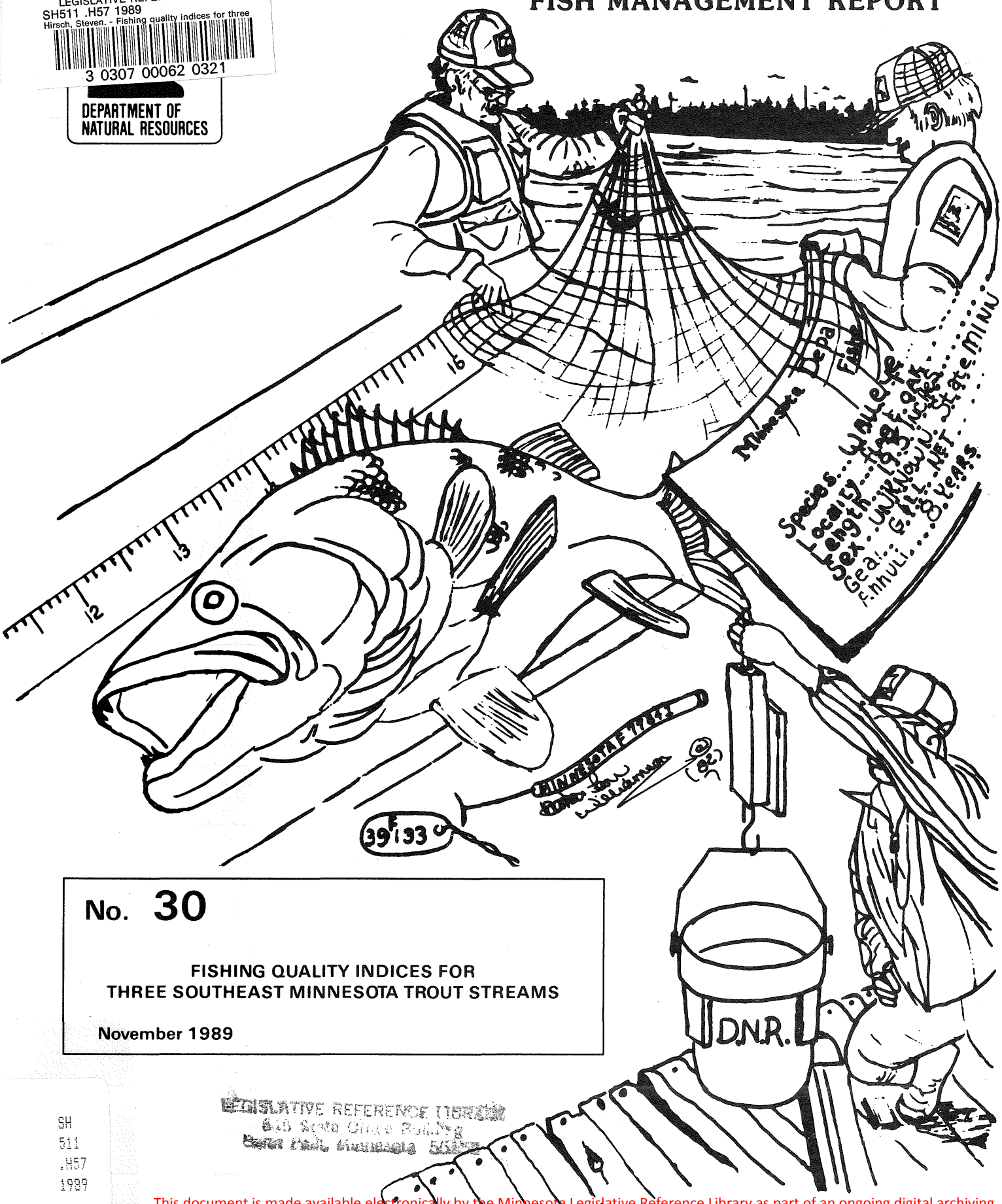
FISH MANAGEMENT REPORT



No. 30

FISHING QUALITY INDICES FOR THREE SOUTHEAST MINNESOTA TROUT STREAMS

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Division of Fish and Wildlife

Fishing Quality Indices for Three Southeast Minnesota Trout Streams[1]

by

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ABSTRACT

A roving creel survey was made of four southeast Minnesota trout stream reaches in the Whitewater River watershed from 1981-83. Methods developed by Weithman and Anderson (1978) and Weithman and Katti (1979) were used to calculate various fishing quality indices. Fishing quality was poor when compared to the fixed index developed by Weithman and Katti (1979); comparison to a regional index would be more appropriate. Length of brown trout required to satisfy anglers differed markedly on two of the streams; smaller fish were considered relatively important on one stream and unimportant on another stream. Increased rainbow trout harvest did not improve fishing quality on one stream because the fish were not considered very important by the average angler. Fishing quality indices provided information on anglers' acceptance of various sizes and species of trout which would not have been available from creel survey data.

INTRODUCTION

Weithman-Anderson fishing quality indices (WAFQI) are quantitative descriptors based on anglers' perceptions of controllable fishing quality parameters (Weithman and Anderson 1978). These parameters include the importance of the kind, number, size, and species of fish caught and the enjoyment derived from catching more than one species of fish and catching and releasing fish. There may be compensating factors relating to anglers' perceptions of fishing quality and success but fishery managers cannot evaluate this from traditional creel survey data. WAFQI have been calculated for different lake types in Minnesota (Nelson 1983 and various creel survey reports) but data for Minnesota trout streams are lacking.

WAFQI questions were incorporated into a roving creel survey of three trout streams in southeast Minnesota. WAFQI were used to examine trout stream management options involving stocking, habitat improvement, or regulation changes. In addition, baseline data would be established from which effects of future changes in trout stream management, habitat quality, and angling pressure could be evaluated.

STUDY AREA AND DESCRIPTION OF FISHERY

The study streams included the South Branch Whitewater River (divided into Upper South Branch Whitewater River (USBW) and Lower South Branch Whitewater River (LSBW)), Middle Branch Whitewater River (MDBW) and Beaver Creek

(BEAV). All of the streams were located in the Whitewater River watershed, close to Elba, Minnesota (Fig. 1). Surrounding land use consisted of agricultural uplands, steep wooded valleys, and a mixture of agriculture and woodlands in the valley bottom. The LSBW and MDBW were the largest of the study streams, the USBW was somewhat smaller, and BEAV was the smallest (Table 1).

Southeast Minnesota trout streams were generally very productive with alkalinities ranging from 220 to 250 mg/l. The USBW and BEAV had good water quality and support substantial wild brown trout (BNT) populations (55-70 kg/ha and 70-90 kg/ha respectively) (Lake City Management and Research files). LSBW and MDBW were more marginal because of higher water temperatures and increased siltation and supported wild BNT populations of 18-27 kg/ha and 9-18 kg/ha respectively. The LSBW and MDBW were stocked annually with BNT yearlings because of limited natural reproduction. In addition, all of the study streams were stocked at least once with RBT fingerlings during the study period (Table 2). Fall stocked RBT fingerlings provided primarily a yearling fishery the following spring (May-June) (Thorn 1984).

