Biological and Social Dynamics of the White River Brown Trout Fishery, 2014-2015 WBIC – 2892500

Chris Coffin, WDNR fisheries technician, displays a White River brown trout caught during sampling in 2015. Photo: Scott Toshner

Scott Toshner, Kirk Olson and Chris Coffin
Wisconsin Department of Natural Resources
Northern District - Brule
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Executive Summary

The White River is one of only eight trout streams in Wisconsin containing more than 40 miles of Class I or II trout water. The river is known for its top quality brown trout *Salmo trutta* fishery that is relatively inaccessible by roads. The 2014-2015 White River study was initiated to update trout population, trout catch and harvest and angler attitudes, based on the recommendations of Toshner and Manz (2008). In this report we compare recent with historic data and update management recommendations based on what was learned from 2005 to 2015. This study utilized many of the same methodologies that were developed in historic surveys on the White River.

Brown trout density from 2014 to 2015 has declined below the management recommendation of 300 -550 fish/mile (Toshner and Manz, 2008), which was the density thought to be adequate to maintain natural recruitment. These lower densities were likely the result of one or more small year classes of brown trout in the system. Densities of brown trout ≥ 6 inches have declined to 125 fish/mile in 2014-2015, compared to the consecutive year average of 523 fish/mile from 1984 to 2005. Additionally, we observed a substantial decline in age-I brown trout in 2013 and 2014 at all six trend stations located on tributaries and upper reaches of the White River, likely leading to weak year classes on the lower White. The cause of low year class strength may be related to several factors. Two of which may be severe winters in 2012/2013 and 2013/2014 and a large rain event in July of 2013 which caused a fish kill.

Our results indicate the brown trout decline in density is likely not from angler over-harvest. The average exploitation of brown trout ≥ 6 in was the lowest ever observed in 2014-2015 (11%) and exploitation did not exceed 20% in the two most recent creel surveys in 1992-1993 and 2004-2005. Exploitation of large brown trout (≥ 15 in) was 10 % in the current survey, declining from1992-1993 and 2003-2004 exploitation rates of 22% and 25%, respectively.

Regulation changes may have been partly responsible for the higher proportion of brown trout ≥ 15 in observed in surveys post regulation change. A more restrictive regulation was implemented in 2016. The genesis of this regulation was the rule simplification process for trout fishing regulations that began in 2013. In light of the 2014 and 2015 survey information, decreasing angler harvest is warranted even though angler exploitation is currently at a low level. Since the density of brown trout is now well below management recommendations, we feel that all management tools should be used to limit exploitation of adult fish. Future surveys will document changes in brown trout density and if densities rise to within or above management goals, a less restrictive regulation should be considered.

Annual trend monitoring on both wadable and non-wadable stations on the White River has provided useful information. Wadable trend station data has shown the possible link between recruitment in the tributaries of the White River and density of brown trout in lower sections of the White River. Wadable trend monitoring stations indicated that age-I brown trout abundance in the tributaries to the White River has the most potential for estimating year class strength. Stable isotope analysis revealed upstream spawning movements of brown trout from lower reaches to the headwaters of the South Fork of the White River.

One hundred and forty seven anglers responded to the angler questionnaire. Angler opinion corroborated population estimate data in regard to lower abundance of brown trout in the White River. In 2014 and 2015, 78% of respondents said they were either very satisfied or somewhat satisfied with their fishing experiences on the White River. There was nearly an even split of bait choices among anglers. The more conservative regulation starting in 2016 on the White River was viewed as having a positive impact on the fishery by the majority of anglers (61%), though live bait anglers preferred it less than fly anglers. However, when asked whether they favor or oppose the regulation, anglers were evenly split, with bait anglers more strongly opposing the regulation (70%) than fly anglers (20%). The lack of angler recruitment on the White River may be a cause for concern. The percent of anglers 50 years of age or older increased from 48% in 2006 to 68% in 2015. Increasing angler recruitment on the White River will be critical for maintaining public interest in the watershed and justifying continued fisheries management activities.

Management recommendations for the White River include: (1) Maintain 300-550 brown trout/mile $\geq$ 6 inches; (2) retain current regulations at this time and consider more liberal harvest regulations if the brown trout population increases to levels within management goals; (3) discern, through the use of expanded stable isotope studies, coarse-scale movement patterns of adult brown trout to identify spawning areas and summer and winter home ranges; (4) continue an active monitoring program with population estimates, angler questionnaires and creel surveys every 10 years and bi-annual non-wadable and annual wadable index stations. (5) work with interested parties to assist in accomplishing management recommendations and support the many groups that are preserving the White River and its watershed.

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Introduction

The White River is one of only eight trout streams in Wisconsin containing more than 40 miles of Class I or II trout water and has been known as a top quality brown trout fishery with limited road access. The 2014-2015 White River study was initiated to gather additional trout population, trout catch and harvest and angler attitudes regarding the fishery, following the management recommendations in Toshner and Manz (2008). In this report we compare recent to historic data and update management recommendations based on what we learned between 2005 and 2015.

The White River watershed is located in northwestern Wisconsin. The river originates in the Chequamegon National Forest in central Bayfield County and is the largest river in the county. The river flows east from its origin near Delta, 32 miles and enters Ashland County. A forty-nine foot power dam, located just inside Ashland County, creates the 56-acre White River Flowage and prevents upstream movement of fish 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 (Avery 1990). Numerous tributaries enter the White River, the largest of which is the Long Lake Branch that originates from Lake Owen in Bayfield County and joins the White River near the downstream end of the Bibon Swamp Natural Area. Eighteen Mile and Twenty Mile Creeks are the second and third largest tributaries to the White River and join the Long Lake Branch north of Grandview in the southern edge of the Bibon Swamp (Fig. 1).

The average daily discharge of the White River (1949 to 2005) near the power dam is 273 cubic feet per second (cfs) (USGS, station number: 04027500, waterdata.usgs.gov). April has the highest monthly average discharge (572 cfs) and January has the lowest monthly average discharge (182 cfs). Peak streamflow from 1949 to 2014 was 6,720 cfs recorded on July 24, 2005.

In the late 1800s the White River and its tributaries were used extensively to transport and process timber logged in the watershed. Many of the dams found throughout the watershed had their origins from the logging period. These dams were used either for power production for mills or as storage devices that could be opened or blown out in spring to float the logs to downstream locations. Logging activity from the turn of the 20th century still impacts water quality and channel morphology.

Citizens, local politicians and resource managers have worked to protect the White River watershed since the 1950s. Motor boats have been prohibited on the White River above State Highway 63 since 1967 when the Delta and Mason town boards adopted such action to secure the future of the unique recreational opportunities offered by the river. In addition, there are four major land protection areas on the White River that now encompass the headwaters to where the White River enters Tribal lands. The four protection areas include two fisheries areas (White River Fishery Area and the White River Fisheries - Expansion), a natural area (Bibon Swamp Natural Area) and a wildlife area (White River Wildlife Area). The White River Fisheries Area was established first in 1961 and the expansion was established in 2004.

The White River and its tributaries have a diverse fishery with nearly 40 species of fish identified (Appendix I, Table 1). Historic fish management of the White River and its watershed has included fisheries surveys, stocking, various length and bag regulations, installation of instream habitat improvement structures, headwater spring pond dredging and beaver *castor canedensis* control activities. Trout population surveys in the Bibon Swamp section of the White River occurred in 1984, 1985, 1986, 1988, 1989, 1992, 1993, 2003, 2004 and 2005. Creel surveys occurred in 1984, 1985, 1992, 1993, 2004 and 2005. Various other surveys have occurred on upper sections of the White River and its tributaries. These surveys mainly utilized backpack and towable electrofishing units. Objectives of these surveys were to assess fish passage and instream habitat improvement, or as part of the statewide wadable baseline monitoring program.

The White River has a long stocking history and has been stocked predominately with brook trout, brown trout and rainbow trout since at least 1920 according to records from the Wisconsin Fish Commission, and 1933 according to records from the Brule DNR office file (Appendix I, Table 2). The exception was one stocking of black bass (unknown species) in 1935. From 1933 to 1948 a combination of brook trout, brown trout, and rainbow trout were stocked primarily as fingerlings. Stocking from 1949 to 1969 consisted mostly of brown trout and brook trout; however the age of fish stocked during this period was mostly yearlings. Brown trout were stocked from 1949 to 1981 as predominately yearlings. Since 1981 no stocking has occurred and the fishery has been maintained by natural reproduction. Historic hatchery records indicate that the strain of brown trout stocked into the White River originally came from Europe in the early 1900s. The strain was started in the Nevin Hatchery and transferred to the Wild Rose Hatchery in 1946 where it was crossed with a strain from Cortland, New York.

The fishing season on the White River opens the first Saturday in May and ends October 15th. Trout fishing regulations have changed over time on the White River. Prior to 1990, bag and length restrictions on the White River included a 6 in minimum length limit, a daily bag limit of 10 trout in May (only 5 browns and rainbows), and a daily bag of 10 trout of any species from June through September. In 1990, from downstream of Pikes River Road bridge to the White River dam was changed to a Category 5 (3 trout over 9 in, only 1 brown trout over 15 in; Fig. 1). Upstream from Pikes River Road Bridge the fishing regulation was changed to a Category 2 (7 in minimum length and 5 trout daily bag limit). The 1990 change in regulations was in response to excessive angler exploitation of brown trout ≥ 15 in (Avery 1990).

Several changes to angling regulations have been made in 2016 as a result of the statewide push toward trout regulation simplification. Beginning in 2016, all of the White River and its tributaries are open to catch and release fishing (first Saturday in January to the first Friday in May) upstream of the power dam. Additionally, the White River upstream of Pike River Road, unnamed tributaries to the White River and East, West and South Forks of the White River have been changed to a 8 in minimum length and 3 trout daily bag limit in 2016. The White River downstream of Pike River Road and the Long Lake Branch of the White River changed to a18 in minimum length and 1 trout daily bag limit. Tributaries to the Long Lake Branch of the White River changed to a no minimum length limit and 5 trout daily bag limit. These regulation changes resulted from a statewide trout regulation simplification effort, which removed the historic regulations categories on the White River system from which managers could choose. Data presented in this report had not been collected when these regulation changes were made.

Recent management efforts have focused on fisheries surveys, beaver control, land acquisition and habitat improvement and protection. Land acquisition has been occurring in all of the various management areas as funding has been available and where landowners have been willing to sell or provide easements. Over 1,000 acres have been purchased by the State of Wisconsin since 2006 within the property boundaries. Stream habitat projects have mainly been focused on stretches of stream near the headwaters area. Controlling glossy buckthorn infestations and maintaining instream habitat improvements have been the main activities involving stream habitat since 2006.

The primary objectives of this report were to: (1) determine brown trout abundance, size structure, growth, movement patterns, (2) estimate angler pressure, harvest and attitudes on the White River and (3) compare these estimates to previous surveys on the White River. In addition, we describe the size structure and relative abundance of northern pike in the White River and results from water temperature monitoring in the White River and its tributaries.

Methods

Trout Populations

A 21.3 mile reach of the White River, beginning at Pikes River Road Bridge and continuing downstream to Bibon Road Bridge was selected for the study and was the same reach studied in historic fishery surveys (Avery 1990, Avery 1999; Fig. 1). Two, 4-mile long electrofishing stations were surveyed in 2014 and 2015 and encompassed two thirds of the historic survey stations per recommendations from Toshner and Manz 2008. Station start positions were located at the confluence of Bolon Creek and the White River and the Sutherland Bridge crossing (Figure 1). Data collected in 2014-2015 was compared to data collected in 1984-1986, 1988-1989, 1992-1993 and 2003-2004.

Mark-recapture electrofishing surveys using two mini-boomshocker boats, one following the other a short distance behind, were conducted from 2014-2015. Both mini-boomshocker units utilized two-booms. All electrofishing surveys progressed downstream during daylight using DC electricity (240 volts, 6.0 amps, on average). One pass was completed for each station for both the mark and recapture portions of the survey. Both brown and brook trout captured on the marking run were measured to the nearest 0.1 in total length, weighed, given a temporary fin clip and released within the station at least ½ mile from either the start or end of the station sampled. Both brown and brook trout captured on the recapture run were examined for marks, measured and released. Mark and recapture electrofishing runs were separated by one day to allow fish to redistribute between runs. Although some 3.0 - 5.9 in brown trout were captured each spring, the efficiency of their capture was poor, thus this discussion refers only to brown trout $\geq$ 6 in.

Brown trout population abundance was estimated with the Bailey modification of the Petersen estimator for trout $\geq$ 6 in (Ricker 1975). Population estimates for each station were divided into inch groups based upon the proportion of unmarked trout captured in each inch group on both the mark and recapture runs. Estimates and their variances were combined to determine total population parameters. Confidence intervals for mean brown trout density during each time period (combination of consecutive years) was estimated using population estimates from each sampling reach (n = 2-3 for each time series) as replicates. Trends in population abundance were evaluated using linear regression. Average lengths of trout were determined based on measurements from all stations and trends evaluated using linear regression. Population estimates were not calculated for brook trout due to their low abundance.

Scale samples were taken from 5 brown trout per 0.5 in group during electrofishing surveys and scales and otoliths were taken from angler harvested fish (as available) for age and growth analysis. Scale age was estimated by viewing scales under a 30X microfilm projector. Sagittal otolith age was determined by cross section and magnification under a compound microscope at 4X magnification. Age at length was back calculated using scale annulus measurements in 2003 and 2005 due to growth observed after annulus formation. Back calculation of lengths from scales relies on recognition of annual growth markings (annuli) on scales to calculate an estimated body length associated with each annulus. Body lengths estimated in this way make up a growth history, from which growth rate can be inferred (Pierce et al. 1996). The Fraser-Lee proportional method was used in back calculation of scales (Fraser

1916, Lee 1920). In 2004 and 2015, age at length was not back calculated because annulus formation was occurring at the time of the capture. Von Bertalanffy growth curves were modeled to estimate length at infinity for the scale samples collected during electrofishing and for scale and otolith samples from angler harvested fish.

Sport Fishery

In 2014 and 2015, a partial creel survey was conducted in the White River Study area from Pike River Road to Bibon Road (Figure 1). The creel occurred between the first Saturday in May and the end of the Hex (*Hexagenia limbata*) Hatch in mid-July. Though previous creel surveys occurred throughout the open fishing season (first Saturday in May to the end of September), Toshner and Manz (2008) recommended this shortened creel period given the limited pressure that occurs after the hex hatch and the consistency of seasonal trends in angler pressure. Otherwise, we followed the design described by Toshner and Manz (2008).

A stratified, random design was used to quantify angler effort and harvest (e.g. Avery 1990, Avery 1999, Toshner and Manz 2008). Creel clerks worked at randomly assigned 8 hour AM (6:00-14:00) or PM (14:00 – 22:00) shifts during three randomly selected weekdays and on both weekend days. Creel clerks followed this schedule throughout the creel period except during opening weekend (16 hour shifts were worked between 6:00 – 22:00) and the hex hatch (shifts were adjusted two hours later to improve coverage). During their shift, creel clerks conducted instantaneous car counts at 2-hour intervals, visiting all access points in the study area. Between instantaneous car counts, anglers completing fishing trips were interviewed to allow an estimate of mean angler hours per vehicle, catch rates and harvest rates.

Pressure was estimated separately for weekend and weekdays within seven strata (opening weekend, remainder of May, June before the hex hatch, hex hatch, July after the hex hatch, August and September). Catch and harvest rates were also estimated separately within each of the seven strata. We used the following equation to estimate pressure within each:

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

where, n is the number of car counts possible in a day, C_i is the mean number of cars present at each car count period i, T_i is the time interval represented by each car count, A_{wd} is the mean number of anglers per car on weekend days and holidays, A_{wed} is the mean number of anglers per car on weekend days and holidays, WD is number of weekdays in the month, and WED is the number of weekend days in the month. Fishing pressure for opening weekend was estimated separately following a similar (same?) equation.

Total harvest for each stratum was estimated by multiplying harvest rate from creel clerk interviews and angler pressure within each stratum. Though previous studies incorporated information from voluntary angler catch cards (Avery 1990, 1999), we only used information from creel clerk interviews. Because our creel survey ended in Mid-July (end of the hex hatch), we expanded angler pressure for the remainder of the trout season based on angler pressure estimates from 2004 and 2005. We also used the mean harvest rate from surveyed strata to estimate total harvest for the entire trout season, excluding opening weekend in 2014 because of unprecedented weather conditions. Harvest within each size class was estimated by taking the proportion of creeled fish in a size class (using creel clerk interviews) and multiplying the result by the total harvest. Exploitation was estimated by dividing harvest by abundance.

Annual electrofishing surveys

Annual single-pass electrofishing surveys were conducted on six wadable sites in the White River Watershed between 2007 and 2015 and at one non-wadable station in the lower White River between 2006 and 2015. Wadable sampling took place during the month of August when water levels were within 0.2 m of the normal water level. Non-wadable sampling generally took place in late March after ice out. The non-wadable station encompassed the area from Sutherland Road to the primitive campsite for all survey years except 2015 when the station end was one half mile upstream of the primitive campsite. A comparable survey on the non-wadable station was not completed in 2013 due to high water and late ice. In 2014, an error resulted in the catches of the leading and trailing boats being combined. In order to make 2014 catch per unit effort comparable, we corrected the total catch per unit effort to that of a single boat, based on previous data from two boat surveys on the river. All fish collected were identified, enumerated and measured to the nearest 0.1 inch. Fish were classified into three age categories (age-0, age-I and older than age-I) based on a visual evaluation of length frequency histograms and length at age information from a previous scale analysis (Toshner and Manz 2008). A Ricker stock-recruitment curve (assuming log-normal error) was fit to the data to examine the relationship between age-0 relative abundance and age-I abundance the following year (e.g. Maceina and Pereira 2007).

We examined trends in catch per effort (CPE) and the influence of temperature and flow on relative abundance of age-0 and age-I brown trout within each site. Flow data were collected from the USGS gauge on the lower White River (USGS, waterdata.usgs.gov, station: 04027500) and temperature data were collected from a weather Station in Brule, WI . We summarized flow data by taking the mean daily flow for each season during open water (spring, summer and fall) and temperature by estimating winter degree days (base 20°F) and summer degree days (base

75°F) for each season. Simple linear regression and multiple linear regression (backward variable selection) were used to evaluate relationships between relative abundance and environmental conditions. Residuals plots were examined for normality and homoscedasticity. Summer degree days was excluded from our analysis as it was highly correlated to winter degree days and winter degree days were more often strongly correlated to relative abundance.

<u>Stable Isotope Analysis</u>

Samples for C and N stable isotope analysis were collected during the 2015 field season on the White and the South Fork of the White River (Fig. 2). Adipose fins were collected in place of muscle samples to limit sampling mortality. Several studies have identified adipose fins as a suitable proxy for brown trout and other Salmonids (Jardine et al. 2005, Hanisch et al. 2010, Graham et al. 2013). Samples were collected haphazardly except for a portion of the fall sample, when larger (>9 in) spawning fish were targeted. Adipose fin clips were collected from brown trout in the main stem of the White River during late March (n = 20) and early August (n = 6). Brown trout in the south fork of the White River were sampled during early August (n = 13) and early November (n = 23; when active spawning was observed).

Samples were dried, homogenized and placed in tin capsules after collection. Sample processing was contracted through UC Davis Stable Isotope Facility (cost: $8 per sample, 2016 USD) and results were reported in the delta (δ) notation, using Peedee Belemite carbonate and atmospheric nitrogen as standards:

$$\delta(‰_0) = \left[\left(\frac{R_{Sample}}{R_{Reference}}\right) - 1\right] * 1000$$

where R_{Sample} is the ratio of heavy isotope to light isotope ($^{13}C/^{12}C$ or $^{15}N/^{14}N$) of the sample and $R_{Reference}$ is the ratio of heavy isotope to light isotope of the standard. Samples were adjusted for lipid content using C:N as a proxy for lipid content and following the correction equation of Hoffman and Sutton (2010).

