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Job 3

Minnesota Department of Natural Resources
Fisheries Division, Lake Superior Area

Status of Coaster Brook Trout in the Minnesota Lake Superior Tributaries

2013

Completed by:
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Introduction

Brook trout *Salvelinus fontinalis* is the only native anadromous salmonid in the Minnesota waters of Lake Superior. Brook trout that spend a portion of their life in Lake Superior are referred to as "coaster" brook trout (Becker 1983). Coaster brook trout were once thought to be widely distributed among Lake Superior tributaries (Newman and Dubois 1997). Anecdotal angling reports indicate that large brook trout were more frequently caught prior to the 1890's (Smith and Moyle 1944) and populations experienced precipitous declines thereafter due to overfishing and habitat degradation (Horns et al. 2003; Schreiner et al. 2008). Despite adversities over the past 150 years, coaster brook trout are still present, though in relatively small numbers, in the Minnesota waters of Lake Superior and utilize tributaries along the Minnesota shore for spawning.

In early attempts to rehabilitate coasters in Minnesota, various life stages of brook trout were stocked from the mid to late 1900's with minimal success (Schreiner et al. 2006). No stocking efforts to rehabilitate coasters have been made by the Minnesota Department of Natural Resources (MNDNR) since 1987. However, stocking by the Grand Portage Band of Chippewa has occurred within reservation waters. Interest in coaster rehabilitation intensified among both biologists and anglers over the past few decades. In 1999 the Great Lakes Fishery Commission produced "A Brook Trout Rehabilitation Plan for Lake Superior", which provided a framework for brook trout rehabilitation efforts in Lake Superior (Newman et. al 1999). A number of agencies have attempted to protect remnant stocks, primarily through harvest regulation. In 1997 the MNDNR implemented a conservative regulation for the Minnesota waters of Lake Superior and the below-barrier portions of Lake Superior tributaries. The regulation includes an open season from the inland trout opener in mid-April through Labor Day, with a bag limit of one fish and a minimum size limit of 508 millimeters (20 inches). Fall spawning assessments in tributaries are called for in the Lake Superior Management Plan (Schreiner et. al 2006) and are conducted every five years to assess the status of the coaster brook trout population. This report summarizes the 2013 survey and adds to the coaster brook trout survey information collected since 1997. The goal of the survey is to monitor the status of coaster brook trout in the Minnesota waters of Lake Superior and measure the results of the conservative regulation implemented in 1997.

Methods

The study area for the coaster brook trout survey consisted of 29 streams along the Minnesota shore of Lake Superior between Duluth and the Grand Portage Reservation (Figure 1, Table 1). Streams were sampled from early October through early-November. Streams were sampled from the lake to the first natural barrier, or to a previously established landmark if a barrier falls was not present. Fish were sampled using an ETS Electrofishing ABP-3 electrofishing unit (600 V). When more than one unit was required to adequately sample a stream, a Smith Root model LR-24 and/or a Halltech model HT 2000 was also used. At times two anodes were used off of the ABP-3, but generally if more than one anode was necessary for adequate stream coverage, an additional electrofishing unit was used. Electrofishing settings (volts, frequency, and duty cycle) were recorded during all sampling events. Effort was recorded as time (seconds) of electrofishing at each station. Time sampled was recorded from each backpack when more than one was used. If two anodes were used off of one pack, the time fished was not doubled. Multiple passes were not made during any sampling event due to the general low abundance of brook trout and time constraints.

Sample crews consisted of three or four individuals on smaller to medium sized streams and five or six individuals on larger streams. All individuals carried dip nets. A five gallon bucket for fish was carried for each backpack electrofisher being used. Water temperature (°C), conductivity (µs), dissolved oxygen (mg/L) and discharge (m^3/s) were measured on each stream on each sample date. A water sample was collected during each sampling event and used to determine alkalinity (meq $liter^{-1}$) and pH back in the lab. UTM coordinates for the upstream and downstream end of each station were established from previous surveys, so new coordinates were not obtained.

All brook trout sampled were measured to the nearest millimeter (mm), weighed to the nearest gram (g), and sex was determined if possible. Young-of-the-year were considered immature. Females were classified as either ripe, green, or spent. Scale samples were collected for age determination and calculation of the mean length at the time of the last annulus formation. A piece of tissue was removed from the left rear pelvic fin for genetic analysis and marking purposes. Tissue samples were placed in individually numbered envelopes for future genetic analysis. The presence of other species was recorded as either present, common, or abundant, but not enumerated. Although in prior years population estimates were made on streams that were sampled multiple times, population estimates were not made this year. There was clearly migration into and out of the study streams, which is a violation of mark-recapture assumptions.

Results and Discussion

2013 Results

Twenty-six of the 29 survey streams were sampled, which included 39 sampling events (Table 2). Eleven streams were sampled twice and two streams were sampled three times. A total of 68.4 hours of electrofishing covering 21.7 kilometers of stream occurred between October 7th and November 8th. A total of 264 brook trout were captured, including 244 unique individuals and 20 recaptures. The overall catch per unit effort (CPUE) for brook trout was 3.9 fish/hr and 12.2 fish/km (Figure 2). Catch rates per stream ranged from 0.0 fish/hr to 25.3 fish/hour, and 0.0 fish/km to 126.1 fish/km (Table 3). Mean catch rates (fish/km) were highest at Kadunce Creek, Spruce Creek, Little Manitou River, and Gooseberry River.

Over half of captured brook trout were between 100 and 200 mm, but 4.0% were ≥300 mm (Table 4, Figure 3). Brook trout up to 536 mm were captured. Fifty-seven percent of brook trout were age-1 while 27.5% were age-2 through age-6 (Table 5, Figure 4). Brook trout had growth increments of 72 mm between age-1 and age-2, 73 mm between age-2 and age-3, 107 mm between age-3 and age-4, 98 mm between age-4 and age-5, and 30 mm between age-5 and age-6 (Table 6, Figure 5). Of the brook trout where sex was determined, 42% were male (n=58) and 58% were female (n=80) (Figure 6). The other 106 brook trout were either unknown sex (n=67) or immature young-of-the-year (n=39). Approximately 89% of brook trout were sampled in October and 11% were sampled in November (Table 7, Figure 7). Fifty-one percent of brook trout were sampled when water temperatures were ≤4.2^{o}C (≤40^{o}F) (Table 8,

Figure 8). Precipitation totals during the 2013 survey period were similar to other years with the exception of 2007 (Figure 9).

Rainbow trout were the most common species sampled and were captured in 24 of the 26 surveyed streams (Table 9, Figure 10). Brook trout and coho salmon were the next most common species, both captured in 19 streams. A total of 13 species of gamefish and 13 species of non-gamefish were sampled during the survey (Table 9, Figure 10).

