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DEPARTMENT OF NATURAL RESOURCES

RESEARCH

REPORT 76

DEC. 1974

EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT AT WESTFIELD CREEK

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INTRODUCTION

In June, 1967 the 32-acre Westfield Millpond in the Town of Westfield was drawn down to stream channel to facilitate installation of a new waterwheel by the Westfield Milling and Electric Light Company. While the millpond was down, the Bureau of Fish Management treated 3.6 miles of Westfield Creek from the dam on Lawrence Lake to the downstream dam on Westfield Millpond with antimycin. Treatment was primarily aimed at removing the abundant carp population which had brought about a decline in the sport fishery for largemouth bass and bluegill in the Westfield Millpond. The stream segment itself contained a few largemouth bass and "panfish" but at best received only a few hours of fishing pressure each year. Chemical treatment was believed to be 100% successful with the total weight of fish being picked up approximating 23,000 pounds: 95% carp, 4.5% suckers and 0.5% other fish (Primising, pers. comm.).



Westfield Creek

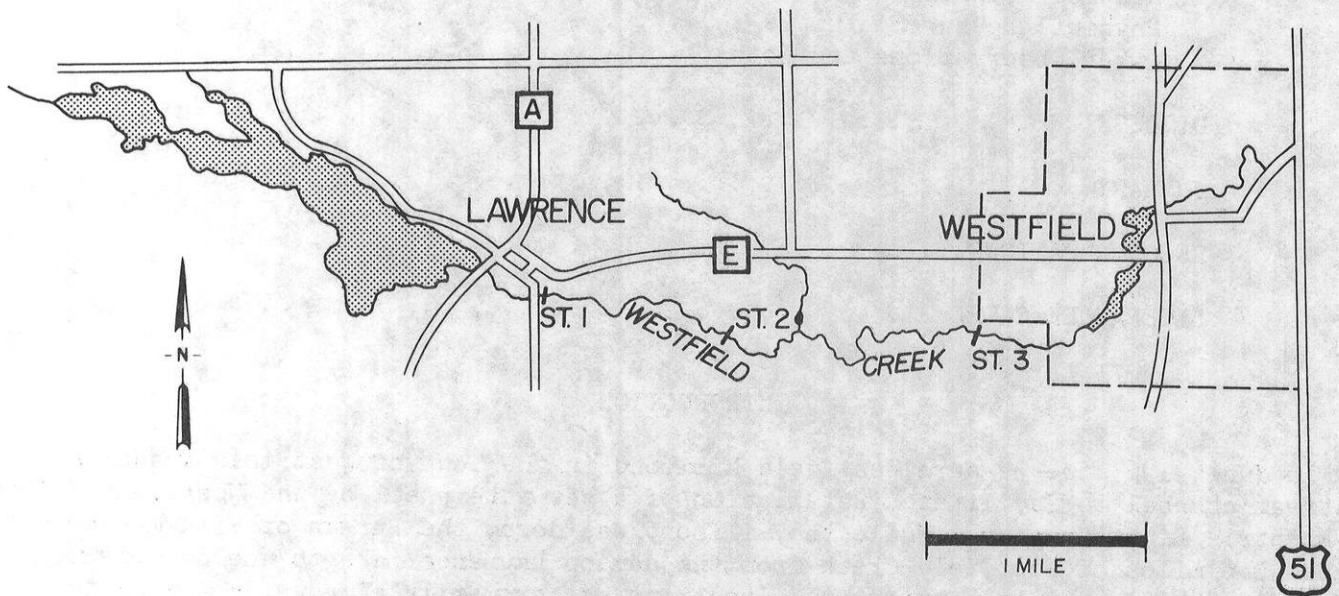


FIGURE 1. Study area of Westfield Creek showing location of "minnow" stations.

Concurrent with the chemical treatment of Westfield Creek, the Bureau of Research was beginning a study concerning rehabilitation of trout streams, the overall objective being to quantitatively evaluate chemical treatment as a trout management tool. Although quantitative pretreatment data about the fishery and fish populations in Westfield Creek were lacking, there remained the opportunity to monitor growth and survival of stocked trout and the resurgence of undesirable fishes in a stream which lacked trout and provided very little sport fishing prior to chemical treatment. Millponds are common on central Wisconsin trout streams and information collected during this study would also be of value to future management efforts on similar segments of other streams.

STUDY AREA

The 3.6-mile segment of Westfield Creek originates at the outlet of Lawrence Lake in northwestern Marquette County and terminates at the downstream dam on Westfield Millpond (Fig. 1). Both dams are owned by the Westfield Milling and Electric Light Company. Average discharge from the Lawrence Lake dam is 25 cfs, but stream flow fluctuates greatly due to frequent releases of large amounts of water at Lawrence to generate electricity to meet local demands. Flow is also augmented from several small sources of groundwater entering in the first 0.5 mile of stream below the dam and from a small impounded tributary entering approximately midway between Lawrence and Westfield.

Average width of Westfield Creek is 35 feet and few holes exceed 5 feet in depth. Substrate is primarily sand with occasional pockets of gravel and short stretches of hard-pan clay. Fallen trees and undercut banks provide adequate hiding cover for fish.

The water is moderately hard with a total alkalinity of 170 mg/l CaCO_3 , a pH of 8.5 and specific conductance of 290 micromhos/cm at 25°C. Water color is usually clear unless large amounts of water are being released from the Lawrence Lake dam; at such times the water becomes slightly cloudy.

METHODS

Trout Stocking

Domestic rainbow trout and both domestic and wild brown trout were stocked in Westfield Creek during 1967-1971 (Table 1). Trout were floated down and released at intervals throughout the 3.6 miles of stream on each stocking date. Prior to release, 10% of each group of trout were measured to the nearest 0.1 inch and weighed to the nearest 1.0 gram to determine their average length and weight, respectively. Wild brown trout came from Emmons Creek in southeastern Portage County, Wisconsin, where slow growth is characteristic of the resident brown trout population. Domestic trout came from the DNR state fish hatchery at Wild Rose, Wisconsin.

Trout Population Estimates

During the spring, summer and fall of 1968-1970 and the fall of 1971, Petersen mark and recapture studies were made on the trout population in the 3.6-mile study area. A stream shocker boat equipped with a 230 volt, DC generator was used to capture trout. Trout captured on the marking run were measured to the nearest 0.1 inch, weighed to the nearest gram and given a temporary finclip. On the recapture run, trout were identified by their finclips, measured and released. Population estimates were calculated using the Baily (1951) modification of the Petersen mark and recapture formula. Clopper and Pearson's charts for binomial distribution as presented by Adams (1951) were used to determine the 95% confidence limits of each population estimate.

Nontrout Population Estimates

In 1968, three 100-meter sections of Westfield Creek were selected in which to determine the return and subsequent build up of nontrout fishes (Fig. 1). Within each section, stream width was measured every 10 meters to determine average width and thus total surface area. Petersen mark and recapture studies were conducted each fall during 1969-1971. Fish captured on the marking run were given a temporary caudal finclip to permit subsequent identification on the recapture run. Whenever possible, at least 50 of each fish species were measured to the nearest 0.1 inch and weighed to the nearest gram. Population estimates and confidence intervals were attempted using the same methods employed in the trout studies.

In the fall of 1973, estimates of the nontrout fishes in the upper two sections were attempted using the successive removal technique. With this method, successive catches are plotted against the previous cumulative catch and the X intercept represents the initial population (Libosvasky 1966). Each station was blocked with seines and two successive removals were made.

Trout Growth Studies

Two 300-meter sections of Westfield Creek were electrofished on 29 July, 26 August, and 25 October 1968 to gather growth information about trout stocked on 1 July 1968. One section was located near the middle of the 3.6-mile study area while the other section was near the upper end. Both 300-meter sections were electrofished again on 21 November 1969, and 30 January 1970, to obtain growth information on trout stocked in October, 1969.

