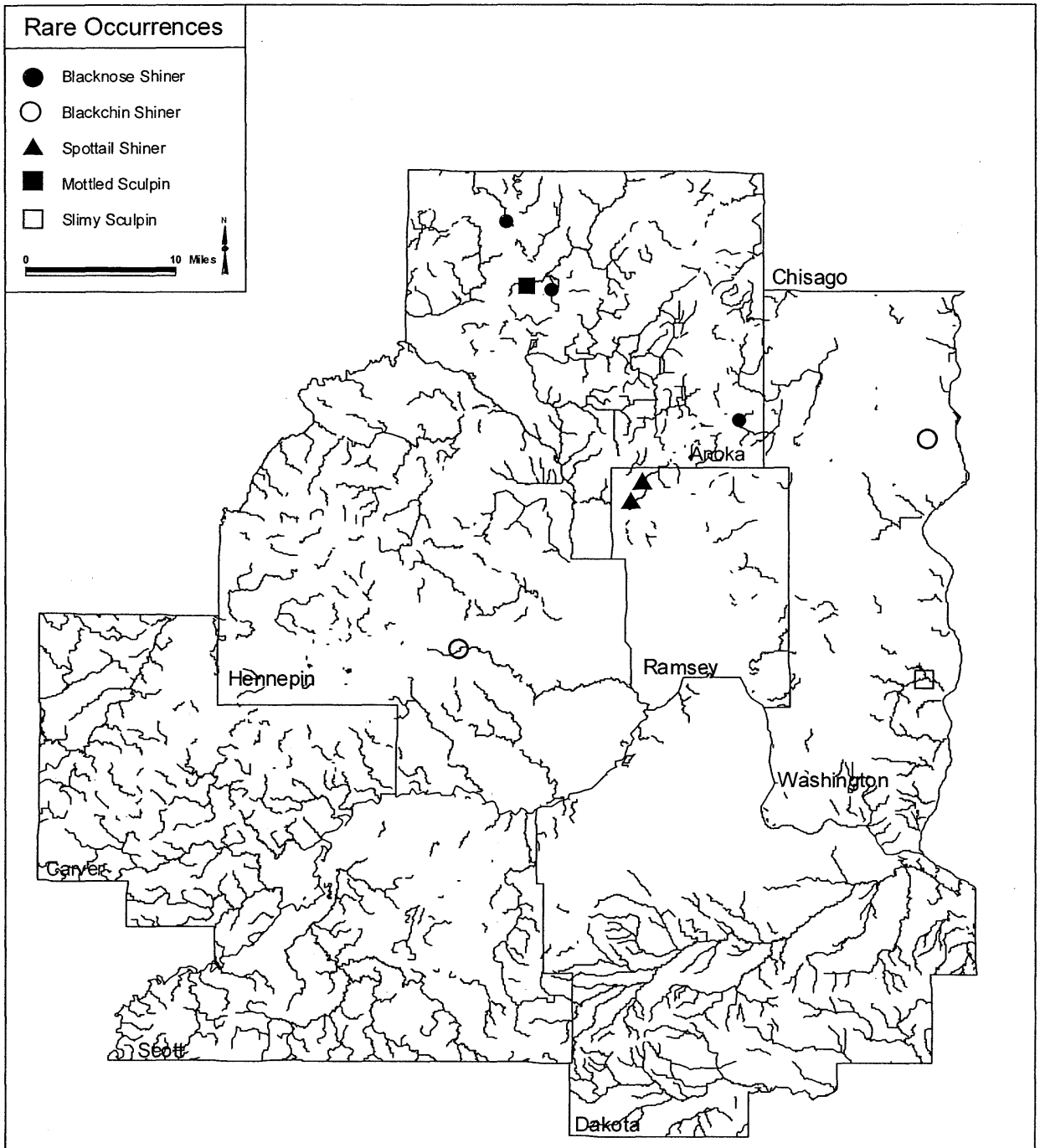

Figure 6. Metro stream survey locations where blacknose shiner, blackchin shiner, spottail shiner, mottled sculpin, and slimy sculpin were found.

