

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

# RESEARCH REPORT 150

May 1990

THE WHITE RIVER TROUT POPULATION  
AND SPORT FISHERY:  
AN EXPLORATORY STUDY, 1984-1986

By Ed L. Avery  
Bureau of Research, Waupaca

## ABSTRACT

Trout populations and the sport fishery in a 21.3-mile reach of the White River (Bayfield Co.) flowing through the Wisconsin Department of Natural Resources (DNR) Bibon Swamp Natural Area were studied during 1984-86 to: (1) gather baseline quantitative data, (2) determine the current impact of fishing on trout, and (3) determine remedial management measures necessary to sustain large brown trout in the fishery. A 15-mile segment of the study area is the longest reach of trout water in Wisconsin inaccessible by public road. Historically, this segment has provided a popular, rare canoe fishery for large wild brown trout (*Salmo trutta*), including occasional fish of trophy size ( $\geq 20.0$  inches).

Wild brown trout, brook trout (*Salvelinus fontinalis*), and rainbow trout (*Oncorhynchus mykiss*) were found in the study area, but 99% of the biomass each spring from 1984-86 consisted of brown trout. During the 3 years of study, spring density of legal-sized ( $\geq 6.0$  inches) brown trout averaged 544/mile (432-733/mile range); biomass averaged 48 lb/acre (41-59 lb/acre range). Abundance of brown trout  $\geq 10.0$  inches averaged 267/mile in April (222-321/mile range). Abundance of brown trout  $\geq 15.0$  inches averaged 27/mile (21-36/mile range). The average size of legal-sized trout in April was 10.3 inches (10.1-10.5 inches range).

Annual fishing pressure increased from 86 hours/acre in 1984 to 106 hours/acre in 1985 due to favorable weather and river conditions as well as an increase in public access. Angler harvest increased from 173 trout/mile in 1984 to 213 trout/mile in 1985. Angler exploitation of brown trout  $\geq 6.0$  inches,  $\geq 10.0$  inches, and  $\geq 15.0$  inches averaged 33%, 51%, and 111%, respectively, during the 2 fishing seasons. In spring 1986, biomass of legal-sized brown trout and brown trout  $\geq 10.0$  inches was the lowest observed during the study.

The average size of creel brown trout declined from 12.2 inches in 1984 to 11.8 inches in 1985. The dominant age group in the harvest changed from age III in 1984 to age II in 1985. Substantial voluntary catch-and-release fishing, for example catch-and-sort for larger trout, was practiced during both years of creel census.

Anglers fishing the White River were more successful (77%), creel larger trout (12.2 inches in 1984 and 11.8 inches in 1985), and traveled farther to fish (46% traveled more than 100 miles) than on any other Wisconsin trout stream studied to date. Approximately 43% of the anglers fished from canoes.

Angler exploitation of the brown trout population as a whole was within safe limits, but exploitation of trout  $\geq 10.0$  inches, especially those  $\geq 15.0$  inches, was high enough to warrant increased attention and management concern.

Recommendations include: (1) greater attention by the Wisconsin DNR to this rare and unique fishery to restore, preserve, and enhance its status; (2) increased encouragement by the DNR for anglers to voluntarily restrict their harvest to not more than 1 trout/day  $\geq 15.0$  inches (a practice initiated before the 1986 fishing season); (3) a repeat population survey in spring 1989 of stations sampled in 1984-86; (4) another creel census through mid-July of the 1989 fishing season; and (5) no additional construction of public parking facilities or public access along the White River within the DNR Bibon Swamp Natural Area.

## **CONTENTS**

INTRODUCTION, 3

STUDY AREA, 4

METHODS, 5

    Assessment of Trout Populations, 5

    Assessment of Sport Fisheries, 6

        Creel Census, 6

        Estimation of Fishing Pressure and Harvest, 6

RESULTS, 7

    Trout Populations, 7

    Sport Fisheries, 10

        Fishing Pressure, 10

        The Logic Behind Assessing Harvest, 11

        Harvest, 12

            Age Structure, 14

            Size vs. Age, 14

    Exploitation, 14

    Angler Characteristics, 15

DISCUSSION, 17

    Trout Population Dynamics and the Sport Fishery, 17

    Comparisons with Other Brown Trout Streams, 18

MANAGEMENT CONSIDERATIONS, 20

APPENDIX, 21

    A. Notes on the Long Lake Branch Sport Fishery in Bayfield County, 21

    B. Table 1. Electrofishing scheme used in the 3 stations sampled in the White River, spring 1984-86, 22

        Table 2. Average weights per inch group of brown trout from the White River study area, spring 1984-86, 22

    C. Creel census questionnaire, 23

    D. Angler interview card, 24

LITERATURE CITED, 25



## INTRODUCTION

The White River originates in the Chequamegon National Forest in central Bayfield County and is that county's largest river. From its origin near the village of Delta, the river flows east 32 miles and enters Ashland County. A 49-ft power dam just inside Ashland County creates the White River Flowage and prevents upstream movement of anadromous salmonids from Lake Superior. Below the power dam, the river flows northeast 14 miles to its junction with the Bad River near Odanah and then another 4 miles into Lake Superior.

The White River averages 44 ft in width, with an average discharge of 234 cfs (Johannes et al. 1971). It is one of only 8 rivers in Wisconsin with over 40 miles of Class I or Class II trout water (Wis. Dep. Nat. Resour. 1980b). The upper 2 miles (above Pikes Road Bridge to the confluence of the East and South forks) are Class I trout water, while the lower 44 miles are Class II trout water (Fig. 1). The upper 12 miles of the White River (above Sutherland Bridge on Townline Road) are part of the DNR White River Fishery Area, established in 1961 (Weiher et al. 1981).

The White River is neither as large nor as well known as the Bois Brule River in neighboring Douglas County, the Wolf River in Langlade County, or the Peshtigo River in Marinette County. However, the White River does have a long-established reputation for producing large brown trout (*Salmo trutta*), including occasional fish in the trophy class ( $\geq 20.0$  inches). The reach flowing through the Bibon Swamp in east central Bayfield County is especially known for producing large trout (Fig. 1). The 15-mile river segment between the Sutherland and Bibon Road bridges is the longest reach of high-quality trout water in Wisconsin inaccessible by public road; historically, it has provided a rare canoe fishery for wild brown trout.

In October 1980, the Wisconsin Department of Natural Resources (DNR) established the Bibon Swamp Natural Area. As stated in the final environmental impact statement for the proposed acquisition, development, and management of the Bibon Swamp Natural Area, "the goal of the proposed Bibon Swamp Natural Area project is to preserve the unique wild resource values of the White River and adjacent

Bibon Swamp; to provide high quality trout fishing, hunting and trapping; and to accommodate other compatible recreational day use activities in a natural setting" (Wis. Dep. Nat. Resour. 1980a:4). The 13,486-acre project area includes the White River from Sutherland Bridge on Townline Road to the Bibon Road Bridge (Fig. 1).

During the late 1970s and early 1980s, complaints from long-time trout anglers on the White River increased at the DNR Area Office in Brule. Anglers suspected that the number of large brown trout being caught from the Bibon Swamp had declined. Area fish managers Bill Weiher and Steve Schramm observed increasing numbers of vehicles along the river during this period, which suggested increasing fishing pressure. However, no quantitative estimates of fishing pressure, trout harvest, or resident trout populations were available in DNR files to assess the situation and determine if remedial management efforts were necessary. Therefore, a 3-year cooperative study between DNR fish management and fish research personnel was initiated in July 1983 to gather quantitative baseline information upon which a more effective fish management program could be established.

## STUDY AREA

A 21.3-mile reach<sup>1</sup> of the White River, beginning at the Pikes Road Bridge and continuing downstream to the Bibon Road Bridge, was selected for study (Fig. 1). A small public parking lot is located at Pikes Road Bridge. Additional angler access is provided via a dead-end road that parallels the north side of the river for approximately 1.8 miles below Pikes Bridge.

Sutherland Bridge, on Townline Road, is located 6.4 river miles below Pikes Road Bridge and is the only bridge crossing the study area. A small, privately owned parking area with canoe access is located at the Sutherland Bridge and is generally available to the public. The Bibon Road Bridge is approximately 15 river miles below the Sutherland Bridge, and a public parking lot with canoe access is located there.<sup>2</sup>

Six tributaries enter the study area and are all classified as trout water (Fig. 1). Five of them (Kern, Bolen, Sajdak Spring, Hanson, and Johnson creeks) are small enough to jump across. The sixth tributary, Long Lake Branch, is a major artery that significantly



*Sutherland Bridge on the White River (sandy access for canoes through private land is in foreground).*



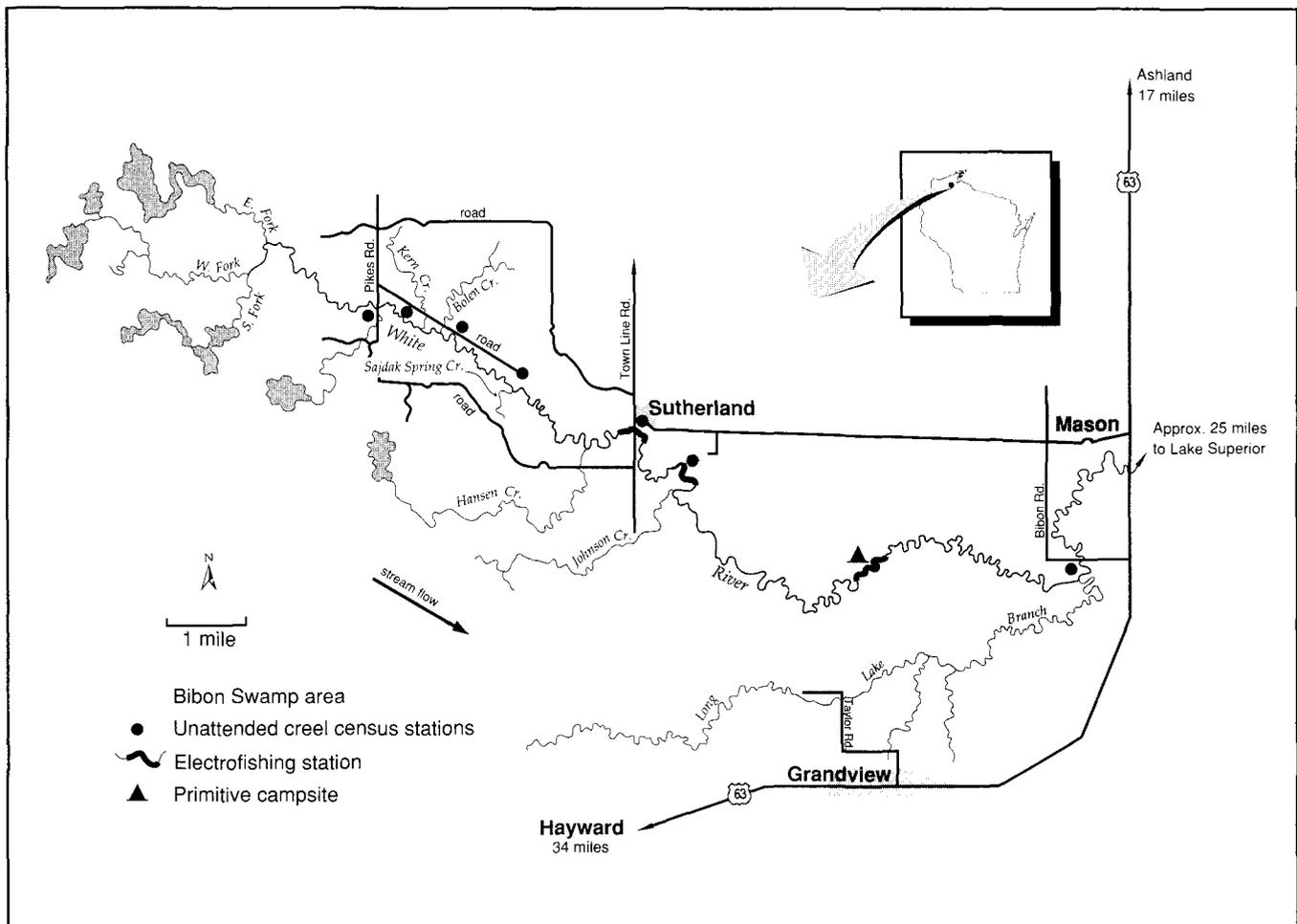
*The White River in the vicinity of electrofishing station 2 (boom of mini-boom shocker boat is in foreground).*