METHODS

The Research Unit of the Section of Fisheries evaluated fall rainbow trout (RBT) fingerling stocking on the study streams from 1981-83, which included a roving creel survey (Thorn 1984). MDBW was not surveyed in 1983. The trout season began on 1 March in 1981 and in mid-April in 1982-83

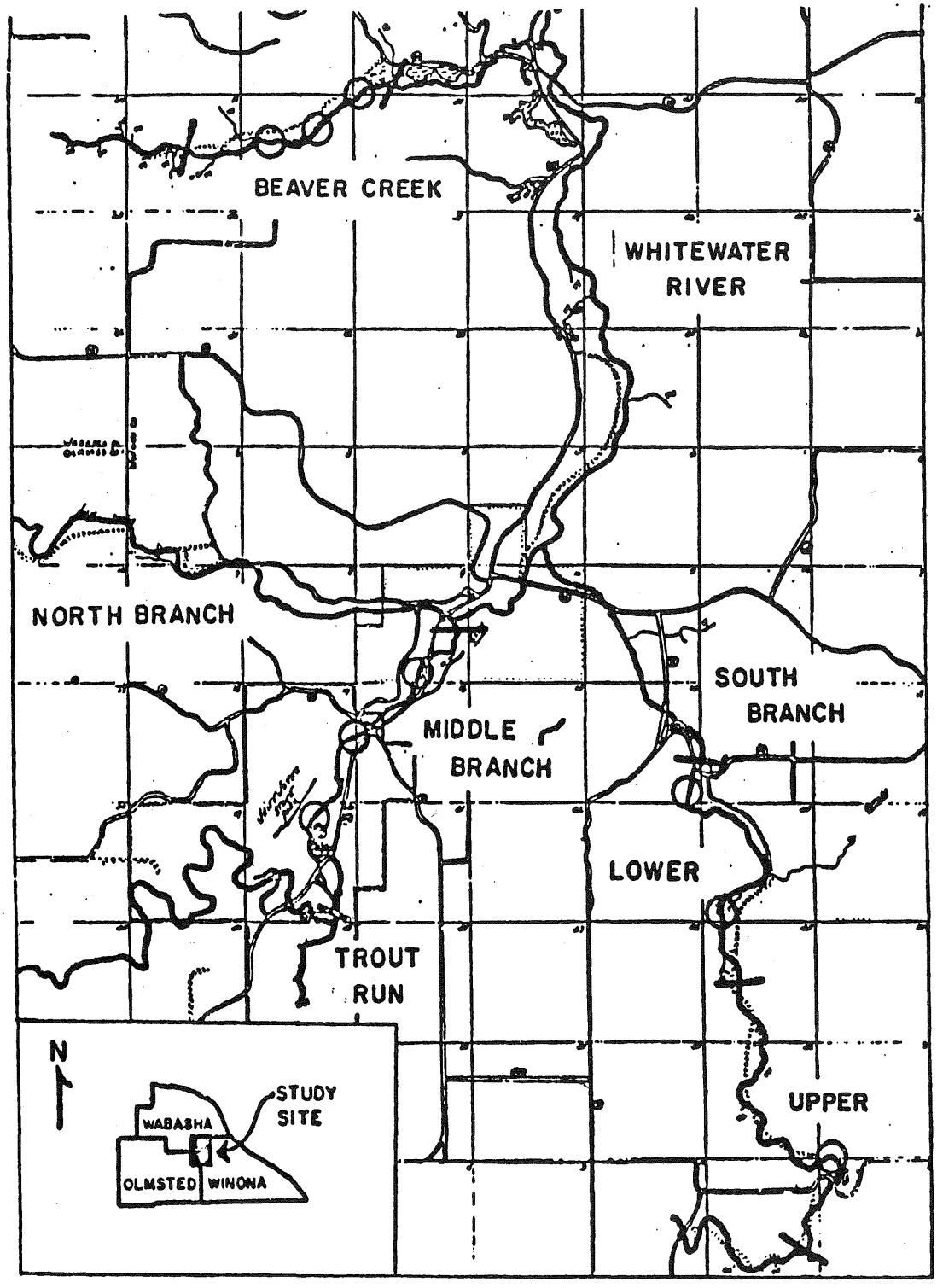

Figure 1. The study area for the fall fingerling rainbow trout stocking evaluation. Stream study sites are between bold lines perpendicular across each stream. Electrofishing stations are represented by open circles.

Table 1. Physical characteristics[a] of the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW), and Beaver Creek (BEAV), 1980-81.

Stream	Length (km)	Width (m)	Area (ha)	Normal summer flow (m3/s)
USBW	6.9	10.7	7.5	0.4-0.7
LSBW	6.3	11.1	6.6	1.1-1.5
MDBW	5.6	11.1	6.1	1.0-1.3
BEAV	10.1	5.2	5.2	0.2-0.4

[a] Data are for stream sections included in the study area.

Table 2. Number/km of rainbow trout fingerlings (RBT FGL) stocked in the fall and brown trout yearlings (BNT YRL) stocked in the spring/summer in the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW) and Beaver Creek (BEAV), October 1980 through September 1983.

	Stream			
Year/spp.	USBW	LSBW	MDBW	BEAV
1980				
RBT FGL	492	379	367	303
1981				
BNT YRL	--	625	70	--
RBT FGL	--	1,250	538	--
1982				
BNT YRL	--	625	70	--
RBT FGL	--	1,250	536	--
1983				
BNT YRL	--	625	70	--

and ended on 30 September during all years of the study.

Fishing quality questions as described by Weithman and Anderson (1978) were asked of all anglers contacted during the creel survey. Anglers were asked to rate the importance of kind, size, number and species of fish caught and the enjoyment of catching more than one kind of fish and catching and releasing fish (scale: 1 - extremely important or enjoyable, to 5 - unimportant or unenjoyable, personal communication, Stephen Weithman, Missouri Department of Conservation, 1984). In addition, the importance of each harvested fish was determined (Nelson 1983). Creel survey data were analyzed by Thorn (1984) and WAFQI data are analyzed in this paper.

WAFQI were calculated with a computer program written in BASIC for Apple Computers, using the formulas described by Weithman and Anderson (1978) and Weithman and Katti (1979) and the modification incorporated by Nelson (1983). Data analysis was stratified by stream and angling method. Indices calculated included fish quality (FQ), catch quality (CQ), harvest quality (HQ), successful ($\geq$1) trip quality (TQ) and overall fishing quality (Q). The Nelson modification involved using individual ratings for each harvested fish to calculate HQ. Overall species ratings were used to calculate CQ for each released fish, as in the original paper by Weithman (1978). Mean length of released trout was calculated each month of the survey from angler recalled lengths and numbers. The monthly mean length was

used for each released trout to calculate CQ. World record lengths used to calculate CQ and HQ were 1016 cm for BNT and 965 cm for RBT.