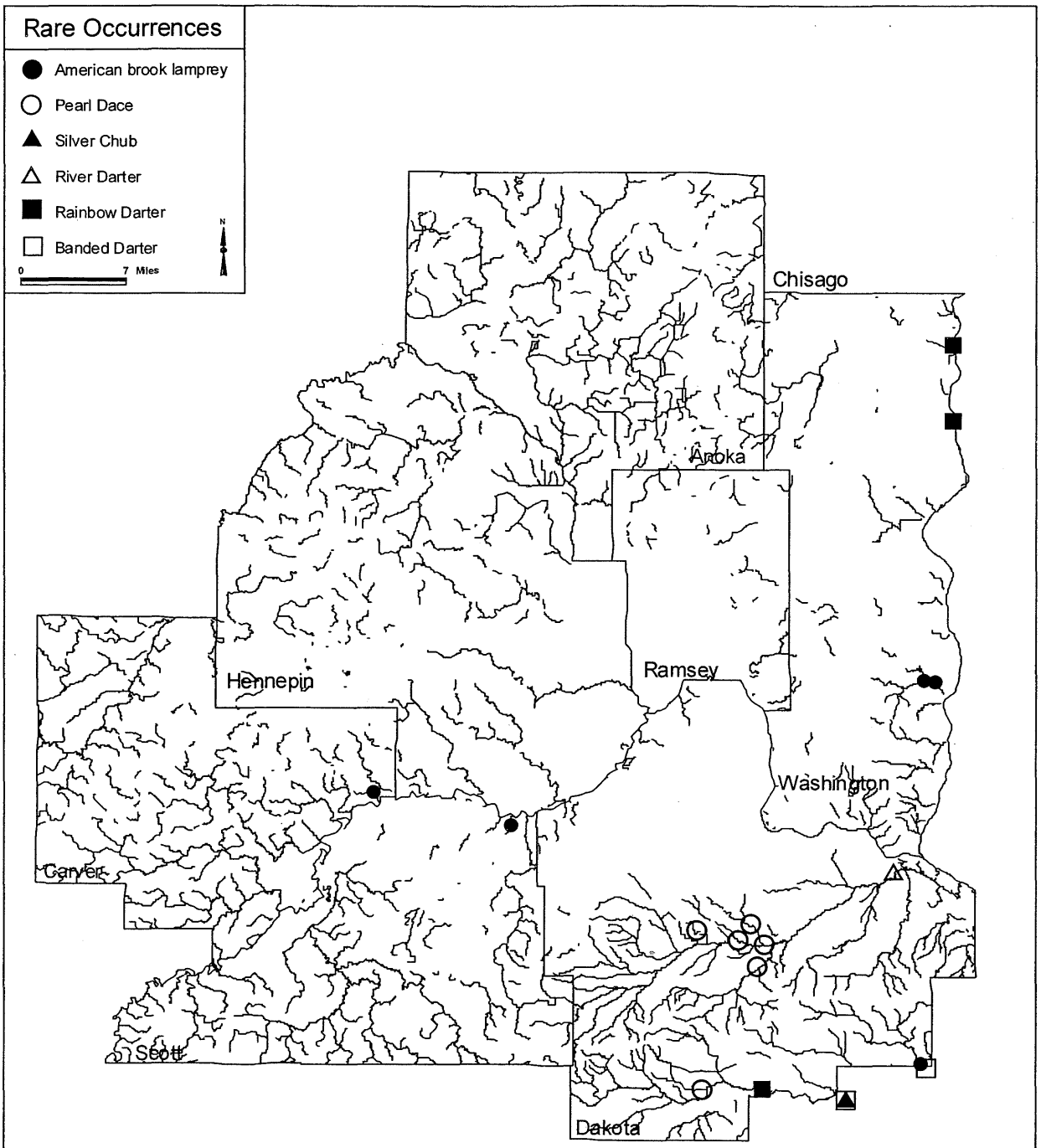

Figure 7. Metro stream survey locations where American brook lamprey, pearl dace, silver chub, river darter, rainbow darter, and banded darter were found.

Pearl dace were collected at five stations in the Vermillion River watershed and one new locality in the Cannon watershed, a ditched tributary to Chub Creek (Dakota County). This species is often common in the Upper Mississippi and St. Croix river basins north of the Twin Cities, but has a very infrequent distribution in southeastern Minnesota.

Blackchin shiners were sampled at two stations. A single specimen was collected from the outlet of Square Lake (Washington County) and an incredible 213 specimens from Minnehaha Creek, a few miles downstream of Lake Minnetonka. This is an extremely intolerant species which inhabits very clear lakes and streams with dense beds of submerged vegetation. This species and its preferred habitat are much more prevalent in central and northern Minnesota. Blacknose shiners were collected at three stations in Anoka County, at Clearwater Creek, Mahoney Brook, and Seelye Brook. This species is frequently associated with and similar to the blackchin shiner in tolerance, habitat preference, and distribution.

Spottail shiners were collected at two stations in Rice Creek (Anoka County). This species prefers clear lakes and streams, but has a wider distribution and is slightly more tolerant than the blackchin and blacknose shiners.

The mottled sculpin was collected at one station in Cedar Creek (Anoka County) which is a new locality for this intolerant species often associated with trout and coldwater streams. The slimy sculpin was collected at one station in Valley Branch (Washington County). This population is isolated from others in northern and southeastern Minnesota. This species is almost always associated with trout, is more intolerant, and requires colder temperatures than the mottled sculpin.

Rainbow darters were collected at two stations in the St. Croix drainage from Gilbertson and Spring creeks (Washington County), and a single specimen from Chub Creek (Dakota County) in the Cannon River watershed. This is an intolerant species which appears to be exhibiting a serious decline in the Cannon River watershed. It was formerly found in the Cannon River and Belle Creek near Welch (Goodhue County). However, repeated fish kills in the Cannon River, from the operation and maintenance of the Byllesby Dam, and degrading conditions in Belle Creek may have eliminated rainbow darters from the lower portion of the watershed where it has not been reported in several years. Upstream of Byllesby reservoir, collections of the species have been restricted to Prairie (Goodhue County) and Chub creeks (Dakota County).

Banded darters were collected at only two stations in the Cannon River (Dakota and Goodhue counties). This species is at the periphery of its range in the Cannon River and is more common in other southeastern Minnesota streams such as the Root, Upper Iowa, and Zumbro rivers. There is also an isolated population in the Minnesota drainage where it inhabits the mainstem and lower reaches of larger tributaries from approximately St. Peter to Appleton.

The river darter was collected at one station in the Vermillion River (Dakota County). Like the silver chub, this species prefers large rivers, is more common south of the Twin Cites, and personal observations indicate it is more vulnerable to nocturnal than diurnal sampling efforts.