augments the flow of the White River and also supports an excellent trout fishery (Append. A).

Motor boats are prohibited on the White River above U.S. Highway 63, in accordance with town board mandates and the goals of the Bibon Swamp Natural Area. A significant proportion of the fishing within the Bibon Swamp is done from canoe. Assuming 2 persons/canoe and no delays for fishing, the trip from Pikes Road Bridge down to Sutherland Bridge takes 2 hours, and the trip from Sutherland Bridge to Bibon Road Bridge takes 5 hours. A primitive camp-

<sup>1</sup> Length was determined from U.S.G.S. topographic maps, using a Houston Instruments digitizing pad connected with an Apple II-E computer.

<sup>2</sup> The old Bibon Road Bridge was replaced during this study, and a public parking lot with canoe access was constructed in conjunction with the new bridge.



**FIGURE 1.** White River study area in Bayfield County.

site is located 5 river miles below Sutherland Bridge and serves as a base for anglers wishing to fish for more than one day in the Bibon Swamp (Fig. 1).

Three electrofishing stations were selected in the study area, and trout populations were surveyed in the springs of 1984-86. In 1984 Station 1, located at Sutherland Bridge on Townline Road, included 0.25 mile above the bridge and 0.5 mile below the bridge. In 1985 and 1986, Station 1 included 0.5 mile above and 0.5 mile below the bridge. Station 2 began approximately 1.75 miles below Sutherland Bridge and extended 1.0 mile downstream during all 3 years. At the midpoint of this station is a private access. Station 3 was located in the vicinity of a primitive campsite several miles below Station 2, deep in the Bibon Swamp, and included 0.5 mile above and 0.5 mile below the campsite during all 3 years (Fig. 1).

## METHODS

### Assessment of Trout Populations

Mark-recapture electrofishing surveys were conducted at the 3 electrofishing stations using 2 boats: an 18- or 20-ft boom shocker followed closely by a 14-ft minishocker (Append. B Table 1). All electrofishing surveys progressed downstream during daylight, using primarily dc electricity. Trout captured on the marking run were measured to the nearest 0.1 inch, weighed to the nearest gram, given a temporary caudal fin clip, and released near the midpoint of the portion of the station sampled. In most cases, trout were processed every 0.5 mile. Trout captured on the recapture run were examined for fin clips, measured, and also released near the middle of the portion of the

station sampled. Mark-recapture electrofishing runs were separated by 1-2 days to allow fish to redistribute themselves between runs. The electrofishing gear used in this study was inadequate to effectively sample smaller (3.0-5.0 inch) fish.

The Bailey modification of the Petersen mark and recapture formula was used to estimate the population of legal-sized trout, i.e.  $\geq 6.0$  inches, in each of the 3 stations during all 3 years. Confidence intervals at the 95% level for the total population estimate were determined as  $\pm 2 \sqrt{\text{variance}}$  (Ricker 1958). Population estimates for each station were divided into inch groups based upon the proportion of unmarked trout captured in each inch group on both mark and recapture runs. Average lengths and weights of trout in each inch group were determined based on measurements and weights of trout from all stations.

## Assessment of Sport Fisheries

### Creel Census

A partial creel census was conducted in the White River study area throughout the 1984 and 1985 fishing seasons.<sup>3</sup> No census was conducted in 1986. A DNR creel census clerk normally worked one of two 8-hour shifts on each census day (5:30 a.m. to 1:30 p.m. or 1:30 p.m. to 9:30 p.m.) and averaged 40 hours/week on the stream. On opening weekend, double shifts (16-hour days) were worked, to approximate a complete census and to accommodate the heavy fishing pressure. With the exception of opening weekend, census days and 8-hour shifts were randomly selected within the constraints of a 40-hour workweek to best represent all days as well as a.m. and p.m. shifts.

The census was conducted on 89 days of the 149-day fishing season in 1984 and included 39 weekend days and holidays plus 50 weekdays. Excluding opening weekend, when both 8-hour shifts were worked on both days, 50 shifts were worked on weekends and holidays, and 51 shifts were worked on weekdays. In 1985, the census was conducted on 93 days of the 150-day fishing season and included 39 weekend days and holidays plus 54 weekdays. Excluding opening weekend, when both 8-hour shifts were worked on both days, 51 shifts were worked on weekends and holidays, and 54 shifts were worked on weekdays.

A significant mayfly (*Hexagenia limbata*) hatch occurs on the White River during late June-early July and stimulates a resurgence of fishing pressure because the hatch attracts fly fishers. The hatch begins at dusk and continues well after dark. During

this 1-2 week period, the scheduled p.m. creel census shifts began 2 hours later and extended 2 hours later (3:30 p.m. to 11:30 p.m.), in order to contact more anglers.

On each census day, the census clerks interviewed anglers to gather information on the number of anglers in their party, the location of their residences, the length of time fished, fishing methods used, and their catch. A sample questionnaire is shown in Appendix C. Most anglers were interviewed as they returned to their cars at the end of their fishing trip. All creel trout were measured to the nearest 0.1 inch and examined for fin clips or other identification marks. Scale samples were taken from most trout to facilitate aging.

In addition to angler interviews, 7 unattended creel census stations were established at prominent access points along the river in 1984 and 1985 to collect voluntary information (Fig. 1). Pencils and specially designed creel census cards (Angler Interview Cards, Append. D) were provided at each of these sites, along with a map of the study area and an explanation of the purpose of the requested information. In addition, fishing diaries were distributed to anglers who fished the river often or who were camped overnight and float-fished within the study area. Completed census cards and diaries could be left in a drop box at any of the 7 census stations or mailed to a DNR address provided on each form.

### Estimation of Fishing Pressure and Harvest

Vehicles at or near bridge crossings and other common access points were counted at 2-hour intervals on each census day. The first vehicle count on the morning shift was at 6:30 a.m. The last vehicle count on the afternoon shift was at 8:30 p.m. (ex-



Down in the Bibon Swamp on the White River.

<sup>3</sup> In general, the trout fishing season in Wisconsin opens the first Saturday in May and runs through 30 September. The length of the fishing season varies each year.

tended to 10:30 p.m. during the *Hexagenia* mayfly hatch). Vehicle counts represented the midpoint of 2-hour time intervals with the exceptions of the 6:30 a.m. and 8:30 p.m. counts. Time intervals represented by these 2 counts were determined by the earliest car on the stream and the last car leaving the stream, respectively, during each month. The mean number of anglers per car was based on interviews with anglers who had driven vehicles to the stream.

Fishing pressure was estimated monthly, and these monthly totals were summed to achieve a season estimate. Data collected on weekends and holidays vs. weekdays were computed separately each month.

Monthly fishing pressure (as angler hours) was estimated by the formula:

$$\left[ \sum_{i=1}^n (\bar{C}_i T_i) \right] (A_{wd}) (WD) + \left[ \sum_{i=1}^n (\bar{C}_i T_i) \right] (A_{wed}) (WED)$$

where

- n = number of car counts possible per day; maximum of 8
- $\bar{C}_i$  = mean number of cars present at each car count period
- $T_i$  = the time interval represented by each car count, usually 2 hours
- $A_{wd}$  = mean number of anglers per car on weekdays
- $A_{wed}$  = mean number of anglers per car on weekend days and holidays
- WD = number of weekdays in the month
- WED = number of weekend days and holidays in the month.

$$\left[ \sum_{i=1}^{n=2} (\bar{C}_i T_i) \right] (A_{owed}) (OWED)$$

Fishing pressure on opening weekend in May was considered separately and was computed by the formula:

where

- $A_{owed}$  = mean number of anglers per car on opening weekend
- OWED = number of days in opening weekend.

Fishing pressure during the *Hexagenia* mayfly hatch was considered separately too. The appropriate substitutions for the mean number of anglers per car



Opening day fishing pressure at Sutherland Bridge in 1984.

during this period and for the number of days during this period were made in the above formula in order to compute fishing pressure.

Each month, harvest rate (trout creel per hour) was determined from anglers who had completed fishing. Monthly trout harvest was computed by multiplying the harvest rate by (1) the estimated fishing pressure on weekends and holidays and (2) the estimated fishing pressure on weekdays. The 2 resulting values were summed. Trout species harvested were apportioned based on their observed frequency in the creel. Season harvest was derived by summing the monthly estimates.

## RESULTS

### Trout Populations

During spring electrofishing surveys of the White River in 1984-1986, brown trout and brook trout (*Salvelinus fontinalis*) were captured. Brown trout made up more than 99% of the trout captured each spring and therefore is the primary species referred to in this report. Although some 3.0-5.0 inch brown trout were captured each spring, this discussion refers only to the legal-sized component ( $\geq 6.0$  inches) of the population.

In April 1984, density of legal-sized brown trout ranged from 355/mile to 532/mile in the 3 stations sampled on the White River (Table 1) with an average density of 468 trout/mile. Biomass ranged from 34 lb/acre to 52 lb/acre, with an average of 43 lb/acre. Average length of legal-sized brown trout from all 3 stations was 10.5 inches. Density of brown trout  $\geq 10.0$  inches averaged 257/mile. Brown trout  $\geq 15.0$  inches were uncommon, with an average density of 21 trout/mile. The largest trout captured was 18.0 inches.

