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THE 2013 WINTER TROUT FISHERY ON SOUTHEAST MINNESOTA STREAMS[1]

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Abstract. – The Minnesota Department of Natural Resources has allowed a winter fishery on selected trout streams in southeast Minnesota since 1988 and has monitored angler use with periodic creel surveys. The number of stream miles open to winter anglers has been incrementally increased five times since its inception, in part to alleviate initial concerns with angler crowding and secondarily to increase angler participation. In an effort to continue monitoring angler participation and stream use trends we conducted a winter creel survey in 2013. We specifically sought to determine current and temporal changes in angler characteristics, stream selection, angler satisfaction, angler pressure, catch rates, and catch. Anglers were contacted with a letter survey either left on cars during a roving survey or picked up at state parks. Winter anglers were mostly Minnesota resident (95%) male anglers (98%) that used fly fishing gear (76%) and originated from either southeast Minnesota or the Twin Cities Metropolitan area. These characteristics have remained essentially unchanged, other than aging of a core group of anglers, since the winter fishery opened in 1988. Winter angling was mostly a solitary activity in 2013 and anglers spent an average of 3.8 hours fishing each trip. Most anglers fished a small group of streams that included several branches of the Whitewater River (e.g., Middle Branch, South Branch and North Branch), Hay Creek and the South Branch Root River. Fly anglers tended to be more specialized toward these streams than lure anglers who fished a broader range of streams. Easy access, favorite stream, and proximity were the most common reasons why anglers fished a particular stream. Angler satisfaction appeared to be high as about 87% of all anglers were either satisfied or very satisfied with their winter angling experience. Trout catch rate was significantly associated with angler satisfaction but only explained at most, 19% of the variation in satisfaction scores. Anglers that caught more than 2.0 trout/hour were never dissatisfied with their angling experience. Angling pressure on all streams was estimated to be 13,603 (± 53) angler-hours during 2013, a decline from the 15,941 angler-hours estimated in 2002 when fewer streams were available to winter anglers. Pressure estimates in 2013 declined on all streams open to angling in 2002 except two, the Middle Branch Whitewater River and the Main Branch Whitewater River. Eleven streams newly opened in 2003 had zero anglers observed fishing them. Taken together, these results suggest that overall angler participation did not increase with the expansion of streams open to winter fishing and instead suggest a slight re-distribution of anglers to a small number of open streams. However, weather conditions in 2013 were harsher than in 2002 and might explain some of the discrepancy. Overall, winter anglers made about 3,580 angling trips, caught about 1.38 trout/hour, and caught a total of 5,978 trout in 2013.

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INTRODUCTION

Fluctuating fishing license and stamp sales can make it challenging for natural resource management agencies to successfully accomplish their mission and goals to maintain and improve recreational fisheries. To reverse declining trends or to make such sales more consistent, it is imperative for management agencies to understand their constituency and factors contributing to their satisfaction. It is also important to understand factors constraining participation by others not engaged in natural-resource based recreation (Ritter et al. 1992). Numerous constraints have been suggested to influence angler participation. One constraint often cited is a lack of angling opportunities or access (Shelby et al. 1989; Sutton 2007; Schroeder et al. 2008).

Southeast Minnesota supports an important trout fishery on 147 streams representing over 800 miles (1,280 km) of coldwater habitat. Statewide trout stamp sales, that partially support this fishery, have been variable and declining over the past decade. For example, trout stamp sales between 2000 and 2012 have ranged from a high of 97,449 in 2001 to a low of 80,484 in 2011 (MN DNR License Center data). Overall, trout stamp sales have declined at an average annual rate of 1.22% from 2000 to 2012. This suggests a continuing need to gather information describing the current angling constituency and factors influencing their satisfaction as well as trying different management approaches to attract new, while still maintaining, current anglers.

The trout fishery in southeast Minnesota encompasses four seasons: a winter catch-and-release season on selected streams, an early spring catch-and-release season on all streams, a summer season (harvest allowed with the exception of a few selected streams) and an early fall catch-and-release season (all streams) (Table 1). To increase angling opportunities and improve angler satisfaction, stream miles open to winter angling have been expanded four times since 1988 (Table 2). A winter creel survey was conducted in 2002, prior to the latest season expansion in 2003, to quantify demographics of winter anglers and to provide baseline estimates of angler pressure that could be used for future comparisons (Nelson 2002). Angler pressure across all 12 streams open to winter angling in 2002 (48.2 total miles) was estimated to be 15,941 angler-hours. In 2003, winter angling opportunities were expanded to portions of an additional 20 streams (131.6 total miles) (Table 2).

The Minnesota Department of Natural Resources (MN DNR) Lanesboro and Lake City Fisheries offices received numerous comments from trout anglers regarding an interest in again increasing winter trout angling opportunities in southeast Minnesota (Houston, Fillmore, Mower, Dodge, Olmsted, Winona, Wabasha and Goodhue counties). Consequently, MN DNR Fisheries managers developed a proposal to change and improve trout stream regulations that included the opening of all designated trout streams in southeast Minnesota to winter trout angling. Fisheries managers would like to determine if the expansion of winter angling opportunities increases participation (i.e., increases total angler hours; possibly due to attraction of new anglers), or if it simply re-distributes the current angling clientele. A re-distribution of current anglers would be suggested by a similar amount of angler-hours expended, but with increasing hours spent on newly opened streams. Managers would also like to determine if demographic characteristics of winter anglers are changing as well as their overall satisfaction and factors influencing satisfaction. Thus, the objectives of this creel were to determine (1) current and temporal changes in angler characteristics, (2) stream selection patterns and reasons for stream selection, (3) angler satisfaction and factors associated with satisfaction, and (4) provide current estimates of angler pressure, catch, and catch rates and compare to previous winter creel surveys (e.g., Nelson 2002). Objective 4 will help determine whether overall angler participation has increased or simply re-distributed following previous expansions of winter angling opportunities.

TABLE 1. Trout angling seasons and restrictions in southeast Minnesota (Houston, Fillmore, Mower, Dodge, Olmsted, Winona, Wabasha, and Goodhue counties) during January 1 to December 31, 2013.

Season	Dates (2013 Example)
Winter trout stream angling, barbless hooks only	January 1 to March 31
Trout catch-and-release, barbless hooks only	April 1 to April 12
Trout angling (multiple gear and harvest regulations)	April 13 to September 14
Trout catch-and-release, barbless hooks only	September 15 to September 30
Trout angling closed	October 1 to December 31

TABLE 2. History of the number of stream miles open to winter trout angling in southeast Minnesota. All winter trout seasons were from January 1 to March 31.

Stream name	Kittle Number	1988-1990	1991-Feb. 1997	Mar. 1997-1998	1999-2002	2003-2013
Whitewater River, Middle Branch	M-031-019	2.9	2.9	4.2	4.2	13.0
Whitewater River, South Branch	M-031-017	1.9	1.9	3.8	3.8	3.8
Beaver Creek (Whitewater)	M-031-006		3.9	6.3	6.3	6.5
Hay Creek	M-046		3.9	4.2	4.2	10.2
Whitewater River, Main	M-031			6.9	6.9	13.3
Whitewater River, North Branch	M-031-018			2.2	2.2	8.4
East Beaver Creek	M-009-010-003-008				2.4	2.4
Camp Creek	M-009-025-003				3.5	3.5
Duschee Creek	M-009-025-001				5.3	5.3
Root River, South Br. (Lanesboro)	M-009-025				3.0	2.8
Root River, South Br. (Forestville)	M-009-025				3.8	2.9
Forestville Creek	M-009-025-009				1.0	2.6
Canfield Creek	M-009-025-010				1.6	1.6
Root River, South Fork	M-009-010					7.4
Crooked Creek	M-004					6.4
Pine Creek	M-009-017-005					5.8
Rush Creek	M-009-017					4.6
Diamond Creek	M-009-023					4.4
Wisel Creek	M-009-010-010					4.0
Gribben Creek	M-009-024					3.5
Money Creek, West Branch	M-009-011-008					3.1
Daley Creek	M-009-012					2.4
West Beaver Creek	M-009-010-003-009					2.0
Torkelson Creek	M-009-026					1.9
Bee Creek	I-006					1.6
Garvin Brook	M-026-001					1.4
Trout Valley Creek	M-031-001					1.3
Trout Run Creek (Whitewater)	M-031-019-002					1.3
Ferguson Creek	M-009-017-012					1.3
Crooked Creek, South Fork	M-004-009					1.1
Swede Bottom Creek	M-009-010-001					0.8
Hemmingway Creek	M-009-017-005-006					0.8
Coolridge Creek	M-009-017-005-005					0.2
Total		4.8	12.6	27.6	48.2	131.6

METHODS

Survey design.—To gather information on angler characteristics, satisfaction, angling pressure and catch rates, we intercepted anglers using a roving-roving survey design with progressive counts following methods in Pollock et al. (1994) and similar to counts used in Nelson (2002). Anglers supplied information on letter surveys that were left on parked cars or given directly to anglers observed fishing. The winter angling season (January 1 to March 31, 2013) across all 32 streams was stratified into three stream areas (Areas A, B, C; Figure 1) and seven biweekly strata, with each biweekly time period further stratified by day type (weekday vs. weekend/holiday).

Each of the three stream areas represented a group of streams that could be surveyed in one day by a single creel clerk. Financial resources allowed the hiring of two creel clerks. The survey schedule was designed for one clerk to conduct one progressive count through an entire stream area in a single day. Based on angler pressure estimates in previous creel surveys, one clerk was assigned to sample stream Areas A and B while the second clerk sampled Area C exclusively. Within each stream area, streams (and sites along each stream; Appendix A) were identified and surveyed along a route. All angler access sites were on lands accessible to the general public such as state angling easements and state parks. The sequence of sample sites within Areas A and B was alternated by either starting at one end of the route (head end) or the other end of the route (tail end). Sites within Area C were also surveyed along a route, but the starting point alternated between random selections of the three watersheds (Garvin Brook, Hay Creek and Whitewater). Checkpoint times were established for each site to ensure clerks stayed on a schedule to minimize length-of-stay biases inherent in roving creel surveys (Pollock et al. 1994).

In each biweekly strata, all weekend/holidays and three randomly selected weekdays within each 5-day work week were sampled. There were three holidays during this survey (January 1 – New Years, January 21 – Martin Luther King Jr. Day and February 18 – President's Day). Two of these holidays were on a Monday, so one weekday was removed from those weeks. For Areas A and B (clerk #1), selection for areas and routes were completed for weekday and weekend/holiday strata separately. Area selection was random without replacement (A and B each received 50% of sampling). Route selection was random with replacement (head end or tail end). For Area C (clerk #2), route selection was completed for weekday and weekend/holiday strata separately. Area C received 100% of the sampling effort from clerk #2. Route selection was random with replacement. Thus, the sample schedule was developed by randomizing the specific area to survey (only for Areas A and B; Area C was always sampled), followed by the day of the survey and then the starting location. This design targeted a sample size of 5-13 angler counts per month per stream area for weekdays and 4-10 counts per month per stream area for weekends and holidays (Table 3). These represent samples for 45 to 100% of the days available in each stratum.

TABLE 3. Total number of days available (number sampled), by month and stream area strata, southeast Minnesota winter trout stream creel survey, January 1 to March 31, 2013.

		Month		
Days	Total	January	February	March
Total number of days	90 (65)	31 (22)	28 (20)	31 (23)
Number of week days	61 (36)	21 (12)	19 (11)	21 (13)
Number of weekend/holidays	29 (29)	10 (10)	9 (9)	10 (10)
		Stream Area		
	Total	A	B	C
Total number of days	90 (65)	90 (32)	90 (33)	90 (65)
Number of week days	61 (36)	61 (17)	61 (19)	61 (36)
Number of weekend/holidays	29 (29)	29 (15)	29 (14)	29 (29)

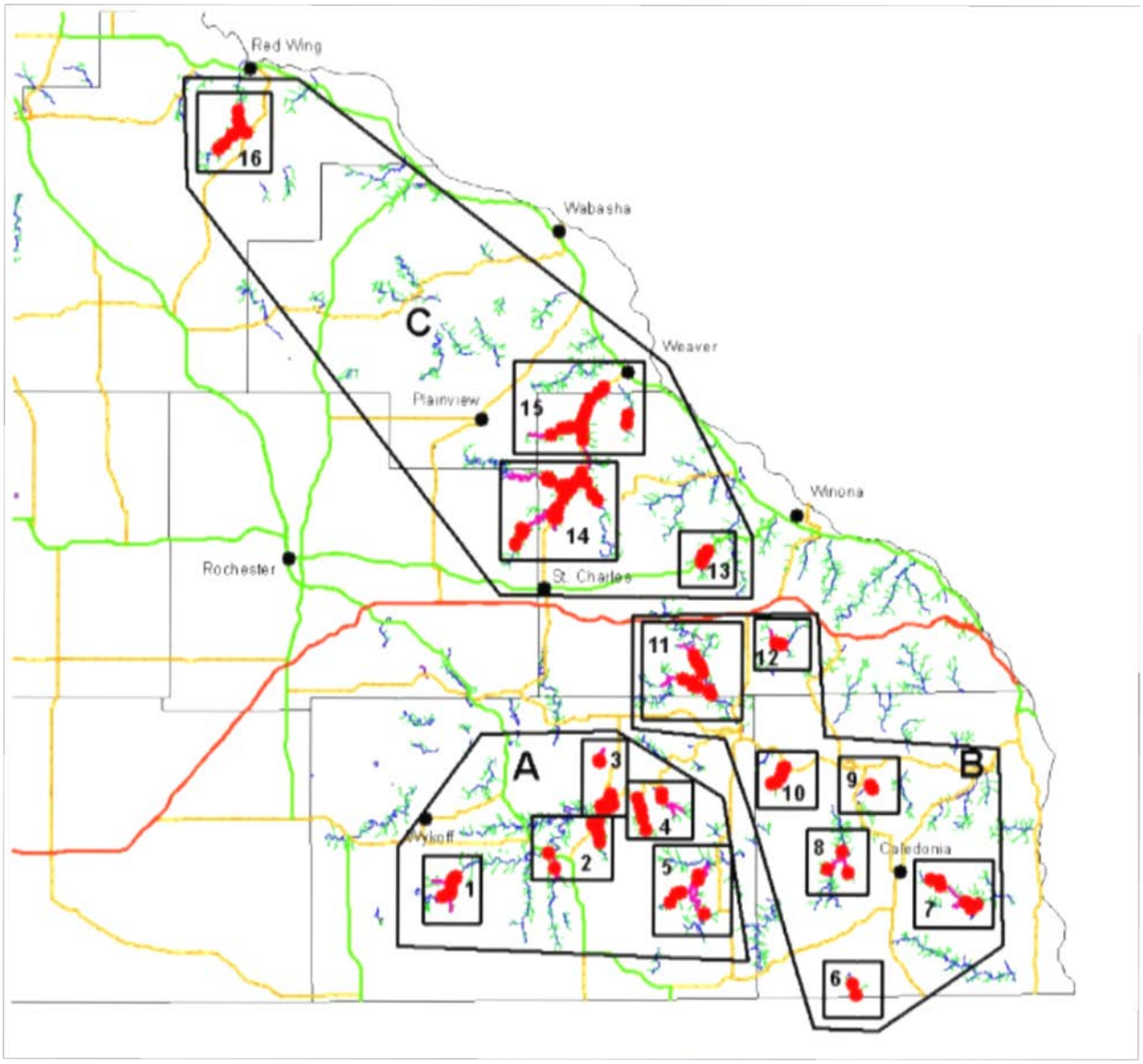

FIGURE 1. Map of stream areas (A, B, and C) surveyed in the winter trout stream creel January 1 to March 31, 2013 in southeast Minnesota. The number within each block of streams facilitated survey routes for creel clerks. 1) Forestville Creek, Canfield Creek, South Branch Root River; 2) Duschee Creek, Camp Creek; 3) South Branch Root River, Torkelson Creek; 4) Gribben Creek, Diamond Creek; 5) Wisel Creek, South Fork Root River; 6) Bee Creek; 7) Crooked Creek, South Fork Crooked Creek; 8) East Beaver Creek, West Beaver Creek; 9) Swede Bottom Creek; 10) Daley Creek; 11) Rush Creek, Pine Creek, Hemmingway Creek, Coolridge Creek; 12) West Branch Money Creek; 13) Garvin Brook; 14) Middle Branch Whitewater River, South Branch Whitewater River, North Branch Whitewater River; 15) Main Whitewater River, Beaver Creek (Whitewater), Trout Valley Creek; 16) Hay Creek.