With the exception of brown trout, which is managed as a game species, and common carp, very few exotics were sampled in the TCMA. Goldfish, which are usually the result of aquarium releases, were found at two stations: Phalen Creek and a Willow Creek tributary (Ramsey County). Rainbow trout, another game species, were collected at one station in a Valley Branch tributary (Washington County).

The TCMA surveys collected one range extension for channel catfish in Rice Creek (Ramsey County). This species was historically absent from the Upper Mississippi River drainage (St. Anthony Falls in Minneapolis to Lake Itasca). However, around 1960 navigational locks were added to the

dams at St. Anthony Falls thus permitting fish passage from the lower Mississippi River to the dam at Coon Rapids. Additionally, MDNR stocking efforts in the Upper Mississippi River provided channel catfish above the Coon Rapids dam. Since these two occurrences, channel catfish have been documented in the mainstem of the Mississippi River and its larger tributaries up to Brainerd.

Recommendations

Stream surveys should continue in the TCMA to monitor changes in the fish community, and voucher specimens should be deposited in the fish collection at the Bell Museum. Through cooperation of the MDNR, University of Minnesota, and other interested parties, all permanent streams should be investigated on a recurrent basis with variable survey intervals determined by stream management plans and impact assessment. A selection of representative sites, that account for the geographical and hydrological diversity of the TCMA, should be surveyed on a more frequent basis to provide timely indicators of environmental change. Through appropriate environmental review and application of water and land use regulations, riparian zones and historical drainage patterns should be protected and restored.

Dams, water control structures, and road culverts can impede or prevent the upstream movement of fish which can isolate populations and block access to spawning and rearing habitats. Proposals for new or modified structures should be reviewed to mitigate any potentially detrimental effects of road maintenance and water management practices. Opportunities for the removal of existing unnatural barriers must be scheduled and prioritized in order to restore the connectivity of important aquatic habitat components in streams of the TCMA.

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Appendix 1. Warmwater IBI summaries and scores.

Station	Stream Name	Total number of native species	Number of darter species	Number of sucker species	Number of sunfish species	Number of intolerant species	Percent tolerant species	Percent omnivores	Percent insectivores	Percent top carnivores	Percent simple lithophils	IBI Score
98RM001	Vermillion River	17	2	1	1	1	80.3%	39.3%	10.2%	0.2%	30.9%	17
98RM002	Vermillion River trib	5	1	0	0	1	5.2%	0.0%	75.3%	0.0%	0.0%	30
98RM003	Vermillion River	17	2	1	2	1	89.4%	33.4%	6.5%	1.0%	34.8%	22
98RM004	Vermillion River	13	2	1	1	1	79.4%	45.9%	16.0%	7.5%	47.5%	7
98RM005	Vermillion River trib	14	1	1	2	1	51.8%	34.4%	44.1%	0.0%	33.3%	15
99TC001	Fish Creek	5	0	0	1	0	89.0%	84.3%	1.2%	0.0%	0.0%	0
99TC003	Willow Creek	9	1	1	2	1	70.1%	1.5%	8.2%	0.7%	1.5%	35
99TC005	Phalen Creek	2	0	0	0	0	100.0%	100.0%	0.0%	0.0%	0.0%	no score
99TC006	Elm Creek	14	1	1	2	0	75.2%	2.9%	5.1%	2.9%	8.8%	20
99TC007	Rush Creek	11	1	1	2	0	86.2%	0.7%	5.8%	1.4%	6.9%	20
99TC008	Diamond Creek	4	0	0	1	0	89.0%	7.9%	11.0%	0.0%	0.0%	10
99TC009	Battle Creek	13	0	1	4	0	60.0%	57.3%	25.8%	0.4%	25.4%	5
99TC010	Battle Creek	5	0	1	1	0	95.6%	93.3%	0.0%	0.0%	57.8%	0
99TC011	Valley Creek	7	0	0	3	0	15.4%	0.0%	53.8%	15.4%	0.0%	no score
99TC012	Valley Creek	7	0	0	2	0	77.6%	36.8%	18.4%	0.0%	30.3%	15
99TC016	Vermillion River (SB)	15	2	1	1	1	84.4%	62.8%	3.5%	0.0%	60.9%	7
99TC022	Porter Creek	14	1	1	2	0	76.0%	20.5%	12.3%	0.7%	22.6%	15
99TC023	Porter Creek	10	1	1	2	0	92.8%	16.5%	5.1%	0.4%	5.9%	17
99TC024	Pickerel Lake trib	7	0	0	3	0	32.8%	10.3%	1.7%	0.0%	0.0%	20
99TC028	Black Dog Creek	4	0	0	1	0	85.7%	42.9%	0.0%	14.3%	0.0%	no score
99TC036	Mississippi River trib	6	0	1	1	0	90.2%	87.8%	7.3%	2.4%	2.4%	0
99TC037	Tanners Lake trib	7	0	0	2	0	89.7%	40.8%	7.4%	0.0%	0.0%	5
99TC038	Vermillion River	30	3	4	6	4	3.8%	3.0%	94.3%	0.5%	78.8%	55
99TC039	Vermillion River	16	2	1	2	1	74.4%	34.4%	4.9%	0.0%	40.1%	17
99TC040	Vermillion River	19	2	1	3	1	85.6%	42.9%	7.8%	0.3%	32.2%	12
99TC042	Silver Creek	4	0	0	2	0	66.7%	0.0%	66.7%	16.7%	0.0%	no score
99TC043	Perro Creek	1	0	0	1	0	100.0%	0.0%	100.0%	0.0%	0.0%	no score
99TC045	Mississippi River trib	15	2	1	3	1	61.8%	50.9%	30.2%	0.0%	13.7%	31
99TC046	Mississippi River trib											no fish
99TC047	County Ditch 17 trib(A)	10	0	0	3	0	27.9%	14.7%	30.9%	0.0%	2.0%	30
99TC048	County Ditch 17 trib(B)	7	0	0	2	0	36.2%	13.5%	0.6%	0.0%	3.7%	25
99TC049	Rice Creek	20	1	1	4	1	33.5%	23.2%	21.2%	1.5%	1.1%	27
99TC050	Rice Creek	16	1	1	4	0	37.3%	26.8%	47.8%	0.6%	42.6%	15