Some modification of Weithman-Anderson analysis methods was necessary. During 1981-82, species ratings were not obtained for released trout; therefore, no rating for released fish was available for calculation of CQ. As an alternative, a constant of "2" was used as a rating for the importance of each released trout (personal communication, Stephen Weithman, Missouri Department of Conservation, 1984). In 1983, species ratings for BNT, RBT and brook trout (BKT) were obtained from all anglers and quality indices were calculated using the true rating and constants of "2" and "3". Results were used to determine if "2" was an appropriate choice for a constant. Unless otherwise noted, reported indices were calculated using a constant of "2" for the importance of released trout.

Catch rates, harvest rates, mean lengths of harvested trout, percentage of rainbow trout in the catch and percentage of the catch which was released were calculated from anglers who answered all fishing quality questions appropriately. (A small percentage of anglers contacted did not comprehend or were unwilling to cooperate with the fishing quality questions.)

A mean rating was calculated for each of the fishing quality questions from responses by all anglers and results were stratified by stream and angling method. Relationship

of mean rating of harvested fish and length of harvested fish was examined using weighted linear regression analysis for BNT from USBW and BEAV and RBT from LSBW and MDBW. The slopes of the regression lines for BNT rating and length on USBW and BEAV were tested using analysis of covariance.

RESULTS

In general, large differences were not observed in the various fishing quality indices among the study streams. There were some subtle differences, however, which would be worth examining in more detail in future work of this type.

Overall fishing quality varied among the study streams with BEAV having the highest quality and MDBW the lowest (Table 3). USBW had the widest range in fishing quality during the study. LSBW fishing quality did not change from 1981 to 1982, but increased 100% in 1983.

Fishing quality results did not differ appreciably among the various angling methods except that anglers using a mixture of methods (MIX) had relatively poor fishing quality (Table 4). Sample size for MIX anglers was low.

WAFQI calculated with the constant "2" for the rating given to importance of released trout gave results which were very similar to those obtained from the actual ratings in 1983 (Table 5). Calculations with the constant "3" tended to give results which were not as close to results from the actual ratings.

Mean catch rates and mean harvest rates varied among the study streams with BEAV having the highest catch rate

Table 3. Mean fishing quality indices for the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW) and Beaver Creek (BEAV), 1981-1983 (±95% confidence limits and sample sizes in parentheses).

	1981				1982				1983		
Indices	USBW	LSBW	MDBW	BEAV	USBW	LSBW	MDBW	BEAV	USBW	LSBW	BEAV
Fish quality	0.16	0.21	0.17	0.12	0.19	0.15	0.16	0.15	0.10	0.13	0.16
	(0.03)	(0.04)	(0.04)	(0.01)	(0.04)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
	(149)	(212)	(93)	(270)	(133)	(410)	(184)	(197)	(242)	(423)	(176)
Catch quality	0.68	1.13	0.88	0.68	1.14	0.92	0.67	1.02	0.57	0.60	1.01
	(0.17)	(0.28)	(0.25)	(0.10)	(0.30)	(0.15)	(0.22)	(0.23)	(0.16)	(0.10)	(0.22)
	(149)	(212)	(93)	(270)	(133)	(410)	(184)	(197)	(242)	(423)	(176)
Harvest quality	1.14	1.41	1.53	1.06	1.71	1.23	1.09	1.54	1.53	1.00	1.80
	(0.34)	(0.45)	(0.42)	(0.13)	(0.47)	(0.24)	(0.56)	(0.39)	(0.91)	(0.23)	(0.47)
	(70)	(108)	(46)	(170)	(55)	(194)	(76)	(112)	(40)	(157)	(58)
Trip quality ≥ 1	2.79	5.88	3.43	3.75	3.49	3.03	3.07	4.13	2.92	3.40	3.76
	(12)	(32)	(22)	(38)	(21)	(53)	(23)	(37)	(19)	(53)	(22)
% successful	9	10	11	21	28	17	7	30	31	28	28
	(123)	(296)	(184)	(168)	(74)	(314)	(330)	(122)	(58)	(184)	(78)
Overall quality	0.03	0.06	0.04	0.09	0.11	0.06	0.03	0.15	0.11	0.12	0.14
	(0.02)	(0.03)	(0.02)	(0.04)	(0.05)	(0.02)	(0.01)	(0.05)	(0.06)	(0.04)	(0.07)

Table 4. A comparison of fishing quality indices among anglers using live bait (BAIT), artificial lures (ART), fly fishing gear (FLY), and a mixture of angling methods (MIX) for the South and Middle Branches of the Whitewater River and Beaver Creek from 1981-1983 (data are combined for all streams, ±95% confidence limits and sample sizes in parentheses).

	1981				1982				1983			
Indices	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX
Fish quality	0.22	0.14	0.19	0.09	0.17	0.11	0.11	0.17	0.13	0.18	0.14	0.08
	(0.02)	(0.02)	(0.05)	(0.02)	(0.12)	(0.02)	(0.02)	(0.04)	(0.02)	(0.05)	(0.03)	(0.01)
	(423)	(141)	(115)	(45)	(536)	(174)	(148)	(66)	(452)	(87)	(227)	(75)
Catch quality	0.81	0.78	1.08	0.49	1.05	0.67	0.67	0.72	0.75	1.06	0.46	0.44
	(0.14)	(0.16)	(0.98)	(0.10)	(0.14)	(0.15)	(0.19)	(0.44)	(0.13)	(0.33)	(0.08)	(0.08)
	(423)	(141)	(115)	(45)	(536)	(174)	(148)	(66)	(452)	(87)	(227)	(75)
Harvest quality	1.16	1.37	1.61	0.79	1.38	1.35	0.83	1.18	1.26	1.73	1.29	0.79
	(0.18)	(0.34)	(0.40)	(0.18)	(0.20)	(0.35)	(0.36)	(1.36)	(0.28)	(0.84)	(0.45)	(0.16)
	(276)	(49)	(51)	(18)	(334)	(52)	(26)	(25)	(186)	(21)	(25)	(23)
Trip quality ≥ 1	3.87	5.27	4.55	2.96	3.27	3.25	3.62	4.11	3.48	4.53	2.84	2.03
	(64)	(14)	(21)	(5)	(89)	(18)	(18)	(9)	(59)	(8)	(20)	(5)
% successful	13	13	19	8	14	22	18	17	29	24	39	15
	(491)	(108)	(110)	(62)	(613)	(79)	(95)	(53)	(204)	(35)	(51)	(30)
Overall quality	0.06	0.08	0.09	0.03	0.06	0.10	0.07	0.08	0.12	0.13	0.14	0.04
	(0.02)	(0.05)	(0.05)	(0.03)	(0.01)	(0.05)	(0.04)	(0.06)	(0.03)	(0.10)	(0.07)	(0.05)

Table 5. A comparison of fishing quality indices calculated using constants of "3", "2" and actual ratings for the importance of released fish for the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW) and Beaver Creek (BEAV), 16 April through 30 September 1983.