Upon arriving at each stream site, clerks recorded their arrival time, air temperature and weather conditions and counted the number of parked cars and visible anglers seen. Any anglers or cars encountered at these sites received a letter survey (Appendix B) and a prepaid envelope allowing the owner of the car to fill out the survey and mail it to us. Each letter survey was marked with the stream location where it was left to determine return rates by stream. The clerk then recorded the number of surveys left (i.e., car counts). Car counts were assumed to be instantaneous counts. The letter survey (Appendix B) included questions to determine (1) the proportion of cars counted that were anglers; (2) the mean number of anglers per car; (3) the mean fishing trip length; (4) the home location of anglers; (5) angler age and gender; (6) reason for angling at that location; (7) gear type; (8) satisfaction; and (9) the numbers and sizes of fishes caught. The latter was used to estimate angler catch rates. Catch rates were only estimated from anglers fishing longer than one hour to ensure variance estimators were not influenced by extreme catches from short angling trips (Pollock et al. 1994). To secure additional information on angler characteristics, letter surveys were also left at the front counter of three state parks (Whitewater State Park, Forestville State Park and Beaver Creek Valley State Park). The parks survey included a short letter explaining to anglers that they should complete any letter surveys left on their cars that day instead of the parks survey they just received.

Analysis.—Angler characteristics examined included: sex, age, state and city of origin, distance driven, gear type used, party size and trip length. Information on sex, age, state and city of origin, distance driven, gear type used, party size and trip length were then summarized from returned letter surveys and qualitatively compared with similar information from previous winter creel surveys in southeast Minnesota.

Stream selection was assessed with three indices and a question to determine more specifically, why anglers fished each stream on the day they were observed. To describe stream selection patterns we applied three common ecological indices to angler use data: resource electivity, resource breadth, and resource overlap; and specifically examined differences between the two primary gear types used during winter: flies and lures. We used Manly's alpha (Manly et al. 1972; Chesson 1978) to determine resource electivity (i.e., selection or avoidance) for each stream for all anglers overall and specifically for fly and lure anglers independently. Manly's alpha is calculated as:

$$\alpha_i = r_i/n_i \, (1/\sum r_1/n_i)$$

where α_i is Manly's alpha for each stream, r_i is the proportion of angler use for stream i, and n_i is the proportion of use available to anglers to fish for each stream. Proportion of use available to anglers varied among streams because many streams had more than one access point. For example, anglers could have accessed the South Branch Root River at up to 16 different locations whereas they could only access Coolridge Creek at one location. Thus, to determine availability we multiplied the number of access points at each stream times the number of days that stream was actually visited by a creel clerk. Angler use of each stream was the sum of all anglers using each stream as reported on letter surveys. Values of $\alpha > 1/m$, where m is the total number of streams available (31), suggest selection for a stream. Values where $\alpha = 1/m$ indicate neutral selection, and values $< 1/m$ suggest a stream was avoided. This index provides a complementary assessment of angler use of streams independent of just angling pressure, because it also incorporates the availability of each stream to angling.

To assess resource breadth we used Levins' measure of niche breadth (Levins 1968) for fly and lure anglers independently. Levins' measure (B) is calculated as:

$$B = 1/\sum p_j^2$$

where p_j is the proportion of angler days spent on each stream j. Levins' index was standardized (B_A) to a 0 to 1 scale using the modification suggested by Hurlbert (1978):

$$B_A = B - 1/n - 1$$

where n is the number of possible streams open to winter angling (31). A B_A value of zero indicates complete specialization on a single stream, whereas a value of one indicates equal use of all streams available.

To assess stream resource overlap between fly and lure anglers, we used Schoener's percentage overlap index (Renkonen 1938; Schoener 1970). This index is calculated as:

$$P_{jk} = [\sum(\text{minimum } p_{ij}, p_{ik})]100$$

where p_{ij} is the proportion of angler days spent on stream *i* by angler group *j* (i.e., fly anglers), p_{ik} is the proportion of angler days spent on stream *i* by angler group *k* (lure anglers). In the ecological literature, overlap values > 0.60 are considered to be biologically significant.

To determine why anglers fished a stream, they were asked why they decided to fish that stream on that day. They were given five answers to choose from: favorite stream, live close by, easy access, numbers of fish, and size of fish. Although asked to only select one answer, a few anglers selected more than one response. Angler answers were then summarized and expressed as percentages overall and by gear type.

To determine satisfaction, anglers were asked three questions and given five options to answer: very satisfied, satisfied, neither, dissatisfied, or very dissatisfied. Questions concerned satisfaction with their overall fishing experience, size of trout caught, and numbers of trout caught and responses were simply summarized. To assess factors influencing satisfaction, we tested associations between satisfaction responses (scaled from 1 = very dissatisfied to 5 = very satisfied) and selected variables of trout catch rate, mean daily air temperature, and time spent angling using Pearson's correlation coefficient *r* (α = 0.05). Catch rates and time spent angling were determined from returned angler surveys. Mean daily air temperature was obtained from the nearest National Weather Service station.

Angler pressure and catch rates were analyzed following two similar methods. Method 1 explicitly followed calculations in Nelson (2002) to ensure a more appropriate comparison of angler pressure to the 2013 survey. Using the same methods and calculations between these two time periods allows the best assessment of whether overall angler pressure increased after opening more streams in 2003, or whether anglers simply re-distributed themselves among the new streams that were opened. However, the calculations in Nelson (2002) were mainly developed by Minnesota Department of Natural Resources staff for roving creel surveys of central Minnesota lakes and may not be the best representation of pressure for streams and rivers. Also, there were no calculations presented in Nelson (2002) that allowed estimates of angler catch and catch rates. Thus, we also used calculations (i.e., Method 2) following the more widely used methods in Polock et al. (1994) which also included calculations for catch and catch rate. Both methods should provide complementary estimates and should serve to cross-validate each other.

To estimate angler pressure (angler-hours) following Method 1 (see Nelson 2002 for specific formulas for angler metrics and their standard errors), we first calculated the proportion of observed cars recorded that were anglers. The proportion was calculated from returned surveys for each stream across all months and day types combined and ranged from 0.17 to 1.00. This proportion was then multiplied by the mean number of anglers per car (i.e., mean party size) to get an estimate of the mean number of anglers per day per stratum. Mean party size was estimated for each stream across all months and day types combined. Overall pressure was then calculated per stratum (i.e., per month and day type) as the product of the mean number of anglers per day times the number of days times mean day length (daylight hours). Mean day length estimates were taken from Nelson (2002) and were 10.3 hours in January, 11.5 hours in February and 12.9 hours in March. These calculations resulted in pressure estimates for each stream, month and day type combination to better test for angler re-distribution patterns, but were summed for an overall estimate of angler pressure.

Angler pressure for Method 2 was calculated independently for each of the clerk areas (A/B combined and C) and for weekdays and weekend/holiday strata and then summed for a total estimate. Daily pressure was calculated as (the number of cars determined to be anglers) ÷ (sampling probability for each stream area) x (mean party size per car) x (available daylight in each month). To determine the number of cars that were anglers, raw car counts for each creel day were corrected by the proportion of cars observed that were anglers. These proportions were again determined from returned surveys (as in Method 1) but were expressed by each stream area (Area A = 0.91, B = 0.67, C = 0.68) over the entire winter survey. The sampling probability for each stream area (Area A and B = 0.50, Area C = 1.00) was used to extrapolate the daily estimate. Mean party size in each car was determined from returned surveys for Area A/B combined (1.46 anglers/car) and Area C (1.49 anglers/car) independently. Available

daylight hours in each month were again taken from Nelson (2002). Daily estimates were simply summed for all weekend/holiday days to get a total estimate for this stratum because all were sampled. An estimate of mean daily pressure was calculated and extrapolated to all weekdays in the 2013 winter season because not all weekdays were sampled. Variance estimates followed calculation in Pollock et al. (1994) and were converted to standard errors.

Catch and catch rates were only calculated for total trout caught. To determine catch and catch rates for each day (i.e., the statistical replicates), five scenarios were addressed:

1. No surveys were left on cars because no cars were found on the route for the day (or the creel was cancelled for the day due to dangerous driving conditions).
2. Surveys were left on cars but none were returned for that day.
3. Surveys were left on cars but only some of them were returned for that day.
4. Surveys were left on cars and all were returned for that day. However only information on total trout caught was reported (i.e., no data on specific species or sizes).
5. Surveys were left on cars and all were returned for that day. Information was complete.

For scenario 1, trout catch was assumed to be zero for those days (because no one was observed fishing) and consequently, we did not use those days in the calculation of catch rate. We excluded all days in scenario 2 because we did not know if trout were caught or not on those days. For scenario 3, we estimated catch rates from available data and extrapolated that catch rate up to all anglers estimated to be fishing that day. For scenarios 4 and 5, only information regarding total trout caught was used because of limitations imposed by scenario 4 and because scenario 5 was uncommon. Daily catch was calculated for each day as the product of mean daily catch rate times the estimated number of angler hours. Total catch was then calculated as the product of the mean daily catches times the total number of days available in each stratum. All calculations, including variance and standard error estimates, followed methods in Pollock et al. (1994).

RESULTS

A total of 602 letter surveys were distributed to possible anglers and an additional 105 park surveys were picked up at Whitewater State Park (91 surveys) and Forestville State Park (14 surveys). No anglers picked up surveys at Beaver Creek Valley State Park. Overall return rate for letter surveys was 44.0%, whereas the park survey return rate was 32.7%. Questions pertaining to angler satisfaction were obtained from 252 car (n=207) and park (n=45) surveys.

Letter survey return rates varied widely among streams and sites (Table 4). There were 60 letter surveys returned from non-anglers (22% of the total returned). The proportion of cars occupied by anglers ranged from 17% (excluding all streams with no survey distribution due to never finding an angler) to 100% (Table 4).

Angler characteristics.—The winter angling constituency in 2013 has remained almost exclusively male, with ages between 1 and 83 represented. The percentage of winter anglers that was male was virtually the same in 1997 (97.3%; Hendrickson 1998) and in 2013 (97.6%). About 90% of anglers in 2013 were between 20 and 69 years old. Mean and median ages were the same at 43. The age distribution of anglers was different in 2013 as compared to the winter creel survey conducted in 1997 (Figure 2). Angler age groups under-represented in 2013, compared to 1997, were 16-44 years old whereas 45-65+ year olds were over represented. This suggests that the angling clientele in 1997 has simply shifted, or gotten older with a smaller percentage of younger anglers participating in the winter season.

Winter trout anglers came from across Minnesota and three Midwest states to fish southeast Minnesota streams during the 2013 winter season (Appendix C). Minnesota residents composed 95.2% of anglers surveyed, while Wisconsin and Iowa residents composed 2.9% and 1.3% of anglers, respectively. The farthest distance traveled by anglers surveyed was by two residents of Lincoln, Nebraska (about 425 miles one way) who reportedly fish the winter trout season in southeast Minnesota at least once each year. These numbers were very similar to previous winter surveys where Minnesota residents composed 93% of total anglers in 2002 (Nelson 2002) and 95.5% in 1997 (Hendrickson 1998). In 2002, non-resident anglers were from Wisconsin (5%), Iowa (1%) and Illinois (<1%).

TABLE 4. Survey distribution from clerks by stream and site with overall return rate, estimated percent of cars that were anglers, and mean party size for a southeast Minnesota winter trout stream creel survey, January 1 to March 31, 2013.

Stream	Surveys distributed	Surveys returned	Surveys returned that were anglers	Overall return rate (%)	Percent cars that were anglers (mean party size)
Beaver Creek (Whitewater)	13	4	2	31	50 (1.33)
Bee Creek	3	3	2	100	67 (1.50)
Camp Creek	17	8	8	47	100 (1.25)
Canfield Creek	2	1	1	50	100 (1.00)
Coolridge Creek	0	0	0	-	-
Crooked Creek	7	2	2	29	100 (2.00)
Daley Creek	2	0	0	0	0
Diamond Creek	1	0	0	0	0
Duschee Creek	7	5	5	71	100 (1.60)
East Beaver Creek	13	6	1	46	17 (1.00)
Ferguson Creek	0	0	0	-	-
Forestville Creek	1	1	0	100	0
Garvin Brook	2	2	2	100	100 (2.00)
Gribben Creek	1	0	0	0	0
Hay Creek	74	38	32	51	84 (1.34)
1. Upstream regulations	5	3	1	60	
2. Nelson HI	38	20	20	53	
3. Rebuffoni's	9	6	6	67	
4. State Trail	4	1	1	25	
5. Hay Creek (Town)	1	1	1	100	
6. Stephani's	2	1	1	50	
7. State Forest	2	1	1	50	
8. State Forest Bridge	2	0	0	0	
9. State Forest	3	2	1	67	
10. State Forest,	8	3	0	38	
Mid. Br. Whitewater River	208	105	68	51	65 (1.53)
1. County 9	12	12	12	100	
2. Round Barn	5	5	4	100	
3. Quincy Bridge	27	20	19	74	
4. Group Camp Park	12	5	3	42	
5. Hwy 74 Bridge	4	3	1	75	
6. Trout Run parking	64	21	5	33	
7. Park HQ	69	33	18	48	
8. Lazy D	8	3	3	38	
9. Elba	9	3	3	34	
N. Br. Whitewater River	68	29	26	43	90 (1.38)
1. WMA parking	30	12	10	40	
2. Fairwater Upstream	15	6	5	40	
3. Fairwater Downstream	12	3	3	25	
4. LTM	3	0	0	0	
5. Bridge	7	7	7	100	
6. Hwy 74 Bridge	1	1	1	100	
Pine Creek (M-009-017-005)	5	2	2	40	100 (2.00)
1. Pine Creek mouth	1	0	0	0	
2. Brekke's	0	0	0	-	
3. Kopperud's	0	0	0	-	
4. Jacobson's	0	0	0	-	
5. Jacobson's	1	1	1	100	
6. Anderson's	4	1	1	25	

TABLE 4. Continued.

Stream	Surveys distributed	Surveys returned	Surveys returned that were anglers	Overall return rate (%)	Percent cars that were anglers (mean party size)
Rush Creek	11	5	5	45	100 (1.40)
South Branch Root River	37	23	21	62	91 (1.42)
1. Vreeman's	0	0	0	-	
2. Loop B Park	2	1	1	50	
3. Forestville Creek mouth	2	2	1	100	
4. Forestville Creek mouth	1	0	0	0	
5. Historic Forestville	1	0	0	0	
6. Historic Forestville	5	1	0	20	
7. Lanesboro Dam	6	6	6	100	
8. Hwy 8 Bridge	1	0	0	0	
9. Lanesboro Fire Station	4	0	0	0	
10. BBQ	3	2	2	67	
11. Hwy 250 Bridge	3	3	3	100	
12. Sales Barn	0	0	0	-	
13. Hwy 16	0	0	0	-	
14. Mini-Madison	8	7	7	88	
15. Sand Beach	1	1	1	100	
16. Hwy 250 near confluence	0	0	0	-	
S. Br. Branch Whitewater River	55	23	22	42	96 (1.52)
South Fork Crooked Creek	2	0	0	0	0
South Fork Root River	8	3	3	38	100 (1.67)
1. WMA	2	0	0	0	
2. Bonfe's	0	0	0	-	
3. LTM Bridge	2	1	1	50	
4. Million Dollar Bridge	3	1	1	33	
5. Wunderlich's Slab Bridge	1	1	1	100	
Swede Bottom Creek	0	0	0	-	-
Torkelson Creek	0	0	0	-	-
Trout Valley Creek	4	2	0	50	0
West Beaver Creek	3	1	1	33	100 (2.00)
West Branch Money Creek	1	0	0	0	0
Wisel Creek	1	1	1	100	100 (3.00)
Whitewater River	56	3	3	6	100 (1.51)
1. Elba	13	2	2	15	
2. Parking lot	13	0	0	0	
3. Parking lot	5	0	0	0	
4. Canoe launch	2	0	0	0	
5. Hwy 30 Bridge	4	1	1	25	
6. Parking lot (Dns Beaver)	1	0	0	0	
7. Parking lot	7	0	0	0	
8. Parking lot	8	0	0	0	
9. Parking lot	0	0	0	-	
10. Parking lot	3	0	0	0	
Totals	602	267	207	44	78