Appendix 1. Continued

99TC051	Rice Creek trib	16	1	1	3	0	66.4%	58.5%	14.6%	0.0%	6.2%	30
99TC052	Rice Creek	33	2	2	8	1	33.5%	9.0%	48.0%	1.0%	0.6%	42
99TC054	Clearwater Creek	18	1	1	4	1	25.5%	6.6%	1.6%	2.5%	2.2%	30
99TC055	Hardwood Creek	5	1	1	0	0	56.7%	16.7%	0.0%	6.7%	16.7%	no score
99TC058	O'Conners Lake trib	1	0	0	0	0	0.0%	0.0%	0.0%	100.0%	0.0%	no score
99TC060	Lake Jones outlet	7	0	0	4	0	93.2%	12.1%	0.4%	2.8%	0.0%	20
99TC061	Vadnais Lake trib	4	0	0	0	0	96.5%	20.0%	2.6%	0.9%	0.0%	7
99TC063	Square Lake outlet	9	1	0	2	1	45.2%	27.0%	34.4%	0.0%	0.0%	15
99TC064	Big Carnelian Lake trib	3	0	1	0	0	42.9%	14.3%	0.0%	0.0%	14.3%	no score
99TC065	St. Croix River trib											no fish
99TC067	Little Lake Johanna trib	2	0	0	0	0	90.7%	90.7%	9.3%	0.0%	0.0%	0
99TC068	Gervais Lake trib	9	0	1	4	0	64.6%	2.9%	3.7%	8.6%	0.2%	20
99TC069	Willow Creek trib	9	0	1	2	0	89.2%	70.3%	0.9%	8.1%	2.7%	0
99TC070	Eagle Point Lake trib	7	1	0	2	1	64.7%	45.2%	0.0%	0.0%	0.0%	20
99TC071	Mississippi River trib	10	0	1	1	0	94.0%	91.0%	5.1%	0.0%	84.2%	2
99TC072	Mississippi River trib											no fish
99TC073	Mississippi River trib											no fish
99TC074	McCarron's Lake trib	3	0	0	1	0	96.2%	65.4%	3.8%	0.0%	0.0%	no score
99TC075	Sarita Creek	1	0	0	0	0	100.0%	100.0%	0.0%	0.0%	0.0%	0
99TC076	Long Lake trib	13	1	1	3	0	56.0%	6.6%	2.3%	1.7%	6.2%	20
99TC077	Mississippi River trib	1	0	0	0	0	100.0%	0.0%	100.0%	0.0%	0.0%	no score
99TC078	Mississippi River trib	7	0	0	3	0	7.8%	5.6%	90.7%	0.0%	87.7%	25
99TC079	Mississippi River trib	1	0	0	0	0	100.0%	100.0%	0.0%	0.0%	0.0%	10
99TC080	Browns Creek trib	5	0	0	1	0	70.5%	28.1%	27.3%	0.0%	0.0%	25
99TC081	Wakefield Lake trib	3	0	0	2	0	28.6%	0.0%	57.1%	0.0%	0.0%	no score
99TC082	Lake Elmo outlet	11	1	1	3	1	51.1%	37.8%	4.4%	11.1%	8.9%	0
99TO002	Fish Creek	4	0	0	1	0	69.6%	0.0%	10.9%	0.0%	0.0%	0
00TC001	Chub Creek	29	4	3	1	3	41.2%	21.6%	43.3%	1.0%	22.7%	37
00TC003	Black Dog Lake trib 2	7	1	0	1	0	81.8%	74.3%	14.3%	0.3%	0.0%	30
00TC006	Credit River	23	2	4	3	1	31.9%	12.1%	50.0%	0.7%	51.3%	42
00TC011	Nine Mile Creek (SF)	9	1	0	3	0	45.8%	0.0%	10.2%	5.1%	0.0%	10
00TC012	Nine Mile Creek	10	1	1	1	0	90.0%	13.9%	8.3%	0.0%	14.6%	12
00TC013	Purgatory Creek	10	2	0	1	0	10.1%	1.8%	80.9%	0.0%	73.0%	27
00TC014	Chaska Creek	15	2	1	2	1	52.4%	15.8%	46.5%	0.1%	62.6%	25
00TC015	Carver Creek	30	5	5	3	3	14.7%	6.8%	73.4%	2.8%	77.4%	60
00TC016	Minnesota River trib	5	0	0	0	0	40.9%	4.5%	59.1%	0.0%	54.5%	no score