Comparisons among 1997, 2002, 2007-08, and 2013

Twenty-six streams were sampled in 2013 compared to 22, 10, and 25 streams in 1997, 2002, and 2007-08 (Tilma et al. 1999, Pranckus and Ostazeski 2003, Ward 2008). The number of sampling events completed was 41 (1999), 24 (2002), 59 (2007-08), and 39 (2013) (Table 2). The high number of sampling events in 2007-08 was due to the survey being split between two years. The fall of 2007 was very wet with 215 mm of precipitation in October in Grand Marais (Figure 9). Due to the resulting high water conditions only small to medium size streams were sampled. The larger rivers were then sampled in 2008 along with some of the more productive streams from 2007.

A total of 385, 126, 358, and 264 brook trout were sampled during the 1997, 2002, 2007-08, and 2013 surveys (Table 7). The overall CPUE (fish/hr) was 17.7, 16.1, 4.6, and 3.9 fish/hr during the survey years (Figure 2). The overall CPUE (fish/km) was 12.2, 6.7, 8.8, and 12.2 fish/km. The number of fish/hr was low in both 2007-08 and 2013 compared to 1997 and 2002. The difference is likely the result of gear configuration and differences between sampling crews. For example, time fished was recorded based on the number of backpacks used, not the number of anodes. Therefore, if a crew opted to use two backpacks instead of a two-anode configuration, effort was essentially doubled. Also, crews electrofish at different speeds and the crews in 2007-08 and 2013 likely spent more time electrofishing per area of stream. The number of sampling events in 1997 and 2013 were almost identical, but there were only 21.6 hours of effort in 1997 compared to 68.4 in 2013. Station length on each stream did not change throughout the surveys and fish/km is likely a better measure of catch per effort than fish/hr. Based on fish/km, there has not been an increase in the overall abundance of brook trout (Figure 2). However, the catch of brook trout ≥300 mm/km was 0.19 (1997), 0.11 (2002), 0.84 (2007-08), and 0.46 (2013), which indicates there were more large brook trout present in recent surveys compared to 1997 and 2002.

Although most brook trout sampled were relatively small, the size-structure of the brook trout sampled in 2013 included 4.0% ≥300 mm, compared to 1.8%, 1.9%, and 10.3% in 1997, 2002, and 2007-08 (Table 4, Figure 3). The relatively high percentage of larger brook trout sampled in 2007-08 appears to be related to sampling conditions. As previously mentioned, 2007 was a very wet fall and consequently the smaller streams had high flows, but could still be sampled effectively, and large brook trout were captured. In 2008 flows were relatively normal which allowed for effective sampling of the larger rivers as well as some of the smaller streams, but the smaller streams did not produce many large fish in 2008 whereas the larger rivers did. In 2013, which had conditions similar to 2008, the large brook trout were again caught primarily in the larger rivers. Therefore, flow conditions appear to influence which streams coaster brook trout utilize for spawning. While a lower percentage of the 2013 sample was large brook trout compared to 2007-08, several legal sized fish (>508 mm or 20 inches) were sampled, which had not occurred in any of the previous surveys.

The age-structure of brook trout sampled in 2013 reflects the increased presence of large brook trout in the population. Of the brook trout sampled, 8.1% were age-3 or older, which is similar to 2007-08 (9.8%), but higher than both 1997 (2.8%) and 2002 (1.0%) (Table 5, Figure 4). In 2013, brook trout up to age-6 were sampled, and in previous surveys no brook trout greater than age-4 were sampled. Brook trout length-at-age was similar in 2013 to previous surveys (Table 6, Figure 5). Growth rates of brook trout from the 1993 Isle Royale, Michigan sample (Slade 1994) were greater for all age categories when compared to those collected in Minnesota. The ratio of females to males has remained fairly equal throughout the surveys (Figure 6).

Brook trout have been captured primarily late in the fall and when water temperatures are cold. Nearly 92% of brook trout sampled in 2013 were captured after October 11th (Table 7, Figure 7), and collectively almost 89% of brook trout throughout all survey years were sampled later than this date. Overall, few brook trout have been captured at water temperatures above 6.9°C (44°F), and in all years except 2007-08 over 50% of brook trout were sampled at water temperatures below 4.2°F (40°F) (Table 8, Figure 8). However, minimal effort was expended in 2013 early in the fall when stream temperatures were warm, mostly because few fish were caught during these conditions in previous surveys. Overall, these data suggest that brook trout tend to enter streams to spawn late in the fall when water temperatures are cold.

Tissue samples were collected during the 2013 survey for possible future genetic analysis. Genetic analysis of the brook trout sampled in the 1997 survey by the

MNDNR concluded that a substantial genetic diversity still exists within brook trout populations along Minnesota's shoreline, and native brook trout populations suffered no significant genetic impact from previous stockings (Burnham-Curtis 2000). Genetic analysis of the 2007-08 sample showed that most brook trout were Minnesota strain fish, with few Isle Royal strain or hatchery strain fish present. This suggests that the larger brook trout observed in recent surveys are the result of conservative regulations rather than stocking efforts or strays from Isle Royal.

The conservative regulations implemented in 1997 appear to be contributing to the shift in size structure that includes some larger, older brook trout. Anecdotal angler reports have also indicated that they are catching more large brook trout as well. Few complaints about the conservative regulation have been voiced in recent years, indicating anglers are satisfied with the regulation. Furthermore, angler compliance has been good with few illegally harvested brook trout observed in annual creel surveys, further demonstrating anglers' acceptance of the regulation. Support for this, or any regulation, is essential for its success.

It should be noted that sampling every five years is a minimal level and only provides a snapshot of the population. If funding exists, future consideration should be given to increasing the frequency of sampling. Although larger fish have been sampled in recent surveys and anglers are reporting catching larger brook trout, it is unlikely the Minnesota waters of Lake Superior will ever support high numbers of coaster brook trout and expectations of both biologists and anglers must be kept reasonable. Lack of suitable stream spawning and rearing habitat, volatile stream flow regimes and a lack of groundwater, warm stream temperatures, and competition with other species are all obstacles for coaster brook trout that are extremely difficult to address, if at all. Protecting watersheds and working to improve their hydrology is a critical component of further coaster brook trout rehabilitation.