Relationships between length and stable isotope signatures were examined across all brown trout using simple linear regression. Because $\delta^{15}N$ was linearly correlated to length across all brown trout sampled, a length adjustment (e.g. Fraser et al. 1998) was applied following the equation:

$$Y_i' = Y_i - b(L_i - L)$$

Where L_i is the total length for fish i, L is the mean total length of all fish sampled, Y_i' is the size-corrected $\delta^{15}N$ value for fish i, Y_i is the uncorrected $\delta^{15}N$ value for fish i and b is the slope of the linear regression line for total length vs. $\delta^{15}N$. This adjustment allowed the examination of $\delta^{15}N$ signatures independent of length. We compared length adjusted $\delta^{15}N$ and lipid adjusted $\delta^{13}C$ among fish from sites sampled prior to spawning using one-way ANOVA.

Angler Questionnaire

The methods for the angler questionnaire were similar to those used by Toshner and Manz (2008). The questionnaire, with cover letter describing the survey, was delivered in October following the closure of the inland fishing season. To increase response rate, one additional mailing was made to non-respondents and “reminder” post-cards were sent on another occasion. In all, anglers were given approximately two months to respond. A return envelope, with postage was included with each questionnaire. .

The questionnaire was designed to gauge angler motivation, satisfaction, participation, and years of experience. The questionnaire included questions on where and how anglers fished, each angler's history on the White River, and angler opinions on regulations and the fish they catch. In order to evaluate differences in attitudes between user groups, anglers were also asked what type of angling method they preferred (i.e. worms/live bait, artificial lures or fly fishing). Almost all of the questions included in the survey were close-ended questions where the answer choices were provided (see Appendix II for the complete questionnaire and answers by percentage). Close ended questions are preferable when more quantitative data is desired on participation rates and the intensity of feelings pertaining to issues regarding the fishery (Dillman 1978; Fenske 1983).

Northern pike

Northern pike sampled in all stations during 2014-2015 were processed much like the trout captured. Abundance could not be determined for northern pike due to low catch rate.

Temperature Monitoring

Onset© Computer Corporation Hobo® Water Temp Pro continuous temperature monitoring devices were installed at 7 sites in the White River Watershed to record water temperatures during 2002-2015. Water temperatures were recorded at ½ to 1 hour increments. The Wild Rivers Chapter of Trout Unlimited deployed, maintained and downloaded water temperature data using Box Car Pro 4.3 software from 2002 to 2005. WDNR deployed, maintained and downloaded water temperature data using Hoboware software from 2010 to 2015. Maximum daily mean temperatures from June through August (summer) were used for site and historic comparison purposes and to determine whether the stream was cold (< 20.7 C), cool (20.7 C to 24.6 C) or warm (> 24.6 C; Lyons et al. 1996).

Results

Trout populations

Brown trout (N = 1,316) and brook trout (N = 32) were captured during spring electrofishing surveys of the White River in 2014-2015 (N excludes recaptured fish). Brown trout comprised more than 98% of the trout captured and therefore is the primary species referred to in this report. The low frequency of brook trout is similar to historic surveys (Avery 1990, Toshner and Manz 2008).

Brown trout density declined between 1984 and 2015 ($R^2 = 0.72$, $p < 0.0001$, Fig. 4). Brown trout density reached its highest level in 1988-1989 at 656 fish/mile and declined to its lowest level in 2014-2015 at 125 fish/mile (Fig. 3; Appendix I, Table 3). Yearly and within station variation of brown trout density was often considerable. Annual brown trout density averaged 448 (N= 12, 1 SD = 200) fish/mile from 1984 to 2015 but ranged from 93 fish/mile (2015) to 757 fish/mile (1988; Figure 4; Appendix I, Table 4). The lowest annual brown trout densities of 139 and 93 fish/mile occurred in 2014 and 2015, respectively. Individual station brown trout density also differed but generally showed a decline with time. Between 1984 and 2015, density of brown trout (≥ 6 in) ranged from 77 fish/mile to 964 fish/mile in the various stations sampled (Appendix I, Table 4).

Compared to previous surveys, fewer fish were present in the 7.0 to 15.0 inch length groups in 2014 and 2015 (Fig. 5). Density of 6 to 8.9 inch brown trout ranged from 31 fish/mile in 2014-2015 to 196 fish/mile in 1984-1986 (Appendix I, Table 3). Brown trout densities between 9 and 14.9 inches ranged from 34 fish/mile in 2014-2015 to 409 fish/mile in 1988-1989. Density of brown trout ≥15 inches ranged from 27 fish/mile in 1984-1986 to 64 fish/mile in 1992-1993 (Fig. 6). The second highest density of brown trout ≥15 inches by sampling period occurred in 2014-2015 (60 fish/mile). Mean length of brown trout has increased significantly over time (R^2 = 0.5, P = 0.030; Fig. 7).

Brown trout sampled during the 2015 population estimate ranged in age from II to VII based on scale samples (Fig. 9). Age-II brown trout accounted for 8% of the population in 2015 versus an average of 40% from 2003-2005. Age-II and age-III brown trout accounted for 27% of the population in 2015 versus an average of 69% from 2003-2005. Brown trout growth was similar among survey years (Fig. 10). Age-II and age-IV brown trout averaged 7.7 and 13.7 inches, respectively, for all survey years. The oldest brown trout, age-VIII using scales as an aging structure, were represented in 2005 and 2015 but not in 2003 and 2004.

Agreement among age estimates determined from paired samples of scales and otoliths taken from individual angler harvested fish was 36% (Fig. 11). When age estimates from structures differed, 83% and 13% were within 1 and 2 years of age, respectively. The maximum age difference of three years was a 14.9 inch brown trout which had a scale age of five and an otolith age of two. Relative to otoliths, scales appear to underage fish with a scale age of three but overage fish with a scale age of four and older. When age estimates from age structures differed, otoliths suggest fish with scale age of four and older were overaged by one to two years 77% of the time. The oldest brown trout aged by use of an otolith was age-X and was 20.5 inches in length. Length at infinity of brown trout derived from von Bertalanffy modeling was variable amongst aging structure and sampling method. Scale samples taken during electrofishing sampling produced a length at infinity of 39.1 inches. Length at infinity from samples of otoliths and scales taken from angler harvested brown trout were 43.0 and 25.0 inches, respectively.

Brook trout represented 2.5% of all trout captured in the White River from 2014-2015, similar to the 2003-2005 survey (1.6%). Relative abundance of brook trout for 2014-2015 was

0.9 fish/mile in the population estimate stations (Fig. 1). In comparison, relative abundance of brook trout was 3.7 fish/mile in 2003 and 2005. Brook trout relative abundance was not available from surveys prior to 2003 on the White River.

Sport Fishery

Angler pressure in 2014 and 2015 was lower than previous years when a creel had occurred (Fig. 12). Estimated angler hours declined by 3,766 hours (on average) since the 2004 and 2005 comprehensive survey. Total harvest, catch rate, harvest rate and exploitation also declined on average, when compared to previous surveys (Fig. 13, 14 and 15). Though all these values decreased on average in 2014 and 2015, there were large differences in estimates between 2014 and 2015.

Estimates for catch and harvest rates, angler pressure, total harvest and exploitation all increased from 2014 to 2015. Total angler pressure increased by 927 hours between 2014 and 2015, with the greatest increases occurring in month of May (Fig. 16). Catch rates in 2015 also increased to levels observed in previous years (Fig. 14). Exploitation of brown trout ≥ 6 in. increased 12% between 2014 and 2015, and was similar to exploitation estimates after 1985. Exploitation of brown trout ≥ 15 in. increased slightly between 2014 and 2015 (2%) but remained lower than all other previous estimates of exploitation (Fig. 15).

Annual electrofishing surveys

Catch per unit effort (catch/mile. CPUE) of brown trout was highly variable on the non-wadable station from 2006 to 2015 (Fig. 17). Mean CPUE for brown trout surveyed in the non-wadable station was 76 fish/mile (1 SD = 25.7, N = 8) and ranged from 115 fish/mile in 2012 to 29.5 fish/mile in 2015. Correlation between mean CPUE of age-I brown trout from the wadable trend monitoring stations and the CPUE of brown trout 10.0 to 14.9 inches in length (representing age-III + brown trout) from the non-wadable trend monitoring station in the Bibon

Swamp showed a non-significant correlation ($R^2 = 0.6$, $P = 0.13$; Fig. 18). However, the lowest and highest mean CPUE of age-I brown trout from wadable trend stations produced the lowest and highest CPUE of age-III brown trout two years later in the non-wadable trend station, respectively.

Catch per unit effort (catch/mile) of age-I and older brown trout was highly variable on Twenty Mile Creek (CV = 77 %) and moderately variable within the remaining trend sites (CV = 25% - 47%, mean CV = 42%). Catch per unit effort of age-I and older brown trout were highly correlated among the Long Lake Branch, Twenty-mile Creek, Eighteen-mile Creek, the upper White River and the lower White River (r = 0.78- 0.92) but not the South Fork of the White and the East Fork of the White (r = -0.02 – 0.50, Fig. 19). Generally, catch per unit effort was highest on the South fork (mean CPE = 1270), lowest on the lower white river (mean CPE = 69) and variable among the remaining sites (mean CPE = 389-897, Fig. 20). Relative abundance of both age-I and age-I and older brown trout dropped sharply at nearly every site in 2013 and relative abundances were the lowest observed in 2013 or 2014 at every trend station (Fig. 19, 20).

Age-0 brown trout catches were highly variable at wadable trend stations (CV = 57% - 96%, mean CV = 76%) except the South Fork of the White River (CV = 38%). Age-0 catch per unit effort was not as strongly correlated among sites as age-I and older catches. Age-0 catch per unit effort was highly correlated among the East Fork, Twenty Mile Creek and the upper White River (r = 0.79 – 0.857) and correlations were lower among other sites (r = -0.12 – 0.68). Age-0 CPE was highest on the South Fork (mean CPE = 4,579), lowest on Twenty Mile Creek (mean CPE = 167 trout/mile) and variable among remaining sties (mean CPE = 236 – 1,160, Fig. 21 and 22). In 2013 and 2014 we did not capture any age-0 brown trout on Eighteen Mile Creek and Twenty Mile Creek, respectively.

Only the upper White River had a significant Ricker stock-recruitment relationship between age-0 CPE and age-I CPE the following year (observed vs. predicted, $R^2 = 0.598$, P = 0.025). The Ricker model did not fit the relationships between age-0 CPE and age-I CPE at the remaining sites well (observed vs. predicted, $R^2 = 0.03 – 0.26$, P = 0.16 – 0.73). Winter degree days (base 25ºF) had a significant negative correlation to relative abundance of age-I and older fish at three sites (upper White River, lower White River and the South Fork of the White River, $R^2 = 0.45 – 0.47$, $P <0.05$). A multiple regression model, including winter degree days and summer mean flow fit relative abundance of age-I and older fish in Eighteen Mile Creek (P = 0.0261). Age-0 relative abundance was positively correlated to fall flows on the Long Lake Branch (R^2 =, P = 0.044), and summer flows were positively correlated to age-0 CPE on Twenty Mile Creek ($R^2 = 0.633$, P = 0.0104).

<u>Stable Isotope Analysis</u>

Brown trout sampled in the summer on the upper South Fork of the White River had a significantly enriched $\delta^{13}C$ signature relative to brown trout sampled in the summer on the lower South Fork, near the confluence with the West Fork, and the main stem of the White in both spring and summer (Tukey's HSD, p<0.001, Fig. 23). $\delta^{13}C$ signatures of brown trout sampled during the summer on the South Fork decreased with distance from Lake Two (Fig. 24). Length adjusted $\delta^{15}N$ signatures for brown trout sampled in the summer on the South Fork of the White River overlapped with fish sampled in the spring on the upper White River, but were significantly depleted relative to fish sampled in the summer on the upper White River and fish sampled in the spring on the lower White River (Fig. 24).

Three of the 23 fish we sampled during the fall on the upper South Fork had signatures within the range of fish sampled during spring and summer lower in the watershed (near the mouth of the South Fork and in the White River, Fig. 24). These fish ranged in size from 10.1-

19.7 in. in total length. Of the remaining twenty, twelve had signatures within the range of fish sampled in the upper South Fork during the summer, seven had signatures more enriched than any fish we had previously sampled and one fish had a signature in the area of overlap between lower river sites and the upper South Fork (Fig. 25).

Angler Questionnaire

Questionnaire return rates were 77.0% (147 out of 191) in 2015 and 72.8% (233 out of 320) in 2006. These are above average response rates considering that full-participation percentages are between (43-64%) as stated by (Sztramko et al. 1991). Respondents comprised a broad spectrum of ages and experience, and traveled from near and far to fish the White River. Ninety Three percent of respondents in the 2015 survey were male, which was similar to the 2006 survey (94%). The age composition of anglers that responded to the survey has increased. The 2015 survey showed that 68% of anglers were 50 years or older compared to 48% in the 2006 survey. The average age of anglers also increased from 48 in 2006 to 53 in 2015. Over three quarters of all anglers had fished the White River for more than 11 years. Just under half (48%) of respondents were local anglers, traveling less than 50 miles one way to reach their fishing location, while 39% traveled between 50 and 200 miles, and 14% traveled over 200 miles. The longest distance an angler traveled was 1,850 miles one way.

Fishing experience satisfaction among anglers was high but has decreased slightly over time. In 2014 and 2015, 78% of respondents said they were either very satisfied or somewhat satisfied with their fishing experiences on the White River which compares to 84% of anglers who answered similarly in 2006. However, the percentage of anglers who were “very satisfied” with their fishing experience declined from 37% in 2006 to 26% in 2015 and the percent of anglers “not at all satisfied” increased from 2% in 2006 to 8% in 2015. The average number of days anglers fished the White River ranged between 6 and 8 days for 2014 and 2015 survey periods. Fishing the White River ranks as one of the most important fishing destinations for 68% of respondents. Over half (53%) of respondents in the 2015 survey thought that fishing on the White River has probably or definitely worsened compared to 49% in 2006.

Anglers were passionate with regard to how they fish the White River. Popular angling methods include fly fishing, use of live bait (worms), and artificial lures. A total of 50% of respondents answered that they never use live bait and 37% answered that they would never fly fish. Fifty six percent of respondents answered that they would never use artificial lures.

The average length of brown trout considered a trophy by anglers increased from 20 inches in 2006 to 25 inches in 2015. A total of 55% of respondents said the largest brown trout that they have caught in the White River was over 20 in. Many White River anglers practice live release of legal length trout. The majority (82%) of respondents in 2015 said they released some legal trout and kept others, with 30% releasing all legal trout. Only 6% of respondents said they kept all legal trout. Most anglers (90%) felt that the practice of live release of legal length trout has either increased or remained the same since they have been fishing the White River.

The more conservative regulation starting in 2016 on the White River, with an 18-inch length and a bag limit of one trout, was viewed as having a positive impact on the fishery by 61% of respondents, while 14% viewed it as neither positive nor negative, and 25% viewed it as probably or definitely negative. Eighty percent of anglers that never use live bait viewed the regulation change as having a positive effect on the White River. Anglers that never fly fish also believe that the regulation change will have a positive effect on the White River brown trout fishery but they were fewer (50% positive). Thirty three percent of anglers that would never fly fish viewed the more restrictive regulation as having a negative impact on the brown trout population.

When it came to the question of whether or not respondents favor or oppose trout regulations with an 18-inch minimum length and a bag limit of one trout, (47%) of respondents would definitely or probably oppose, and 44% of respondents would definitely or probably favor, and 9% were not sure. Seventy three percent of anglers that never use live bait favor the more conservative regulation. On the other hand, 70% of anglers that never fly fish oppose the more conservative regulation.

Northern Pike

A total of 13 northern pike were captured in White River surveys from 2014-2015, compared to 49 captured from 2003-2005. Mean length of northern pike from 2014-2015 was 26.4 inches (SD = 3.5, N = 13) and ranged from 18.0 to 30.2 inches. Mean length of northern pike from 2003-2005 was 21.0 inches (SD = 6.3, N = 49) and ranged from 7.2 to 35.8 inches.

Temperature Monitoring

Water temperatures during summer months in the White River system were colder in 2010-2012 and 2015 than 2002-2004, with the exception of the East Fork of the White River which had higher temperatures in 2010-2012 and 2015 than the 2002-2004 (Fig. 26). Maximum summer daily mean temperatures (MSDMT) on Eighteen Mile Creek and the South Fork of the White River indicated cold water conditions throughout the survey period.   MSDMT changed from cool to cold between survey periods on the White River at Pike River Road and Sutherland Bridge, the Long Lake Branch of the White River at Taylor Lane and Twenty Mile Creek at North Sweden Road. In contrast, mean, maximum and minimum air temperatures increased from 2002-2004 to 2010-2012, 2015 (WI State Climatological Survey).

Summary and Discussion

The White River was surveyed in 2014-2015 to determine the status of the fishery, add to the information collected in previous surveys and report on additional data collected per management recommendations made by Toshner and Manz (2008). More specifically, we analyzed brown trout population parameters, creel survey metrics, wadable and non-wadable trend station data, brown trout movement via stable isotope analysis and changes in angler perceptions/ dynamics and angler opinions on regulations.

Brown trout density in the White River has been variable from year to year and station to station from 1984 to 2015. When consecutive years and stations within years are combined, however, the trend indicates a decrease in the brown trout abundance ≥ 6 inches. Densities of brown trout ≥ 6 inches have declined to 125 fish/mile in 2014-2015, compared to the consecutive year average of 523 fish/mile from 1984 to 2005. Brown trout density from 2014 to 2015 has fallen below the management recommendation of 300 to 550 fish/mile (Toshner and Manz, 2008), which was the density thought to be adequate to maintain natural recruitment. These lower densities were likely the result of one or more small year classes of fish in the system. Relative abundance of age-I brown trout at our long term trend stations declined sharply in 2013 and was the lowest observed at every station in 2013 or 2014, indicating weak year class strength in those years. Severe winters may have had an effect on age-I year class strength in the tributaries in 2012/2013 and 2013/2014. Winter degree days had a significant negative correlation on several tributaries to the White River that are thought to strongly contribute to recruitment. Overwinter mortality has been shown to regulate abundance in other populations of stream dwelling salmonids (Hunt 1969, Meyer and Griffith 1997). In addition, an extreme rain event in the late July of 2013, when approximately 7 inches of rain fell in a 24 hour period at Sutherland Bridge, caused a fish kill event. The fish kill was likely caused by the flushing of wetlands surrounding the White River which had low levels of dissolved oxygen at a time when water temperatures where warm, thus reducing available oxygen to trout. Quantifying the extent of the 2013 fish kill is difficult due to the remote nature and turbid water of the Bibon Swamp, but anglers reported seeing in excess of 80 dead brown trout between Sutherland Bridge and Goldbergs Landing in the days following the rain event. The severity of the 2013 fish kill may have been high based on results from the non-wadable trend station data that indicated relative abundance of brown trout was the highest in 2012 from the time period from 2006 to 2012. The high relative abundance from the non-wadable trend station in 2012 would have been expected to carry over to the 2014 and 2015 population estimates, but this did not occur.

There has been a shift in the brown trout population size structure since the late 1980s toward larger fish. A shift in size structure toward larger fish seems desirable but may warrant concern. Reduction of new recruits into a population will shift a population size structure to larger, older fish if recruitment is low (Toshner 2004, Margenau et al. 2008, Zale et al. 2012). Length frequencies of brown trout in 2014 and 2015 exhibited low numbers of fish in the 7.0 to 8.9 inch and 9.0 to 15.0 inch length groups when compared to historic surveys (Fig. 5). Furthermore, age-II and age-III brown trout accounted for 27% of the population in 2015 versus an average of 69% from 2003-2005. Both length frequency and age distribution of brown trout indicate low recruitment may be a likely cause for lower brown trout densities in the White River in 2014 and 2015.