Appendix 1. Continued

00TC017	Brewery Creek	8	1	1	0	0	76.7%	8.0%	6.9%	0.0%	6.4%	15
00TC018	Robert Creek	7	0	1	0	0	72.4%	0.4%	3.4%	0.0%	58.7%	15
00TC019	Riley Creek	5	0	0	0	0	91.3%	88.5%	0.0%	7.7%	1.0%	0
00TC021	Sand Creek	28	3	4	4	1	27.3%	21.2%	51.1%	2.6%	33.7%	45
00TC023	Bluff Creek	4	1	0	0	1	27.6%	27.6%	25.2%	0.0%	0.0%	20
00TC024	Bluff Creek	2	0	0	0	0	7.7%	7.7%	92.3%	0.0%	0.0%	20
00TC025	Chaska Creek	5	1	0	0	0	97.6%	0.0%	2.1%	0.0%	54.9%	10
00TC026	Bevens Creek	26	2	6	3	1	29.2%	4.3%	31.4%	1.2%	45.0%	42
00TC029	Cannon River	16	4	3	2	3	2.2%	0.1%	94.5%	0.8%	95.7%	47
00TC030	Cannon River	19	3	4	1	3	0.2%	0.2%	96.1%	0.3%	95.4%	45
00TC031	Cannon River	16	1	4	1	1	27.8%	25.6%	43.7%	0.2%	29.4%	20
00TC032	Chub Creek (NB)	10	1	1	1	0	73.3%	41.1%	5.0%	0.0%	32.2%	10
00TC034	Chub Creek trib	10	1	1	1	0	83.3%	54.2%	5.6%	0.0%	59.7%	30
00TC036	Chub Creek	15	2	2	1	0	41.2%	11.9%	39.1%	0.0%	23.9%	27
00TC039	Sand Creek	11	1	1	1	0	86.9%	14.4%	6.0%	0.0%	14.8%	15
00TC040	Sand Creek	14	1	0	3	1	8.2%	4.6%	87.0%	1.2%	85.3%	30
00TC042	Long Meadow L. outlet	19	1	0	5	1	13.2%	10.7%	59.9%	17.5%	28.4%	35
00TC044	Long Meadow Lake trib											no fish
00TC045	Long Meadow Lake trib	11	1	0	2	1	30.2%	12.0%	16.1%	12.4%	0.0%	35
00TC048	Sunrise River (WB)	16	2	0	4	1	47.6%	5.1%	23.6%	2.3%	0.0%	32
00TC051	Minnehaha Creek	18	1	1	3	1	69.6%	58.2%	28.0%	0.0%	13.5%	10
00TC052	Minnehaha Creek	16	2	1	3	1	9.7%	9.5%	80.7%	5.7%	27.2%	32
00TC055	St. Croix River trib											no fish
00TC067	Bass Creek	4	0	0	1	0	85.4%	82.2%	14.6%	0.0%	0.0%	0
00TC068	Cedar Creek	13	1	1	2	1	12.8%	6.1%	31.8%	0.6%	29.1%	30
00TC069	Mahoney Brook	13	2	1	0	2	26.2%	1.6%	64.3%	0.0%	66.7%	45
00TC070	Ford Brook	6	0	0	0	0	87.5%	0.0%	9.4%	0.0%	6.3%	no score
00TC071	Seelye Brook	18	2	1	2	4	37.6%	15.5%	23.2%	1.2%	30.9%	32
00TC072	Bassett Creek	5	0	0	1	0	28.6%	28.6%	33.3%	14.3%	0.0%	no score
00TC073	Minnesota River trib	2	1	0	0	1	0.0%	0.0%	96.3%	0.0%	0.0%	no score
00TC074	Mattson Brook	5	0	0	1	0	81.6%	26.3%	18.4%	0.0%	0.0%	0
00TC075	Minnesota River trib	12	1	0	3	2	28.4%	0.0%	4.3%	9.5%	1.7%	25
00TC076	Blue Lake outlet	16	1	1	3	1	5.1%	4.7%	92.2%	0.2%	67.7%	55
00TC077	Gun Club Lake trib	9	0	0	4	0	86.6%	76.0%	2.4%	0.4%	0.0%	10

Appendix 2. Coldwater IBI summaries and scores.

