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Fisheries and Habitat Research Section

FINAL REPORT

PROJECT F-95-P

Statewide Fisheries and Habitat Research

FISH COMMUNITY AND HABITAT RESPONSES IN A NORTHERN WISCONSIN BROOK TROUT STREAM 18 YEARS AFTER BEAVER DAM REMOVAL

Study: SSMQ

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ABSTRACT:

This 2-year study is a follow-up to 5 years of study in the 1980's and completes an 18-year study testing the hypothesis that removal of beaver dams and maintenance of free-flowing conditions in a badly damaged brook trout stream results in significant improvements in fish habitat, the fish community and the sport fishery. More than 200 beaver dams were removed from 10 miles of the No. Br. Pemebonwon River (Pemonee River) and 22 miles of its tributaries in the winter of 1982-1983. A total of 546 beaver dams were removed by the end of 1986 and a free-flowing system was maintained through 2000. Physical, chemical, biological, and sport fishery data were collected on the Pemonee River and 7 of its tributaries in 1982, 1984, 1986 and 2000. In 1986, four years after the initial dam removals, significant improvements in water temperatures, water chemistries, and brook trout (*Salvelinus fontinalis*) populations occurred in the smaller, higher gradient tributaries. Modest improvements in water temperatures occurred on the larger, lower gradient main river, but declines in both the brook trout population and sport fishery occurred.

In 2000, 18 years after removal of beaver dams, summer water temperatures in the 7 tributaries to the Pemonee River were significantly cooler than in 1982. Summer water temperatures in the Pemonee River were also cooler in 2000 than in 1982 in spite of a warmer, dryer summer in 2000. Wild brook trout populations in the 7 tributaries continued to increase since 1986 and were all significantly greater in 2000 than populations observed in 1982. Wild brook trout populations in the Pemonee River were also significantly greater in 2000 than in 1982. Populations exceeded those present prior to dam removals by 67% in the spring (417/mile vs 697/mile) and 24% in the fall (1,429/mile vs 1,778/mile). Abundance of legal-size brook trout (≥7inches) increased 311% in the spring (61/mile vs 251/mile) and 70% in the fall (220/mile vs 373/mile). Fishing pressure and angler harvest in 2000 exceeded levels observed in 1982 by 13% and 33%, respectively. Average size of brook trout creeled by anglers increased from 7.6 inches in 1982 to 8.9 inches in 2000. Abundance of intolerant fishes in the study area (e.g. brook trout and mottled sculpin, *Cottus bairdi*) increased, while tolerant fishes (e.g. central mudminnow *Umbra limi*, creek chub *Semotilus atromaculatus*, blacknose dace *Rhinichthys atratulus*, and white sucker *Catastomus commersoni*) remained status quo or declined compared to 1982. Index of Biotic Integrity (IBI) ratings for the Pemonee River and its tributaries were generally better in 2000 than in 1982 and verified improved environmental conditions and the development of a healthier coldwater ecosystem following the removal of beaver dams. This study quantitatively validates the removal of beaver and beaver dams as one of Wisconsin's most cost effective trout habitat management tools.

INTRODUCTION:

The long-term deleterious effects of beaver (*Castor canadensis*) impoundments on salmonid habitat in low gradient trout streams of the Upper Midwest has long been viewed as a serious threat to native brook trout (*Salvelinus fontinalis*) populations (Knudsen 1962; Patterson 1951; Avery 1983). Although beaver ponds have been found to benefit trout populations for an initial 2-4 years after creation (Salyer 1935; Hale and Jarvenpa 1950; Hale 1966), considerable evidence points to a number of negative outcomes attributable to beaver impoundments as they age and as their numbers increase on individual streams. Some of these negative outcomes include: warming of water in summer; cooling of water in winter; blockage of trout movement; reduction in trout spawning; reduced levels of dissolved oxygen; a net decrease in insect fauna preferred by trout for food; increased populations of non-trout fishes that compete with trout for food and space; increased concentrations of avian and mammalian predators; and deteriorated stream channel characteristics (Adams 1952; Hale and Jarvenpa 1950; Hale 1966; Patterson 1951; Reid 1952; Salyer 1935; Sprules 1941).

In the late 1970's and early 1980's, beaver dams on Wisconsin trout streams reached unprecedented densities of $\geq$1 per mile. Environmental changes produced by these dams were substantially reducing trout stream carrying capacities and the removal of beaver and beaver dams became a major fisheries management effort. Although the assumption, "removing beaver dams results in better trout streams", is probably correct when dealing with low gradient ($\leq$15 ft/mile) streams typical of Wisconsin, only a few short-term studies (Avery 1992; McRae and Edwards 1994; Stock and Schlosser 1991), have quantified the effects of beaver dam removal on resident fish populations and/or their habitat. The most comprehensive of these studies (and the precursor to the present study) was completed on the North Branch Pemebonwon River (Pemonee River) watershed in northeastern Wisconsin (Avery 1992). Although water temperatures declined and shifts in the macroinvertebrate community suggested improved water quality, wild brook trout populations and the sport fishery in the Pemonee River declined during the 4 years following removal of all beaver dams and maintenance of free-flowing conditions. In 6 of 7 first order tributaries, however, wild brook trout populations increased significantly in response to reduced water temperatures, immigration from the Pemonee River, and increased natural reproduction. Avery speculated that in the larger, lower gradient Pemonee River that much longer than 4 years was needed for both the habitat and the wild brook trout population to recover.

Other studies too suggest that a new environment suitable for trout may take decades to develop following the removal of beaver dams. The return of woody vegetation and the concomitant reestablishment of shade along streams is inhibited by soggy, peaty soil, that is low in pH and dissolved oxygen and high in Fe and toxic "swamp gases" (Moyle 1951; Hale 1966; Wilde, et al. 1950). Such conditions permit the establishment of only sedges and marsh plants and can delay a return to pre-impoundment conditions for many years.

Currently, the Wisconsin Department of Natural Resources (DNR) spends approximately $1.25 million per year restoring and improving trout habitat using Trout Stamp funds earmarked exlusively for trout stream habitat restoration. Beaver control and beaver dam removal on targeted watersheds is an important part of this program (13% of the funding). Although the practice of removing beaver dams will probably continue as a major trout management tool, there are currently no studies that quantitatively document the long-term response of fish habitat, fish populations, and the sport fishery to the removal of beaver dams.

STUDY OBJECTIVE:

Test the hypothesis that removal of beaver dams and long-term maintenance of free-flowing conditions in a badly damaged brook trout stream results in significant improvements in fish habitat, the fish community and the sport fishery.

STUDY AREA:

The Pemonee River flows through northern Marinette County in northeastern Wisconsin. The river is 23.4 miles in length, averages 24.5 ft wide, has a gradient of <0.3%, and a summer discharge of 14.3 cfs near the river mouth (Thuemler and Heizer 1977). The study area included 9.8 miles of the Pemonee River from U.S. Highway 141 upstream to a highline crossing above Ernst Road (Figure 1). Also included were 7 tributaries with a total length of 17.9 miles. Additional physical and chemical characteristics of the Pemonee River and its tributaries are provided in Avery (1992).

STUDY DESIGN:

Since the initial removal of 219 beaver dams during the winter of 1982-1983 and the subsequent removal of 327 dams through 1986, the Pemonee River study area has been maintained in a free-flowing state by the DNR. Avery (1992) studied the impacts of removing the beaver dams upon the physical/chemical characteristics, brook trout populations, sport fishery, nontrout fishes, and macroinvertebrate community during the first 4 years following beaver dam removals. The 2000 study will duplicate prior sampling protocols at the same locations within the watershed to quantify long-term changes (18 years) in physical characteristics, the fish community, and the sport fishery. Previous data collections made during 1982, 1983, 1984, and 1986 will provide the basis for comparisons with the current study.

PROCEDURES AND PERFORMANCE ON SCHEDULED ACTIVITIES:

Activity 1 – Physical Characteristics

Beaver and beaver dam control - During October 1999, the Pemonee River study area was walked to determine if any beaver dams were present. One recently constructed beaver dam was located on the Pemonee River near the entrance of Genrick and No Name creeks. No other evidence of beaver activity was observed. All beaver and the beaver dam were removed within 48 hours by personnel from the U.S. Department of the Interior's Animal Plant and Health Inspection Service-Animal Damage Control Unit (APHIS)[1] headquartered in Rhinelander, WI.

Ambient temperature and precipitation - Daily minimum and maximum air temperatures and daily precipitation in 2000 were measured at the DNR Ranger Station in Wausaukee, WI as part of routine operations. Wausaukee is located 25 miles south of the study area. Monthly print-outs of air temperature and precipitation data in 2000 were acquired to compare with similar data from 1982 (before removal of beaver dams) as well as 1984 and 1986.

Summer (July/August) 2000 was warmer and dryer than summer 1982 (Tables 1-2). For the year, average maximum daily air temperatures for 9 of 11 comparable months ranged from 0.5-7.7 C warmer in 2000 than in 1982. Summer precipitation in 2000 was 2.8 inches less than in summer 1982 while annual precipitation was down 5.0 inches. August 2000 was the dryest August observed during any previous year of study. In addition, average maximum daily air temperature in August 2000 was warmer than in any previous August studied except 1984.

Winter (January-March) 2000 was also warmer and dryer than winter 1982 (Tables 1-2). Average maximum daily air temperatures in January, February, and March 2000 ranged from 4.6-7.7 C warmer than comparable temperatures in 1982. Precipitation in winter 2000 was only 0.1 inch less than in 1982.

Water temperature - In late December 1999, continuous-recording water temperature recorders were installed near the headwaters and near the mouth on 2 tributaries, near the mouth on 4 other tributaries, and at 4 sites on the Pemonee River (Figure 1). Water temperatures were recorded at 1-hour intervals from 1 January through 2 November 2000. Mean weekly water temperatures at all 12 sites during 2000 were compared to similar data for 1982 (the year before removal of beaver dams), 1984, and 1986.

Tributaries - Mean weekly water temperatures peaked during August 2000 at the mouth of all 6 tributaries (Figures 2-7;Tables 3-8). High mean weekly summer temperatures ranged from 16.9 C in Genrick Creek to 14.4 C in Lost Creek. Mean

[1]The Wisconsin Department of Natural Resources began contracting with APHIS in 1988 to maintain the Pemonee River watershed and numerous other watersheds free of beaver dams.

weekly temperatures in No Name, Ernst, Brown Spur, and Cooks & Bullets creeks peaked at 15.2 C, 15.8 C, 15.9 C, and 15.6 C, respectively.

Mean weekly summer temperatures at the upstream sites on Brown Spur and No Name creeks peaked at 16.3 C and 14.9 C, respectively, in 2000 and were 0.3 C warmer and 0.3 C cooler than their downstream counterparts. Mean weekly summer temperatures averaged essentially the same at both upstream and downsteam sites on Brown Spur Creek (Table 9). Mean weekly summer temperatures at the upper site on No Name Creek averaged 0.7 C cooler than the downstream site.

Mean weekly winter temperatures at the mouth of the 6 tributaries ranged from 0 C to 3.9 C from mid-January through March (Figures 2-7). The warmest tributary was Lost Creek with mean weekly temperatures averaging 0.9 C. The coolest tributary was No Name Creek with mean weekly temperatures averaging 0.4 C. Mean weekly winter temperatures at the upstream sites on Brown Spur and No Name creeks ranged from 0.1 C to 3.2 C. Average mean weekly winter temperatures at the upper and lower sites on Brown Spur Creek were both 0.5 C. Average mean weekly temperature at the upper site on No Name Creek was 0.4 C warmer than at the downstream site.

In 2000, peak mean weekly summer water temperatures in the 6 tributaries ranged from 1.4 C to 8.6 C cooler than in 1982, prior to removal of beaver dams (Table 10). This occurred in spite of warmer summer air temperatures and 2.8 inches less summer rainfall than in 1982. Peak mean weekly summer water temperatures in 2000 were also the coolest recorded since the removal of beaver dams in 4 of the 6 tributaries. Peak mean weekly winter water temperatures in 2000 ranged from 2.1 C to 3.4 C warmer in 5 of the 6 tributaries than in 1982. No comparisons were possible in 1 tributary. The winter (January thru March) 2000 was warmer than the same period in 1982 and corresponding precipitation in both years was similar.

No. Br. Pemebonwon River - Mean weekly water temperatures at all 4 sites on the Pemonee River peaked during the week of 2-8 August 2000 (Figures 8-11;Tables 11-14). High mean weekly temperatures ranged from 19.2 C at Ernst Road (the uppermost site) to 18.3 C at both Barlow Lake Road and U.S. Hwy 141 (the progressively lowermost sites). Coldest winter water temperatures occurred during January through February when mean weekly temperatures hovered between 0 C to 0.1 C at all 4 sites. Mean weekly temperatures at the 4 sites warmed to between 4.4 C and 4.8 C by the end of March.

Water temperature changes following the removal of beaver dams in the winter of 1982-83 were more subtle on the Pemonee River than those observed on the smaller tributaries. They did, however, follow the same cooling trend in summer and warming trend in winter. Peak mean weekly summer water temperatures at the 4 sites in 2000 were 0.9 C to 1.4 C cooler than at corresponding sites in

1982, before removal of beaver dams (Table 15). This occurred even though summer air temperatures were higher and precipitation less in 2000 than in 1982. High mean weekly summer temperatures at the 4 sites in 2000 were also 0.5-1.8 C cooler than at comparable sites in 1986 and were 0.1-0.8 C cooler at 2 of the 4 sites (CTH "O" and US Hwy 141) than in 1984. Again, this occurred even though summer rainfall in 2000 was less than in either 1984 or 1986 and average daily maximum air temperature in August 2000 was higher than in either August 1984 or 1986. Peak mean weekly winter water temperatures at 3 of the 4 sites in 2000 were 3.0 C to 4.1 C warmer than at corresponding sites in 1982. No comparisons were possible at the 1 site. Winter (January thru March) air temperatures were warmer in 2000 than in 1982 and precipitation was similar. However, I believe much of the increase in winter water temperatures observed in both the main river and tributaries in 2000 was the result of removing the beaver dams and impoundments. Beaver ponds and impounded river reaches dilute the warmer groundwater sources (springs) and warmer baseflow river discharge during winter which results in colder winter water temperatures.

Streamflow – Discharge of the Pemonee River was measured at the upper (Ernst Rd. bridge) and lower (U.S. Hwy 141) boundaries of the study area on 24 July and 21 August 2000 (Figure 1). Discharge near the mouth of the 7 tributaries studied was also measured on 24 July and 21 August 2000.

No. Br. Pemebonwon River - Discharge of the Pemonee River in July 2000 was 3.6 cfs and 5.6 cfs at the upper and lower boundaries of the study area, respectively (Table 16). Streamflow at both sites was considerably less than corresponding discharges measured in June 1983, 1984 or 1986. No discharge measurements were taken in 1982. In August 2000, discharge at the upper and lower sites was15.9 cfs and 21.0 cfs, respectively. Streamflow at both sites was much greater than at corresponding sites in June 1983, 1984 or 1986.

Tributaries - Discharge of the tributaries in July 2000 ranged from too low to measure in No Name Creek to 0.3 cfs in Brown Spur Creek (Table 16). Together, the 7 tributaries contributed 0.9 cfs to the Pemonee River and comprised 45% of the gain in river discharge within the study area. Discharge of the 7 tributaries ranged from 0.1 cfs to 1.1 cfs in August and together contributed 2.9 cfs to the Pemonee River. Total discharge of the tributaries comprised 57% of the gain in river discharge within the study area. Generally, streamflows in the tributaries during both July and August 2000 were below those observed in June/July 1982, 1983, 1984, and 1986.