Our results indicate the brown trout decline in density is likely not from angler over-harvest. The average exploitation of brown trout ≥ 6 inches has steadily declined from 35% in 1984-1985 to the all-time low of 11% in 2014-2015. Exploitation of large brown trout (≥ 15 inches) was 10 % in the current survey and also declined compared to the 1992-1993 and 2003-2004 exploitation rates of 22% and 25%, respectively. An 11% exploitation rate is generally considered sustainable, even for slow growing or sporadically recruiting salmonids (Hansen 1996, Ebner et al. 2008). However, even 11% exploitation could negatively impact the population if recruitment remains low.

A more restrictive regulation will be implemented beginning in 2016. The genesis of this regulation was the rule simplification process for trout fishing regulations that began in 2013. The former regulation was no longer available for use; the choice involved either a more liberal regulation or a more conservative regulation. At the time of the decision data present in this report had yet to be collected, but erring on the conservative side was thought to be prudent. In light of the 2014 and 2015 survey information decreasing angler harvest is warranted even though angler exploitation is currently low. Since the density of brown trout is now below management recommendations, using all available management tools to limit exploitation becomes reasonable. Future surveys will document changes in brown trout density and if recruitment increases and densities rise to within or above management goals, consideration of a less restrictive regulation should be considered.

Potential outcomes of a more restrictive regulation may include a decreased abundance of brown trout if intra-specific competition (i.e. predation of large brown trout on small brown trout) is affecting recruitment (Dong and DeAngelis 1998). However, historical data suggests that this is unlikely given the number of brown trout ≥ 15 inches has remained consistent between 1993 and 2015 while the number of brown trout from 6 to 14.9 inches has been widely variable.Anderson and Nehring (1984) found that a catch-and-release regulation in a wild trout population in Colorado had catch rates that average 48% greater than in the standard regulation of the same stream that had the additional benefit of catchable-size trout stocking. They also found that catch rate of trophy sized trout (≥ 15 inches) was 28 times greater in the catch and release section than in the harvest section. Carline et al. (1991) similarly found that catch rates of brown trout increased from 0.2 to 1.3/h after the implementation of a catch and release only regulation on a Pennsylvanian trout stream, they also found that abundance of age-I and older brown trout increased by 165%.

We did not detect a significant relationship between age-I brown trout abundance in headwater reaches (wadable trend stations) and age-III abundance on the lower White two years later. However, our sample size was small (N = 5) and there are initial indications that a positive relationship may exist between the two. Therefore, we recommend continuing annual sampling on the wadable trend stations and annual sampling on the non-wadable trend station.

Relative abundance of age-0 brown trout in our annual trend stations was highly variable. Age-0 abundances fluctuated widely and patterns were not always consistent across sites or years. It appears that synchronicity in age-0 relative abundance occurred in some years but not others (e.g. in 2012 vs. 2007; Fig. 21 and 22). It may be that stream specific conditions (e.g. differences in flow and temperature regimes) are causing this variability. Age-0 relative abundance was not usually related to age-I abundance in the following year, except on the upper White River, where we documented a significant stock recruitment relationship.

Interestingly, age-I and older relative abundance was highly synchronous among four of the six trend stations. This suggests that stream conditions experienced across the watershed influence the relative abundance of age-1 and older brown trout at these sites. Winter intensity (winter degree days) was the stream variable most frequently correlated to age-I and older abundance (four sites, negative correlations). Over winter mortality of stream trout can be substantial (Hunt 1968, Meyer and Griffith 1997) and has largely been attributed to depletion of energy reserves (Cunjak 1988, Hutchings et al. 1999). However, our results should be interpreted with caution given the correlations among measured stream conditions (e.g. negative relationship between summer degree days and winter degree days) and the possibility of correlations with unmeasured stream conditions.

Brown trout $\delta^{13}C$ signatures decreased from the upper South Fork to the main stem of the White River which is inconsistent with patterns described in other watersheds (Doucett et al. 1996, Finlay 2001). We expected fish $\delta^{13}C$ signatures to increase in a downstream direction due to a combination of increased in-stream productivity and decreased proportional contribution from terrestrial sources (Doucett et al. 1996, Finlay 2001). The headwaters of the South Fork begin in a large, productive spring pond complex, including Lake Two (16 acres, 7 ft. max. depth). Primary producers within these spring complexes may be enriched in $\delta^{13}C$ (relative to downstream river reaches) due to high productivity coupled with low water velocities (Finlay et al. 1999, Finlay 2004, Ishikawa 2012) and this carbon may be contributing to fish production downstream from Lake Two, resulting in the pattern we observed. Regardless, the high degree of separation between brown trout sampled in the upper South Fork and those sampled in the lower South Fork and White River allowed us to distinguish between fish originating from each location. Though some overlap between South Fork and White River $\delta^{13}C$ signatures occurred, only one brown trout sampled during the fall spawning on the upper South Fork had a value within the range of overlap (Fig. 24).

Based on $\delta^{13}C$ signatures, three of the 23 brown trout sampled during spawning on the South Fork originated from the lower South Fork or the White River. One of these brown trout was larger than any that had been captured in previous surveys on the South Fork (19.7 in. total length, WDNR unpublished data, 21 surveys, 1978-2015), while fish over 19 in. are relatively common in the White River (Toshner and Manz 2008). Twelve brown trout had signatures within the range of fish sampled during the summer on the South Fork and one fish had a signature that fell within the range of overlap between upstream and downstream reaches on the lower South Fork and White River. The remaining fish (n = 7) were more enriched than any fish we sampled earlier in the season and likely originated upstream of our summer sampling sites (Fig. 24).

This is one of a few studies that have applied naturally occurring carbon and nitrogen stable isotopes to describe movements of fish within a river system (Cunjak et al. 2005, Sepuvelda et al. 2009, Ramsay et al. 2012) and the only study, that we are aware of, which has documented the utility of carbon stable isotopes to discriminate between fish occupying stream reaches < 2.5 mi. apart. Given the small spatial scale, we observed an extremely wide range of carbon isotope signatures in fish sampled during summer (-21.3 to -30.3 $\delta^{13}C$) on the South Fork. Doucett et al. (1996) documented a similar range of $\delta^{13}C$ signatures in resident trout from sites separated by 11.2 mi. The gradient we described may be present in other tributaries that begin as productive lakes or springs in the watershed (e.g. West Fork, East Fork). Carbon isotopes may be used to track spawning movements at these sites.

Without samples from each nearby tributary, it is possible that the $\delta^{13}C$ depleted brown trout we sampled during the fall attained their signature in another tributary of the White that was not sampled (e.g. West Fork). It is also possible that some of the brown trout we sampled during the spring and summer may have been migrants from other reaches. This would be unlikely for brown trout sampled in the summer since movements of stream dwelling brown trout are generally low during summer (Clapp et al. 1990, Meyers et al. 1992, Ovidio et al. 1998, Burrell et al. 2000). Future work should compare $\delta^{13}C$ samples from invertebrates or more sedentary fish species (e.g. sculpin, Cunjak et al. 2005) from each major tributary in the upper White River to validate our current $\delta^{13}C$ baselines and interpretation of these data.

Our results highlight the connectivity of brown trout in the White River, and are consistent with the extensive literature on brown trout spawning movements via telemetry (Clapp et al. 1990, Meyers et a. 1992, Ovidio et al. 1998, Burrell et al. 2000, Davis et al. 2015). The WDNR has invested extensive resources into protecting the watershed of the South Fork and enhancing in-stream fish habitat. Our results indicate that this work is not only supporting the local brown trout population but likely downstream populations as well.

Continuous temperature monitoring in the White River watershed from 2010 to 2015 was compared to results from 2002 to 2004. The maximum summer daily mean temperature was lower or stable at all monitoring locations with the exception of the East Fork of the White River, which had increased temperatures. In contrast, mean, maximum and minimum air temperatures increased from 2002-2004 to 2010-2012, 2015 (WI State Climatological Survey). In stream temperature dynamics are complex and influenced by a range of other variables (Poole and Berman, 2001). The contradiction between decreasing water temperature and increasing air temperature during survey periods may be partially explained by increased groundwater discharge into the White River during the 2010 to 2015 survey period. The drought of the mid-2000's and subsequent end of the drought in the late 2000's could have provided a mechanism for increased ground water discharge that buffered higher air temperatures from 2010 to 2015. Changing flow and temperature regimes due to climate change have the potential to substantially impact abundances of stream dwelling salmonids (Dunham et al. 2015). Modeled changes in stream temperature due to climate change (FishVis data viewer, http://ccviewer.wim.usgs.gov/FishVis/#) indicate that increased water temperatures in the mid to late 21st century may reduce thermal habitat for cold water species such as brown and brook trout. Due to these concerns, summer water temperature monitoring should be continued to monitor water temperature regimes in the White River and its tributaries.

The social component of anglers on the White River is complex. Replication of many aspects of the angler questionnaire from 2006 allowed comparison to responses from the angler questionnaire from 2015. Angler opinion corroborated population estimate data in regard to lower abundance of trout in the White River. When asked if fishing has improved or worsened those who indicated “worsened” cited fewer trout as the reason in 2006 (14%) increased to 40% in 2015. There remained a nearly even split of bait type choices among anglers however, anglers who answered they would “never” fly fish decreased by 7% and those who answered they would never use live bait increased by 11% from 2006 to 2015. The more conservative regulation starting in 2016 on the White River, with an 18-inch length and a bag limit of one trout was viewed as having a positive impact on the fishery by the majority of anglers (61%), although anglers who fished with live bait preferred it less than those who fly fish. However, when asked whether they favor or oppose the new regulation anglers were evenly split. Anglers who fished with bait strongly opposed the new regulation (70%) whereas anglers who fly fish strongly favored the new regulation (73%). Fortunately for bait anglers, sections of the White River, the Long Lake Branch of the White River and their tributaries still allow harvest opportunity and have an 8 inch minimum length restriction and a daily bag limit of 3 trout. If brown trout densities increase in future surveys, consideration should be given to liberalization of the regulations to allow anglers increased harvest opportunity. A lack of angler recruitment may be cause for concern on the White River. The average age of anglers who completed the questionnaire increased from 48 years in 2006 to 53 years in 2015. The percent of anglers 50 years of age or older increased from 48% in 2006 to 68% in 2015. Increasing angler recruitment on the White River will be critical for maintaining public interest in the watershed and justifying continued fisheries management activities.

Evaluation of previous management objectives (Toshner and Manz 2008, Italics) and future Recommendations

1. Population goals. *Proposed a management goal of 300-550 brown trout/mile ≥ 6 inches. At that density recruitment should be adequate to support the fishery*.

Brown trout densities from the 2014 and 2015 surveys for brown trout ≥ 6 inches have declined to 125 fish/mile and have decreased below the goal. Reasons for this are likely linked to low recruitment caused by harsh winters in 2012/2013 and 2013/2014 and the summer of 2013 fish kill caused by a large rain event. If recruitment increases in the future we expect brown trout densities to increase.

2. Regulations. *Implementation of regulation changes were not advised because harvest in the 2004 and 2005 creel surveys on the White River indicated angler exploitation was not limiting abundance of brown trout.*

The regulations on the White River have been changed as a result of the statewide trout regulation simplification process which began in 2013. In light of the decline of the brown trout population in the most recent survey the more restrictive regulation may be appropriate if only to provide a small degree of protection to the population. If future surveys show an increase in brown trout densities to within or above population management goals, consideration should be given to liberalizing regulations to allow anglers to harvest more brown trout.

3. Monitor recruitment. *Counting redds in the fall in tributaries that are known recruitment sources for the White River and comparing those to year class strength was proposed to provide information on the importance of the specific habitat types in the watershed.*

Redd counts were attempted in 2008 with the aid of volunteers. Results were difficult to discern and few redds were identified. This may have been due to timing of the investigation. In any case, the effort required and the usefulness of these data encouraged us to explore other routes to investigate recruitment and these are explored in this report.

Recommended continuous temperature monitoring data collection.

Continuous temperature monitoring data has been collected and results are included in this report.

4. Trout movement/passage. *Recommended studying movement patterns of brown trout.*

A grant proposal for radio tagging brown trout was submitted in 2009 to the Great Lakes Fish and Wildlife Restoration Initiative and was not chosen for funding. The cost of the radio tagging study was estimated to be $89,000. Due to the advancement of stable isotope technology and the low cost associated with this technique (~$1,000 for study described in this report) we used the method to demonstrate brown trout movement within the White River watershed. The results of which are included in this report along with management recommendations for further use of this technique.

Recommended completion of relative abundance surveys on the area of the White River from State Highway 63 downstream to the dam.

This section of the White River was sampled for the first time in 2005. Results showed low abundance of brown trout in the area which correlated to the high water temperatures observed in the section of river. While the lower section of the White River may be seasonally important to brown trout, completion of surveys in this logistically challenging section of river were considered lower priorities when compared to the annual trend monitoring and period population estimates, creel surveys and angler questionnaires.

Recommended exploring the condition of fish passage from Eighteen Mile Creek to the Long Lake Branch.

A fish passage survey evaluation was completed in 2009. Results of the survey indicated brown and brook trout could pass the area from the Long Lake Branch of the White River into Eighteen Mile Creek. We also found that all sizes of both brown and brook trout could navigate this heavily braided stream segment (Toshner 2009).

Proposed continued funding of beaver control activities for the White River system as a whole both for fish passage and water temperature concerns from dams.

Beaver control in the White River watershed is ongoing and is contracted by WDNR through the United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS). APHIS removed over 250 beaver and over 270 beaver dams from 2007 to 2016 in the White River watershed.

5. <u>Northern pike.</u> *Proposed continued monitoring of northern pike in the White River.*

Northern pike continued to be sampled during monitoring activities on the White River. The numbers of northern pike capture declined from 49 in the 2003 to 2005 survey to 13 in the 2104 to 2015 survey.

6. Age validation. *Recommended the use of otoliths from angler harvested brown trout for comparison to scales to generate aging data and to discern differences in brown trout longevity.*

Otoliths were collected from angler harvested brown trout in 2014 and 2015 and results are presented in this report. Prior to the use of otoliths for age interpretation the oldest scale age for a brown trout was 8 years. Otoliths helped identify a 10 year old brown trout that was 20.5 inches in length. We found that interpretation of both scales and otoliths present challenges when trying to accurately determine the age of brown trout. We propose an age validation study using coded wire tags on age-I brown trout sampled in the wadable trend monitoring stations. This method would provide a "known" age fish sample that we could use to correlate with aging data in the future. We also recommend collection of both otoliths and scales from the tagged brown trout when encountered during surveys. Until results from an age validation study are analyzed, population estimate surveys should continue to collect a subsample of scales which can be used to provide comparative data to historic surveys. Accurate age assessment is important to determine year class strength in the White River.

7. Future surveys. *Proposed future population, creel, angler questionairre and continuous temperature monitoring surveys on the White River should be conducted every 10 years.*

The 2014-2015 survey accomplished this recommendation. We propose to continue this frequency with the next comprehensive survey to be scheduled for 2024-2025.

Proposed utilizing stations longer in length due to movement out of the one mile stations and considerable differences found between the alternate stations surveyed in 2005 and the historic locations along with the advantage of including a larger portion of the study area. The proposal called for three stations, each four miles in length.

The 2014-2015 survey utilized two stations that were each four miles in length, the upper and middle stations. Logistically the sampling of the lower station would require an extra two electrofishing days and is in a location that is difficult to access, therefore we recommend future surveys utilize the upper and middle stations only. We feel that these stations adequately represent the study area, especially in terms of where angler effort is concentrated and will adequately reflect population trends in the White River as a whole. In addition, these stations require only one week to survey which is important since the timing of the survey conflicts with lake survey efforts the Brule Fishery office conducts annually.

Recommended annual electrofishing survey be completed on the middle station utilizing one mini-boomshocker with one pass to provide relative abundance, length frequency and year class strength information on brown trout.

This recommendation has been completed with the exception of 2013, which was due to unconducive weather conditions. The results of this survey are presented in this report. We recommend the annual frequency of this survey to continue. In correlation with the non-wadable trend station monitoring we recommend annual wadable trend monitoring to continue. We propose sampling the wadable trend stations of Twenty Mile Creek, Eighteen Mile Creek, Long

Lake Branch of the White River, South Fork of the White River and East Fork of the White River. The list of stations eliminates the wadable station on the White River due to the inability to efficiently sample this location. The continuation of wadable stream trend monitoring enables the quantification of year class strength through the use of age-I brown trout abundance.

Proposed several recommendations for future creel surveys.

Due to our desire to maintain the comparability of creel surveys the protocol remained similar in 2014-2015. Shortening the creel survey to reduce the cost of gathering data was the only creel recommendation acted upon in 2014-2015.

8. Partners. *Recommended working with interested parties to assist in accomplishing management recommendations, the completion of which will help further our understanding of the unique fishery that the White River* supports.

Partners worked with include, Bayfield Regional Conservancy, Bibon Swamp Advisory Committee, Friends of the White River, United States Forest Service, United States Fish and Wildlife Service, West Wisconsin Land Trust and The Wild Rivers Chapter of Trout Unlimited. Further protection of the White River watershed has occurred since the prior report. Hundreds of acres have been acquired and protected and numerous public education events held. Continuing and possibly expanding these efforts are encouraged in the future.

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Table 1. Description of the seven strata used in the 2014 and 2015 creel survey.

Strata	Time period
1	Opening Weekend
2	Remainder of May
3	June before the Hex hatch
4	Hex hatch
5	Remainder of July
6	August
7	September

Table 2. Angler pressure estimates for 1984-2015. Estimates prior to 2014 included information from angler questionnaires, only angler interviews were used after 2005. Pressure by strata were only available for 2004-2015.

Fishing pressure (angler hours)

Year	Strata 1	Strata 2	Strata 3	Strata 4	Strata 5	Strata 6	Strata 7	Total
1984								**9760**
1985								**12087**
1992								**12676**
1993								**13377**
2004	786	1841	792	1987	284	575	747	**7013**
2005	595	2862	665	1567	315	459	598	**7061**
2014	138	673	356	1051	120	204	266	**2807**
2015	510	858	538	1045	159	272	353	**3734**

Table 3. Catch and harvest rates of trout from the White River study area. Estimates for July after the hex hatch through September in 2014 and 2015 were based on mean catch rates for surveyed period, excluding opening weekend 2014.