In April 1985, legal-sized brown trout ranged from 505/mile to 964/mile in the 3 stations inventoried (Table 2). Average density was 733 trout/mile, up almost 57% from 1984. Biomass ranged from 44 lb/acre to 74 lb/acre, with an average of 59 lb/acre. Average biomass was up 37% from 1984. Average length of legal-sized brown trout from all stations was 10.1 inches. Density of brown trout  $\geq 10.0$  inches averaged 321/mile, while brown trout  $\geq 15.0$  inches averaged 36/mile. Density of both of these size groups represented increases of 25% and 80%, respectively, from 1984. The largest trout captured was 18.9 inches.

In April 1986, density of legal-sized brown trout ranged from 320/mile to 526/mile in the 3 stations sampled (Table 3). Average density was 431 trout/mile, down nearly 41% from 1985 and 8% below the average density in 1984. Biomass ranged from 29 lb/acre to 49 lb/acre and averaged 41 lb/acre. Average biomass in 1986 was down 28% from 1985 and down 5% from 1984. Average length of legal-sized brown trout from all sampling stations was 10.4 inches. Average density of brown trout  $\geq 10.0$  inches was 222/mile, down 31% from 1985 and 14% less than the average density in 1984. Brown trout  $\geq 15.0$  inches were uncommon, with an average density of 25 trout/mile. This density was 31% less than in 1985 but 25% higher than in 1984. The largest brown trout captured was 18.5 inches.

A composite length frequency of the estimated brown trout population from the 3 stations of the White River was bi-modal each year (Fig. 2). The first mode was evident in the 8.0-inch size group during all 3 years of study and reflected age II trout. The second mode occurred in the 12.0-inch size group in 1984 and in the 11.0-inch size group in both 1985 and 1986, and reflected age III trout.

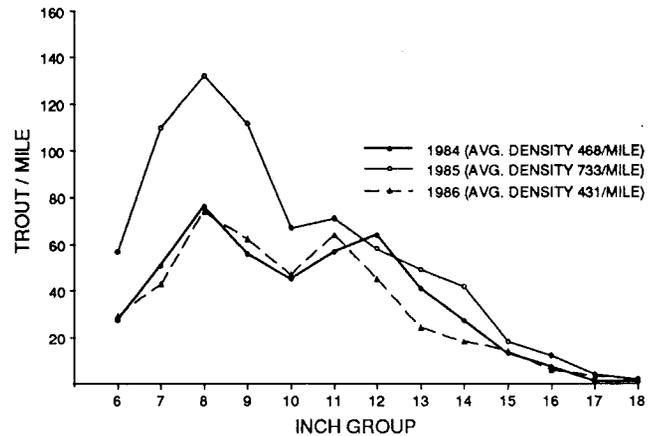


FIGURE 2. Length frequency of the estimated legal-sized brown trout population present in 3 sampling stations on the White River in April 1984, 1985, and 1986.

TABLE 1. Population characteristics of legal-sized brown trout in 3 electrofishing stations on the White River in April 1984 (95% C.I. in parenthesis).

Inch Group	Station 1*		Station 2		Station 3	
	P.E.	Biomass (lb)	P.E.	Biomass (lb)	P.E.	Biomass (lb)
6	25	2	11	1	37	3
7	22	3	45	7	80	12
8	47	10	53	12	112	24
9	61	19	39	12	47	14
10	33	14	40	17	50	22
11	47	25	57	31	52	28
12	72	49	43	29	54	37
13	47	41	31	27	30	26
14	22	23	19	20	34	36
15	17	21	8	10	9	11
16	0	0	9	13	11	16
17	3	0	0	0	0	0
18	2	0	0	0	0	0
Totals	398 (227-571)	207+*	355 (283-427)	179	516 (373-659)	229
No./mile	532		355		516	
Lb/acre	52		34		43	
Avg. length (inches)	11.0		10.7		10.1	

\* Included 0.25 mile above and 0.5 mile below; other stations sampled were 1.0 mile in length. Station 1 was enlarged to 1.0 mile in subsequent sampling years.

\*\* Value does not include biomass for 17.0- and 18.0-inch fish, which were not weighed.

**TABLE 2.** Population characteristics of legal-sized brown trout in three 1.0-mile electrofishing stations on the White River in April 1985 (95% C.I. in parenthesis).

Inch Group	Station 1		Station 2		Station 3	
	P.E.	Biomass (lb)	P.E.	Biomass (lb)	P.E.	Biomass (lb)
6	30	3	69	6	73	6
7	64	9	138	20	127	18
8	104	22	154	32	138	29
9	79	22	159	44	99	27
10	28	11	115	44	57	22
11	49	26	99	52	64	33
12	44	27	83	52	46	29
13	35	29	85	71	26	22
14	47	47	41	41	37	37
15	12	15	12	15	29	36
16	7	10	9	13	20	28
17	3	4	0	0	9	13
18	3	7	0	0	4	9
Totals	505 (413-597)	232	964 (750-1,178)	390	729 (549-909)	309
No./mile	505		964		729	
Lb/acre		44		74		58
Avg. length (inches)	10.4		10.1		10.1	

**TABLE 3.** Population characteristics of legal-sized brown trout in three 1.0-mile electrofishing stations on the White River in April 1986 (95% C.I. in parenthesis).

Inch Group	Station 1		Station 2		Station 3	
	P.E.	Biomass (lb)	P.E.	Biomass (lb)	P.E.	Biomass (lb)
6	21	2	36	4	30	3
7	27	4	50	8	53	8
8	60	14	77	17	85	19
9	50	16	78	25	59	19
10	32	13	72	30	37	16
11	51	30	92	54	48	28
12	38	28	51	38	47	35
13	25	24	21	20	26	25
14	7	8	23	25	23	25
15	5	7	15	20	22	30
16	0	0	9	16	9	16
17	4	8	2	4	3	6
18	0	0	0	0	5	11
Totals	320 (272-368)	154	526 (446-606)	261	447 (369-525)	241
No./mile	320		526		447	
Lb/acre		29		49		46
Avg. length (inches)	10.3		10.5		10.5	

## Sport Fisheries

### Fishing Pressure

Estimated fishing pressure in the White River study area was 86 hours/acre in 1984 and equalled 115 angler trips/mile of river.<sup>4</sup> Anglers fished an average of 4.0 hours/trip. Theoretically, the study area received an average of 16 angler trips daily, which was equivalent to each angler having exclusive use of approximately 1.3 miles of river.

In 1985, estimated fishing pressure in the study area was 106 hours/acre, representing a 24% increase over 1984. Approximately 121 trips/mile were made to the river, and anglers fished an average of 4.7 hours/trip. The study area received an average of 17 fishing trips daily, which was equivalent to each

angler having exclusive use of almost 1.3 miles of river.

An average of 16% of the total season fishing pressure occurred on opening weekend in May during 1984 and 1985 (Tables 4, 5). An average of 47% of the season fishing pressure occurred by the end of May, while roughly 65% was exerted by the end of June. Fishing pressure during the 7-12 day *Hexagenia* mayfly hatch period accounted for an average of 17% of the total season fishing pressure. During the last 12 weeks of the fishing season in both 1984 and 1985, i.e., from the end of the *Hexagenia* mayfly hatch through 30 September, an average of only 18% of the season fishing pressure was exerted. These 12 weeks represented roughly 56% of the total time of both fishing seasons.

TABLE 4. Estimated fishing pressure and trout harvest during 1984 in the White River study area.

Creel Census Dates	Creel Census Period	Hours Fished	No. Trout Harvested			Total No. Harvested*
			Brown	Brook	Rainbow	
<b>May</b>						
5-6	Opening weekend	1,459	406	21	11	438
7-31	Weekends and holidays	1,711	653	31	0	684
	Weekdays	<u>1,354</u>	<u>522</u>	<u>20</u>	<u>0</u>	<u>542</u>
	Subtotals	4,524	1,581	72	11	1,664
<b>Jun</b>						
Entire month	Weekends and holidays	676	338	0	0	338
	Weekdays	<u>760</u>	<u>380</u>	<u>0</u>	<u>0</u>	<u>380</u>
	Subtotals	1,436	718	0	0	718
<b>Jul</b>						
1-7	Peak <i>Hexagenia</i> mayfly hatch	1,610	634	10	0	644
8-31	Weekends and holidays	329	115	17	0	132
	Weekdays	<u>235</u>	<u>77</u>	<u>14</u>	<u>3</u>	<u>94</u>
	Subtotals	2,174	826	41	3	870
<b>Aug</b>						
Entire month	Weekends and holidays	71	36	0	0	36
	Weekdays	<u>408</u>	<u>204</u>	<u>0</u>	<u>0</u>	<u>204</u>
	Subtotals	479	240	0	0	240
<b>Sep</b>						
Entire month	Weekends and holidays	694	182	20	6	208
	Weekdays	<u>453</u>	<u>136</u>	<u>0</u>	<u>0</u>	<u>136</u>
	Subtotals	1,147	318	20	6	344
<b>Totals</b>		9,760	3,683	133	20	3,836

\*Harvest is based upon average harvest rates determined from angler interviews and voluntary returns shown in Table 6.

<sup>4</sup> Based on an average width of 44 ft and an estimated surface area of 113.6 acres.

**TABLE 5.** Estimated fishing pressure and trout harvest during 1985 in the White River study area.

Creel Census Dates	Creel Census Period	Hours Fished	No. Trout Harvested			Total No. Harvested*
			Brown	Brook	Rainbow	
<b>May</b>						
4-5	Opening weekend	2,096	813	20	3	836
6-31	Weekends and holidays	1,783	694	17	2	713
	Weekdays	<u>1,982</u>	<u>772</u>	<u>19</u>	<u>2</u>	<u>793</u>
	Subtotals	5,861	2,279	56	7	2,342
<b>Jun</b>						
1-27	Weekends and holidays	875	344	6	0	350
	Weekdays	<u>1,507</u>	<u>592</u>	<u>11</u>	<u>0</u>	<u>603</u>
	Subtotals	2,382	936	17	0	953
<b>Jun-Jul</b>						
28 Jun-9 Jul	Peak <i>Hexagenia</i> mayfly hatch					
	Weekends and holidays	899	356	4	0	360
	Weekdays	<u>1,191</u>	<u>471</u>	<u>5</u>	<u>0</u>	<u>476</u>
	Subtotals	2,090	827	9	0	836
<b>Jul</b>						
10-31	Weekends and holidays	302	60	0	0	60
	Weekdays	<u>251</u>	<u>50</u>	<u>0</u>	<u>0</u>	<u>50</u>
	Subtotals	553	110	0	0	110
<b>Aug</b>						
Entire month	Weekends and holidays	270	104	4	0	108
	Weekdays	<u>313</u>	<u>121</u>	<u>4</u>	<u>0</u>	<u>125</u>
	Subtotals	583	225	8	0	233
<b>Sep</b>						
Entire month	Weekends and holidays	395	124	34	0	158
	Weekdays	<u>233</u>	<u>73</u>	<u>20</u>	<u>0</u>	<u>93</u>
	Subtotals	628	197	54	0	251
<b>Totals</b>		12,097	4,574	144	7	4,725

\*Harvest is based upon average harvest rates determined from angler interviews and voluntary returns shown in Table 11.