Acknowledgements

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2013

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Approved by: Donald R Schreiner Date: 3/11/14
Area Supervisor

Approved by: [signature] Date: 3-19-14
Regional Supervisor

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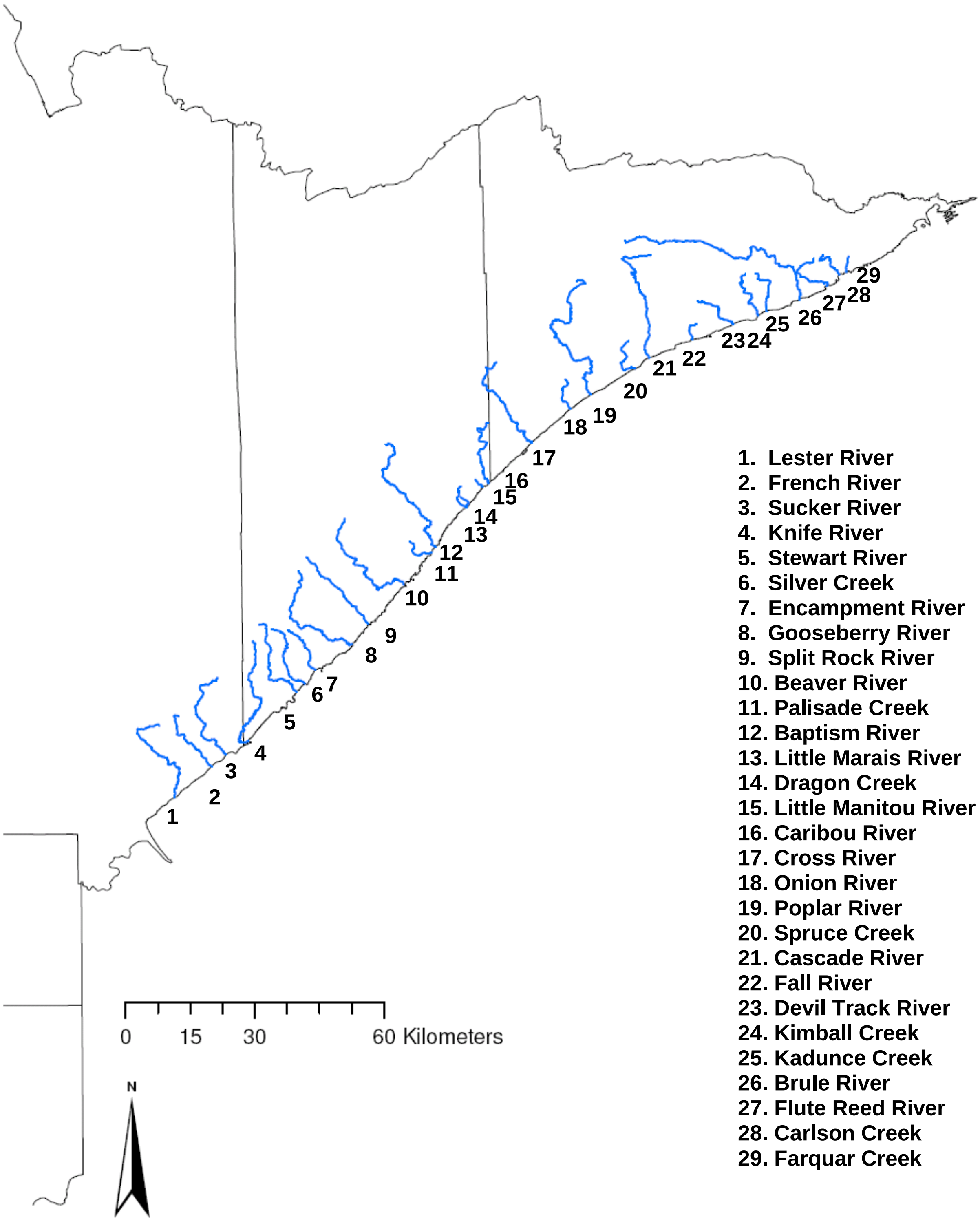

Figure 1. Streams sampled on the Minnesota shore of Lake Superior for brook trout in either the 1997, 2002, 2007-2008, or 2013 surveys.

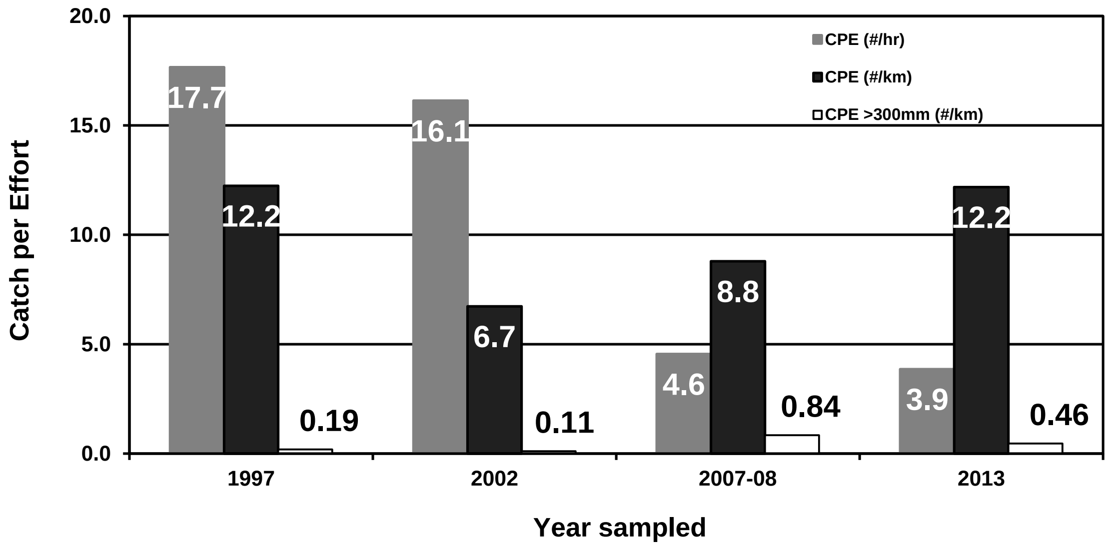

Figure 2. Shorewide catch per effort (fish/hour, fish/kilometer, and fish >300mm/kilometer) of brook trout in the 1997, 2002, 2007-2008 and 2013 surveys.

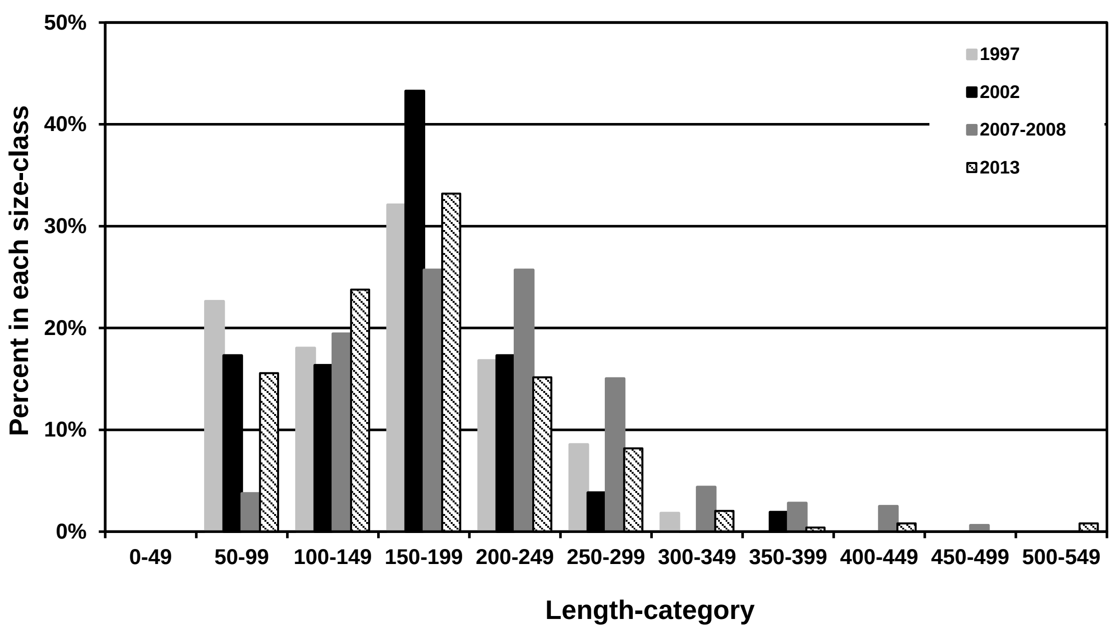

Figure 3. Comparison of brook trout size-structure between the 1997, 2002, 2007-2008, and 2013 samples.