Creel Strata	**Trout Species**	**2004** Catch/Hr	**2004** Harvest/Hr	**2005** Catch/Hr	**2005** Harvest/Hr	**2014** Catch/Hr	**2014** Harvest/Hr	**2015** Catch/Hr	**2015** Harvest/Hr
Strata 1	Brown	0.42	0.22	0.51	0.34	0.03	0.01	0.19	0.12
	Brook	0.03	0.01	0.02	0.01	0.00	0.00	0.04	0.03
	Total	0.45	0.23	0.53	0.35	0.03	0.01	0.23	0.14
Strata 2	Brown	0.75	0.30	0.72	0.25	0.14	0.05	0.50	0.12
	Brook	0.07	0.03	0.05	0.01	0.02	0.00	0.08	0.03
	Total	0.82	0.33	0.77	0.26	0.17	0.05	0.58	0.15
Strata 3	Brown	1.09	0.18	0.81	0.21	0.22	0.08	0.56	0.12
	Brook	0.04	0.00	0.09	0.00	0.02	0.01	0.16	0.01
	Total	1.13	0.18	0.90	0.21	0.24	0.09	0.72	0.13
Strata 4	Brown	0.52	0.12	0.23	0.07	0.34	0.05	0.34	0.05
	Brook	0.00	0.00	0.02	0.00	0.03	0.00	0.06	0.00
	Total	0.52	0.12	0.25	0.07	0.37	0.05	0.40	0.05
Strata 5	Brown	1.16	0.10	0.55	0.11		0.06		0.10
	Brook	0.30	0.00	0.11	0.05		0.00		0.02
	Total	1.46	0.10	0.66	0.16				
Strata 6	Brown	1.16	0.10	0.41	0.03		0.06		0.10
	Brook	0.30	0.00	0.19	0.06		0.00		0.02
	Total	1.33	0.09	0.60	0.09				
Strata 7	Brown	0.43	0.15	0.49	0.14		0.06		0.10
	Brook	0.25	0.00	0.05	0.00		0.00		0.02
	Total	0.68	0.15	0.54	0.14				
Season Average	Brown	0.79	0.17	0.53	0.16				
	Brook	0.14	0.01	0.08	0.02				
	Total	0.93	0.17	0.61	0.18	0.20	0.05	0.48	0.12

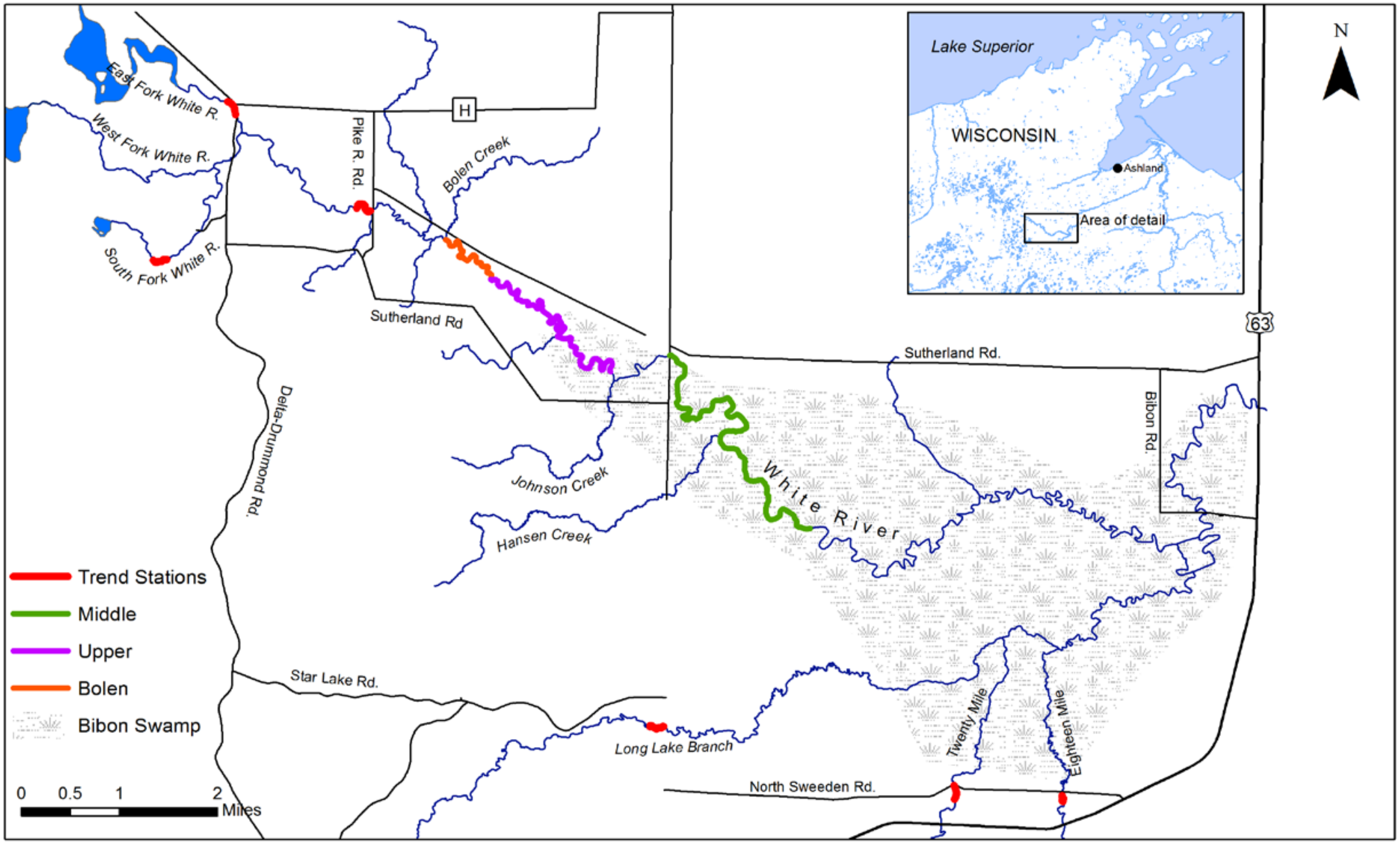

Figure 1. Map of the White River Watershed, 2014 and 2015 population estimate reaches and long term trend stations, Bayfield County, Wisconsin.

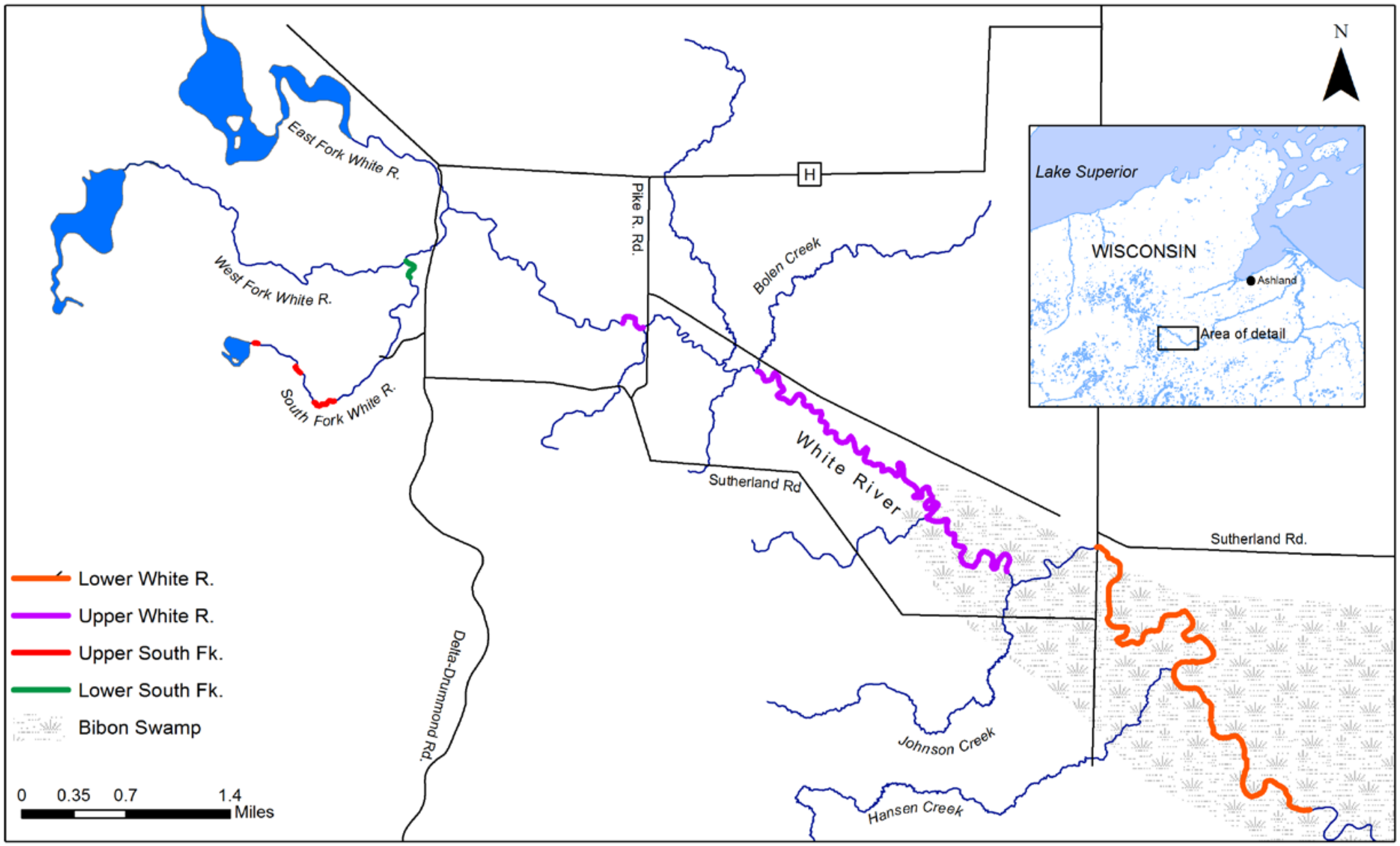

Figure 2. Location of sampling reaches for brown trout stable isotope analysis.

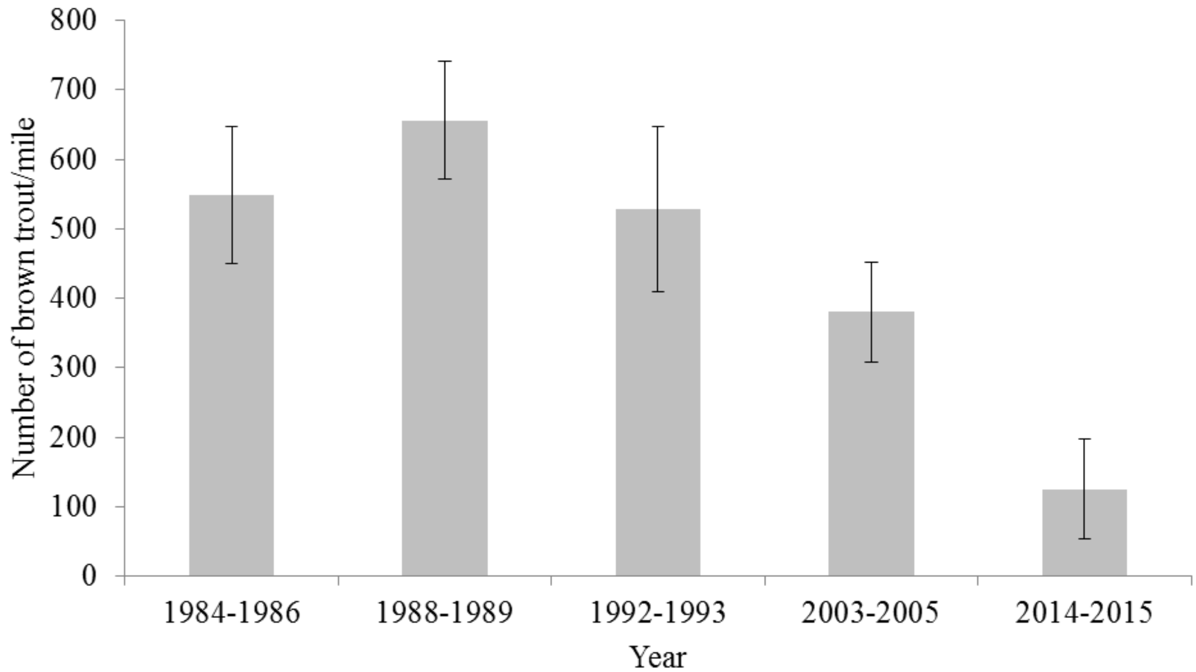

Figure 3. Density of brown trout ≥ 6 inches (fish/mile ± 95% confidence intervals) by consecutive years combined and all stations combined in White River, Bayfield County, Wisconsin.

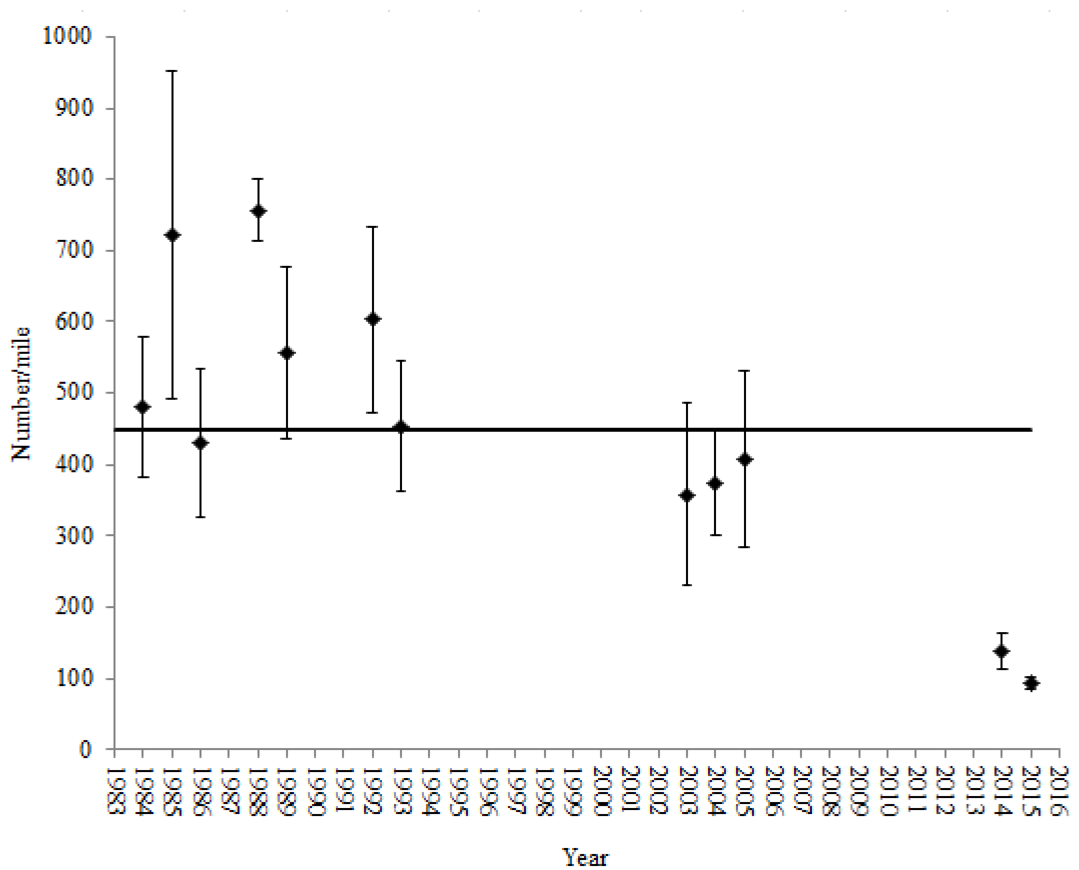

Figure 4. Number of brown trout ≥ 6 inches (fish/mile ± 95% confidence intervals) by year with all stations combined in White River, Bayfield County, Wisconsin. Horizontal line represents average brown trout density (448 fish/mile).

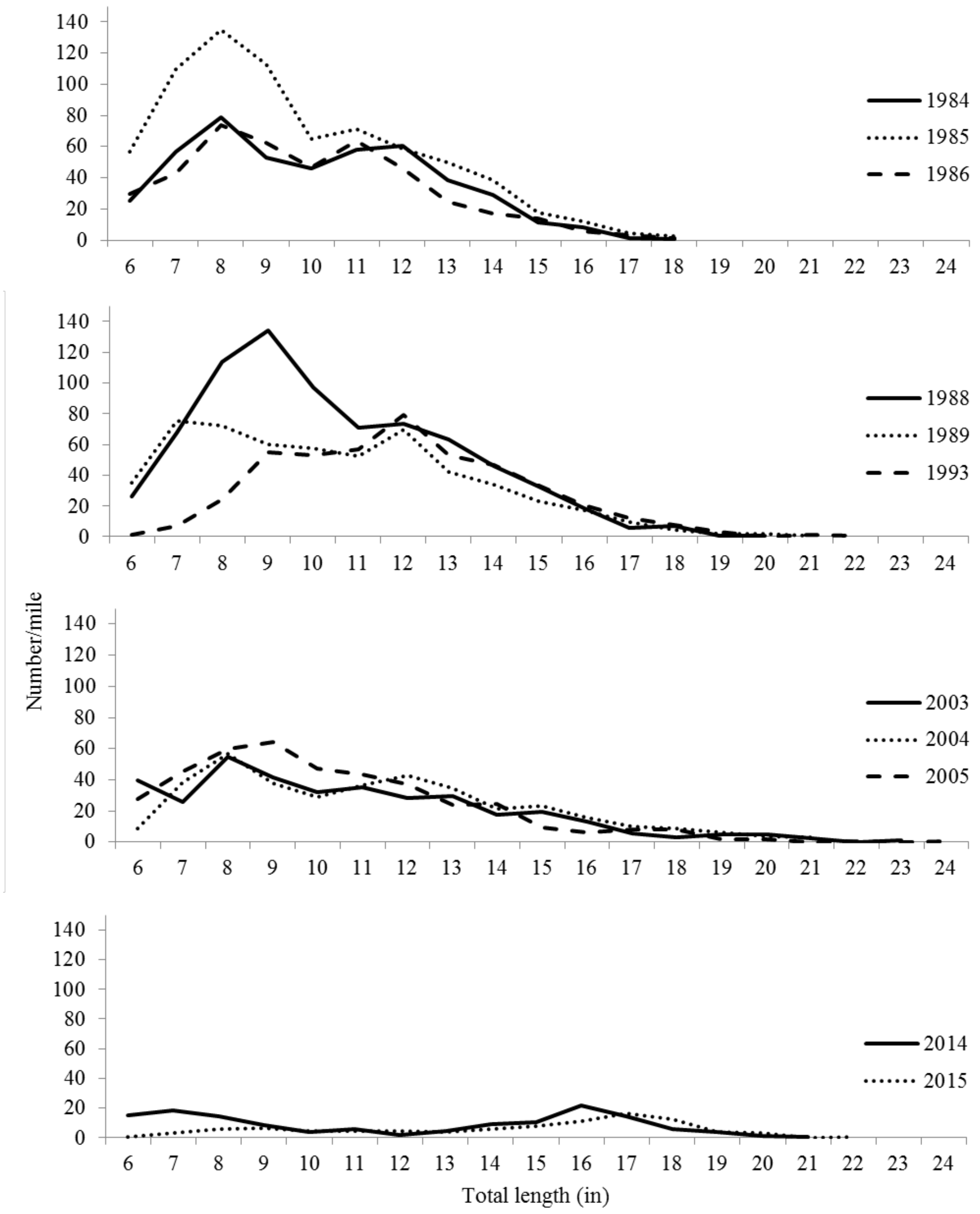

Figure 5. Brown trout abundance by length with all stations combined, White River, Bayfield County, Wisconsin.