Station	Stream Name	Total number of species	Number of coldwater species	Number of minnow species	Number of benthic species	Number of tolerant species	Percent salmonids as brook trout	Percent intolerant individuals	Percent coldwater individuals	Percent white suckers	Percent top carnivores	Number of coldwater individuals	Number of warmwater individuals	IBI Score
99TC014	Trout Brook	4	2	0	2	1	0.0%	11.1%	77.8%	0.2%	11.1%	7	2	
99TC015*	Browns Creek	11	2	1	2	5	0.0%	5.1%	5.4%	0.0%	5.1%	16	278	30
99TC017*	Pine Creek	3	1	0	1	1	0.0%	97.6%	97.6%	0.0%	97.6%	120	3	100
99TC018*	Trout Brook	6	4	0	0	2	74.4%	89.1%	95.0%	0.0%	89.1%	96	5	105
99TC019*	Kennaley's Creek	5	1	0	1	2	0.0%	2.6%	2.6%	0.0%	56.4%	1	38	50
99TC020*	One Mile Creek	12	1	1	2	6	0.0%	0.0%	16.4%	0.0%	0.0%	45	229	25
99TC025*	Valley Branch	4	3	0	0	0	0.0%	98.0%	99.0%	0.0%	98.0%	99	1	100
99TC026*	Valley Branch trib	5	5	0	1	0	12.8%	74.2%	100.0%	0.0%	74.2%	221	0	100
99TC027*	Valley Branch	4	2	0	0	0	70.4%	93.1%	93.1%	0.0%	93.1%	27	2	95
99TC029*	Harnack Creek	2	1	0	0	1	0.0%	0.0%	86.2%	0.0%	0.0%	75	12	70
99TC030*	Eagle Creek	5	2	0	1	2	0.0%	36.1%	86.1%	0.2%	36.1%	31	5	52
99TC031*	Assumption Creek	11	1	0	3	5	0.0%	21.6%	16.5%	0.6%	21.6%	16	81	20
99TC033*	Trout Brook	2	2	0	0	0	100.0%	92.1%	100.0%	0.0%	92.1%	76	0	115
99TC034	Trout Brook trib	2	2	0	0	0	100.0%	35.7%	100.0%	0.0%	35.7%	14	0	
99TC035*	Pine Creek	2	2	0	0	0	0.0%	81.0%	100.0%	0.0%	81.0%	63	0	115
99TC041*	Old Mill Stream	3	2	0	0	1	98.9%	98.9%	98.9%	0.0%	98.9%	92	1	110
99TC044*	Willow Brook	1	1	0	0	0	100.0%	100.0%	100.0%	0.0%	100.0%	186	0	110
99TC053*	Gilbertson Creek	4	3	0	1	0	98.4%	99.2%	99.2%	0.0%	99.2%	127	1	115
99TC056*	Falls Creek	2	2	0	0	0	100.0%	100.0%	100.0%	0.0%	100.0%	207	0	115
99TC057	St. Croix River trib	1	1	0	0	0	100.0%	100.0%	100.0%	0.0%	100.0%	21	0	
99TC059	St. Croix River trib	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0	0	
99TC062	St. Croix River trib	2	2	0	0	0	100.0%	100.0%	100.0%	0.0%	100.0%	5	0	
99TC066	St. Croix River trib	1	1	0	0	0	100.0%	100.0%	100.0%	0.0%	100.0%	19	0	
00TC004*	One Mile Creek trib 1	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%	0	0	
00TC053	Spring Creek 1	4	3	0	1	0	100.0%	80.0%	84.0%	0.0%	80.0%	126	24	105
00TC054	Spring Creek 2	3	3	0	0	0	100.0%	35.7%	100.0%	0.0%	35.7%	238	0	105
00TC057	Lawrence Creek	2	1	0	0	1	100.0%	97.3%	97.3%	0.0%	97.3%	252	7	110

*Designated trout stream

Appendix 3. Natural Heritage Program EORs of Tracked Fishes Reported in the TCMA.

Common Name	Scientific Name	MDNR Status	Lake or Stream	County	Last Reported
LAMPREY	**PETROMYZONTIDAE**				
Southern brook lamprey	*Ichthyomyzon gagei*	special concern	St. Croix River	Washington	1996
American brook lamprey	*Lampetra appendix*	delisted	Assumption Creek	Carver	2000
American brook lamprey	*Lampetra appendix*	delisted	Trout Brook	Dakota	2000
American brook lamprey	*Lampetra appendix*	delisted	Credit River	Scott	1935
American brook lamprey	*Lampetra appendix*	delisted	Eagle Creek	Scott	1994
American brook lamprey	*Lampetra appendix*	delisted	Minnesota River trib	Scott	2000
American brook lamprey	*Lampetra appendix*	delisted	Valley Branch trib	Washington	2000
STURGEON	**ACIPENSERIDAE**				
Lake sturgeon	*Acipenser fulvescens*	special concern	St. Croix River	Washington	1998
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	delisted	Minnesota River	Carver	1999
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	delisted	Minnesota River	Hennepin	1992
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	delisted	Minnesota River	Ramsey	1980
PADDLEFISH	**POLYODONTIDAE**				
Paddlefish	*Polyodon spathula*	threatened	Minnesota River	Dakota	1993
Paddlefish	*Polyodon spathula*	threatened	Mississippi River	Ramsey	1990
Paddlefish	*Polyodon spathula*	threatened	St. Croix River	Washington	1996
HERRINGS	**CLUPEIDAE**				
Skipjack herring	*Alosa chrysochloris*	special concern	Minnesota River	Scott	1899
Skipjack herring	*Alosa chrysochloris*	special concern	St. Croix River	Washington	1928
MINNOWS	**CYPRINIDAE**				
Pallid shiner	*Notropis amnis*	special concern	St. Croix River	Washington	1926
Pugnose shiner	*Notropis anogenus*	special concern	St. Croix River	Washington	1926
Pugnose shiner	*Notropis anogenus*	special concern	Lake Waconia	Carver	1948
Pugnose shiner	*Notropis anogenus*	special concern	Cedar Lake	Hennepin	1941
Pugnose shiner	*Notropis anogenus*	special concern	Christmas Lake	Hennepin	1941
Pugnose shiner	*Notropis anogenus*	special concern	Fish Lake	Hennepin	1948
Pugnose shiner	*Notropis anogenus*	special concern	Lake Harriet	Hennepin	1948