### The Logic Behind Assessing Harvest

One of the most difficult decisions made in the processing and subsequent analysis of creel census data collected during this study was how to treat information from voluntary angler returns. Statisticians discourage combining data from nonrandom sources (voluntary returns) and random sources (interviews). However, previous creel census studies have shown no serious bias (Calhoun 1950, Schearer et al. 1962) and also significant positive bias (Simpson and Bjorn 1965, Carline 1972) in harvest estimates based on voluntary returns, as opposed to harvest estimates based on angler interviews. I chose to combine data from voluntary census forms and DNR interviews to estimate the sport harvest for several reasons.<sup>5</sup> First, in 1984 the census clerk had poor success in personally contacting anglers associated with parked vehicles within the study area. So few interviews were acquired during some months of the fishing season that year that the data were not representative, and

lumping interview data with the additional data from voluntary returns was the best way to estimate total harvest characteristics. For example, a 0.9 trout/hour harvest rate was determined from only 6 angler interviews during August 1984 (Table 6). This information was combined with data from 26 voluntary returns received during August to yield an average monthly harvest rate of 0.5 trout/hour. Another example was a 0.0 trout/hour harvest rate, determined from only 8 interviews made during the *Hexagenia* mayfly hatch (Table 6). This information was combined with data from 53 voluntary returns received during the same 7-day period, to yield an average harvest rate of 0.4 trout/hour.

Second, randomly selected census days and 8-hour shifts resulted in sampling primarily during daytime and did not always reflect what was happening on the river, especially during the *Hexagenia* mayfly hatches in 1984 and 1985. Fishing pressure and trout harvest increased dramatically during those

<sup>5</sup> This decision does not affect estimates of monthly or annual fishing pressure because of the specific procedures employed.

*Hexagenia* mayfly hatches, and most anglers fished from dusk to midnight during those 7-12 day periods. Combining the data from volunteer returns (primarily from nighttime anglers) and angler interview data (primarily from daytime anglers) produced a more accurate estimate of season harvest.

Third, more than twice the number of anglers were interviewed in 1985 than in 1984. The increase in angler interviews paralleled significant changes in the length frequency of the measured harvest between 1984 and 1985 (Fig. 3). Length frequency of the measured harvest in 1985, especially for trout  $\geq 10$  inches, agreed closely with corresponding length frequency data reported from voluntary returns (Fig. 4). There was little change between 1984 and 1985 in the length frequency of reported harvest from voluntary returns (Fig. 5). Therefore, even with a 31% increase from 1984 to 1985 in the number of voluntary returns, combining the voluntary data with interview data again produced the best season harvest.

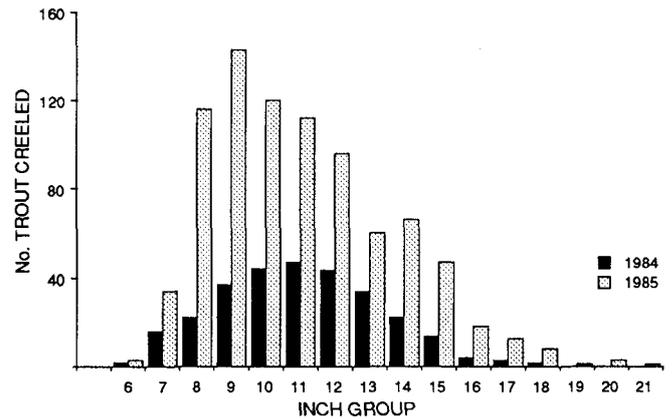
Finally, if only successful anglers returned cards, a positive bias could result from combining these data with data from angler interviews. This bias could result in an overestimate of harvest, which would lead to more conservative management implications than those based on underestimates of angler harvest. Conservative management strategies are preferred if a major management goal is to restore or sustain a fishery for large wild brown trout.

## Harvest

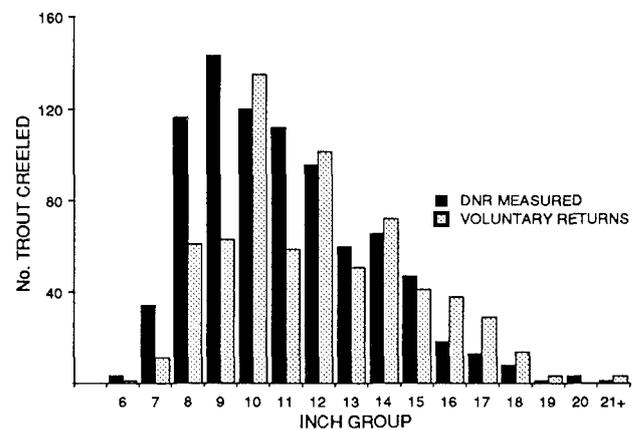
Using the data from both angler interviews and voluntary returns, estimated angler harvest of trout from the White River in 1984 was 3,836, or 180 trout/mile (Table 4). Brown, brook, and rainbow trout (*Oncorhynchus mykiss*) were all represented in the angler harvest, but 96% (173 trout/mile) were brown trout.

Based upon measurements of 897 creel brown trout (290 measurements from angler interviews and 607 measurements from voluntary returns), approximately 81% of the season harvest in 1984 consisted of trout  $\geq 10.0$  inches (Table 7). Harvest of trout  $\geq 10.0$  inches was 140/mile. Brown trout  $\geq 15.0$  inches accounted for 14% of the season harvest and represented a catch of 30 trout/mile. Average size of the estimated harvest was 12.2 inches, and total biomass creel was approximately 24 lb/acre.<sup>6</sup>

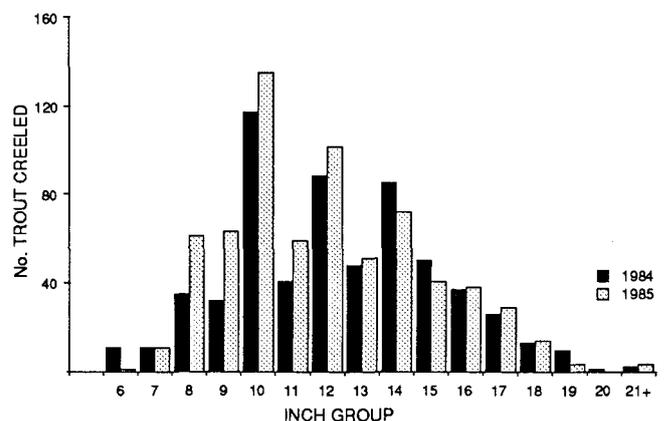
In 1985, estimated harvest of trout from the White River was 4,727, or 222 trout/mile (Table 5). Approximately 97%, or 215 trout/mile, were brown trout, with the remainder consisting of brook trout and rainbow



**FIGURE 3.** Comparisons of length frequency histograms of brown trout creel from the White River in 1984 and 1985 and measured by DNR personnel.



**FIGURE 4.** Comparisons of length frequency histograms of creel brown trout measured by DNR personnel and creel brown trout reported on voluntary returns from the White River in 1985.



**FIGURE 5.** Comparisons of length frequency histograms of brown trout harvest reported on voluntary returns from the White River in 1984 and 1985.

<sup>6</sup> Based on average weights per inch group in the spring (Append. B Table 2).

**TABLE 6. Catch and harvest rates of trout from the White River study area during the 1984 fishing season.**

Creel Census Period	Angler Interviews		Volunteer Returns*		Combined	
	Catch/Hour	Harvest/Hour	Catch/Hour	Harvest/Hour	Catch/Hour	Harvest/Hour
<b>May</b>						
Opening weekend	0.3	0.3	0.3	0.2	0.3	0.3
Remainder	0.8	0.4	0.7	0.4	0.7	0.4
<b>Jun</b>						
Entire month	0.8	0.4	1.4	0.6	1.2	0.5
<b>Jul</b>						
1-7 ( <i>Hexagenia</i> mayfly hatch)	0.1	0.0**	1.2	0.5	1.0	0.4
Remainder	1.0	0.2	2.1	0.6	1.6	0.4
<b>Aug</b>						
Entire month	1.7	0.9	0.7	0.4	0.9	0.5
<b>Sep</b>						
Entire month	0.5	0.4	0.6	0.1	0.5	0.3
<b>Season avg.</b>	<b>0.6</b>	<b>0.3</b>	<b>1.1</b>	<b>0.5</b>	<b>0.8</b>	<b>0.4</b>

\*Includes Angler Interview Cards and angler diaries.

\*\*Actually 0.03 trout/hour.

**TABLE 7. Length frequency of estimated season harvest of brown trout from the White River study area, 1984.**

Inch Group	No. Brown Trout Creeled/Month						Season Total	% Accumulated Harvest
	May	Jun	1-7 Jul	8-31 Jul	Aug	Sep		
6	0	0	46	16	11	7	80	2
7	39	2	0	0	26	80	147	6
8	98	45	8	12	42	22	227	12
9	140	61	0	12	21	22	256	19
10	266	117	31	92	68	65	639	37
11	195	55	38	12	10	51	361	46
12	289	93	107	8	26	7	530	61
13	152	61	107	8	5	22	355	70
14	199	90	122	4	16	14	445	83
15	117	58	61	8	0	14	258	90
16	31	64	38	12	5	0	150	94
17	12	40	61	8	0	7	128	97
18	23	19	0	0	10	0	52	98
19	16	11	15	0	0	0	42	99
20	0	0	0	0	0	7	7	*
21	0	2	0	0	0	0	2	*
22	4	0	0	0	0	0	4	*
Totals	1,581	718	634	192	240	318	3,683	
Avg. length (inches)	12.2	13.0	13.5	11.1	10.5	10.5	12.2	

\*The harvest in these larger size classes brings the total harvest to 100%.

trout. The harvest of brown trout represented a 24% increase from 1984. Angler harvest of all trout was up 23% from 1984.

Based upon measurements of 1,523 brown trout (841 measurements from angler interviews and 682 measurements from voluntary returns), approximately 72% of the season harvest in 1985 consisted of trout

≥ 10.0 inches (Table 8). Harvest of trout ≥ 10.0 inches was 154/mile, up 10% from 1984. Brown trout ≥ 15.0 inches comprised 14% of the estimated harvest (at 31 trout/mile); this figure is identical to the 1984 harvest figure. Average size of the season harvest was 11.8 inches, while total biomass creeled was 27 lb/acre.