Activity 2 – Fish Populations

No. Br. Pemebonwon River - A total of 1,513 brook trout were permanently marked (LV finclip) at the DNR Lakewood Hatchery on 14 April 2000. A permanent mark was given to permit subsequent identification from wild resident brook trout after stocking. Lengths to the nearest 0.1 inch were recorded on 225 fish (15% sample). Average length of the sample was 7.6 inches. Equal numbers by weight were stocked in the Pemonee River at Ernst Road, Cooks & Bullets Road, and CTH "O" on 2 May 2000 (Figure 1). Average length and weight on the stocking receipt was 8.0 inches and 95 grams (4.8/lb), respectively.

A total of 3,000 brook trout were permanently marked (A finclip) at the Niagra Trout Rearing Pond on 12 May 2000. A permanent mark was given for reasons mentioned previously. Lengths to the nearest 0.1 inch were recorded on 300 fish (10% sample). Average length of the sample was 8.3 inches. Approximately 1,100 of the 3,000 brook trout were stocked in the Pemonee River study area on 24 May 2000. Ernst Road, CTH "O", and a site off the road paralleling the river below CTH "O" each received 200 trout while 500 trout were stocked off Cooks & Bullets Road (Figure 1). Average length and weight on the stocking receipt was 8.8 inches and 130 grams (3.5/lb). The total number of brook trout stocked in the Pemonee River study area has remained relatively the same throughout the study period.

Mark and recapture electrofishing surveys were conducted in 7 stations on the Pemonee River during spring and fall 2000 to estimate brook trout populations (Figure 12). Stations 1, 2, 4, 5, and 6 were each 600 yd in length. Stations 3 and 7 were 1,009 yds and 766 yds in length, respectively. Electrofishing surveys were made with a towed stream shocker boat equipped with 3 positive anodes, a negative cathode of stainless steel covering the boat bottom, and a 230v DC generator. Spring surveys were conducted during 17-20 April and 24-25 April. Fall surveys were conducted during 2-5 October and 9-12 October. In the fall, mark and recapture electrofishing surveys of all fishes were also made in a 100 yd segment of stations 1, 2, 3, 4, and 6 to estimate the total fish community. Prior to sampling, the upstream boundary of each 100 yd segment was blocked with a ¼ inch mesh nylon seine to prevent movement of fishes out of the reach being sampled.

Fish population estimates (P.E.s) were made using the Bailey modification of the Petersen mark and recapture formula (Ricker 1958). Population estimates of brook trout in each station were made for fish <6 inches and >6 inches and the two estimates summed for a total P.E. Variance (S^2) of both P.E.s were summed and the 95% confidence interval (C.I.) for the total P.E. was determined as $+2$ times the square root of the summed S^2s. Population estimates were apportioned to inch groups based upon the total numbers of brook trout captured per inch group on the first electrofishing survey plus unmarked fish captured per inch group on the second electrofishing survey. In addition to P.E.s in the individual stations, P.E.s in all 7 stations were summed for a total estimate in the 2.7 miles surveyed. The 95% C.I. of this P.E. was determined as $+2$ times the square root of the sum of all individual S^2s. In the fall, P.E.s in the upper 6 stations were summed for a total estimate of brook trout in the 2.3 miles represented. Population estimates of trout as well as non-trout fishes were compared to P.E.s made in the same sampling stations in 1982, 1984, and 1986.

An Index of Biotic Integrity (IBI) is a multimetric index that rates the existing structure, composition, and functional organization of the fish assemblage with regional and habitat-specific expectations derived from comparable high-quality ecosystems (Lyons et al. 1996). An IBI was computed for the 5 fish community stations sampled during fall 2000 and compared with IBI's computed from data gathered during 1982, 1984, and 1986.

Brook trout populations in the spring of 2000 ranged from 202/mile to 1,660/mile in the 7 stations surveyed on the Pemonee River (Table 17). Fish over 6.0 inches ranged from 156/mile to 431/mile. Overall abundance of brook trout in the 2.7 miles of river inventoried was 697/mile (Table 18). Abundance of legal-size trout ($\geq$7 inches) was 251/mile.

In the fall of 2000, brook trout populations ranged from 540/mile to 3,279/mile in the 7 stations inventoried (Table 17). Fish over 6.0 inches ranged from 387/mile to 1,924/mile. Abundance of trout in the combined 2.7 mile reach inventoried was 1,706/mile (Table 19). Legal-size trout ($\geq$7 inches) comprised 557/mile.

Wild brook trout populations declined initially in the Pemonee River following removal of beaver dams but 18 years later (in 2000) populations were significantly greater than before dam removals. The spring 2000 population of 697 wild brook/mile represented a 67% increase over the population of 417/mile present in spring 1982, before removal of beaver dams (Table 20; Figure 13). Sublegal brook trout (<7 inches) increased 26% between 1982 and 2000 but the big gain was in legal size brook trout ($\geq$7 inches). Legal size fish increased 305%, from 62/mile to 251/mile.

The fall 2000 population of 1,778 brook trout/mile was 24% greater than the fall population of 1,429 brook trout/mile present in 1982 (Table 20; Figure 14). The abundance of legal size brook trout ($\geq$7 inches) increased 138% between 1982 and 2000 and was responsible for the entire population gain.

The length frequency diagram comparing the fall 2000 population with the fall 1982 population (Figure 14) illustrates still another positive response to the removal of beaver dams. A shift in the abundance of similar age fish to the right indicates an increase in growth rates. Most age 0 (YOY) brook trout in fall 1982 were in the 3 inch and 4 inch groups while in fall 2000 most YOY were in the 4 and 5 inch groups. Average size of YOY brook trout in fall 1982 was 4.0 inches while in 2000 average size of YOY was 4.5 inches. Most age I brook trout in 1982 were in the 5-7 inch groups while in 2000 most age I trout were in the 6-8 inch groups. For a species that seldom lives beyond their 3rd birthday (at least in WI), the increased growth rate translates to more and larger brook trout available to the angler as age II's (as fish $\geq$9 inches). The faster growth of brook trout in 2000 not only reflects improved water temperatures but also qualitative increases in gravel substrates and aquatic insect life, particularly large stonefly (*Pteronarcys sp.*) numphs, observed in the river.

Mottled sculpin (*Cottus bairdi*), blacknose dace (*Rhinichthys atratulus*), brook trout, and creek chub (*Semotilus atromaculatus*) were the 4 most abundant fishes in the 5 fish community stations sampled in the Pemonee River in the fall 2000 (Table 21). Ten non-salmonid species were captured but only mottled sculpin and blacknose dace were more numerous in the river than brook trout. Brook trout and mottled sculpin are species intolerant to environmental degradation and severe environmental conditions while blacknose dace, creek chub, central mudminnow (*Umbra limi*), and white sucker (*Catastomus commersoni*) are tolerant species (Lyons 1992). Brook trout and mottled sculpin, the two intolerant species, comprised 64% of the fish community in the Pemonee River while the 4 tolerant species comprised only 34%.

Although present in the fish community, brook trout captured in the fish community stations in fall 1982 were not kept separate from brook trout captured in the remainder of the trout sampling stations. Fall populations of non-salmonids present before removal of beaver dams were therefore compared to non-salmonid populations present in fall 1984, 1986, and 2000 to determine changes in the fish community that may have resulted from the removal of the beaver dams.

Populations of mottled sculpin, an intolerant specie as well as a "trout indicator" specie (Becker 1983), increased progressively following the removal of beaver dams (Table 22). The fall 2000 population was more than 3 times the population present in fall 1982. Mottled sculpins comprised 36% of the non-salmonid community in 1982 and 58% of the community in 2000, 18 years after dam removals. Four tolerant species (blacknose dace, creek chub, central mudminnow, and white sucker) comprised 49% of the non-salmonid community in 1982 but only 40% of the community in 2000. Blacknose dace was the only tolerant specie that exhibited a substantial increase in numbers. This specie prefers cool headwater streams with moderate to rapid water and has also been called a "trout indicator" specie because it is such a common inhabitant of trout streams (Becker 1983). Abundance of creek chubs and central mudminnows both declined while numbers of white suckers increased marginally. The common shiner (*Luxilus cornutus*) was 1 of the 3 most common non-salmonids present before removal of beaver dams but in 2000 was nearly absent from the river.

Fall IBI ratings for the 5 fish community stations sampled in 2000 were "Good" in stations 1, 3, 4, and 6 and "Fair" in station 2 (Table 23). The IBI scores and ratings were better overall than for the same stations in 1982 before removal of beaver dams. The increase in intolerate fishes (e.g. brook trout and mottled sculpin) as well as improved IBI's in the Pemonee River in 2000 verifies that a healthier coldwater ecosystem exists today than it did in 1982 before removal of beaver dams.

Tributaries – Either mark and recapture electrofishing surveys or 3 successive removal electrofishing surveys were conducted in 14 stations (a-m, o) on 7 tributaries to the Pemonee River during 26-27 April and 15-16 May, 2000 to estimate brook trout populations present (Figure 12). Similar electrofishing surveys were conducted in 11 stations (c-f, h-m, o) on 6 tributaries to the Pemonee River during 6-19 October. Stations a and b on Ernst Creek and station g on Brown Spur Creek were not sampled in October because they were not sampled in the fall 1982 before removal of beaver dams.

In most cases, two 12v battery operated, DC back-pack electrofishing units were used concurrently to sample each of the fish community stations. In one or two instances, however, one back pack unit was used on the first and/or the second electrofishing runs. Station lengths ranged from 67-300 yd. Population estimates were made following previously described protocols and using either the Bailey modification of the Petersen mark and recapture formula or the multiple removal technique developed by Zippin (1958) and modified by Armour et al. (1983). Confidence intervals (C.I.s) were determined as ± 2 times the square root of the variance (S^2).

In October, either mark and recapture electrofishing surveys or 3-4 successive removal electrofishing surveys of all fishes were made in sub-sections of 9 of the 11 trout stations (c-f, i-l, m) on 5 tributaries. These fish community stations ranged from 33 yd to 67 yd in length. Population estimates of trout and non-trout species were made using previously described techniques.

Ideally, the length of stream sampled to compute an IBI should be at least 35 times the mean stream width (Lyons 1992), although a reach as short as 18-20 times the mean width is usually adequate. The minimum length of stream sampled should never be less than 109 yd (Lyons et al. 1996). Length of 5 of the 9 fish community stations sampled in October 2000 exceeded 35 times their corresponding mean stream width and all 9 stations exceeded 20 times their corresponding mean stream widths. Although the minimum length requirement of 109 yd was not achieved, an IBI was nonetheless computed for all fish community stations sampled in October.

Population estimates of brook trout made in tributaries during spring and fall 2000 were compared to similar P.E.s computed in the same sampling stations during 1982, 1984 and 1986. Population estimates of non-salmonid fishes as well as IBI's computed in the fish community stations sampled in October 2000 were also compared to similar parameters computed in the same sampling stations in 1982, 1984, and 1986.

Brook trout were present in all 7 tributaries and in all 14 stations sampled during spring 2000 (Table 24). Populations ranged from 9/mile in upper Genricks Creek to 1,267/mile in lower Brown Spur Creek. Abundance of fish over 6.0 inches ranged from none in 3 of the 14 stations to 235/mile in lower Brown Spur Creek.

In the fall, brook trout were found in all 6 tributaries sampled and in 10 of 11 stations sampled. Brook trout populations ranged from none in upper Genrick Creek to 1,924/mile in lower Brown Spur Creek. Fish over 6.0 inches ranged from none in 2 of the 11 stations to 694/mile in lower Brown Spur Creek.

Both the distribution and abundance of brook trout in tributaries increased quickly following the removal of beaver dams in the winter of 1982-1983. Brook trout occurred in 4 of 7 tributaries and in only 4 of 12 stations sampled in spring 1982 (Table 25). Four years later, brook trout occurred in all 7 tributaries and in 11 of 12 stations inventoried in spring 1986. Abundance of brook trout increased substantially in 8 of the 11 stations too. In fall 1982, just prior to dam removal, brook trout were present in 4 of 6 tributaries sampled and in 5 of 9 stations inventoried. In fall 1986, brook trout occurred in all 6 tributaries and in 8 of 9 stations sampled. Marked increases in abundance were present in all 8 stations.

Eighteen years after the removal of beaver dams, i.e. in 2000, continued increases in both distribution and abundance of brook trout were evident in all 7 tributaries to the Pemonee River. Brook trout were present in all 7 tributaries and in all 12 stations sampled in the spring and in all 6 tributaries and in 8 of 9 stations sampled in the fall (Table 25). Trout populations in all 12 stations sampled in spring 2000 were equal to or higher (in most cases substantially higher) than populations last observed in spring of 1986. Similarly, brook trout populations in the fall 2000 were equal to or higher (in most cases markedly higher) in 6 of 8 stations than when last sampled in fall 1986.

From 1 to 8 fish species were found in fish community stations sampled on 5 tributaries of the Pemonee River during October 2000 (Table 26). Only brook trout were present in Lost Creek, the most pristine tributary. From 3 to 8 species were found in the remaining 4 tributaries with the highest diversity occurring in Genrick Creek. Species captured on the first electrofishing pass and corresponding IBI ratings in 9 fish community stations suggested ecosystem qualities ranging from "poor" to "excellent" (Table 27).

Eight of the 9 fish community stations sampled in fall 2000 were also sampled in 1982 (before removal of beaver dams), 1984, and 1986 (Avery 1992). Comparisons of the fish community in these 8 stations reveal a subtle change from a composition dominated by "tolerant" species in 1982 to one more equally represented by "tolerant" and "intolerant" species in 2000 (Table 28). "Tolerant" and "intolerant" species comprised 51% and 16%, respectively, of the fish community in 1982. In 2000 (18 years after dam removal), "tolerant" and "intolerant" species comprised 37% and 24%, respectively, of the fish community. Northern redbelly dace (*Phoxinus eos*) was 1 of the 2 most common non-salmonids present in the tributaries before removal of beaver dams but in 2000 it was an uncommon resident. This dace prefers the quiet waters of beaver ponds and the quiet pool-like expansions of headwater streams (Becker 1983).

Thus, its near absence in 2000 reflects the change in habitat in the tributaries following the removal of beaver dams.

Additional insight into ecosystem changes following removal of beaver dams is revealed by comparing IBI ratings in the individual fish community stations before and after dam removals. In 5 of the 8 stations, IBI scores were higher in 2000 than in 1982 before removal of beaver dams (Table 29). IBI ratings in 2000 were equal to or better in all eight stations than they were in 1982.

Activity 3 – Sport Fishery Investigations

A 40-hour per week creel survey throughout the 2000 trout fishing season (1st Saturday in May thru September) was conducted in the Pemonee River study area. Opening weekend was regarded as a separate entity and a complete survey was conducted. For the remainder of the fishing season, the survey was stratified so that 50% of the effort was exerted on weekend days and holidays and 50% was exerted on weekdays. Vehicle counts were made at 2-hour intervals on each census day at all access sites within the study area. Anglers were interviewed at the completion of their fishing trip to determine catch and harvest statistics and other demographic data. Specifics of the creel survey design and protocols used to estimate fishing pressure and harvest are described in Avery (1992). Estimated fishing pressure, harvest statistics, etc. gathered during 2000 are compared to similar data gathered in 1982, 1984, and 1986.

Fishing pressure on the Pemonee River in 2000 was 102 hours/acre and 52% of it occurred during the first month of the fishing season, i.e. May (Table 30). Anglers harvested 300 brook trout/mile and 55% of it occurred in May. Approximately 58% of the season harvest consisted of wild brook trout with the remaining 42% consisting of stocked fish.

Fishing pressure in 2000 represented a modest increase of 13% from 1982, the year prior to removal of beaver dams (Table 31). Brook trout harvest increased 33%, from 226/mile in 1982 to 300/mile in 2000. Composition of the harvest (wild trout vs domestic trout) was particularly significant. Anglers creeled essentially the same number of domestic trout in 1982 and 2000 (122/mile vs 125/mile). However, angler harvest of wild brook trout increased from 104/mile in 1982 to 175/mile in 2000 and comprised all of the 33% increase in total harvest.