Appendix 3. Continued

Common Name	Scientific Name	MDNR Status	Lake or Stream	County	Last Reported
Pugnose shiner	*Notropis anogenus*	special concern	Lake Minnetonka	Hennepin	1991
Pugnose shiner	*Notropis anogenus*	special concern	McCarrons Lake	Ramsey	1931
Pugnose shiner	*Notropis anogenus*	special concern	Forest Lake	Washington	1941
Ozark minnow	*Notropis nubilus*	special concern	Trout Brook	Dakota	1986
Pugnose minnow	*Opsopoeodus emiliae*	delisted	Mississippi River	Dakota	1995
Pugnose minnow	*Opsopoeodus emiliae*	delisted	St. Croix River	Washington	1996
SUCKERS	**CATOSTOMIDAE**				
Blue sucker	*Cycleptus elongatus*	special concern	Minnesota River	Carver	1996
Blue sucker	*Cycleptus elongatus*	special concern	Mississippi River	Dakota	1996
Blue sucker	*Cycleptus elongatus*	special concern	Mississippi River	Ramsey	2000
Blue sucker	*Cycleptus elongatus*	special concern	St. Croix River	Washington	2000
PERCH	**PERCIDAE**				
Crystal darter	*Crystallaria asprella*	special concern	St. Croix River	Washington	1982
Least darter	*Etheostoma microperca*	special concern	Rum River	Anoka	1935
Least darter	*Etheostoma microperca*	special concern	Lake Minnewashta	Carver	1962
Least darter	*Etheostoma microperca*	special concern	Lake Zumbra	Carver	1997
Least darter	*Etheostoma microperca*	special concern	Christmas Lake	Hennepin	1997
Least darter	*Etheostoma microperca*	special concern	Crystal Lake	Hennepin	1931
Least darter	*Etheostoma microperca*	special concern	Lake Minnetonka	Hennepin	1997
Gilt darter	*Percina evides*	special concern	St. Croix River	Washington	1998

Appendix 4. Rare, Intolerant, Exotic, and Range Extensions Reported in the TCMA.

Common Name	Scientific Name	Comments	Lake or Stream	County	Last Reported
MOONEYES	**HIODONTIDAE**				
Goldeye	*Hiodon alosoides*	endangered-WI	Mississippi River	Dakota	1996
Goldeneye	*Hiodon alosoides*	endangered-WI	Mississippi River	Ramsey	1958
Goldeneye	*Hiodon alosoides*	endangered-WI	St. Croix River	Washington	1968
EELS	**ANGUILLIDAE**				
American eel	*Anguilla rostrata*	special concern-WI	Minnesota River	Hennepin	1982
American eel	*Anguilla rostrata*	special concern-WI	Minnesota River	Dakota	1965
American eel	*Anguilla rostrata*	special concern-WI	Mississippi River	Ramsey	1976
American eel	*Anguilla rostrata*	special concern-WI	Pleasant Lake	Ramsey	1984
American eel	*Anguilla rostrata*	special concern-WI	St. Croix River	Washington	1983
MINNOWS	**CYPRINIDAE**				
Goldfish	*Carassius auratus*	exotic	Bassett Creek trib	Hennepin	2000
Goldfish	*Carassius auratus*	exotic	Northwood Pond	Hennepin	1993
Goldfish	*Carassius auratus*	exotic	Kohlman Creek	Ramsey	1997
Goldfish	*Carassius auratus*	exotic	Phalen Creek	Ramsey	1999
Goldfish	*Carassius auratus*	exotic	Willow Creek trib	Ramsey	1999
Redside dace	*Clinostomus elongatus*	extirpated-IA/	Trout Brook	Dakota	1983
Redside dace	*Clinostomus elongatus*	special concern-WI			
Silvery minnow	*Hybognathus nuchalis*	peripheral	Minnesota River trib	Scott	1899
Speckled chub	*Macrhybopsis aestivalis*	threatened-WI	Minnesota River	Carver	1999
Speckled chub	*Macrhybopsis aestivalis*	threatened-WI	Vermillion River	Dakota	1963
Speckled chub	*Macrhybopsis aestivalis*	threatened-WI	Minnesota River	Scott	1996
Speckled chub	*Macrhybopsis aestivalis*	threatened-WI	Mississippi River	Hennepin	1995
Speckled chub	*Macrhybopsis aestivalis*	threatened-WI	Mississippi River	Ramsey	2000
Silver chub	*Macrhybopsis storeriana*	special concern-WI	Mississippi River	Dakota	1997
Silver chub	*Macrhybopsis storeriana*	special concern-WI	Mississippi River	Hennepin	1989
Silver chub	*Macrhybopsis storeriana*	special concern-WI	Mississippi River	Ramsey	2000
Silver chub	*Macrhybopsis storeriana*	special concern-WI	Minnesota River	Scott	1899
Silver chub	*Macrhybopsis storeriana*	special concern-WI	St. Croix River	Washington	1968