Stream	(rating)	Importance of released fish (mean)	Catch quality (mean)	Trip quality ≥1 (mean)	Log_{10} trip quality ≥1 (percent)	Successful anglers Q
USBW	3	0.45	2.58	0.33	25	0.08
	2	0.57	2.92	0.37	31	0.11
	actual rating	0.60	2.93	0.37	32	0.12
LSBW	3	0.55	3.35	0.41	25	0.10
	2	0.60	3.40	0.42	28	0.12
	actual rating	0.60	3.39	0.41	28	0.11
BEAV	3	0.87	3.70	0.50	22	0.11
	2	1.01	3.76	0.50	28	0.14
	actual rating	1.09	3.98	0.52	26	0.14

in 1981 and USBW the highest in 1982-83 1981 and USBW the highest in 1982-83 (Table 6). Mean catch rates were highest in all streams in 1983 and, except for BEAV, lowest in 1981. BEAV had the highest harvest rates among the study streams in 1981-82 and LSBW the highest in 1983.

Harvested BNT were generally smaller but more important to anglers on BEAV than on the other study streams (Tables 6 and 7). Harvested BNT were relatively large in the USBW but were the least important to anglers among the study streams. Harvested RBT were generally smaller and less important than brown trout to anglers on all the study streams.

Importance (or enjoyment) of the various fishing quality questions did not differ appreciably among streams; however, some differences occurred from year to year (Table 8). The importance of catching a particular kind of fish increased from 1981 to 1982 and then decreased somewhat in 1983. The enjoyment of catching more than one kind of fish increased each year of the study. The enjoyment of catching and releasing fish increased from 1981 to 1982 and decreased slightly in 1983. The importance of size and number of fish caught was relatively constant from 1981-83.

Importance (or enjoyment) of the various fishing quality questions was similar among angling methods except that fly fishing (FLY) anglers enjoyed catching and releasing fish more than other anglers (Table 9). All anglers tended to rate the enjoyment of catching and

Table 6. Creel census statistics for the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW) and Beaver Creek (BEAV), 1981-1983 (±95% confidence limits and sample sizes in parentheses).

	1981				1982				1983		
Statistics	USBW	LSBW	MDBW	BEAV	USBW	LSBW	MDBW	BEAV	USBW	LSBW	BEAV
Catch rate (fish/hr)	0.44	0.37	0.44	0.75	0.76	0.62	0.31	0.63	1.46	1.18	0.91
	(0.16)	(0.13)	(0.17)	(0.19)	(0.25)	(0.13)	(0.11)	(0.18)	(0.57)	(0.25)	(0.32)
	(123)	(296)	(184)	(168)	(74)	(314)	(330)	(122)	(58)	(184)	(78)
Harvest rate (fish/hr)	0.22	0.20	0.21	0.51	0.34	0.31	0.15	0.43	0.15	0.48	0.30
	(0.09)	(0.07)	(0.09)	(0.16)	(0.14)	(0.08)	(0.06)	(0.13)	(0.07)	(0.13)	(0.12)
Mean length (cm) harvested brown trout	28.7	25.7	28.7	24.4	29.7	27.4	25.4	25.9	27.9	24.4	25.9
	(45)	(87)	(20)	(122)	(42)	(89)	(31)	(109)	(35)	(80)	(59)
Mean length (cm) harvested rainbow trout	22.4	22.9	24.1	21.3	23.6	22.4	22.4	--	22.9	21.1	--
	(23)	(15)	(27)	(21)	(9)	(87)	(44)		(6)	(84)	
% of rainbow trout in catch	34	17	56	14	18	46	51	tr	5	59	0
% of catch released	53	53	51	46	58	53	61	45	83	63	68

Table 7. Mean angler ratings (scale: 1 - extremely important to 5 - unimportant) given to harvested brown trout (BNT) and rainbow trout (RBT) for the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW) and Beaver Creek (BEAV), 1981-1983 (±95% confidence limits and sample sizes in parentheses).

	1981				1982				1983		
Species	USBW	LSBW	MDBW	BEAV	USBW	LSBW	MDBW	BEAV	USBW	LSBW	BEAV
BNT	2.8	2.6	2.3	2.2	2.7	2.3	2.7	2.2	3.0	2.6	2.4
	(0.3)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.3)	(0.2)	(0.2)	(0.2)	(0.3)
	(45)	(87)	(20)	(122)	(42)	(89)	(31)	(109)	(35)	(80)	(59)
RBT	3.5	3.4	2.6	2.7	2.7	2.8	3.0	--	3.7	2.7	--
	(0.1)	(0.4)	(0.3)	(0.5)	(0.7)	(0.3)	(0.2)		(0.7)	(0.2)	
	(23)	(15)	(27)	(21)	(9)	(87)	(44)		(6)	(84)	

Table 8. Mean angler ratings (scale: 1 - extremely important to 5 - unimportant) given to the importance of catching a particular kind of fish (KIND), size of fish caught (SIZE), number of fish caught (NUMBER) and the enjoyment from catching more than one kind of fish (DIVERSITY) and catching and releasing fish (CATCH & RELEASE) for the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW) and Beaver Creek (BEAV), 1981-83 (±95% confidence limits and sample sizes in parentheses).

	1981-1983 combined				Streams combined			
	USBW	LSBW	MDBW	BEAV	1981	1982	1983	1981-83
KIND	2.9	2.6	2.6	2.7	3.6	1.9	2.4	2.6
	(0.1)	(0.1)	(0.1)	(0.2)	(0.1)	(0.1)	(0.3)	(0.1)
	(255)	(794)	(514)	(368)	(771)	(840)	(320)	(1,931)
SIZE	2.6	2.7	2.7	2.7	2.7	2.6	2.7	2.7
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(<0.1)
NUMBER	3.0	3.1	3.0	3.1	3.0	3.0	3.2	3.0
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
DIVERSITY	3.6	3.6	3.6	3.6	4.0	3.5	2.8	3.6
	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.2)	(0.1)
CATCH & RELEASE	2.4	2.3	2.4	2.5	2.8	2.0	2.2	2.4
	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)

Table 9. Comparison of mean ratings (scale: 1 - extremely important to 5 - unimportant) given to the importance of catching a particular kind of fish (KIND), size of fish caught (SIZE), number of fish caught (NUMBER) and the enjoyment from catching more than one kind of fish (DIVERSITY) and catching and releasing fish (CATCH & RELEASE) among anglers using live bait (BAIT), artificial lures (ART), fly fishing gear (FLY) and a mixture of angling methods (MIX) for the South and Middle Branches of the Whitewater River and Beaver Creek from 1981-83 (data are combined for all streams and years) (±95% confidence limits and sample sizes in parentheses).

Question	BAIT	ART	FLY	MIX
KIND	2.6 (0.1) (1,411)	2.7 (0.2) (402)	2.6 (0.2) (490)	2.9 (0.2) (186)
SIZE	2.6 (0.1)	2.8 (0.1)	2.8 (0.1)	2.7 (0.2)
NUMBER	3.0 (0.1)	3.2 (0.2)	3.2 (0.2)	3.0 (0.1)
DIVERSITY	3.6 (0.1)	3.6 (0.2)	3.7 (0.2)	3.6 (0.3)
CATCH & RELEASE	2.5 (0.1)	2.3 (0.2)	1.9 (0.2)	2.4 (0.1)

releasing fish higher than the other fishing quality parameters (Tables 8 and 9).