Age structure of wild brook trout creeled in 2000 included 71% age II's and 18% age III's (Table 32). In 1982, age I fish comprised 50% of the harvest and age II's accounted for 40%. A change from a minimum legal size of 6 inches in the 1980's to a minimum size of 7 inches beginning in 1990 may be partially responsible for the increase in older fish in the harvest. However, the presence of greater numbers of larger, older trout in 2000 as opposed to 1982 seems more plausible given the significant increase in trout populations observed.

Concurrent with the increase in older brook trout harvested in 2000 was a substantial increase in the average size of trout creeled. In 1982, before removal of beaver dams, creeled brook trout averaged 7.6 inches (Avery 1992). In 2000, the average size of brook trout in the anglers creel was 8.9 inches. Approximately 26% of 230 anglers interviewed at the completion of their fishing trip in 2000 creeled the daily limit of 5 brook trout. In 1982, the daily bag limit was 10 fish and only 3% of the completed anglers interviewed creeled their limit.

Average length of the fishing trip in 2000 was 2.4 hours. This was less than the trip duration of 2.6 hours observed in both 1982 and 1986 and 2.8 hours observed in 1986 (Avery 1992). Season catch rate averaged 2.5 trout/hour in 2000 while season harvest rate averaged 0.9 trout/hour. The catch rate in 2000 was almost double that observed in 1982 (1.3 trout/hr) while the harvest rate was essentially the same (0.8 trout/hr in 1982). Anglers in 2000 were therefore able to spend less time on the stream, catch more trout, and sort through and keep much larger fish than they could in 1982 before removal of beaver dams. Put another way, in 1982 anglers had to fish longer to catch fewer trout and were far more likely to keep what they caught without sorting.

Anglers living within a 25-mile radius of the Pemonee River comprised 38% of the angling clientle in 2000. Anglers living more than a 50-mile radius from the stream comprised 42% of the angling clientle. The only perceptible change in distance traveled to fish, compared to the 1980's, was an increase in anglers traveling 25-49 miles to fish (an avg. of 7% in the 80's compared to 20% in 2000). Approximately 95% of all anglers in 2000 were male and 5% were female. Anglers less than 16 years of age, between 16 years and 64 years, and 65 years or older comprised 15%, 81%, and 4%, respectively, of the angling clientle in 2000. In the 1980's, an average of 15% of the anglers were 65 years or older; thus, a change to a younger angling clientle was evident in 2000. Of the anglers interviewed in 2000 that used only 1 bait type, 74% used worms, 17% used spinners, 8% used flies, and 1% used something else. Of 38 anglers that used two or more bait types, worms was used by all. Both spinners and worms were used 84% of the time. The only notable change in terminal tackle from the 1980's was an increase in the use of spinnerbaits by anglers using only 1 bait choice (avg. 4% in 80's to 17% in 2000).

DISCUSSION:

The removal of beaver dams on low gradient streams is viewed by some as doing more harm than good (Evans 1948; Wilde, et al. 1950). Ecologists recognize that ecotones[1] in landscapes are often critical in regulating nutrient and organic transfers, biological productivity, and biological diversity (Forman and Godron 1986). Ecotones between beaver ponds and downstream areas exhibit potentially high invertebrate and fish abundances (Schlosser and Ebel 1989) due to the effect of beaver dams on organic retention and nutrient cycling (Naiman and Melillo 1984; Naiman et al. 1986) Johnston and Naiman 1987; Naiman et al 1988). It is recognized by the Wisconsin DNR that the removal of beaver dams may suppress biological productivity and diversity in order to focus management on maintaining a specific resource (wild brook trout) and the biotic integrity of the coldwater ecosystem which is highly valued by the general public.

This study is the culmination of one of the most exciting trout habitat management success stories in Wisconsin and certainly validates the DNR's expenditure of trout stamp money to remove beaver and beaver dams in selected watersheds. It completes a rare, if not unique, long-term documentation of the positive long term benefits of beaver and beaver dam removal in a low gradient, coldwater ecosystem. Cost of this trout habitat management technique ranges from $75/mile to $160/mile of trout stream restored. The removal of beaver and beaver dams can not only be added to the list of proven habitat management options in Wisconsin but also can take pre-eminence as one of the most cost-effective trout management tools.

ACKNOWLEDGEMENTS:

I thank Kent Niermeyer (retired DNR Technician 3- Waupaca, WI) and Russell Heizer (DNR fisheries manager-Pestigo, WI) for providing assistance in field sampling, logistics, and data analyses in 2000 and for assistance in procuring a creel survey clerk. Both of these men were intimately involved in this long term study from its inception in 1982 and were invaluable assets to its successful conclusion in 2000. Special thanks also to the Marinette Chapter of Trout Unlimited, Green Bay Chapter of Trout Unlimited, and the Wisconsin Trout Unlimited State Council for donations of $1000.00, $2000.00, and $1000.00, respectively, toward the support of the creel survey clerk during 2000.

[1] a transition between two or more diverse communities.

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APPROVALS:

Section Chief: ______________________ Date: ____________________

These are the Correct Un-named codes for these streams (Lee Meyers).

Table 25. Wild brook trout per mile in tributaries of the No. Br. Pemebonwon River sampled 1 year before (1982) and 2 (1984), 4 (1986), and 18 (2000) years after removal of beaver dams (n/s=not sampled).

Stream	Stream Length	Station	SPRING 1982	SPRING 1984	SPRING 1986	SPRING 2000	FALL 1982	FALL 1984	FALL 1986	FALL 2000	Notes
T38N, R20E											
Ernst Cr.		a	0	n/s	132	158	n/s	n/s	n/s	n/s	* ~~Not sampled before~~ flows out of Florence Co.
Cr. 31-15	1.1 miles	b	0	132	26	132	n/s	n/s	n/s	n/s	
T37N, R20E Lost Cr.		c	150	211	326	643	880	642	1,743	634	* ~~Never sampled before~~ flows out of Florence Co.
" Cr. 6-5	0.5 miles										
Cooks & Bullets Cr.		d	0	53	18	563	0	246	70	651	* Non-Trout water Heizer 1977
Cr. 8-6	2.0 miles	e	176	123	88	484	643	704	1,197	1,224	
T37N, R20E East Cataline Cr.		f	185	370	79	449	368	475	818	158	* Non-Trout water Heizer, 1977
Cr. 9-11	0.7 mile										
" Brown Spur Cr.		g	0	n/s	35	185	n/s	n/s	n/s	n/s	
Cr. 2-11	4.0 mile	h	411	88	241	1,267	376	316	411	1,924	Class 1, Heizer, 1977
T37N, R20E No Name Cr.	0.7 mile	i	0	n/s	158	185	0	26	18	264	* Never Sampled before
Creek 2-14b		j	0	9	0	678	0	71	194	625	
T37N, R20E Genrick Cr.	1.0 mile	k	0	n/s	9	9	0	0	0	0	Class 1, Heizer, 1977
Creek 2-14a		l	0	26	70	694	9	167	264	431	

* 5 streams should be Class 1 Brook trout

* The North Branch Pembonwon should be Reclassified?

* stream length is a "guesstimate" (Marinette Co.) Florence Co.?

* Brown Spur & Genick are correct names for these streams?

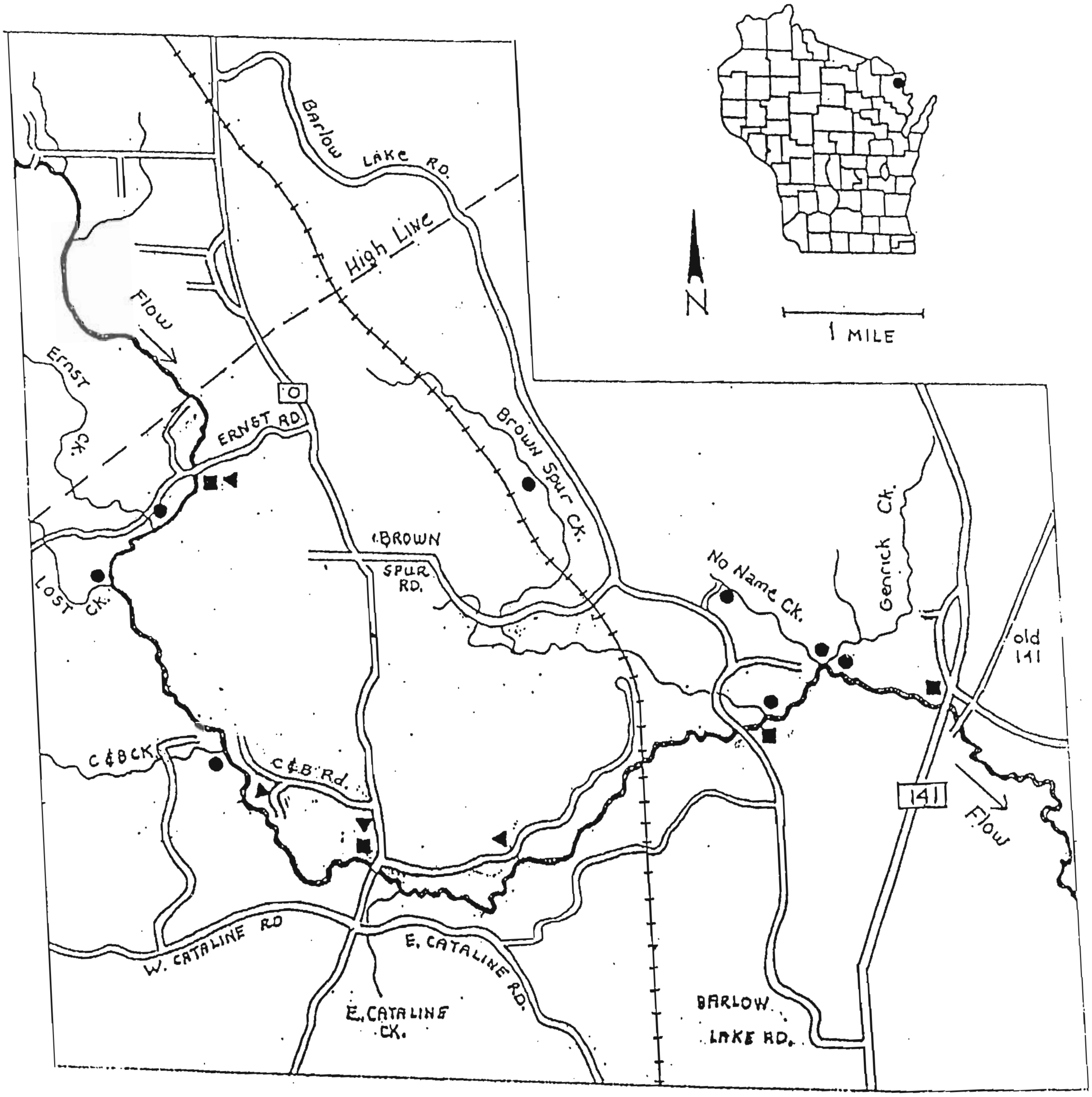


Figure 1. No. Br. Pemebonwon River study area showing thermograph locations (■ main stream; ● tributaries) and brook trout stocking sites (▶).

Figure 2. Mean weekly water temperatures at the mouth of Lost Creek before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

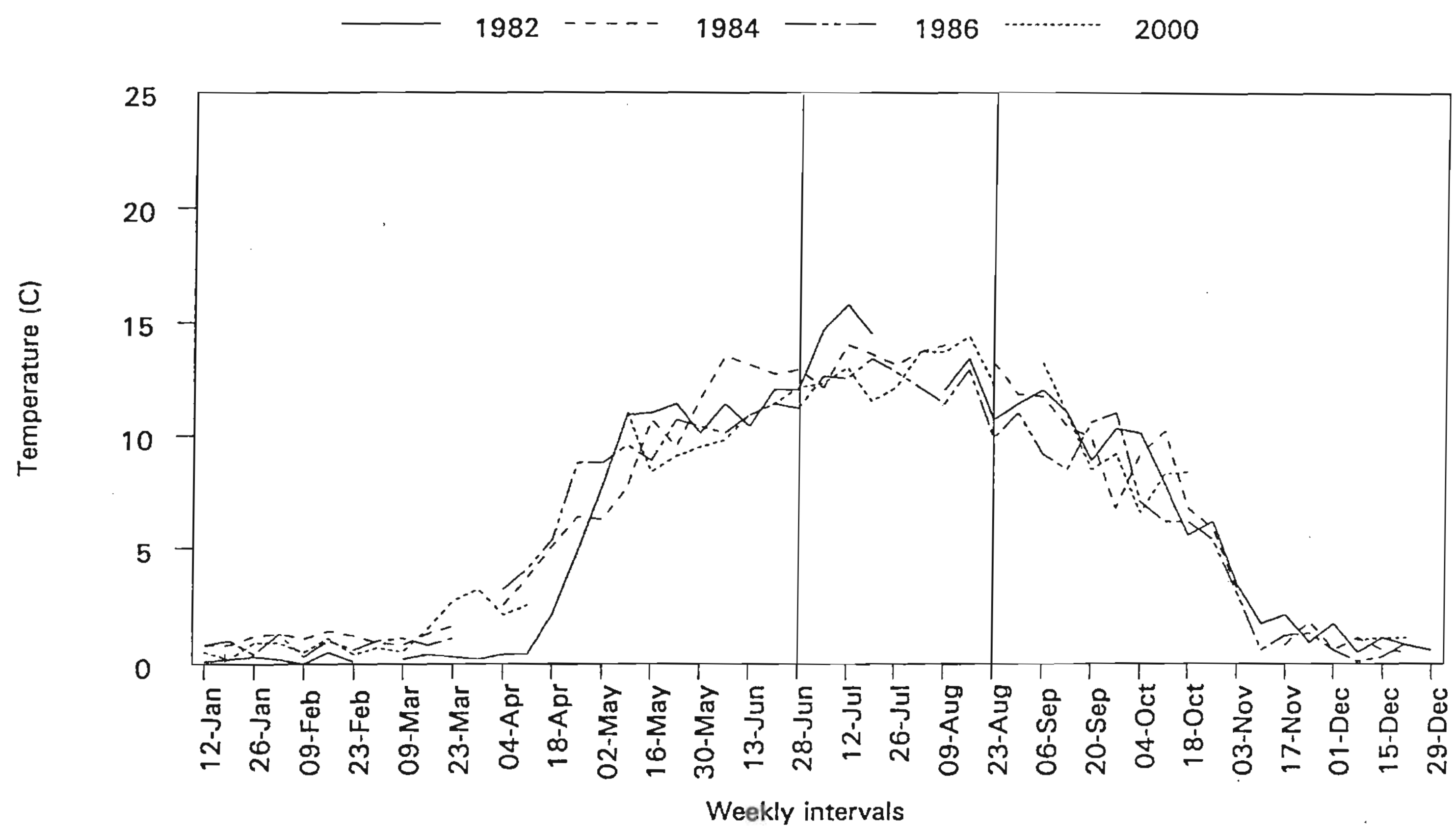


Figure 3. Mean weekly water temperatures at the mouth of Ernst Creek before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