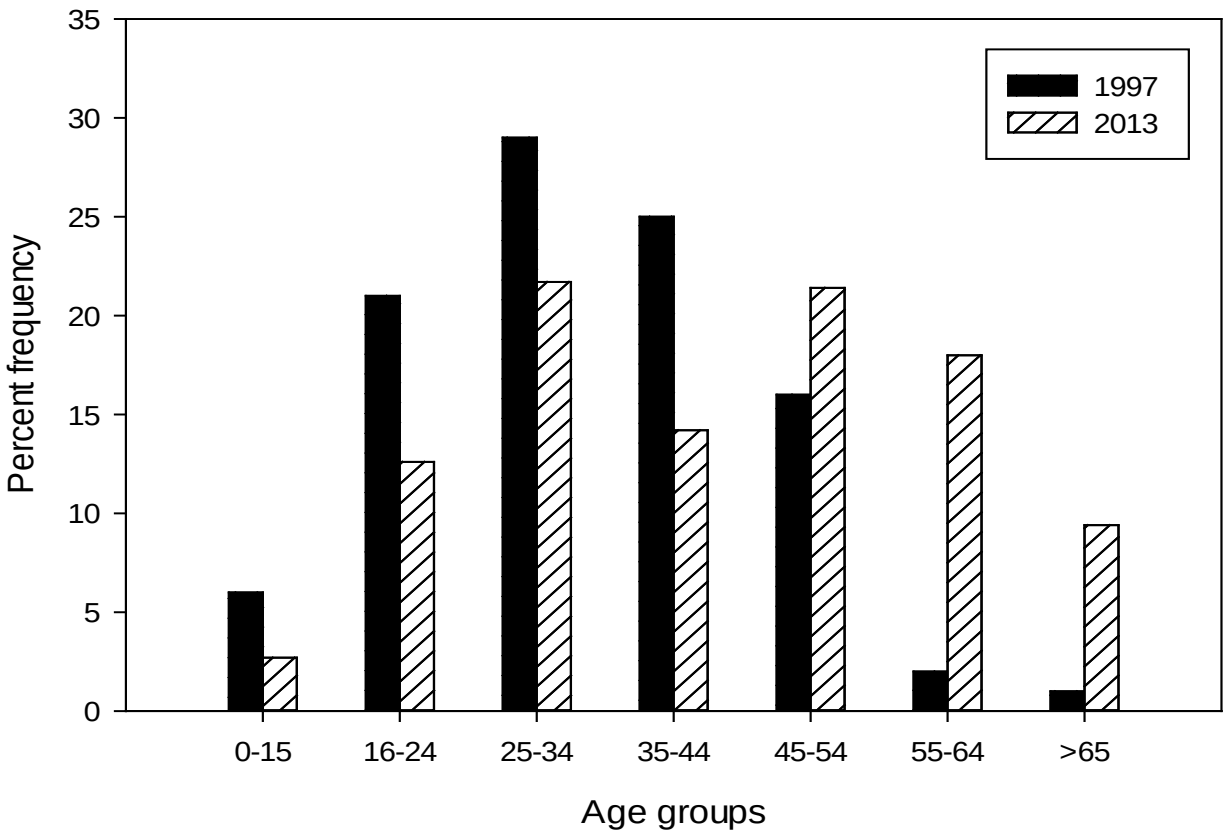

FIGURE 2. Age distribution of anglers fishing the winter trout season in southeast Minnesota, January 1 to March 31, in 1997 (Hendrickson 1998) and 2013.

Similar to previous winter surveys, the distances anglers drove to fish southeast Minnesota streams exhibited two distinct modes (Figure 3). The first mode represented "local anglers" that traveled distances of less than 50 miles. About 41.4% of anglers traveled this distance in 2013, whereas about 63% of anglers traveled this distance in 2002. The second mode peaked at about 100 miles in 2002 and represented mostly greater Minneapolis/St. Paul metropolitan anglers. About 28% of winter anglers in 2002 traveled between 50 and 100 miles and in 2013, only about 19.5% of anglers traveled this distance. Instead, the second mode in 2013 peaked at about 120 miles but still represented mostly metropolitan anglers.

Anglers were also categorized by grouping selected counties of residence. Local anglers were specifically defined as those living in the eleven counties surrounding the Lanesboro and Lake City management areas (Houston, Fillmore, Mower, Dodge, Olmsted, Winona, Wabasha, Goodhue, Rice, Freeborn and Steele counties). These local anglers represented 50% of surveyed individuals in 1997, but only 41% in 2013. Metropolitan anglers were defined as those living in the eight counties surrounding Minneapolis/St. Paul (Dakota, Ramsey, Washington, Anoka, Scott, Carver, Hennepin and Wright). Metropolitan anglers represented about 41% of anglers surveyed in 1997, but only 33% in 2013. Instead, Minnesota residents from "other" counties made up the difference representing 4.5% of anglers in 1997, but 21% in 2013. Many of these anglers originated from counties such as those in northeast Minnesota (St. Louis or Lake; cities of Duluth, Ely, Beaver Bay), south central Minnesota (Nicollet, LeSueur; cities of Mankato, St. Peter) and north central Minnesota (Crow Wing; city of Brainerd).

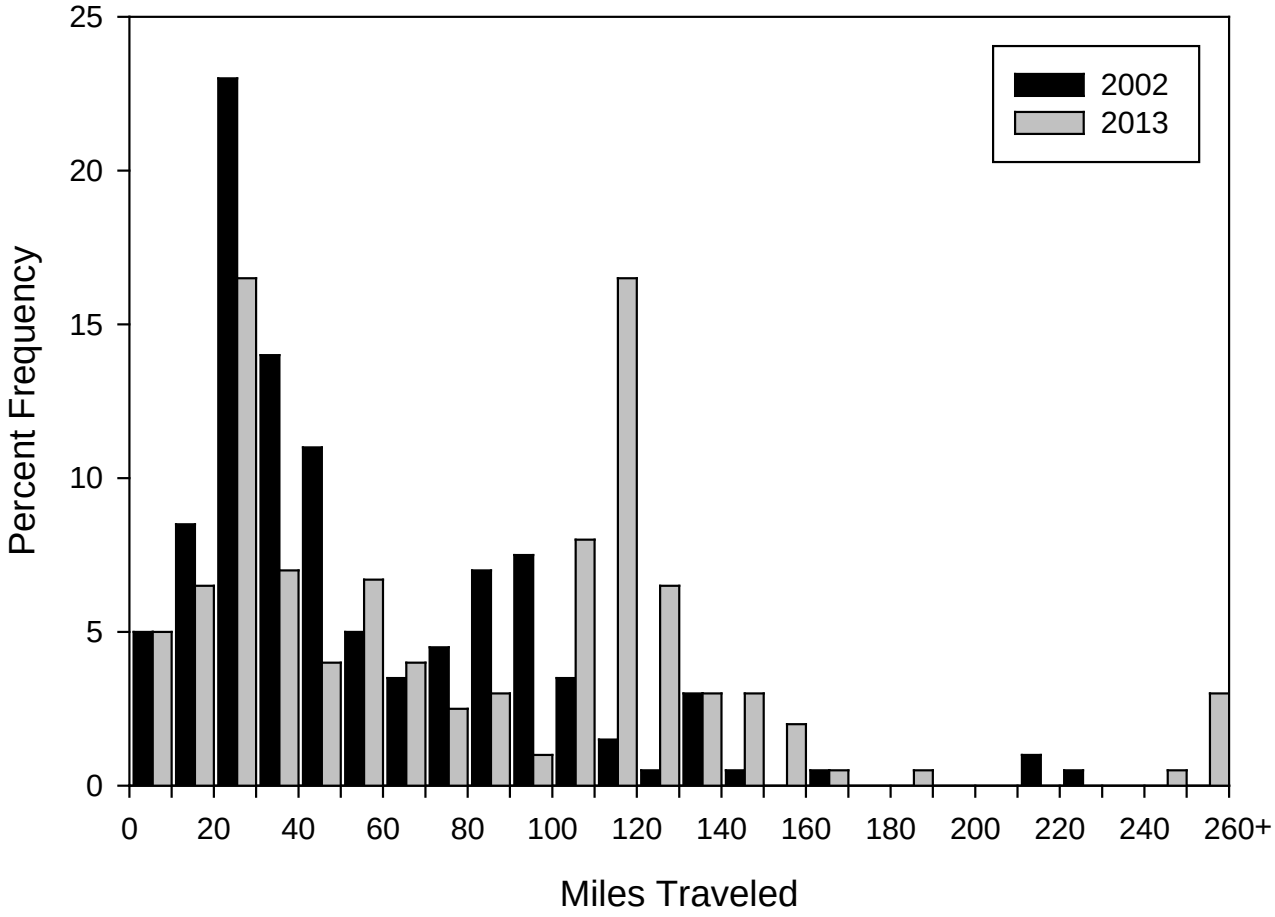

FIGURE 3. Percent frequency distribution for distances anglers traveled (one-way) to fish trout streams in southeast Minnesota during the winter trout fishing seasons (January 1 to March 31) in 2002 and 2013. The 2002 data taken from Nelson (2002.

The winter angling season in southeast Minnesota has historically been, and continues to be dominated by anglers using fly fishing gear (Figure 4). In the first winter seasons in 1988 and 1989, fly anglers were dominant and constituted more than 60% of all anglers fishing on the Middle Branch and South Branch Whitewater River (Hayes 1990). Fly angling has continued to increase in popularity constituting 73% of winter anglers in 1997 (Hendrickson 1998) and 76% in 2013. Lure and bait angling have decreased slightly (Figure 4). In 2013, bait anglers consisted of only 2% of surveyed anglers, lure anglers 16%, and mixed method anglers 5% (bait/lure and lure/fly). Within each gear type in 2013, fly fishing was most common among middle-aged anglers (ages 20-69; Table 5). Lure anglers tended to be most dominant in the 30-39 (36.6%) and 50-59 (21.9%) year old age groups, whereas mixed method anglers were most common in the 20-29 age group. While anglers from all three Minnesota resident categories (Metro, Local and Other) mostly used fly fishing gear, local anglers had the highest percentage of individuals that used lures (25.7%) (Table 6).

Winter trout fishing was mostly a solitary activity that anglers enjoyed for about three to four hours each day. Most anglers fishing southeast Minnesota trout streams during 2013 traveled by themselves (57.8% of those surveyed). Traveling with two in the car occurred 35.5% of the time. The occurrence of three or more anglers in each car was relatively rare (6.8%). Mean party size among streams ranged from 1.00 to 3.00 (Table 4). Overall mean party size in winter 2013 was 1.51 anglers/car compared with 1.40 anglers/car in 2002 (Nelson 2002). Mean trip length was slightly shorter on streams in Area A/B (3.5 hours) than on streams around the Whitewater River and Hay Creek (i.e., Area C = 3.9 hours). Overall, winter anglers fished for an average of 3.8 hours during 2013.

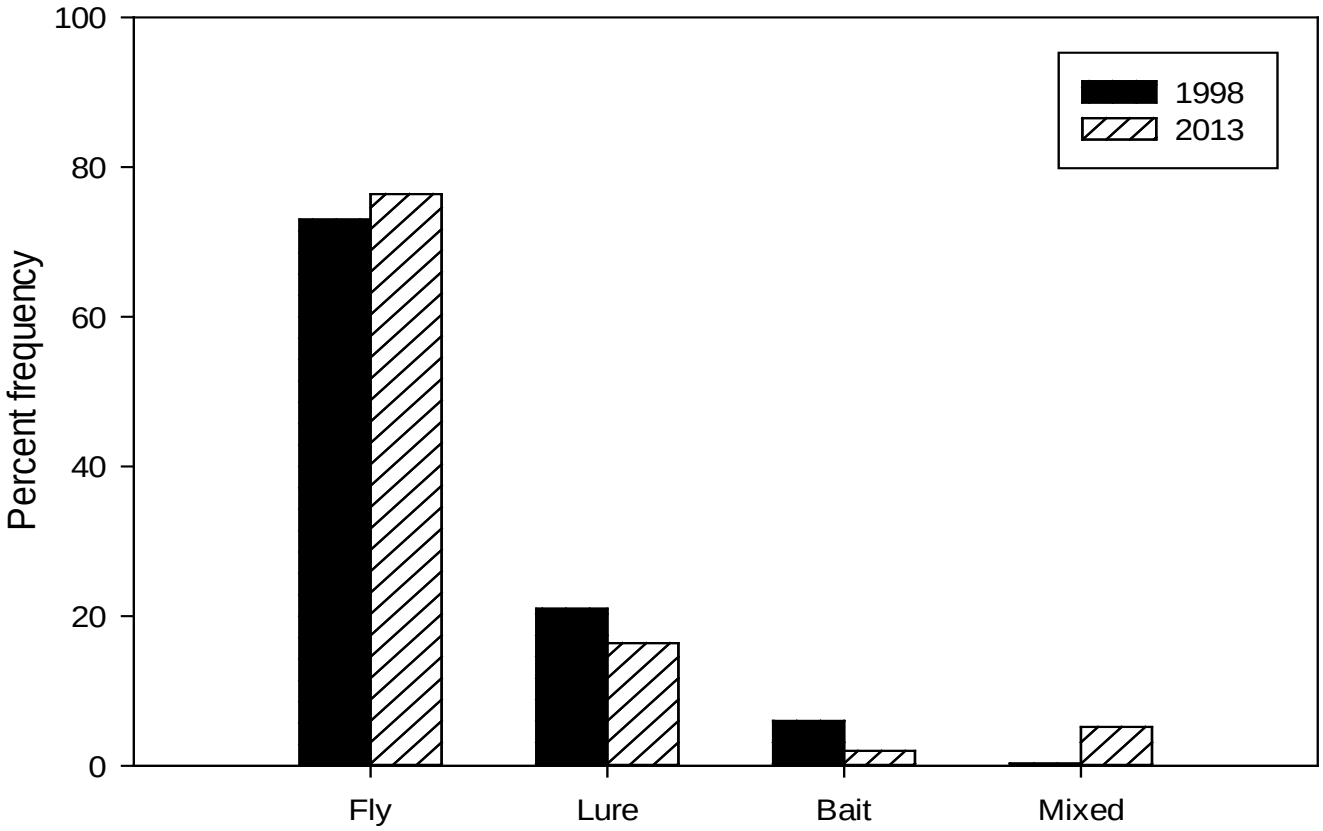

FIGURE 4. Distribution of anglers using different gear types during the winter trout season in southeast Minnesota, January 1 to March 31 in 1997 and 2013 (1997 data from Hendrickson 1998).

TABLE 5. Angling gear choice by age in percent from letter surveys of anglers fishing 32 trout streams in southeast Minnesota open to winter angling from January 1 to March 31, 2013.

Gear	Age (years)							
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	n
Bait			25.0		50.0		25.0	4
Fly	1.6	12.6	22.6	14.7	24.2	19.5	4.7	190
Lure	4.9	14.6	36.6	9.8	21.9	12.2		41
Mixed	7.7	46.2	15.4		30.8			13

TABLE 6. Gear choice by percent of Minnesota resident anglers fishing the winter trout season in southeast Minnesota, January 1 to March 31, 2013. Local anglers are those with home zip codes in Dodge, Fillmore, Goodhue, Houston, Mower, Olmsted, Steele, Wabasha and Winona counties. Metro anglers are those with home zip codes in Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington counties.

Area	Fly Fishing	Lure	Bait	Mixed	n
Metro	84.2	7.9	4.0	4.0	101
Local	66.1	25.7	0.9	7.3	109
Other	84.6	15.4	0	0	26

Stream selection.—Anglers fished the stream they were surveyed on for a number of reasons. Though asked to pick one of the five possible choices, some anglers circled two or more choices for the question, "Why did you decide to fish here today?" The following information reflects any time they chose a reason, whether by itself or with other reasons. Overall, anglers fished a stream most often because it was easily accessible (32.0%). The second most frequent reply was "favorite winter stream" (31.0%), followed by "live close by" (23.3%). "Numbers of fish" and "size of fish" were chosen least with 10.6% and 3.3%, respectively.

When considering availability of winter streams in conjunction with angler use, anglers actively selected nine of the 31 streams to fish (Table 7). The most strongly selected streams, based on Manly's alpha, were South Branch Whitewater River, Camp Creek and the Middle Branch Whitewater River. All three were actively selected by both fly and lure anglers. Several streams were simultaneously selected for by lure anglers but avoided by fly anglers. These included Crooked, West Beaver, Bee, Rush, and Ferguson creeks. Conversely, fly anglers selected at least three streams that lure anglers avoided: North Branch Whitewater River, Hay Creek, and Forestville Creek. Stream use overlap between fly and lure anglers was relatively high at 55% (Figure 5). Fly anglers exhibited greater stream specialization (B_A = 0.14) than lure anglers, which exhibited a broader use of winter streams (B_A = 0.22; Figure 5).

TABLE 7. Angler selection for streams open to winter angling January 1 to March 31, 2013 in southeast Minnesota as determined using Manly's alpha index scores. Scores > 0.03 indicate selection for a stream, scores = 0.03 indicate neutral selection, and scores < 0.03 indicate avoidance of a stream.