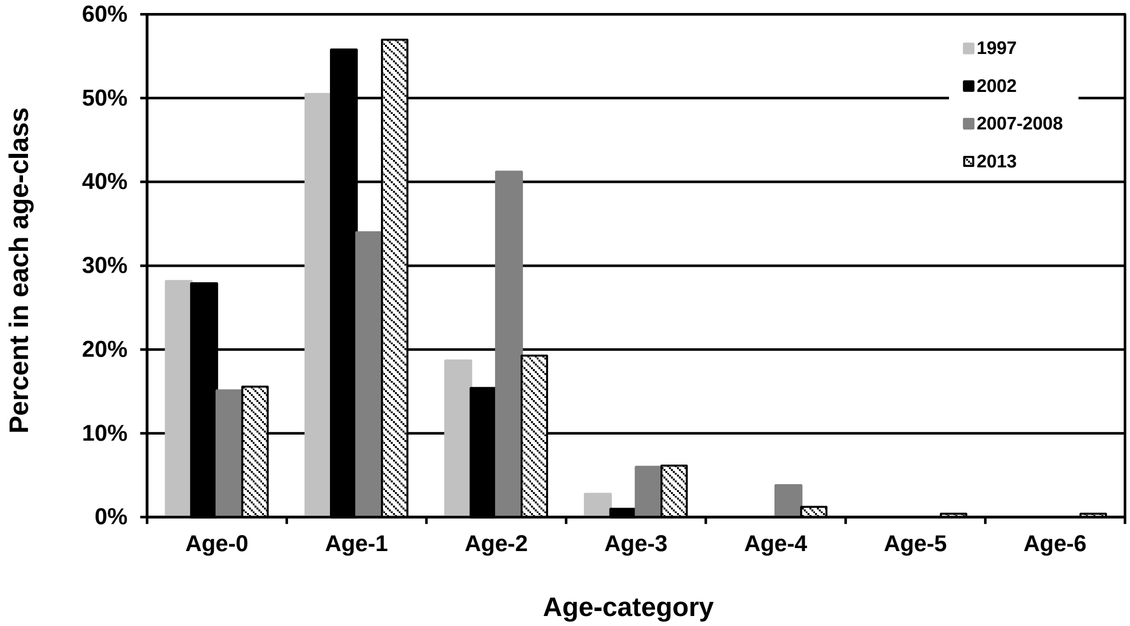

Figure 4. Comparison of brook trout age-structure between the 1997, 2002, 2007-2008, and 2013 surveys.

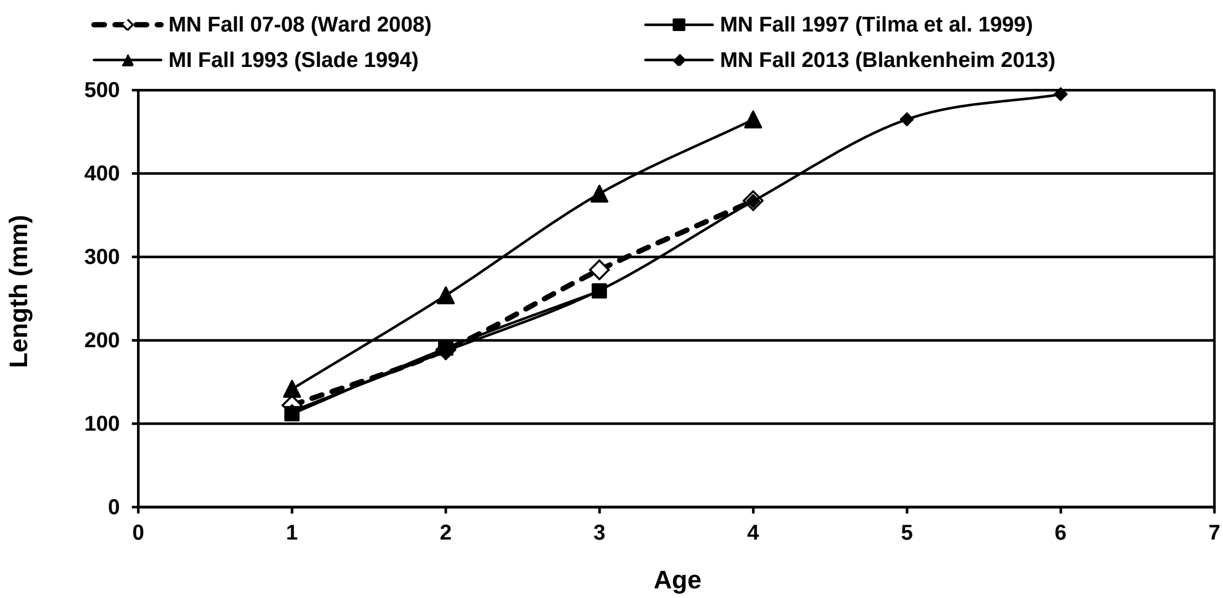

Figure 5. Comparison of mean back-calculated length-at-age for brook trout in Minnesota in the fall of 1997, 2007-2008, 2013, and Isle Royale, Michigan fall 1993.

