Minnesota
F-29-R(P)-22
Study 4
Job 616

Minnesota Department of Natural Resources
Fisheries Division, Lake Superior Area

Coaster Brook Trout Status in Minnesota-Lake Superior Tributaries Following Regulation Changes

2003

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Introduction

The abundance of brook trout, *Salvelinus fontinalis*, in Lake Superior has declined since the turn of the century primarily due to over fishing and habitat destruction (Newman et al. 1998). The term "coaster" brook trout refers to brook trout that spend part of their life in Lake Superior. There is renewed interest among Lake Superior biologists and angling groups to rehabilitate coaster populations. Recently, two documents were developed that form the framework for rehabilitation in Lake Superior (Newman et al. 1998, Newman and DuBois 1996).

Lake wide, a number of management agencies have attempted protection for coaster brook trout stocks through more restrictive regulations such as season closures and reduced possession limits. Minnesota has initiated a number of techniques in an attempt to bolster remnant coaster populations along its shoreline. In 1997, conservative fishing regulations were implemented to protect potential coaster brook trout populations in Minnesota's portion of Lake Superior and its tributaries. These regulations include a closed season from September 1 until the inland trout opener in mid-April and a possession limit of only one fish over 20 inches. Strict harvest regulations may prevent overexploitation and may allow populations to recover without intervention. This assessment was an initial step to determine if restrictive regulations had any effect on the population abundance and structure of remnant brook trout stocks in Minnesota.

The objective of this study was to document the distribution, abundance and size structure of coaster brook trout in streams tributary to Lake Superior below the natural barriers following implementation of regulation changes. The information collected in fall of 2002 can be compared to pre-regulation data from 1997 (Tilma et al. 1999) to determine if changes have occurred. The potential effects of the regulation changes is of interest to Minnesota and other management agencies on Lake Superior because it has been proposed as a major strategy for coaster restoration (Newman et al. 1999).

Methods

Coaster brook trout were sampled in 10 Minnesota tributaries in October 2002 during the spawning period. Streams were selected based partly on where numbers of fish were caught in the 1997 assessment, and also on anecdotal reports of brook trout being present (Figure 1). Streams were sampled using a Smith Root model 11-A back-pack electrofishing unit (400-600 V, 60 Hz). Sampling crews were consisted of two or three people. Streams were generally sampled from the mouth of the tributary to the first natural barrier, where present. For a complete description of sampling locations, see Appendix A. Water temperature, conductivity and discharge were measured at each site.

Effort was concentrated on areas of the stream most likely to hold fish such as deep pools and cover. Little sampling effort was spent in areas such as shallow runs. Fish were measured to the nearest millimeter and examined for sex by the expression of gametes and spawning condition. Scale samples were collected for age determination and adipose fins removed for genetic analysis and for marking purposes. The number of fish captured was standardized for on-time effort to allow direct comparison among streams and between 1997 and 2002.

Population estimates for streams were made based on the modified Schnabel mark-recapture method where sample sizes where large enough (Ricker 1975). Estimates of the upper and lower 95% confidence intervals were made based on a Poisson distribution around the population estimate. An important assumption that could not be met in the mark-recapture method was that there was no migration into and out of the study reaches by brook trout.