Creel Census

A partial creel census was conducted on Westfield Creek during the 1970 trout season. Census days included the first 8 days of the season, all holidays* and at least one of each normal weekday per month. On each census day a vehicle count was made every 3 hours from 6:30 a.m. to 6:30 p.m. and again at 8:30 p.m. A conscientious effort was made to contact all anglers associated with each vehicle and to complete a creel census card (Table 11). Creeled trout were examined for identifying finclips and measured to the nearest $\frac{1}{4}$ inch.

Fishing pressure and harvest statistics were calculated separately for opening weekend, weekend days and weekdays. Holidays were considered as weekend days. Estimated pressure and harvest statistics were computed using the following formula:

$$\frac{X}{100} = \frac{\text{Observed No. trout creeled during each category (weekends, etc.)}}{\text{Percentage of days censused within each category}}$$

Totals for each category were summed to obtain monthly totals; monthly totals were summed to get season totals.

Trout Food Habits

Stomachs from 62 angler caught trout were collected during the 1970 trout season on Westfield Creek and their contents examined. These 62 stomachs included 18 from age I brown trout stocked as age 0 fish in October, 1969; 25 from age I rainbow trout also stocked as age 0 fish in October, 1969; 12 from age II brown trout stocked as age 0 fish in July, 1968; 1 from an age II rainbow trout stocked as an age 0 fish in July, 1968; and 6 from wild age III trout stocked as age I fish in July, 1968.

* Mother's Day, Armed Forces Day, Memorial Day, Flag Day, Father's Day, Independence Day and Labor Day.

Physical Measurements

Water temperatures of Westfield Creek were recorded during 1968-1970 at both upper and lower extremities of the 3.6-mile study area using either 8-day or 45-day Ryan thermographs. Stream flow was measured at the upper thermograph station using a pigmy Gurley meter. Water level was recorded weekly from a staff gauge also installed at the upper thermograph station.

RESULTS

Trout Growth and Survival

Fall Stock, 1967. Age 0 domestic brown trout stocked as 6.0-inch fish in Westfield Creek on 19 September 1967 averaged 9.1 inches on 20 April 1968. Growth was 3.1 inches overwinter (Table 2). Average weight in April was 163 grams which represented an increase of 118 grams or 2.6 times their initial weight overwinter. Overwinter survival was 61%.

In mid-September, 1968, age I brown trout averaged 11.2 inches and 268 grams (Table 2). Growth between April and September 1968, was 2.1 inches and 105 grams. Average growth during the first year in Westfield Creek was 5.2 inches and 253 grams. Survival at the end of this time was 22%.

Age II brown trout averaged 12.4 inches on 27 March 1969. Growth was 1.2 inches overwinter (Table 2). Average weight in March was 378 grams or a gain of 110 grams overwinter. Overwinter survival as Age I trout was 41% compared to the 61% overwinter survival as age 0 trout. Survival of this lot of brown trout since being stocked in Westfield Creek was 9%.

On 1 October 1969, age II brown trout averaged 15.6 inches and 825 grams (Table 2). Growth since 27 March was 3.2 inches and 447 grams; the latter representing a gain of 1.2 times their initial weight during the 6-month period. Average growth of brown trout during two years in Westfield Creek was 9.6 inches and 780 grams. Survival of these trout after two years was 3%.

In April, 1970 approximately 2% of the fall, 1967 stock of brown trout remained in Westfield Creek (Table 2). Although few in number, these age III trout averaged 15.9 inches and 974 grams and offered great "trophy" appeal to the angler. In mid-September, 1970, less than $\frac{1}{2}\%$ of the fall, 1967 stock remained in Westfield Creek and this was the last time any survivors were captured. The 5 age III brown trout captured in September averaged 17.4 inches and 1103 grams.

Fall Stocks, 1969. Age 0 domestic rainbow trout and brown trout stocked in Westfield Creek on 6 October 1969 averaged 4.4 inches and 4.3 inches, respectively (Table 3). Domestic brown trout were hatchery "runts" and smaller rainbow trout were therefore selected to minimize the size advantage of one species over the other. Age 0 wild brown trout stocked on 13 October 1969, averaged 3.8 inches or 0.5 inch smaller than domestic brown trout and 0.6 inch smaller than the domestic rainbow trout introduced one week earlier.

Growth studies conducted in November, 1969 and February, 1970, indicated that domestic rainbow trout were growing faster than domestic brown trout and both domestic rainbow trout and brown trout were growing faster than wild brown trout (Fig. 5).

On 6 April 1970 domestic rainbow trout, domestic brown trout and wild brown trout averaged 6.2 inches, 5.8 inches and 4.8 inches, respectively (Tables 3 and 4). Average weights were 40 grams, 37 grams and 18 grams, respectively. Growth between October, 1969 and April, 1970 was 1.9 inches and 25 grams for domestic rainbow trout, 1.4 inches

and 21 grams for domestic brown trout, and 1.0 inch and 9 grams for wild brown trout. Survival was 53% for domestic rainbow trout, 44% for domestic brown trout and 65% for wild brown trout.

Rainbow trout grew faster than domestic and wild brown trout between April and July 1970, but both domestic and wild brown trout grew faster than rainbow trout between July and September (Tables 3 and 4). On 15 September 1970 age I domestic rainbow trout, domestic brown trout and wild brown trout averaged 9.6 inches, 9.4 inches and 7.9 inches, respectively. Average weights of domestic rainbow trout, domestic brown trout and wild brown trout were 144 grams, 142 grams and 82 grams, respectively. Rainbow trout grew 3.4 inches and 104 grams between April and September 1970; domestic brown trout grew 3.6 inches and 105 grams; wild brown trout grew 3.1 inches and 64 grams.

Growth during their first 11 months in Westfield Creek was 5.3 inches and 129 grams for rainbow trout, 5.0 inches and 126 grams for domestic brown trout and 4.1 inches and 73 grams for wild brown trout. Survival, after 11 months, was 7% for rainbow trout, 19% for domestic brown trout and 54% for wild brown trout.

In October, 1971, 27 domestic brown trout and 116 wild brown trout were all that remained of the fall, 1969 stocks of trout. No rainbow trout were captured. Age II domestic brown trout averaged 14.7 inches and 591 grams (Table 3). Age II wild brown trout averaged 12.3 inches and 326 grams (Table 4). Survival of domestic and wild brown trout after two years in Westfield Creek was 1% and 26%, respectively.

Summer Stocks, 1968. Age 0 domestic rainbow trout and brown trout stocked in Westfield Creek on 1 July 1968 averaged 5.3 inches and 4.7 inches, respectively (Table 5). Wild age I brown trout stocked at the same time averaged 4.8 inches (Table 6). Growth studies conducted on 29 July and 26 August indicated that trout grew slowly in July and more rapidly in August (Fig. 6). Average lengths of trout captured in the August samples were greater than or equal to the corresponding average lengths of trout captured 2½ weeks later in the entire stream. Growth of trout in the two sections of stream samples was therefore not representative of growth in the entire stream but was positively biased.

On 10 September 1968 age 0 domestic rainbow trout averaged 6.8 inches and 59 grams; age 0 domestic brown trout averaged 5.8 inches and 40 grams; and wild age I brown trout averaged 6.0 inches and 37 grams (Tables 5 and 6). Growth of domestic rainbow trout, domestic brown trout and wild brown trout during the first 9 weeks in Westfield Creek was 1.5 inches and 34 grams, 1.1 inches and 23 grams and 1.2 inches and 19 grams, respectively. Survival of age 0 domestic rainbow trout and age 0 domestic brown trout was similar at 23% and 22%, respectively, while survival of wild age I brown trout was 68%.

Growth studies conducted on 24 October 1968 indicated that significant growth of all trout occurred during the 6 weeks after closing of the general trout season on 15 September and that both growth and average size of domestic brown trout had surpassed the growth and average size of wild brown trout (Fig. 6).