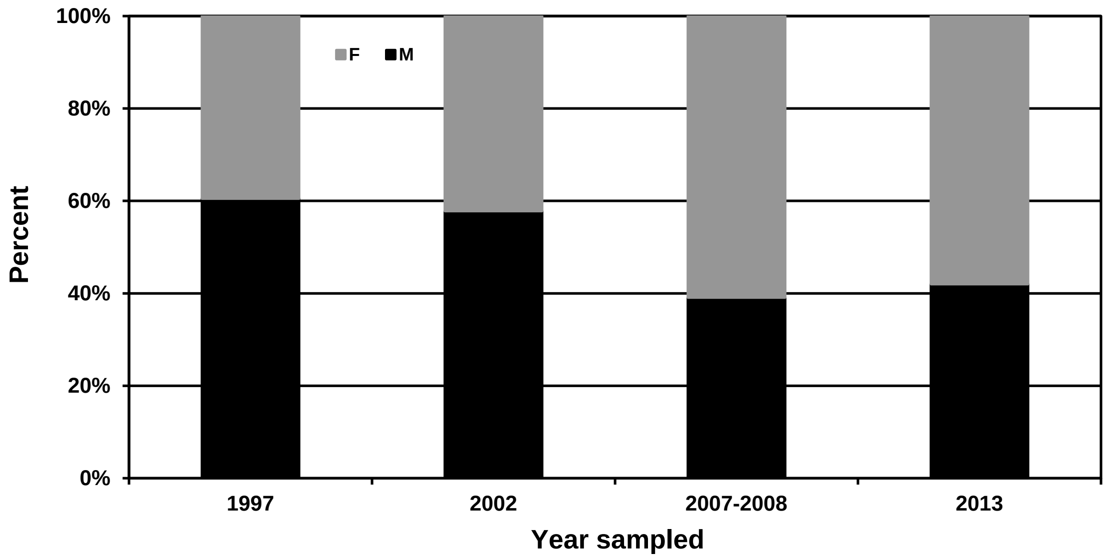

Figure 6. Comparison of brook trout sex ratio sampled in the 1997, 2002, 2007-2008, and 2013 surveys.

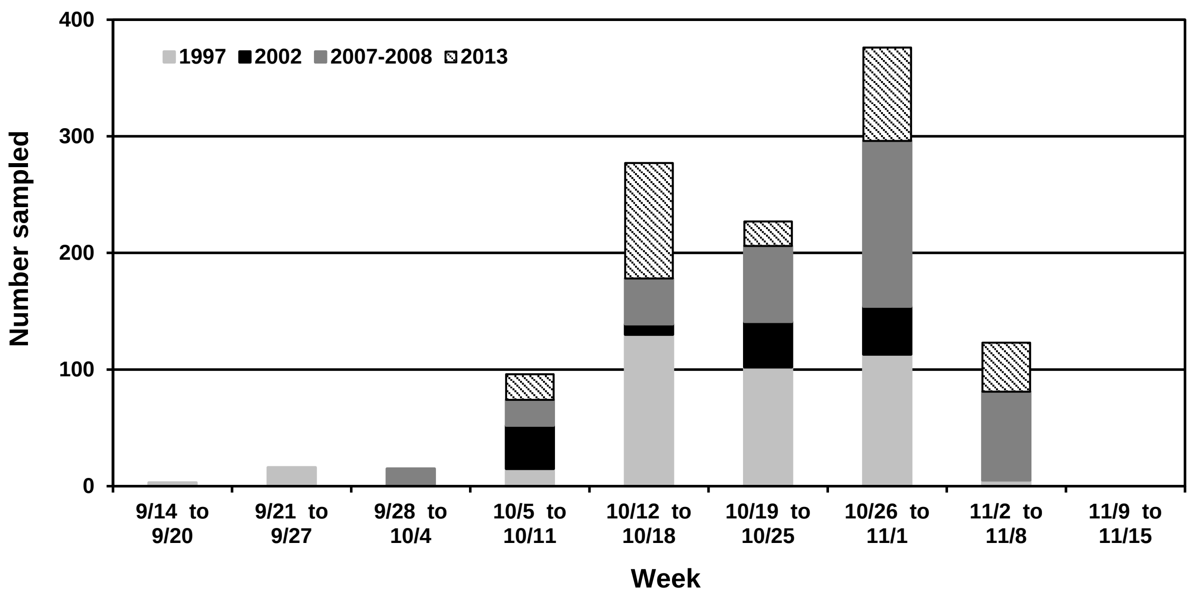

Figure 7. Comparison of the time period when brook trout were sampled in the 1997, 2002, 2007-2008, and 2013 surveys. These numbers include recaptures from earlier sample dates.

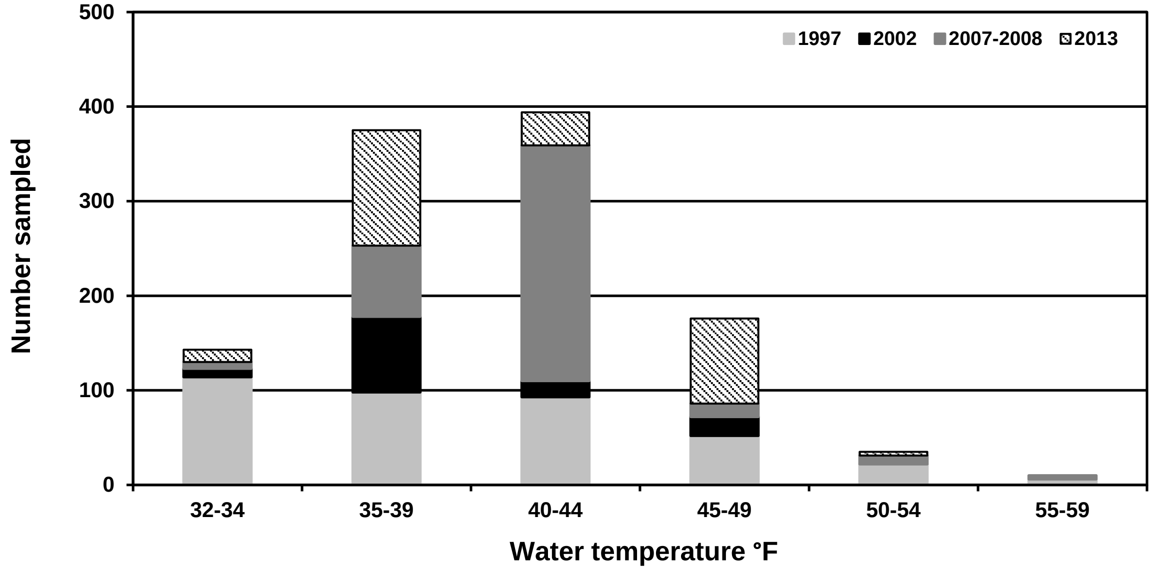

Figure 8. Comparison of water temperature when brook trout were sampled in the 1997, 2002, 2007-2008, and 2013 surveys. Numbers include recaptures from earlier sample dates.