Catching BNT was more important to anglers than catching RBT and BKT on all of the study streams (Table 10). Catching RBT and BKT was slightly more important than catching BNT for anglers using artificial lures (ART). Catching BKT was most important, and RBT least important, to

Table 10. Comparison of mean ratings (scale: 1 - extremely important to 5 - unimportant) given to importance of catching brown trout (BNT), rainbow trout (RBT) and brook trout (BKT) for anglers using live bait (BAIT), artificial lures (ART), fly fishing gear (FLY) and a mixture of angling methods (MIX) on the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW) and Beaver Creek (BEAV), 1983 (±95% confidence limits and sample sizes in parentheses).

	USBW			LSBW			BEAV			All streams combined		
Method	BNT	RBT	BKT	BNT	RBT	BKT	BNT	RBT	BKT	BNT	RBT	BKT
BAIT	2.0 (0.3) (32)	2.5 (0.4)	2.7 (0.4)	2.2 (0.1) (130)	2.3 (0.2)	2.4 (0.2)	1.9 (0.3) (42)	2.7 (0.3)	2.7 (0.4)	2.0 (0.2) (204)	2.4 (0.1)	2.5 (0.1)
ART	2.3 (0.5) (8)	1.9 (0.5)	2.1 (0.5)	2.1 (0.5) (15)	2.0 (0.5)	2.1 (0.6)	1.8 (0.5) (12)	2.3 (0.6)	2.1 (0.6)	2.0 (0.3) (35)	2.1 (0.3)	2.1 (0.3)
FLY	1.6 (0.4) (13)	2.6 (0.6)	1.8 (0.5)	1.7 (0.4) (23)	2.6 (0.5)	2.4 (0.5)	1.5 (0.4) (15)	1.9 (0.7)	1.9 (0.5)	1.6 (0.2) (51)	2.6 (0.3)	2.2 (0.2)
MIX	1.8 (0.7) (5)	2.2 (0.4)	1.8 (0.4)	2.4 (0.7) (16)	2.6 (0.6)	1.9 (0.6)	1.9 (0.6) (9)	1.9 (0.7)	1.9 (0.5)	2.2 (0.5) (30)	2.3 (0.4)	1.9 (0.3)
Grand mean	2.0 (0.2) (58)	2.4 (0.3)	2.3 (0.3)	2.1 (0.2) (184)	2.3 (0.2)	2.3 (0.2)	1.8 (0.2) (78)	2.5 (0.2)	2.4 (0.3)	2.0 (0.1) (320)	2.4 (0.1)	2.3 (0.1)

MIX anglers. Catching BNT was more important to FLY anglers than ART, MIX or live bait anglers.

A linear relationship existed between trout length and importance to the angler for each of the study streams (Figs. 2 and 3). According to the models, LSBW and MDBW RBT received a "3" rating at 21.0 cm and a "2" rating at 32.1 cm. Anglers on the USBW and BEAV gave similar ratings to BNT which were 40 cm or larger, however, the slopes of the regression lines differed (ANCOVA; $P < 0.001$) because anglers on BEAV placed greater importance on small fish than did anglers on the USBW.

DISCUSSION

Fishing quality was consistently poor ($Q < 0.4$) during this study when compared to the criteria established by Weithman and Katti (1979). Nelson (1983) also found poor fishing quality in seven walleye-centrarchid lakes in Pope and Douglas counties, Minnesota. Since a variety of trout streams were censused over a three year period, it is unlikely that the fishing quality in all streams was always poor relative to what could be realistically expected. It would be more useful to evaluate Q values for a regional resource over a range of water bodies and years for each type of fishery examined, rather than according to a single rating system. Angling for wild trout in southeast Minnesota requires considerable skill for consistent success, yet many casual anglers participate in the fishery. This would result in relatively low percentages of

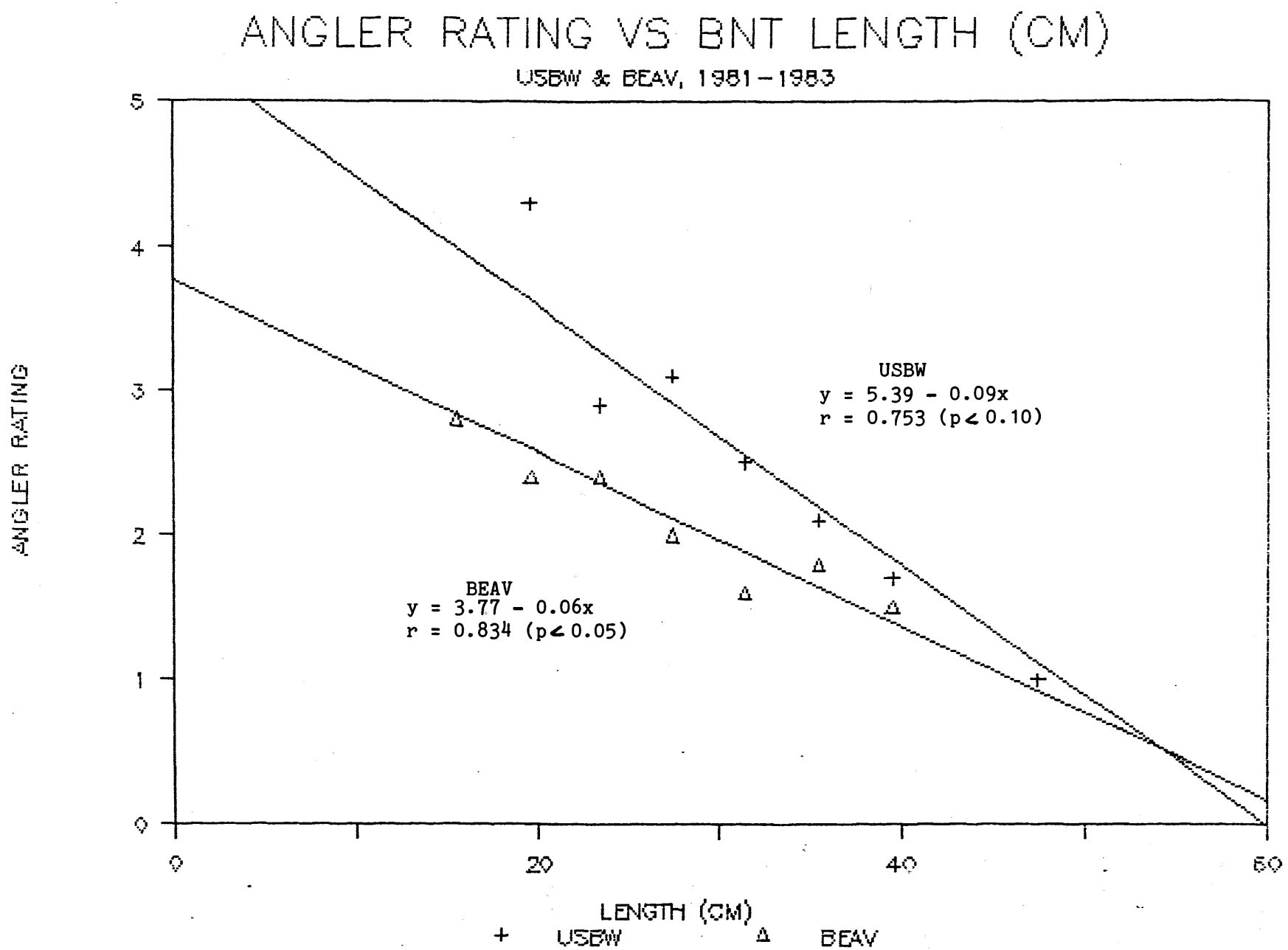

Figure 2. Relationship of angler rating (scale: 1 - extremely important to 5 - unimportant) and length (cm) of harvested brown trout on the Upper South Branch Whitewater (USBW) and Beaver Creek (BEAV), 1981-1983.