	Overall*		Fly Angler		Lure Angler	
Stream	Score	Interpretation	Score	Interpretation	Score	Interpretation
South Branch Whitewater	0.15	Selection for	0.20	**Selection for**	0.05	**Selection for**
Camp Creek	0.12	Selection for	0.17	**Selection for**	0.06	**Selection for**
Middle Branch Whitewater	0.12	Selection for	0.13	**Selection for**	0.07	**Selection for**
Wisel Creek	0.07*	Selection for	0.00	Avoidance	0.00	Avoidance
North Branch Whitewater	0.07	Selection for	0.09	**Selection for**	0.02	Avoidance
South Branch Root River	0.06	Selection for	0.07	**Selection for**	0.03	Neutral
Hay Creek	0.05	Selection for	0.07	**Selection for**	0.02	Avoidance
Forestville Creek	0.05	Selection for	0.08	**Selection for**	0.00	Avoidance
Bee Creek	0.04	Selection for	0.00	Avoidance	0.16	**Selection for**
Whitewater River (Main)	0.03	Neutral	0.03	Neutral	0.07	**Selection for**
Rush Creek	0.03	Neutral	0.01	Avoidance	0.09	**Selection for**
Duschee Creek	0.03	Neutral	0.03	Neutral	0.03	Neutral
Canfield Creek	0.02	Avoidance	0.04	**Selection for**	0.00	Avoidance
South Fork Root River	0.02	Avoidance	0.02	Avoidance	0.04	**Selection for**
Ferguson Creek	0.02	Avoidance	0.00	Avoidance	0.11	**Selection for**
West Beaver Creek	0.02	Avoidance	0.00	Avoidance	0.11	**Selection for**
East Beaver Creek	0.02	Avoidance	0.04	**Selection for**	0.00	Avoidance
Crooked Creek	0.02	Avoidance	0.00	Avoidance	0.07	**Selection for**
Pine Creek	0.02	Avoidance	0.00	Avoidance	0.04	**Selection for**
Beaver Creek (WW)	0.01	Avoidance	0.01	Avoidance	0.00	Avoidance
Garvin Brook	0.01	Avoidance	0.00	Avoidance	0.03	Neutral
Coolridge Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
Daley Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
Diamond Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
Gribben Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
Hemmingway Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
South Fork Crooked Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
Swede Bottom Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
Torkelson Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
Trout Valley Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance
West Branch Money Creek	0.00	Avoidance	0.00	Avoidance	0.00	Avoidance

*Overall score and interpretation includes data from mixed method and/or bait angler use.

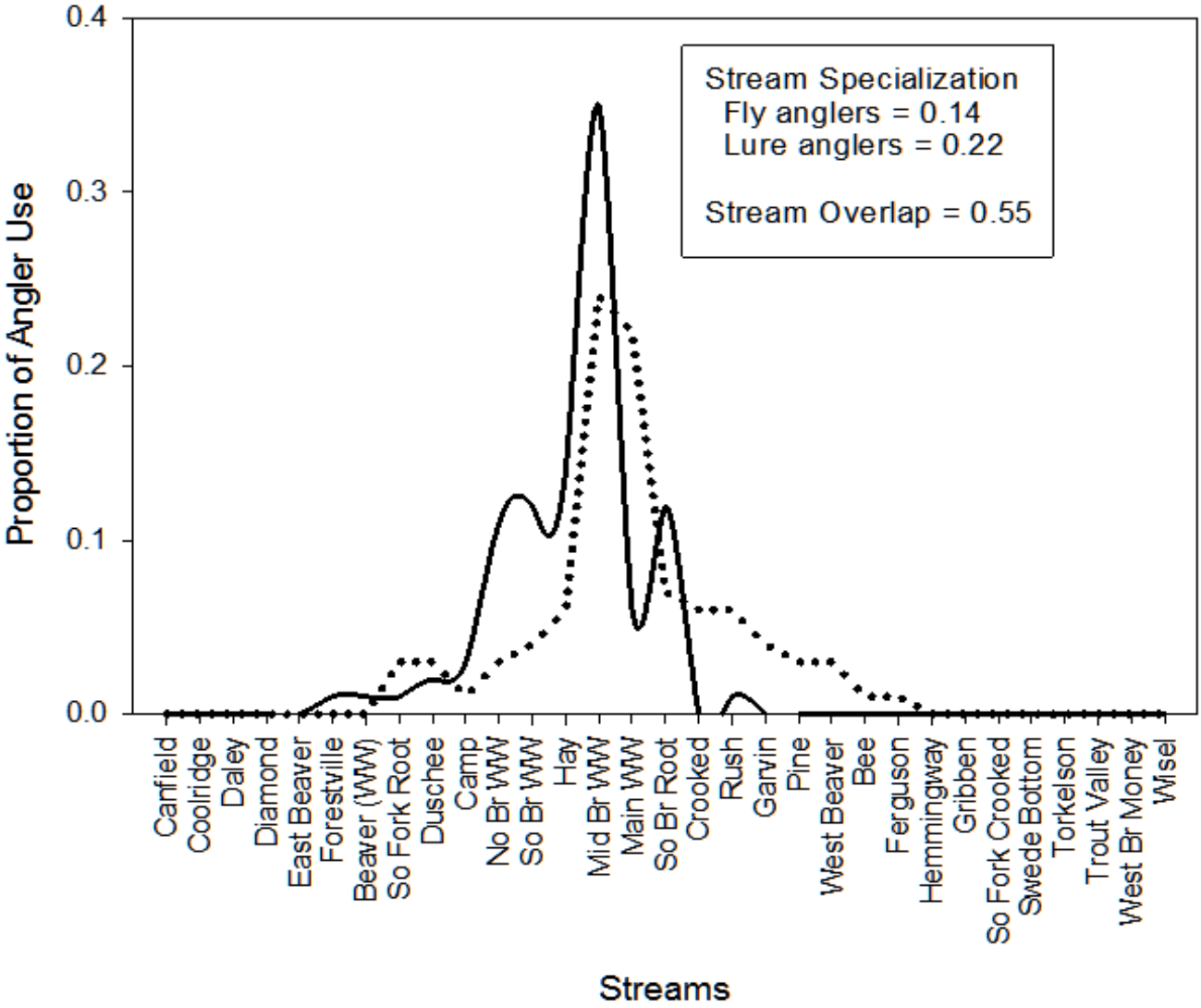

FIGURE 5. Proportions of stream use by two angler groups (fly anglers = solid line; lure anglers = dashed line) fishing during the winter season January 1-March 31, 2013 in southeast Minnesota. Stream specialization was assessed with Levin's index of niche breadth where lower values indicate greater specialization on a fewer number of streams. Stream overlap was assessed with Schoener's index of percentage niche overlap.

Not surprisingly, the nine streams actively selected for were usually fished because they were an angler's "favorite stream", it was "close by" or the stream had "easy access". The answer "favorite stream" was frequently given when on streams in the Whitewater watershed (Table 8). The Middle Branch Whitewater River received this answer most frequently at 32.5%. The South Branch Root River was also a favorite for 15.6% of anglers. The answer "live close by" was also most commonly used for streams in the Whitewater watershed (Table 9). Hay Creek tied with Middle Branch Whitewater River for the most common stream fished with this answer (27.4%). For streams with the answer, "easy access" it was apparent that the Middle Branch Whitewater River dominated the other streams with 44.2% of the responses (Table 10).

The Middle Branch Whitewater River was the most frequent response for anglers fishing a stream because of the "numbers of fish" (25.0% of anglers that gave the response "numbers of fish"). However, this represented only 2.5% of all angler responses. Other streams fished because of the perception of "numbers of fish" present included Hay Creek and the North Branch Whitewater River (14.3% each of the response to "numbers of fish"; 1% of overall angler responses). Winter anglers almost never fished a particular stream because of their perception of the "size of fish" available. Still, for these few anglers, the South Branch Root River was the most frequently identified stream.

TABLE 8. Rank of streams fished, with answer "Favorite stream" to question, "Why did you decide to fish here today?" taken from letter surveys of anglers fishing the winter trout season in southeast Minnesota from January 1 to March 31, 2013. (Note that some surveyed chose multiple reasons.) N = 77

Rank	Stream	Percent answer
1	Middle Branch Whitewater River	32.5
2	South Branch Root River	15.6
3	Hay Creek/South Branch Whitewater River	10.4
4	Whitewater River	9.1
5	Camp Creek/North Branch Whitewater River	5.2
6	Beaver Creek (WW)/Trout Run (WW)	2.6
7	Bee Creek/Duschee Creek/Forestville Creek/Pine Creek/Rush Creek	1.3

TABLE 9. Rank of streams fished, with answer "Live close by" to question, "Why did you decide to fish here today?" taken from letter surveys of anglers fishing the winter trout season in southeast Minnesota from January 1 to March 31, 2013. (Note that some surveyed chose multiple reasons.) N = 62

Rank	Stream	Percent answer
1	Hay Creek/Middle Branch Whitewater River	27.4
2	North Branch Whitewater River	11.3
3	South Branch Whitewater River	9.7
4	South Branch Root River/Whitewater River	6.5
5	Camp Creek	4.8
6	Bee Creek/Canfield Creek/Pine Creek/Rush Creek	1.6

TABLE 10. Rank of streams fished, with answer "Easy access" to question, "Why did you decide to fish here today?" taken from letter surveys of anglers fishing the winter season in southeast Minnesota from January 1 to March 31, 2013. (Note that some surveyed chose multiple reasons.) N = 86

Rank	Stream	Percent answer
1	Middle Branch Whitewater River	44.2
2	North Branch Whitewater River	11.6
3	South Branch Whitewater River	9.3
4	Hay Creek/South Branch Root River	7.0
5	Rush Creek	4.7
6	Camp Creek/Duschee Creek	3.5
7	Whitewater River	2.3
8	Crooked Creek/E. Beaver Creek/Garvin Brook/S. Fork Root River/Wisel Creek	1.2

Angler satisfaction.—Overall, most winter anglers were satisfied with their fishing experience during the 2013 season. Almost 87% of anglers were either satisfied or very satisfied with their overall angling experience, whereas only about 6% were dissatisfied or very dissatisfied (Table 11). When specifically asked about satisfaction with either the sizes or numbers of trout caught, the percentage of anglers that were satisfied or very satisfied declined slightly to about 66-67%. Conversely, the percentage of dissatisfied or very dissatisfied anglers increased to about 9-13% (Table 11).

When angler satisfaction was examined by gear choice some slight distinctions became apparent. Lure anglers tended to be slightly more dissatisfied with their overall fishing experience and size of trout caught than fly anglers (Table 12). Conversely, a larger percentage of fly anglers tended to be dissatisfied with numbers of trout caught than lure anglers. However, for overall fishing experience, anglers using each gear type were mostly satisfied or very satisfied (Figure 6).

TABLE 11. Percent (number) satisfaction to three questions asked of winter anglers taken from letter surveys of anglers fishing 32 trout streams in southeast Minnesota open to winter angling from January 1 to March 31, 2013.

Response	Overall fishing experience	Size of trout caught	Number of trout caught
Very Satisfied	38 (95)	14 (35)	20 (49)
Satisfied	49 (124)	53 (132)	46 (113)
Neither	8 (19)	23 (58)	22 (54)
Dissatisfied	4 (10)	7 (17)	10 (24)
Very Dissatisfied	2 (4)	2 (6)	3 (8)

TABLE 12. Percent of responses for anglers using the two most common types of fishing gear to three questions regarding satisfaction with winter angling taken from letter surveys of anglers fishing 32 trout streams in southeast Minnesota open to winter angling from January 1 to March 31, 2013.

Response	Fly anglers	Lure anglers
Question 1-Satisfaction with overall fishing experience		
Very Satisfied	37	34
Satisfied	53	47
Neither	5	11
Dissatisfied	1	8
Very Dissatisfied	3	1
Question 2-Satisfaction with size of trout caught		
Very Satisfied	21	13
Satisfied	35	51
Neither	35	22
Dissatisfied	5	13
Very Dissatisfied	4	2
Question 3-Satisfaction with number of trout caught		
Very Satisfied	15	20
Satisfied	49	46
Neither	20	24
Dissatisfied	12	8
Very Dissatisfied	5	3

FIGURE 6. Overall fishing experience satisfaction taken from surveys of anglers fishing during the winter trout season in southeast Minnesota, January 1 to March 31, 2013.

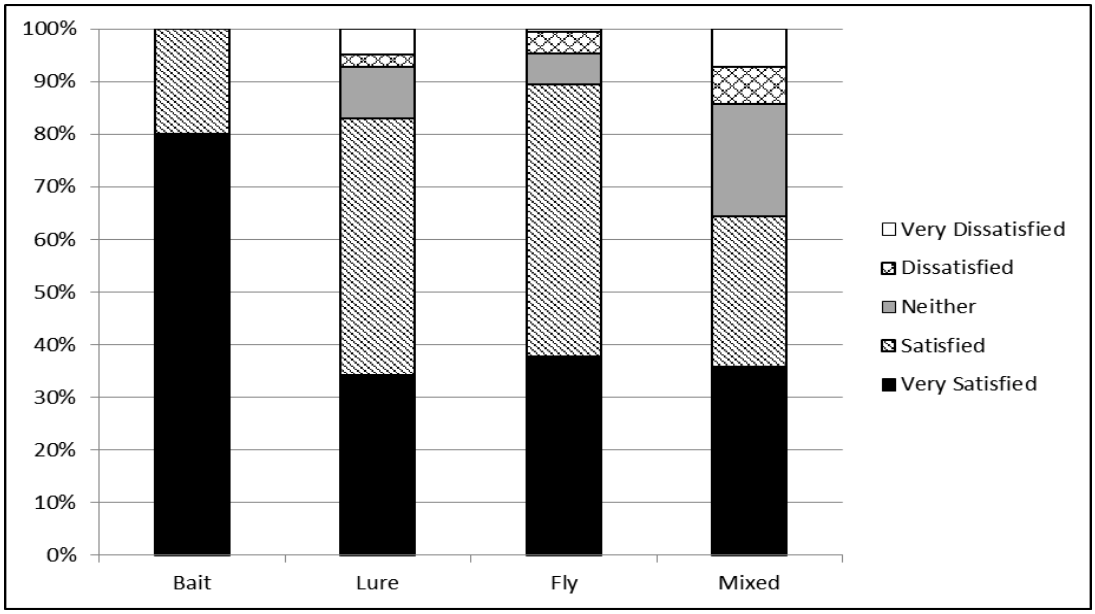

TABLE 13. Coeffients of determination (r^2) testing selected associations among angler satisfaction indices and other variables collected during a winter trout fishing creel between January 1 and March 31, 2013 in southeast Minnesota. A minus sign preceding a coefficient denotes a negative relationship; *P*-values and sample sizes shown in parentheses.

Variables	Satisfaction with overall experience	Satisfaction with numbers of trout caught	Trip length for each party	Total minutes the entire party fished	Trout catch rate (#/hr)
Satisfaction with size of trout	0.29 (<0.01; 248)	0.50 (<0.01; 247)			
Satisfaction with numbers of trout	0.43 (<0.01; 248)				
Trout catch rate (#/hr)	0.06 (<0.01; 252)	0.19 (<0.01; 248)		-0.04 (<0.01; 252)	
Mean daily air temperature (°F)	0.01 (0.17; 246)	0.02 (0.03; 243)	<0.01 (0.34; 246)	<0.01 (0.75; 246)	0.01 (0.16; 246)

Several factors may influence angler satisfaction. First, all three satisfaction questions were highly correlated with each other (Table 13) suggesting that anglers that were satisfied with their overall fishing experience were likely to be satisfied with the numbers and sizes of trout caught as well. Satisfaction with the overall fishing experience and, not surprisingly, satisfaction with the numbers of trout caught, were also significantly correlated with catch rates. However, the preponderance of satisfied and very satisfied anglers made it difficult to identify strong relationships. For example, coefficients of determination between angler satisfaction and trout catch rates ranged from 0.06-0.19 suggesting that catch rates by themselves explained less than 20% of angler satisfaction. A closer examination of the association between catch rates and overall angler satisfaction, indicates that when catch rates were < 2.0 trout/hour, anglers could be satisfied or dissatisfied (Figure 7). However, anglers that were dissatisfied, very dissatisfied, or neither almost always caught fewer than 2.0 trout/hour. Mean daily air temperature was not significantly correlated with satisfaction with the overall angling experience. Though significantly associated with satisfaction with numbers of trout caught, air temperature only explained about 2% of that variation (Table 13).