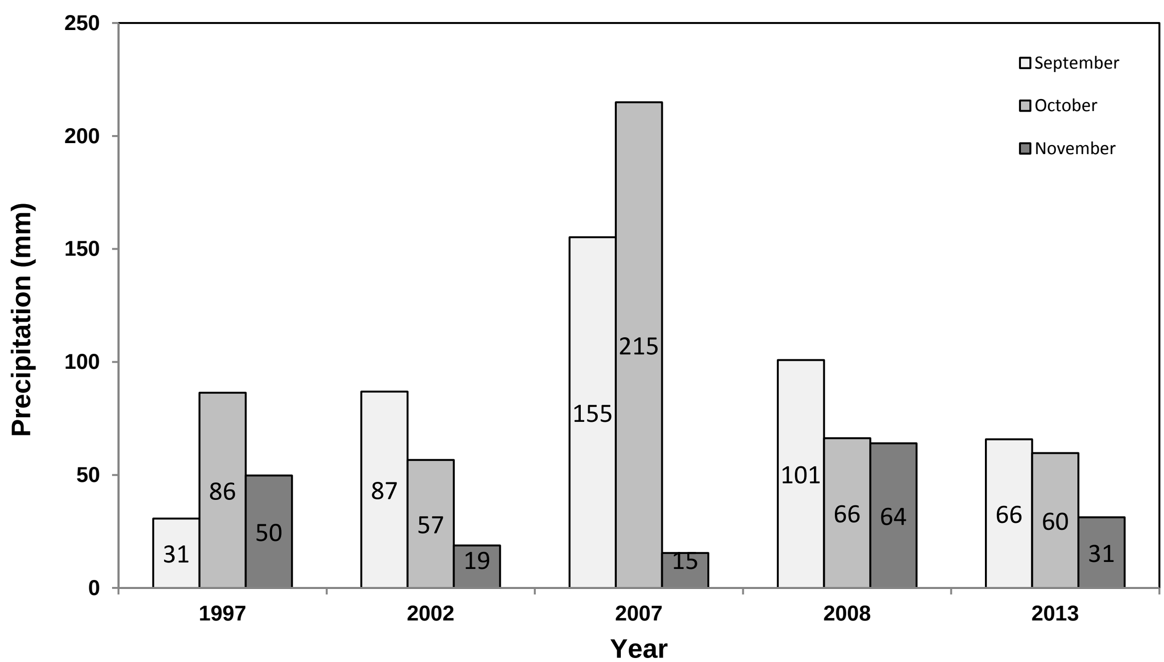

Figure 9. Monthly precipitation totals (mm) in Grand Marais during the sampling years.

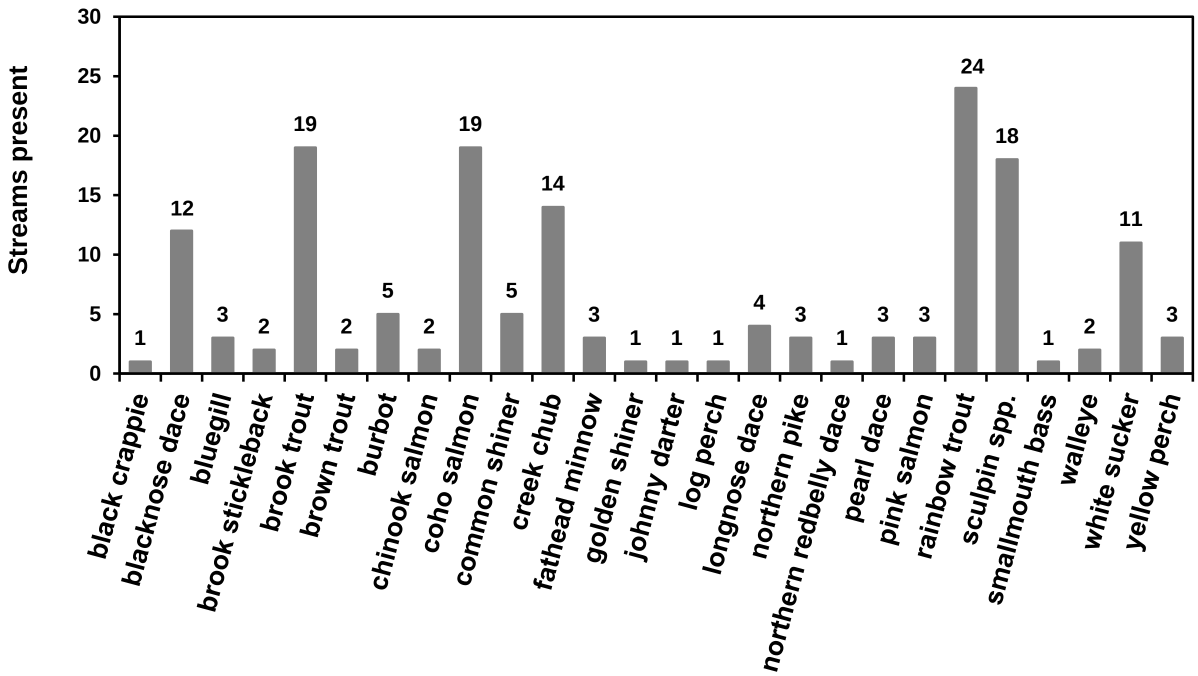

Figure 10. Number of streams where species were sampled in 2013.

Table 1. Study site descriptions for the 1997, 2002, 2007-2008, and 2013 below-barrier brook trout station locations.

Stream	Kittle number	Site description	Station length (m)	Fisheries Area	County	Highway mile number	Downstream Easting	Downstream Northing	Upstream Easting	Upstream Northing
Lester River	S-05	Lake to barrier falls in park	1,060	Duluth	St. Louis	5.8	575800	5187457	575967	5188347
French River	S-11	fish captured in adult trap	93	Duluth	St. Louis	11.9	584367	5194564	584316	5194642
Sucker River	S-15	Lake to barrrier downstream of Hwy. 61	712	Duluth	St. Louis	14.5	587728	5197133	587250	5197478
Knife River	S-17	fish captured in adult trap	902	Duluth	Lake	17.9	592613	5200190	591799	5199926
Stewart River	S-19	Lake to barrier falls below powerline	1,562	Duluth	Lake	28.5	604026	5211375	603134	5212110
Silver Creek	S-21	Lake to barrier falls	403	Duluth	Lake	30.2	605933	5213130	605759	5213410
Encampment River	S-22	Partial barrier at first falls by cabin	360	Duluth	Lake	32.8	608426	5216296	608262	5216471
Gooseberry River	S-26	Upstream end of lagoon to falls at park	427	Duluth	Lake	39.3	616307	5221832	616194	5222175
Split Rock River	S-29	Upstream end of Hwy 61 culvert to falls	1,209	Finland	Lake	43.5	620699	5226668	619884	5227453
Beaver River	S-35	Upstream end of lagoon to barrier falls	200	Finland	Lake	51.2	629055	5235430	628894	5235516
Palisade Creek	S-37	Lake to slides at Hwy 61	718	Finland	Lake	57.1	635391	5242825	634840	5242557
Baptism River	S-38	Under Hwy 61 bridge to barrier falls	1,190	Finland	Lake	58.3	636200	5244098	635475	5244772
Little Marais River	S-44	Lake to barrier falls	160	Finland	Lake	65.8	643395	5252959	643266	5253019
Dragon Creek	S-44.1	Lake to falls downstream of highway	543	Finland	Lake	66.6	643454	5252979	643589	5253457
Little Manitou River	S-46	Lake to Hwy 61	255	Finland	Lake	69.5	647181	5257598	647017	5257794
Caribou River	S-47	Lake to barrier falls	155	Finland	Lake	70.5	648611	5258373	648499	5258431
Cross River	S-52	Lake to barrier falls/Hwy 61	468	Finland	Cook	79.0	658611	5267664	658304	5267757
Onion River	S-56	Lake to barrier falls	295	Grand Marais	Cook	86.5	667540	5275151	667412	5275386
Poplar River	S-58	Lake to barrier falls by Lutsen Resort	150	Grand Marais	Cook	90.0	672197	5278391	672214	5278520
Spruce Creek (Deer Yard)	S-62	Lake to barrier falls	166	Grand Marais	Cook	97.7	682558	5284293	682495	5284431
Cascade River	S-64	Lake to falls	244	Grand Marais	Cook	100.0	685831	5286704	685747	5286879
Fall River (Rosebush)	S-66	Lake to barrier falls	72	Grand Marais	Cook	106.9	695798	5290809	695780	5290871
Devil Track River	S-67	Lake upstream end of fish sanctuary	2,253	Grand Marais	Cook	113.4	705201	5294213	703939	5295231
Kimball Creek	S-70	Lake to slides	1,635	Grand Marais	Cook	117.3	711077	5296144	710869	5297194
Kadunce Creek	S-72	Lake to barrier falls	428	Grand Marais	Cook	118.9	713093	5297256	712926	5297612
Brule River	S-75	Lake to falls	2,324	Grand Marais	Cook	124.0	720723	5299860	720785	5301585
Flute Reed River	S-77	Lake to Hwy 61	570	Grand Marais	Cook	128.8	727007	5302855	727256	5303343
Carlson Creek	S-79	Lake to barrier falls	854	Grand Marais	Cook	131.0	729975	5305452	729501	5305977
Farquar Creek	S-80	Lake to Hwy 61	181	Grand Marais	Cook	132.0	731537	5305987	731486	5306144