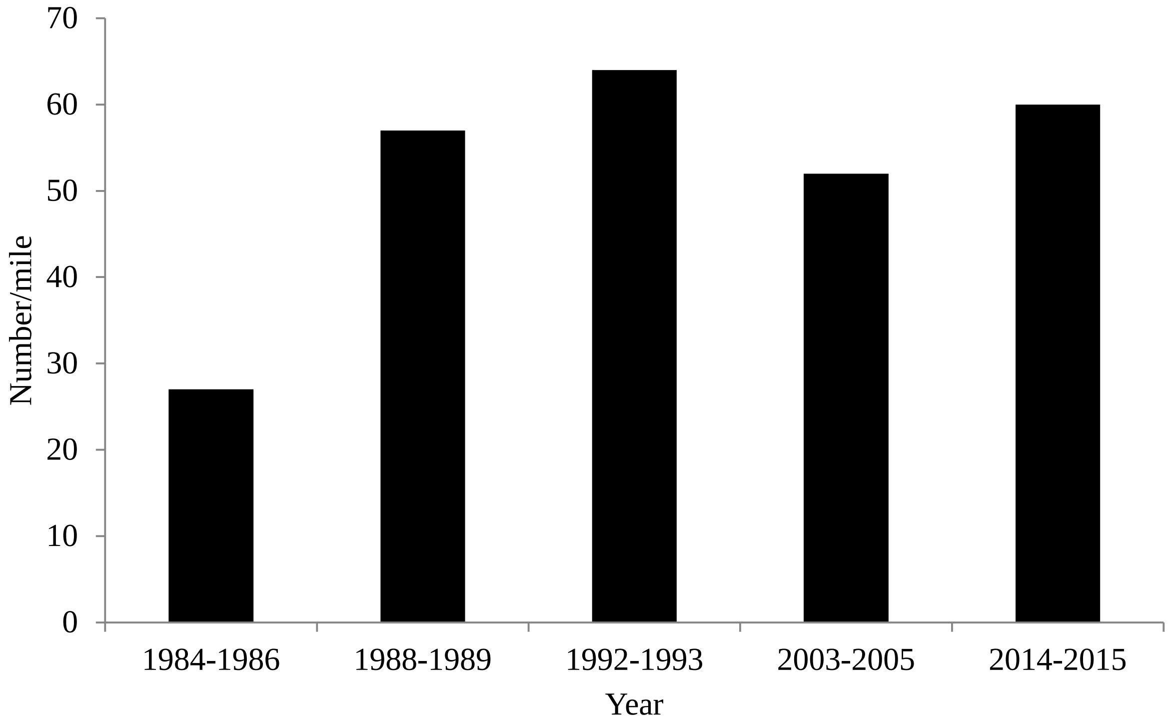

Figure 6. Density of brown trout ≥ 15 inches consecutive years combined and all stations combined in White River, Bayfield County, Wisconsin.

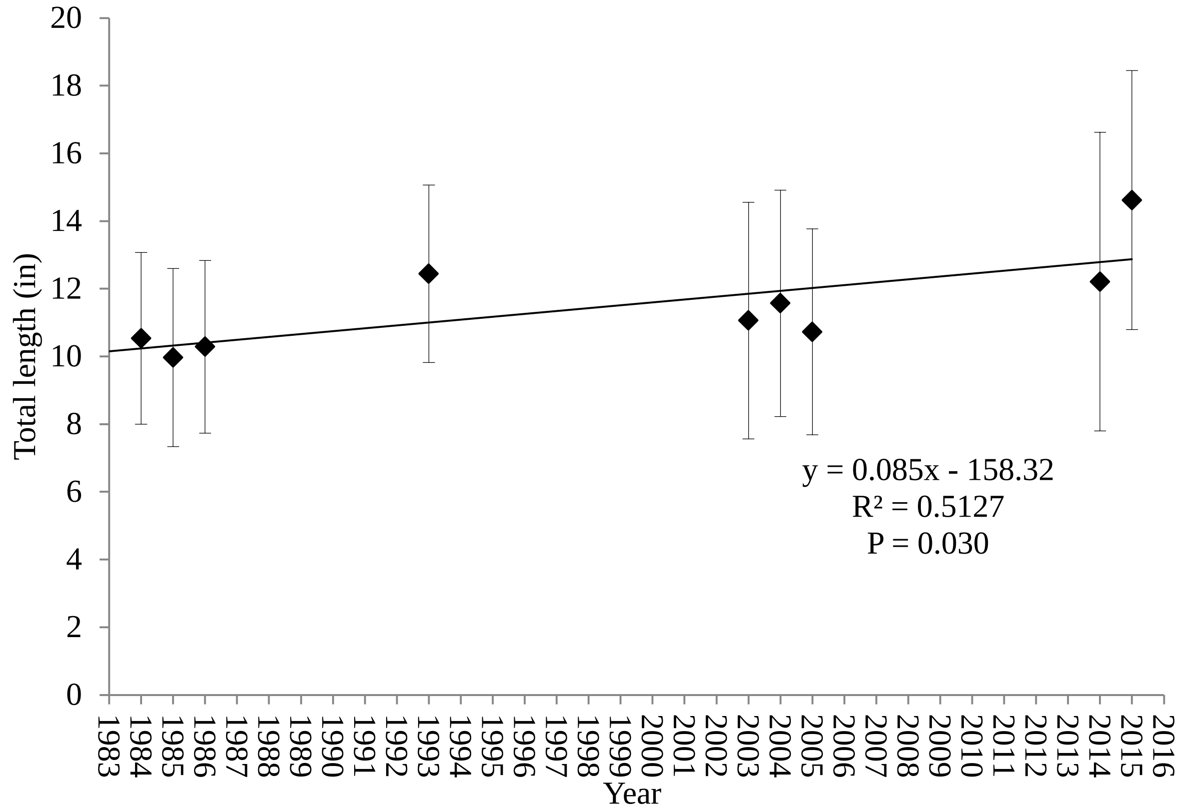

Figure 7. Mean length of brown trout by year with all stations combined in White River, Bayfield County, Wisconsin. Errors bars represent ± 1 SD. Solid line represents linear trend.

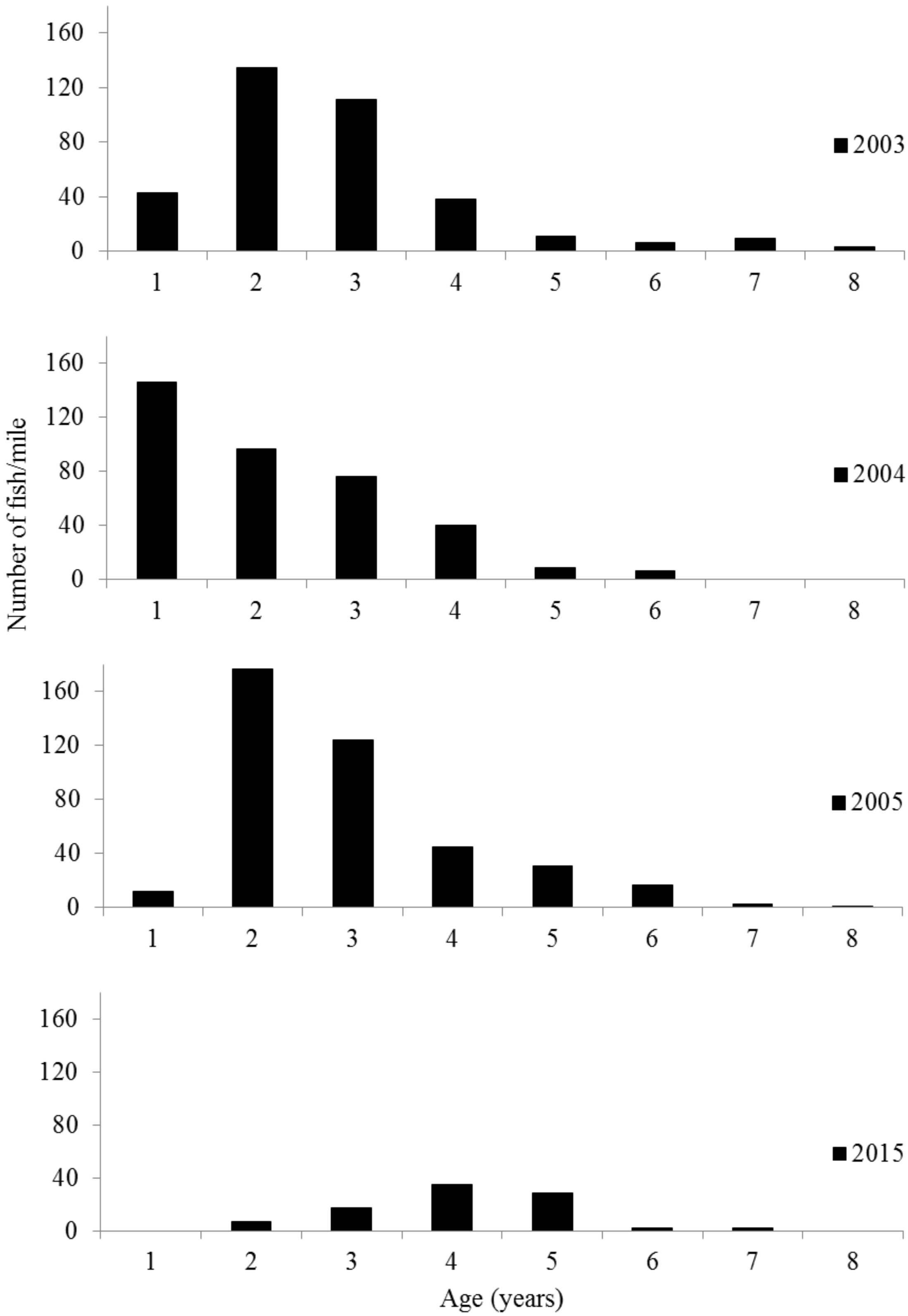

Figure 9. Density of brown trout by age and year, White River, Bayfield County, Wisconsin.

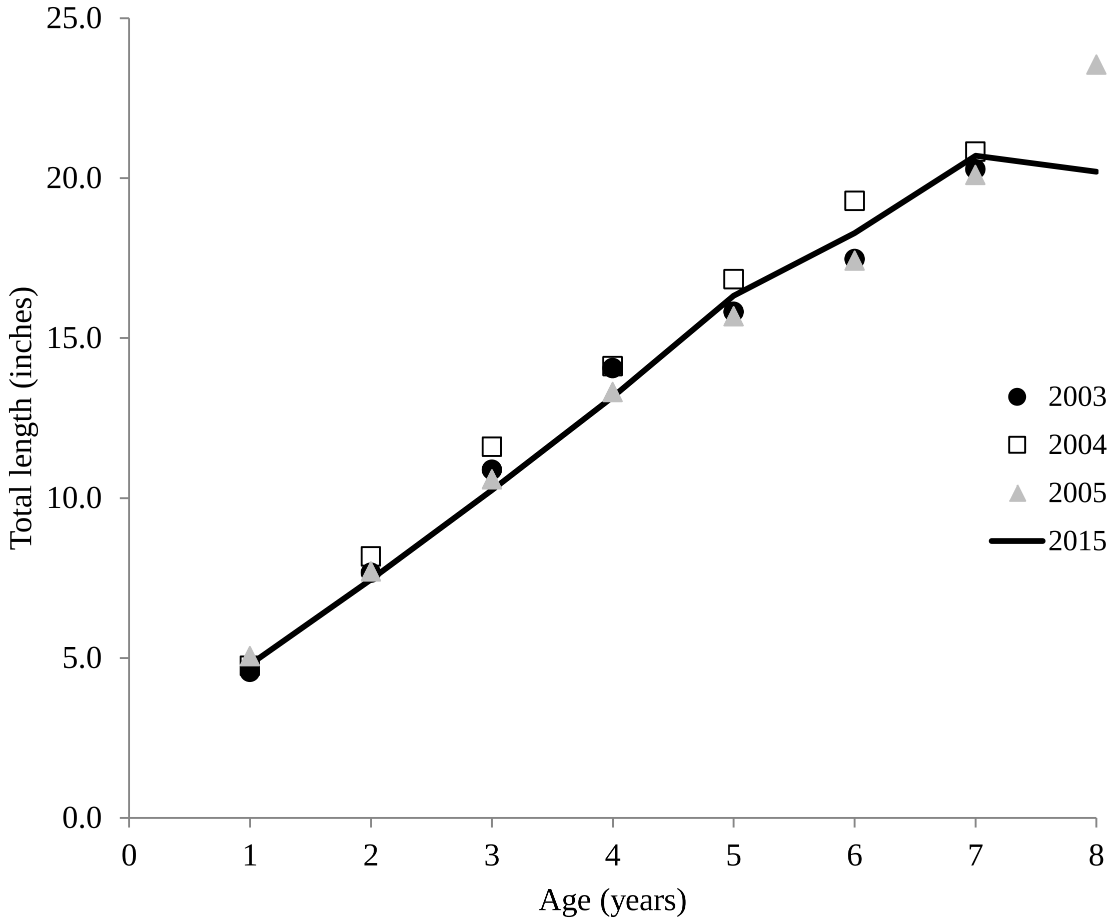

Figure 10. Brown trout length at age, White River, Bayfield County, Wisconsin, 2003-2015. Mean length at age in 2003 and 2005 determined from Frazier-Lee back calculations.

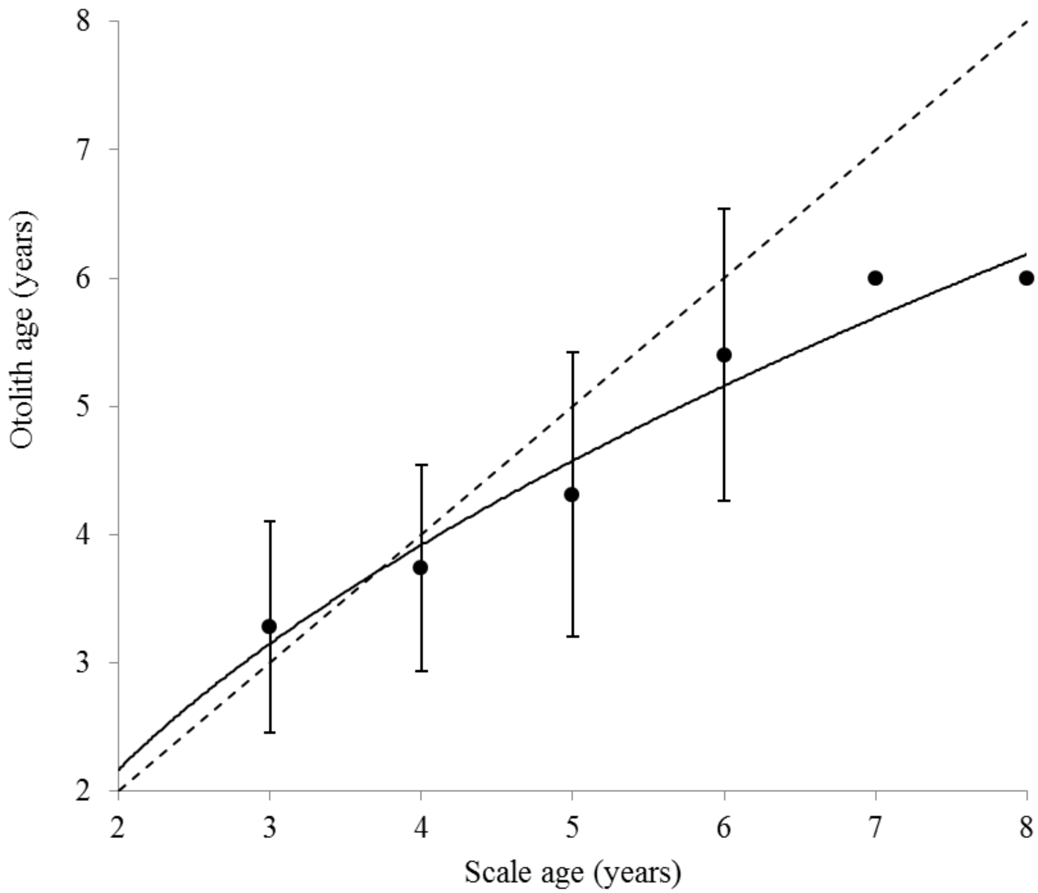

Figure 11. Mean otolith age (circles) compared to the estimated scale age for angler harvested brown trout during the 2014 and 2015 fishing seasons, White River, Bayfield County, Wisconsin. Errors bars represent ± 1 SD. Solid and dashed lines represent the age bias curve and theoretical 1:1 agreement, respectively.

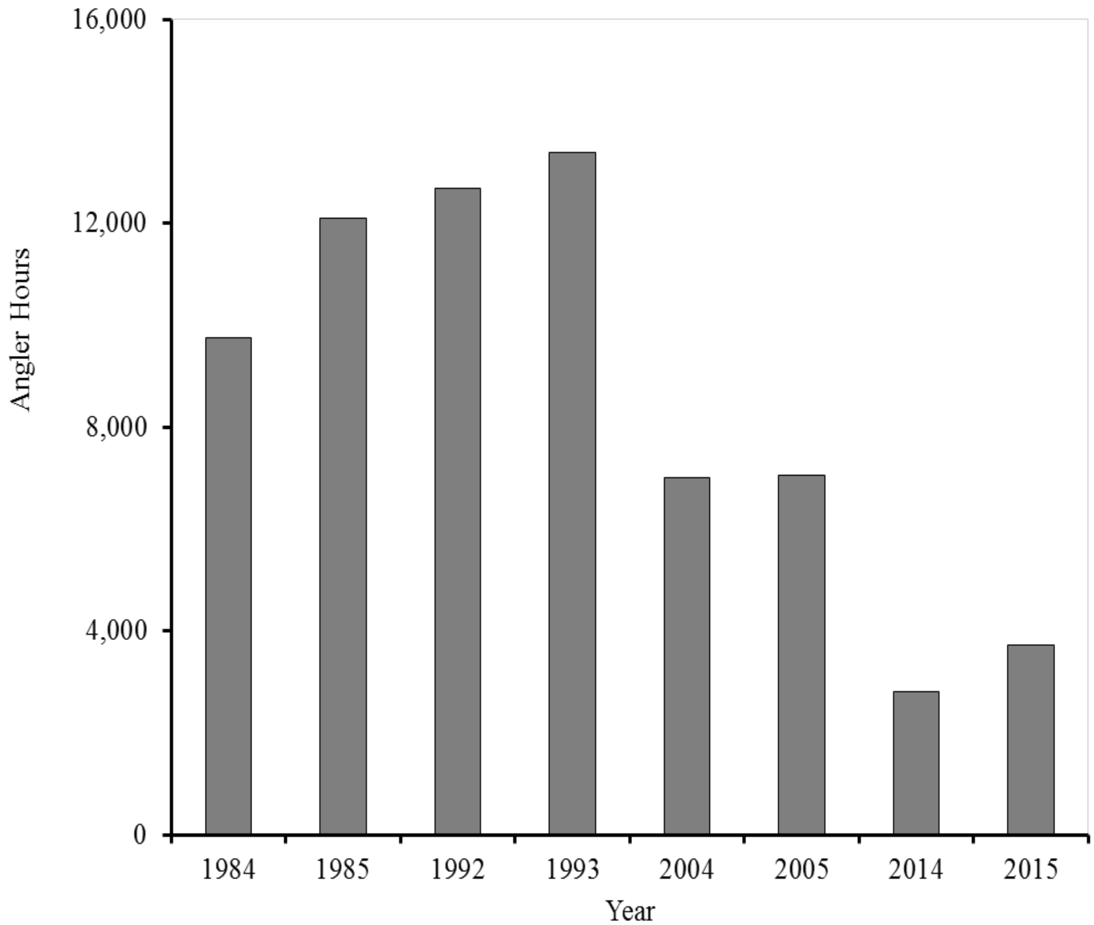

Figure 12. Total angler hours expended between 1984 and 2015 on the White River, Bayfield County, Wisconsin.