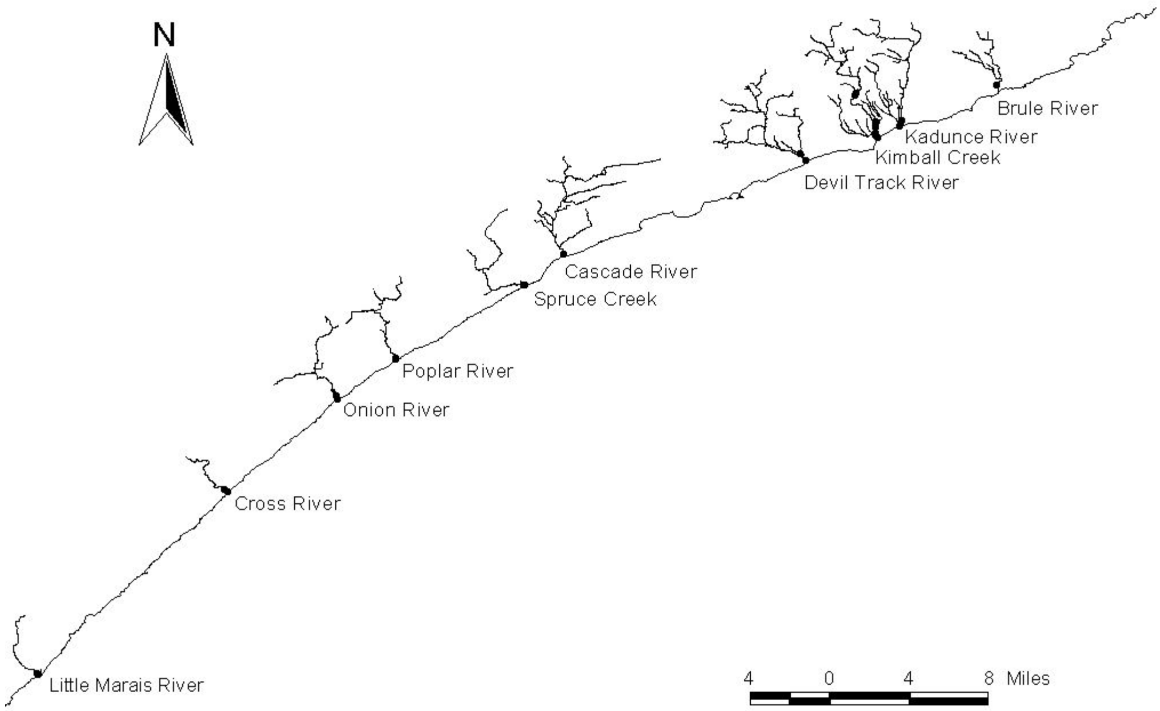

Figure 1. Minnesota-Lake Superior tributaries sampled during fall brook trout population assessment, 2002.

Results

Temperature varied from 32.5 F ^{o} to 43.0 F ^{o} (Table 1). Discharge varied from 1.7 cm^3/s to 43.3 cm^3/s. Conductivity varied from 60.1 µS to 91.4 µS.

Table 1. Mean stream temperature, discharge and conductivity from Minnesota-Lake Superior tributary streams, Fall 2002.

Stream	Temperature. (F^o)	Discharge (cm^3/s)	Conductivity (µS)
Brule	35.0	----	60.1
Cascade	36.0	36.3	75.5
Cross	37.7	18.8	71.0
Devil Track	32.5	27.6	70.7
Kadunce	38.5	2.5	91.4
Kimball	39.8	2.4	91.0
Little Marais	43.0	1.7	----
Onion	37.5	1.5	66.2
Poplar	36.3	43.3	78.3
Spruce	37.0	3.0	68.5

**Means are represented when multiple passes were performed

Sampling occurred from October 7 to October 30, 2002 and included 25 electrofishing passes with a total on-time effort of 468 minutes (Table 2). The mean on-time effort per electrofishing pass was 19 minutes. A total of 104 brook trout were caught during the sampling period. In streams where multiple passes were done, 22 fish were recaptured. Some of these fish may have been recaptured more than once so the actual number recaptured may be fewer than 22. Although sample sizes in individual streams were fairly small (<5 fish), three of the ten streams sampled, Kadunce and Kimball creeks and Onion River, had large enough sample sizes to discuss brook trout population structure on an individual stream basis.

Table 2. Mean catch, effort and fish size estimates for Fall 2002 brook trout (BKT) sampling.

Stream	No. of Passes	Total Effort (min)	Mean Effort (min)	Total BKT Caught	Mean BKT Caught/Pass	Mean Length of BKT (in)	Min.and Max. Length of BKT (in)
Overall	25	468	19	104	4.2	6.8	(2.6,14.1)
Brule	1	5	----	0	0	0.0	----
Cascade	1	6	----	1	1.0	----	----
Cross	3	84	28	4	1.3	7.1	(6.4,7.6)
Devil Track	2	85	43	3	1.5	8.7	(8.0,9.8)
Kadunce	4	68	17	13	3.3	7.8	(2.7,14.1)
Kimball	5	60	12	45	9.0	5.4	(2.6,9.0)
Little Marais	1	14	----	1	1.0	----	----
Onion	4	91	23	33	8.3	6.8	(2.8,10.9)
Poplar	3	47	16	2	0.7	11.9	(9.9,13.9)
Spruce	1	8	----	2	2.0	7.1	(6.4,7.7)

The mean length of all brook trout caught was 6.8 inches (Table 2). The smallest fish captured was 2.6 inches and the largest fish captured was 14.1 inches. Fifty-percent of the fish captured were between 5.5 inches and 8 inches (Figure 2). Length frequencies of fish caught in Kimball Creek, Onion River and Kadunce Creek are given in Figures 3-5.