Table 2. Dates rivers were sampled in 1997, 2002, 2007-2008, and 2013.

	1997						2002				2007				2008		2013		
Stream	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#1**	**#2**	**#3**	**#4**	**#1**	**#2**	**#3**	**#4**	**#1**	**#2**	**#1**	**#2**	**#3**
Lester River															11/5				
French River																			
Sucker River	9/17	10/3									11/8				10/31		10/9		
Knife River																	11/7		
Stewart River	9/24	10/15									10/29	11/8					10/25		
Silver Creek	9/17	10/14									9/28	10/29					10/7	10/22	
Encampment River	10/7										9/28	10/29					10/7		
Gooseberry River															10/31		10/28	11/6	
Split Rock River	9/24	10/10	10/21	10/28											10/24	10/30	10/23		
Beaver River	9/26										10/2	11/6					10/11		
Palisade Creek											10/4	11/7					10/11		
Baptism River	9/26	10/22													10/23		11/1		
Little Marais River	10/14						10/7				10/2	10/17	10/31	11/6	10/28		10/8	10/22	
Dragon Creek															10/28		10/8	10/22	
Little Manitou River															10/28		10/22		
Caribou River	10/7	10/21									10/4	10/31			10/24		10/31		
Cross River	9/23	10/8	10/15	10/22	10/28	11/4	10/7	10/16	10/24						10/20	11/3	10/14	10/31	
Onion River	10/14	10/26	10/31				10/9	10/16	10/24	10/30	10/15	10/31					10/14	10/24	
Poplar River							10/10	10/16	10/24		11/2				10/20	11/3	10/10	10/24	11/5
Spruce Creek	10/17	10/31					10/21				10/17	10/26	11/6		10/28	11/3	10/10	10/24	11/5
Cascade River	10/19	10/25					10/21										11/5		
Fall River											10/16	10/25	11/1				11/5		
Devil Track River	10/18	10/24	10/29				10/10	10/22							10/22	11/4	10/29		
Kimball Creek	10/18	10/25					10/11	10/22	10/25	10/30	10/15	11/1			10/29		10/17	11/8	
Kadunce Creek	10/18	10/25					10/11	10/21	10/25	10/30	10/1	10/16	10/30	11/5	10/21		10/16	10/30	
Brule River							10/22												
Flute Reed River	10/17	10/19									10/26	11/7			10/21		10/16	10/30	
Carlson Creek	10/17										10/1	10/25					10/17		
Farquar Creek	10/17										10/8	10/25					10/30		

Table 3. Effort (hours electrofishing) and catch per effort (number of brook trout per hour and number per kilometer) in the 2013 survey.

River/Stream	2013 Dates sampled #1	#2	#3	Total number sampled #1	#2	#3	Total	Catch per effort pass 1 (number/hour) #1	#2	#3	Mean	Catch per effort pass 1 (number/kilometer) #1	#2	#3	Mean
Sucker River	10/9			1			**1**	0.5			**0.5**	1.4			**1.4**
Knife River	11/7			9			**9**	4.0			**4.0**	10.0			**10.0**
Stewart River	10/25			0			**0**	0.0			**0.0**	0.0			**0.0**
Silver Creek	10/7	10/22		1	0		**1**	1.0	0.0		**0.5**	2.5	0.0		**1.2**
Encampment River	10/7			0			**0**	0.0			**0.0**	0.0			**0.0**
Gooseberry River	10/28	11/6		13	13		**26**	3.4	3.2		**3.3**	30.5	30.5		**30.5**
Split Rock River	10/23			0			**0**	0.0			**0.0**	0.0			**0.0**
Beaver River	10/11			0			**0**	0.0			**0.0**	0.0			**0.0**
Palisade Creek	10/11			1			**1**	1.3			**1.3**	1.4			**1.4**
Baptism River	11/1			3			**3**	0.5			**0.5**	2.5			**2.5**
Little Marais River	10/8	10/22		3	0		**3**	6.3	0.0		**3.1**	18.8	0.0		**9.4**
Dragon Creek	10/8	10/22		0	1		**1**	0.0	2.4		**1.0**	0.0	1.8		**0.9**
Little Manitou River	10/22			9			**9**	19.7			**19.7**	35.3			**35.3**
Caribou River	10/31			4			**4**	5.2			**5.2**	25.7			**25.7**
Cross River	10/14	10/31		4	5		**9**	2.1	2.2		**2.2**	8.5	10.7		**9.6**
Onion River	10/14	10/24		14	3		**17**	16.1	4.5		**11.1**	47.5	10.2		**28.8**
Poplar River	10/10	10/24	11/5	1	3	5	**9**	1.9	4.4	3.4	**3.3**	6.7	20.0	33.4	**20.0**
Spruce Creek	10/10	10/24	11/5	15	5	4	**24**	25.3	15.0	5.3	**14.3**	90.1	30.0	24.0	**48.1**
Cascade River	11/5			0			**0**	0.0			**0.0**	0.0			**0.0**
Fall River	11/5			1			**1**	5.4			**5.4**	13.8			**13.8**
Devil Track River	10/29			18			**18**	3.2			**3.2**	8.0			**8.0**
Kimball Creek	10/17	11/8		27	10		**37**	7.3	2.9		**5.2**	16.5	6.1		**11.3**
Kadunce Creek	10/16	10/30		54	34		**88**	18.8	24.2		**20.6**	126.1	79.4		**102.7**
Flute Reed River	10/16	10/30		0	3		**3**	0.0	1.1		**0.6**	0.0	5.3		**2.6**
Carlson Creek	10/17			0			**0**	0.0			**0.0**	0.0			**0.0**
Farquar Creek	10/30			0			**0**	0.0			**0.0**	0.0			**0.0**

Table 4. Length-frequency distribution of brook trout from the 1997, 2002, 2007-2008, and 2013 surveys.