The time anglers participated in the act of fishing was associated with catch rates but not with mean daily air temperature (Table 13). Catch rates were negatively correlated with the total time all anglers in each party fished (Figure 8). Anglers that caught more than 5 trout/hour generally spent less time fishing than anglers that caught fewer trout per hour.

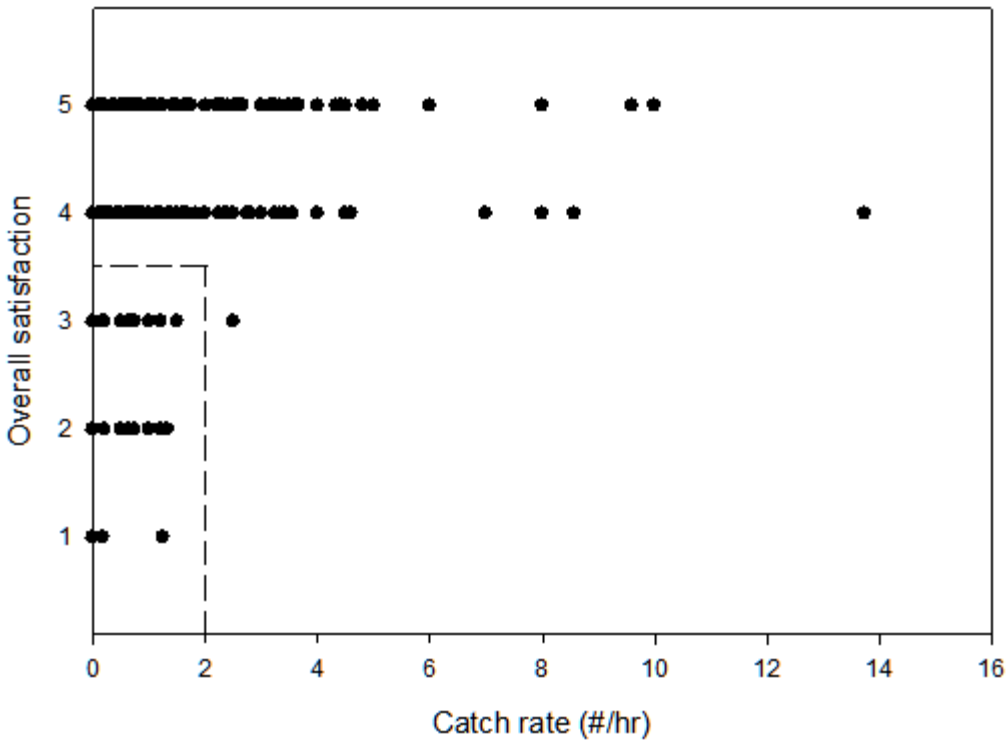

FIGURE 7. Relationship between satisfaction of the overall angling experience (1=very dissatisfied, 2=dissatisfied, 3=neither, 4=satisfied, and 5=very satisfied) and catch rates of trout for anglers fishing the winter trout season in southeast Minnesota, January 1 to March 31, 2013. Reference line at 2 trout/hour on the x-axis suggests a point at which anglers fishing for trout are never dissatisfied with their experience if they catch more than 2 trout/hr.

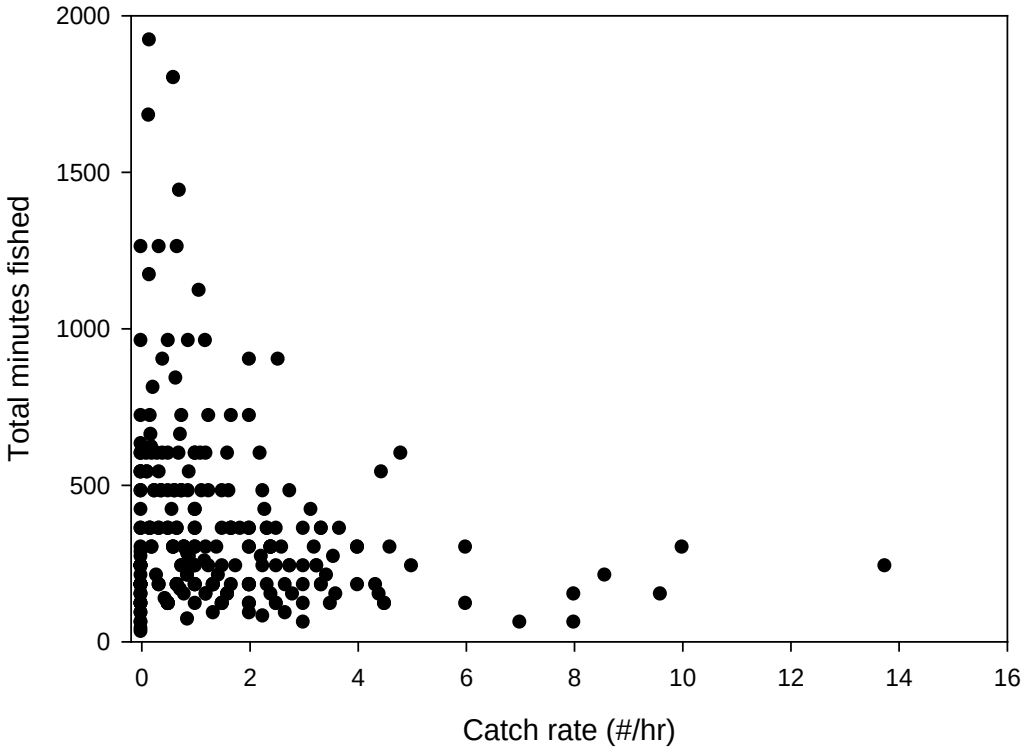

FIGURE 8. Relationship between the total minutes fished by each angling party (i.e., trip length x total number of anglers in the party) and their catch rate for anglers fishing the winter trout season in southeast Minnesota, January 1 to March 31, 2013.

Angler pressure (Method 1).–Total winter angling pressure across all streams in 2013 was estimated to be 13,603 angler-hours following calculations in Nelson (2002) (Table 14). Total angler trips was estimated to be 3,580 in winter 2013 (i.e., 13,603 angler-hours/3.8 hours (mean trip length)). Pressure estimates in 2013 declined on all streams open to winter angling in 2002 except two, the Middle Branch Whitewater River and Main Branch Whitewater River (Table 14). However, the streams originally open to winter angling in 2002 still accounted for 84% of all the winter pressure in 2013. Of the 19 streams that were newly opened in 2003, only eight had some angling pressure recorded during winter 2013: Bee Creek, Crooked Creek, Garvin Brook, Pine Creek, Rush Creek, South Fork Root River, West Beaver Creek and Wisel Creek. No one was observed or reported angling on the other 11 streams.

Overall, three streams accounted for about half of all winter pressure: Middle Branch Whitewater River, Main Branch Whitewater and South Branch Root River. The addition of three more streams (North Branch Whitewater, South Branch Whitewater and Hay Creek) accounted for about 76% of all the winter angling pressure in 2013. Angling pressure, expressed as angler-hours/mile/day (excluding streams with no pressure observed), ranged from a low of 0.23 hours (i.e., ≈ 14 minutes/mile/day) on Beaver Creek in the Whitewater watershed to a high of 3.60 hours/mile/day on the South Branch Whitewater River. Based on these data, overall angling pressure did not increase between 2002 and 2013, suggesting that the opening of new streams likely did not result in the addition of new anglers to this fishery. Instead, patterns among stream-specific estimates indicate that the opening of new streams in 2003 has resulted in a modest redistribution of anglers among streams open to winter angling in southeast Minnesota (Figure 9).

Angler pressure (Method 2).–Total winter angling pressure across all streams estimated with Method 2 (i.e., Pollock et al. 1994) was 12,311 angler-hours (Table 15), an estimate very similar to the 13,603 hours estimated with Method 1 (Nelson 2002). This indicates good precision between the two methods. There was almost twice as much pressure estimated in Area C (7,920 angler-hours) than in Area A/B (4,391 angler-hours) (Table 15). Angling pressure was higher on weekdays (4,858 angler-hours) than on weekends-holidays (3,062 angler-hours) in Area C, but nearly equivalent in Area A/B.

Angler catch rate and catch.–Catch rate for Area A/B was estimated to be 1.45 trout/hour for weekends and holidays and 1.49 trout/hour for weekdays. For Area C, angler catch rate was estimated to be 1.36 trout/hour for weekends and holidays and 1.21 trout/hour for weekdays. The overall winter creel angler catch rate was 1.38 trout/hour.

All three species of trout present in southeast Minnesota streams (Brown Trout *Salmo trutta*, Rainbow Trout *Oncorhynchus mykiss*, and Brook Trout *Salvelinus fontinalis*) were caught during this creel survey. Total catch of trout for Area A/B on weekends/holidays was estimated to be 1,637 trout with an estimate of 849 trout on weekdays. For Area C, the estimated total trout catch on weekends/holidays was 2,106 trout and 1,656 trout on weekdays. The overall winter creel catch was 5,978 trout. One angler reported catching a White Sucker *Catostomus commersoni*.

TABLE 14. Estimated fishing pressure by individual stratum (stream x month x day type), during southeast Minnesota winter fishing seasons 2002 and 2013 (January 1 to March 31). Data for 2002 from Nelson (2002). WD = Weekday, WEH = Weekend/Holiday. Fishing pressure is in angler-hours (± 1 SE).

			Fishing pressure			Angler-hours /mile		Angler-hours /mile/day	
Stream	Month	Day type	2002	2013	% change	2002	2013	2002	2013
Beaver Creek	Jan.	WD	159(128)	33(30)					
(Whitewater)		WEH	466(411)	27(45)					
	Feb.	WD	73 (48)	15(17)					
		WEH	230(107)	15(28)					
	Mar.	WD	257(109)	42(32)					
		WEH	163 (91)	0 (0)					
		Total	1,349(468)	132(92)	-90%	214	20	2.38	0.23
Bee Creek	Jan.	WD	na	0 (0)					
*New		WEH	na	21(49)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	77(87)					
		WEH	na	0 (0)					
		Total	na	98(81)	+98%		63		0.70
Camp Creek	Jan.	WD	100 (71)	45 (46)					
		WEH	213 (93)	103(160)					
	Feb.	WD	38 (38)	55 (55)					
		WEH	120(121)	181(210)					
	Mar.	WD	134 (66)	0 (0)					
		WEH	239(200)	129(201)					
		Total	844(272)	513(311)	-39%	241	144	2.68	1.60
Canfield Creek	Jan.	WD	95 (68)	72 (46)					
(South Branch		WEH	58 (58)	0 (0)					
Creek)	Feb.	WD	72 (48)	0 (0)					
		WEH	114 (82)	0 (0)					
	Mar.	WD	0 (0)	0 (0)					
		WEH	32 (33)	0 (0)					
		Total	370(134)	72(46)	-80%	231	47	2.57	0.53
Coolridge Creek	Jan.	WD	na	0 (0)					
*New		WEH	na	0 (0)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00

*New stream opened to winter angling in 2003

(TABLE 14 continued on next page)

TABLE 14. Continued.

Stream	Month	Day type	Fishing pressure 2002	Fishing pressure 2013	% change	Angler-hours /mile 2002	Angler-hours /mile 2013	Angler-hours /mile/day 2002	Angler-hours /mile/day 2013
Crooked Creek	Jan.	WD		0 (0)					
*New		WEH		165(162)					
	Feb.	WD		0 (0)					
		WEH		155(328)					
	Mar.	WD		0 (0)					
		WEH		0 (0)					
		Total		320(177)	+320%		50		0.56
Daley Creek	Jan.	WD		0 (0)					
*New		WEH		0 (0)					
	Feb.	WD		0 (0)					
		WEH		0 (0)					
	Mar.	WD		0 (0)					
		WEH		0 (0)					
		Total		0 (0)	0%		0		0.00
Diamond Creek	Jan.	WD		0 (0)					
*New		WEH		0 (0)					
	Feb.	WD		0 (0)					
		WEH		0 (0)					
	Mar.	WD		0 (0)					
		WEH		0 (0)					
		Total		0 (0)	0%		0		0.00
Duschee Creek	Jan.	WD	177 (78)	58 (58)					
		WEH	162 (62)	66 (87)					
	Feb.	WD	0 (0)	70 (71)					
		WEH	128(128)	66 (88)					
	Mar.	WD	48 (48)	0 (0)					
		WEH	36 (36)	41 (88)					
		Total	551(173)	301(149)	-45%	100	57	1.11	0.63
East Beaver Creek	Jan.	WD	103 (46)	0 (0)					
		WEH	47 (48)	17 (37)					
	Feb.	WD	29 (30)	7 (10)					
		WEH	47 (48)	13 (30)					
	Mar.	WD	69 (48)	6 (9)					
		WEH	186 (96)	13 (31)					
		Total	482(138)	57 (70)	-88%	201	24	2.23	0.26
Ferguson Creek	Jan.	WD		0 (0)					
*New		WEH		0 (0)					
	Feb.	WD		0 (0)					
		WEH		0 (0)					
	Mar.	WD		0 (0)					
		WEH		0 (0)					
		Total		0 (0)	0%		0		0.00

(TABLE 14 continued on next page)

TABLE 14. Continued.

Stream	Month	Day type	Fishing pressure 2002	Fishing pressure 2013	% change	Angler-hours /mile 2002	Angler-hours /mile 2013	Angler-hours /mile/day 2002	Angler-hours /mile/day 2013
Forestville Creek	Jan.	WD	35 (36)	0 (0)					
(North Branch		WEH	32 (32)	0 (0)					
Creek)	Feb.	WD	0 (0)	0 (0)					
		WEH	0 (0)	0 (0)					
	Mar.	WD	0 (0)	0 (0)					
		WEH	36 (36)	0 (0)					
		Total	104 (60)	0 (0)	-104%	104	0	1.16	0.00
Garvin Brook	Jan.	WD	na	0 (0)					
*New		WEH	na	0 (0)					
	Feb.	WD	na	44 (49)					
		WEH	na	23 (54)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	67 (45)	+67%		46		0.52
Gribben Creek	Jan.	WD	na	0 (0)					
*New		WEH	na	0 (0)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00
Hay Creek	Jan.	WD	670(324)	188 (91)					
		WEH	1166(491)	221(161)					
	Feb.	WD	287(147)	271 (98)					
		WEH	480(268)	155(158)					
	Mar.	WD	109 (70)	259(112)					
		WEH	333(190)	160(145)					
		Total	3043(693)	1254(396)	-59%	725	123	8.06	1.37
Hemmingway	Jan.	WD	na	0 (0)					
Creek		WEH	na	0 (0)					
*New	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00
Middle Branch	Jan.	WD	251 (87)	445(155)					
Whitewater		WEH	155(156)	296(266)					
(including Trout	Feb.	WD	254(151)	498(190)					
Run in park)		WEH	173(111)	376(175)					
	Mar.	WD	385(256)	991(306)					
		WEH	229(161)	537(499)					
		Total	1447(398)	3143(706)	+117%	345	219	3.83	2.44

(TABLE 14 continued on next page)

TABLE 14. Continued.

Stream	Month	Day type	Fishing pressure 2002	Fishing pressure 2013	% change	Angler-hours /mile 2002	Angler-hours /mile 2013	Angler-hours /mile/day 2002	Angler-hours /mile/day 2013
North Branch Whitewater	Jan.	WD	213(107)	165 (85)					
		WEH	475(354)	115(119)					
	Feb.	WD	81 (53)	243 (68)					
		WEH	416(211)	242(156)					
	Mar.	WD	48 (48)	284(154)					
		WEH	327(176)	239(190)					
		Total	1,558(466)	1,287(406)	-17%	708	153	7.87	1.70
Pine Creek *New	Jan.	WD	na	260(173)					
		WEH	na	41 (87)					
	Feb.	WD	na	73 (73)					
		WEH	na	52(109)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	425(123)	+425%		73		0.81
Rush Creek *New	Jan.	WD	na	121(123)					
		WEH	na	87(184)					
	Feb.	WD	na	102(103)					
		WEH	na	72(155)					
	Mar.	WD	na	54 (55)					
		WEH	na	36 (77)					
		Total	na	472(247)	+472%		104		1.15
South Branch Root River	Jan.	WD	428(n/a)	234(154)					
		WEH	466(n/a)	80(113)					
	Feb.	WD	190(n/a)	283(158)					
		WEH	445(n/a)	215(235)					
	Mar.	WD	255(n/a)	410(147)					
		WEH	560(n/a)	268(152)					
		Total	2,343(n/a)	1,489(439)	-36%	345	263	3.82	2.92
South Branch Whitewater	Jan.	WD	283(164)	169 (99)					
		WEH	864(623)	105(117)					
	Feb.	WD	202(121)	159(109)					
		WEH	544(230)	201(187)					
	Mar.	WD	665(247)	394(158)					
		WEH	363(207)	206(184)					
		Total	2,921(766)	1,234(354)	-58%	769	324	8.54	3.60
South Fork Crooked Creek *New	Jan.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00

(TABLE 14 continued on next page)

TABLE 14. Continued.