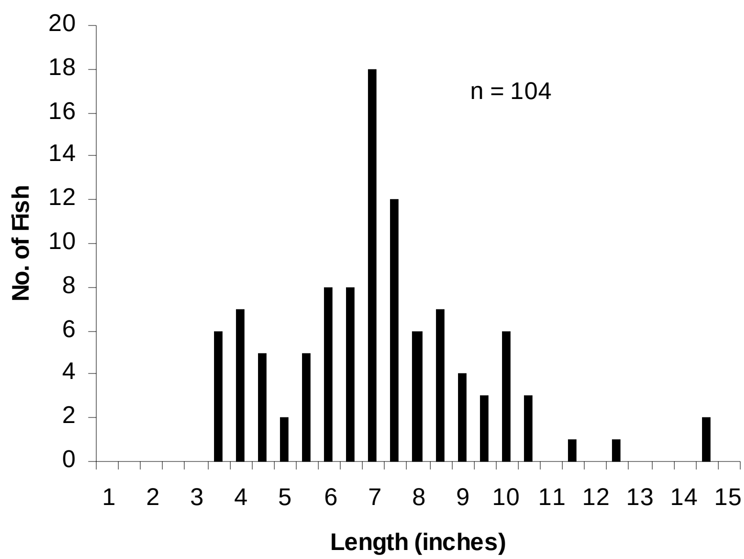

Figure 2. Length frequency of brook trout captured in Minnesota-Lake Superior tributaries, Fall 2002.

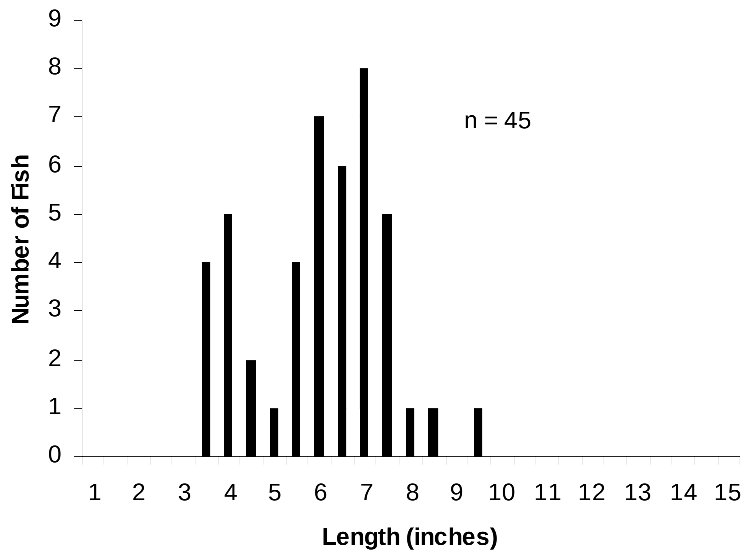

Figure 3. Length frequency of brook trout captured in Kimball Creek, Minnesota, Fall 2002.

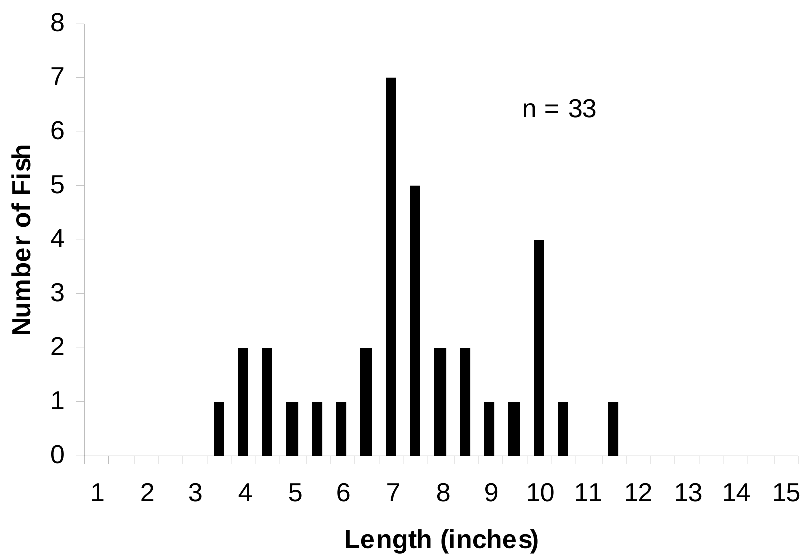

Figure 4. Length frequency of brook trout captured in Onion River, Minnesota, Fall 2002.