Appendix 4. Continued

Common Name	Scientific Name	Comments	Lake or Stream	County	Last Reported
Pearl dace	*Margariscus margarita*	endangered-IA	Credit River	Scott	1954
Pearl dace	*Margariscus margarita*	endangered-IA	Chub Creek trib	Dakota	2000
Pearl dace	*Margariscus margarita*	endangered-IA	Vermillion River	Dakota	1999
River shiner	*Notropis blennius*	peripheral	Minnesota River	Carver	1954
River shiner	*Notropis blennius*	peripheral	Mississippi River	Dakota	1974
River shiner	*Notropis blennius*	peripheral	Vermillion River	Dakota	1954
River shiner	*Notropis blennius*	peripheral	Mississippi River	Ramsey	1995
River shiner	*Notropis blennius*	peripheral	Credit River	Scott	1994
River shiner	*Notropis blennius*	peripheral	Sand Creek	Scott	1954
Blackchin shiner	*Notropis heterodon*	intolerant	Centerville Lake	Anoka	1962
Blackchin shiner	*Notropis heterodon*	intolerant	Lake George	Anoka	1983
Blackchin shiner	*Notropis heterodon*	intolerant	Lake Minnewashta	Carver	1998
Blackchin shiner	*Notropis heterodon*	intolerant	Pierson Lake	Carver	1954
Blackchin shiner	*Notropis heterodon*	intolerant	Christmas Lake	Hennepin	1996
Blackchin shiner	*Notropis heterodon*	intolerant	Crystal Lake	Hennepin	1933
Blackchin shiner	*Notropis heterodon*	intolerant	Lake Harriet	Hennepin	1948
Blackchin shiner	*Notropis heterodon*	intolerant	Lake Minnetonka	Hennepin	1969
Blackchin shiner	*Notropis heterodon*	intolerant	Minnehaha Creek	Hennepin	2000
Blackchin shiner	*Notropis heterodon*	intolerant	Minnesota River	Scott?	1899
Blackchin shiner	*Notropis heterodon*	intolerant	Big Carnelian Lake	Washington	1993
Blackchin shiner	*Notropis heterodon*	intolerant	Big Marine Lake	Washington	1996
Blackchin shiner	*Notropis heterodon*	intolerant	Forest Lake	Washington	1994
Blackchin shiner	*Notropis heterodon*	intolerant	Square Lake outlet	Washington	1999
Blacknose shiner	*Notropis heterolepis*	intolerant	Cedar Creek	Anoka	1969
Blacknose shiner	*Notropis heterolepis*	intolerant	Clearwater Creek	Anoka	1999
Blacknose shiner	*Notropis heterolepis*	intolerant	Ford Brook	Anoka	1998
Blacknose shiner	*Notropis heterolepis*	intolerant	Island Lake	Anoka	1960
Blacknose shiner	*Notropis heterolepis*	intolerant	Lake George	Anoka	1983
Blacknose shiner	*Notropis heterolepis*	intolerant	Mahoney Brook	Anoka	2000
Blacknose shiner	*Notropis heterolepis*	intolerant	Rum River trib	Anoka	1999

Appendix 4. Continued

Common Name	Scientific Name	Comments	Lake or Stream	County	Last Reported
Banded killifish	*Fundulus diaphanus*	intolerant	Big Carnelian Lake	Washington	1997
Banded killifish	*Fundulus diaphanus*	intolerant	Big Marine Lake	Washington	1999
Banded killifish	*Fundulus diaphanus*	intolerant	Bonny Lake	Washington	1941
Banded killifish	*Fundulus diaphanus*	intolerant	Forest Lake	Washington	1994
Banded Killifish	*Fundulus diaphanus*	intolerant	Square Lake	Washington	1998
SCULPINS	**COTTIDAE**				
Mottled sculpin	*Cottus bairdi*	intolerant	Coon Creek	Anoka	2000
Mottled sculpin	*Cottus bairdi*	intolerant	Cedar Creek	Anoka	2000
Slimy sculpin	*Cottus cognatus*	intolerant	Valley Branch	Washington	2000
SUNFISH	CENTRARCHIDAE				
Orangespotted sunfish	*Lepomis humillis*	range extension	Mississippi River	Anoka	2000
Orangespotted sunfish	*Lepomis humillis*	range extension	Crow River	Carver	1999
Orangespotted sunfish	*Lepomis humillis*	range extension	Crow River	Hennepin	2000
Orangespotted sunfish	*Lepomis humillis*	range extension	Elm Creek	Hennepin	1995
Longear sunfish	*Lepomis megalotis*	threatened-WI	McCarrons Lake	Ramsey	1978
DARTERS	PERCIDAE				
Western sand darter	*Ammocrypta clara*	special concern- WI	Minnesota River	Dakota	1980
Western sand darter	*Ammocrypta clara*	special concern-WI	St. Croix River	Washington	1996
Mud Darter	*Etheostoma asprigene*	special concern-WI	St. Croix River	Washington	1998
Rainbow darter	*Etheostoma caeruleum*	intolerant	Chub Creek	Dakota	2000
Rainbow darter	*Etheostoma caeruleum*	intolerant	Credit River	Scott	1956
Rainbow darter	*Etheostoma caeruleum*	intolerant	Browns Creek	Washington	1995
Rainbow darter	*Etheostoma caeruleum*	intolerant	Old Mill Stream	Washington	1999
Rainbow darter	*Etheostoma caeruleum*	intolerant	St. Croix River	Washington	1998
Rainbow darter	*Etheostoma caeruleum*	introduced?	Phalen Lake	Ramsey	2000
Banded darter	*Etheostoma zonale*	intolerant	Cannon River	Dakota	2000

Acknowledgments

We acknowledge the following individuals for their contributions to the study: Joan Galli (MDNR) funded the surveys through the Nongame Wildlife Program; Jack Enblom (MDNR) and Scott Niemela (MPCA) provided the field equipment; Louise Hotka (MPCA) funded the water chemistry lab analyses; Andrew Simons (University of Minnesota) cataloged specimens into the James Ford Bell Museum of Natural History fish collection; Nick Proulx (MDNR) produced the maps used in this report; and Steve Kittelson (MDNR) assisted in several surveys, and also recruited volunteers for the larger river stations. We also thank Charles Anderson, Jack Enblom, John Lyons, Jason Moeckel, Neal Mundahl, and David Wright for comments and

Edited by:
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SPECIAL PUBLICATIONS*

No. 146 Life History and Taxonomic Status of Purple Loosestrife in Minnesota: Implications for Management and Regulations of this Exotic Plant, by Charles H. Welling and Roger L. Becker. May 1992.

No. 147 Manual of Instructions for Lake Survey, by Tim Schlagenhaft. March 1993.

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