On 27 March 1969, approximately six weeks before the general trout fishing season opened, age I domestic rainbow trout averaged 9.6 inches and 170 grams; age I domestic brown trout averaged 8.7 inches and 128 grams; and age II wild brown trout averaged 8.4 inches and 101 grams (Tables 5 and 6). Overwinter growth (September-March) of age I rainbow trout, age I brown trout and age II wild brown trout was 2.8 inches and 111 grams, 2.9 inches and 88 grams, and 2.4 inches and 64 grams, respectively. Total growth of rainbow trout in the 9 months since being stocked was 4.3 inches and 145 grams. Corresponding growth of domestic and wild brown trout was 4.0 inches and 111 grams and 3.6 inches and 83 grams, respectively. Overwinter survival of rainbow trout, domestic

brown trout and wild brown trout was 48%, 56% and 62% respectively. Total survival 6 weeks before the trout season was 11% for age I rainbow trout, 12% for age I brown trout and 42% for wild age II brown trout.

On 5 April 1970, 21 months after their introduction and 5 weeks before entering their second fishing season, age II domestic rainbow trout averaged 14.1 inches and 597 grams; age II domestic brown trout averaged 14.5 inches and 694 grams; and wild age III brown trout averaged 12.4 inches and 342 grams (Tables 5 and 6). Survival of these domestic rainbow trout, domestic brown trout and wild brown trout in Westfield Creek was 1%, 2% and 21%, respectively.

On 15 September 1970 after 2 years $2\frac{1}{2}$ months in Westfield Creek, less than $\frac{1}{4}\%$ of the 2,000 rainbow trout and approximately 1% of the 2,000 brown trout stocked in July, 1968 remained (Table 5). In contrast, 13% of the 876 wild brown trout stocked in July, 1968 were present and approximately 6% still remained as age IV trout on 1 October 1971 after $3\frac{3}{4}$ years in the stream (Table 6).

Spring Stock, 1971. Age 0 brown trout stocked as 2.2 inch fish on 26 April 1971 averaged 6.2 inches and 45 grams on 1 October 1971. Growth between April and October was 4.0 inches and 43 grams. Survival was 21%.

Trout Harvest, 1970

During the partial creel census conducted in 1970, 107 anglers made 142 fishing trips, exerted 346 hours (28 hr/acre) of fishing pressure and caught 155 rainbow trout and 61 brown trout. The catch ratio was 0.6 trout/hr. Anglers interviewed on completion of their fishing trips and those interviewed while still fishing had catch ratios of 0.6 and 0.5 trout/hr, respectively.

During the first 8 days of the 1970 trout season, which included two Saturdays, 17% of the census effort was exerted, 64% (139) of the creeled trout were recorded and 54% (188 hr) of the fishing pressure was exerted. Twenty-six of the 139 trout examined during the first 8 days of the trout season were between 15-20 inches in length and 13 of them were over $16\frac{1}{2}$ inches.

During May, which included the first 22 days of the trout season, 34% (16 days) of the census effort was expended, 81% (174) of the creeled trout were recorded, and 67% (233 hr) of the fishing pressure exerted. Of the trout creeled, 78% (136) were rainbow, 17% (29) were domestic brown trout and 5% (9) were wild brown trout.

During the entire 1970 trout season on Westfield Creek, 71% (154) of the trout creeled were domestic rainbow trout, 24% (52) were domestic brown trout and 5% (10) were wild brown trout.

Local fishermen (residing within 10 miles) accounted for 32% (46) of the fishing trips to Westfield Creek during 1970. Only 3% (4) of the trips were made by out-of-state anglers. Twenty-three anglers made 29% (41) of the fishing trips, exerted 34% (117 hr) of fishing pressure and caught 75% (163) of the trout creeled. The average fishing trip on Westfield Creek was 2.4 hours in duration and 25% (25) of the anglers made return visits to the stream.

Expansion of the partial creel census data for the number of trout creeled and for the amount of angler use in 1970 yielded a total season catch of 237 rainbow trout, 92 domestic brown trout and 15 wild brown trout in 269 angler trips and 648 hours (52 hr/acre) of fishing pressure. Of the fall, 1969 stocks of domestic trout, 63 brown trout and 185 rainbow trout were captured. None of the wild brown trout stocked in the fall of 1969 were captured. These catch statistics are conservative because only 86% of the

anglers interviewed in 1970 had completed fishing, some anglers fishing more remote sections of Westfield Creek were probably not interviewed, and other anglers were missed because the length of the average fishing trip (2.4 hr) was shorter than the interval between car counts (3 hr).

Trout Food Habits

Food categories represented in at least 50% of the stomachs of age I brown trout included, in order of decreasing importance, miscellaneous terrestrial insects, Diptera, snails and caddisflies (Table 6). Other food categories represented in 20-40% of their stomachs included, in order of decreasing importance, plant remains, scuds, aquatic bugs, and earthworms. Lengths of the age I brown trout ranged from 7.8-10.5 inches.

Food categories represented in at least 50% of the stomachs of age I rainbow trout included, in order of decreasing importance, Diptera, plant remains, miscellaneous terrestrial insects and caddisflies (Table 7). Other food categories represented in 20-45% of their stomachs included, in order of decreasing importance, scuds, Gammarus, mayflies, aquatic beetles, aquatic bugs, dragonflies and earthworms. Lengths of age I rainbow trout ranged from 7.1-10.0 inches.

The most important food item found in the stomachs of age II domestic brown trout and age III wild brown trout was fish, primarily brook sticklebacks (Table 8). Fish occurred in 83.3% of the stomachs from age II domestic brown trout and in 66.7% of the stomachs from age III wild brown trout. Fish were also present in the stomach of the age II rainbow trout examined. Crayfish and caddisflies were present in 2 of the 6 or 33% of the wild brown trout examined. Crayfish were not found in stomachs of age II domestic brown trout but caddisflies were present in 2 of the 12 or 17% of the fish examined. Lengths of age II domestic brown trout ranged from 13.6 to 17.5 inches. Lengths of age III wild brown trout ranged from 12.1 to 15.1 inches.

Nontrout Fishes

Petersen mark and recapture estimates of nontrout fishes in the three, 100-meter minnow stations in Westfield Creek lacked the precision necessary to adequately define standing stocks present or changes in standing stocks between years (Table 9). Population estimates made in the fall of 1973 using the successive removal technique were, for the most part, also inconclusive. However, a few larger fishes, i.e., white suckers and creek chubs, were captured on the second removal and estimates of these species are probably accurate. Confidence intervals are not possible using the successive removal method of estimation.

Due to the shortcomings involved in the population estimates of nontrout fishes in Westfield Creek, comparisons of total numbers and total biomass of unmarked fishes captured during both marking and recapture runs in 1969-1971 and during the two successive removals in 1973 were made (Table 9). Comparisons were made using data from "minnow" stations 1 and 2 since station 3 was not sampled in 1971 and 1973. Total surface area of the two "minnow" stations was 0.46 acres.

In October 1969 two years after chemical treatment, 12 fish species were collected from the "minnow" stations in Westfield Creek (Table 10). Collectively, sunfishes (bluegill, pumpkinseed and green sunfish) comprised 66% of the total biomass and were the second most abundant fishes captured. Brook sticklebacks were the most abundant fish encountered and ranked third in total biomass comprising 8% of the total. White suckers were third in abundance and second in total biomass comprising 17%. Total biomass of all fishes collected was 55.6 pounds (120.1 lb/acre).

In September, 1970 and 1971, total biomass of fish captured in the two "minnow" stations in Westfield Creek was 40.4 pounds (87.8 lb/acre) and 51.5 pounds (112.0 lb/acre),

respectively (Table 9). During the two collecting periods, four "new" fish species were encountered bringing the number of different fish species captured since chemical treatment of Westfield Creek to 16. In relation to 1969, the most notable changes in 1970 and 1971 were: (1) the almost complete absence of brook sticklebacks, (2) a decline in the abundance and biomass of sunfishes, and (3) a large increase in the abundance and biomass of white suckers and creek chubs. White suckers comprised 73% and 53% of the total biomass in 1970 and 1971, respectively, compared to 17% of the total biomass which they comprised in 1969. Suckers were the second most abundant fishes in 1970 and 1971 compared to their third place ranking in 1969. Creek chubs were insignificant in 1969, but in 1970 and 1971 they were the most numerous fish captured and ranked second in biomass comprising 14% and 23% of the totals, respectively.