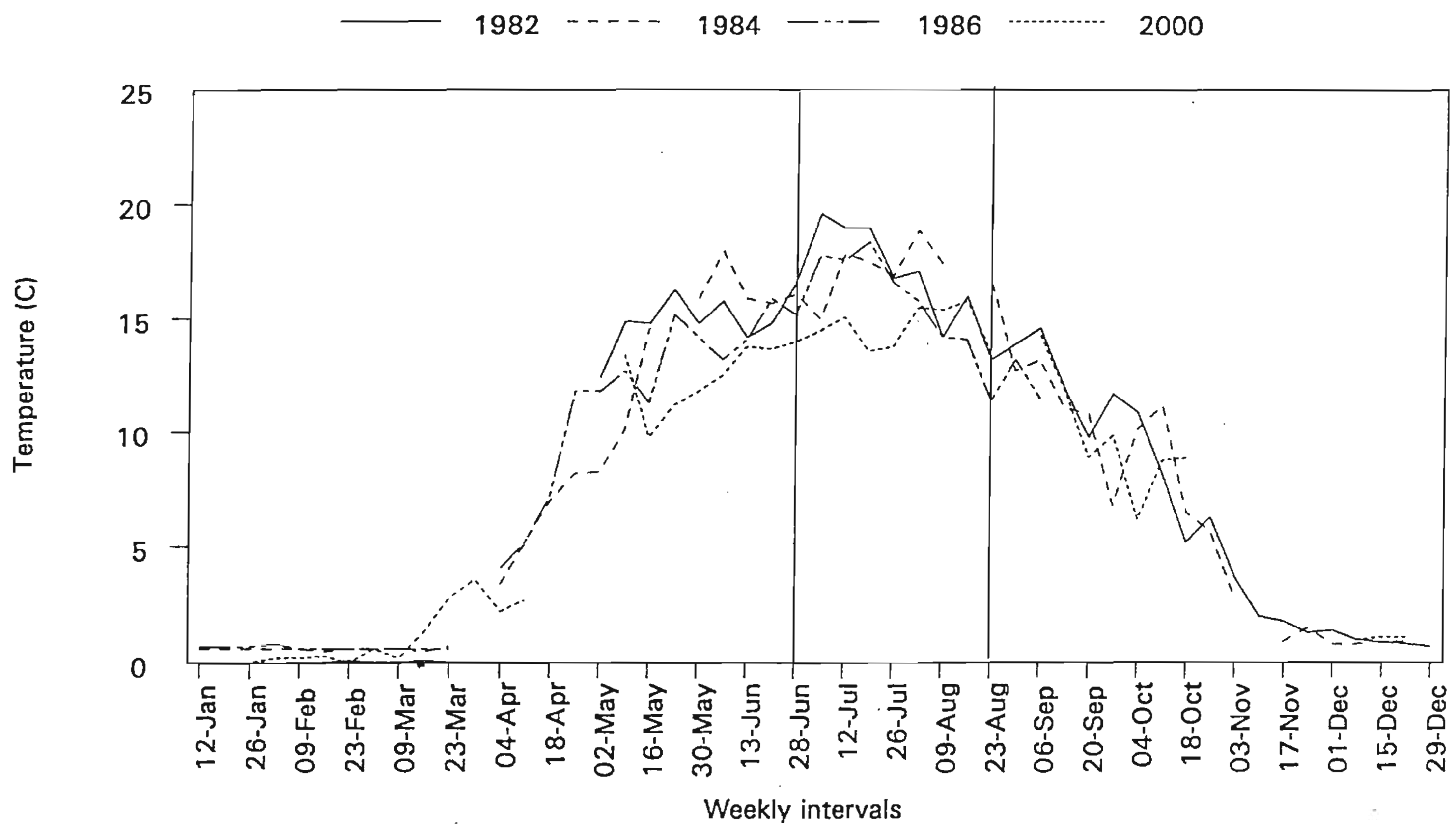


Figure 4. Mean weekly water temperatures at the mouth of Cooks and Bullets Creek before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

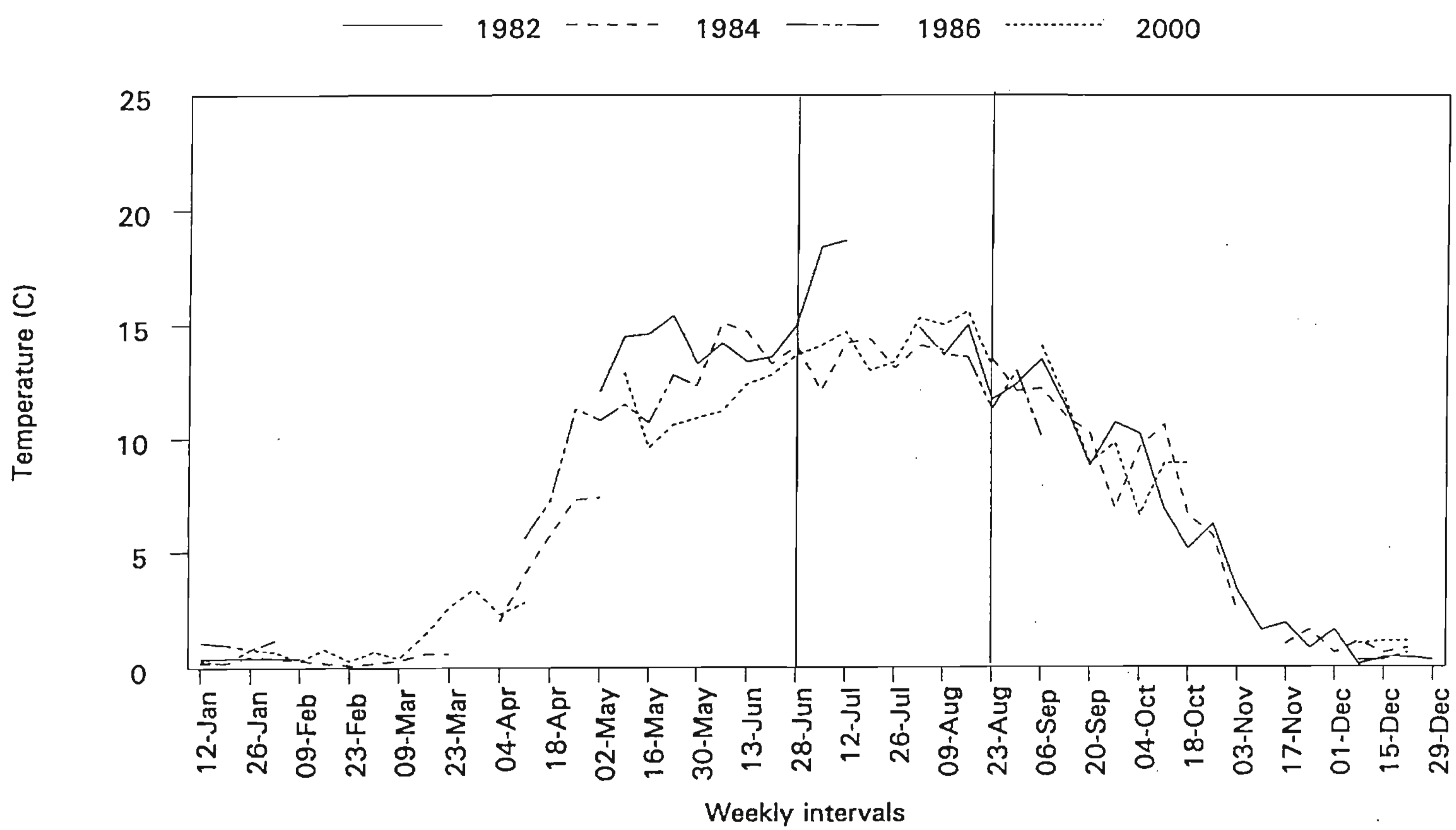


Figure 5. Mean weekly water temperatures at the mouth of Brown Spur Creek before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

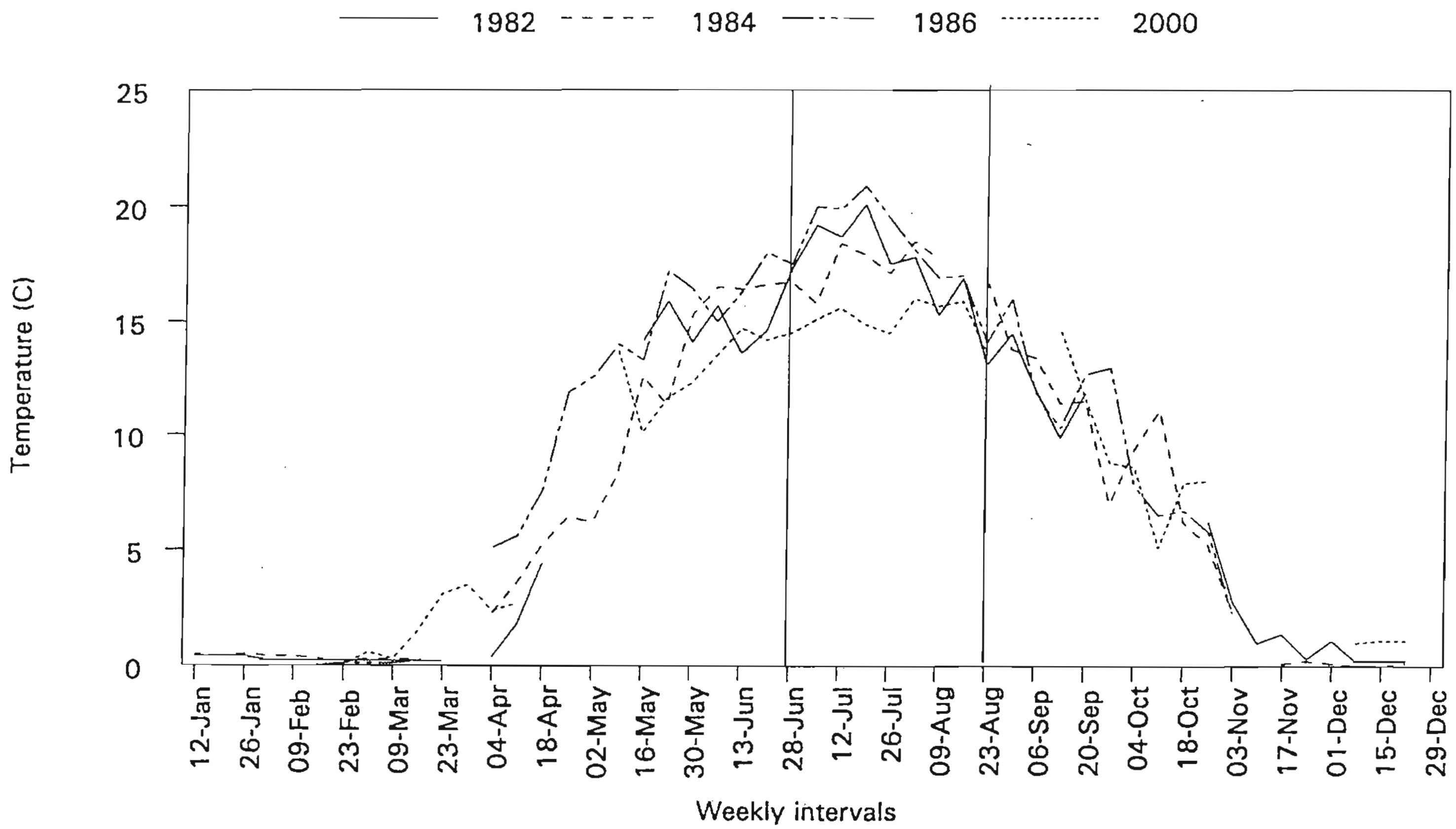


Figure 6. Mean weekly water temperatures at the mouth of No Name Creek before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

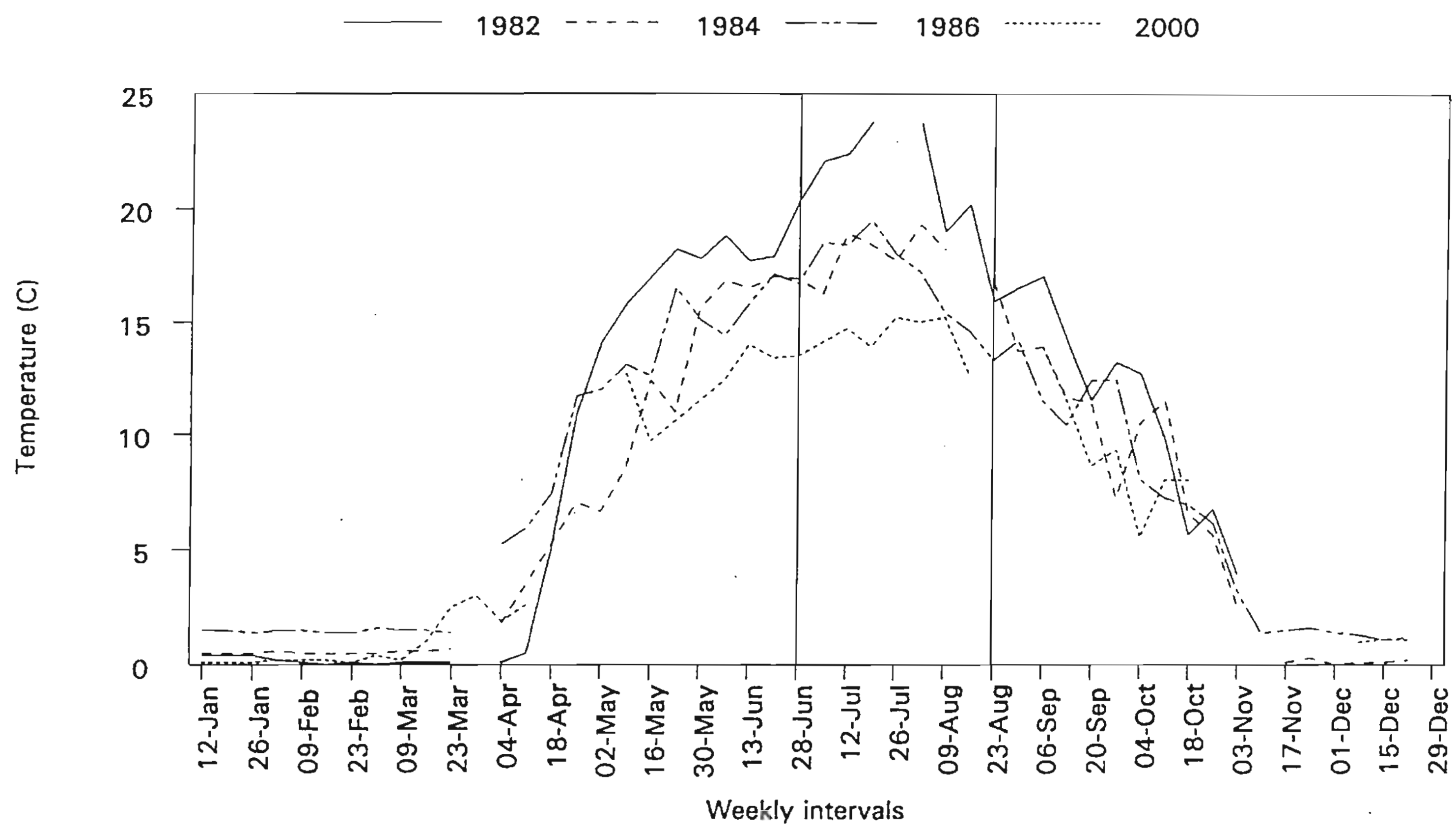


Figure 7. Mean weekly water temperatures at the mouth of Genricks Creek before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

