A successful application of catch and release regulations on a Wisconsin trout stream. No. 119 1981

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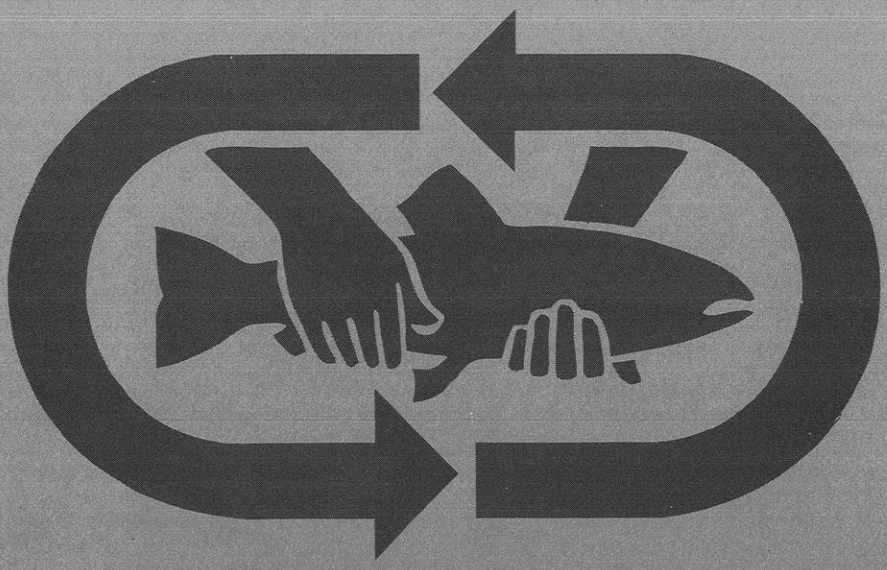

A Successful Application of Catch and Release Regulations on a Wisconsin Trout Stream

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ABSTRACT

This study assessed the impact of restrictive angling regulations that emphasize release of most trout caught on a stocked brown trout *(Salmo trutta)* fishery. It is the first completed evaluation of deliberately imposed catch and release regulations in Wisconsin that provides field data on both the sport fishery and the trout populations. Angling regulations imposed were the use of artificial flies and lures only, a minimum length limit of 13 in., and a daily bag limit of one trout. Assessment procedures involved a partial season-long creel census and spring and fall trout population estimates during a 4-year period, the first year (1976) under normal statewide angling regulations and the following 3 years under the special regulations. Parallel data were also obtained from a reference zone where statewide regulations prevailed throughout the entire 4-year period.

The catch and release fishery was judged to be highly successful. (1) Angler use remained high in comparison to that during the 1976 baseline season; there was a 5% reduction in angler hours but angler trips/season increased by an average of 15%. Angler use during 1977 amounted to 1,015 hours/acre, the highest known value on a Wisconsin trout stream. (2) Harvest was reduced by 99%, while the number of trout released increased by 116%. The 3-season average of trout released to trout creeled was 268:1 as compared to a ratio of 2:1 in 1976. (3) Some trout were probably released more than once per season since the catch of trout creeled or released exceeded the number present in April. (4) In response to the catch and release regulations, more anglers fished 10-20 times/season and the frequency of releasing more than 10 trout/trip increased. (5) Distribution of angling effort over the course of the season was more even. (6) The combined catch rates (trout creeled or released) increased to atypically high values for Wisconsin — from 0.8/hour in 1976 to 1.08, 1.46, and 1.48 in 1977-79.

Abundance, biomass, and survival rate characteristics of trout all changed favorably, based on average values for 1977-79 vs. 1976 data. The number of I+ trout increased in April by 58% (to 3,379/mile) and April biomass increased by 46% (to 164 lb/acre). The average number of I+ trout in October increased by 126% (to 1,889/mile) and their biomass increased by 50% (to 129 lb/acre). April to October survival of I+ trout averaged 56% during the special regulation seasons vs. 39% survival in 1976.

Abundance of trout over 13 in. in early October (week after close of the fishing season) increased an average of only 12%. The successful catch and release fishery that evolved was not augmented by a much-improved "trophy trout" fishery. Lack of suitable habitat for such trout may have been the principal factor preventing a greater buildup. Removal of trout over 13 in. by anglers was not a limiting factor preventing a sustained accumulation in the population.

The findings support continuation of the special regulations on the Race Branch as a highlight feature of trout management in that region and a modest expansion of catch and release regulations to other trout streams in Wisconsin to further diversify the variety of trout angling opportunities and strengthen the "management for quality" concept that is a basic component of present Department of Natural Resources trout management policy.

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By
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INTRODUCTION

BACKGROUND

The term "catch and release" as it presently applies to regulations used in management of trout fisheries is no longer narrowly restricted by definition to regulations requiring release of all trout captured. Such regulations are more properly termed "no kill", or even more accurately, "no harvest", since some hooking and handling mortality is inevitable. The catch and release concept can include no harvest situations, but it more broadly refers to regulations that mandate release of most but not all trout captured. The primary intent of this type of regulation is to place greater emphasis on enhancing the quality of the fishing experience and reducing emphasis on the take-home catch (Barnhart and Roelofs 1977). Three factors are particularly important to improving both the on-site quality of a fishing experience and its subsequent recollection quality, namely the number of fish caught, the rate of catching these fish and the sizes of fish caught. A basic premise of catch and release fisheries is that all three of these quality factors will be enhanced for most participating anglers.

Another basic and related goal of most catch and release fisheries is to substantially reduce angling mortality, that due to harvest and that caused by the catching and release process. Consequently such fisheries normally restrict anglers to use of artificial lures and/or flies. Use of live baits or preserved material baits is usually prohibited because of the much higher mortality rates of released fish that occur when such baits are used (Wydoski 1977).

Regulations that emphasize release of all or nearly all trout captured have been applied sparingly in Wisconsin. Prior to 1977, only 11.5 miles of the 9,560 miles of Wisconsin trout streams had been designated for special regulations management that stressed "qualitative yield." In 1955, a 5-mile stretch of the Peshtigo River in Marinette Co., a 3-mile stretch of the Wolf River in Langlade Co., and a 2-mile stretch of the same river in Menominee Co. were designated as "fly fishing only" waters. The daily bag limit was set at 5 trout throughout the season and the minimum length limit was set at 12 in. In 1971, the minimum length limit was lowered to 10 in. Both streams are in northeastern Wisconsin. All three stretches are dependent on annual stocking of legal-sized and sublegal trout to sustain the fishery. Potential for natural reproduction is low.

Other than occasional interviews of anglers on opening weekends of the fishing seasons, there has been no evaluation of the special regulations on the Wolf or Peshtigo River stretches. Such evaluation has not been made primarily because both stretches are too large to effectively sample the trout stocks with conventional electrofishing gear.