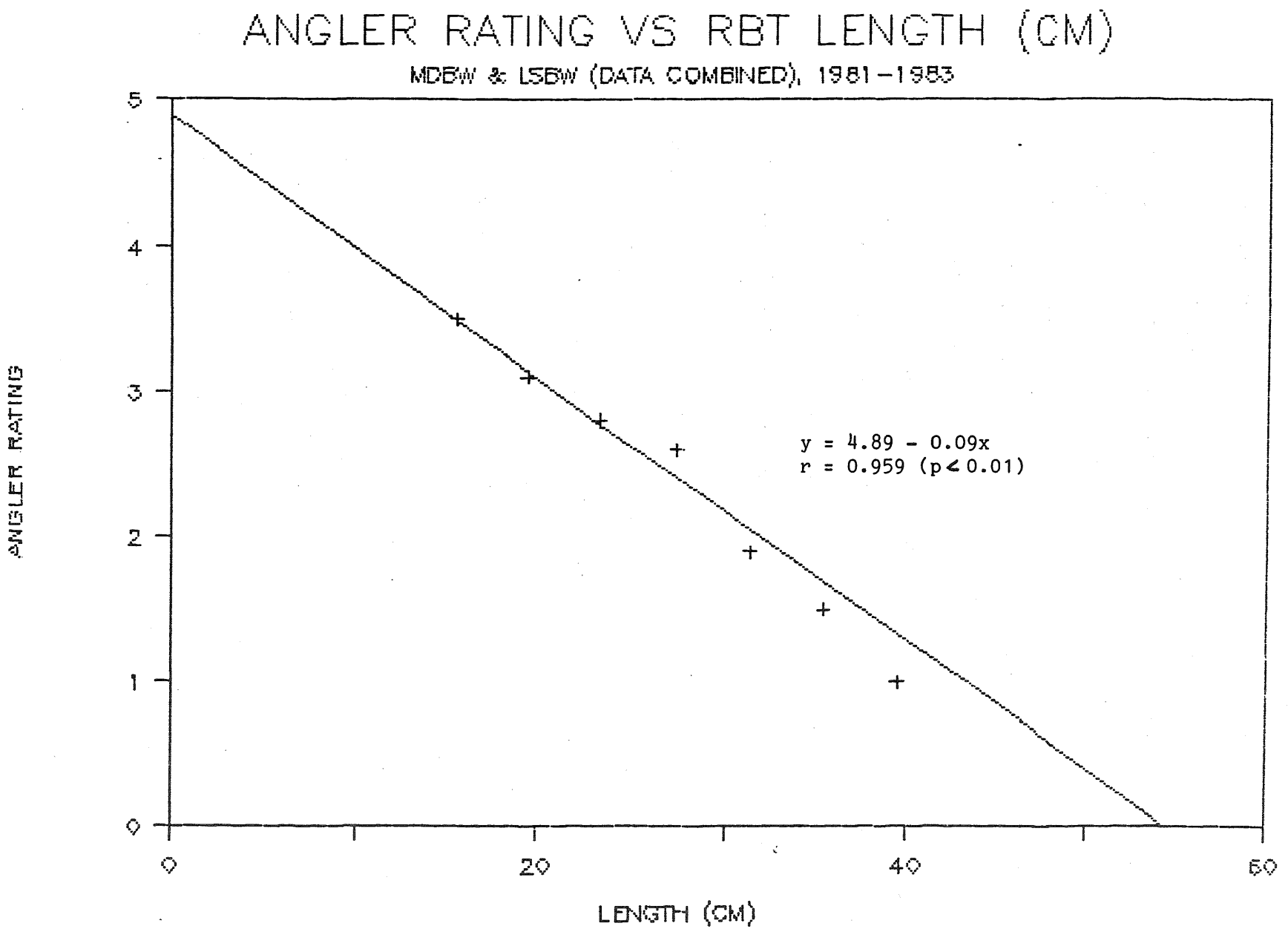

Figure 3. Relationship of angler rating (scale: 1 - extremely important to 5 - unimportant) and length (cm) of harvested rainbow trout on the Lower and Middle Branches of the Whitewater River, 1981-1983.

successful anglers and reduce Q values.

Although the Nelson modification (1983) provided very useful data on the relationship of fish length and importance to the angler, there are problems with its use in calculation of quality indices which may have affected data analysis in this study. The original method (Weithman and Anderson 1978) called for using species ratings in the calculation of CQ for released fish and HQ for harvested fish. The Nelson modification uses individual fish ratings for harvested fish (HQ); however, species ratings must still be used for released fish (CQ). As a result, smaller released fish may get a higher rating than harvested fish if an angler rates a species relatively high but the fish he has kept relatively low. This happened fairly frequently in this study, usually when anglers considered a species important, but kept fish of that species which they considered to be marginal. Future studies should use species ratings for both harvested and released fish when calculating HQ and CQ.

Since anglers often experience difficulty in interpreting and answering fishing quality questions, it is extremely important that questions be worded consistently from year to year. In this study, the largest year to year variation in angler response occurred with questions concerning the importance of the kind of fish caught, and the enjoyment of catching more than one kind of fish and catching and releasing fish. These questions also appeared

to be more difficult for anglers to understand than the questions concerning the importance of size and number of fish caught (relatively straightforward concepts). Creel survey clerks should receive specific instructions to avoid having them develop personal styles in leading anglers to answer questions appropriately.

An important question for fishery managers is whether WAFQI offers something unique or if it simply restates traditional creel survey information. This study indicates that WAFQI can offer insights beyond those which would be gained from creel survey data alone. Creel survey statistics appeared to show that the LSBW fishery improved from 1981 to 1982; harvest rate increased from 0.20 to 0.31 fish/hr, catch rate increased from 0.37 to 0.62 fish/hr, and estimated harvest increased from 1567 to 1896 fish (Thorn 1984). WAFQI showed, however, no change in the LSBW fishery from 1981 to 1982. Examination of harvest statistics revealed that the increases in 1982 were due to more RBT harvested; BNT harvest actually decreased. Apparently, the increased harvest of RBT was not important enough to anglers to increase fishing quality.

The Nelson modification (1983) helped to determine specific sizes of RBT which would be needed to increase their importance to anglers. Presumably, if the same number of larger (more important) RBT could have been provided in the 1982 LSBW fishery by yearling stocking and/or regulation changes, fishing quality could have been increased.