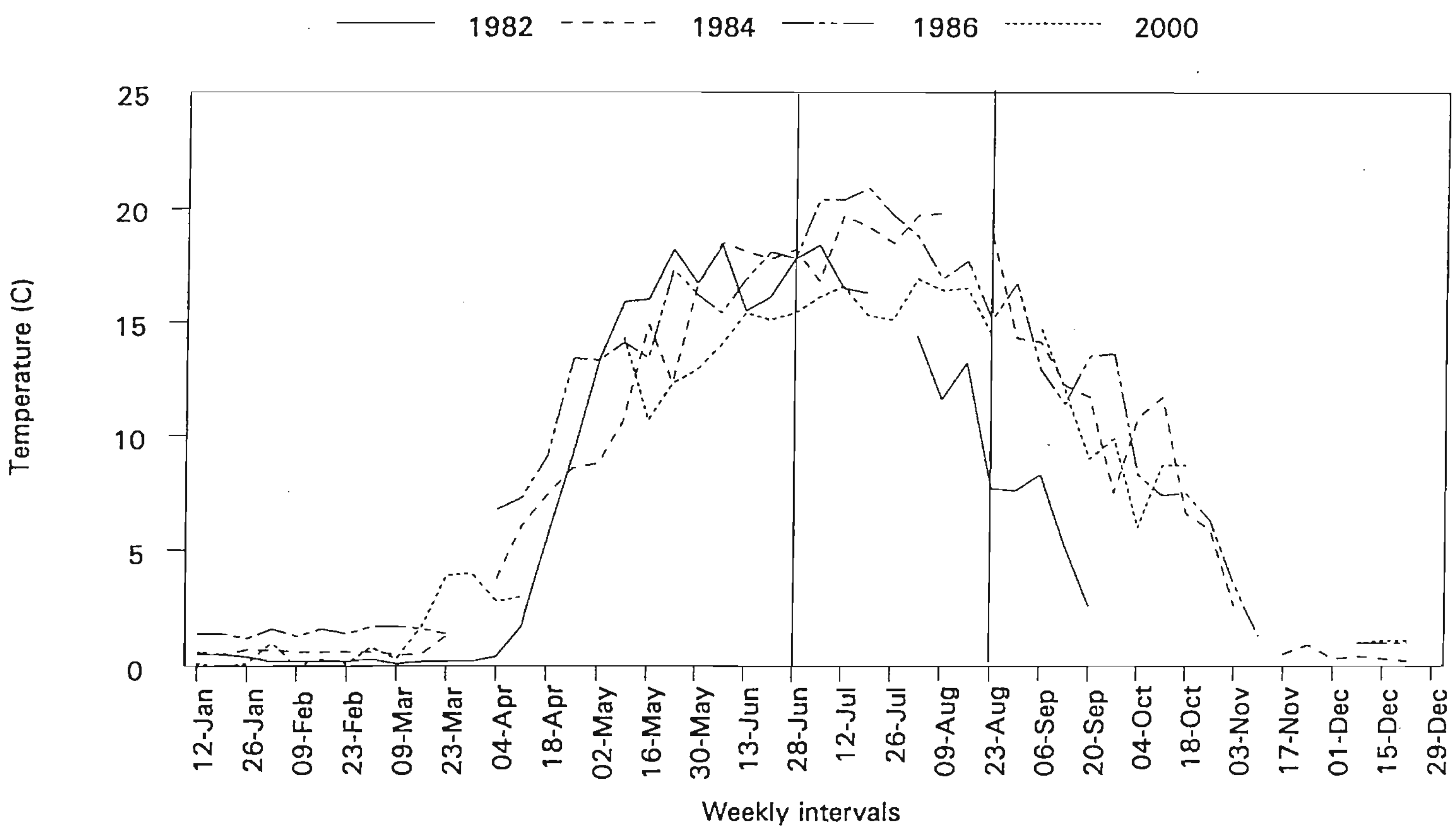


Figure 8. Mean weekly water temperatures at Ernst Road on the No. Br. Pemebonwon River before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

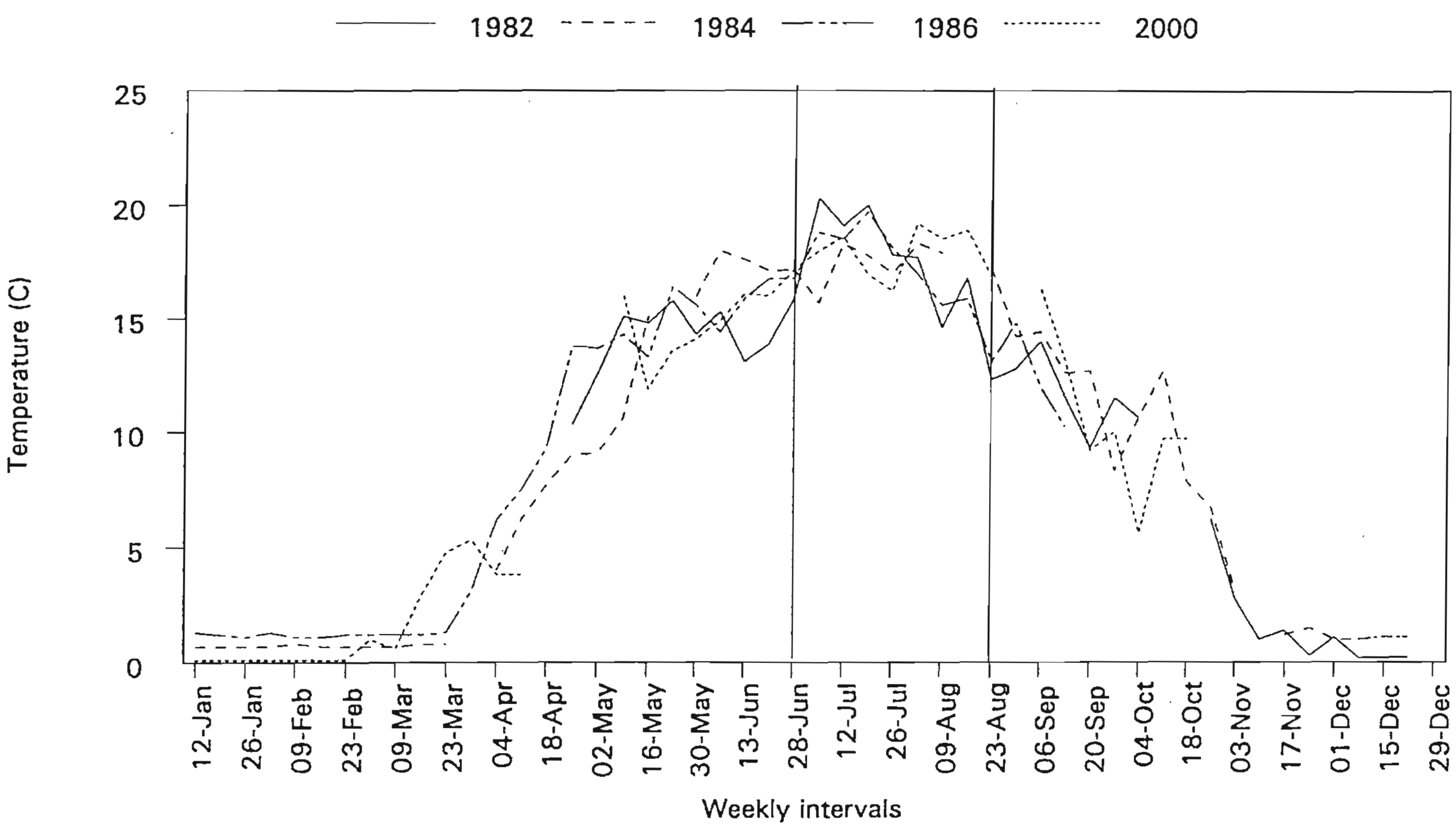


Figure 9. Mean weekly water temperatures at CTH "O" on the No. Br. Pemebonwon River before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

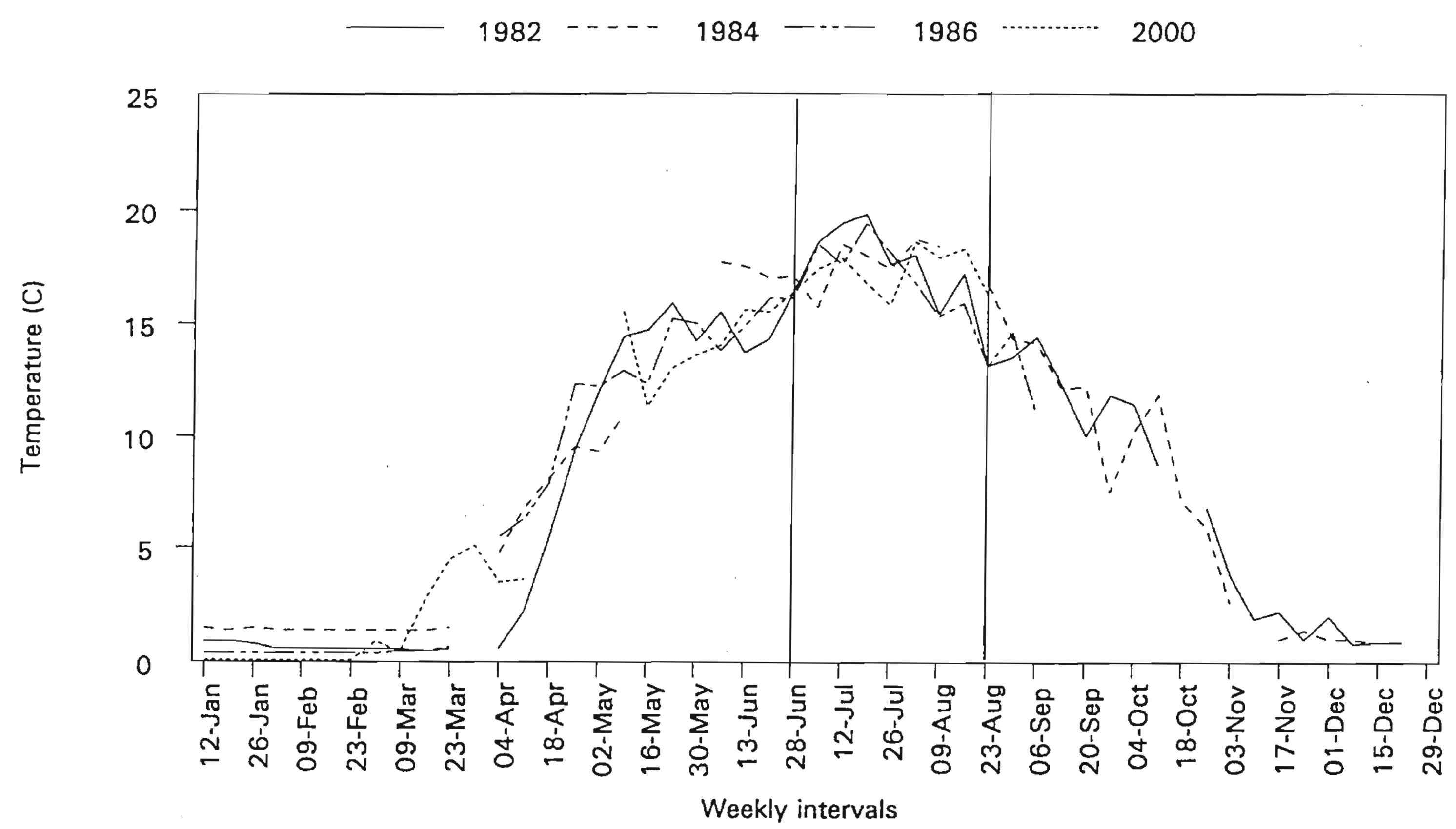


Figure 10. Mean weekly water temperatures at Barlow Lake Road on the No. Br. Pemebonwon River before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).

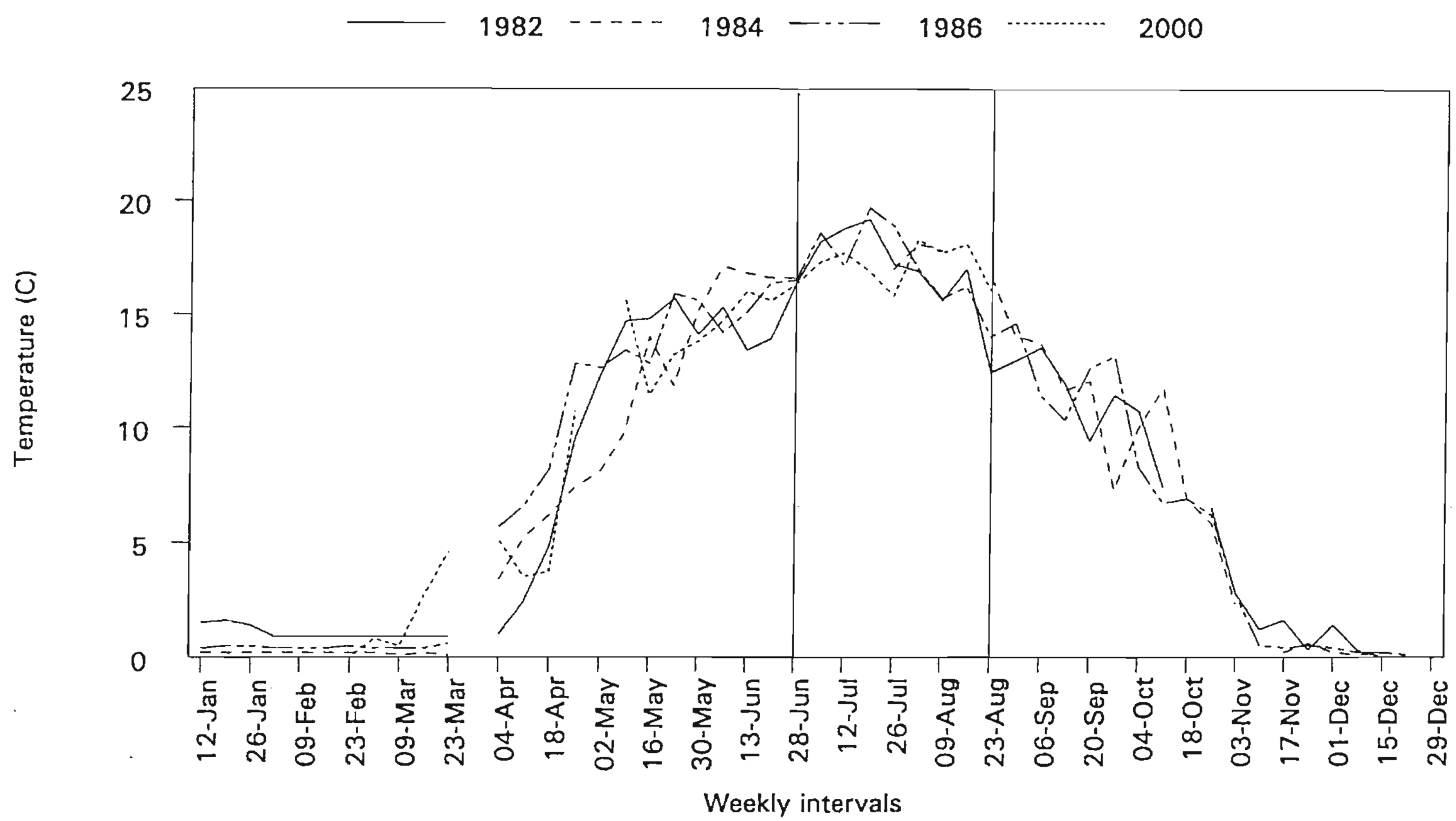
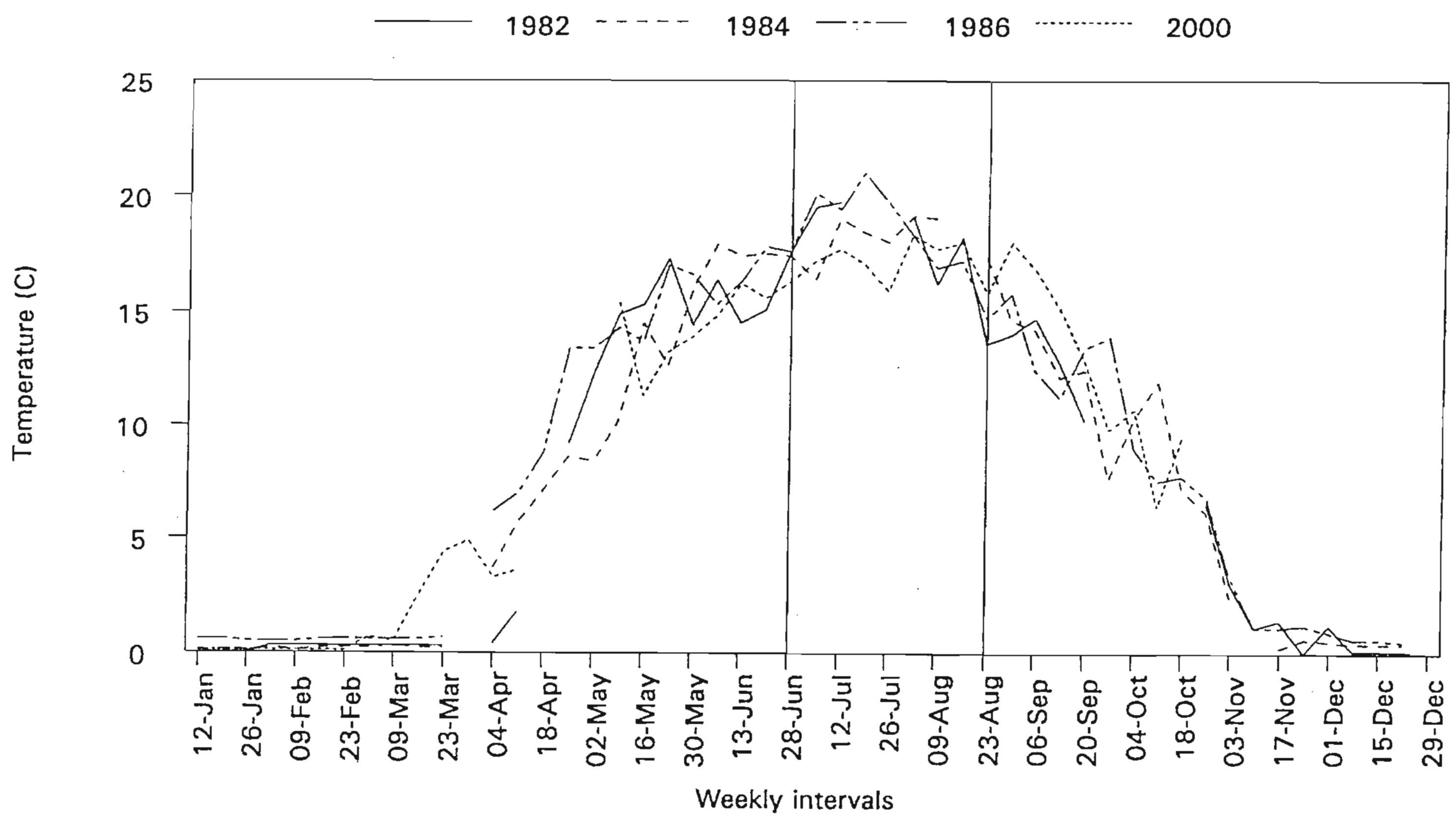