A partial season-long creel census was conducted on the Pestigo River stretch of fly-fishing-only water during the 1956-59 fishing seasons. Burdick and Brynildson (1960) concluded from this census effort that this portion of the river was receiving about 100 hours/acre of angler use each year, a use intensity that was probably above average for northeastern Wisconsin trout streams. Approximately 20% of the anglers interviewed were successful in catching at least one legal-sized trout (12 in. or larger). Survival of stocked trout from one year to the next was poor for legal-sized trout and practically nil for stocked age 0 trout. Maximum harvest of 3,000 stocked, legal-sized brown trout *(Salmo trutta)* was 16%; maximum harvest for a similar stock of rainbow trout *(Salmo gairdneri)* was 40%.

No studies of the above special regulation waters have been made since the minimum length limit was reduced to 10 in.

During 1955-67 several sets of experimental regulations were applied to the fishery for brook trout *(Salvelinus fontinalis)* on Lawrence Creek in central Wisconsin. Evaluations of two sets of these regulations are pertinent.

During the 1958-60 trout fishing seasons, the minimum length limit was set at 9 in. and the bag limit was 5/day. There was no special restriction on fishing methods. Although it was not the primary intent of these regulations to promote a catch and release fishery, such a fishery did evolve — one in which 15 trout were released for every trout creeled. However, catch and release of wild brook trout less than 9 in. was not a satisfying experience for most anglers. Angling trips and hours declined dramatically and harvest fell far below that predicted. The 9-in. length limit proved to be too high when applied to this wild brook trout fishery to stimulate either a satisfactory catch-to-eat harvest (Hunt, Brynildson and McFadden 1962) or a good catch and release fishery (Hunt 1977).

During 1961-67 angling in a 1.5-mile portion of Lawrence Creek was restricted to fly-fishing-only, the minimum length limit was set at 8 in. and the daily bag limit reduced to 5. This portion of stream was made up of the two most downstream zones of four study zones. The major conclusion from the 1961-67 period of study was that the minimum length limit of 8 in. was the most influential regulation affecting harvest and exploitation, not the fly-fishing-only regulation (Hunt 1970). The latter regulation, however, did attract anglers who preferred to fish with flies.

In 1977, portions of two more trout streams were added to the list of special regulation waters: a 3.6-mile stretch of Castle Rock Creek in Grant Co., southwestern Wisconsin, and a mile-long stretch of the Willow River in St. Croix Co., in west central Wisconsin. Special regulations applying to Castle Rock Creek restrict angling to use of artificial lures and no harvest. Season length is from January 1 through September 30. The trout population is maintained by annual stocking of 4- to 6-in. age 0 brown trout in late summer or fall.

Evaluation of the no-harvest fishery on Castle Rock Creek to date has included electrofishing inventories of trout each spring and fall throughout the entire special regulation zone and a 1.6-mile downstream reference zone, a partial creel census during June-August of 1977 and 1978, and a partial creel census throughout the 1979 fishing season. Census efforts involved both periodic counts of angler cars and on-site interviews. Findings have not yet been published.

The portion of the Willow River designated in 1977 as a special regulation water constitutes a well-defined side channel known locally as the Race Branch of the Willow River (Fig. 1). It is the site selected for evaluating the special regulations to be reported on in

this paper. This study was initiated largely in response to the growing need within the Wisconsin Department of Natural Resources (DNR) for a better reference base of field data from Wisconsin waters for the potential development of trout management strategies that place greater emphasis on the qualitative rather than the quantitative aspects of trout fishing. This shift in trout management philosophy and the need for experimental data to support it is highlighted in the recently completed long-range Strategic Plan developed for managing Wisconsin's stream trout resource (Wisconsin Department of Natural Resources 1979). In this plan, projected statewide harvest of wild trout is expected to exceed tolerable exploitation by 1985 unless remedial management action is taken. Reduced harvest via reduced bag limits, increased length limits and other restrictive regulations are some of the management strategies identified as approaches to circumvent anticipated overexploitation. Increased testing of these and other special regulations is cited as a specific prerequisite to provide a broader and more up-to-date base of management knowledge.

My study was also prompted in part by increasing inquiries to the DNR from individuals and organized angler groups who were interested in promoting additional trout streams for special regulation status. Particularly prominent in this movement were various Wisconsin-based chapters of the national Trout Unlimited organization. Following the decision to proceed with an intensive research study of special regulations, the final choice of the Race Branch of the Willow River as the study site was strongly influenced by background information and encouragement received from Trout Unlimited members familiar with this stream. Information on the stream derived from several years of DNR study to evaluate success of stocking age 0 trout (Frankenburger 1969) also contributed to the final choice of the Willow-Race system as the study site.

STUDY OBJECTIVE

This study was designed to assess the impact on the fishery and trout populations of experimental regulations that emphasized release of most of the trout caught during three successive fishing seasons. The study constituted the first intensive investigation in Wisconsin to deliberately impose catch and release regulations, an investigation which would serve as a pilot study to determine if additional portions of Wisconsin trout streams should be similarly managed.

Of the several combinations of length limits, bag limits, and restrictions on fishing methods that could have been used to develop a catch and release fishery on the Race Br., the following set was selected after a preliminary survey of the trout populations in May 1975: (1) a minimum length limit of 13 in.; (2) a daily bag limit of 1 trout; and (3) use of artificial flies or lures only.