**TABLE 8.** Length frequency of estimated season harvest of brown trout from the White River study area, 1985.

Inch Group	No. Brown Trout Creeled/Month						Season Total	% Accumulated Harvest
	May	1-27 Jun	28 Jun-9 Jul	10-31 Jul	Aug	Sep		
6	3	0	0	0	9	0	12	1
7	45	8	17	3	46	18	137	3
8	301	95	42	21	52	15	526	15
9	316	144	101	18	25	24	628	28
10	374	193	134	8	34	34	777	45
11	257	83	89	16	22	43	510	57
12	329	91	106	18	25	21	590	69
13	181	76	64	5	3	6	335	77
14	187	83	115	5	3	12	405	86
15	134	30	67	8	3	12	254	91
16	64	53	42	5	3	3	170	95
17	56	45	28	0	0	3	132	98
18	17	27	17	0	0	6	67	99
19	3	4	3	3	0	0	13	*
20	8	0	0	0	0	0	8	*
21	6	4	0	0	0	0	10	*
24	0	0	2	0	0	0	2	
Totals	2,281	936	827	110	225	197	4,576	100
Avg. length (inches)	11.7	12.1	12.4	11.5	9.6	11.3	11.8	

\*The harvest in these larger size classes brings the total harvest to 100%.

In 1984 and 1985, anglers creeled an average of 46% of the total season harvest of brown trout in May, including an average of 14% taken on opening weekend (Tables 4, 5). An average of 20% of the season harvest occurred in June. Another 18%, on average, was creeled during the 7-12 day periods of the peak *Hexagenia* mayfly hatches in late June-early July. During the final 12 weeks of both fishing seasons, anglers took an average of only 16% of the total harvest.

**Age Structure.** Age III brown trout made up 43% of the harvest from the White River in 1984 and were the dominant age group represented in the harvest (Table 9). Age IV+ brown trout accounted for 27% of the harvest, while age II's made up another 25%. Yearlings (age I) accounted for the remaining 5% of the season harvest.

In 1985, age II trout made up 46% of the brown trout harvest from the White River and were the dominant age group represented (Table 10). Age III brown trout accounted for 31% of the season harvest, while age IV+ fish constituted another 18%. Yearlings (age I) accounted for the remaining 5% of the season harvest.

**Size vs. Age.** An average of 72% of the brown trout creeled by anglers from the White River that were in the 8.0-10.9 inch size range were age II brown trout (Tables 9, 10). Age III brown trout constituted an average of 71% of the harvest taken in the

11.0-13.9 inch size range, while an average of 88% of the brown trout  $\geq$  14.0 inches were age IV+.

## Exploitation

In 1984, angler exploitation of the brown trout population was 37%, based on an average population density of 468 legal-sized brown trout/mile and an estimated harvest of 173/mile during the 5-month fishing season (Tables 1, 4). Corresponding angler exploitation of brown trout  $\geq$  10.0 inches was 54%, while exploitation of brown trout  $\geq$  15.0 inches was 136%.

In 1985, angler exploitation of the brown trout population was 29%, based on an average population density of 733 legal-sized brown trout/mile and an estimated harvest of 215/mile during the 5-month fishing season (Tables 2, 5). Angler exploitation of brown trout  $\geq$  10.0 inches was 47%, while corresponding exploitation of trout  $\geq$  15.0 inches was 86% of the spring population.

These exploitation values fail to consider recruitment due to growth and immigration into the legal size range or into the size categories of  $\geq$  10.0 inches or  $\geq$  15.0 inches. The exploitation values are therefore inflated, but do provide a point of reference between 1984 and 1985 and baseline references for similar studies conducted in the future.

**TABLE 9.** Size and age distribution of angler-caught brown trout from the White River study area, 1984.

Inch Group	Age Group						Totals
	I	II	III	IV	V	VI	
7	7	3					10
8	5	11	2				18
9	1	26	5				32
10		12	20	1			33
11		9	35	0			44
12		2	28	13			43
13			15	14			29
14			3	18	2		23
15			2	6	4	2	14
16				1	2	1	4
17				1	3	0	4
18				1	1	0	2
Totals	13	63	110	55	12	3	256
Avg. length (inches)	7.9	9.7	11.8	13.9	16.2	15.7	

**TABLE 10.** Size and age distribution of angler-caught brown trout from the White River study area, 1985.

Inch Group	Age Group						Totals
	I	II	III	IV	V	VI	
6	3						3
7	17	7					24
8	11	83	1				95
9		102	15				117
10		71	22				93
11		28	60	1	1		90
12		2	55	8	0		65
13			30	5	2		37
14			15	28	5	1	49
15			1	29	6	0	36
16				10	2	0	12
17				2	5	0	7
18				3	3	2	8
19				1	0		1
20					1		1
21					1		1
Totals	31	293	199	87	26	3	639
Avg. length (inches)	7.7	9.5	11.9	14.9	16.1	17.0	

### Angler Characteristics

Of the 506 angler returns accumulated during the 1984 fishing season, 49% were from Angler Interview Cards and diaries voluntarily returned by anglers, and 51% were from questionnaires completed by DNR census clerks while interviewing anglers. Average season catch and harvest rates computed from voluntary angler returns were substantially higher than corresponding values computed from personal angler interviews (Table 6). High catch and harvest rates on



*This opening day "limit" of 15-inch wild brown trout is equivalent to removing 25 years of growth from the White River.*

voluntary returns in June and July were largely responsible for this divergence. Most volunteer returns during June and July were from accomplished fly fishers who were familiar with the river, fished on more than one occasion, often fished at night, and were very successful.

In 1985, voluntary returns and angler interviews comprised 36% and 65%, respectively, of 902 returns accumulated during the fishing season. Average season catch and harvest rates computed from voluntary returns were again higher than corresponding values computed from angler interviews (Table 11). Higher catch and harvest rates from voluntary returns in May, June, and July were primarily responsible for the differences.

Based upon both the voluntary returns and angler interviews, anglers fished an average of 1.2 hours for every trout caught and an average of 2.5 hours for every legal-sized trout kept from the White River in 1984 and 1985. Season catch rate averaged 0.8

**TABLE 11.** Catch and harvest rates of trout from the White River study area during the 1985 fishing season.

Creel Census Period	Angler Interviews		Volunteer Returns*		Combined	
	Catch/Hour	Harvest/Hour	Catch/Hour	Harvest/Hour	Catch/Hour	Harvest/Hour
<b>May</b>						
Opening weekend	0.6	0.4	2.7	1.3	0.7	0.4
Remainder	0.9	0.4	0.6	0.4	0.8	0.4
<b>Jun and Jul</b>						
1-27 Jun	0.7	0.3	1.9	0.6	1.1	0.4
28 Jun - 9 Jul ( <i>Hexagenia</i> mayfly hatch)	0.7	0.3	1.5	0.4	0.9	0.4
<b>Jul</b>						
10-31	0.4	0.1	1.1	0.2	0.6	0.2
<b>Aug</b>						
Entire month	0.5	0.3	0.8	0.5	0.6	0.4
<b>Sep</b>						
Entire month	0.8	0.4	0.9	0.5	0.8	0.4
<b>Season avg.</b>	0.7	0.4	1.2	0.5	0.8	0.4

\*Includes creel census and angler diaries.

trout/hour and season harvest rate averaged 0.4 trout/hour during both years.

An average of 77% of the anglers interviewed on the White River during the 1984 and 1985 fishing seasons were successful, i.e. caught at least 1 trout/trip, whether kept or released (Tables 12, 13). Anglers who kept at least 1 legal-sized brown trout/trip accounted for an average of 60% of the fishing trips made to the river.

The daily bag limit of 5 brown trout was taken on 12% of the fishing trips in May 1984 and 18% of the fishing trips in May 1985. From June through September, the daily limit of 10 brown trout was taken on 1% of the trips in both 1984 and 1985. Five or more brown trout were creel on 11% of all fishing trips in 1984, while 4 or more brown trout were creel on 16% of the trips. In 1985, 5 or more brown trout were creel on 12% of the angler trips, while 4 or more brown trout were creel on 21% of the trips.

Anglers on the White River in 1984 and 1985 were from diverse origins, with many anglers traveling substantial distances to fish. Wisconsin residents and nonresidents accounted for an average of 82% and 18%, respectively, of the fishing trips recorded in the study area. Anglers from 13 states fished the study area in 1984, while anglers from 14 states were recorded in 1985. Anglers from Minnesota and Illinois accounted for an average of 60% and 14%, respectively, of the fishing trips made by nonresidents.

Considering all fishing trips made to the White River in 1984-85, an average of 46% of the trips were

made by anglers living at least 100 miles from the river. Approximately 66% of the trips were made by anglers who lived 50 miles or more from the river, while only 28% of the trips were made by anglers living within 25 miles.

Males made up 96% of the anglers on the White River in 1984 and 95% in 1985. Approximately 84% of all anglers during both years were between 16 and 64 years of age. Approximately 7% were younger than 16, and 9% were older than 64.

Worms, flies, and spinners were used by an average of 48%, 36%, and 15%, respectively, of anglers who used only one bait type during 1984-85. If anglers who used 2 or more bait types per trip are considered, worms, flies, and spinners were used as one of the baits on an average of 49%, 37%, and 25% of the trips, respectively. Worms were the preferred bait in May 1984 and May, August, and September 1985. Artificial lures, i.e. flies and spinners, were preferred in June and July 1984, while flies were the preferred bait in June and July 1985. Anglers showed little preference among bait types in August and September 1984.

Anglers fishing the White River from canoes or other boats accounted for an average of 43% of the anglers on the river during 1984-85. The remaining anglers either waded or fished from shore, with the exception of approximately 1% of the anglers fishing from inner tubes in 1985.

**TABLE 12.** Number of angler trips during which trout were harvested during the 1984 fishing season on the White River.

No. Trout Harvested/Trip	No. Trips					Total
	May	Jun	Jul	Aug	Sep	
0	67	14	22	7	5	15
0'	13	43	32	8	7	103
1	31	38	23	6	11	109
2	15	30	10	3	8	66
3	18	14	8	3	3	46
4	10	8	2	4	-	24
5	21 <sup>**</sup>	8	2	2	5	38
6	-	2	-	2	-	4
7	-	3	1	-	1	5
8	-	1	1	-	1	3
9	-	-	2	-	-	2
10	-	3	2 <sup>a</sup>	-	-	5
Total no. trips	175	164	105	35	41	520

- <sup>\*\*</sup> Trips on which no brown trout were harvested, but one or more brown, brook, or rainbow trout were caught and released.
- <sup>\*\*</sup> An additional 2 limit catches of 5 trout, i.e. 23 limits, were taken if rainbow trout are included in the harvest figures.
- <sup>a</sup> An additional 2 limit catches of 10 trout, i.e. 4 limits, were taken if brook trout are included in the harvest figures.

**TABLE 13.** Number of angler trips during which trout were harvested during the 1985 fishing season on the White River.