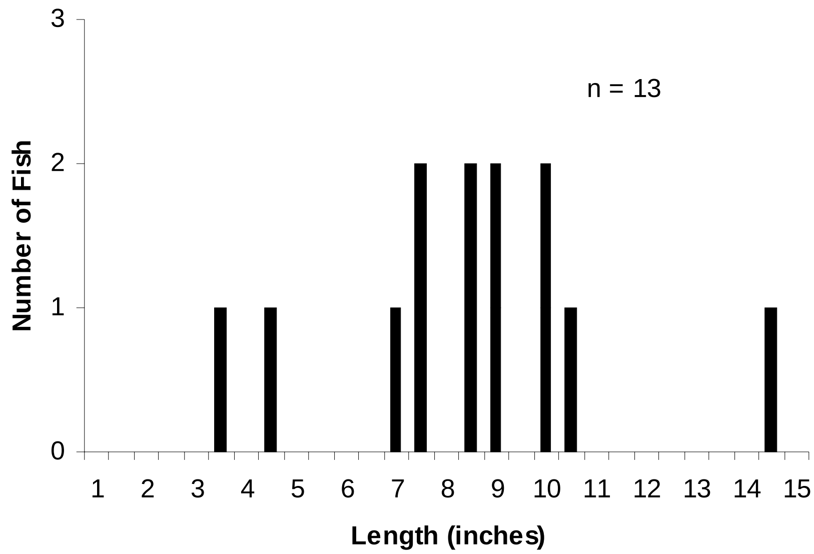

Figure 5. Length frequency of brook trout captured in Kadunce River, Minnesota, Fall 2002.

Scale samples from 103 brook trout were examined to determine overall age structure of the sample population. Young-of-the-year fish made up approximately 28% of the sample population (Figure 6). Age 1 and age 2 fish made up approximately 56% and 15%, respectively. One age 3 fish was caught during the sampling period and no fish older than age 3 were captured. Age-length frequencies for Kimball Creek, Onion River and Kandunce Creek can be found in Figures 7-9.

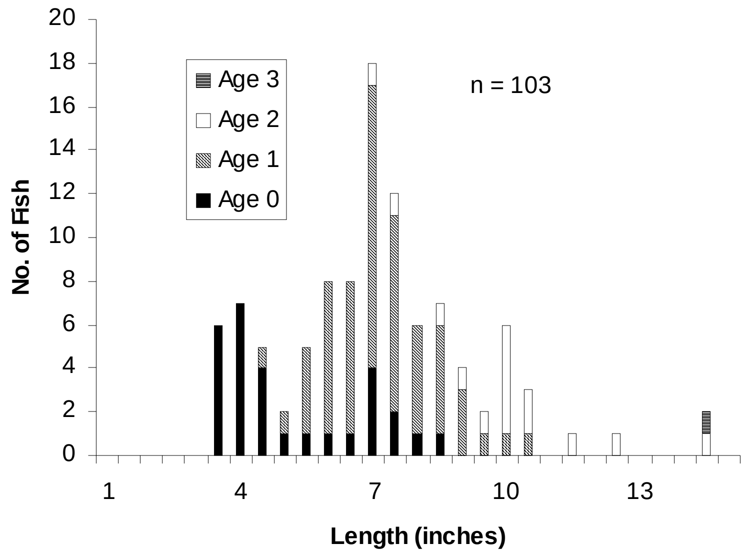

Figure 6. Age-length frequency of brook trout captured in Minnesota-Lake Superior tributaries, Fall 2002.

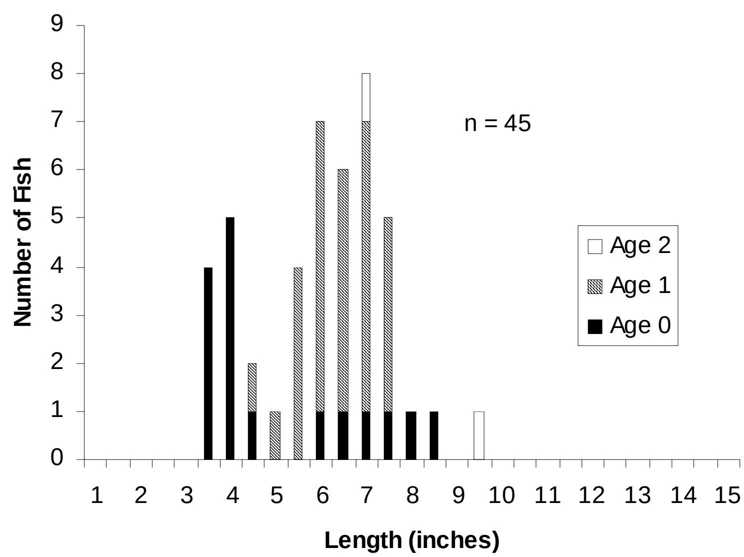

Figure 7. Age-length frequency of brook trout captured in Kimball Creek, Minnesota, Fall 2002.