Between the fall of 1971 and the fall of 1973, total biomass of nontrout fishes in Westfield Creek more than doubled. Total biomass collected in the fall of 1973 was 107.4 pounds (233 lb/acre). Creek chubs and white suckers comprised 89% of the total biomass and ranked 1 and 2, respectively, in numbers of fish captured. The spottail shiner was the only new fish species identified and this increased the number of different nontrout fishes captured in the "minnow" stations to 17.

In April, 1971 carp were captured for the first time since chemical treatment (June 1967) in the Westfield Millpond. Two carp measuring 7.0 inches and 7.5 inches were captured and six others of similar size were seen (Primising, pers. comm.). On 1 October 1971, several small carp in the 4-6 inch range were also captured in Westfield Creek during the normal fall trout population inventory. In all probability, these carp gained access to Westfield Creek and the millpond by coming through the dam on Lawrence Lake.

Physical Measurements

Water temperatures at the upper and lower thermograph stations in Westfield Creek were recorded continuously from 28 May 1968 through 20 February 1969; 30 May 1969 through 19 December 1969; and 13 March 1970 through 26 December 1970 (Figs. 2, 3, and 4). Data missing during these periods resulted from equipment malfunctions.

Maximum water temperature during 1968-1970 never exceeded 80 F at either the upper or lower thermograph stations. Weekly mean temperatures never exceeded 74 F at either thermograph station. Weekly mean temperatures at the upper station were generally 2-4 F cooler than weekly mean temperatures at the lower station during the hottest parts of the years (June-August). Stream temperatures during the coldest part of the year (January-February) hovered between 34-36 F at the upper station and 32-35 F at the lower station.

In 1970, mean weekly temperatures never exceeded 69 F while during 1968 and 1969 (July-August) mean weekly temperatures fluctuated between 71-74 F. Maximum temperature in 1970 never exceeded 70 F at the upper thermograph and 78 F at the lower thermograph. Maximum temperature in 1968 reached 80 F at both upper and lower stations. Maximum temperature in 1969 reached 76 F at the upper thermograph and 80 F at the lower thermograph.

Water level of Westfield Creek was recorded at weekly intervals from 26 June 1968 to 12 December 1968. During this period, water levels fluctuated 1.1 feet. On 25 July 1970 stream discharge was measured at 16.6 cfs. Later the same day, the dam on Lawrence Lake was opened and within 30-45 minutes stream water level rose 0.9 foot. Stream discharge was then measured at 69.1 cfs; an increase of 52.5 cfs or over 4 times the original flow. Such water level fluctuations occur at least once during every 36 hours depending on the water-release schedule established by the Westfield Milling and Electric Light Company.

Other Observations and Notes

During the mid-summer and fall trout population inventories made in Westfield Creek in 1970, 11 unmarked wild brown trout fingerlings were captured. In the fall of 1970 and 1971, brown trout were observed spawning in Westfield Creek and between 12 and 16 redds were located in the upper $\frac{1}{2}$ mile of stream. Most substrate suitable for trout

spawning is present in this portion of the stream. A limited amount of gravel substrate prevented many redds from being constructed but natural reproduction was further hampered by the fluctuating water levels. Brown trout apparently spawned in response to the daily increase in discharge from Lawrence Lake and approximately one-third of the redds located in 1970 and 1971 were left exposed when the discharge was reduced to normal.

A reoccurring comment made by anglers during the 1970 creel census and during conversations with local residents and anglers in other years was that trout from Westfield Creek tasted "muddy" and this discouraged them from fishing the stream as much as they would otherwise.

DISCUSSION

Overwinter survival of the fall 1967 stock of domestic brown trout and the fall 1969 stocks of domestic rainbow trout and brown trout in Westfield Creek were 61%, 53% and 44%, respectively. In Wisconsin stream sections with near freezing or freezing water temperatures, adequate cover and low resident trout densities, 40-55% is good overwinter survival (Brynildson and Christenson 1961). Accordingly, overwinter survival of fall-stocked trout was good to very good in Westfield Creek.

Domestic brown trout stocked in late September, 1967 averaged 1.6 inches larger than the domestic brown trout stocked in early October, 1969. Overwinter survival of the larger trout was 17% better thus suggesting direct relationship between average size of fall fingerlings (age 0) and overwinter survival. Brynildson et al (1966) found this relationship also to be true in more southerly Wisconsin trout streams.

Between July and September 1968, 78% of the age 0 brown trout and 77% of the age 0 rainbow trout disappeared from Westfield Creek. Between April and September 1968, 63% of the April population of age I brown trout disappeared from Westfield Creek. In 1970, 86% of the April population of age I rainbow trout and 57% of the April population of age I brown trout disappeared by September*. Estimated angler harvest in 1970 accounted for only 18% and 7% of the April populations of age I rainbow trout and brown trout, respectively. High summer mortality evidently occurs in Westfield Creek and angler harvest accounts for a relatively small portion of it. High summer water temperatures in conjunction with the large and rapid fluctuations in both water level and stream temperatures are probably significant factors contributing to the high summer mortalities.

Age 0 rainbow trout stocked in Westfield Creek in the fall of 1969 grew 1.8 inches overwinter compared to 1.5 inches of overwinter growth made by their brown trout counterparts. Faster growth of rainbow trout continued until July, 1970, when growth of brown trout became more rapid. By mid-September and the end of the 1970 trout season, a 0.6 inch size advantage of rainbow trout present in July, 1970 had been reduced to 0.2 inch. Growth of age 0 rainbow trout stocked in July, 1968 was also faster than the growth of their brown trout counterparts during the remainder of 1968. However, while rainbow trout averaged 0.9 inch larger than brown trout in April, 1969, the size advantage was reduced to 0.1 inch by October. Two conclusions may be made from this information. First, rainbow trout fingerlings stocked in the summer or fall in Westfield Creek grow faster than brown trout fingerlings of the same age class and maintain a size advantage over the brown trout through their first trout season. Second, brown trout in Westfield Creek begin to grow more rapidly after they reach a length of approximately 8.5 inches and by their 2nd spring (at age II) are larger than similar age rainbow trout.

Growth and survival of the 2-3 inch brown trout stocked in April, 1971 were surprisingly good in Westfield Creek during the April-September period (4.0 inches and 21%, respectively). With an anticipated overwinter survival of 50%, 500 of the 5,000

* Westfield Millpond was shocked in April, 1970 to determine if trout had moved into the pond rather than died. Results were negative.

trout stocked should have remained in the spring of 1972. With an additional growth of 1.5-2.0 inches, survivors should have averaged 8.0 inches or more by opening of the 1972 trout season. Two important advantages of stocking fingerlings in the spring include: (1) the increased "payload" and range of hatchery trucks possible as opposed to stocking much larger fingerlings in the fall, and (2) making use of the natural productive capacity of streams rather than occupying valuable space in the hatchery and having to feed commercial diets for another 5-6 months. It would have been valuable to know if another spring stock in 1973 would have been as successful as the 1971 stock considering the abundance of nongame fishes in 1973.

Comparative results of the two stocks of wild brown trout with the corresponding stocks of domestic trout can be summed up very briefly. In each instance, survival and longevity of wild brown trout were far superior to survival and longevity of domestic brown trout and rainbow trout; however, growth and yield to the angler of both domestic species of trout were far superior to the wild trout. There is, consequently, no overriding advantage of stocking wild brown trout from Emmons Creek in Westfield Creek rather than domestic trout from DNR fish hatcheries. If, however, conditions for natural reproduction were improved in Westfield Creek, then the greater longevity of wild brown trout would favor stocking some wild fish to assure sufficient numbers of spawning adults and perpetuation of the stream population.