No. Trout Harvested/Trip	No. Trips					Total
	May	Jun	Jul	Aug	Sep	
0	79	64	54	11	15	223
0'	28	42	55	10	8	143
1	57	61	40	8	11	177
2	43	30	18	4	4	99
3	55	22	12	5	4	98
4	52	15	8	2	2	79
5	70	13	1	1	3	88
6	-	1	1	1	-	3
7	-	3	-	2	-	5
8	-	3	1	2	1	7
9	-	4	-	-	-	4
10	-	4	-	-	1	5
Total no. trips	384	262	190	46	49	931

- <sup>a</sup> Trips on which no brown trout were harvested but 1 or more brown, brook, or rainbow trout were caught and released.

## DISCUSSION

### Trout Population Dynamics and the Sport Fishery

Density and biomass of legal-sized brown trout in the White River in spring 1985 increased 57% and 37%, respectively, from spring 1984 (Tables 1, 2). Unfortunately, no information is available on fishing pressure and harvest in 1983 that would help interpret these increases compared with fishing pressure and harvest observed during this study in 1984. Density and biomass of legal-sized trout in spring 1986, however, decreased 41% and 28%, respectively, from spring 1985 (Tables 2, 3). These declines paralleled a 24% increase in fishing pressure and a 23% increase in angler harvest from 1984 to 1985 and certainly suggest a cause-and-effect relationship.

Several factors contributed to increased fishing pressure and trout harvest in 1985. Weather and water conditions on opening weekend and during the remainder of May were the most important factors. In 1984, the White River was high and muddy on opening weekend, and the weather was overcast and cold with intermittent rain. Census clerks reported high, muddy river conditions on 50% of the remaining workdays in May and recorded inclement weather on 59% of the remaining workdays. In contrast, the White River was low and clear on opening weekend in 1985, and the weather was partly cloudy and warm. For the remainder of May, census clerks reported high, muddy river conditions on only 5% of the workdays, and mild weather was reported on 74% of the workdays.

In addition to better weather and better river conditions in 1985, another reason for increased fishing pressure and angler harvest was an increase in angler access. Construction of a public parking lot and canoe access began in spring 1984 in conjunction with the replacement of the bridge on Bibon Road. The access was completed just before the start of the 1985 trout fishing season. The average number of vehicles present at 2-hour intervals on opening weekend at the Bibon Road Bridge increased from 16 in 1984 to 33 in 1985, while the average number of vehicles present at 2-hour intervals at the other 2 bridge crossings in the study area remained relatively unchanged.

Annual angler exploitation of stream trout should not exceed 40% of the legal-sized fish present in spring, if the population is to remain healthy (Wis. Dep. Nat. Resour. 1979). Estimated exploitation rates of 37% on the White River in 1984 and 29% in 1985 pose no apparent problem, if the management objective is to sustain only a fishable population of legal-sized trout. However, the White River has a long

tradition of producing large brown trout, including fish in the trophy class ( $\geq 20.0$  inches). The possibility of catching large brown trout is therefore the focal point around which the White River sport fishery revolves. Estimated angler exploitation of brown trout  $\geq 15.0$  inches was 136% in 1984 and 86% in 1985. Although these rates are inflated, a reduction by one half would still leave exploitation rates of 68% in 1984 and 43% in 1985. These estimates, in conjunction with an observed 31% decline in brown trout  $\geq 10.0$  inches in spring 1986, indicate that even maintaining the status quo of trout  $\geq 15.0$  inches under present angling restrictions and fishing pressures may not be possible.

A form of voluntary catch-and-release fishing, i.e. catch-and-sort for larger trout, is commonly practiced on the White River. Catch rates (based on angler interviews and voluntary returns) were almost always double harvest rates during both years of this study, with opening weekend being the only exception because of the presence of many one-time anglers. Anglers also indicated that most trout released were predominantly over the minimum legal size of 6.0 inches. In effect, this sorting process means that larger trout are more scarce in the river than indicated by their proportion in the angler harvest, because anglers are sorting through more fish to get them. Several brown trout  $> 20.0$  inches were harvested during both 1984 and 1985, but none  $> 18.9$  inches were captured during the spring electrofishing surveys, which covered 14% of the study area. This fact further suggests a higher proportion of large trout in the harvest than are in the river and hints of over-exploitation.

## Comparisons with Other Brown Trout Streams

Maximum size, average size, and biomass of legal-sized brown trout were generally higher in the White River than in 3 other large trout streams in northern Wisconsin for which comparable information was available. Brown trout as large as 18.9 inches were captured during electrofishing surveys of the White River during 1984-86. On several occasions during 1984-85, brown trout  $> 20.0$  inches were observed in the angler harvest. Average size of legal-sized brown trout in the White River varied from 10.1-10.5 inches during 1984-86 electrofishing surveys, and average spring biomass in the White River during this study was 47.7 lb/acre.

Mason and Wegner (1970) found brown trout up to 18.3 inches in the Pine River, 16.7 inches in the Popple River, and 19.0 inches in the Pike River systems during electrofishing surveys conducted in 1966-68. These authors reported that most trout in the Pine, Popple, and Pike river systems were  $< 10.0$

inches. Biomass of brown trout in the Pine and Popple systems was  $< 10$  lb/acre. A maximum biomass of 36.3 lb trout/acre was documented in the Pike River system.

Density of large trout is an important measure of potential fishing quality. I compared the size structure of brown trout in the White River with similar data compiled on 18 other well-known brown trout streams located throughout Wisconsin (R. A. Kerr, Wis. Dep. Nat. Resour., to DNR Fish Managers and Cold Water Research Personnel, in memo 6 March 1980) (Table 14). Compared with these 18 trout streams, the White River ranked second in abundance of trout  $\geq 13.0$  inches and fourth in abundance of trout  $\geq 15.0$  inches. If streams under special regulations to protect large trout are excluded from this list, i.e. Castle Rock Creek and Race Branch, the White River ranks first in abundance of trout  $\geq 13.0$  inches and third in abundance of trout  $\geq 15.0$  inches.

Trout populations were estimated in Eighteen Mile and Mt. Vernon creeks, the 2 streams with higher densities of trout  $\geq 15.0$  inches in fall, while populations in the White River were estimated in spring. Eighteen Mile Creek, the stream with the highest density of trout  $\geq 15.0$  inches, is also a second-order tributary to the White River (Fig. 1) and benefits from late summer and fall immigration of large trout from downstream areas (Avery 1983).

In addition to supporting one of the highest densities of large wild brown trout in Wisconsin, the average size of wild brown trout creel from the White River (12.2 inches in 1984 and 11.7 inches in 1985) is the largest thus far recorded from a Wisconsin trout stream. The average size of brown trout caught from Rowan Creek in southern Wisconsin was 10.3 inches (Larson 1982). Hunt (1985) observed an average size of 10.5 inches for brown trout creel from Timber Coulee Creek in southwestern Wisconsin. The average size of wild brown trout creel from 4 central Wisconsin streams ranged from 8.5-9.5 inches (Avery and Hunt 1981). I found an average length of 10.5 inches for brown trout taken from the North Branch of Beaver Creek in northeastern Wisconsin, while the average brown trout creel from Eighteen Mile Creek in northwestern Wisconsin was 9.5 inches (Avery 1983).

Angler success, i.e. the percentage of anglers catching at least 1 trout/trip, is a common criterion used to assess angling quality. Meyers and Thuemler (1976) found a 19% success rate for anglers on a northeastern Wisconsin brown trout stream partially supported by stocking. Angler success on 2 other brown trout streams in northern Wisconsin was 39% and 54%, respectively (Avery 1983). Angler success on 4 wild brown trout streams in central Wisconsin averaged 41% (Avery and Hunt 1981). Angler success on the White River during this study averaged a

**TABLE 14.** Brown trout population data from the White River study area and 18 other Wisconsin trout streams.

Stream	County	Region		Month/Year	Miles Surveyed	Brown Trout/Mile				Biomass (lb/acre)
		of State	Class			≥6 Inches	≥10 Inches	≥13 Inches	≥15 Inches	
Eighteen Mile Cr.	Bayfield	NW	I	Sep 79	5.3	836	156	73	33	118
White R.	Bayfield	NW	II	Apr 84-86	3.0	544	267	94	27	48
Yellow R.	Barron	NW	I	Jun 78	0.8	683	131	33	9	110
No. Brch.										
Beaver Cr.	Marinette	NE	I	Sep-Oct 79	3.4	461	116	48	21	88
Race Brch.*	St. Croix	WC	II	Sep-Oct 76-79	1.0	1,878	643	64	14	132
Willow Br.	St. Croix	WC	II	Sep-Oct 76-79	1.0	853	261	63	11	58
Kinnickinnic R.	St. Croix	WC	I	Apr 73-77	1.0	3,126	569	15	1	193
Trempealeau R.**	Jackson	WC	I	Aug 77	0.8	87	37	12	5	26
Beef R.**	Jackson	WC	I	Aug 77	1.0	95	21	17	7	19
Emmons Cr.	Waupaca	C	I	Sep-Oct 75-77	1.2	1,548	218	20	6	143
Radley Cr.	Waupaca	C	I	Sep-Oct 75-77	1.5	1,126	184	21	6	133
Lunch Cr.	Waushara	C	I	Sep-Oct 73-76	1.3	726	83	8	2	101
So. Brch.										
Wedde Cr.	Waushara	C	I	Sep-Oct 75-77	1.1	955	97	8	1	163
Mecan R.	Waushara	C	I	Sep-Oct 75-77	1.4	772	107	18	6	74
Castle Rock Cr.*	Grant	SW	II	Oct 79	2.4	570	370	98	31	91
Big Green R.	Grant	SW	II	Nov 79	8.6	103	84	19	8	—
Trout Cr.	Iowa	SW	I and II	Sep-Oct 78-79	5.2	498	90	25	5	206
Timber Coulee	Vernon	SW	I	Spring 83	—	2,336	320	75	24	293
			II	Apr 86	1.0	1,072	592	38	3	161
Mt. Vernon Cr.	Dane	S	I and II	Sep-Oct 78-79	6.1	559	189	35	30	125

\*The survey on Race Branch was through a special regulation zone.

\*\*The Trempealeau River and Beef River have more brook trout than brown trout.

\*The survey on Castle Rock Creek was through a "no kill" zone.

whopping 75%, and 60% of the anglers creeled at least 1 trout/trip.

No other non-anadromous trout stream in Wisconsin attracts such a high percentage (46%) of its angling clientele from over 100 miles away. Meyers and Thuemler (1976) found that only 10% of anglers fishing the lower North Branch Beaver Creek in northeastern Wisconsin had traveled more than 100 miles. Larson (1982) found that 11% of the anglers fishing a popular southern Wisconsin stream came from more than 50 miles away. More than 50% of all anglers traveled more than 50 miles to fish 3 of 6 central and northern Wisconsin streams studied by Avery (1983) and Avery and Hunt (1981). However, it is unlikely that the proportion who traveled more than 100 miles to fish these streams approached the proportion observed on the White River.