Size structure	1997		2002		2007-2008		2013		Total	
	N	%	N	%	N	%	N	%	N	%
0-49	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
50-99	74	22.6%	18	17.3%	12	3.8%	38	15.6%	142	14.3%
100-149	59	18.0%	17	16.3%	62	19.4%	58	23.8%	196	19.7%
150-199	105	32.1%	45	43.3%	82	25.7%	81	33.2%	313	31.5%
200-249	55	16.8%	18	17.3%	82	25.7%	37	15.2%	192	19.3%
250-299	28	8.6%	4	3.8%	48	15.0%	20	8.2%	100	10.1%
300-349	6	1.8%	0	0.0%	14	4.4%	5	2.0%	25	2.5%
350-399	0	0.0%	2	1.9%	9	2.8%	1	0.4%	12	1.2%
400-449	0	0.0%	0	0.0%	8	2.5%	2	0.8%	10	1.0%
450-499	0	0.0%	0	0.0%	2	0.6%	0	0.0%	2	0.2%
500-549	0	0.0%	0	0.0%	0	0.0%	2	0.8%	2	0.2%
Total	327	100%	104	100%	319	100%	244	100%	994	100%

Table 5. Age distribution of brook trout in the 1997, 2002, 2007-2008, and 2013 surveys.

Age structure	1997		2002		2007-2008		2013		Total	
	N	%	N	%	N	%	N	%	N	%
Age-0	92	28.1%	29	27.9%	48	15.1%	38	15.6%	207	20.8%
Age-1	165	50.5%	58	55.8%	108	34.0%	139	57.0%	470	47.3%
Age-2	61	18.7%	16	15.4%	131	41.2%	47	19.3%	255	25.7%
Age-3	9	2.8%	1	1.0%	19	6.0%	15	6.1%	44	4.4%
Age-4	0	0.0%	0	0.0%	12	3.8%	3	1.2%	15	1.5%
Age-5	0	0.0%	0	0.0%	0	0.0%	1	0.4%	1	0.1%
Age-6	0	0.0%	0	0.0%	0	0.0%	1	0.4%	1	0.1%
Total	327	100%	104	100%	318	100%	244	100%	993	100%

Table 6. Back-calculated length at age (mm) for brook trout sampled in the 2013 survey.

Age	Sample size	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6
1	139	110					
2	46	119	183				
3	14	133	189	246			
4	2	160	218	280	338		
5	1	167	231	343	395	476	
6	1	148	240	327	396	453	495
Weighted mean		**115**	**187**	**260**	**367**	**465**	**495**

Table 7. Number of brook trout caught by time period during the 1997, 2002, 2007-2008, and 2013 surveys. Recaptures are included.

Week	1997		2002		2007-2008		2013		Total	
	N	%	N	%	N	%	N	%	N	%
9/14 to 9/20	3	0.8%	0	0.0%	0	0.0%	0	0.0%	3	0.3%
9/21 to 9/27	16	4.2%	0	0.0%	0	0.0%	0	0.0%	16	1.4%
9/28 to 10/4	1	0.3%	0	0.0%	14	3.9%	0	0.0%	15	1.3%
10/5 to 10/11	15	3.9%	37	29.4%	22	6.1%	22	8.3%	96	8.5%
10/12 to 10/18	130	33.8%	9	7.1%	39	10.9%	99	37.5%	277	24.4%
10/19 to 10/25	102	26.5%	39	31.0%	65	18.2%	21	8.0%	227	20.0%
10/26 to 11/1	113	29.4%	41	32.5%	142	39.7%	80	30.3%	376	33.2%
11/2 to 11/8	5	1.3%	0	0.0%	76	21.2%	42	15.9%	123	10.9%
11/9 to 11/15	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total	385	100%	126	100%	358	100%	264	100%	1133	100%

Table 8. Water temperature range at which brook trout were sampled in the 1997, 2002, 2007-2008, and 2013 surveys. Recaptures are included.

Temperature		1997		2002		2007-2008		2013		Total	
^{o}F	^{o}C	N	%	N	%	N	%	N	%	N	%
32-34	0.0-1.4	114	29.6%	9	7.1%	7	2.0%	13	4.9%	143	12.6%
35-39	1.4-4.2	98	25.5%	80	63.5%	75	20.9%	122	46.2%	375	33.1%
40-44	4.2-6.9	93	24.2%	17	13.5%	249	69.6%	35	13.3%	394	34.8%
45-49	6.9-9.7	52	13.5%	20	15.9%	14	3.9%	90	34.1%	176	15.5%
50-54	9.7-12.5	22	5.7%	0	0.0%	9	2.5%	4	1.5%	35	3.1%
55-59	12.5-15.0	6	1.6%	0	0.0%	4	1.1%	0	0.0%	10	0.9%
Total		385	100%	126	100%	358	100%	264	100%	1133	100%

Table 9. Species sampled by river in the 2013 survey.

	black crappie	blacknose dace	bluegill	brook stickleback	brook trout	brown trout	burbot	chinook salmon	coho salmon	common shiner	creek chub	fathead minnow	golden shiner	johnny darter	log perch	longnose dace	northern pike	northern redbelly dace	pearl dace	pink salmon	rainbow trout	sculpin spp.	smallmouth bass	walleye	white sucker	yellow perch
Sucker River		X	X		X	X	X	X	X		X					X	X			X	X	X			X	X
Knife River		X			X	X			X		X			X							X	X				
Stewart River		X					X		X	X	X										X	X				
Silver Creek		X			X				X	X	X										X	X			X	
Encampment River		X					X		X	X	X	X							X		X	X			X	
Gooseberry River		X			X				X	X	X	X			X					X	X	X			X	
Split Rock River		X		X			X		X		X										X				X	
Beaver River	X	X	X								X						X					X			X	X
Palisade Creek					X				X												X					
Baptism River		X			X						X										X				X	
Little Marais River					X				X			X				X					X	X				
Dragon Creek				X	X				X									X			X	X			X	
Little Manitou River					X																X					
Caribou River					X																X	X				
Cross River		X			X		X		X		X					X				X	X	X		X	X	
Onion River					X				X		X								X		X	X				
Poplar River			X		X					X	X		X				X				X	X	X	X	X	X
Spruce Creek		X			X				X												X					
Cascade River																					X					
Fall River					X																					
Devil Track River					X				X		X										X					
Kimball Creek					X			X	X										X		X	X				
Kadunce Creek		X			X				X							X					X	X				
Flute Reed River					X				X		X										X	X			X	
Carlson Creek									X												X	X				
Farquar Creek									X												X	X				