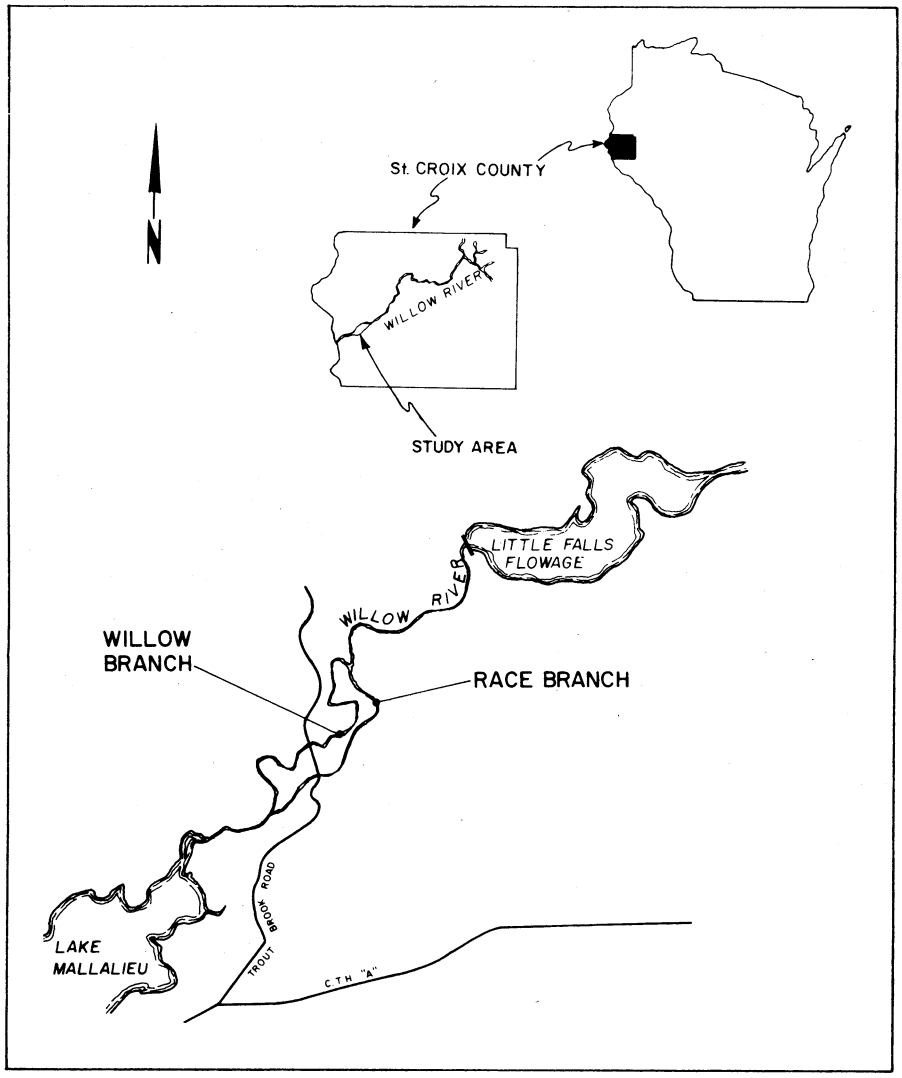


FIGURE 1. *Locations of Race Br. and Willow Br. study zones.*

Prior to applying these special regulations to the Race Br. spring and fall trout population estimates and one full fishing season of creel census information were collected from both study zones in 1976 under conditions of normal fishing regulations on both zones. The regulations were: (1) a minimum length limit of 6 in.; (2) a daily bag limit of 5 trout in May and 10 during June-September; (3) no restriction on using conventional fishing bait and artificial lures; and (4) season length from the first Saturday in May through September 30.

This set of regulations remained in effect on the Willow Br. reference zone during the 1977-79 fishing season too, during which time the set of special regulations was being tested on the Race Br.

DESCRIPTION OF STUDY AREA

The Willow River originates in northeastern St. Croix Co. and flows southwesterly to join the St. Croix River in the city of Hudson. Total stream length is approximately 40 miles. About 26 miles of the stream is classified as trout water (10.6 miles as Class II and 15.5 miles as Class III)*.

Some natural reproduction of brook trout and brown trout occurs in Class II portions but annual stocking is carried out throughout the trout water to sustain the fishery. Seven miles above the confluence of the Willow River with the St. Croix River is Little Falls Dam (17 ft high), impounding Little Falls Flowage. About 1.5 miles below the dam the Willow River splits into two distinct channels which subsequently reunite (Fig. 1). The smaller more easterly channel is known as the Race Branch. The western channel is designated as the Willow Branch. Trout Brook Road bridges both branches below their midpoint and constitutes the principal access way used by anglers. Both branches are Class II trout water.

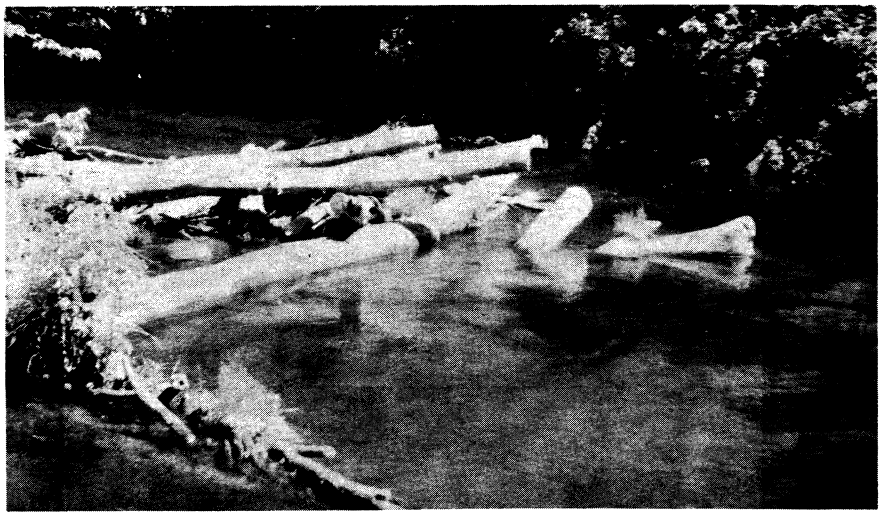
For the purposes of this study, the entire length of the Race Br. was included as one study zone, the "treatment zone", where the special regulations to be tested were applied. On the Willow Br. only that portion above Trout Brook Road to its juncture with the Race Br. was included for use as a "reference zone". Normal fishing regulations were retained on this zone throughout the 4-year study.

The remainder of the Willow Br. was not included because it contained several large pools too deep to electrofish effectively with the gear available. Confinement of the "reference zone" to only the upper portion of the Willow Br. also resulted in two study zones of nearly equal length, the Willow Br. zone having a midchannel length of 0.97 mile and the Race Br. zone having a midchannel length of 1.03 mile.

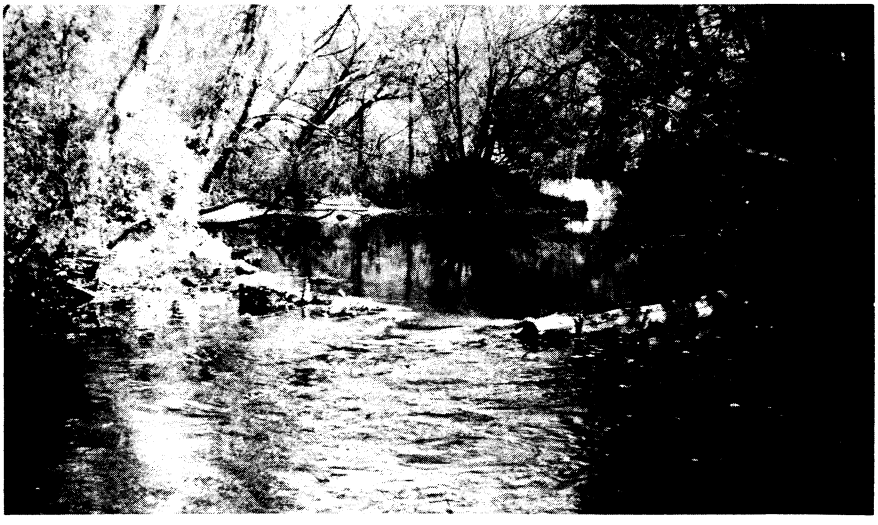
In regard to other physical dimensions of the study zones, the Willow Br. is 10% wider (average of 43.3 ft vs. 39.3 ft), has a 50% greater average depth (17.4 in. vs. 11.6 in.) and a 6% greater surface area (5.17 acres vs. 4.90 acres). Baseflow discharge in September 1977-78 averaged 365% more for the Willow Br. (43.7 cfs vs. 9.4 cfs) at the bridges on Trout Brook Road.