The White River fishery also provides a rare option for trout anglers in Wisconsin to fish from canoes while traversing several miles of pristine stream. An average of 43% of the anglers who fished the White River during 1984-85 did so from canoes. A review of creel census studies on other Wisconsin trout streams revealed no data on the proportion of anglers fishing from canoes. The upper half of the 50-mile-long Bois

Brule River is probably the only other trout stream where the proportion of anglers fishing from canoes may be as high as that documented on the White River.



*The opportunity to fish for trout from canoes in a pristine environment draws many anglers to the White River.*

## MANAGEMENT CONSIDERATIONS

This 1984-86 study quantitatively substantiated what local fisheries management personnel and experienced anglers have previously concluded based on involvement and participation: the Bibon Swamp reach of the White River supports a rare, high-quality sport fishery for wild brown trout in terms of average size creel, angler success and harvest rates, and proportion of anglers who fish from canoes. In addition, the Bibon Swamp is highly scenic and remote. The White River trout fishery is also one of the few in Wisconsin that has statewide and even interstate significance in terms of the distance anglers will travel to experience this fishery. However, this study also documented perceptions that the quality of this fishery may be declining and that remedial management efforts should be initiated soon to reverse this trend.

A first step in remedial management was instituted in 1986. Before the start of the fishing season, informational signs encouraging anglers to keep only 1 trout/day  $\geq$  15.0 inches were posted by the DNR at all commonly used public access points within the Bibon Swamp portion of the study area. These signs were posted as a result of informal DNR research/management personnel discussions, held during the fall and winter of 1985-86. These discussions included recognition of the fact that such a voluntarily imposed constraint on harvest during the 1984-85 seasons would have theoretically reduced the kill of brown trout  $\geq$  15.0 inches by about 25%. I recommend that

we continue to encourage anglers to reduce the harvest of large trout. I also recommend that we augment that encouragement via other public relations outlets, until additional quantitative harvest and exploitation data have been obtained.

The trout population surveys of the census stations used in 1984-86 should be conducted again in spring 1989, and if possible, 2 additional stations should be added: one below the mouth of Bolen Creek and the other deep in the Bibon Swamp, 3-4 miles below the primitive campsite. These follow-up investigations in 1989 would help determine: (1) the extent of voluntary compliance in releasing large trout, (2) increases in fishing pressure and harvest, and (3) whether or not sufficient justification exists to mandate more restrictive angling regulations to perpetuate this unique fishery for large wild brown trout.

Construction of the public parking lot and canoe access at the Bibon Road Bridge was certainly justified on the basis of relieving parking congestion and improving public safety. However, this action has probably increased the need for more restrictive angling regulations on the White River. I recommend that any plans for additional public parking areas on the White River within the Bibon Swamp Natural Area be discouraged, in view of the potential of such areas to further increase fishing pressure and harvest. Encouraging additional fishing pressure or harvest would seriously compromise the fundamental goal of the Bibon Swamp Natural Area project—preservation of the unique wild resource values of the White River and adjacent Bibon Swamp.

## APPENDIX A. Notes on the Long Lake Branch sport fishery in Bayfield County.

The following information was acquired in conjunction with creel census activities conducted on the White River in 1984 and 1985 in Bayfield County. Data from anglers interviewed and from volunteer returns left at special census stations on the White River are included together. Most data were acquired at or near the Bibon Road Bridge on the White River, where public parking and a canoe access are provided. The Bibon Road Bridge is the most common access point to lower Long Lake Branch, which enters the White River approximately 1/3 mile upstream. The lower 6.0 miles of Long Lake Branch flow through and partially drain the Bibon Swamp. This section is Class I trout water, and has few other access points (Johannes et al. 1971).

**TABLE 1.** *Miscellaneous creel census data acquired on Long Lake Branch (Bayfield Co.) in 1984 and 1985.*

Characteristic	1984	1985
Angler returns	17	41
Trout harvest		
Brown trout	36	119
Brook trout	1	9
Average length		
Brown trout	12.9 inches (8.0-19.0 inches)	13.9 inches (7.0-23.0 inches)
Brook trout	8.0 inches	10.8 inches (8.0-14.0 inches)
Successful anglers (caught at least 1 trout)	13	37
Unsuccessful anglers (caught no trout)	4	4
Anglers fishing from canoe	16	39
Anglers fishing from stream bank	1	2
Duration of average fishing trip	7.5 hours	8.3 hours
Wisconsin residents	15	32
Nonresidents	0	5

**TABLE 2.** *Number of anglers of various age groups who fished on the Long Lake Branch (Bayfield Co.) in 1984 and 1985.*

Age Group	No. Anglers	
	1984	1985
< 16 years	0	1
16-64 years	7	25
≥ 65 years	0	3
Total	7	29

**TABLE 3.** *Harvest characteristics and distance traveled by anglers fishing the Long Lake Branch (Bayfield Co.), 1984 and 1985.*

Characteristic	No. Anglers	
	1984	1985
<b>Daily bag size (Brown trout only)</b>		
0	4	4
0 (did catch trout)	2	3
1	3	7
2	0	3
3	2	6
4	3	3
5	3	14
6	<u>0</u>	<u>1</u>
Total	17	41
<b>Bait choice of anglers using only one bait type</b>		
Worms	5	28
Flies	2	3
Spinners	1	<u>2</u>
Total	8	33
<b>Distance traveled one way</b>		
≤ 25 miles	1	10
26-50 miles	2	2
51-99 miles	0	9
≥ 100 miles	<u>12</u>	<u>16</u>
Total	15	37

## APPENDIX B.

**TABLE 1.** *Electrofishing scheme used in the 3 stations sampled in the White River during spring 1984-86.*

Electrofishing Station	Length (miles)	Date	Marking Run		Recapture Run		
			Boom Shocker, Current Type	No. Passes	Boom Shocker, Current Type	No. Passes	
Station 1	above	0.25	Apr 84	mini, dc	2	mini, dc	2
	below	0.50	Apr 84	reg., ac	1	reg., dc	1
				mini, dc	2	mini, dc	1
	above	0.50	Apr 85	mini, dc	3	mini, dc	2
	below	0.50	Apr 85	reg., ac	2	reg., dc	2
				mini, dc	2	mini, dc	2
	above	0.50	Apr 86	mini, dc	3	mini, dc	2
	below	0.50	Apr 86	reg., dc	2	reg., dc	2
				mini, dc	2	mini, dc	2
	Station 2	above	0.50	Apr 84	reg., ac	1	reg., dc
				mini, dc	2	mini, dc	1
below		0.50	Apr 84	reg., ac	1	mini, dc	2
				mini, dc	2		
upper		0.25	Apr 84	reg., dc	1	(included in above run)	
				mini, dc	1		
entire		1.0	Apr 85	reg., dc	2	reg., dc	2
				mini, dc	2	mini, dc	2
entire		1.0	Apr 86	reg., dc	2	mini, dc	2
				mini, dc	2	(included in above run)	
Station 3	upper	0.75	Apr 84	reg., dc	1	mini, dc	2
				mini, dc	1	(included in above run)	
	lower	0.25	Apr 84	mini, dc	2	mini, dc	2
	upper	0.50	Apr 85	reg., dc	3	reg., dc	2
			Apr 85	reg., dc	2	mini, dc	2
				mini, dc	2	(included in above run)	
	lower	0.50	Apr 85	reg., dc	2	reg., dc	2
			mini, dc	2	mini, dc	2	

**TABLE 2.** *Average weights per inch group of brown trout from the White River study area, spring 1984-86.*

Inch Group	No. Weighed	Avg. Weight (g)
3	1	8
4	20	16
5	54	24
6	60	42
7	117	68
8	145	99
9	106	137
10	92	187
11	119	249
12	93	311
13	80	402
14	56	479
15	39	578
16	27	703
17	5	764
18	3	1,000
Total	1,017	

# Appendix C. Creel census questionnaire.

DEPARTMENT OF NATURAL RESOURCES

## ANGLER INTERVIEW

FORM 3600-114

REV. 5-82

COUNTY	COUNTY CODE*	WATER NAME	WATER NUMBER*	1. <input type="checkbox"/> LAKE*	SHEET NUMBER*
				2. <input type="checkbox"/> STREAM*	
CENSUS SITE		DATE (MONTH-DAY-YEAR)*		1. <input type="checkbox"/> WEEKDAY* 2. <input type="checkbox"/> WEEKEND/HOLIDAY*	

1.\* WAS THE ANGLER A: 1.  DRIVER  
 2.  PASSENGER 3.  NO VEHICLE

2. AGE: 1.  UNDER 16 3.  65 & OVER  
 2.  16-64

3. SEX: 1.  MALE 2.  FEMALE

4. ANGLER RESIDENCE: 1.  WIS. 2.  NON-RES.  
 DISTANCE (MILES): 1.  0-25  
 2.  26-50 3.  OVER 50

WIS. COUNTY CODE OR NON-RESIDENT STATE: \_\_\_\_\_

5. LICENSE: 1.  NONE 5.  ANNUAL  
 2.  SPORT 6.  FAMILY  
 3.  RES. COMB. 7.  15-DAY  
 4.  PERM. RES. 8.  4-DAY

6.\* NUMBER OF ANGLERS IN PARTY: \_\_\_\_\_

7. TYPE OF TACKLE (MAX. OF 2):

1.  SPINNING 4.  CANE POLE  
 2.  BAIT CASTING 5.  JIG POLE  
 3.  FLY 6.  TIP UP  
 7.  OTHER \_\_\_\_\_

8. ANGLING METHOD (MAX. OF 2):

1.  STILL FISHING 4.  JIGGING  
 2.  CASTING 5.  SNAGGING  
 3.  TROLLING  
 6.  OTHER \_\_\_\_\_

9. BAITS USED (MAX. OF 2):

1.  WORM 6.  SPOONS  
 2.  MINNOW 7.  PLUGS  
 3.  OTHER NAT. BAIT 8.  FLY  
 4.  PREPARED BAIT 9.  JIGS  
 5.  SPINNERS  
 10.  OTHER \_\_\_\_\_

10. ANGLER WAS: 1.  GUIDED 2.  NOT GUIDED

11.\* FISHING WAS FROM: 1.  BOAT  
 2.  SHORE OR DOCK 4.  ICE SHANTY  
 3.  WADING 5.  OPEN ICE

12.\* COMPLETED FISHING: 1.  YES 2.  NO

13.\* TIME STARTED FISHING: \_\_\_\_\_ : \_\_\_\_\_

14.\* TIME ENDED FISHING: \_\_\_\_\_ : \_\_\_\_\_

15.\* CATCH AND HARVEST INFORMATION:

SPECIFICALLY FISHED FOR	% OF TIME FISHED FOR	NUMBER CAUGHT	NUMBER KEPT

16. LENGTH IS RECORDED IN: 1.  INCHES & TENTHS 2.  CM & MM  
 17. WEIGHT IS RECORDED IN: 1.  POUNDS & OUNCES 2.  KGS. & GRAMS

SPECIES CODE	SPECIES	LENGTH		WEIGHT		FIN CLIP	TAG		TAG NUMBER
		IN. CM.	10TH MM.	LBS. KGS.	OZ. GMS.		TYPE	COLOR	
L. STURGEON	B01								
SHOVELNOSE	B02								
GAR, UNSP.	D00								
BOWFIN	E01								
HIODON, UNSP.	H00								
CISCO	I04								
L. WHITEFISH	I05								
COHO S.	I14								
CHINOOK S.	I16								
ATLANTIC S.	I20								
TROUT, UNSP.	I01								
RAINBOW T.	I19								
BROWN T.	I21								
BROOK T.	I22								
LAKE T.	I23								
TIGER T.	I27								
SPLAKE	I28								
SMELT	J01								
N. PIKE	L02								
MUSKIE	L03								
HYB. MUSKIE	L08								
CARP	M12								
BUFFALO, UNSP.	N03								
REDHORSE, UNSP.	N04								
SUCKER, UNSP.	N02								
WH. SUCKER	N09								
BULLHD., UNSP.	O00								
BLACK BHD.	O05								
BROWN BHD.	O07								
YELLOW BHD.	O06								
CH. CATFISH	O08								
FLATHD. CAT.	O12								
BURBOT	R01								
WHITE BASS	V01								
YELLOW BASS	V02								
PANFISH	Z97								
SUNFISH, UNSP.	W03								
ROCK BASS	W04								
GREEN SUNFISH	W05								
PUMPKINSEED	W06								
WARMOUTH	W07								
BLUEGILL	W09								
WH. CRAPPIE	W13								
BL. CRAPPIE	W14								
Y. PERCH	X15								
SM. BASS	W11								
LM. BASS	W12								
SAUGER	X21								
WALLEYE	X22								
FW. DRUM	Y01								

19. COMMENTS:

\*MANDATORY INFORMATION

(COMMENT CODE)

Appendix D. Angler interview card.

Department of Natural Resources **ANGLER INTERVIEW CARD** Form 8100-74  
3-84

Date: \_\_\_\_\_ Name (optional): \_\_\_\_\_

Area Fished: \_\_\_\_\_ Address: \_\_\_\_\_ town \_\_\_\_\_ state \_\_\_\_\_

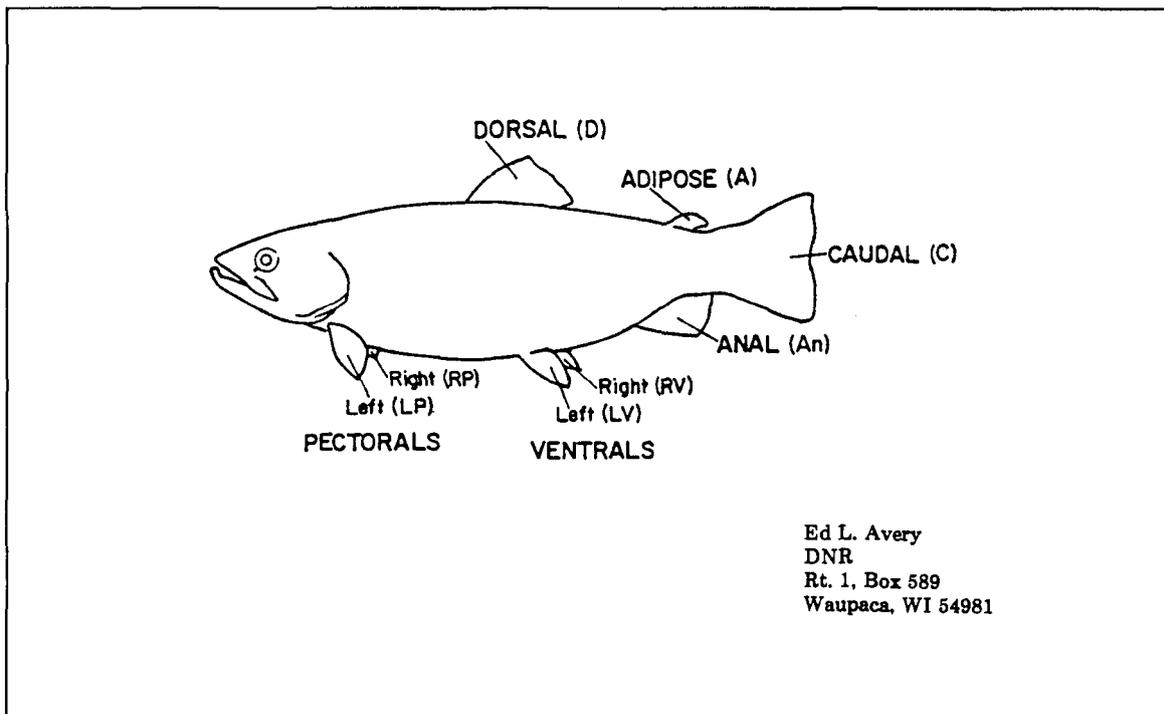
Time Began: (circle) a.m. \_\_\_\_\_ p.m. \_\_\_\_\_ End: (circle) a.m. \_\_\_\_\_ p.m. \_\_\_\_\_

Fishing From: Shore \_\_\_\_\_ Wading \_\_\_\_\_ Canoe \_\_\_\_\_ Other \_\_\_\_\_

Bait Used: Worm \_\_\_\_\_ Spinner \_\_\_\_\_ Fly \_\_\_\_\_ Minnow \_\_\_\_\_ Other \_\_\_\_\_

RECORD OF EACH BROWN TROUT REMOVED			Total Number of Trout Released:		
Total Length	Finclip (see back of card)	Tag (No./Color)	_____		
			Lengths (to nearest inch):		
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

NO TROUT CAUGHT (check) \_\_\_\_\_



## LITERATURE CITED

- Avery, E. L.  
1983. Population dynamics of wild brown trout and associated sport fisheries in two northern Wisconsin streams. Wis. Dep. Nat. Resour. Tech. Bull. No. 141. 31 pp.
- Avery, E. L. and R. L. Hunt  
1981. Population dynamics and associated sport fisheries in four central Wisconsin streams. Wis. Dep. Nat. Resour. Tech. Bull. No. 119. 26 pp.
- Calhoun, A. J.  
1950. California angling catch records from postal card surveys: 1936-1948; with an evaluation of postal card non-response. Calif. Fish and Game 36(3):177-234.
- Carline, R. F.  
1972. Biased harvest estimates from a postal survey of a sport fishery. Trans. Am. Fish. Soc. 101(2):262-66.
- Hunt, R. L.  
1985. Results and trout management implications of a 9-month creel census on Timber Coulee Creek in 1984. Wis. Dep. Nat. Resour. Res. Rep. No. 135. 23 pp.
- Johannes, S. I., L. M. Sather, and C. W. Threinen  
1971. Surface water resources of Bayfield County. Wis. Dep. Nat. Resour. 372 pp.
- Larson, T.  
1982. Characteristics of the sport fishery of Rowan Creek and the impact of fishing on the wild brown trout population. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 112. 15 pp.
- Mason, J. W. and G. D. Wegner  
1970. Wild river fish populations (Pine, Popple and Pike Rivers). Wis. Dep. Nat. Resour. Res. Rep. No. 58. 41 pp.
- Meyers, L. S. and T. F. Thuemler  
1976. Creel census on the lower North Branch Beaver Creek, 1975. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 89. 14 pp.
- Ricker, W. E.  
1958. Handbook of computations for biological statistics of fish populations. Fish. Res. Board Can. Bull. 119. 300 pp.
- Schearer, L. W., D. E. Ritchie, Jr., and C. M. Frisbie  
1962. Sport fishing survey in 1960 of the lower Patuxent estuary and the 1958 year-class of striped bass. Chesapeake Sci. 3(1):1-17.
- Simpson, J. C. and T. C. Bjornn  
1965. Methods used to estimate salmon and steelhead harvests in Idaho. Proc. 45th Annu. Conf. West. Assoc. State Game and Fish Comm. Anchorage, Alaska. 45:217-26.
- Weiher, W., D. Bublitz, W. Kiefer, and J. Semo  
1981. Master plan concept element White River fishery area, Bayfield County. Wis. Dep. Nat. Resour. 25 pp.
- Wisconsin Department of Natural Resources  
1979. Stream trout management plan. pp. 3-1 to 3-7 in Fish and wildlife comprehensive plan. Part I: management strategies 1979-1985. Wis. Dep. Nat. Resour.  
1980a. Wisconsin Department of Natural Resources final environmental impact statement for the proposed acquisition, development and management of Bibon Swamp Natural Area, Bayfield County, Wisconsin. Wis. Dep. Nat. Resour. 101 pp.  
1980b. Wisconsin trout streams. Wis. Dep. Nat. Resour. Publ. 6-3600(80). 67 pp.



## ACKNOWLEDGMENTS

I want to thank all members of the Mason and Delta town boards for granting the use of large, motorized electrofishing boats on the White River during this study. I especially thank those volunteers who assisted in this study and also Eugene Westlund, who provided a site to park the small mobile home to house summer creel census clerks.

I am grateful to both Dr. Lee Stadnyk and the Job Placement Office at Northland College (Ashland, WI) for their assistance in procuring reliable personnel to conduct summer creel census operations. Part-time employees Brett Welch and David Carlson were responsible for faithfully conducting the often tedious but necessary creel census phases in 1984-85.

My thanks to Bill Weiher, Steve Schramm, and Jeff Kampa (DNR fish managers in Brule) for their cooperation in supplying crew members and equipment for electrofishing surveys and for their valuable local insights pertinent to the study.

Robert Hunt, Cold Water Research Group Leader, contributed valuable assistance and counsel in both the field and writing phases of the study. Equal appreciation goes to Kent Niermeyer, technician in the Cold Water Group, who ably and enthusiastically assisted in all phases of field work and preliminary processing of field data. I also wish to thank Lyle Christenson, Chief of the Fishery Research Section, and Eugene Lange, Chief of the Research Technical Services Section, for their critical review of the manuscript.

This research was supported in part by funds provided by the Federal Aid in Fish Restoration Act under Dingell-Johnson project F-83-R. This report represents the final report for Study No. 409.

## ABOUT THE AUTHOR

Ed L. Avery is a Project Leader with the Cold Water Research Group, headquartered at Route 1, Box 589, Waupaca, Wisconsin 54981.

### Production Credits

Stefanie Brouwer, Technical Editor  
Wendy McCown, Copy Editor  
Alice Miramontes, Figure Preparation  
Ruth King, Illustrator  
Georgine Price, Layout and Production Artist