The estimated fishing pressure of 52 hr/acre on Westfield Creek in 1970 was undoubtedly more than the stream received prior to chemical treatment but is relatively insignificant compared to other trout fisheries in Wisconsin established in chemically treated sections of stream. One explanation for this limited use is the disagreeable taste of the fish in Westfield Creek. "Muddy" or "earthy-musty" odors and tastes in fish are caused by absorption of an earthy smelling substance called "geosmin" (Iredale and Shaykewich 1972) which is produced by certain actinomycetes and blue-green algae (Lovell and Sackey 1973). Anglers who persistently returned to Westfield Creek in 1970 indicated that their interest was primarily in catching a "trophy" brown trout rather than in taking meat home for the table. A second explanation for the light amount of fishing pressure on Westfield Creek was and is the lack of public access to the stream. Adjacent lands are privately owned and for the most part "posted". Several discouraged anglers contacted me about this problem following my article about Westfield Creek in the May-June 1971 issue of the Wisconsin Conservation Bulletin.

With the exception of the "sunfish" populations, nontrout fishes in Westfield Creek were insignificant in the fall of 1969, two years after chemical treatment. By the fall of 1971, 4 years after chemical treatment, "sunfish" populations were insignificant* but populations of creek chubs and white suckers had begun to burgeon. Six years after chemical treatment, in the fall of 1973, creek chubs and white suckers comprised 89% of the total biomass of 233 lb/acre of nontrout fishes collected.

SUMMARY

- (1) A trout fishery was established in a 3.6-mile reach of Westfield Creek following chemical removal of all fishes with antimycin in June, 1967. Growth and survival characteristics of 8 different groups of stocked trout were studied between 1967 and 1973 as well as the subsequent build up of nontrout fishes.
- (2) Age 0 rainbow trout of the same approximate size as age 0 brown trout introduced at the same time, grew faster and maintained a size advantage through their first trout season as age I fish. Brown trout survived better in Westfield Creek and by their second trout season, as age II fish, averaged larger than their rainbow trout counterparts.

* Most "sunfish" probably moved downstream to live in Westfield Millpond.

- (3) Summer mortality of trout in Westfield Creek was high due to high water temperatures in conjunction with rapidly changing fluctuations in both water temperatures and stream discharges.
- (4) Regardless of the time of year stocked, survival and longevity of introduced wild brown trout were much better than similar characteristics of same age or size domestic brown trout and rainbow trout stocked at the same time. Domestic trout grew more rapidly, however, and contributed more to the creel than introduced wild trout. Natural reproduction was nil in Westfield Creek thus there was no over-riding advantage in stocking wild brown trout.
- (5) A partial creel census conducted on Westfield Creek in 1970 revealed relatively light angling pressure (52 hr/acre). Trout from the stream had an "earthy-musty" taste and anglers who consistently fished the stream did so because of the opportunity to catch "trophy" size brown trout rather than bring home meat for the table.
- (6) The resurgence of nontrout fishes occurred rapidly in Westfield Creek. In the fall of 1969, 2½ years after chemical treatment, 120.1 lb/acre of nontrout fishes were captured in two 100-meter sections of the stream. In the fall of 1973, 6 years after chemical treatment, 209.0 lb/acre were collected from the same 200 meters.

MANAGEMENT RECOMMENDATIONS FOR WESTFIELD CREEK

- (1) Westfield Creek is marginal trout water where annual stocking is necessary to sustain the fishery, where access to the stream and permission to fish is at the discretion of private landowners, and where chemical treatment is again necessary to remove abundant populations of nontrout fishes. Repeated chemical treatment every 5-7 years and subsequent stocking with trout is not recommended, however, unless fishing easements and access routes can be obtained by the DNR along the upper half of the 3.6-mile segment of stream.
- (2) If the above prerequisites are accomplished, trout should be stocked only in the upper 1.75 miles of Westfield Creek where water temperatures are cooler and instream cover appears more abundant. (The majority of trout from previous stocks preferred to reside here and most of the fishing pressure was exerted in this portion of stream.)
- (3) Due to the poor "taste" acquired by trout in Westfield Creek, greater emphasis should be given to establishing a "trophy" fishery for trout in the 15-20 inch size range.
- (4) Considering the better survival, longer life span, attainment of larger size and better overall growth of brown trout in Westfield Creek, only brown trout should be stocked.
- (5) Brown trout should be stocked as fingerlings (age 0) either in the fall or early spring. Five times as many fingerlings stocked in the fall should be stocked in the spring to provide comparable numbers of trout available to the angler in subsequent fishing seasons. Number of fall fingerlings recommended is 3,000.
- (6) A solution to the large, almost daily fluctuations in discharge of Westfield Creek should be sought. Better survival and perhaps a significant amount of natural reproduction could be achieved if a more constant discharge were maintained.

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ACKNOWLEDGMENTS

Supported in part by funds from the Federal Aid in Fish Restoration Act under Dingell-Johnson Project F83-R.

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Edited by Ruth L. Hine.

TABLE 1. Record of trout stocked in Westfield Creek, 1967-71 (D = domestic, W = wild).

Date Stocked	Origin	Species	Number Stocked	Avg. Length (Range) in Inches	Avg. Wt. (g)	Age
19 September 1967	D	Brown	1,500	6.0	45	0
1 July 1968	D	Brown	2,000	4.7 (4.0-5.5)	17	0
	D	Rainbow	2,000*	5.3 (3.9-7.1)	25	0
	W	Brown	876	4.8 (4.0-5.5)	18	I
6 October 1969	D	Brown	2,000	4.4 (4.0-5.0)	16	0
	D	Rainbow	2,000	4.3 (4.0-5.0)	15	0
13 October 1969	W	Brown	450	3.8 (2.7-4.8)	9	0
26 April 1971	D	Brown	5,000	2.2	2	0

* Fall-spawned rainbow trout

TABLE 2. Characteristics of fall, 1967 stock of brown trout in Westfield Creek, 1967-69 (length range in parenthesis)

Date	Population Estimate	Avg. Length (Range) in Inches	Avg. Wt. (g)	Total Survival (Percent)
19 September 1967	1,500 stocked	6.0	45	--
20 April 1968	913	9.1 (7.3-11.5)	163	61
15 June 1968	503	10.1 (7.7-12.5)	220	34
10 September 1968	334	11.2 (8.6-14.0)	268	22
27 March 1969	136	12.4 (9.9-14.8)	378	9
15 July 1969	55	14.4 (11.3-17.4)	684	4
1 October 1969	39	15.6 (12.7-18.1)	825	3
2 April 1970	28	15.9 (13.7-18.0)	974	2
1 July 1970	9	17.2 (15.0-19.2)	---	<1
10 September 1970	5	17.4 (16.9-18.7)	1,103	<1

TABLE 3. Characteristics of fall, 1969 stocks of domestic rainbow trout and brown trout in Westfield Creek, 1969-71 (length range in parenthesis).

Date	Population Estimate		Average Length (Range) in Inches		Avg. Weight (g)		Survival (Percent)	
	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown
6 October 1969	2,000	2,000	4.3 (4.0-5.0)	4.4 (4.0-5.0)	15	16	--	--
6 April 1970	1,054	870	6.2 (4.9-8.2)	5.8 (4.5-7.6)	40	37	53	44
1 July 1970	333	504	9.0 (6.9-10.9)	8.4 (6.7-10.4)	125	112	17	25
15 September 1970	149	372	9.6 (7.8-11.0)	9.4 (6.7-11.6)	144	142	7	19
1 October 1971	-	27	-	14.7 (12.5-16.7)	-	591	0	1

TABLE 4. Characteristics of fall, 1969 stock of wild brown trout in Westfield Creek, 1969-71 (length range in parenthesis).

Date	Population Estimate	Average Length (Range) in Inches		Avg. Weight (g)	Survival (Percent)
13 October 1969	450	3.8 (2.7-4.8)		9	--
6 April 1970	293	4.8 (3.3-7.5)		18	65
1 July 1970	257	6.9 (5.4-8.5)		59	57
15 September 1970	241	7.9 (6.3-10.2)		82	54
1 October 1971	116	12.3 (10.0-14.3)		326	26

TABLE 5. Characteristics of July, 1968 stocks of age 0 domestic trout in Westfield Creek, 1968-70 (length range in parenthesis).