Frankenburger (1969) estimated that substrate composition of both zones combined was 60% gravel, 10% rubble, 20% sand, and 10% silt. Rubble and gravel substrates are more common in the Willow Br. Most of the Willow Br. in the study zone and the upper half of the Race Br. flow through mature but only moderately dense stands of deciduous trees. Neither zone, however, provides a wild environmental setting. Several large houses and smaller summer cottages overlook portions of both study zones. Angler access along all of the Willow Br. study zone and most of the Race Br. is assured via public ownership of one or both stream banks as part of the DNR Willow River State Park. Both stream banks of the lower third of the Race Br. are privately owned but throughout the study angler access was permitted.

Prior to the opening of the 1976 fishing season, large wooden signs were erected at the upstream and downstream boundaries of the study zones

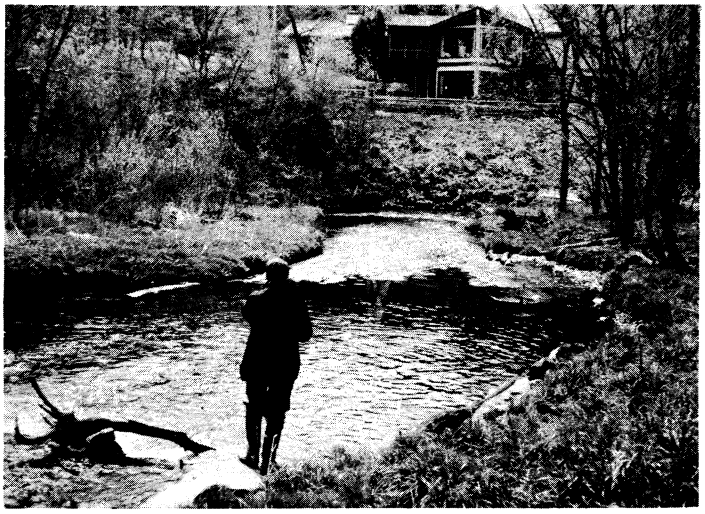


Several log jams, like this one, provide good natural cover for trout in both study zones.



A series of man-made structures installed by local sportsmen's groups also provide additional habitat diversity in both study zones. Most such structures, however, particularly the V deflectors, like the one shown in this picture, are partially nonfunctional and in need of replacement with more esthetic and more effective bank cover structures.

*By Wisconsin DNR Standards, Class II trout streams require some stocking of trout to maintain a desirable fishery. Class III streams are entirely dependent on stocked trout. Class I trout streams are not stocked.



Most of the stream banks of the study zones are naturally vegetated, but several large homes are also present along the lower half of the Race Branch.

Large wooden signs and smaller paper signs were strategically placed at study zone boundaries to assist anglers.

TABLE 1. *Physical-chemical characteristics of the Race Br. and Willow Br. study zones.*

	Race Br.	Willow Br.
Physical characteristics (1 Jun 1976)		
Midchannel length (ft)	5,421	5,147
Midchannel length (miles)	1.03	0.97
Avg. width (ft)	39.3	43.3
Avg. depth (in.)	11.6	17.4
Surface area (acres)	4.90	5.17
Baseflow discharge at Trout Brook Road (cfs):		
Sept. 1977	9.7	36.5
Sept. 1978	9.2	50.9
Avg.	9.4	43.7
Chemical characteristics (2 Oct 1979)		
Total alkalinity (mg/l-$CaCO_3$)	162	116
pH	7.9	7.9
Nitrite (mg/l-N)	0.022	0.016
Nitrate (mg/l-N)	0.51	0.40
Ammonia (mg/l-N)	0.07	0.05
Organic nitrogen (mg/l-N)	0.13	0.25
Total phosphate (mg/l)	0.01	0.02
Sulfate (mg/l)	6	6
Chloride (mg/l)	7	7
Calcium (mg/l)	37	34
Magnesium (mg/l)	22	22
Sodium (mg/l)	4	4
Potassium (mg/l)	1.5	1.6
Specific conductance (umhos/cm at 25°C)	422	397

to inform anglers that the zones were being used in a trout research project. Smaller bright yellow cardboard signs were also posted at several locations along each study zone. These detailed the regulations in effect in each zone and dates of the fishing season.

Also pertinent to this study is the geographic proximity to the St. Paul-Minneapolis urban complex, within an hour's auto drive west of Hudson.

Both study zones support diverse fish populations, due in part to the presence of flowages above and below the study zones from which some fish species not normally associated with Wisconsin trout streams have immigrated to the study zones (Table 11, Append.).

Fish of forage size for trout were judged to be abundant in both study zones (particularly darters, chubs, dace, and logperch) but no quantitative assessments of their abundance were made.

Brown trout constituted the principal sport fish throughout the study. Rainbow trout were second in importance during the last three years of the study after stocking of this species was initiated in the fall of 1976. Some natural recruitment of brown trout occurred in both study zones each year of the study, but annual stocking largely sustained the standing stocks.

Chemical characteristics of water in the two study zones are summarized in Table 1. Ground water input is somewhat greater in the Race Br. which probably accounts for its slightly higher alkalinity of 162 ppm.

Several favorable factors contributed to selection of the Race Br. and Willow Br. as study zones:

1. The unusual but highly practical physical attributes of having two parallel flowing study zones to work with, attributes that especially contributed to efficiency of the creel census and reduction in potential public opposition by confining special regulations to only one branch.
2. Background data on the study zones from Frankenburger's investigations during 1958-63.
3. Enthusiastic support for the study by the local Trout Unlimited Chapter.
4. Ability to partially control recruitment of trout by adjusting stocking rates if recruitment changes became desirable during the study.
5. The reputation of the stream as one providing good fishing and high angler use.
6. Stream channels physically suited to use of fly fishing and artificial bait fishing gear.
7. Concentration of angler access and parking areas to only a few locations along the study zones.
8. Preliminary field observations that suggested availability of unused habitat for trout over 13 in.