WAFQI also added additional insight into the BEAV fishery. BEAV creel survey statistics were fairly good with catch rates ranging from 0.63 to 0.91 fish/hr. BEAV is, however, a small stream which produces small trout. Creel survey statistics do not help to determine whether the small trout size is offset by angler success or attitudes; however, Q values indicated that BEAV had relatively good fishing quality. The high ratings which small BNT in BEAV received, especially when compared to similar sized BNT in the USBW, helped to illustrate that small BNT were not causing poor fishing quality in BEAV and indicated that anglers may have tailored their expectations according to what was available. Information such as this can be useful when prioritizing management efforts such as trout stream habitat improvement. In this case, habitat improvement or regulations designed to increase BNT size in BEAV may not be considered a high priority, since anglers appear to be rating the available trout relatively high.

In conclusion, WAFQI added additional insight into fishing quality on the streams surveyed. The utility of WAFQI may be affected, however, by the nature of the fishery being studied. Trout streams can be manipulated through various management techniques (stocking, habitat improvement, and regulations) and evaluated more easily than the traditional lake fishery. This may give WAFQI more practical importance in trout stream management than in management of cool and warm water lakes. Fishery managers

should decide on a case by case basis if WAFQI would be useful information to collect during creel surveys.

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Table A1. A comparison of fishing quality indices among anglers using live bait (BAIT), artificial lures (ART), fly fishing gear (FLY), and a mixture of angling methods (MIX) for the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW) and Beaver Creek (BEAV), 1981-83 (±95% confidence limits and sample sizes in parentheses).

	USBW - 1981				LSBW - 1981				MDBW - 1981			
Indices	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX
Fish quality	0.18	0.12	0.10	0.12	0.21	0.15	0.31	0.09	0.14	0.11	0.30	0.11
	(0.04)	(0.03)	(0.07)	(0.05)	(0.05)	(0.05)	(0.12)	(0.09)	(0.03)	(0.07)	(0.16)	(0.08)
	(105)	(25)	(9)	(10)	(113)	(62)	(34)	(3)	(54)	(11)	(21)	(7)
Catch quality	0.75	0.47	0.65	0.46	1.09	0.84	1.79	0.34	0.78	0.53	1.43	0.37
	(0.23)	(0.19)	(0.70)	(0.24)	(0.42)	(0.30)	(0.85)	(0.22)	(0.24)	(0.37)	(0.85)	(0.26)
	(105)	(25)	(9)	(10)	(113)	(62)	(34)	(3)	(54)	(11)	(21)	(7)
Harvest quality	1.22	0.90	1.85	0.62	1.40	1.53	1.47	0.47	1.32	1.00	2.26	0.81
	(0.40)	(0.59)	(11.81)	(0.35)	(0.56)	(0.82)	(0.67)	--	(0.38)	(1.14)	(1.17)	(0.82)
	(54)	(8)	(2)	(6)	(75)	(17)	(15)	(1)	(27)	(4)	(13)	(2)
Trip quality ≥ 1	3.11	3.00	1.32	1.10	5.48	5.22	8.05	--	2.98	1.81	4.08	3.63
	(9)	(1)	(1)	(1)	(17)	(9)	(6)		(11)	(1)	(9)	(1)
% successful	14	4	7	4	8	17	10	0	8	6	27	6
	(63)	(21)	(16)	(23)	(180)	(47)	(50)	(12)	(114)	(23)	(31)	(16)
Overall quality	0.06	0.02	0.01	tr	0.05	0.10	0.06	0.00	0.03	0.02	0.14	0.03
	(0.04)	(0.04)	(0.02)	--	(0.03)	(0.08)	(0.07)	--	(0.02)	(0.03)	(0.10)	(0.07)

Table A1. (Cont'd).

Indices	BEAV - 1981				USBW - 1982				LSBW - 1982			
	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX
Fish quality	0.13	0.14	0.09	0.08	0.20	0.13	0.08	--	0.16	0.15	0.12	0.07
	(0.02)	(0.03)	(0.02)	(0.02)	(0.04)	(0.04)	(0.01)		(0.02)	(0.06)	(0.05)	(0.01)
	(151)	(43)	(51)	(25)	(67)	(46)	(16)		(255)	(47)	(68)	(40)
Catch quality	0.67	0.97	0.52	0.57	1.19	0.66	0.55	--	1.02	0.99	0.86	0.35
	(0.12)	(0.28)	(0.18)	(0.15)	(0.39)	(0.21)	(0.08)		(0.19)	(0.45)	(0.39)	(0.07)
	(151)	(43)	(51)	(25)	(67)	(46)	(16)		(255)	(47)	(68)	(40)
Harvest quality	0.92	1.77	1.15	0.94	1.69	1.65	--	--	1.25	1.61	1.24	0.15
	(0.14)	(0.36)	(0.04)	(0.33)	(0.56)	(0.62)			(0.25)	(0.74)	(0.91)	(0.14)
	(120)	(20)	(21)	(9)	(42)	(13)			(158)	(18)	(7)	(10)
Trip quality $\geq$ 1	3.43	6.44	2.79	3.35	3.15	2.15	3.31	--	2.66	3.86	5.04	1.51
	(18)	(10)	(6)	(4)	(13)	(7)	(1)		(36)	(6)	(7)	(4)
% successful	18	23	46	33	24	50	10	--	16	27	21	18
	(122)	(53)	(13)	(11)	(50)	(13)	(9)		(236)	(24)	(34)	(20)
Overall quality	0.07	0.18	0.17	0.14	0.09	0.14	0.05	--	0.06	0.15	0.11	0.02
	(0.04)	(0.14)	(0.14)	(0.17)	(0.06)	(0.11)	(0.10)		(0.02)	(0.12)	(0.09)	(0.03)

Table A1. (Cont'd).

Indices	MDBW - 1982				BEAV - 1982				USBW - 1983			
	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX
Fish quality	0.13	0.07	0.08	0.19	0.19	0.09	0.12	0.13	0.13	0.10	0.08	0.10
	(0.04)	(0.01)	(0.02)	(0.19)	(0.04)	(0.02)	(0.04)	(0.03)	(0.04)	(0.01)	(0.01)	(0.04)
	(104)	(29)	(37)	(14)	(109)	(51)	(26)	(11)	(101)	(44)	(86)	(11)
Catch quality	0.69	0.36	0.50	1.55	1.36	0.57	0.49	1.02	0.74	0.44	0.44	0.54
	(0.25)	(0.07)	(0.19)	(2.10)	(0.39)	(0.19)	(0.13)	(0.26)	(0.38)	(0.11)	(0.05)	(0.22)
	(104)	(29)	(37)	(14)	(109)	(51)	(26)	(11)	(101)	(44)	(86)	(11)
Harvest quality	0.99	0.46	0.74	2.65	1.74	1.19	0.66	1.20	1.79	1.16	1.12	0.93
	(0.43)	(0.36)	(0.97)	(4.82)	(0.51)	(0.57)	(0.34)	(0.32)	(1.41)	(0.51)	(0.37)	(0.54)
	(55)	(6)	(7)	(7)	(79)	(15)	(9)	(8)	(26)	(5)	(5)	(4)
Trip quality $\geq$ 1	3.22	5.77	1.90	4.17	4.44	3.12	3.84	2.87	2.24	3.50	3.52	--
	(14)	(1)	(6)	(2)	(24)	(4)	(7)	(2)	(9)	(2)	(8)	
% successful	6	3	16	9	23	50	38	33	26	25	54	0
	(235)	(34)	(37)	(23)	(92)	(8)	(15)	(7)	(32)	(8)	(13)	(5)
Overall quality	0.03	0.02	0.04	0.04	0.12	0.22	0.18	0.15	0.08	0.12	0.23	0.00
	(0.02)	(0.04)	(0.04)	(0.08)	(0.06)	(0.19)	(0.16)	(0.25)	(0.06)	(0.17)	(0.18)	--

Table A1. (Cont'd).