Date	Population Estimate		Average Length (Range) in Inches		Avg. Weight (g)		(Percent)	
	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown	Rainbow	Brown
1 July 1968	2,000*	2,000	5.3 (3.9-7.1)	4.7 (4.0-5.5)	25	17	--	--
10 September 1968	467	433	6.8 (5.2-9.5)	5.8 (4.5-7.7)	59	40	23	22
27 March 1969	222	243	9.6 (7.2-12.2)	8.7 (6.6-11.3)	170	128	11	12
15 July 1969	66	114	12.2 (10.3-15.1)	11.5 (9.2-13.2)	365	342	3	6
1 October 1969	32	96	13.5 (10.2-15.4)	13.4 (10.1-17.8)	545	506	2	5
5 April 1970	20	44	14.1 (11.2-15.7)	14.5 (11.8-18.1)	597	694	1	2
1 July 1970	7	30	15.8 (15.0-16.7)	16.4 (13.8-18.3)	810	925	<1	2
15 September 1970	4	19	15.2 (14.6-16.3)	16.7 (14.0-19.7)	736	898	<1	1

* Fall - spawned rainbow trout.

TABLE 6. Characteristics of July, 1968 stock of wild age I brown trout in Westfield Creek, 1968-71 (length range in parenthesis).

Date	Population Estimate	Average Length (Range) in Inches	Avg. Weight (g)	Survival (Percent)
1 July 1968	876	4.8 (4.0-5.5)	18	--
10 September 1968	598	6.0 (4.7-8.0)	37	68
27 March 1969	369	8.4 (5.9-10.6)	101	42
15 July 1969	299	10.8 (8.3-13.3)	252	34
1 October 1969	329*	11.8 (9.0-15.8)	295	38
5 April 1970	184	12.4 (10.3-16.3)	342	21
1 July 1970	162	13.5 (10.2-17.3)	455	18
15 September 1970	117	13.9 (10.4-17.6)	477	13
1 October 1971	34	14.7 (11.3-18.8)	567	4

* Based on higher recapture efficiencies and a larger sample of fish collected, this is a more reliable estimate than the estimate made in July.

TABLE 7. Food habits of age I domestic trout in Westfield Creek, 1970.

Trout species	Brown trout	Rainbow trout
No. of stomachs	18	25
Length range (inches)	7.8-10.5	7.1-10.0
Food Items	Stomachs containing Food Item (%)	Stomachs containing Food Item (%)
Diptera (flies)	61.1	84.0
Misc. terrestrial insects	77.8	60.0
Plant remains	38.9	64.0
Caddisflies	50.0	60.0
Snails	61.1	28.0
Sowbugs (scuds)	27.8	44.0
Beetles (aquatic)	16.7	36.0
<u>Gammarus</u>	11.1	44.0
Aquatic bugs*	27.8	28.0
Mayflies	11.1	40.0
Dragonflies	16.7	24.0
Earthworms	22.2	20.0
Fish**	5.6	12.0
Crayfish	----	4.0
Alderflies	5.6	4.0
Molluscs (pill clam)	----	4.0

* Corixidae, Gerridae, Notonectidae

** Brook sticklebacks

TABLE 8. Food habits of age II domestic rainbow trout, age II domestic brown trout and age III wild brown trout in Westfield Creek, 1970.

Trout species	Rainbow Trout	Brown Trout	Wild Brown Trout
No. of stomachs	1	12	6
Length range (inches)	15.0	13.6-17.5	12.1-15.1
Food Items	Stomachs containing Food Item (%)	Stomachs containing Food Item (%)	Stomachs containing Food Item (%)
Fish*	100.0	83.3	66.7
Crayfish	-	-	33.3
<u>Gammarus</u>	-	8.3	16.7
Snails	-	8.3	16.7
Caddisflies	100.0	17.0	33.3
Earthworms	-	8.3	16.7
Plant remains	-	-	16.7
Mayflies	-	-	16.7
Diptera (flies)	-	-	16.7
Misc. terrestrial insects	-	-	16.7

* Except for 1 mottled sculpin, all fish were brook sticklebacks.

TABLE 9. Population estimates of nontrout fishes made in the 100-meter stations of Westfield Creek, 1969-71 and 1973 (95% confidence intervals given in parenthesis).

Species	Station 1				Station 2				Station 3	
	1969	1970	1971	1973	1969	1970	1971	1973	1969	1970
White sucker	328 (121-20,500)	166 (150-195)	1,269 (776-3,233)	208	88 (62-180)	61 (46-114)	654 (473-1,040)	40	--	5
N. creek chub	---	979 (843-1,158)	411 (294-726)	119	64 (50-115)	674 (585-826)	1,145 (786-1,878)	630	324 (188-900)	---
Miscellaneous*	56	400 (206-2,857)	2,836 (1,331-4,943)	57	193 (139-335)	28 (21-72)	1,190 (77-2,527)	395	105 (67-238)	---
Johnny darters	---	---	---	15	---	200 (99-1,343)	162	245	158 (92-362)	1,368 (940-2,238)
Mottled sculpin	---	---	---	---	278 (169-700)	494 (281-1,343)	252 (120-350)	---	75 (34-1,067)	40 (26-64)
Pumpkinseed	220 (122-733)	57 (39-125)	654 (381-1,686)	58	---	---	---	18	---	---
Bluegill	1,160 (497-10,875)	---	---	---	---	4	---	---	10 (4-400)	---
Green sunfish	302 (197-592)	7	---	8	13 (8-100)	---	---	---	---	---
Brook stickleback	2,021 (1,433-3,080)	3	---	---	1,112 (714-1,923)	---	---	---	10,697 (7,355-16,180)	68 (30-800)
Tadpole madtom				16				---		
Black bullhead				---				17		

* Includes primarily bluntnose minnows, fathead minnows and common shiners; spottail shiners identified and included in 1973.

TABLE 10. Characteristics of nontROUT fishes captured on two collecting runs made in "minnow" stations 1 and 2 of Westfield Creek during fall 1969-71 and 1973.

Species	Numbers				Avg. Lengths				Total Biomass			
	1969	1970	1971	1973	1969	1970	1971	1973	1969	1970	1971	1973
White sucker	109	195	493	244	4.9	6.0	4.3	8.6	9.6	29.6	27.4	70.0
N. creek chub	51	983	508	649	4.0	2.5	4.0	4.4	2.0	5.8	11.9	26.0
Miscellaneous*	145	134	555	374	2.6	2.8	2.6	2.6	1.2	1.2	3.9	2.6
Johnny darters	10	62	38	187	2.6	2.2	2.5	2.9	*	0.3	0.2	1.6
Mottled sculpin	99	142	71	35	2.8	2.6	3.0	3.4	1.4	1.9	1.0	0.7
Pumpkinseed	76	41	215	62	4.0	2.8	3.1	4.4	4.6	1.0	5.4	4.0
Bluegill	126	12	28	19	6.1	1.7	2.8	4.6	24.8	0.1	0.4	1.8
Green sunfish	122	8	28	8	4.2	3.7	3.4	4.0	7.4	0.4	0.8	0.4
Stonecat	2	8	8	16	3.6	2.7	3.7	3.1	*	0.1	0.3	0.2
Largemouth bass	-	2	9	1	-	3.5	2.4	3.2	-	*	0.1	*
Brook stickleback	1,744	3	1	-	1.8	-	-	-	4.6	-	-	-
Black bullhead	-	-	5	15	-	-	6.6	2.7	-	-	0.1	0.1
Redbelly dace	-	1	-	-	-	-	-	-	-	-	-	-
Golden shiner	-	-	2	-	-	-	3.7	-	-	-	-	-

TOTALS 55.6 40.4 51.5 107.4

* Includes primarily bluntnose minnows, fathead minnows and common shiners; spottail shiners identified and included in 1973

* <.05 lb.

TABLE 11. Creel census questionnaire used on Westfield Creek in 1970.