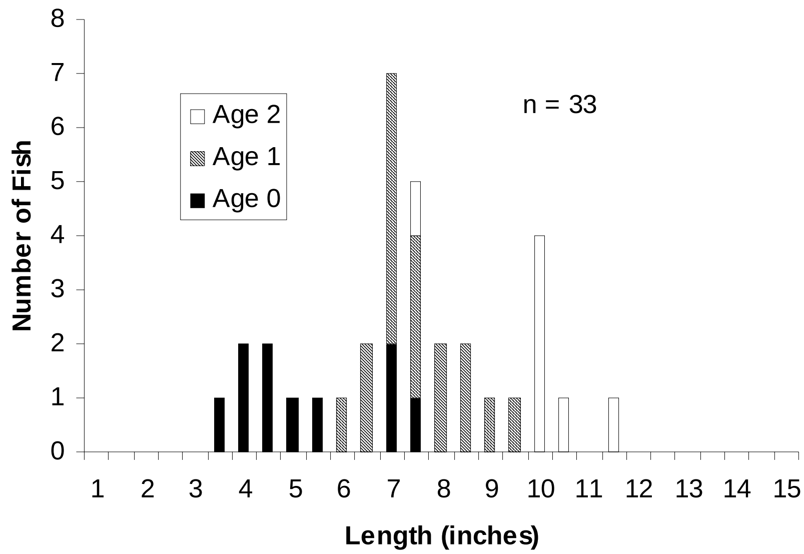

Figure 8. Age-length frequency of brook trout captured in Onion River, Minnesota, Fall 2002.

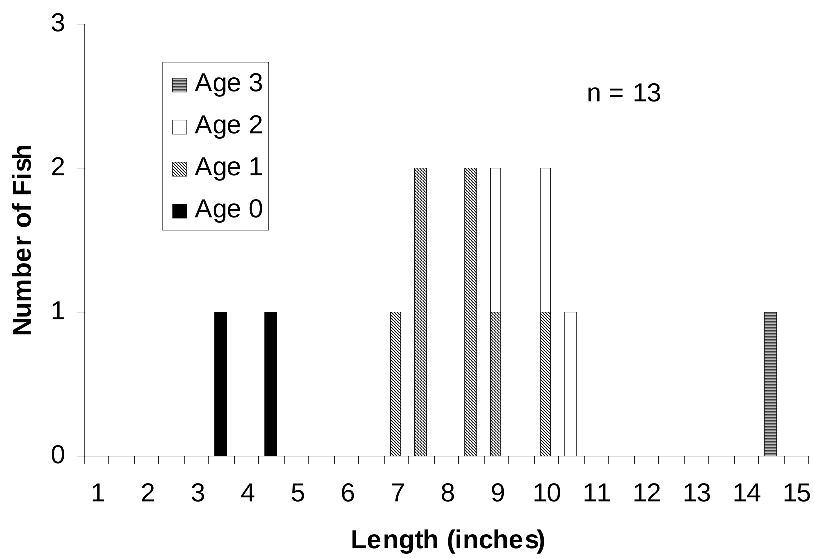

Figure 9. Age-length frequency of brook trout captured in Kadunce River, Minnesota, Fall 2002.

Population estimates were made based on the modified Schnabel method for streams where a large enough sample size was collected during the sampling period and multiple electrofishing passes were made. Estimates of population sizes for both Kadunce Creek and Onion River were 13 fish and 46 fish, respectively (Table 3). In 1997, the population estimate using the Schnabel method was 174 fish for Kadunce Creek and 108 fish for Onion River (Tilma et al. 1999).

Table 3. Population estimates based on modified Schnabel method.

Stream	Lower 95% C.I.	Population Estimate	Upper 95% C.I.
Kadunce	7	13	22
Onion	37	46	61

Of the 46 fish for which sex was determined, 27 were males and 19 were females (Figure 10). Of the females captured, four were green, ten were ripe and five were spent.