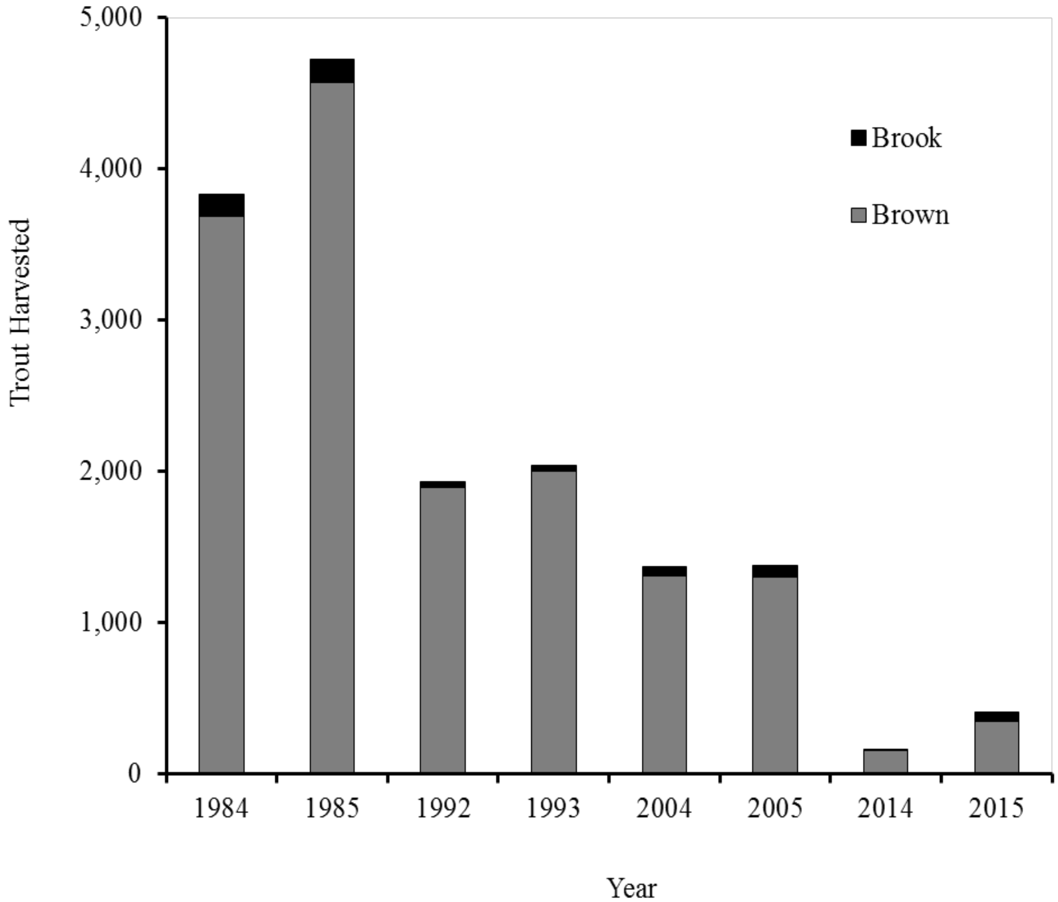

Figure 13. Total harvest of brook and brown trout between 1984 and 2015 on the White River, Bayfield County, Wisconsin.

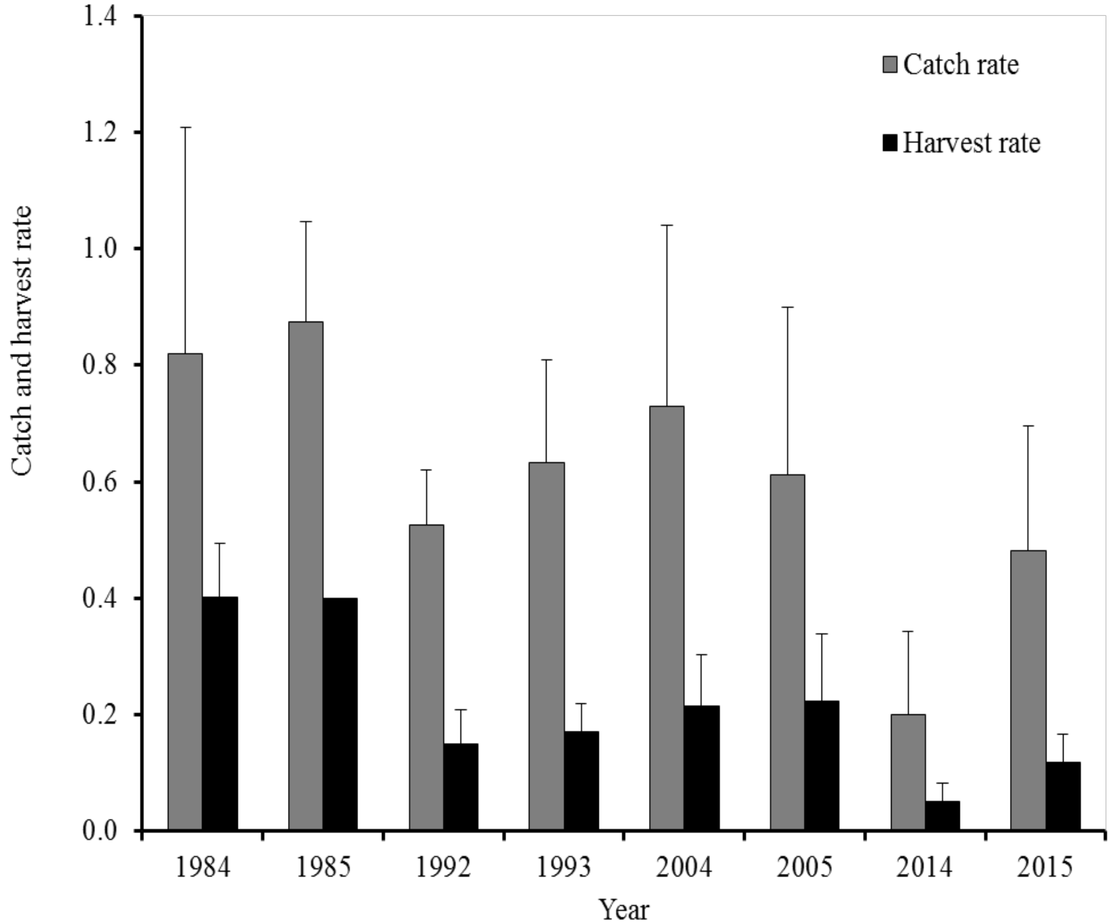

Fig 14. Mean catch and harvest rates (± 1 SD) for creel surveys conducted between 1984 and 2015 on the White River, Bayfield County, Wisconsin. Between 1984 and 1993, harvest and catch rates were estimated by incorporating both creel clerk interviews and voluntary reporting by anglers. After 1993, only creel clerk interviews were used for catch and harvest calculations.

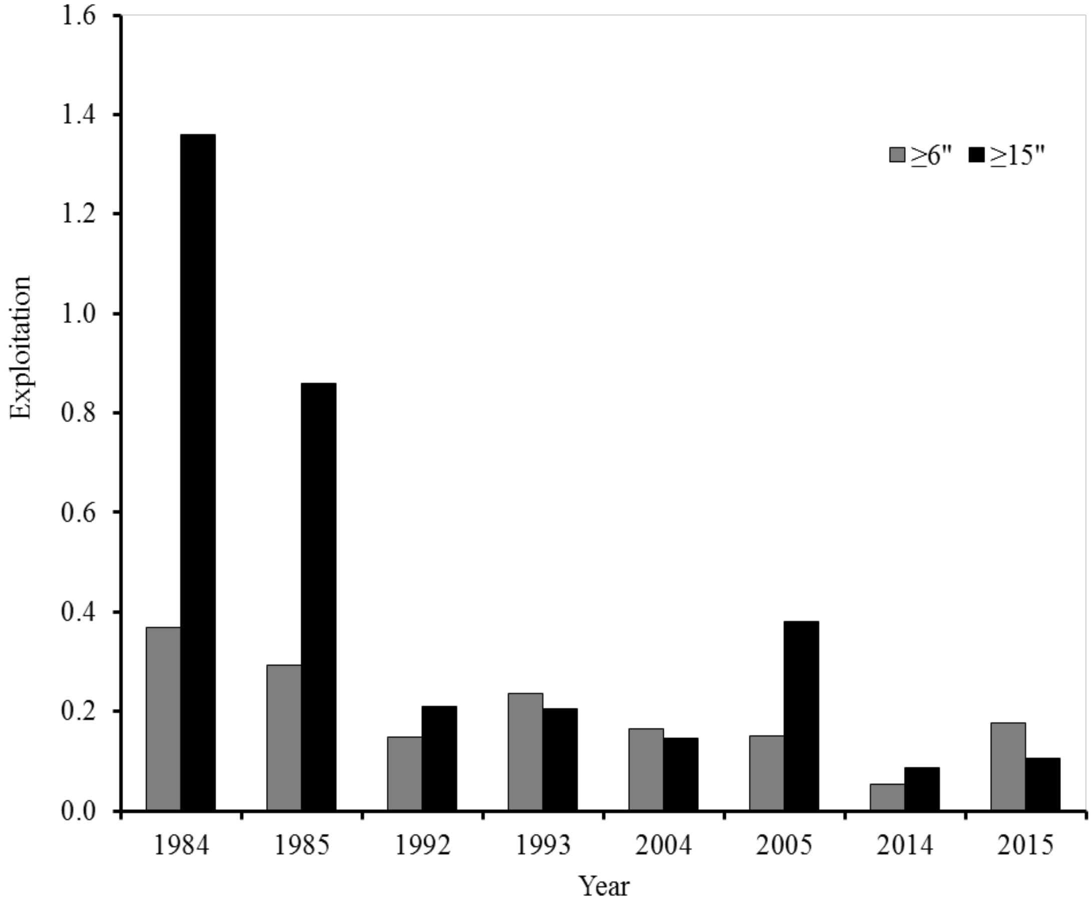

Figure 15. Exploitation of brown trout ≥ 6 inches and ≥ 15 inches on the White River, Bayfield County, Wisconsin.

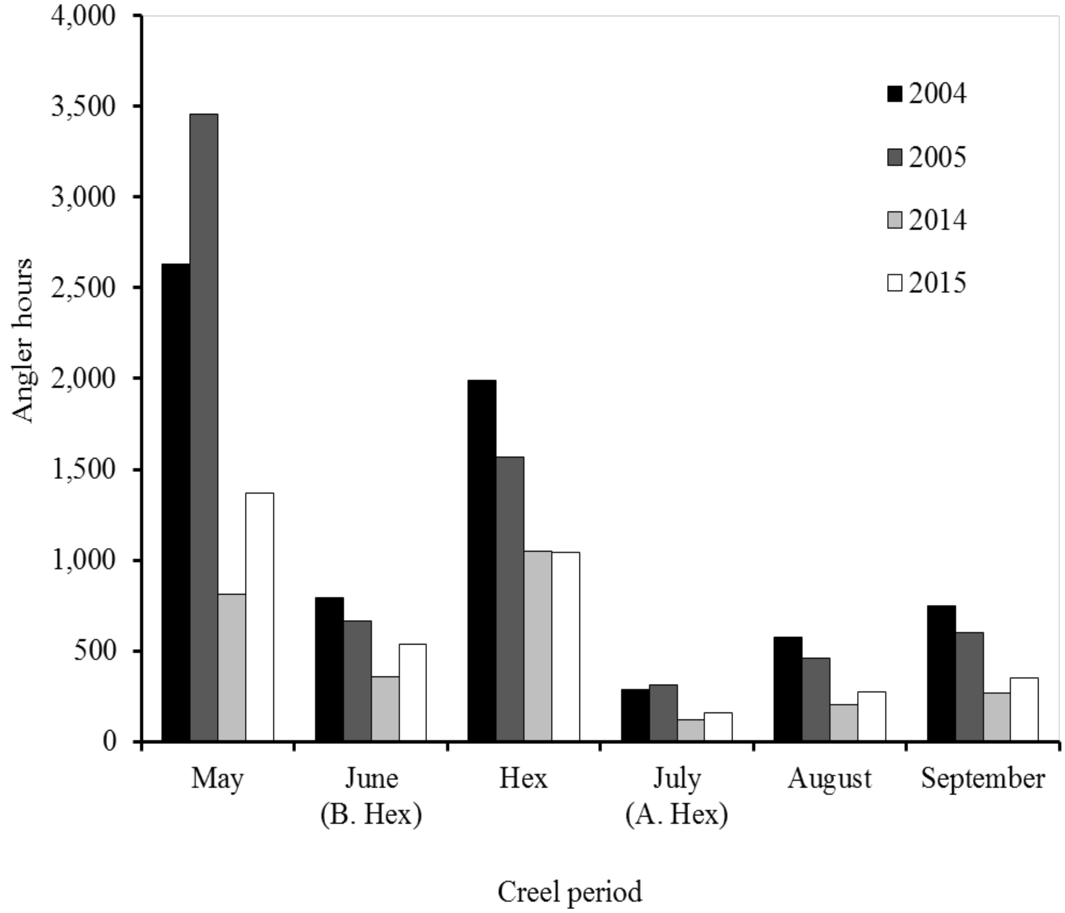

Figure 16. Total angler hours separated by creel period for the White River, Bayfield County, Wisconsin. June (B. Hex) = June prior to the hex hatch, Hex = during the hex hatch in late June and early July, July (A. Hex) = July after the hex hatch.

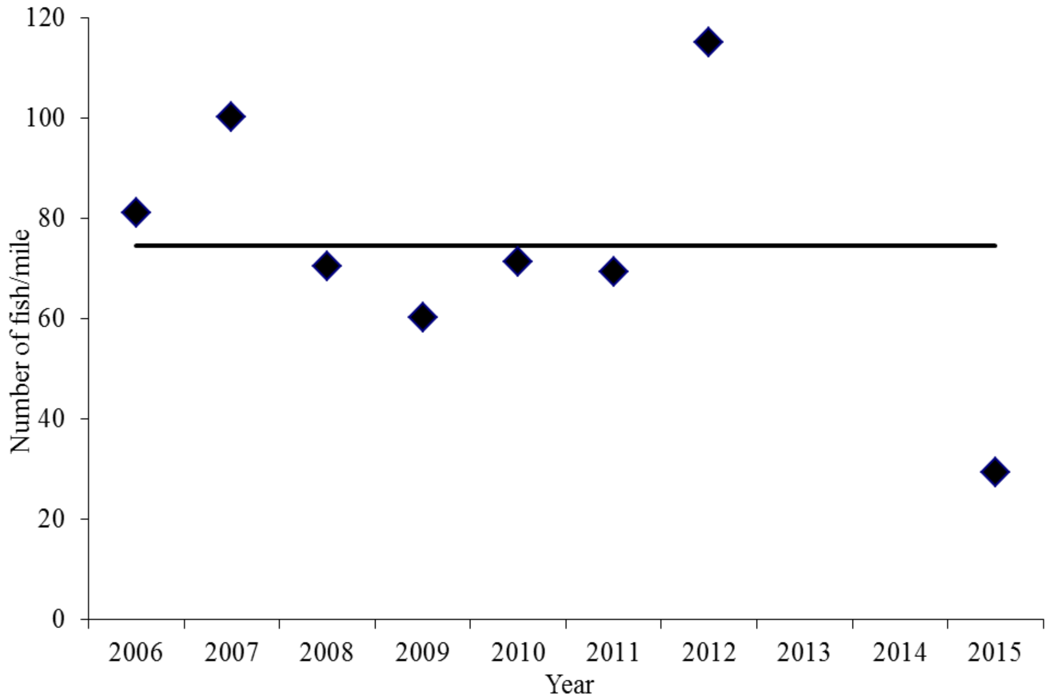

Figure 17. Relative abundance of brown trout at non-wadable long term trend station on the White River, Bayfield County, WI. Solid black line represents the mean relative abundance (75 fish/mile).

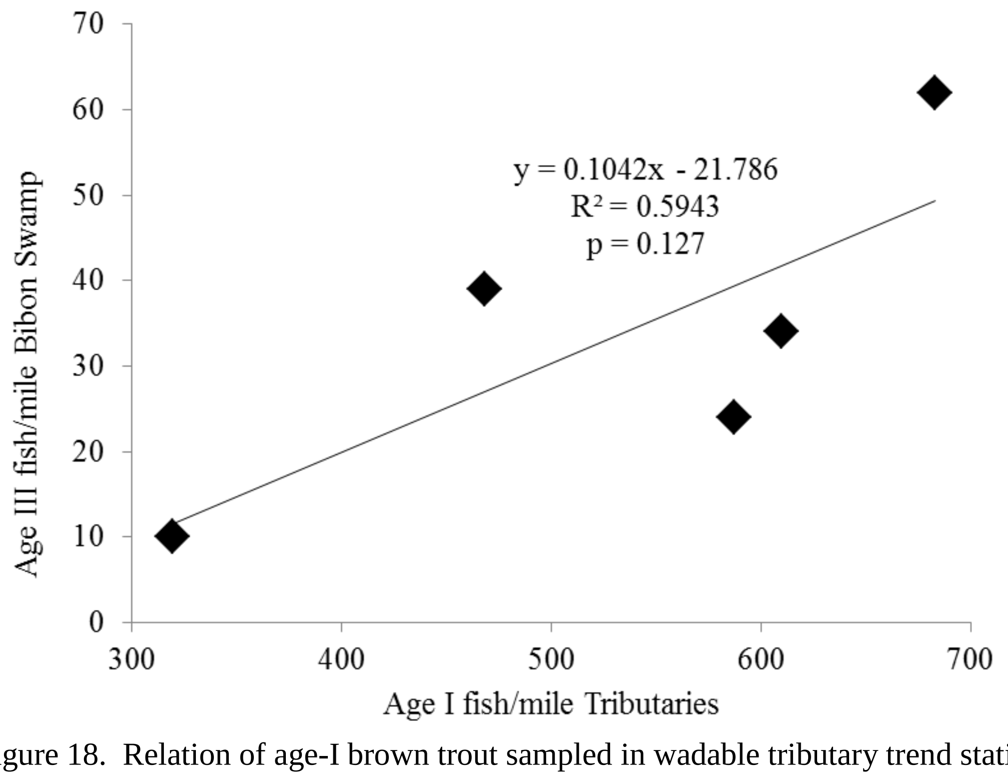

Figure 18. Relation of age-I brown trout sampled in wadable tributary trend stations to age-III brown trout found two years later in the non-wadable trend station in the Bibon Swamp, White River, Bayfield County, Wisconsin. Solid line represents linear trend.

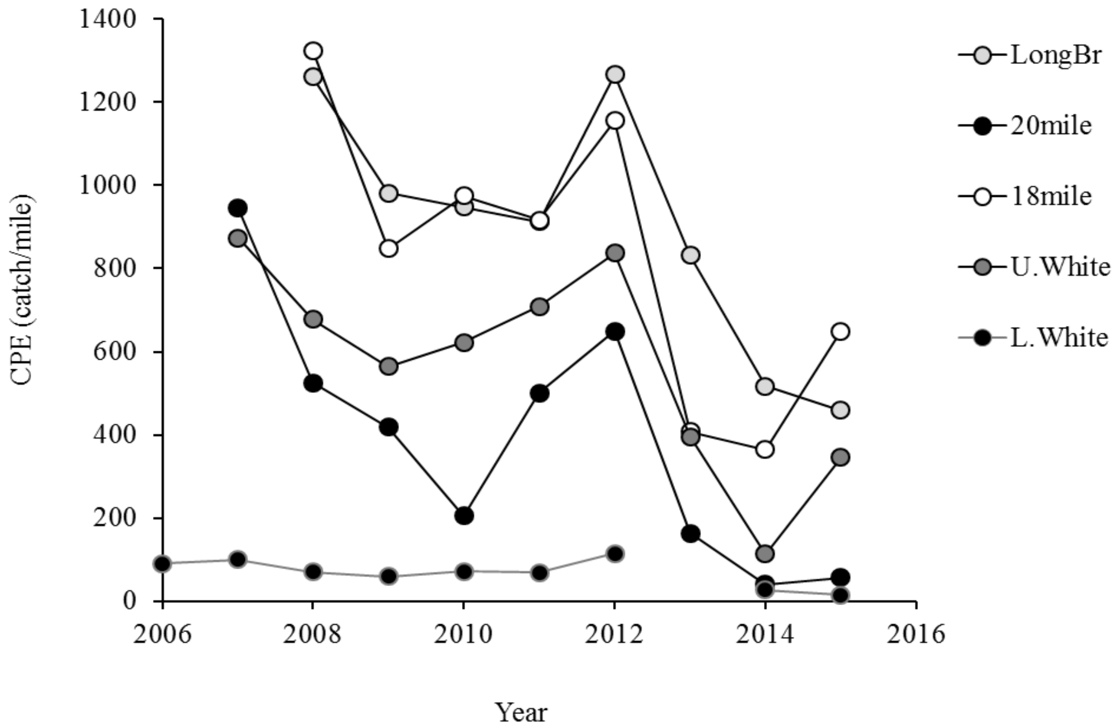

Figure 19. Relative abundance of age-I and older brown trout at long term trend station in the White River Watershed, Bayfield County, WI.