Indices	LSBW - 1983 BAIT	ART	FLY	MIX	BEAV - 1983 BAIT	ART	FLY	MIX
Fish quality	0.12	0.21	0.18	0.07	0.14	0.31	0.14	0.10
	(0.02)	(0.15)	(0.06)	(0.01)	(0.03)	(0.15)	(0.07)	(0.05)
	(237)	(17)	(117)	(52)	(114)	(26)	(24)	(12)
Catch quality	0.73	1.34	0.32	0.40	0.79	1.94	1.17	0.51
	(0.17)	(0.96)	(0.05)	(0.05)	(0.21)	(0.91)	(0.68)	(0.39)
	(237)	(17)	(117)	(52)	(114)	(26)	(24)	(12)
Harvest quality	1.05	1.58	0.58	0.61	1.53	2.54	3.32	1.35
	(0.28)	(1.46)	(0.26)	(0.09)	(0.47)	(2.63)	(2.37)	(1.33)
	(118)	(10)	(14)	(15)	(42)	(6)	(6)	(4)
Trip quality $\geq$ 1	3.65	5.18	2.32	2.03	3.76	4.56	2.51	--
	(37)	(3)	(9)	(4)	(15)	(3)	(4)	
% successful	27	21	35	27	36	27	25	0
	(130)	(15)	(23)	(16)	(42)	(12)	(15)	(9)
Overall quality	0.12	0.10	0.11	0.07	0.18	0.13	0.10	0
	(0.04)	(0.15)	(0.18)	(0.09)	(0.09)	(0.18)	(0.13)	--

Table A2. Mean angler ratings (scale: 1 - extremely important to 5 - unimportant) given to the importance of catching a particular kind of fish (KIND), size of fish caught (SIZE), number of fish caught (NUMBER) and the enjoyment from catching more than one kind of fish (DIVERSITY) and catching and releasing fish (CATCH & RELEASE) for the Upper South Branch Whitewater (USBW), Lower South Branch Whitewater (LSBW), Middle Branch Whitewater (MDBW) and Beaver Creek (BEAV), 1981-83 (±95% confidence limits and sample sizes in parentheses).

	1981				1982				1983		
Question	USBW	LSBW	MDBW	BEAV	USBW	LSBW	MDBW	BEAV	USBW	LSBW	BEAV
KIND	3.7	3.6	3.5	3.7	2.1	1.7	2.1	1.5	2.2	2.4	2.3
	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.1)	(0.1)	(0.2)	(0.2)	(0.2)	(0.3)
	(63)	(180)	(114)	(122)	(50)	(236)	(235)	(92)	(32)	(130)	(42)
SIZE	2.7	2.8	2.7	2.7	2.5	2.5	2.7	2.7	2.7	2.7	2.8
	(0.2)	(0.1)	(0.1)	(0.2)	(0.2)	(0.1)	(0.1)	(0.2)	(0.1)	(0.1)	(0.3)
NUMBER	3.0	3.2	2.8	2.9	3.0	2.9	3.1	3.2	3.2	3.1	3.4
	(0.2)	(0.1)	(0.2)	(0.2)	(0.2)	(0.1)	(0.1)	(0.1)	(0.2)	(0.2)	(0.2)
DIVERSITY	4.0	4.1	3.9	4.0	3.5	3.5	3.6	3.6	2.7	2.9	2.7
	(0.2)	(0.1)	(0.2)	(0.2)	(0.3)	(0.2)	(0.2)	(0.2)	(0.3)	(0.2)	(0.3)
CATCH & RELEASE	2.9	2.7	2.7	3.0	2.0	1.9	2.2	2.0	1.9	2.3	2.1
	(0.3)	(0.1)	(0.2)	(0.2)	(0.3)	(0.1)	(0.1)	(0.1)	(0.3)	(0.2)	(0.3)

Table A3. Comparison of mean ratings (scale: 1 - extremely important to 5 - unimportant) given to the importance of catching a particular kind of fish (KIND), size of fish caught (SIZE), number of fish caught (NUMBER) and the enjoyment from catching more than one kind of fish (DIVERSITY) and catching and releasing fish (CATCH & RELEASE) among anglers using live bait (BAIT), artificial lures (ART), fly fishing gear (FLY) and a mixture of angling methods (MIX) for the study streams, 1981-83 (±95% confidence limits and sample sizes in parentheses).

	1981				1982				1983			
Question	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX	BAIT	ART	FLY	MIX
KIND	3.6	3.5	3.6	3.9	1.9	1.7	1.6	2.0	2.4	2.4	2.1	2.5
	(0.1)	(0.2)	(0.2)	(0.3)	(0.1)	(0.2)	(0.1)	(0.3)	(0.2)	(0.5)	(0.4)	(0.5)
	(479)	(114)	(110)	(62)	(613)	(79)	(95)	(53)	(42)	(12)	(15)	(9)
SIZE	2.8	2.7	2.7	2.6	2.5	2.7	2.9	2.9	2.6	2.9	3.0	2.9
	(0.1)	(0.1)	(0.2)	(0.2)	(0.1)	(0.2)	(0.2)	(0.2)	(0.1)	(0.3)	(0.2)	(0.3)
NUMBER	2.9	3.2	3.3	3.1	3.0	3.2	3.1	3.0	3.1	3.1	3.2	3.6
	(0.1)	(0.2)	(0.2)	(0.3)	(0.1)	(0.3)	(0.2)	(0.3)	(0.2)	(0.3)	(0.4)	(0.4)
DIVERSITY	4.0	4.1	4.1	4.2	3.5	3.4	3.7	3.7	2.9	2.4	3.0	2.0
	(0.1)	(0.2)	(0.2)	(0.3)	(0.1)	(0.3)	(0.2)	(0.5)	(0.2)	(0.4)	(0.4)	(0.6)
CATCH & RELEASE	3.0	2.7	2.1	2.7	2.2	1.8	1.6	2.0	2.4	2.0	1.8	2.1
	(0.1)	(0.3)	(0.2)	(0.3)	(0.1)	(0.2)	(0.2)	(0.3)	(0.2)	(0.3)	(0.3)	(0.4)

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