Stream	Month	Day type	Fishing pressure 2002	Fishing pressure 2013	% change	Angler-hours /mile 2002	Angler-hours /mile 2013	Angler-hours /mile/day 2002	Angler-hours /mile/day 2013
South Fork Root River *New	Jan.	WD	na	120(123)					
		WEH	na	69(147)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	151(154)					
		WEH	na	86(117)					
		Total	na	426(210)	+426%		58		0.64
Swede Bottom Creek *New	Jan.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00
Torkelson Creek *New	Jan.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00
Trout Valley Creek *New	Jan.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00
West Beaver Creek *New	Jan.	WD	na	87 (87)					
		WEH	na	0 (0)					
	Feb.	WD	na	73 (73)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	52(108)					
		Total	na	211 (77)	+211%		105		1.16
West Branch Money Creek *New	Jan.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Feb.	WD	na	0 (0)					
		WEH	na	0 (0)					
	Mar.	WD	na	0 (0)					
		WEH	na	0 (0)					
		Total	na	0 (0)	0%		0		0.00

(TABLE 14 continued on next page)

TABLE 14. Continued.

Stream	Month	Day type	Fishing pressure 2002	Fishing pressure 2013	% change	Angler-hours /mile 2002	Angler-hours /mile 2013	Angler-hours /mile/day 2002	Angler-hours /mile/day 2013
Wisel Creek	Jan.	WD		108(108)					
*New		WEH		0 (0)					
	Feb.	WD		0 (0)					
		WEH		0 (0)					
	Mar.	WD		0 (0)					
		WEH		0 (0)					
		Total		108(108)	+108%		27		0.30
Whitewater River (Main Branch)	Jan.	WD	71 (53)	368(189)					
		WEH	231(160)	319(296)					
	Feb.	WD	135 (86)	386(134)					
		WEH	43 (44)	382(478)					
	Mar.	WD	350(260)	368(121)					
		WEH	97 (63)	171(190)					
		Total	928(331)	1,994(637)	+115%	135	150	1.50	1.67
		Grand Total	15,941 (1,476)	13,603 (53)	-15%	329	103	3.65	1.15

TABLE 15. Estimated fishing pressure (angler-hours ± 1 SE) by month and day type strata for each of two areas in southeast Minnesota during a winter creel survey (January 1 to March 31) in 2013. Pressure estimate made following Method 2 calculations (see text and Pollock et al. 1994 for more information). See Figure 1 for a map showing exact sampling areas and streams.

Month	Day type	Pressure
	Area A/B	
January	Weekends and Holidays	626 (± 229)
	Weekdays	968 (± 351)
February	Weekends and Holidays	750 (± 298)
	Weekdays	561 (± 281)
March	Weekends and Holidays	692 (± 198)
	Weekdays	795 (± 273)
Subtotals A/B	Weekends and Holidays	2,067 (± 409)
	Weekdays	2,324 (± 503)
Subtotal A/B		4,391 (±649)
	Area C	
January	Weekends and Holidays	856 (± 315)
	Weekdays	1,146 (± 361)
February	Weekends and Holidays	1,095 (± 282)
	Weekdays	1,284 (± 331)
March	Weekends and Holidays	1,111 (± 390)
	Weekdays	2,428 (± 645)
Subtotals C	Weekends and Holidays	3,062 (± 554)
	Weekdays	4,858 (± 1,124)
Subtotal C		7,920 (± 1,253)
Grand total		**12,311 (± 1,411)**

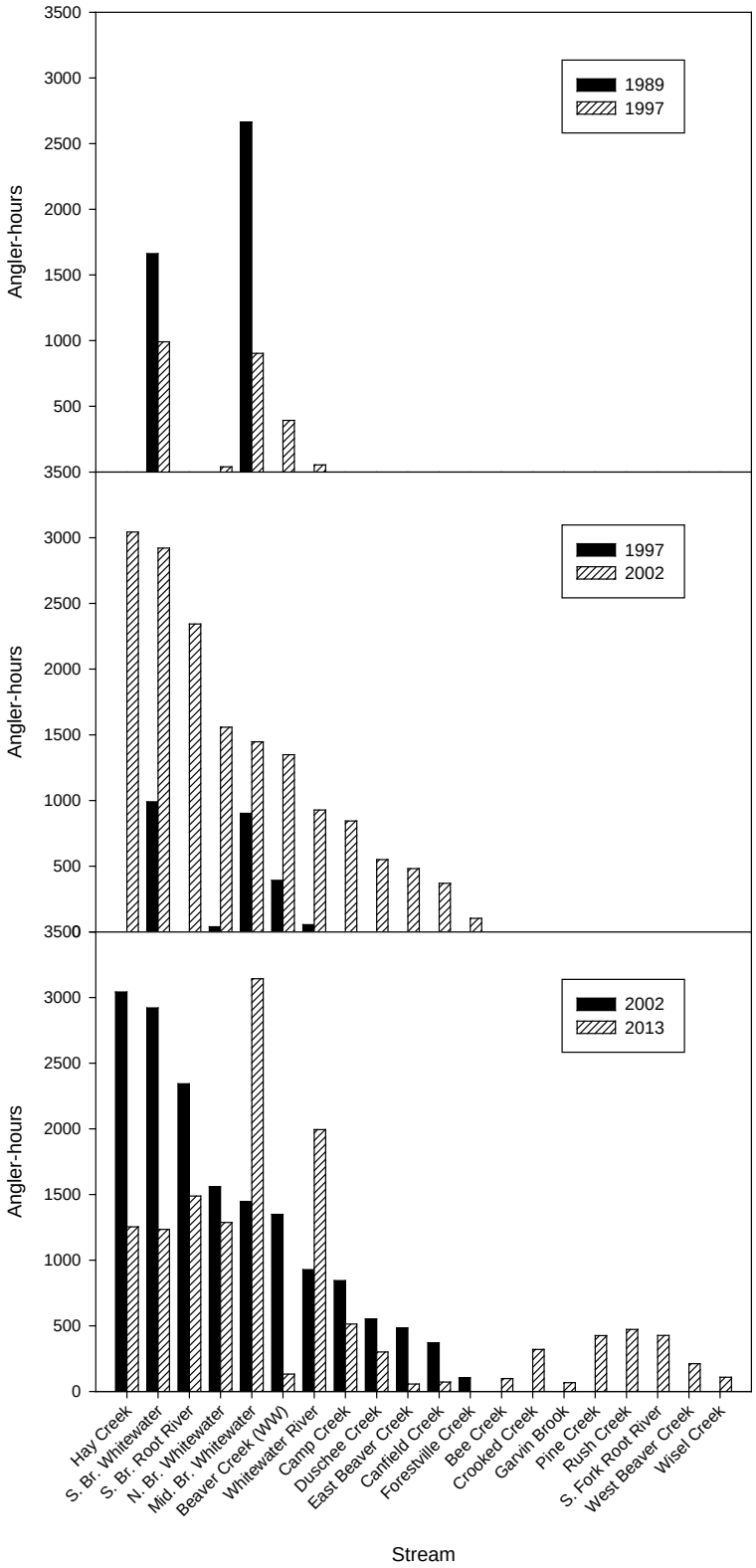

FIGURE 9. Temporal changes in estimates of angler pressure (angler-hours) for streams in the winter trout fishery (January 1 – March 31) in southeast Minnesota. Total pressure was estimated to be 4,328 hours in 1989 (two streams = 4.8 mi); 2,382 hours in 1997 (six streams = 27.6 mi); 15,941 hours in 2002 (12 streams = 48.4 mi); and 13,603 hours in 2013 (32 streams = 131.5 mi; only streams with observed pressure in 2013 are shown).

DISCUSSION

One of the primary reasons for implementing this winter creel was to determine if the opening of new streams to winter angling resulted in an increase in overall angling pressure (possibly due to the addition of new anglers) or whether angling pressure remained the same and anglers simply re-distributed themselves to newly opened streams. Winter angling opportunities in southeast Minnesota have been expanded four times since 1988 (Table 2). Based on sporadic winter creels, these expansions appear to have produced mixed results (Figure 9). When winter stream miles were expanded from 4.8 miles in 1989 to 27.6 miles in 1997, total angling pressure dropped from 4,328 to 2,382 angler-hours and anglers appeared to re-distribute themselves among newly opened streams (Figure 9; Figure 10). However, only six streams covering 27.6 miles and almost all within the Whitewater Wildlife Management Area, were open to winter angling at this time. An additional 20.8 miles were added in 1999 and included portions of streams in other areas of southeast Minnesota such as the South Branch Root River in Lanesboro and East Beaver Creek in Beaver Creek Valley State Park near Caledonia. Total angler pressure in 2002 increased dramatically from the 2,382 angler-hours in 1997 to 15,941 angler-hours (Nelson 2002) indicating that expansion substantially increased overall angling pressure. However, Nelson (2002) noted that the winter of 2002 was mild with a noticeable lack of snowfall. Lack of snow allowed anglers easy access to winter streams, prompting Nelson (2002) to speculate that the increase in pressure may have been an unusual event. Stream expansion in 2003 opened up an additional 82.6 miles across 32 streams, but this creel in 2013 did not show another increase in total pressure (Figure 9). Instead, winter pressure dropped on most streams and expanded to other streams not previously open during the last creel. This strongly suggests that winter anglers again merely re-distributed themselves among streams.

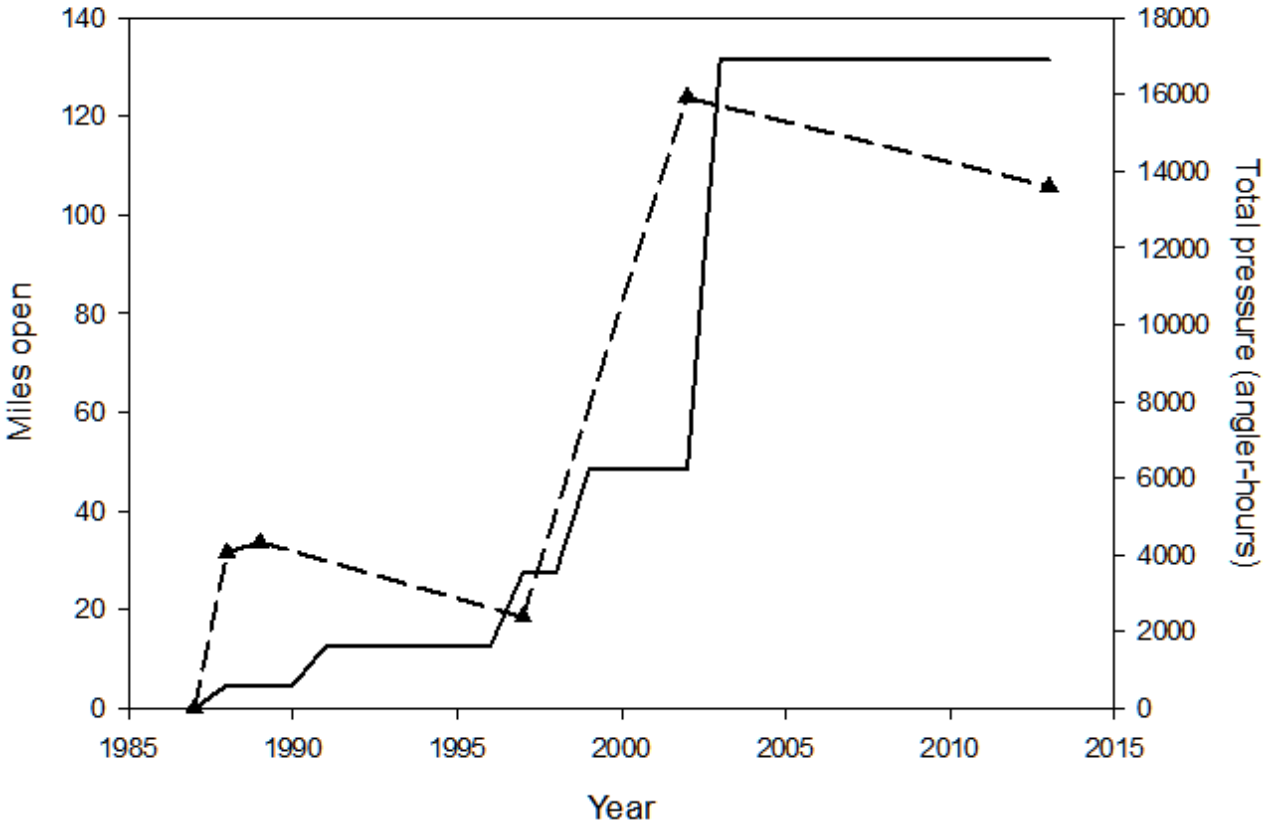

FIGURE 10. Temporal patterns in the number of stream miles open to winter angling (solid line; January 1 – March 31) and total angling pressure (dashed line) during winter in southeast Minnesota.

Differences in angler-hours between 2002 and 2013 could be due to differences in weather. Weather conditions in winter 2002 were much different than the winter of 2013. Average high temperatures were higher in January, February and March 2002 than in 2013 (Table 16). Also average low temperatures were lower those same months in 2013 than 2002. Snowfall totals were also much higher overall in winter 2013 than winter 2002 (Table 17).

From another perspective, the relative similarity of total winter angling pressure estimates between 2002 and 2013 may indicate that the numbers of core anglers for this fishery are fully maximized and if a full use of the winter resource is desired, new angling groups may need to be attracted. The current winter angling constituency has remained essentially the same since the inception of the winter fishery in southeast Minnesota almost 30 years ago in 1988. Based on past and current creel surveys, it has always been dominated by mostly middle-aged male anglers using fly fishing gear that resided either locally in southeast Minnesota or the Twin Cities Metropolitan Area.

Although age distributions have changed slightly between 1997 and 2013, where age groups 45-65+ have become more common (Figure 2), this likely simply reflects the aging of a core angler group. For example, as 1997 was 16 years ago, the 25-44 year old age groups then would now be aged 41 to 60 years old in 2013. Although overall age distributions differed between 1997 and 2013, including 16-34 year olds (Figure 2), the age distribution of winter anglers in 2013 closely represented the age distribution of men in the greater Minnesota population in 2012-2013 (Figure 11; Suburbanstats 2014). Thus, the winter angling constituency in 2013 is probably reflecting the broader age distribution of potential anglers in the state.

Even if the core angling constituency might be fully maximized, it is still imperative to understand their angling motivations and maintain high satisfaction rates to ensure continued participation in and support for the winter trout fishery. Overall satisfaction with this group was high in 2013 with about 87% of anglers being either satisfied or very satisfied. Angler satisfaction was not specifically assessed in previous winter creels in 1988-1989 (Hayes 1990), 1997 (Hendrickson 1998), or 2002 (Nelson 2002), but a general survey of southeast Minnesota trout anglers in 2001 found overall angler satisfaction to be exactly the same at 87% being either satisfied or very satisfied (Vlaming and Fulton 2003).

TABLE 16. Average high, average low, average and departure from normal temperature for winter 2002 and winter 2013 for southeast Minnesota.

Month	Average high temperature (°F)		Average low temperature (°F)		Average temperature (°F)		Departure From normal (°F)	
	2002	2013	2002	2013	2002	2013	2002	2013
January	31.6	26.3	16.9	8.8	24.3	17.5	+12.5	+1.8
February	34.1	26.6	17.8	12.3	25.9	19.4	+7.5	-0.9
March	33.4	31.7	17.5	16.0	25.5	23.8	-5.1	-8.6

TABLE 17. Total precipitation, departure from normal precipitation, and snowfall for winter 2002 and winter 2013 for southeast Minnesota.