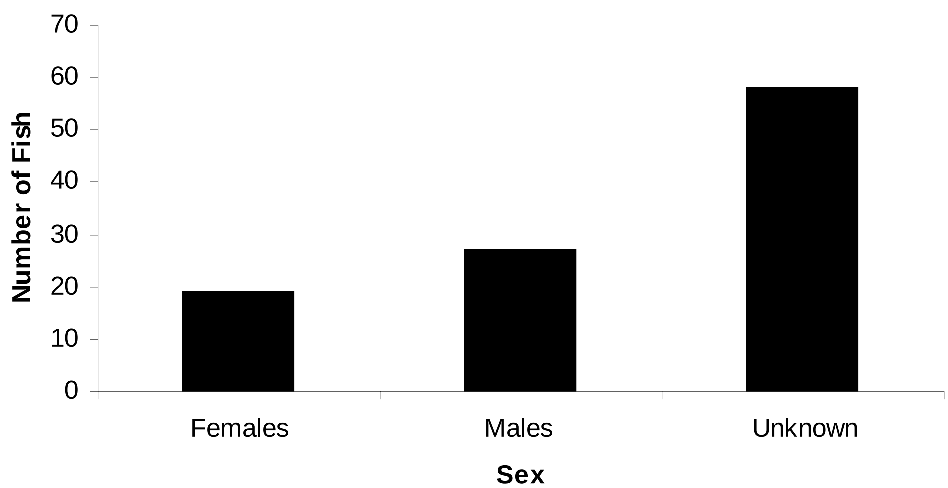

Figure 10. Sex structure of brook trout caught in Minnesota-Lake Superior tributaries during Fall 2002 population assessment.

Discussion

Fewer streams were sampled with less effort and fewer brook trout were caught than in a previous study. In 1997, 324 brook trout were caught in 22 streams during1321 minutes of effort. The catches per unit effort were similar between years, 0.25 fish/minute in 1997 and 0.22 fish/minute in 2002.

Table 4. Effort, sample size and sampled population age structure for 1997 and 2002 brook trout population assessment. Selected streams from both time periods are listed below.

	Overall		Kandunce		Kimball		Onion	
	1997	2002	1997	2002	1997	2002	1997	2002
Total Effort (min)	1321	468	30	68	54	60	23	91
No. of Streams	22	10	----	----	----	----	----	----
No. of Passes	44	25	2	4	2	5	3	4
No. of BKT Caught	324	104	54	13	32	45	66	33
No. of BKT Aged	287	103	51	13	32	45	44	33
Percent-at-Age								
Age 0	32	28	75	15	75	36	34	29
Age 1	51	56	15	54	22	60	64	50
Age 2	16	15	8	23	3	4	2	21
Age 3	1	1	2	8	0	0	0	0

It appears that the regulations limiting the harvest of brook trout below barriers in tributaries has had limited impact on the size and age structure of North Shore brook trout populations. The overall size structure found among streams from Fall 2002 sampling is similar to that observed by Tilma et al. (1999) (Figure 11). The majority of the fish from both years were within the 5.5-inch to 8-inch range. In both studies, very few fish greater than 12 inches were recorded. Abundances of larger fish should increase if regulations are successful. Comparing 2002 to 1997, Kimball Creek, Onion River and Kadunce

Creek appeared to have a larger proportion of the sampled population in larger size classes (Figure 12-14). Sample sizes are likely too small to discern any real temporal pattern (Table 4).

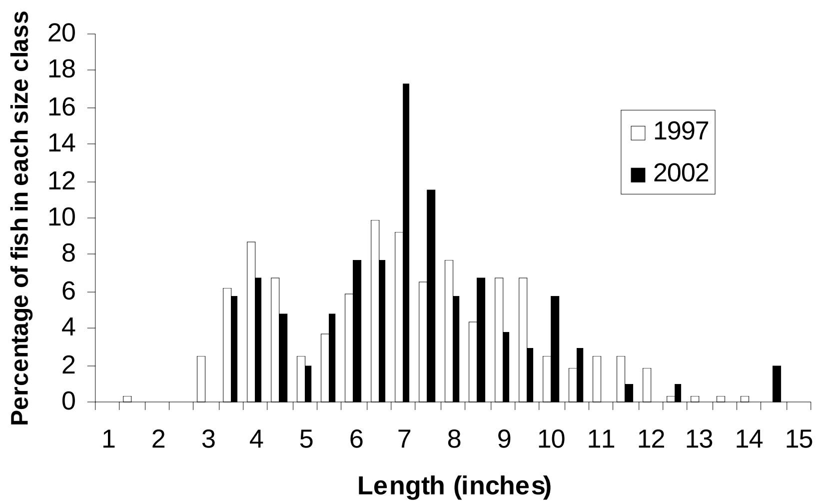

Figure 11. Comparison of size structure between 1997 and 2002 brook trout population assessments in Minnesota-Lake Superior tributaries.