PROCEDURES

TROUT STOCKING

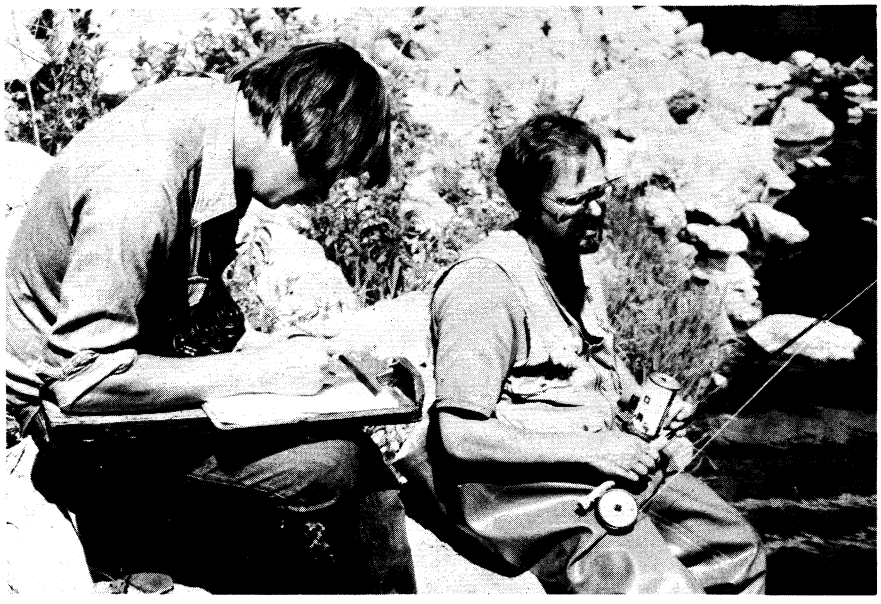
Year classes of age 0 trout stocked in the study zones each fall were sorted to near-equal size (1.0-in. maximum difference), precisely counted and fin-clipped at DNR hatcheries a few days prior to stocking. In October 1975, brown trout were stocked at densities of 612/acre in the Race Br. and 580/acre in the Willow Br. (each representing 3,000/study zone). Rainbow trout were added to the stocking regime in 1976 to improve fishing quality by providing a multi-species dimension to the catch. In October 1976-78, annual stocking rates were 408 brown trout/acre and 204 rainbow trout/acre in the Race Br. vs. 387 brown trout/acre and 193 rainbow trout/acre in the Willow Br. (equivalent to 2,000 brown trout and 1,000 rainbow trout/zone).

All marked stocked trout were scatter-planted in the study zones by Trout Unlimited volunteers. Additional lots of 4,500 age 0 unmarked brown trout were also scatter-planted on the same stocking dates in portions of the Willow River adjacent to the study zones. No special sorting was done to reduce size variation among the unmarked lots (other than the normal sorting done as part of hatchery operations). Since there were no barriers at the boundaries of the study zones, marked and unmarked trout stocked were free to move, respectively, out of or into the study zones. Trout of wild origin were also free, of course, to move across the arbitrary boundary lines of the study zones. Such movements constituted variables of unmeasured significance during the study.

CREEL CENSUS

Creel census data were obtained using a modification of the periodic instantaneous count method (Lambeau 1961). "Instantaneous counts" of anglers in this study covered a period of approximately 30 minutes to walk a nonstop route providing visual contact with all portions of both study zones.

Normally 4 patrols of the study zone were made each work day at 2.0- to 2.5-hour intervals during an 8-hour period. With the exception of opening weekend of the fishing season, work schedules covered 4 of the 5 week days and 1 of the weekend days. Days not worked were selected randomly as was one of two possible daily shifts — either a 7 a.m. to 3 p.m. shift or a 1:30 p.m. to 9:30 p.m. shift. Direction (upstream or downstream) of census routes was also randomized.



Creel census effort each fishing season involved frequent counts of anglers in each study zone and interviews of anglers who had completed their fishing trip.

On both days of the opening weekend of each fishing season, angler counts were made at 2-hour intervals starting at 6 a.m. and concluding at 8 p.m. An "angler day" was arbitrarily set at 16-hours duration for the opening weekend (5 a.m. to 9 p.m.) and 15-hours duration for the remainder of the season (6 a.m. to 9 p.m.).

During times between patrols of the study zones, census effort was concentrated on obtaining interviews with anglers who had finished fishing (a "completed trip" interview). Most of this effort was focused along the Trout Brook Road and adjacent parking areas. Creeled trout were examined for species, length, and fin-clips. Other information collected included angler name and address, time spent fishing, study zone fished, fishing lure used, and estimated number of trout released.

If an angler fished both study zones on the same trip, information was recorded for each zone as if two separate trips had been made. It is recognized that the separate trips thus recorded are not truly independent since one trip affects or constrains the other. The impacts of this effect on the data sets are unknown but some characteristics associated with crossover were recorded.

Interviewed anglers were also offered an informational hand-out card which contained a brief explanation of the study, its objectives and the regulations in effect.

During the 1979 trout fishing season, "angler attitude" survey forms were distributed to 233 anglers who had completed their fishing trips with preaddressed, stamped return envelopes. In addition to a few factual questions, anglers were asked to rank seven characteristics of their most recent trip. Four categories of ranking were provided ranging from "highly satisfied" to "highly dissatisfied."

TROUT POPULATION ESTIMATES

Each year of the study DC electrofishing gear (3 positive electrodes, 1 negative electrode, 230-volt generator) was employed to conduct mark-recapture estimates of trout in each study zone in mid-April and the first week in October. Estimates were made by inch group for each trout species employing the Chapman modification of the basic Petersen estimate formula. Inch group estimates were apportioned by age group based on ratios of known-age fin-clip marks for age I or older trout handled and a clear break in the length frequencies between wild age 0 trout captured in October and all older trout. Scale sample collections were also made to ascertain ages of trout in inch groups for which known-age data were deficient.

RESULTS

THE SPORT FISHERY

Review of Seasons

1976. During this baseline season of the study, when statewide regulations prevailed on both study zones, counts and interview data were gathered on 110 days of the 153-day fishing season. Census hours were equivalent to 39% of the total angler hours. Interviews were obtained from 761 anglers who had completed their fishing trip and 170 who had not. Complete trip interviews represented 25% of the estimated number of angler trips for the season.

Several numerical characteristics of the 1976 sport fishery are summarized by zone in Table 2. With few exceptions these creel census statistics reflected a more intensive fishery on the Race Br. than on the Willow Br.:

- 3% more angler hours/zone or 9% more hours/acre
- 11% more trips/zone, or 17% more trips/acre
- 11% more trout creeled/zone, or 17% more creeled/acre
- 1% less yield measured in lb/zone, but 5% more measured in lb/acre
- 32% more trout released/zone, or 39% more/acre
- 7% higher hourly catch rate for trout creeled
- 29% higher hourly catch rate for trout released

Mean length of trout creeled was slightly greater on the Willow Br. (9.5 vs. 9.1 in.) as was the harvest in terms of pounds (396 vs. 394).

Estimated exploitation rates (proportion of spring stock creeled) differed by only 1% for the two study zones and in both zones the proportion of nonresident anglers was very high.

In both fishing zones it was likely that some trout were caught more than once. For the Race Br. the combined catch of trout creeled and trout released was equivalent to 786/acre (3,740/mile), a figure 76% greater than the density of trout present in April. Moreover, since only 2% of the April stock was not legal-sized (6 in. or more) most of the trout released could have been kept. For the Willow Br. an even greater proportion of the April stock exceeded the legal size limit of 6 in. and the total catch of 601/acre (3,200/mile) exceeded the preseason density by 52%. Some of this "excess" could of course have been attributable to immigration.

Total harvest amounted to 80 lb/acre for the Race Br. and 76 lb/acre for the Willow Br. These values are equivalent to 71% and 68% of the April biomass in the Race and Willow, respectively.