CREEL CENSUS REPORT -- WISCONSIN CONSERVATION DEPARTMENT

Stream: _____

Date: _____
mo da yr

① Name of angler: _____
last first middle initial

② Address of angler: _____
town county state

③ Is he (check):
driver _____
passenger _____
not with a car _____

Identification by:

⑤ Angler:

	Bk	Bn	Rb
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

⑥ Clerk:

	Bk	Bn	Rb

⑦

	Finclip	Length

A-Adipose
P-Pectoral
R-Right V-Ventral
L-Left M-Maxillary

⑨ Time:

Start	End
AM PM	AM PM

Total
hours: _____

④ Number of anglers in the car _____

⑩ Area fished:

⑪ Lure:

W-Worms
F-Flies
S-Spinner
Describe other baits

(12) Finished Fishing?
(check) Yes No

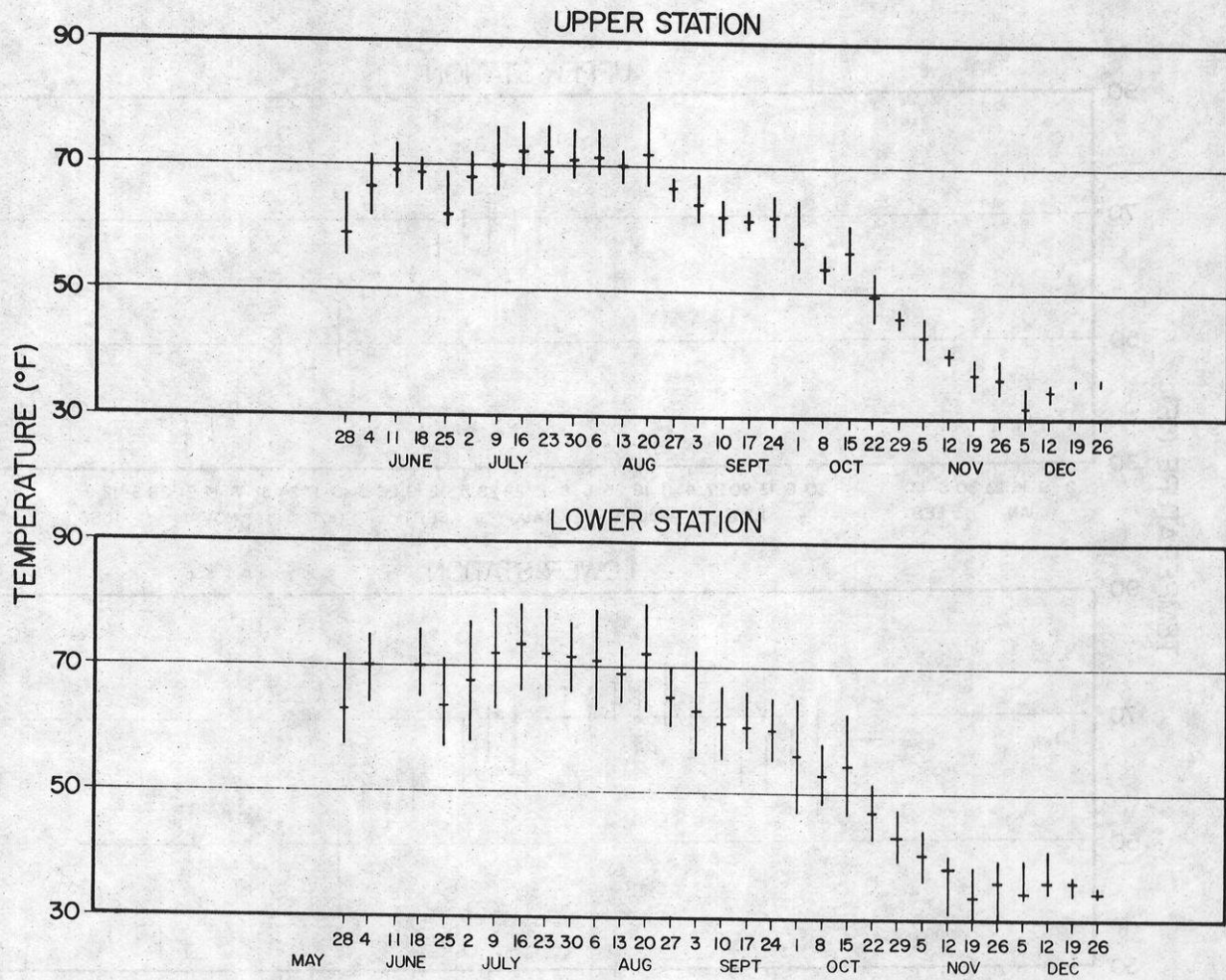


FIGURE 2. Weekly maximum, mean and minimum temperatures of Westfield Creek, 1968 (temperatures are for the week following each date.)

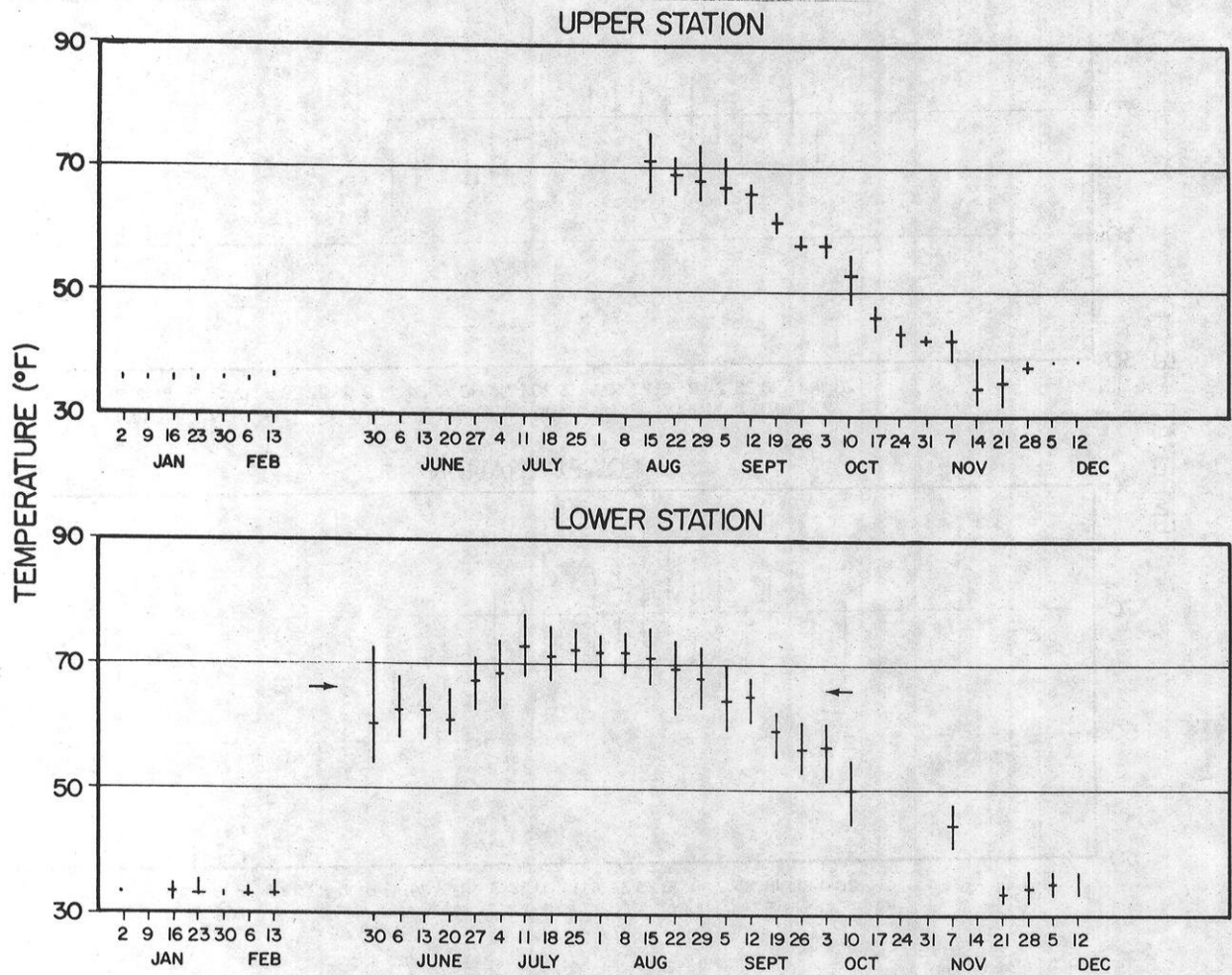


FIGURE 3. Weekly maximum, mean and minimum temperatures of Westfield Creek, 1969 (temperatures are for the week following each date.)