Figure 11. Mean weekly water temperatures at U.S. Hwy 141 on the No. Br. Pemebonwon River before (1982) and after (1984, 1986, and 2000) removal of beaver dams (summer period is bracketed).



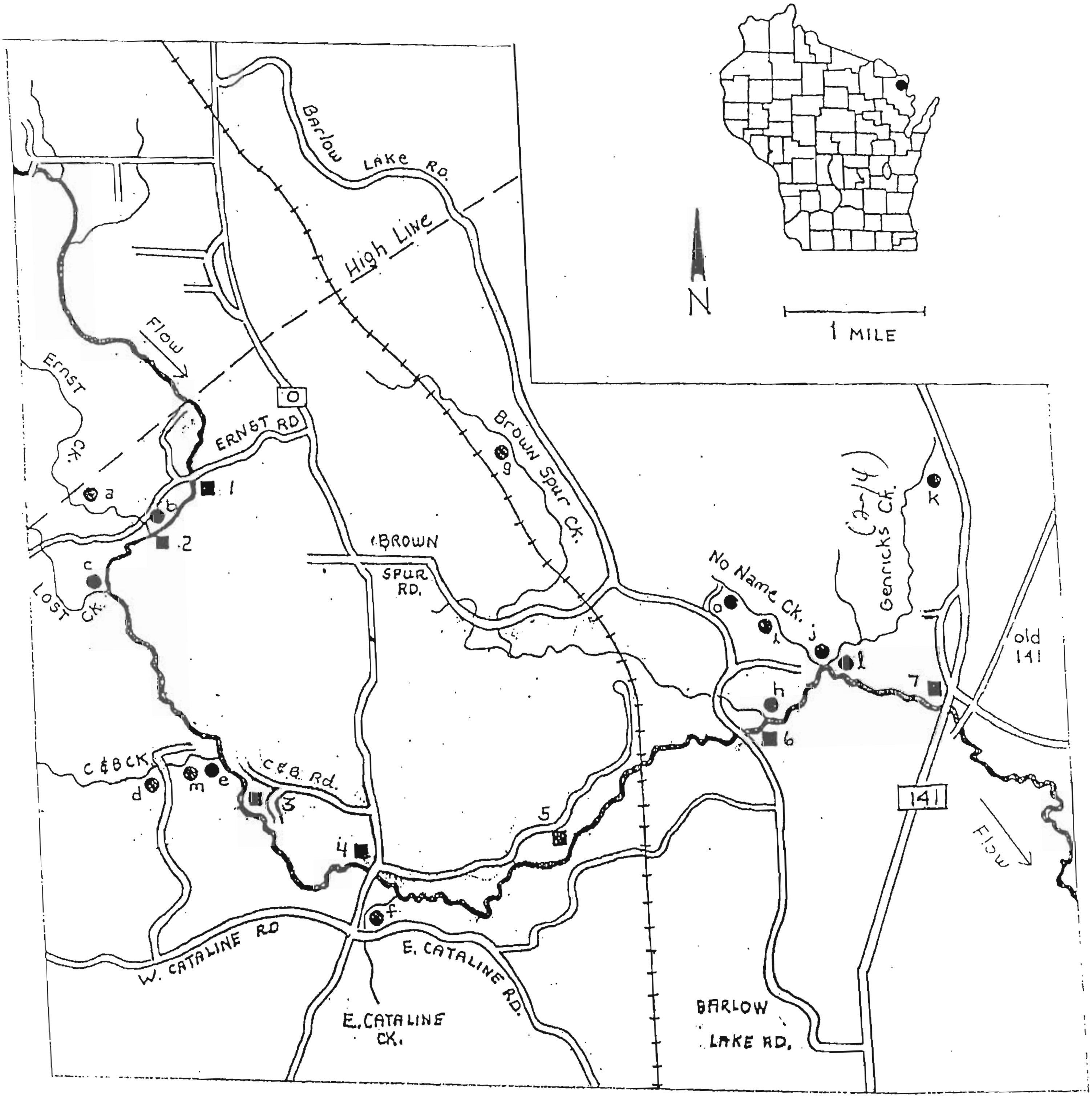


Figure 12. No. Br. Pemebonwon River study area showing fish sampling stations (▩ main stream; ● tributaries).

Figure 13. Spring length frequencies of wild brook trout populations in 2.7 miles of the No. Br. Pemebownwon River sampled the year before (1982) and 18 years after (2000) removal of beaver dams.

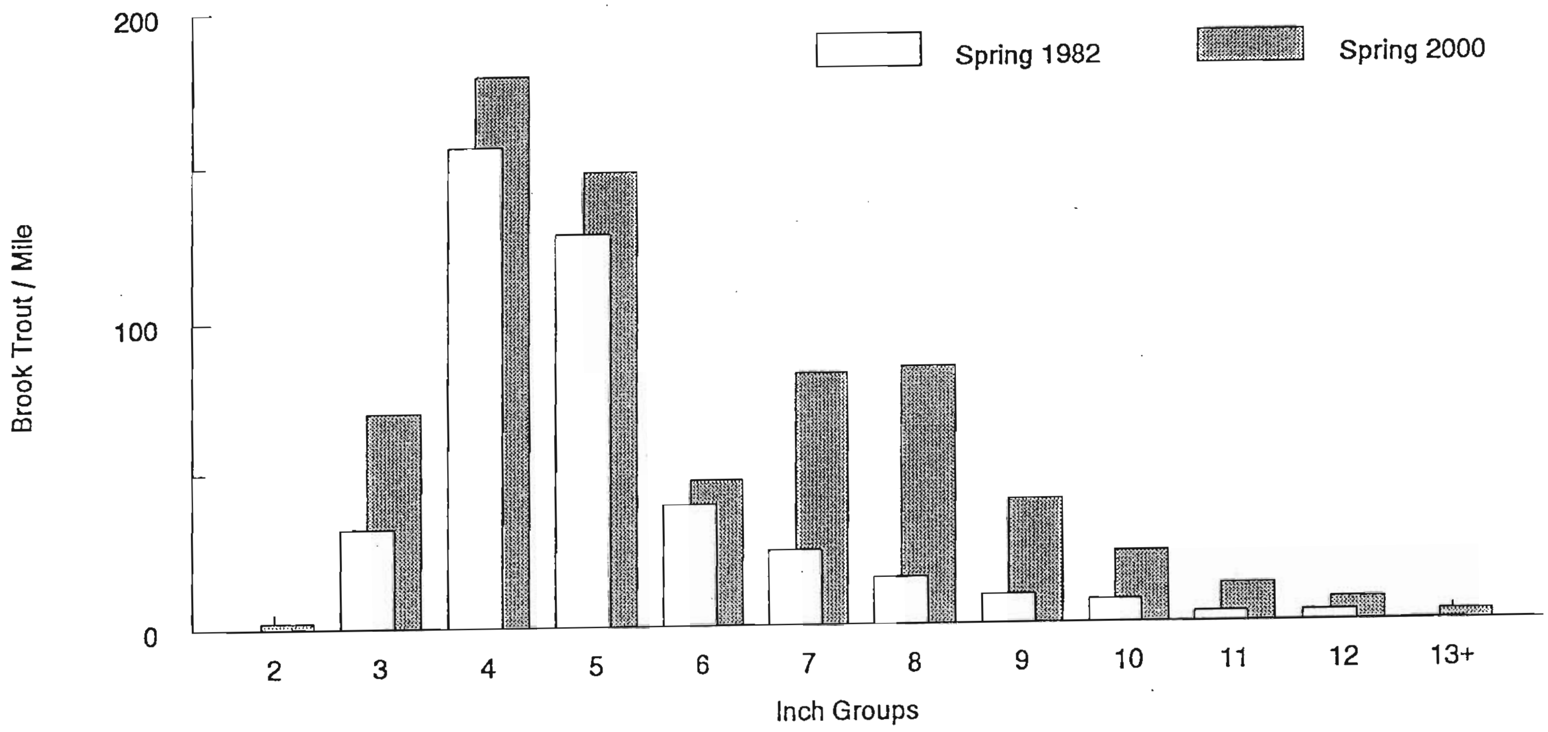


Figure 14. Fall length frequencies of wild brook trout populations in 2.7 miles of the No. Br. Pemebownwon River sampled the year before (1982) and 18 years after (2000) removal of beaver dams.

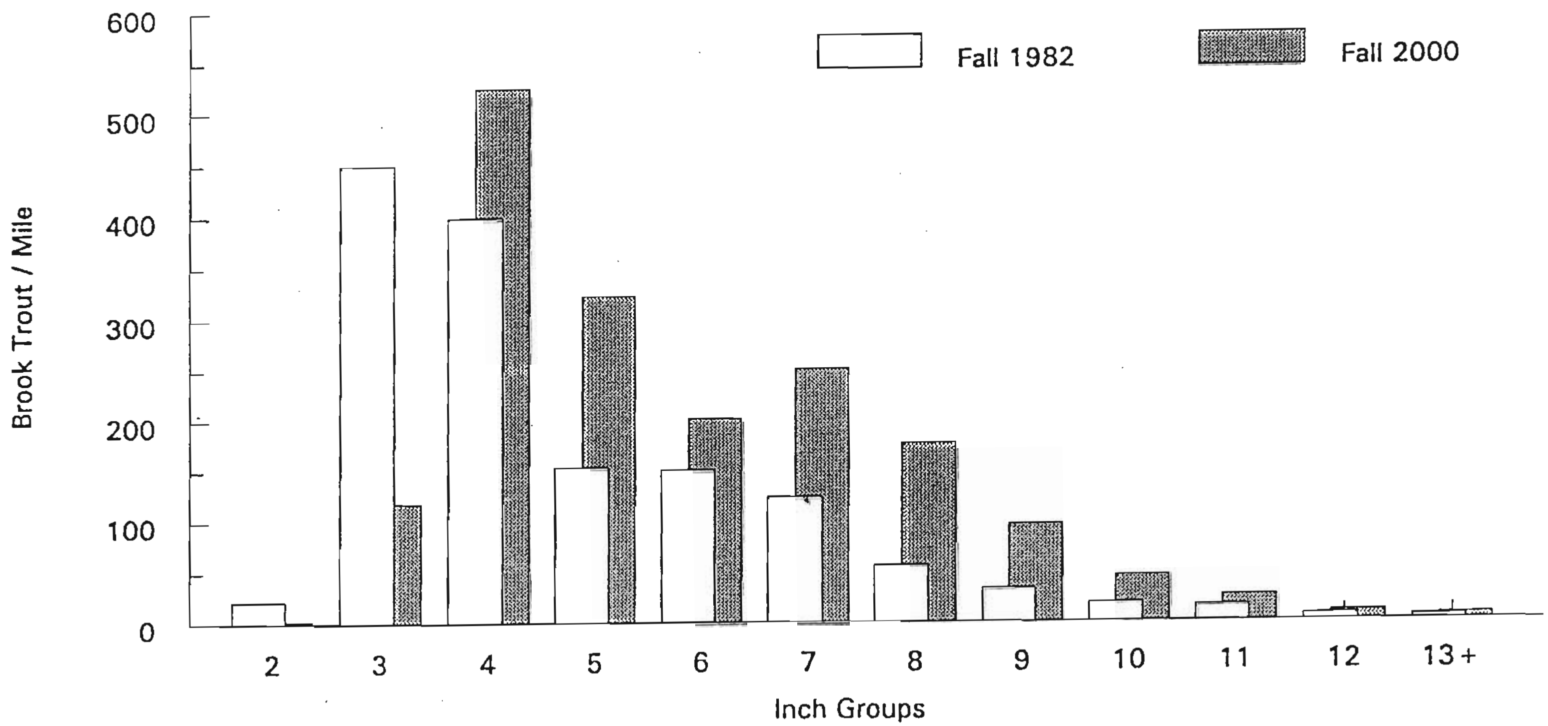


Table 1. Average maximum daily air temperatures (C) from data recorded at the DNR Ranger Station in Wausaukee, WI (summer months are shaded).

Month	YEAR 1982	1984	1986	2000
Jan	-6.7	-4.7	-2.2	-2.1
Feb	-1.6	3.8	-1.6	1.8
Mar	3.0	1.4	6.6	10.7
Apr	12.1	15.2	17.0	12.6
May	23.6	19.7	23.5	21.7
Jun	22.3	26.3	25.2	24.1
Jul	27.1	27.6	28.8	27.0
Aug	24.4	27.8	25.3	26.5
Sep	19.3	20.9	21.4	22.4
Oct	15.4	16.0	15.3	18.1
Nov	5.4	7.5	4.7	7.8
Dec	*	0.1	0.9	-5.3

* insufficient data

Table 2. Monthly and annual precipitation measured in inches at the DNR Ranger Station in Wausaukee, WI (summer months are shaded).