Month	Total precipitation (inches)		Departure from normal precipitation (inches)		Snowfall (inches)	
	2002	2013	2002	2013	2002	2013
January	0.65	0.78	-0.29	-0.08	10.0	1.9
February	1.67	1.22	+0.93	+0.39	5.5	15.4
March	1.24	2.85	-0.64	+0.97	7.1	23.5
Overall					22.6	40.8

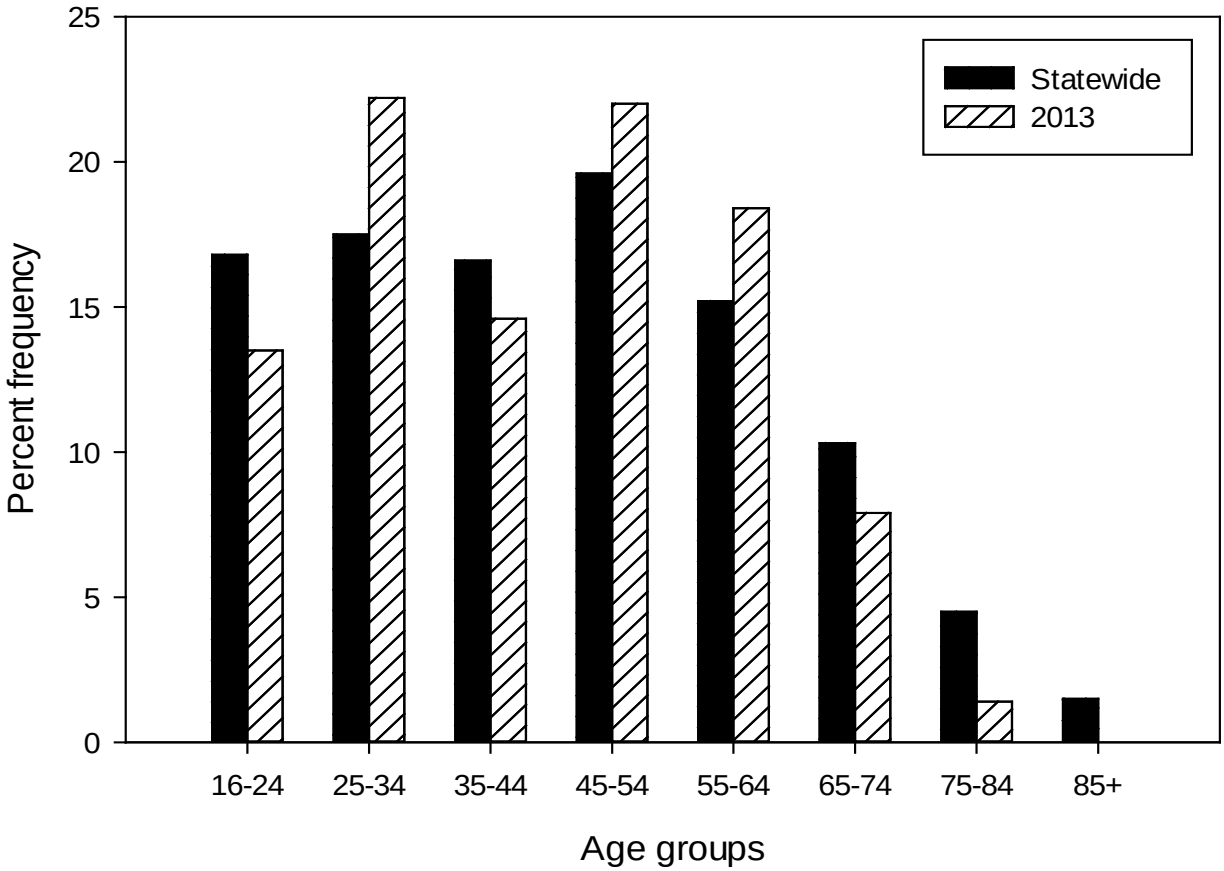

FIGURE 11. Age distribution of men aged 16 years and older statewide in Minnesota in 2012-2013 and for anglers fishing the winter trout season, January 1 to March 31, in 2013. Statewide data for Minnesota from Suburbanstats (2014).

Another objective of expanding winter angling opportunities to new streams was to improve angler satisfaction. Comparison of the percent frequency of overall satisfaction responses on older streams (i.e., streams open to winter angling since 1999) versus newer streams that were opened in 2003 indicated slight differences (Figure 12). Anglers fishing the newer streams were never "very dissatisfied", were less likely to characterize their trip as "neither" and were slightly more likely to have answered "very satisfied". This suggests that opening new streams does improve angler satisfaction.

Overall angler satisfaction was associated with satisfaction with both numbers and sizes of fish caught but this only suggests that satisfied anglers were satisfied with every aspect of their fishing trip. Surprisingly, satisfaction was not associated with weather conditions and only weakly associated with catch rates. Weak associations between overall satisfaction and catch rates corroborated angler motivations to fish in general. But quality fish responses to why anglers fished each stream (i.e., because of the numbers and sizes of fish present) were the lowest rated responses given. Consequently, this suggests that most anglers rarely fished streams in winter because of the trout populations present. Instead, over half the winter anglers fished a particular stream because it was easily accessible or because it was close by. Such responses justify the continued interest in increasing angling opportunities either by acquiring more fishing easements on streams (i.e., to make them easily accessible) or by opening more streams to winter angling to increase chances that anglers will live "close by" a stream to fish. Aprahamian et al. (2010) similarly found that increases in angler participation in a salmonid fishery in England were less dependent on fish abundance and instead more dependent on programs to expedite angling activities.

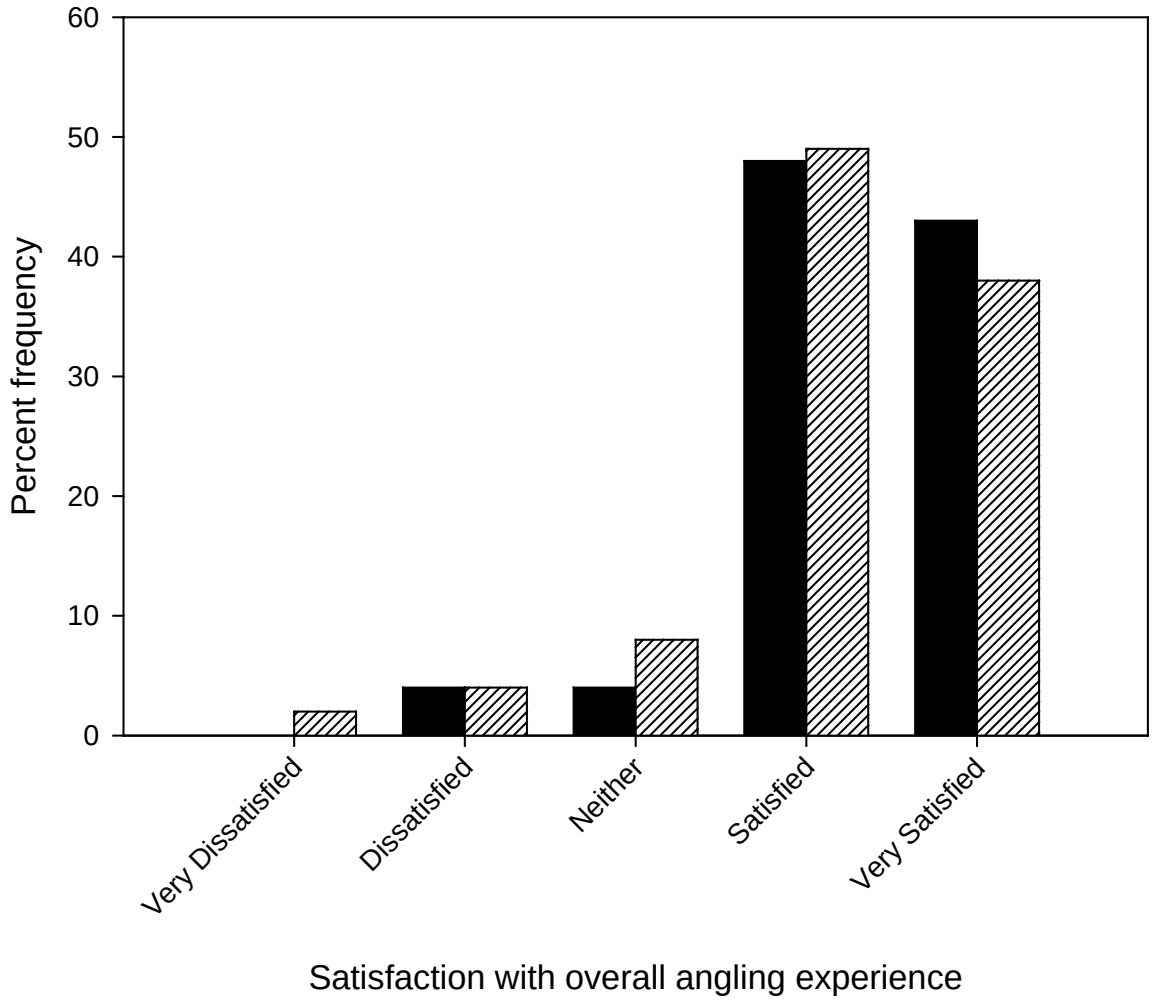

FIGURE 12. Percent frequency distribution of angler responses to the question "How satisfied were you with the overall fishing experience today" in a winter creel survey (January 1 – March 31) in 2013 for streams grouped as having been open to winter angling since 1999 (i.e., older streams = cross-hatched bars) versus streams opened after 2002 (i.e., new streams = solid black bars).

About a third of anglers were motivated to fish a particular stream because it was their "favorite stream". Earlier winter creel surveys noted concerns with angler crowding on the small number of streams originally opened in the late 1980s and early 1990s (Hayes 1990; Hendrickson 1998) which prompted the opening of more streams in the 2000's. However, Nelson (2002) noted that even though more stream miles were open in 2002, angler pressure still dominated on a small number of streams, mostly in the Whitewater watershed. Such patterns continued in the present 2013 creel, especially on the Middle Branch Whitewater River, but it is unknown if these angler patterns continue to result in crowding because no questions were asked in the 2013 survey to measure this. This also suggests that opening more streams may not result in an increase in overall pressure because many anglers will continue to focus their efforts on a few "favorite" streams. Future human dimensions surveys will need to discover what characteristics of streams make them a "favorite".

If the current core group of winter anglers is maximized, suggesting that new additions of anglers from this demographic will only represent modest gains, then new anglers will likely have to come from different angling demographics such as gender, non-residents, younger ages, or different gear types. Female anglers have long been known to be significant modifiers of angling participation, frequently representing a large percentage of recent dropout or inactive anglers (Fedler and Ditton

2001). However, Sutton (2007) noted that female anglers in recreational fisheries in Australia reported fewer constraints to fishing participation than male anglers and Schroeder et al. (2008) found that gender was unrelated to intended future fishing participation in urban fisheries in the Twin Cities Metropolitan area. Clearly, more information is needed to identify what, if any, constraints prohibit greater female angler participation in the winter trout fishery in southeast Minnesota.

Similarly, non-resident anglers have always comprised a small proportion of winter anglers and almost nothing is known about their motivations or constraints. From the limited information in this survey, non-resident anglers were all males between 21 and 71 years old and fished the particular stream that day for a variety of reasons. Interestingly, about a third of them (27%) fished with either live bait or artificial lures. Additions of younger ages (16-34 years old) may represent only modest gains as well because current age distributions in both the winter fishery and the broader Minnesota population mimic each other. Still, when considering fishing gear and age groups, it was apparent that fly fishing was least common for anglers less than 20 years old, whereas mixed methods were most common among 20-29 year olds and lure angling among 30-39 year olds.

Alternatively, examination of factors associated with dissatisfied or very dissatisfied anglers may offer other insights on management actions to increase angler participation. Gear choice again appeared to influence overall satisfaction responses. Mixed method anglers were most likely to respond "neither" or "very dissatisfied" whereas lure anglers were most likely to characterize dissatisfaction with their overall winter fishing experience. Local anglers were most likely to use artificial lures and represented a smaller percentage of winter anglers in 2013 than in 1997. Irrespective of home residence, winter anglers fishing with artificial lures and bait have both declined since 1997 representing 16.4% then, and 2.0% in 2013. In a summer creel survey in southeast Minnesota in 2005, lure anglers represented 21% and bait anglers 37% of all fishing participants (Snook and Dieterman 2005). A more general trout angler survey conducted in 2001 found that 34% of anglers used live bait and 14% used primarily artificial lures (Vlaming and Fulton 2003). Clearly, their presence is more profound in other seasons and years and they are conspicuously absent from the winter fishery in southeast Minnesota.

Examination of the association between catch rates and overall angler satisfaction indicated that when catch rates were < 2.0 trout/hr, anglers could be satisfied or dissatisfied (Figure 7). This might have been because anglers that caught few trout, yet were still satisfied or very satisfied, may have simply been fishing to enjoy the outdoors in a general sense. However, anglers that were dissatisfied, very dissatisfied, or neither almost always caught fewer than 2.0 trout/hr. Stated differently, this means that anglers that caught 2.0 or more trout per hour were never dissatisfied or very dissatisfied. This might suggest a threshold for managers to strive for to ensure fishing quality, as defined by angler satisfaction, is maintained.

Catch rates were also associated with participation time, where anglers catching more than five trout per hour fished for shorter time periods than anglers that caught fewer trout per hour (Figure 8). Such patterns are more common in harvest-based fisheries where high catch rates often indicate anglers that rapidly caught their legal limit of fish to harvest and then stop fishing. There was no harvest during the winter angling season in southeast Minnesota so anglers might instead be fishing to fulfill some level of satisfaction. If so, then anglers that catch a lot of trout may fulfill their daily satisfaction requirement quicker than anglers that catch fewer trout.

Some assumptions were made throughout this creel. The first was that while creel clerks drove their daily route it was assumed that the specific spots on the route were the only ways to access open water. There could have been instances where landowners accessed a stream from their private property. Such instances, if they happened, could have resulted in slightly higher estimates of angler pressure and catch. At times during severe winter weather the creel survey was cancelled for the day. We made the assumption that because of this weather, anglers would not be out fishing. Thus, total pressure and catch estimates could have been biased slightly lower if this assumption was incorrect.

Management Implications

1. Repeat the winter creel survey in five years (2018) to verify angler re-distribution trends, especially if all streams are opened to winter angling and to continue monitoring angler satisfaction with the winter trout season.
2. Maintain high satisfaction levels and interest of the current core angling constituency of middle-aged, white, male fly anglers. To maintain satisfaction, managers should consider opening more streams to winter fishing because satisfaction responses were slightly higher on streams opened more recently (i.e., "new" streams) and because this will address two of the top three motivations for fishing a particular stream (i.e., because it was either "easily accessible" or it was "close by").
3. Conduct more detailed human-dimension surveys to better identify factors leading anglers to identify a stream as a "favorite" stream. Are any of these factors something that can be amenable to management manipulation?
4. Conduct more detailed human-dimension surveys to ascertain constraints and motivations for winter angling of under-utilized demographic groups including females, non-residents and especially lure and bait anglers. Such demographic groups may hold the greatest potential for attracting new anglers to the winter fishery.

Acknowledgements

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Appendix A. Trout streams open for winter angling, area, clerk and specific spots surveyed in southeast Minnesota during the winter creel survey from January 1 to March 31, 2013.

Stream	Area	Clerk	Spot #	UTM location
Camp Creek	A	1		
1. Maust's pasture access			1	576,192 – 4,833,671
2. Mouth access			2	575,444 – 4,835,633
Canfield Creek	A	1		
1. Park parking lot			1	562,649 – 4,830,387
Diamond Creek	A	1		
1. Minimum maintenance road access			1	590,230 – 4,842,466
2. Parking lot access			2	590,136 – 4,843,096
Duschee Creek	A	1		
1. Ruen's access			1	582,081 – 4,836,993
2. Brekke's access			2	581,969 – 4,837,985
3. Kiel's access			3	581,851 – 4,838,255
4. Road access			4	581,427 – 4,838,999
5. Office access			5	581,055 – 4,839,079
6. Grosbeak Road bridge access			6	581,507 – 4,839,402
7. Hwy 16 access			7	581,833 – 4,839,699
Forestville Creek	A	1		
1. Park horse crossing access			1	562,829 – 4,831,858
Gribben Creek	A	1		
1. Spring source access			1	588,133 – 4,838,523
2. Upstream bridge access			2	587,603 – 4,839,955
3. Downstream bridge access			3	587,380 – 4,840,987
4. Camping area access			4	587,392 – 4,841,449
5. Hwy 16 access			5	587,089 – 4,842,579
South Branch Root River	A	1		
1. Vreeman's			1	561,638 – 4,830,159
2. Loop B Park			2	562,781 – 7,830,927
3. Forestville Creek mouth			3	562,861 – 4,832,096
4. Parking Lot			4	563,062 – 4,832,260
5. Historic Forestville			5	563,279 – 4,832,324
6. Historic Forestville			6	563,331 – 4,832,493
7. Lanesboro Dam			7	582,338 – 4,840,958
8. Hwy 8 Bridge			8	582,288 – 4,841,410
9. Lanesboro Fire Station			9	582,304 – 4,841,503
10. BBQ			10	582,267 – 4,841,640
11. Hwy 250 Bridge			11	582,837 – 4,841,674
12. Sales Barn			12	582,986 – 4,841,522
13. Hwy 16			13	583,355 – 4,841,386
14. Mini-Madison			14	583,792 – 4,841,773
15. Sand Beach			15	583,640 – 4,842,269
16. Hwy 250 near confluence			16	583,482 – 4,843,050

(Appendix A continued on next page)

Appendix A. Continued.