Monthly patterns of angler use (Fig. 2) and harvest (Fig. 3) were similar in both zones. More than half of the total angling hours and harvest occurred in May, the first month of the five-month season. Fishing effort and harvest steadily declined during June, July, and August and then increased somewhat in September. Angling effort was slightly higher on the Willow Br. than on the Race Br. during May and September, but over the season total angling hours/acre were 9% more on the Race Br. Harvest/acre/month was higher on the Race Br. every month but September and was 17% greater for the season.

Monthly catches of brown trout released/acre were consistently higher on the Race Br. over the season and exceeded the seasonal catch on the Willow Br. by 39% (Fig. 4). As with angling effort and harvest, more than half of the trout caught and released during the 1976 season were taken in May.

Average length of 1,320 brown trout harvested from the Race Br. was 9.1 in. Trout in the 8-in. group comprised the most dominant inch-group in the harvest (30% of the total). In the Willow Br. average length of 1,190 trout creeled was 9.5 in. but most were in the 8-in. group (28% of the total harvest). A greater proportion of the total harvest in the Willow Br. consisted of brown trout in the 9- to 12-in. size group than occurred in the Race Br. harvest (Fig. 5.).

Despite the large number of trout creeled during the season, few of the interviewed anglers had limit catches of 5 in May or 10 during June-September (Table 3). No catches of more than 6/day were recorded on the Willow Br. during June-September, based on interviewing 159 anglers who had completed fishing, and only one of 266 anglers through fishing on the Race Br. had kept 10 trout during the June-September period.

Among the three most common baits used (live bait, artificial flies and lures) on the Race Br., the greatest proportion of angling hours (46%), the greatest proportion of angling trips (46%), and the greatest proportion of trout released (78%) were accounted for by anglers using flies (Table 4). More trout were caught on live bait and kept (68%) than on flies (14%) or artificial lures (14%) on the Race Br. On the Willow Br. anglers using live bait accounted for the greatest proportions of hours fished (43%), angling trips (42%), and trout harvested (57%). More trout were released in this zone after being caught on flies (61%) than on any other type of bait.

On the Race Br. trout caught on artificial lures and kept averaged 9.8 in. vs. an average of 9.2 in. for fly-caught trout and 8.9 in. for live-bait-caught trout (Table 4). Trout caught and kept by fly fishermen on the Willow Br. averaged 10.1 in.; those taken on live bait averaged 9.1 in.; those taken on artificial lures averaged 9.0 in.

1977-79. During these years, the special angling regulations prevailed on the Race Br. while statewide regulations continued to apply on the Willow Br. Creel census effort in 1977 covered 106 days of the 147-day season and 37% of the potential angler hours. Interview data were obtained from 902 anglers, of whom 717 had completed their fishing trip. This sample represented 21% of the total number of trips estimated for the season.

The 1978 fishing season encompassed 148 days of which 106 were censused. Of the 838 anglers interviewed, 816 had finished fishing. Sample size was equivalent to 25% coverage of the total trips for the season.

In 1979, the creel census included 107 days of the 149-day season during which interviews were made with 674 anglers of whom 652 had finished fishing. Approximately 21% of the angler trips for the season were sampled during this last year of the study.

Details of the sport fishery during 1977-79 will be presented in the following sections in comparison with results from the 1976 baseline season.

Angler Use Characteristics - Hours and Trips

Angler hours/zone increased on the Race Br. in 1977 by 14% over the level recorded for the 1976 baseline season, but decreased by 16% in 1978 as compared to 1976. In 1979, hours/zone increased by 4% over that estimated for 1978 but the total was still less than for 1976 (Fig. 6). On the average, angling effort measured by this index was 5% less after imposition of catch and release regulations (Table 2).

Even though the number of angler hours/season declined on the Race Br. in 1978 and 1979 as compared to 1976,

TABLE 2. *Creel census statistics for the sport fishery on the Race Br. and Willow Br. study zones during the 1976-79 trout fishing season.*

Item	Race Br. Study Zone						Willow Br. Study Zone					
	Base Year	Experimental Years					Base Year Regulations					
	1976	1977	1978	1979	1977-79 Avg.	% Difference (1977-79 Avg. ÷ 1976)	1976	1977	1978	1979	1977-79 Avg.	% Difference (1977-79 Avg. ÷ 1976)
Angler hours	4350	4970	3650	3800	4140	−5	4210	3820	2910	2970	3230	−23
Angler trips	1670	1840	2030	1900	1920	+15	1500	1530	1260	1240	1340	−11
Angler hours/trip	2.6	2.7	1.8	2.0	2.2	−15	2.8	2.5	2.3	2.4	2.4	−14
Trout creeled (no.)												
Brown	1320	28	11	19	19	−99	1190	765	838	863	822	−31
Rainbow	0	4	0	0	1			238	202	52	165	
Total	1320	32	11	19	20	−98	1190	1003	1040	915	987	−17
Trout creeled/acre (no.)												
Brown	270	5.7	2.2	3.9	3.9	−99	231	148	162	167	159	−31
Rainbow		0.0	0.8	0.0	0.3			46	39	10	32	
Total	270	5.7	3.0	3.9	4.2	−98	231	194	201	177	191	−17
Trout creeled (lb)												
Brown	394.0	28.4	10.3	19.1	19.3	−95	396.0	303.0	282.0	362.0	316.0	−20
Rainbow		0.0	2.9	0.0	1.0			52.2	46.0	12.4	36.9	
Total	394.0	28.4	13.2	19.1	20.3	−95	396.0	355.2	328.0	374.4	352.9	−11
Trout creeled/acre (lb)												
Brown	80.4	5.8	2.1	3.9	3.9	−95	76.5	58.7	54.5	70.1	61.1	−20
Rainbow		0.0	0.6	0.0	0.2			10.1	8.9	2.4	7.1	
Total	80.4	5.8	2.7	3.9	4.1	−95	76.5	68.8	63.4	72.5	68.2	−11
Avg. length creeled (in.)												
Brown	9.1	13.8	14.0	13.7	13.8	+52	9.5	10.1	9.5	10.2	9.9	+4
Rainbow		0.0	13.2	0.0	13.2			8.2	8.7	8.5	8.5	
Total	9.1	13.8	13.8	13.7	13.7	+51	9.5	9.1	9.2	10.1	9.4	−1
Trout released (no.)												
Brown	2530	4800	4800	5340	4980	+97	1910	1780	2040	1210	1680	−12
Rainbow		598	600	284	494			222	434	88	248	
Total	2530	5398	5400	5624	5474	+116	1910	2002	2474	1298	1928	+1
Trout released/acre (no.)												
Brown	516	979	980	1090	1020	+97	370	345	394	235	325	−12
Rainbow		122	122	58	101			43	84	17	48	
Total	516	1101	1102	1148	1121	+116	370	388	478	252	373	+1
Trout creeled/hour												
Brown	0.30	<0.01	<0.01	<0.01	<0.01	−98	0.28	0.20	0.28	0.29	0.26	−7
Rainbow		0.00	<0.01	0.00	<0.01			0.06	0.07	0.02	0.05	
Total	0.30	<0.01	<0.01	<0.01	<0.01	−98	0.28	0.26	0.35	0.31	0.31	+11
Trout released/hour												
Brown	0.58	0.96	1.30	1.41	1.22	+110	0.45	0.47	0.69	0.41	0.52	+16
Rainbow		0.12	0.16	0.07	0.12			0.06	0.15	0.03	0.08	
Total	0.58	1.08	1.46	1.48	1.34	+131	0.45	0.53	0.84	0.44	0.60	+33
Trout released/trout creeled												
Brown	2	172	445	280	299	+1473	1.6	2.3	2.4	1.4	2.0	+25
Rainbow			149		368			0.9	2.1	1.7	1.5	
Total	2	193	364	294	268	+1240	1.6	2.0	2.4	1.4	2.0	+25
Exploitation (%)												
Brown	60	1	<1	<1	<1	−98	59	55	47	40	47	−20
Rainbow		0	1	0	<1			58	52	54	55	
Nonresident trips (%)	75	84	68	71	74	−1	60	80	67	66	71	+18