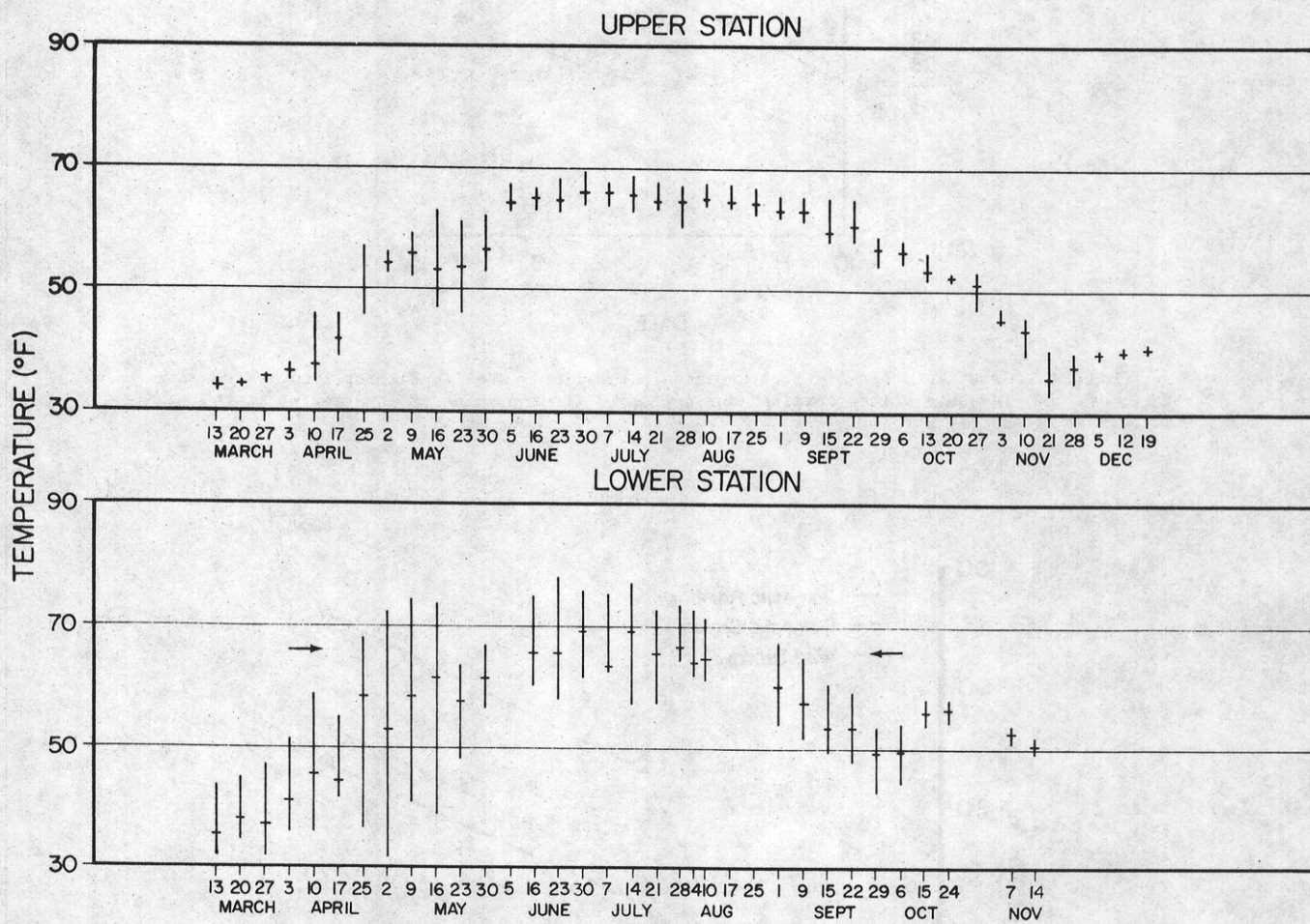


FIGURE 4. Weekly maximum, mean and minimum temperatures of Westfield Creek, 1970 (temperatures are for the week following each date).

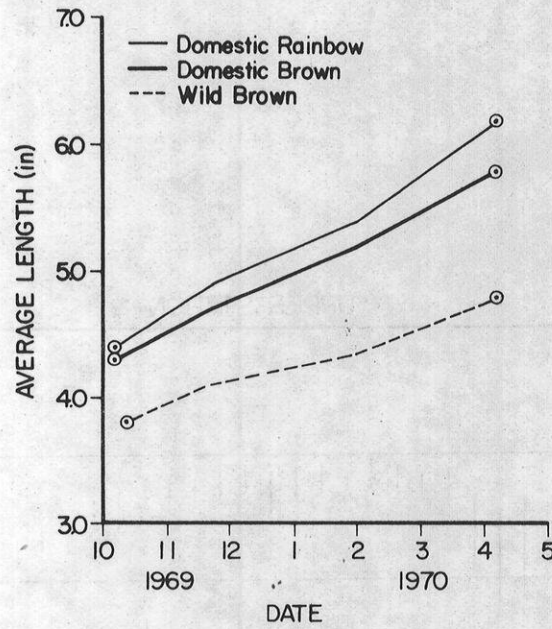


FIGURE 5. Growth studies of trout stocked in Westfield Creek in October 1969 (circles indicate values obtained during normal trout population inventories in the entire stream).

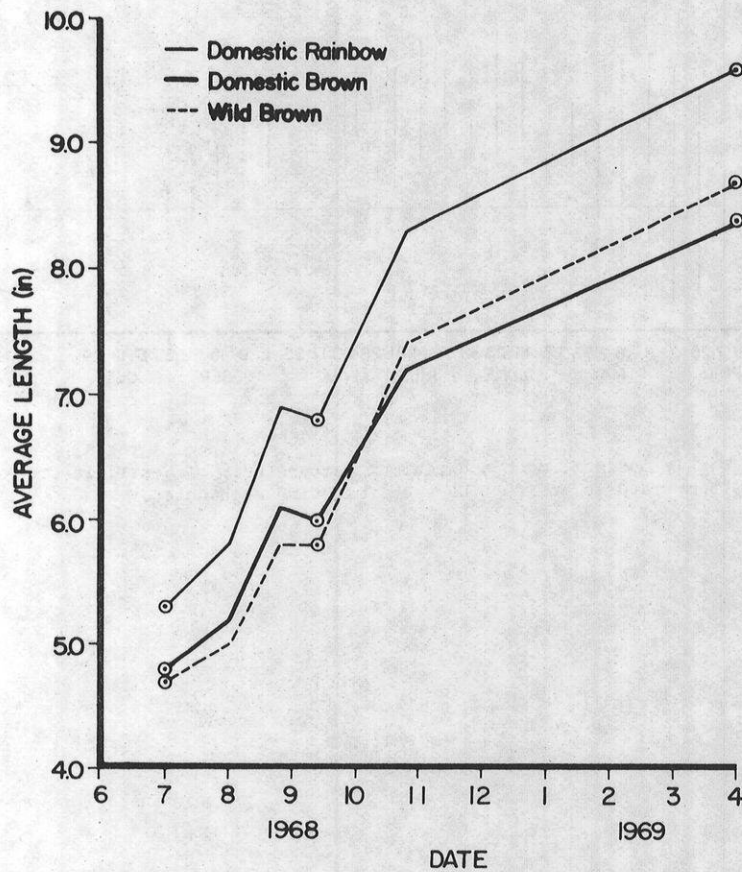


FIGURE 6. Growth studies of trout stocked in Westfield Creek in July 1968 (circles indicate values obtained during normal trout population inventories in the entire stream).