Stream	Area	Clerk	Spot #	UTM location
South Fork Root River	A	1		
1. WMA			1	591,255 – 4,829,343
2. Bonfe's			2	592,124 – 4,830,383
3. LTM Bridge			3	592,778 – 4,830,562
4. Million Dollar			4	594,847 – 4,832,269
5. Wunderlich's			5	594,867 – 4,832,802
Torkelson Creek	A	1		
1. Mouth access			1	582,064 – 4,847,063
2. Bridge access			2	581,886 – 4,847,292
Wisel Creek	A	1		
1. Chickentown Bridge			1	595,778 – 4,827,891
Bee Creek	B	1		
1. Stenhoff's access			1	615,085 – 4,819,075
2. Border access			2	615,603 – 4,817,594
Coolridge Creek	B	1		
1. Same as Pine Creek #6			6	592,870 – 4,857,486
Crooked Creek	B	1		
1. Quarry access			1	625,223 – 4,832,325
2. R1 Trib access			2	626,313 – 4,832,299
3. Hwy 249 access			3	626,498 – 4,831,646
4. Road access			4	629,892 – 4,829,506
5. Road access			5	630,553 – 4,828,765
6. Road access			6	631,275 – 4,829,136
Daley Creek	B	1		
1. Upstream bridge access			1	604,419 – 4,844,480
2. Seive's access			2	604,986 – 4,844,686
3. Bridge access			3	605,482 – 4,845,254
4. Bridge access			4	605,605 – 4,845,429
5. Road access			5	605,835 – 4,845,897
6. Road access			6	605,978 – 4,846,472
7. Hwy 16 bridge access			7	606,276 – 4,846,544
East Beaver Creek	B	1		
1. Park parking lot access			1	614,462 – 4,833,136
Ferguson Creek	B	1		
1. Same as Rush Creek #1 (Wunderlich's)			1	594,243 – 4,860,612
Hemmingway Creek – same as Pine Creek #6	B	1		
1. Same as Pine Creek #6			6	592,870 – 4,857,486

(Appendix A continued on next page)

Appendix A. Continued.

Stream	Area	Clerk	Spot #	UTM location
Pine Creek	B	1		
1. Pine Creek mouth			1	596,493 – 4,855,751
2. Brekke's			2	596,114 – 4,856,248
3. Kopperud's			3	594,800 – 4,856,524
4. Jacobson's			4	594,151 – 4,856,783
5. Jacobson's			5	594,162 – 4,857,275
6. Anderson's			6	592,870 – 4,857,486
Rush Creek	B	1		
1. Wunderlich's access			1	594,243 – 4,860,612
2. Ahrensfeld Creek access			2	594,649 – 4,859,892
3. Road access			3	594,897 – 4,859,568
4. Upstream bridge access			4	595,227 – 4,859,163
5. Downstream bridge access			5	595,379 – 4,858,324
South Fork Crooked Creek – same as Crooked #4	B	1		
1. Same as Crooked Creek #4			4	629,892 – 4,829,506
Swede Bottom Creek	B	1		
1. Trib easement access			1	617,575 – 4,843,767
2. Bridge access			2	617,330 – 4,844,267
West Beaver Creek	B	1		
1. Konkel's walk-in			1	611,781 – 4,833,718
2. Minimum Maintenance Road			2	613,605 – 4,835,807
West Branch Money Creek	B	1		
1. O'Neil's			1	604,971 – 4,862,186
2. O'Neil's			2	605,473 – 4,861,999
3. O'Neil's			3	605,740 – 4,862,026
Beaver Creek (WW)	C	2		575,548 – 4,888,462
1. WMA turn around parking lot			1	577,010 – 4,889,196
2. WMA parking lot			2	577,976 – 4,889,288
3. Hwy 30 access			3	578,809 – 4,889,355
4. Hwy 30 bridge access			4	579,318 – 4,889,652
Garvin Brook	C	2		
1. Upstream end of Farmer's Community Park			1	595,195 – 4,872,343
2. Downstream end of Farmer's Community Park			2	595,187 – 4,872,675
3. Bridge access			3	595,485 – 4,873,111
4. Railroad bridge			4	595,466 – 4,873,325
5. State Forest parking lot			5	596,063 – 4,873,801

(Appendix A continued on next page)

Appendix A. Continued.

Stream	Area	Clerk	Spot #	UTM location
Hay Creek	C	2		
1. Upstream regulations			1	532,049 – 4,924,416
2. Twin Cities TU Coop Habitat Improvement			2	532,811 – 4,924,996
3. Rebuffoni's			3	533,756 – 4,926,194
4. State Trail			4	534,034 – 4,926,107
5. Hay Creek			5	535,740 – 4,926,552
6. Stephani's			6	534,971 – 4,927,282
7. State Forest			7	534,828 – 4,927,615
8. State Forest Bridge			8	534,709 – 4,927,806
9. State Forest			9	534,534 – 4,928,052
10. State Forest, Downstream			10	534,550 – 4,929,163
Middle Branch Whitewater River	C	2		
1. County 9			1	570,913 – 4,874,581
2. Round Barn			2	571,808 – 4,875,897
3. Quincy Bridge			3	571,722 – 4,876,404
4. Quincy Bridge			4	572,132 – 4,876,285
5. Group Camp Park			5	575,801 – 4,878,506
6. Hwy 74 Bridge			6	575,970 – 4,877,978
7. Trout Run parking			7	576,376 – 4,877,930
8. Park HQ			8	576,386 – 4,878,606
9. Park HQ			9	576,270 – 4,878,912
10. Park HQ			10	576,508 – 4,879,176
11. Park HQ			11	577,120 – 4,880,316
12. Lazy D			12	577,853 – 4,881,302
North Branch Whitewater River	C	2		
1. WMA parking			1	575,042 – 4,882,980
2. Fairwater Upstream			2	575,161 – 4,882,702
3. Fairwater Downstream			3	575,622 – 4,882,599
4. LTM			4	576,836 – 4,881,987
5. Bridge			5	577,638 – 4,881,964
6. Hwy 74 Bridge			6	578,241 – 4,881,821
South Branch Whitewater River	C	2		
1. Krodemacher's access			1	581,710 – 4,880,209
2. Snowmobile Bridge access			2	581,067 – 4,880,916
3. Bridge access			3	580,178 – 4,882,368
Trout Run Creek (WW)	C	2		
1. Same as Middle Branch Whitewater #7			7	576,376 – 4,877,930
Trout Valley Creek	C	2		
1. Upstream bridge access			1	585,489 – 4,889,895
2. Downstream bridge access			2	585,583 – 4,891,039

(Appendix A continued on next page)

Appendix A. Continued.

Stream	Area	Clerk	Spot #	UTM location
Whitewater River	C	2		
1. Elba			1	578,936 – 4,882,541
2. Parking lot			2	579,526 – 4,883,684
3. Parking lot			3	579,755 – 4,887,736
4. Canoe launch			4	579,571 – 4,888,853
5. Hwy 30 Bridge			5	579,577 – 4,889,082
6. Parking lot (Downstream Beaver)			6	579,596 – 4,890,047
7. Parking lot			7	579,888 – 4,890,847
8. Parking lot			8	580,136 – 4,891,800
9. Parking lot			9	580,688 – 4,892,841
10. Parking lot			10	581,819 – 4,893,863
11. Parking lot			11	582,422 – 4,894,391

Appendix B. Letter survey distributed to possible anglers by clerks during the winter trout stream creel in southeast Minnesota, January 1 to March 31, 2013.

PLEASE COMPLETE AND MAIL EVEN IF YOU WERE NOT FISHING.

Thank you for participating in the Minnesota Department of Natural Resources Fisheries winter survey. We are conducting this survey to better understand trout angling in southeast Minnesota. Please answer the following questions and mail this survey in the envelope provided. If you were not fishing, only answer 1 and 2. Also, please complete this survey even if you have received another on a different date or location.

Q1. Were you fishing for trout when we left this survey? YES NO

Q2. How many anglers total traveled in this vehicle to the stream today?_____

Q3. What is your (and passengers) home zip code(s)?_____

Q4. a. What is your (and passengers) age(s)?_____
b. Gender (and passengers)? Male_____Female_____

Q5. How long was your fishing trip today (time you left vehicle until you arrived back at vehicle)?_____

Q6. Why did you decide to fish here today? (Choose only one)
a. Favorite winter stream b. Live close by c. Easy access d. Numbers of fish e. Size of fish

Q7. What angling gear were you using on this trip (Circle all that apply)
a. Bait fishing b. Lure fishing c. Fly fishing

How satisfied or dissatisfied were you with…

Q8. The overall fishing experience you had today?
Very dissatisfied Dissatisfied Neither Satisfied Very satisfied

Q9. The size of the trout you caught today?
Very dissatisfied Dissatisfied Neither Satisfied Very satisfied

Q10. The number of trout you caught today?
Very dissatisfied Dissatisfied Neither Satisfied Very satisfied

If you caught any fish today please enter their lengths below?

Species	Fish 1	2	3	4	5	6	7	8	9	10	11	12	Total
Brown													
Brook													
Rainbow													
Other													
Other													
Other													

For more information or questions regarding this survey, please contact the Lanesboro Area Fisheries Office at (507) 467-2442. www.dnr.state.mn.us/areas/fisheries/lanesboro/index.html

Appendix C. Hometown, zip code, and number of anglers from Minnesota residents and non-residents encountered on trout streams open to winter angling between January 1 and March 31, 2013.

City	Zip code	Number of anglers
	Residents	
Rochester	55901, 55902, 55904, 55906, 55093	75
Minneapolis	55401, 55404, 55406, 55408, 55409, 55417, 55419, 55422, 55411, 55416	42
St. Paul	55104, 55105, 55108, 55112, 55116, 55124	29
Northfield	55057	11
St. Charles	55972	9
Winona	55987	9
Bloomington	55425, 55435, 55438	8
Altura	55910	6
Austin	55912	6
Edina	55423, 55436, 55439	6
Minnetonka	55345	6
Plainview	55964	6
Prior Lake	55372	6
Duluth	55804, 55807, 55812	5
Hopkins	55305, 55343	5
Racine	55967	5
Burnsville	55306, 55337	4
Chaska	55318	4
Eagan	55122, 55123	4
Eyota	55934	4
Fountain	55935	4
Owatonna	55060	4
Rollingstone	55969	4
Wayzata	55391	4
Brooklyn Center	55429	3
Chatfield	55923	3
Ely	55731	3
Excelsior	55331	3
Hastings	55033	3
La Crescent	55947	3
Minnesota City	55959	3
New Prague	56071	3
Oronoco	55960	3
Plymouth	55446, 55447	3
Redwing	55066	3
Beaver Bay	55601	2
Brainerd	56401	2
Buffalo	55313	2
Chisago City	55013	2
Circle Pines	55014	2
Delano	55328	2
Dodge Center	55927	2
Eden Prairie	55344, 55347	2

(Appendix C continued on next page)

Appendix C. Continued.

City	Zip code	Number of anglers
Elk River	55330	2
Golden Valley	55426	2
Inver Grove Heights	55076	2
Lakeville	55044	2
Lanesboro	55949	2
Lewiston	55952	2
Lino Lakes	55110	2
Maplewood	55106, 55119	2
Medicine Lake	55441	2
Mound	55364	2
Oakdale	55128	2
Osseo	55369	2
Preston	55965	2
Rushford	55971	2
Shakopee	55379	2
St. Anthony	55418	2
Arden Hills	55126	1
Clear Lake	55319	1
Columbia Heights	55421	1
Crystal	55427	1
Dover	55929	1
Farmington	55024	1
Ham Lake	55304	1
Harmony	55939	1
Hermantown	55811	1
Houston	55943	1
Lake City	55041	1
Mankato	56003	1
Mayer	55360	1
Mendota Heights	55118	1
Newport	55055	1
Savage	55378	1
St. Bonifacius	55375	1
St. Peter	56082	1
Stewartville	55976	1
Wabasha	55981	1
Waconia	55387	1
West St. Paul	55107	1
Woodbury	55125	1

(Appendix C continued on next page)

Appendix C. Continued.

City (state)	Zip code	Number of anglers
	Non-residents	
La Crosse (WI)	54601	4
Greene (IA)	50636	2
Fountain City (WI)	54629	2
Dougherty (IA)	50433	1
Garner (IA)	50438	1
Hager City (WI)	54014	1
New Richmond (WI)	54017	1
Prescott (WI)	54021	1
Lincoln (NE)	68503	1
Lincoln (NE)	68516	1

Appendix D. Comments from anglers written on surveys fishing the winter trout season in southeast Minnesota, January 1 to March 31, 2013.

Date	Stream	Comment
Jan - 3	M. Br. Whitewater	It was 14F no wind and drop dead gorgeous. Thank you.
Jan - 4	Forestville Creek	Didn't catch any most of stream was frozen. Truly appreciate the opportunity to try!
Jan - 4	M. Br. Whitewater	We had a great day!
Jan - 5	Whitewater	I enjoy the winter fishing in…don't fish this spot in summer due to crowding and bait fishermen. Be nice to open this season in fall. Stretches out the fishing so less competition. Thanks
Jan - 6	S. Br. Root River	Will you please open more winter trout water
Jan - 6	S. Br. Whitewater	A great day!
Jan - 8	M. Br. Whitewater	Would like to see bass and other species as well
Jan - 8	Hay Creek	Glad you're doing this survey. Hay Creek is a challenge but easy drive from the Twin Cities. Would be happy to catch more and bigger fish but any trout in the winter an hour and a half from home makes for a good day.
Jan - 9	Whitewater	Total 16 brown trout between 7-10 inches
Jan - 9	M. Br. Whitewater	My friend caught 14 more fish
Jan - 11	Hay Creek	Sorry I didn't get this in sooner.
Jan - 11	S. Br. Whitewater	I had 2 other nice rainbows on for a good bit of the time but I did not land them.
Jan - 17	Whitewater River	Excellent day – lots of follows – fish were slow to strike – lots of fun however
Jan - 18	N. Br. Whitewater	Unusually colored brown, 14" rainbow lateral line coloring. Gorgeous metallic pink gill place – hybrid?
Jan - 18	S. Br. Whitewater	I love having the winter season. I hope the proposed "extra" season from Sept 30 through Dec 31 of 2013 is approved. Thank you for all the work you do.
Jan - 19	Hay Creek	Other than the cold it was a good day
Jan - 25	M. Br. Whitewater	Also hooked but did not land 7 other fish. Two appeared to be in the 12-14 inch range. Cold but beautiful day.
Feb - 3	N. Br. Whitewater	Great Day!
Feb - 9	Whitewater	We were not fishing, we were small game hunting. Thank you.
Feb - 9	S. Br. Root River	Lot of ice in the river difficult to get in, some places shelf ice covered the stream. Park stretch appears to have filled in, mostly shallow flats I remember more pools in the past.
Feb - 13	S. Br. Root River	Fishing was very good in 2012. Water levels were low and clear. I caught 100's of fish – browns and rainbows up to 20" (clipped and wild) brook trout up to 9". Very seldom do I catch 0.
Feb - 18	Duschee Creek	Please add more winter trout water!!
Feb - 18	Camp Creek	All the fish appeared to be very healthy. 2 of the rainbows were close to 14". I have caught more browns in the past.
Feb - 18	S. Br. Root River	I have been fishing the south branch for over 35 years. It makes me sick to see the amount of trash that is in the stream since the canoe and tube rentals started.
Feb - 23	S. Br. Whitewater	Saw good numbers of trout, just couldn't find the right nymph pattern
Feb - 24	Hay Creek	Any plans to open other streams in area for winter season, e.g. Cold Spring, Mazeppa, etc. to relieve pressure on Hay Creek?
Mar - 6	Whitewater	Thanks for all the work you guys do, I've fished SE MN for many years and it's an invaluable resource. Could you please open all the streams during winter season?
Mar - 8	M. Br. Whitewater	Took my dogs for a walk in the lovely park!
Mar - 21	S. Br. Root River	We caught 18 trout today. Mostly browns some rainbows. Sorry, we didn't measure them.
Mar - 23	West Beaver Creek	I have some questions. Please call me at…