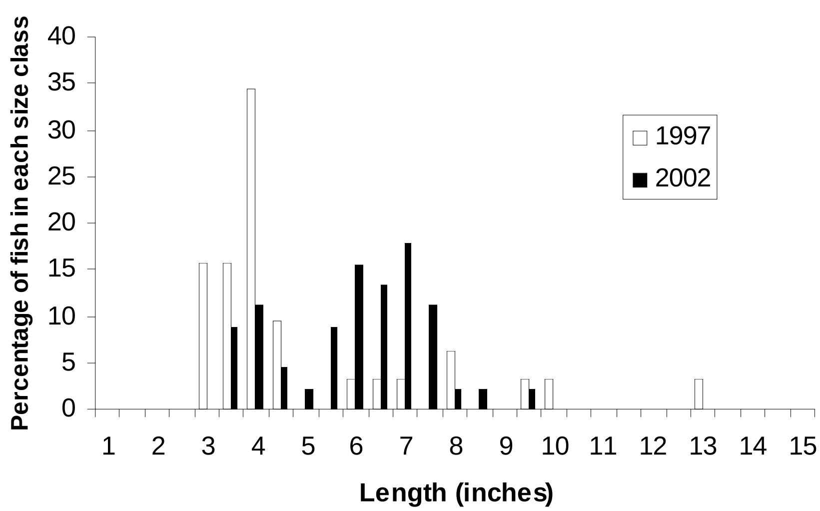

Figure 12. Comparison of size structure between 1997 and 2002 brook trout population assessments in Kimball Creek, Minnesota

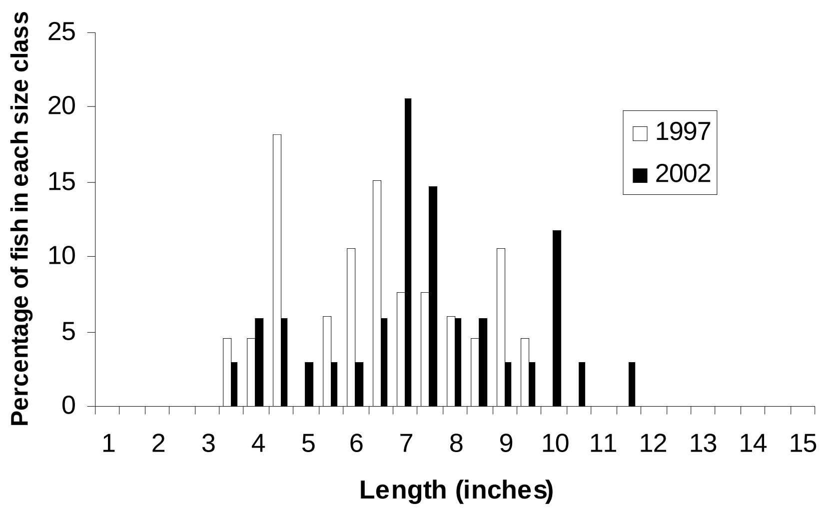

Figure 13. Comparison of size structure between 1997 and 2002 brook trout population assessments in Onion River, Minnesota

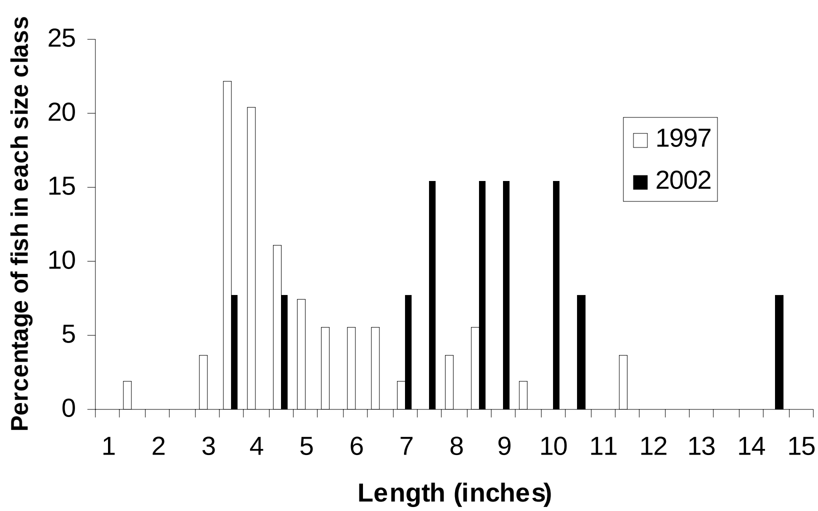

Figure 14. Comparison of size structure between 1997 and 2002 brook trout population assessments in Kadunce Creek, Minnesota.