Month	YEAR 1982	1984	1986	2000
Jan	2.1	0.6	0.8	1.5
Feb	0.2	1.8	0.8	1.1
Mar	2.2	1.3	2.5	1.8
Apr	2.2	3.1	2.6	2.4
May	1.5	2.1	1.1	2.4
Jun	3.2	4.8	3.2	4.8
Jul	7.9	3.3	3.6	3.6
Aug	3	4.3	2.6	1.8
Sep	3.8	4	6.8	7.2
Oct	3.6	3.6	2.2	0.7
Nov	3.3	3	1.1	2.5
Dec	3	2.6	0.3	1.2
Totals	36	34.5	27.6	31

Table 3. Weekly mean water temperatures at the mouth of Lost Creek during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given; highest temperatures shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	12	12.9	11.2	12.1
05-Jul	14.7	12.1	12.6	12.3
12-Jul	15.8	14	12.5	13
19-Jul	14.5	13.6	13.4	11.5
26-Jul	*	13.1	12.8	12.1
02-Aug	*	13.7	12.1	13.7
09-Aug	12	14	11.4	13.7
16-Aug	13.4	*	12.9	14.4
23-Aug	10.7	13.2	9.9	12.2

* incomplete data

Table 4. Weekly mean water temperatures at the mouth of Ernst Creek during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on the date given; highest temperatures are shaded).

	YEARS			
Week	1982	1984	1986	2000
28-Jun	16.6	16.1	15.2	14
05-Jul	19.6	15	17.8	14.5
12-Jul	19	17.9	17.6	15.1
19-Jul	19	17.5	18.4	13.6
26-Jul	16.8	16.9	16.6	13.8
02-Aug	17.1	18.9	15.8	15.5
09-Aug	14.2	17.4	14.2	15.4
16-Aug	16	*	14.1	15.8
23-Aug	13.2	16.6	11.4	13.5

*incomplete data

Table 5. Mean weekly water temperatures at the mouth of Cooks & Bullets Creek during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given; highest temperatures are shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	15	14.1	*	13.7
05-Jul	18.4	12.1	*	14.1
12-Jul	18.7	14.2	*	14.7
19-Jul	*	14.4	*	13
26-Jul	*	13.1	*	13.4
02-Aug	*	14.1	14.9	15.3
09-Aug	13.7	13.9	13.7	15
16-Aug	15	*	13.6	15.6
23-Aug	11.7	13.5	11.3	13.1

* incomplete data

Table 6. Mean weekly water temperatures at the mouth of Brown Spur Creek during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given; highest temperatures are shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	17.3	16.7	17.5	14.5
05-Jul	19.2	15.8	20	15.1
12-Jul	18.7	18.4	19.9	15.6
19-Jul	20.1	17.9	20.9	14.9
26-Jul	17.5	17.1	19.5	14.5
02-Aug	17.8	18.5	18.1	16
09-Aug	15.3	17.7	16.9	15.7
16-Aug	16.9	*	17	15.9
23-Aug	13.1	16.8	14.1	13.6

* incomplete data

Table 7. Mean weekly water temperatures at the mouth of No Name Creek during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given; highest temperatures are shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	20.3	16.9	16.7	13.5
05-Jul	22.1	16.2	18.5	14.1
12-Jul	22.4	18.9	18.4	14.7
19-Jul	23.8	18.4	19.5	13.9
26-Jul	*	17.7	18	15.2
02-Aug	23.7	19.3	17.2	15
09-Aug	19	18.2	15.4	15.2
16-Aug	20.2	*	14.6	12.7
23-Aug	15.9	16.7	13.3	*

* incomplete data

Table 8. Mean weekly water temperatures at the mouth of Genrick Creek during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given; highest temperatures are shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	17.8	18.2	17.8	15.4
05-Jul	18.4	16.8	20.4	16.1
12-Jul	16.5	19.7	20.4	16.6
19-Jul	16.3	19.2	20.9	15.3
26-Jul	*	18.5	19.7	15.1
02-Aug	14.4	19.7	18.8	16.9
09-Aug	11.6	19.8	16.9	16.4
16-Aug	13.2	*	17.7	16.5
23-Aug	7.7	18.8	15.1	14.4

* incomplete data

Table 9. Summer differences in mean weekly water temperatures (C) at upstream sites versus downstream sites on No Name and Brown Spur creeks - 1982, 1984, 1986, and 2000 (week begins with date given).

	1982			1983			1984	
Week	No Name	Brown Spur	Week	No Name	Brown Spur	Week	No Name	Brown Spur
			28-Jun	-2.9	0.4	27-Jun	*	0.2
05-Jul	-3.8	-5.2	05-Jul	-3.7	3.5	04-Jul	*	0.8
12-Jul	-4.1	-3.0	12-Jul	-4.2	2.2	11-Jul	*	0.0
19-Jul	-4.8	-5.3	19-Jul	-3.3	0.6	18-Jul	*	0.0
26-Jul	*	-3.5	26-Jul	-3.6	0.4	25-Jul	*	-0.3
02-Aug	-6.8	-0.7	02-Aug	-2.9	-0.8	01-Aug	*	0.4
09-Aug	-5.2	-0.9	09-Aug	-3.0	0.9	08-Aug	*	0.2
16-Aug	-5.7	-0.8	16-Aug	-3.2	1.0	15-Aug	*	0.0
23-Aug	-4.2	-0.6	23-Aug	-3.0	-1.4	23-Aug	*	0.4
Avg.	-4.9	-2.5	Avg.	-3.3	0.8	Avg.		0.2

	1986			2000	
Week	No Name	Brown Spur	Week	No Name	Brown Spur
			24-Jun	-0.4	0.1
28-Jun	-2.5	-3.3	01-Jul	-0.5	0.1
05-Jul	-2.2	-2.8	08-Jul	-0.5	0.1
12-Jul	-2.3	-2.8	15-Jul	-1.6	-0.8
19-Jul	-2.3	-2.7	22-Jul	-1.0	-0.4
26-Jul	-1.9	-2.5	29-Jul	-1.0	0.3
02-Aug	-1.9	-2.1	05-Aug	-0.8	0.2
09-Aug	-1.4	-2.4	12-Aug	-0.3	0.3
16-Aug	-0.8	-2.9	19-Aug	-0.1	0.3
23-Aug	-1.4	-2.2			
Avg.	-1.9	-2.6	Avg.	-0.7	0.0

* No data recorded.

Table 10. Peak mean weekly water temperatures (C) during summer and winter 1982 at the mouths of 6 tributaries to the No. Br. Pemebonwon River and changes in peak mean weekly temperatures after removal of beaver dams in the winter 1983-1983.

	SUMMER (JULY/AUGUST)					WINTER (JANUARY THRU MARCH)				
	Peak	Changes in Peak Temperatures				Peak	Changes in Peak Temperatures			
	Temp.	1983	1984	1986	2000	Temp.	1983	1984	1986	2000
Creek	in 1982.	vs. 1982	vs. 1982	vs. 1982	vs. 1982	in 1982	vs. 1982	vs. 1982	vs. 1982	vs. 1982
Ernst	19.6	3.6	-0.7	-1.2	-3.8	0.1**	0.8	0.6	0.5	2.7
Lost	15.8	*	-1.8	-2.4	-1.4	0.5	1.1	1.1	0.8	2.2
Cooks and Bullets	18.7	-2.1	-3.6	*	-3.1	*				
Brown Spur	20.1	0.6	-1.6	0.8	-4.2	0.4	0.7	0.1	-0.2	2.7
No Name	23.8	-1.2	-4.5	-4.3	-8.6	0.4	-0.2	0.3	1.2	2.1
Genrick	18.4	5.4	1.4	2.5	-1.5	0.5	0.5	0.5	1.2	3.4

* No data recorded.

** 9 February through 29 March only.

Table 11. Mean weekly water temperatures at Emst Road on the Pemonee River during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given; highest temperatures are shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	15.9	17.2	16.8	17.2
05-Jul	20.3	15.7	18.8	18
12-Jul	19.1	18.3	18.5	18.6
19-Jul	20	17.8	19.7	17
26-Jul	17.8	17	18.1	16.2
02-Aug	17.7	18.3	17	19.2
09-Aug	14.6	17.9	15.6	18.5
16-Aug	16.8	*	15.9	18.9
23-Aug	12.3	17.2	13.1	16.8

* incomplete data

Table 12. Mean weekly water temperatures at C.T.H. "O" on the No. Br. Pemebonwon River during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given; highest temperatures are shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	16.4	17.1	16.1	16.4
05-Jul	18.6	15.7	18.5	17.4
12-Jul	19.4	18.5	17.6	17.9
19-Jul	19.8	18	19.4	16.8
26-Jul	17.6	17.4	18.1	15.8
02-Aug	18	18.7	16.8	18.6
09-Aug	15.4	18.4	15.3	17.9
16-Aug	17.2	*	15.9	18.3
23-Aug	13.1	16.7	13.1	16.2

* incomplete data

Table 13. Streamflow (cfs) of the No. Br. Pemebonwon River and 7 tributaries on 24 July and 21 August, 2000 as well as in June or July 1982, 1983, 1984, and 1986.

	2000		1982	1983	1984	1986
Stream	July	August	July	July**	June	June
No. Br. Pemebonwon R.:						
Ernst Rd. (upper site)	3.6	15.9		7.8	10.7	5
U.S.Hwy 141 (lower site)	5.6	21		10.5	20	11.4
Tributaries:						
Ernst Cr.	0.1	0.6	0.6	0.3	0.6	0.2
Lost Cr.	0.2	0.2	0.6	0.9	0.5	0.4
Cooks & Bullets Cr.	0.1	0.3	0.5	0.9	0.6	0.3
E. Cataline Cr.	0.1	0.2	0.2	0.2	0.3	0.1
Brown Spur Cr.	0.3	1.1	3.6	0.8	1.9	0.9
No Name Cr.	N/A*	0.1	0.4	0.1	0.2	0.1
Genricks Cr.	0.1	0.4	0.8	0.8	1.2	0.5
Totals	0.9	2.9	6.7	40	5.3	2.5

* too low to measure
** discharges of the Pemonee River and Ernst and Lost creeks were recorded in June.

Table 14. Mean weekly water temperatures at U.S. Hwy 141 bridge on the No. Br. Pemebonwon River during the summer before (July/August 1982) and during the 2nd, 4th, and 18th summers after removal of beaver dams (week begins on date given;highest temperatures are shaded).

	YEAR			
Week	1982	1984	1986	2000
28-Jun	17.6	17.4	17.6	16.3
05-Jul	19.5	16.4	20.1	17.2
12-Jul	19.7	19	19.4	17.7
19-Jul	*	18.4	21	17.1
26-Jul	*	18	19.7	15.9
02-Aug	19.1	19.1	18.3	18.3
09-Aug	16.2	19	16.9	17.7
16-Aug	18.2	*	17.2	18
23-Aug	13.6	17.3	14.7	15.8

* incomplete data

Table 15. Peak mean weekly water temperatures (C) during summer and winter 1982 at 4 locations on the No Br. Pemebonwon River and changes in peak mean weekly temperatures after removal of beaver dams in the winter 1982-1983.

	SUMMER (JULY/AUGUST)					WINTER (JANUARY THRU MARCH)				
	Peak	Changes in Peak Temperatures				Peak	Changes in Peak Temperatures			
Station	Temp. in 1982.	1983 vs. 1982	1984 vs. 1982	1986 vs. 1982	2000 vs. 1982	Temp. in 1982	1983 vs. 1982	1984 vs. 1982	1986 vs. 1982	2000 vs. 1982
Ernst Rd.	20.3	1.5	-2	-0.6	-1.1	*				
Co. Tk. Hwy. "O"	19.8	2.5	-1.1	-0.4	-1.2	0.9	0.3	0.6	-0.2	3.6
Barlow Lake Rd.	19.2	0.5	-1.1	0.5	-0.9	1.6	-1.1	-1.4	-1.0	3.0
U. S. Hwy. 141	19.8	3.2	-0.7	0.4	-1.4	0.3	0.5	0.0	0.4	4.1

* No data recorded.

Table 16. Length frequency distribution of brook trout population estimates at 7 stations on the No. Br. Pemebonwon River - October 2000 (95% C.I. for the total population is based on sum of variances at all stations).

Inch	STATIONS								
Groups	1	2	3	4	5	6	7	Totals	No./mile
2			2	1		3	6	12	4
3		9	62	128	25	44	58	326	120
4	15	46	351	327	208	250	248	1,445	532
5	37	41	225	129	139	165	97	833	307
6	44	26	50	112	62	164	47	505	186
7	17	33	101	85	116	219	66	637	235
8	31	61	46	37	71	154	34	434	160
9	21	53	25	26	29	64	14	232	85
10	10	23	6	12	20	32	4	107	39
11	6	9	7	7	16	13		58	21
12	1	6	3	3	1	7	5	26	10
13	2	5	1		1	3	3	15	6
14									
15					2			2	1
Totals	184	312	879	867	690	1,118	582	4,632±194	1,706

Table 17. Brook trout population characteristics at 7 locations on the No. Br. Pemebonwon River - Spring and Fall, 2000.

Station Location	SPRING P.E.	SPRING Biomass (lb)	SPRING No./Mile	SPRING No./Mile ≥6 inches	FALL P.E.	FALL Biomass (lb)	FALL No/Mile	FALL No./Mile ≥6 inches
1 - Ernst Rd.	69±29	14.7	202±85	156	184±20	35.8	540±59	387
2 - Junction Ernst Cr.	131±41	20.1	384±120	241	312±27	71.6	915±79	633
3 - Cooks/Bullets Rd.	264±64	58.9	461±112	284	879±47	74.6	1,534±82	417
4 - CTH "O"	566±233	38	1,660±683	431	867±63	73.9	2,543±185	827
5 - Below CTH "O"	205±47	41.4	601±138	411	690±77	89.5	2,023±226	933
6 - Barlow Lake Rd.	419±242	37.6	1,229±708	290	1,118±111	158.6	3,279±326	1,924
7 - U.S. Hwy 141	237±126	32.7	544±290	287	582±111	51.1	1,335±255	397

Table 18. Length frequency distribution of the brook trout population in 2.7 miles (7 stations) on the No. Br. Pemebonwon River - April 2000 (95% C.I. for the total population is based on sum of variances at all stations).

Inch	STATIONS								
Groups	1	2	3	4	5	6	7	Totals	No./mile
2					2	4		6	2
3			6	81	13	67	24	191	70
4	1	10	29	195	25	169	56	485	179
5	15	39	67	143	25	80	32	401	148
6	14	14	23	36	13	7	20	127	47
7	3	21	42	64	23	26	43	222	82
8	16	24	57	30	48	21	31	227	84
9	9	14	22	13	21	20	10	109	40
10	3	5	8	4	18	13	11	62	23
11	5	3	5		10	6	3	32	12
12	3	1	5		4	4	3	20	7
13					3	2	4	9	3
Totals	69	131	264	566	205	419	237	1,891±371	697

Table 19. Length frequency distribution of the brook trout population in 2.7 miles (7 stations) on the No. Br. Pemebonwon River - October 2000 (95% C.I. for the total population is based on sum of variances at all stations).

Inch	STATIONS								
Groups	1	2	3	4	5	6	7	Totals	No./mile
2			2	1		3	6	12	4
3		9	62	128	25	44	58	326	120
4	15	46	351	327	208	250	248	1,445	532
5	37	41	225	129	139	165	97	833	307
6	44	26	50	112	62	164	47	505	186
7	17	33	101	85	116	219	66	637	235
8	31	61	46	37	71	154	34	434	160
9	21	53	25	26	29	64	14	232	85
10	10	23	6	12	20	32	4	107	39
11	6	9	7	7	16	13		58	21
12	1	6	3	3	1	7	5	26	10
13	2	5	1		1	3	3	15	6
14									
15					2			2	1
Totals	184	312	879	867	690	1,118	582	4,632±194	1,706

Table 20. Wild brook trout per mile in the No. Br. Pemebonwon River during spring and fall (percent gain 18 years after beaver dam removal is in parentheses).