Some young anglers, usually equipped with spin fishing gear, participated in the catch and release fishery, but more than 80% of the angler trips on the Race Branch during 1977-79 were accounted for by adult anglers using fly fishing gear.

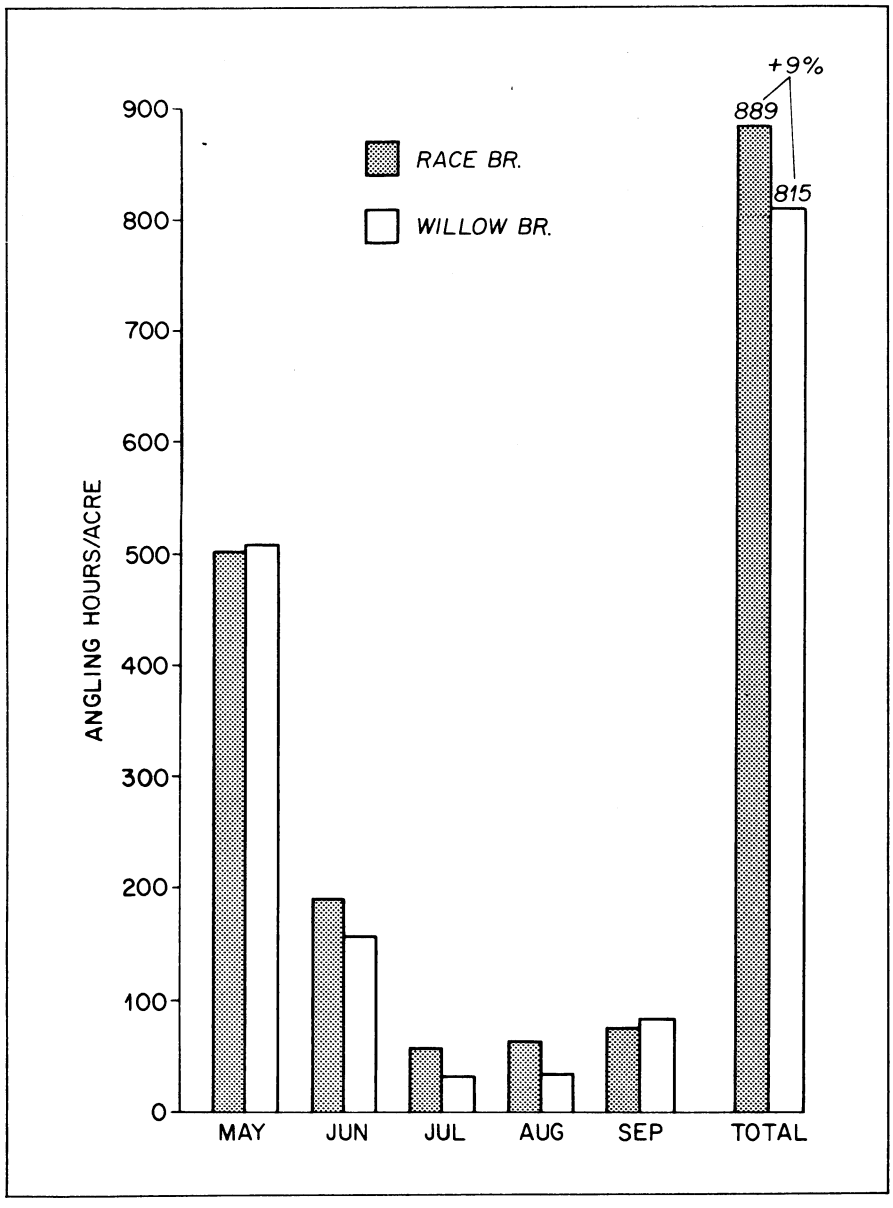


FIGURE 2. *Angling hours/acre in the Race Br. and Willow Br. study zones, during each month of the 1976 trout fishing season.*

there were more angler trips/season during all 3 seasons of catch and release regulations when compared to 1976 data. Angler trips/season peaked in 1978 and averaged 15% more for 1977-79 vs. 1976 (Fig. 6).

On the Willow Br. angler hours/season declined by an average of 23% for 1977-79 vs. 1976 and trips/season averaged 14% less than the number made in 1976.

During all 4 years of the study, the Race Br. received more angler use (both hours and trips) than did the Willow Br.

Differences in the 4-year patterns of hours/season and trips/season in each study zone are partially due to changes in the average amount of time anglers fished per trip. Based on the information obtained from anglers interviewed at the end of their trip, the average trip was 2.6 hours on the Race Br. in 1976, remained about the same duration in 1977, declined to just 1.8 hours in 1978 and then increased again in 1979 to an average of 2.0 hours. As a consequence of these year-to-year changes in average time spent fishing per trip, the greatest number of trips/season on the Race Br. occurred in 1978, the season when the fewest total hours of angling occurred. On the Willow Br. the most trips/season occurred in 1977, the year of second highest use measured in angler hours.

Trout Creeled and Trout Released

As expected, the take-home catch of trout from the Race Br. during the 1977-79 seasons declined dramatically from the 1976 level (Fig. 7). The estimated total harvest in 1977 of 28 trout was only 2% of the number creeled in

TABLE 3. *Frequency distributions of trout creeled/trip in the Race Br. and Willow Br. study zones during the 1976-79 trout fishing seasons.*

Bag Size	Trips in May(%)				Trips in June-September(%)			
	Race Br.		Willow Br.		Race Br.		Willow Br.	
	1976	1977-79 Avg.	1976	1977-79 Avg.	1976	1977-79 Avg.	1976	1977-79 Avg.
0	60.3	98.7	55.6	60.8	78.2	99.2	70.4	71.7
1	16.0	1.3	15.5	12.3	11.3	0.8	18.2	13.4
2	9.8		16.2	10.0	5.2		2.5	5.5
3	4.6		6.3	5.8	2.2		4.4	3.1
4	3.1		3.5	4.4	0.8		1.9	2.3
5	6.2		2.8	6.7	1.9		1.3	0.7
6							1.3	0.5
7								0.5
8								0.5
9								0.7
10					0.4			0.2

1976. During the following two seasons of special regulations, harvest was even less — just 11 trout in 1978 and 19 trout in 1979 (Table 2). Rainbow trout contributed to the harvest only in 1978 when 4 were creeled. The average harvest of 20 trout/season during 1977-79 was equivalent to 1% of the 1976 harvest. Average biomass yield during 1977-79 (4.1 lb/acre) was equivalent to 5% of the biomass removed during the 1976 season (80.4 lb/acre).