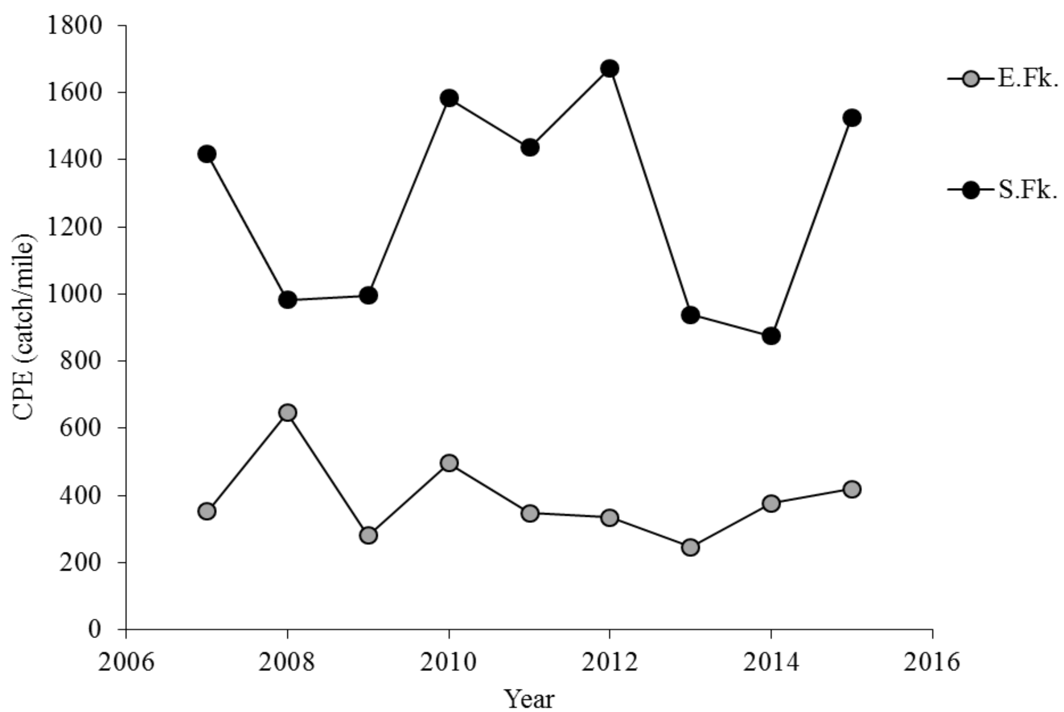

Figure 20. Relative abundance of age-I and older brown trout at long term trend station in the White River Watershed, Bayfield County, Wisconsin.

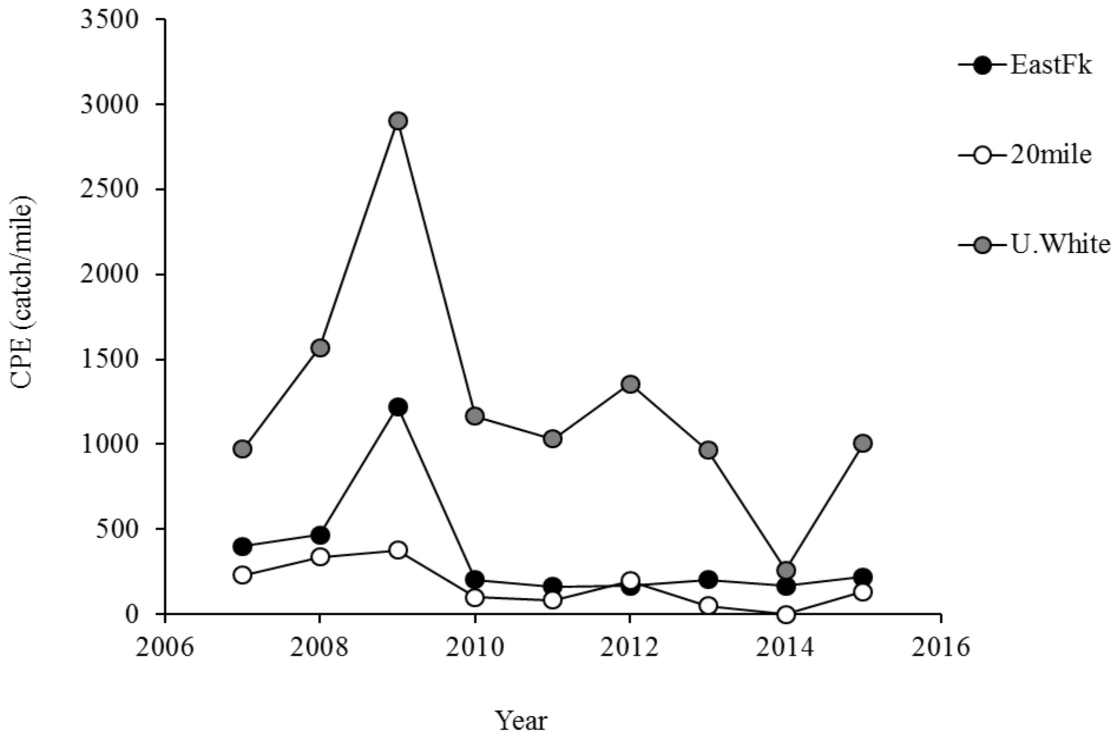

Figure 21. Relative abundance of age-0 brown trout at long term trend station in the White River Watershed, Bayfield County, Wisconsin.

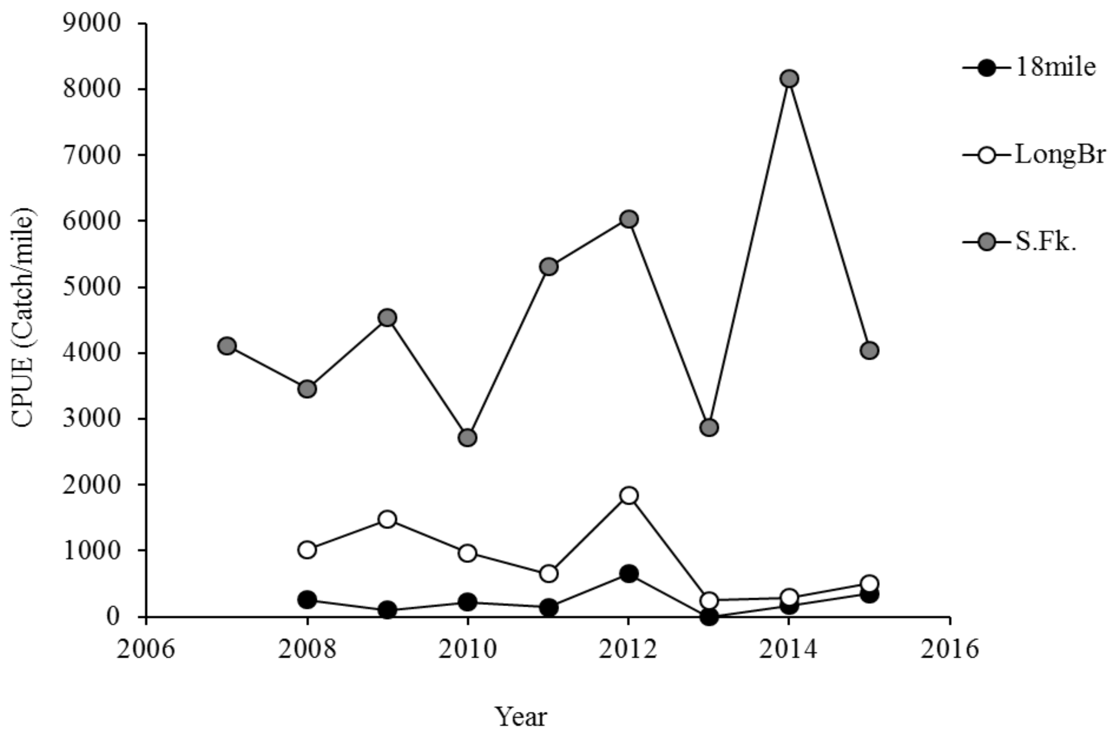

Figure 22. Relative abundance of age-0 brown trout at long term trend station in the White River Watershed, Bayfield County, Wisconsin.

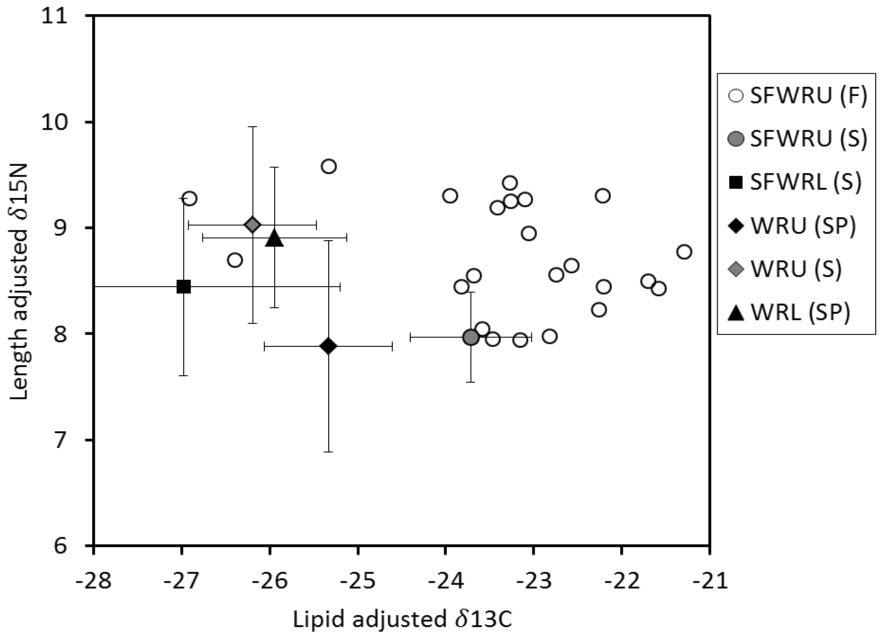

Figure 23. Lipid adjusted $\delta^{13}C$ and length adjusted $\delta^{15}N$ values for brown trout sampled on the lower White River during March (black triangle), upper White River during March (black diamond) and August (grey diamond), South Fork of the White River in August (grey circle) and November (open circles).

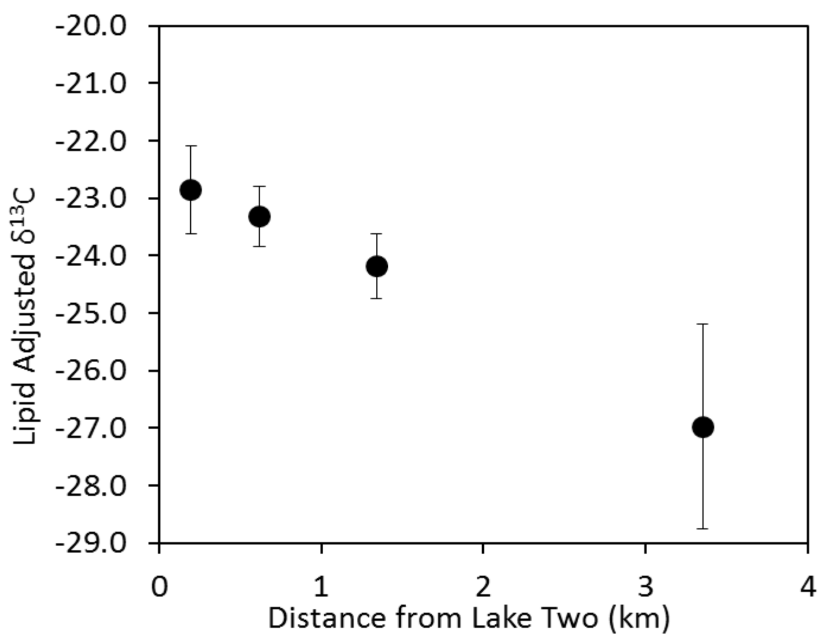

Figure 24. Closest point sampled in fall and does not include three outliers which had d13C signatures similar to lower river brown trout (see figure 25).

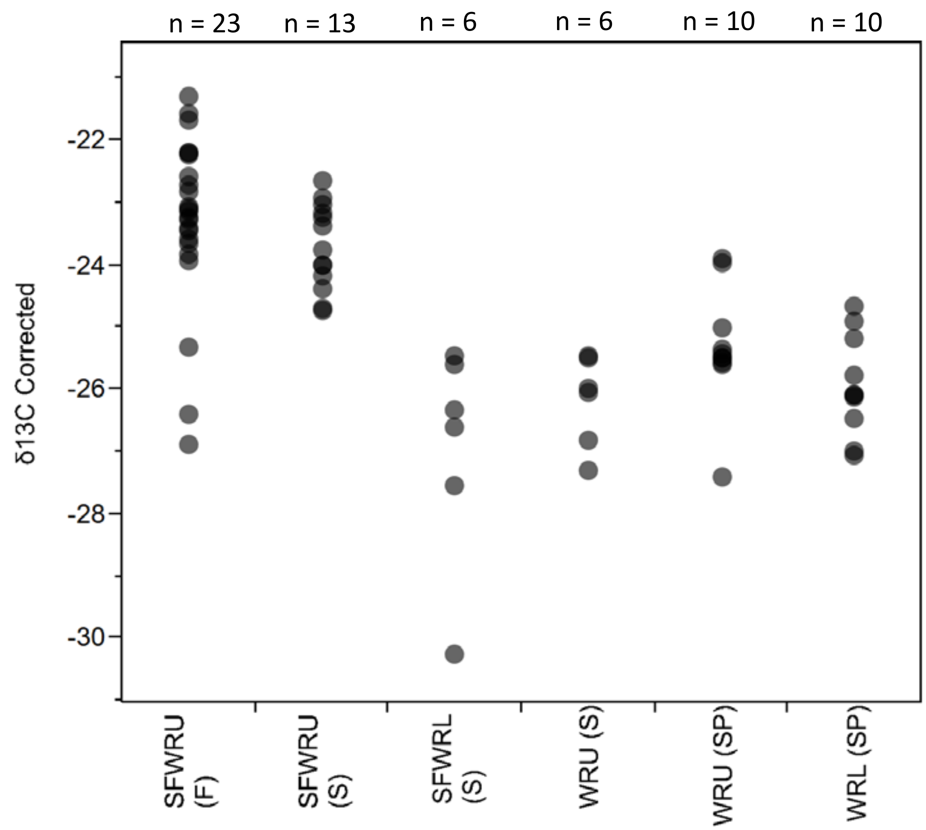

Figure 25. Lipid corrected $\delta^{13}C$ signatures for brown trout sampled in the White River and the South Fork of the White River. SFWRU (F) = brown trout sampled during the fall on the upper South Fork of the White River, SFWRU (S) = brown trout sampled during the summer on the upper South Fork of the White River, WRL (SP) = brown trout sampled during the spring on the lower White River, WRU (S) = brown trout sampled during the summer on the upper White River, WRU (SP) = brown trout sampled during the spring on the upper White River.

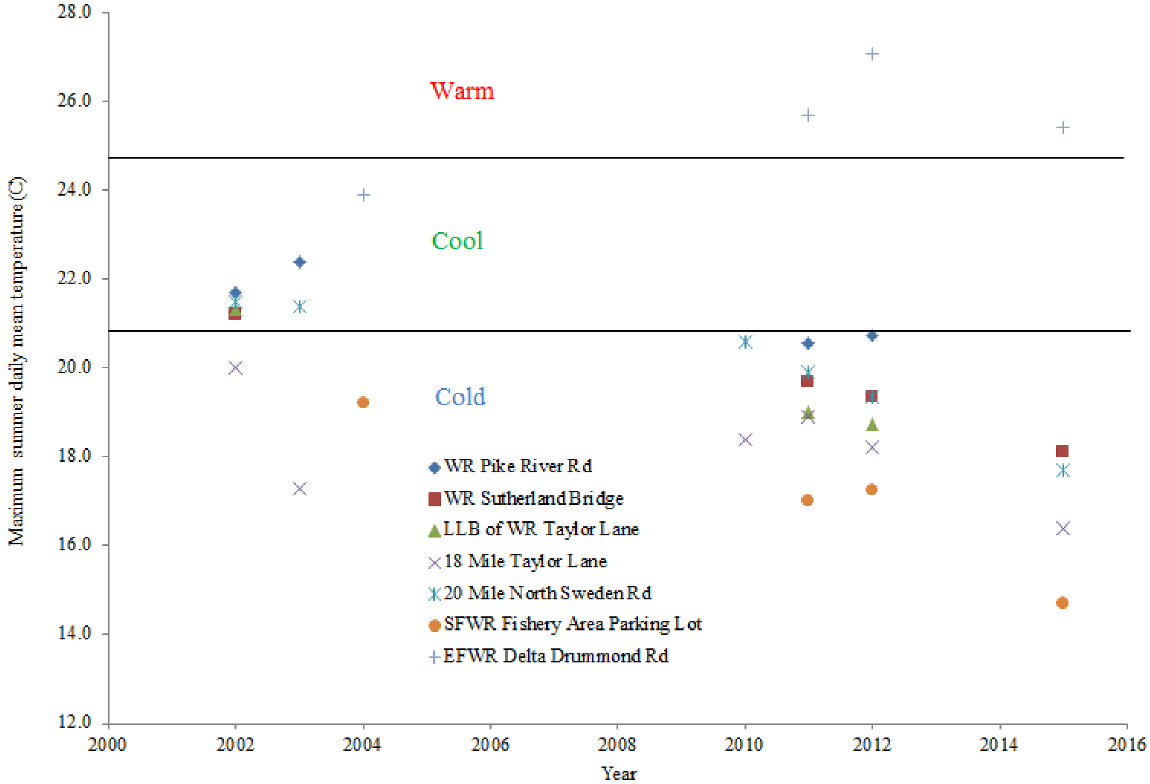

Figure 26. Maximum summer daily mean temperature (MSDMT) at seven locations in the White River Watershed, Bayfield County, Wisconsin, 2002-2015. Warm, cool and cold clasifications as defined by Lyons et al. 1996.

Appendix I, Table 1. Common and scientific names of fish species found in the White River, Bayfield County, Wisconsin.