Year	SPRING			FALL		
	Total	<7 inches	≥7 inches	Total	<7 inches	≥ 7 inches
1982	417	354	62	1,429	1,174	255
Dams removed (winter 1982-1983)						
1984	590	547	43	940	821	119
1986	349	330	19	1,088	946	142
2000	697 (+67%)	446 (+26%)	251 (+305%)	1,778 (+24%)	1,170 (+0%)	608 (+138%)

Table 21. Population estimates (with 95% confidence intervals) of fishes in five, 100-yard fish community stations sampled in the No. Br. Pemebonwon River in October, 2000.

Species	STATIONS 1	2	3	4	6	TOTALS
Mottled sculpin	176±49	50*	395±273	228±170	524±224	1,373
Blacknose dace	25±17	250±84	1*	86±43	256±53	618
Brook trout	37±11	57±10	137±14	121±13	73±16	425
Creek chub	45±28	20±14	135±68	40±12	10*	250
Central mudminnow	2*	0	1*	51±24	4±3	58
White sucker	10±5	6*	0	10±4	1*	27
Pearl dace	3±0	0	0	24±12	0	27
Common shiner	1*	3*	0	0	0	4
Largemouth bass	1*	0	1*	2±0	0	4
Black crappie	0	0	0	1*	0	1
Brook stickleback	0	0	0	2*	0	2
TOTALS	300	386	670	565	868	2,789

* total number captured; not a population estimate

Table 22. Non-salmonid populations in five, 100-yard fish community stations in the No. Br. Pemebonwon River the year before (1982) and during the 2nd (1984), 4th (1986) and 18th (2000) year after removal of all beaver dams.

Species	Tolerance type*	Year 1982	1984	1986	2000
Mottled sculpin	I	421	598	840	1,373
Blacknose dace	T	53	358	349	618
Creek chub	T	387**	1,209	857	250
Central mudminnow	T	88	707	48	58
White sucker	T	18	32	16	27
Pearl dace	O	16	21		27
Common shiner	O	117	73	70	4
Brook stickleback	O	45	211	21	2
No. redbelly dace	O	6	268	13	
Brassy minnow	O	14	3		
Largemouth bass	O	1			4
Black crappie	O				1
Fathead minnow or	T		4	2	
finescale dace	O				
Totals		1,166	3,484	2,216	2,364

* Tolerance types from Lyons et al. (1996): tolerant (T); intolerant (I); other (O).
** Includes some No. redbelly dace.

Table 23. Fish species, number of fish captured, IBI score, and IBI rating in fish community stations sampled in the No. Br. Pemebonwon River the fall before (1982) and the 4th (1986) and 18th fall (2000) after removal of all beaver dams.

		1982			1986			2000		
Station	Species	Total Number	IBI Score	IBI Rating	Total Number	IBI Score	IBI Rating	Total Number	IBI Score	IBI Rating
1	Brook trout	7			7			27		
	Mottled sculpin	38			67			74		
	Creek chub	36			20			15		
	Blacknose dace	6			9			10		
	Brook stickleback	5			1			0		
	No. redbelly dace	4			3			0		
	White sucker	0			6			6		
	Pearl dace	0			0			3		
	Central mudminnow	1			9			1		
	Common shiner	1			4			1		
	Largemouth bass	1			0			0		
	Total	99	60	Good	126	50	Fair	137	60	Good
2	Brook trout	41			21			45		
	Blacknose dace	15			56			75		
	Brassy minnow	14			0			0		
	Creek chub	10			28			10		
	Mottled sculpin	9			12			24		
	Pearl dace	8			0			0		
	White sucker	6			1			2		
	Common shiner	5			10			1		
	No. redbelly dace	0			1			0		
	Total	108	60	Good	129	50	Fair	157	50	Fair
3	Brook trout	20			38			113		
	Common shiner	55			5			0		
	Mottled sculpin	51			25			64		
	Creek chub	49*			62			57		
	Central mudminnow	13			5			1		
	Brook stickleback	7			3			0		
	White sucker	1			1			0		
	Blacknose dace	0			4			1		
	Largemouth bass	0			0			1		
	No. redbelly dace	0			1			0		
	Total	196	50	Fair	144	60	Good	237	70	Good
4	Brook trout	35			57			95		
	Mottled sculpin	16			17			38		
	Central mudminnow	8			9			22		
	Common shiner	3			1			0		
	Brook stickleback	2			2			0		
	Blacknose dace	1			5			38		
	Pearl dace	1			0			14		
	Creek chub	0			27			26		
	White sucker	0			0			8		
	No. redbelly dace	0			1			0		
	Largemouth bass	0			0			2		
	Black crappie	0			0			1		
	Total	66	80	Good	119	70	Good	244	60	Good
6	Brook trout	13			27			48		
	Mottled sculpin	8			20			118		
	Blacknose dace	1			7			140		
	Central mudminnow	1			1			3		
	Unident.	1			0			0		
	Brook stickleback	0			4			0		
	Creek chub	0			17			5		
	White sucker	0			2			0		
	Common shiner	0			3			0		
	Total	24	**Very Poor		81	69	Good	314	60	Good

* Includes some No. redbelly dace.

** Lyons, et al. (1996) advises not to calculate the IBI if fewer than 25 individuals are captured, and instead to tentatively set the rating at "very poor" pending additional biomonitoring.

Table 24. Brook trout population characteristics in tributaries to the No. Br. Pemebonwon River - Spring and Fall, 2000 (n/s=not sampled).

		SPRING				FALL			
			Biomass		No./Mile		Biomass		No./Mile
Creek	Station	P.E.	(lb)	No./Mile	≥6 inches	P.E.	(lb)	No/Mile	≥6 inches
Ernst	a	6±5	0.4	158	26	n/s			
	b	5±2	0.7	132	79	n/s			
Lost	c	73±28	4.2	643	62	72±15	5.9	634	194
Cooks & Bullets	d	32±16	1.3	563	53	37±7	1.2	651	18
	m	53±11	2.1	699	26	75±5	5.6	989	224
	e	55±16	2.2	484	26	139±17	4.7	1,224	62
E. Cataline	f	17±13	0.4	449	26	6*	0.4	158	26
Brown Spur	g	21±6	1.8	185	53	n/s			
	h	216±28	14.5	1,267	235	327±35	25.9	1,924	694
No Name	i	21±10	0.7	185	0	30±11	1.3	264	35
	o	7±0	0.3	184	0	8±7	0.3	211	26
	j	77±12	2.6	678	9	71±11	1.5	625	0
Genrick	k	1*	<0.1	9	0	0	0	0	0
	l	79±22	7.6	694	229	49±13	2.1	431	79

* Number captured; not a population estimate.

Table 25. Wild brook trout per mile in tributaries of the No. Br. Pemebonwon River sampled 1 year before (1982) and 2 (1984), 4 (1986), and 18 (2000) years after removal of beaver dams (n/s=not sampled).

		SPRING				FALL			
Stream	Station	1982	1984	1986	2000	1982	1984	1986	2000
Ernst Cr.	a	0	n/s	132	158	n/s	n/s	n/s	n/s
	b	0	132	26	132	n/s	n/s	n/s	n/s
Lost Cr.	c	150	211	326	643	880	642	1,743	634
Cooks & Bullets Cr.	d	0	53	18	563	0	246	70	651
	e	176	123	88	484	643	704	1,197	1,224
East Cataline Cr.	f	185	370	79	449	368	475	818	158
Brown Spur Cr.	g	0	n/s	35	185	n/s	n/s	n/s	n/s
	h	411	88	241	1,267	376	316	411	1,924
No Name Cr.	i	0	n/s	158	185	0	26	18	264
	j	0	9	0	678	0	71	194	625
Genrick Cr.	k	0	n/s	9	9	0	0	0	0
	l	0	26	70	694	9	167	264	431

Table 26. Population estimates (with 95% confidence intervals) of fishes in 9 fish community stations on 5 tributaries to the No. Br. Pemebonwon River - October 2000.

	Lost	Cooks & Bullets			E.Cataline	No Name		Genrick		Totals
Species	c	d	e	M	f	i	j	k	l	
Brook trout	29±9	17±5	41±0	42±0	2*	8±7	40±8	0	30±8	209
Central mudminnow	0	10±8	14±11	33±24	33±31	1*	4±3	10*	21±20	126
Creek chub	0	4±2	52±30	7±4	1*	0	0	3±0	20±10	87
Blacknose dace	0	0	2*	0	0	0	0	2±0	46±45	50
Brook stickleback	0	0	0	0	0	0	0	34±7	0	34
Pearl dace	0	1±0	2*	0	0	0	0	18±4	1*	22
No. redbelly dace	0	0	0	0	0	0	0	10±0	0	10
Mottled sculpin	0	0	0	0	0	0	3±1	0	4±3	7
Largemouth bass	0	0	0	0	1*	0	0	0	0	1
Totals	29	32	111	82	37	9	47	77	122	546

* Number captured; not a population estimate.

Table 27. Fish species, numbers of fish captured, IBI scores, and IBI ratings in stations sampled on tributaries to the No. Br. Pemebonwon River - October 2000

Creek	Station	Species	Number Captured	IBI Score	IBI Rating
Lost	c	Brook trout	20		
		Total	20	90	Excellent*
C & B	d	Brook trout	13		
		Central mudminnow	5		
		Creek chub	3		
		Pearl dace	1		
		Total	22	60	Good*
	m	Brook trout	42		
		Central mudminnow	11		
		Creek chub	5		
		Total	58	60	Good
	e	Brook trout	41		
		Central mudminnow	7		
		Creek chub	26		
		Blacknose dace	1		
		Pearl dace	2		
		Total	77	60	Good
E. Cataline	f	Brook trout	1		
		Central mudminnow	11		
		Creek chub	1		
		Largemouth bass	1		
		Total	14	30	Fair*
No Name	i	Brook trout	4		
		Total	4	90	Excellent*
	j	Brook trout	32		
		Central mudminnow	3		
		Mottled sculpin	2		
		Total	37	90	Excellent
Genrick	k	Central mudminnow	2		
		Creek chub	3		
		Blacknose dace	2		
		Pearl dace	2		
		N. redbelly dace	4		
		Brook stickleback	15		
		Total	28	10	Poor
	l	Brook trout	21		
		Central mudminnow	7		
		Creek chub	12		
		Blacknose dace	13		
		Mottled sculpin	2		
		Total	55	50	Fair

* Lyons, et al. (1996) suggests listing the IBI as "very poor" when less than 25 fish are collected (pending additional biomonitoring). These IBI ratings are based on fewer than 25 fish but in such small streams are considered more appropriate than a "very poor' rating.

Table 28. Fish populations in 8 fish community stations in 5 tributaries to the No. Br. Pemebonwon River the year before (1982), and during the 2nd (1984), 4th (1986), and 18th (2000) years after removal of all beaver dams.

Species	Tolerance type*	Year 1982	1984	1986	2000
Brook trout	I				
Central mudminnow	T	86	124	50	126
Creek chub	T	237**	387***	489	87
Blacknose dace	T	30	223	154	50
Brook stickleback	O	70	631	145	34
Pearl dace	O	28+	13	16	22
No. redbelly dace	O	135	432	227	10
Mottled sculpin	I	3	13	0	7
Largemouth bass	O	0	0	0	1
Brassy minnow	O	2	26	10	0
Fathead minnow	T	1	28+	1	0
Common shiner	O	0	17	459	0
White sucker	T	0	2	23	0
Finescale dace	O	0	0+	1	0
Totals		592	1,896	1,575	546

* Tolerance types from Lyons et al. (1966); tolerant (T); intolerant (I); other (O).
** Includes a few pearl dace.
*** Includes a few fathead minnows and finescale dace.

Table 29. Fish captured, IBI scores, and IBI ratings in 8 stations sampled on 5 tributaries to the No. Br. Pemebonwon River during fall - 1982, 1984, 1986, and 2000.

Stream	Lost Creek							
Station	c							
Year	1982	1984	1986	2000				
Fish Captured	18	44	39	20				
IBI Score	80	40	90	90				
IBI Rating	Good*	Fair	Excellent	Excellent*				
Stream	Cooks and Bullets Creek							
Station	d				e			
Year	1982	1984	1986	2000	1982	1984	1986	2000
Fish Captured	25	51	43	22	74	103	42	78
IBI Score	10	40	60	60	80	40	50	60
IBI Rating	Poor	Fair	Good	Good	Good	Fair	Fair	Good
Stream	East Cataline Creek							
Station	f							
Year	1982	1984	1986	2000				
Fish Captured	15	27	78	14				
IBI Score	50	50	40	30				
IBI Rating	Fair	Fair	Fair	Fair				
Stream	No Name Creek							
Station	i				j			
Year	1982	1984	1986	2000	1982	1984	1986	2000
Fish Captured	55	61	14	4	50	65	62	37
IBI Score	10	30	10	90	10	40	30	100
IBI Rating	Poor	Poor	Poor*	Excellent*	Poor	Fair	Fair	Excellent
Stream	Genrick Creek							
Station	k				l			
Year	1982	1984	1986	2000	1982	1984	1986	2000
Fish Captured	28	243	0	28	47	156	166	55
IBI Score	10	30	-	10	10	50	30	50
IBI Rating	Poor	Fair	-	Poor	Poor	Fair	Fair	Fair

* This IBI rating is based on fewer than 25 fish but is considered more appropriate than the "very poor" rating recommended by Lyons et al. (1996) when sample size is less than 25 fish.

Table 30. Characteristics of the 2000 trout sport fishery on the No. Br. Pemebonwon River.

Month	Angler Hours	Catch per hour	Harvest per hour	Brook Trout Harvest Wild	Brook Trout Harvest Domestic	Brook Trout Harvest Total
May: Opening Wkend	349	2.4	1.3	275	168	443
Remain. Wkends/holidays	649	1.5	0.7	615*	572*	453
Wkdays	532	3.1	1.4			734
June: Wkends/holidays	232	2.8	0.7	236*	291*	171
Wkdays	247	2.6	1.4			356
July: Wkends/holidays	107	1.6	0.6	77*	72*	68
Wkdays	192	2.3	0.4			81
Aug : Wkends/holidays	108	4.3	0.9	123*	41*	96
Wkdays	138	1.7	0.5			68
Sep : Wkends/holidays	60	2.5	0			
Wkdays	317	2.9	1.5	390	83	473
Totals	2,931			1,716	1,227	2,943
Season Avg.		2.5	0.9			
Hours/acre	102					
Harvest/mile				175	125	300

* Indicates combined harvest for wkend/holidays and wkdays.

Table 31. Estimated fishing pressure (hr/acre) and brook trout harvest (no/mile) on the No. Br. Pemebonwon River before and after removal of beaver dams in the winter of 1982-1983.

	YEAR			
	1982	1984	1986	2000
Pressure:	90	88	47	102
Harvest:				
Wild	104	101	4	175
Domestic	122	171	100	125
Totals	**226**	**272**	**104**	**300**

Table 32. Percent age composition of angler harvested wild brook trout from the No. Br. Pemebonwon River during the 1982, 1984, 1986, and 2000 fishing seasons.

	1982				1984			1986		2000			
Month	I	II	III	IV	I	II	III	I	II	I	II	III	IV
May	16	66	16	2	-	98	2	-	100	1	71	27	1
June	78	20	2	-	60	40	-	-	-	5	86	7	2
July	44	39	17	-	75	25	-	-	-	7	79	2	-
August	72	20	8	-	100	-	-	-	-	50	45	5	-
September	78	22	-	-	87	13	-	60	40	50	50	-	-
Season Totals	50	40	10	<1	40	59	1	25	75	9	71	18	1