The age structure found in 2002 is also similar to the age structure in 1997 (Figure 15). Most streams are dominated by age 0 and age 1 fish. Very few fish older than age 2 were found. However, minor differences in age structure can be detected in individual streams. Between 1997 and 2002, the age structure in Kadunce Creek, Kimball Creek and Onion River shifted from primarily age 0 fish to a greater proportion of age 1 and age 2 year classes (Table 4). Sampling occurred in both studies during the fall period when older, larger adults return to streams to spawn.

Population estimates in 2002 for both Kadunce Creek and Onion River were smaller than the estimates in 1997. Caution is urged when considering these estimates in both years because the sampling frequency used may not be appropriate for below barrier brook trout populations. Fish may be moving in and out of streams on a daily basis, which would directly influence population estimates. Increasing the number of times a stream is sampled and decreasing the time between sampling periods may strengthen the ability to accurately predict true population size.

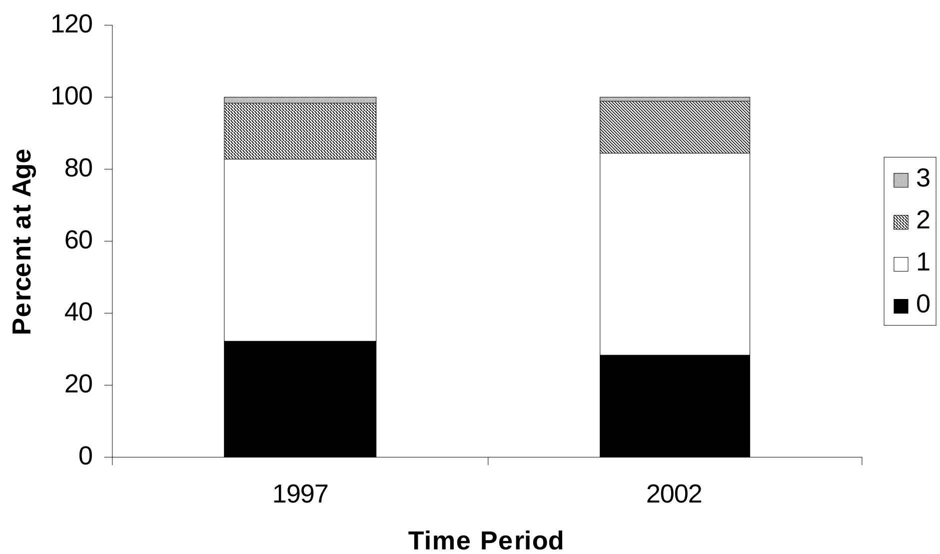

Figure 15. Comparison of sampled population age structure between 1997 and 2002 brook trout population assessments in Minnesota-Lake Superior tributaries.

Abundance of larger fish present in the stream may be underestimated due to inefficiency in sampling deep pool habitats. In 2002, two large, (>10 inches), brook trout were caught in the Poplar River and an additional large brook trout escaped capture. One large individual was caught in Kadunce Creek and one larger individual was found dead in the Cascade River with a hook in its gullet. Trap nets may be worth examining as an alternate means of assessment in the future.

Small sample sizes, variation among years, and difficulty in sampling large brook trout may contribute to the difficulty in detecting large differences between pre- and post-regulation periods. Future consideration may be given to sampling selected streams to understand the variation in size and age structure both within and between years.

Incidental hooking mortality associated with small concentrated populations of an aggressive species such as brook trout and noncompliance with the regulations may limit coaster brook trout recovery. Anglers were observed at the Poplar River on two occasions after the season had closed and we know from anecdotal information that significant fall fishing pressure can occur. Compliance is necessary for regulations to be effective. Increased time and resources may need to be devoted in the future to public education such as additional stream sign postings and handouts at licensing centers and tourist information sites describing the importance of complying with brook trout regulations.

Acknowledgements

We thank Matt Kocian and Phil Kunze for their assistance with several aspects of this study.

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Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of Fisheries Research Board of Canada 191.

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Appendix A. Study site descriptions.

Stream	Site Description
Brule	From mouth to falls.
Cascade	From bridge on Hwy 61 to barrier falls.
Cross	From mouth to first bridge. Accessed from Father Baragas Cross parking lot.
Devil Track	From mouth to approximately 0.5 mile upstream. Accessed from north side of Hwy. 61.
Kadunce	From mouth to deep mouth before first barrier.
Kimball	Accessed from Co. Rd 12. No significant barrier to fish migration upstream.
Little Marais	From mouth to first barrier. Accessed granted by private landowner
Onion	From mouth to falls.
Poplar	From mouth to barrier. Accessed from Lutsen Resort
Spruce	From mouth to falls.

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