Common Name	Scientific Name
chestnut lamprey	*Ichthyomyzon castaneus*
northern brook lamprey	*Ichthyomyzon fossor*
brook trout	*Salvelinus fontilalis*
brown trout	*Salmo trutta*
rainbow trout	*Oncorhynchus mykiss*
tiger trout	*Salvelinus fontilalis X Salmo trutta*
central mudminnow	*Umbra limi*
northern pike	*Esox lucius*
blackchin shiner	*Notropis heterodon*
blacknose dace	*Rhinichthys atratulus*
blacknose shiner	*Notropis heterolepis*
bluntnose minnow	*Pimephales notatus*
brassy minnow	*Hybognathus hankinsoni*
common shiner	*Luxilus cornutus*
creek chub	*Semotilus atromaculatus*
fathead minnow	*Pimephales promelas*
finescale dace	*Phoxinus neogaeus*
golden shiner	*Notemigonus crysoleucas*
hornyhead chub	*Nocomis biguttatus*
longnose dace	*Rhinichthys cataractae*
mimic shiner	*Notropis volucellus*
northern redbelly dace	*Phoxinus eos*
pearl dace	*Margariscus margarita*
white sucker	*Catostomus commersoni*
shorthead redhorse	*Moxostoma macrolepidotum*
black bullhead	*Ameiurus melas*
tadpole madtom	*Noturus gyrinus*
troutperch	*Percopsis omiscomaycus*
brook stickleback	*Culaea inconstans*
largemouth bass	*Micropterus salmoides*
smallmouth bass	*Micropterus dolomieu*
bluegill	*Lepomis macrochirus*
pumpkinseed	*Lepomis gibbosus*
rock bass	*Ambloplites rupestris*
Iowa darter	*Etheostoma exile*
johnny darter	*Etheostoma nigrum*
yellow perch	*Perca flavescens*
mottled sculpin	*Cottus bairdi*
slimy sculpin	*Cottus cognatus*

Appendix I, Table 2. Fish stocking history of White River, Bayfield County, Wisconsin.

Year	Species	Number Stocked	Size
1933	Brook Trout	4,800	
1934	Brook Trout	4,776	
1935	Brown Trout	18,000	Fingerling
	Bass	480	
1936	Brook Trout	9,990	Fingerling
1937	Brook Trout	24,000	Fingerling
1939	Rainbow Trout	25,000	Fingerling
	Brown Trout	4,000	Fingerling
1940	Rainbow Trout	40,026	Fingerling
	Brown Trout	2,000	Fingerling
1941	Brown Trout	15,000	Fingerling
	Rainbow Trout	32,000	Fingerling
	Rainbow Trout	225	Adult
1942	Brown Trout	48,812	Fingerling
	Rainbow Trout	25,500	Fingerling
1943	Rainbow Trout	12,000	Fingerling
	Brown Trout	34,600	Fingerling
1944	Rainbow Trout	9,000	Fingerling
	Brown Trout	19,000	Fingerling
1946	Brown Trout	23,500	Fingerling
1947	Brown Trout	40,000	Fingerling
	Rainbow Trout	30,000	Fingerling
1948	Brown Trout	52,200	Fingerling
1949	Brown Trout	1,600	Yearling
	Brown Trout	28,100	Fingerling
1950	Brown Trout	2,100	Yearling
	Brown Trout	26,100	Yearling
1951	Brown Trout	850	Yearling
	Brown Trout	6,000	Fingerling
1952	Brown Trout	6,000	Yearling
1953	Brown Trout	4,800	Yearling
1954	Brown Trout	2,000	Yearling
1955	Brook Trout	1,000	Yearling
	Brown Trout	500	Yearling
	Rainbow Trout	1,000	Yearling
1956	Brown Trout	3,386	Yearling
1957	Brown Trout	2,850	Yearling
1958	Brown Trout	2,000	Yearling
1959	Brown Trout	1,500	Yearling
	Rainbow Trout	1,000	Yearling
1963	Brown Trout	6,750	Yearling
	Brown Trout	3,876	Fingerling
	Rainbow Trout	5,467	Yearling
1964	Brown Trout	7,250	Yearling
1965	Brown Trout	4,750	Yearling
	Brown Trout	5,000	Fingerling
1966	Brown Trout	5,750	Yearling

Appendix I, Table 2 (continued). Fish stocking history of White River, Bayfield County, Wisconsin.

Year	Species	Number Stocked	Size
1967	Brook Trout	4,500	Yearling
1967	Brown Trout	5,000	Yearling
1968	Brook Trout	2,500	Yearling
	Brown Trout	5,000	Yearling
1969	Brook Trout	15,000	Fingerling
	Brown Trout	7,000	Yearling
1970	Brown Trout	4,200	Yearling
1971	Brown Trout	6,250	Yearling
1972	Brown Trout	4,250	Yearling
1973	Brown Trout	4,250	Yearling
1974	Brown Trout	4,250	Yearling
1975	Brown Trout	4,250	Yearling
1976	Brown Trout	4,250	Yearling
1977	Brown Trout	6,250	Yearling
1978	Brown Trout	3,000	Yearling
1979	Brown Trout	2,000	Yearling
1980	Brown Trout	2,000	Yearling
1981	Brown Trout	2,000	Yearling

Appendix I, Table 3. Average spring brown trout density (fish/mile) by length intervals and station in the White River, Bayfield County, Wisconsin. Includes only trout ≥ 6 in. 95% confidence intervals are in parenthesis.

	1984-86 Stations				1988-89 Stations			
Length Group (in)	Sutherland	Goldberg	Primitive	Avg.	Sutherland	Goldberg	Primitive	Avg.
6.0 - 8.9	133	211	245	196	134	176	260	190
9.0 - 14.9	256	383	279	306	409	461	357	409
≥ 15.0	19	21	40	27	28	60	84	57
Total	408 (115)	615 (314)	564 (147)	529 (98)	571 (103)	697 (50)	701 (57)	656 (85)

	1992-93 Stations				2003-05 Stations			
Length Group (in)	Sutherland	Goldberg	Primitive	Avg.	Sutherland	Goldberg	Primitive	Avg.
6.0 - 8.9	75	42	51	56	117	94	150	120
9.0 - 14.9	514	328	383	408	257	160	207	208
≥ 15.0	35	49	109	64	62	59	34	52
Total	624 (115)	419 (41)	543 (60)	528 (119)	437 (58)	313 (53)	391 (146)	380 (72)

	2014-15 Stations		
Length Group (in)	Bolen	Sutherland	Avg.
6.0 - 8.9	43	20	31
9.0 - 14.9	42	27	34
≥ 15.0	77	43	60
Total	161 (52)	90 (13)	125 (72)

Appendix I, Table 4. Spring brown trout density (fish/mile) by length intervals and station in the White River, Bayfield County, Wisconsin. Includes only brown trout ≥ 6 in. 95% confidence intervals are in parenthesis.

	1984				1985			
	Stations				Stations			
Length Group (in)	Sutherland	Goldberg	Primitive	Avg.	Sutherland	Goldberg	Primitive	Avg.
6.0 - 8.9	138	109	229	158	198	361	338	299
9.0 - 14.9	401	229	267	299	282	582	329	398
≥ 15.0	34	17	20	24	25	21	62	36
Total	573 (244)	355 (72)	516 (139)	481 (98)	505 (92)	964 (214)	729 (180)	733 (230)

	1986				1988			
	Stations				Stations			
Length Group (in)	Sutherland	Goldberg	Primitive	Avg.	Sutherland	Goldberg	Primitive	Avg.
6.0 - 8.9	108	163	168	146	154	196	245	198
9.0 - 14.9	203	337	240	260	536	536	427	500
≥ 15.0	9	26	39	25	30	72	74	59
Total	320 (48)	526 (80)	447 (78)	431 (104)	720 (156)	804 (74)	746 (68)	757 (43)

	1989				1992			
	Stations				Stations			
Length Group (in)	Sutherland	Goldberg	Primitive	Avg.	Sutherland	Goldberg	Primitive	Avg.
6.0 - 8.9	114	155	275	181	101	57	80	79
9.0 - 14.9	282	386	287	318	551	356	504	470
≥ 15.0	26	48	94	56	12	42	108	53
Total	422 (70)	589 (67)	656 (94)	556 (121)	664 (86)	454 (54)	692 (93)	603 (130)

	1993				2003			
	Stations				Stations			
Length Group (in)	Sutherland	Goldberg	Primitive	Avg.	Sutherland	Goldberg	Primitive	Avg.
6.0 - 8.9	49	27	22	33	166	141	52	120
9.0 - 14.9	477	300	262	346	250	174	130	185
≥ 15.0	58	56	110	75	63	56	41	54
Total	584 (75)	384 (58)	394 (72)	454 (113)	479 (91)	371 (60)	224 (56)	358 (128)

	2004				2005			
	Stations				Stations			
Length Group (in)	Sutherland	Goldberg	Primitive	Avg.	Bolen Creek	Johnson Creek	Lower Bibon	Avg.
6.0 - 8.9	63	67	200	110	123	74	198	132
9.0 - 14.9	226	164	206	199	296	142	285	241
≥ 15.0	82	71	46	67	41	50	13	35
Total	371 (68)	302 (63)	452 (120)	375 (75)	460 (70)	267 (37)	496 (58)	408 (123)

	2014			2015		
	Stations			Stations		
Length Group (in)	Bolen	Sutherland	Avg.	Bolen	Sutherland	Avg.
6.0 - 8.9	69	36	48	16	4	10
9.0 - 14.9	57	23	34	26	31	29
≥ 15.0	87	43	58	67	42	54
Total	213 (76)	102 (21)	139 (26)	109 (14)	77 (11)	93 (9)

Appendix II

White River Angler Questionnaire

Final Results 2004-2005 compared to 2014-2015

SECTION I: FISHING THE WHITE RIVER IN 2004 & 2005 - 2014 & 2015

1. What area of the White River did you fish most often in? **(check one)**

Years		
04-05	14-15	
13%	11.5	From Pikes Road Bridge upstream, including headwater areas
48	40.8	From Pikes Road Bridge downstream to Sutherland Bridge
30	40.0	From Sutherland Bridge downstream to Bibon Road Bridge
9	7.7	Downstream of Bibon Road Bridge

2. About how many days did you spend at least part of the day fishing the White River?

Days	2004 Percent	2005 Percent	2014 Percent	2015 Percent
0	7%	11%	11%	5%
1 – 2	23	24	18	24
3 – 4	28	27	19	28
5 – 10	21	24	36	30
> 10	20	16	16	14
Ave. days	8	7	7	6
Max	200	150	60	40

3. How did you typically fish the White River – did you fly fish, use live bait, or artificial lures? **(circle one number for each type of fishing)**

2004-2005

	Live bait	Artificial	Fly fishing
Never	39%	36%	44%
Sometimes	8	23	12
Often	24	23	9
Always	29	18	35

2014-2015

	Live bait	Artificial	Fly fishing
Never	50%	56%	37%
Rarely	3	8	7
Sometimes	10	11	5
Often	14	14	7
Always	22	12	43

4. How many miles one-way did you typically travel to reach your fishing location on the White River during?

1-way miles	04-05 Percent	14-15 Percent
1 – 10	24%	26
11 – 20	14	13
21 – 50	14	9
51 – 100	17	16
101 – 200	20	23
> 200	11	14
Ave. miles	87	109
Max	650	1850

5. Overall, how satisfied were you with your fishing experiences on the White River? **(check one)**

04-05 Percent	14-15 Percent	
37%	26	Very satisfied
47	52	Somewhat satisfied
14	15	Not too satisfied
2	8	Not at all satisfied

6. Your satisfaction with White River fishing may have been influenced by some of the following. To what extent do you disagree or agree that each of the following statements affected your satisfaction with fishing the White River. **(circle one number for each item)**

(Percent responding read across →)

2004-2005

	Strongly disagree	Slightly disagree	Neither	Slightly agree	Strongly agree
Water quality on the river is poor	54%	19	14	11	2
There are too many anglers	26%	33	17	20	5
I don't catch many fish	22%	28	14	27	9
I catch too many small fish	25%	22	31	16	6
I don't catch enough trophy fish	15%	19	27	27	12
The daily bag limit is too low	51%	13	20	13	3
The regulations are complicated	42%	15	19	15	10
The regulations are restrictive	43%	15	24	13	5

	2014-2015				
	Strongly disagree	Slightly disagree	Neither	Slightly agree	Strongly agree
Water quality on the river is poor	52%	20	20	6	3
There are too many anglers	44%	21	17	15	3
I don't catch many fish	17%	16	15	38	14
I catch too many small fish	28%	27	25	14	6
I don't catch enough trophy fish	21%	17	27	21	14
The daily bag limit is too low	53%	11	23	8	5
The regulations are complicated	50%	18	12	16	5
The regulations are restrictive	50%	15	17	13	5

SECTION II: YOUR HISTORY ON THE WHITE RIVER

1. For about how many years have you fished the White River in Bayfield County in the Bibon Swamp area, anywhere between Pikes Road Bridge and Bibon Road Bridge?

	04-05	14-15
Years	Percent	Percent
1 – 2	11%(7% 1year)	10% (3% 1 year)
3 – 5	14	6
6 – 10	18	8
11 – 20	19	23
21 – 30	19	20
> 30	19	33
Ave. yrs	18	24
Max	58	60

2. In what year did you first fish the White River?

2004-2005		2014-2015	
Year(s)	Percent	Years	Percent
2005	4%	2015	3
2004	5	2014	4
2000-03	15	2010 – 13	9
1990-99	26	2000 – 09	14
1980-89	14	1990 – 99	22
1970-79	21	1980 – 89	16
Before 1970	14	1970 –79	20
		Before 1970	12
Mean	1986	Mean	1989
Min	1940	Min	1955

3. In the past ten years how many years have you fished the White River? **(check one)**

1996-2005 Percent	2006-2015 Percent	
14%	13%	Less than 3 years
13	7	3 – 4 years
10	6	5 – 6 years
10	11	7 – 8 years
53	63	9 – 10 years

4. During the 10 year period in general, would you say the number of days in a year you fish the White River has been increasing, decreasing or staying about the same? **(check one)**

1996-2005 Percent	2006-2015 Percent	
9%	9	Increasing
29	26	Decreasing
61	65	Staying about the same

5. How important is fishing the White River to you in comparison to all of your other fishing destinations? Would you say that fishing the White River is… **(check one)**

04-05 Percent	14-15 Percent	
5%	18	My most important fishing destination
66	68	One of the most important fishing destinations
21	12	No more important than any other of my fishing destinations
8	1	Less important than most of my other fishing destinations
1	2	Not at all important to me as a fishing destination
	1	I do not fish any other waters

6. In the past three years have you fished other rivers or streams for trout in Wisconsin? **(check one) (If No please go to question 8)**

04-05 Percent	14-15 Percent	
84%	83	Yes
16	17	No

7. Compared to other trout rivers or streams in Wisconsin would you say the fishing quality on the White River is…**(check one)**

04-05 Percent	14-15 Percent	
17%	19	Much better
40	32	Somewhat better
25	21	About the same
14	23	Somewhat worse
4	5	Much worse

8. In the years that you've fished the White River, how would you say each of the following has changed?
(check one for each item)

(Percent responding read across →)

2004-2005

Number of fish I catch	Increasing 4%	Remained stable 40	Decreasing 56
Average size of fish I catch	Larger 9%	Remained stable 53	Smaller 38
Water quality	Better 2%	Remained stable 86	Worse 12
Crowding from other anglers	More crowded 32%	Remained stable 53	Less crowded 15
Overall management of the river	Better 23%	Remained stable 65	Worse 13

2014-2015

Number of fish I catch	Increasing 4%	Remained stable 36	Decreasing 59
Average size of fish I catch	Larger 19%	Remained stable 51	Smaller 29
Water quality	Better 7%	Remained stable 85	Worse 8
Crowding from other anglers	More crowded 21%	Remained stable 47	Less crowded 32
Overall management of the river	Better 18%	Remained stable 70	Worse 12

9. In general, would you say that fishing the White River has improved or worsened in the years you've been fishing? **(check one)**

04-05 Percent	14-15 Percent	
2%	4	Definitely improved
15	11	Probably improved
33	33	Remained about the same
33	31	Probably worsened
16	22	Definitely worsened

10. Your answer to the previous question may have been influenced by various factors. **If you checked worsened in question 9, please check 2 boxes in the Worsened column, if you checked improved in question 9, please check 2 boxes in the Improved column.**

2004-2005

Worsened Percent		Improved Percent	
17%	Too much fishing pressure	3%	Reduced fishing pressure
14	Other anglers keeping too many fish	8	More catch and release being practiced
12	Ineffective or detrimental regulations	5	Improved fishing regulations
9	Loss of trout habitat	2	Improved trout habitat
2	Water quality becoming worse	0	Improved water quality
14	Lower trout population levels	2	Higher trout populations
2	Higher water temperatures	0	Cooler water temperatures
4	Fewer large brown trout	1	More large brown trout
5	Too many northern pike	4	Fewer northern pike
0	Poor fish management (excluding regs)	6	Improved fish management (excl. regs)
0	Increase in other predators (such as otter and herons)	1	Decrease in other predators (such as otter and herons)

2014-2015

Worsened Percent		Improved Percent	
8%	Too much fishing pressure	15%	Reduced fishing pressure
2	Other anglers keeping too many fish	15	More catch and release being practiced
3	Ineffective or detrimental regulations	3	Improved fishing regulations
5	Loss of trout habitat	12	Improved trout habitat
5	Water quality becoming worse	0	Improved water quality
40	Lower trout population levels	9	Higher trout populations
9	Higher water temperatures	6	Cooler water temperatures
15	Fewer large brown trout	18	More large brown trout
6	Too many northern pike	12	Fewer northern pike
1	Poor fish management (excluding regs)	6	Improved fish management (excl. regs)
5	Increase in other predators (such as otter and herons)	3	Decrease in other predators (such as otter and herons)

SECTION III: REGULATIONS AND THE FISH YOU CATCH

1. How many inches long was the largest brown trout that you caught from 2006 to 2015 from the White River? (Previous creel did not specify a ten year period)

	04-05	06-15
Inches	Percent	Percent
0	3%	4
< 11	3	4
11 – 17.9	24	18
18 – 19.9	24	20
20 – 21.9	16	17
22 – 23.9	18	18
24 or longer	12	20
Ave.	19	19
Max	28	32

2. How many inches long would a brown trout from the White River need to be for you to consider it a “trophy” fish?

	04-05	14-15
Inches	Percent	Percent
12	0%	3
14 – 17	11	10
18 – 19	17	10
20	34	38
21 – 22	14	11
23 or longer	24	28
Ave.	20	25
Max	28	36

3. Think about the legal sized trout you caught from the White River. Would you say that you released all legal trout, released some and kept others, or kept all legal trout from the White River? **(check one)**

04-05	14-15	
Percent	Percent	
3%	12	I did not catch a legal-sized trout
28	30	Released all legal trout
62	52	Released some legal trout and kept others
7	6	Kept all legal trout

4. In the years that you've been fishing the White River, would you say that your catch-and-release fishing of legal sized trout has… **(check one)**

04-05 Percent	14-15 Percent	
30%	22	Definitely increased
16	16	Probably increased
43	52	Remained about the same
9	7	Probably decreased
3	3	Definitely decreased

5. Starting in 2016, the White River will have a regulation with an 18-inch minimum length and a bag limit of one trout. This is a change from regulations implemented in 1990 which allowed a bag limit of three trout with a 9-inch minimum length with one trout of 15-inches or greater allowed. Do you feel this change in the trout regulations will have a positive or negative impact on the White River fishery? **(check one)**

Percent	
32%	Definitely positive
29	Probably positive
14	Neither positive nor negative
8	Probably negative
17	Definitely negative

6. Do you favor or oppose trout regulations with an 18-inch minimum length limit and a bag limit of 1 trout, that will go into effect in 2016? **(check one)**

Percent	
33%	Definitely favor
10	Probably favor
7	Probably oppose
40	Definitely oppose
9	I'm not sure

These last two questions will help us compare your answers to those of other White River anglers.

7. Are you:

04-05 Percent	14-15 Percent	
94%	93	Male
6	7	Female

8. How old are you? __________ years old

Age	04-05 Percent	14-15 Percent
Less than 20	5%	7
20 – 29	12	3
30 – 39	14	12
40 – 49	21	10
50 – 59	21	31
60 and older	27	37
Ave. age	48	53
Max	98	85

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE. PLEASE RETURN IT IN THE POSTAGE-PAID ENVELOPE AT YOUR EARLIEST CONVENIENCE.

Bureau of Integrated Science Services
Wisconsin Department of Natural Resources
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