Take-home catch from the Willow Br. declined by 16% in 1977 vs. 1976, increased 4% in 1978 as compared to 1977 and then decreased 12% in 1979 (Fig. 7). In this study zone rainbow trout made important contributions to yields in 1977 and 1978, accounting for 24% and 19% of the numbers of trout kept. In 1979, however, only 6% of the total number of trout were rainbow trout. The average annual catch of 987 trout (191/acre) from the Willow Br. during 1977-79 represented a 17% decline from that recorded in 1976, a lesser proportional decrease than that calculated for hours of fishing (-23%).

For both study zones declines in harvest were less in terms of weight than in number when averages for the 1977-79 seasons were compared to values for the 1976 season. Harvest in pounds/acre decreased from 80.4 to an average of only 4.1 for the Race Br., a 95% decline. Anglers removed 76.5 lb/acre of trout from the Willow Br. in 1976 and an average of 68.2 lb/acre in 1977-79, a decline of 11%. The highest rate recorded for either zone was 80.4 lb/acre from the Race Br. in 1976. Rainbow trout made up 10% of the biomass cropped during 1977-79 on the Willow Br. (Table 2).

Length frequency distribution of the 1977-79 take-home catch from the Race Br. was markedly skewed in comparison to the 1976 harvest curve (Fig. 5). Approximately 84% of the trout harvested during the 1977-79

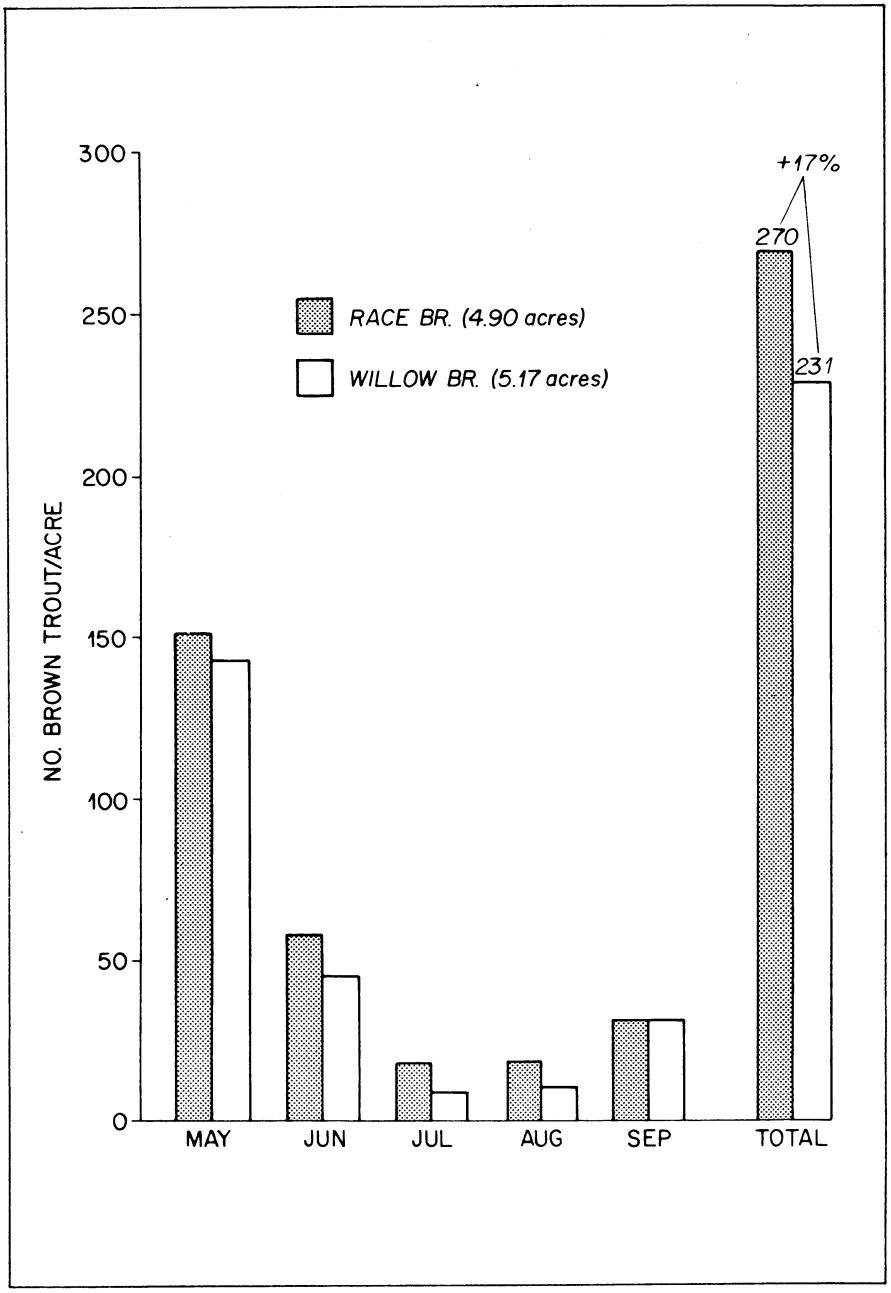


FIGURE 3. *Brown trout/acre harvested in the Race Br. and Willow Br. study zones during each month of the 1976 trout fishing season.*

seasons were in the 13- and 14-in. groups. Average length of legal-sized trout creeled during the three seasons of special regulations on the Race Br. was 13.8 in., with little variation by season. In 1976, trout creeled on the Race Br. averaged 9.1 in. For the Willow Br., average length of brown trout creeled increased from 9.5 in. in 1976 to 9.9 in. for the 1977-79 season. During the three seasons that rainbow trout were available, average lengths of those kept were 8.2, 8.7, and 8.5 in., with a composite average of 8.5 in. (Table 2).

The seasonal catch of trout released, which was already high on the Race Br. in 1976 for fishing under normal regulations, increased dramatically in 1977, by 113%, increased slightly again in 1978 despite a decrease in hours of fishing, and then increased again in 1979 by 4% over the 1978 value and by 123% over the 1976 baseline season value (Fig. 7). Rainbow trout accounted for 11% of the trout reported released by anglers during 1977, and again in 1978, and 5% of those released in 1979. The average number of trout released during 1977-79 exceeded the number released in the Race Br. in 1976 by 117%.

On the Willow Br. the practice of voluntary catch and release produced a slightly greater throw-back catch in 1977 than in 1976, a sharp increase of 23% in 1978, and then a decline of 47% in 1979 to the lowest seasonal total among the four study years (Fig. 7).

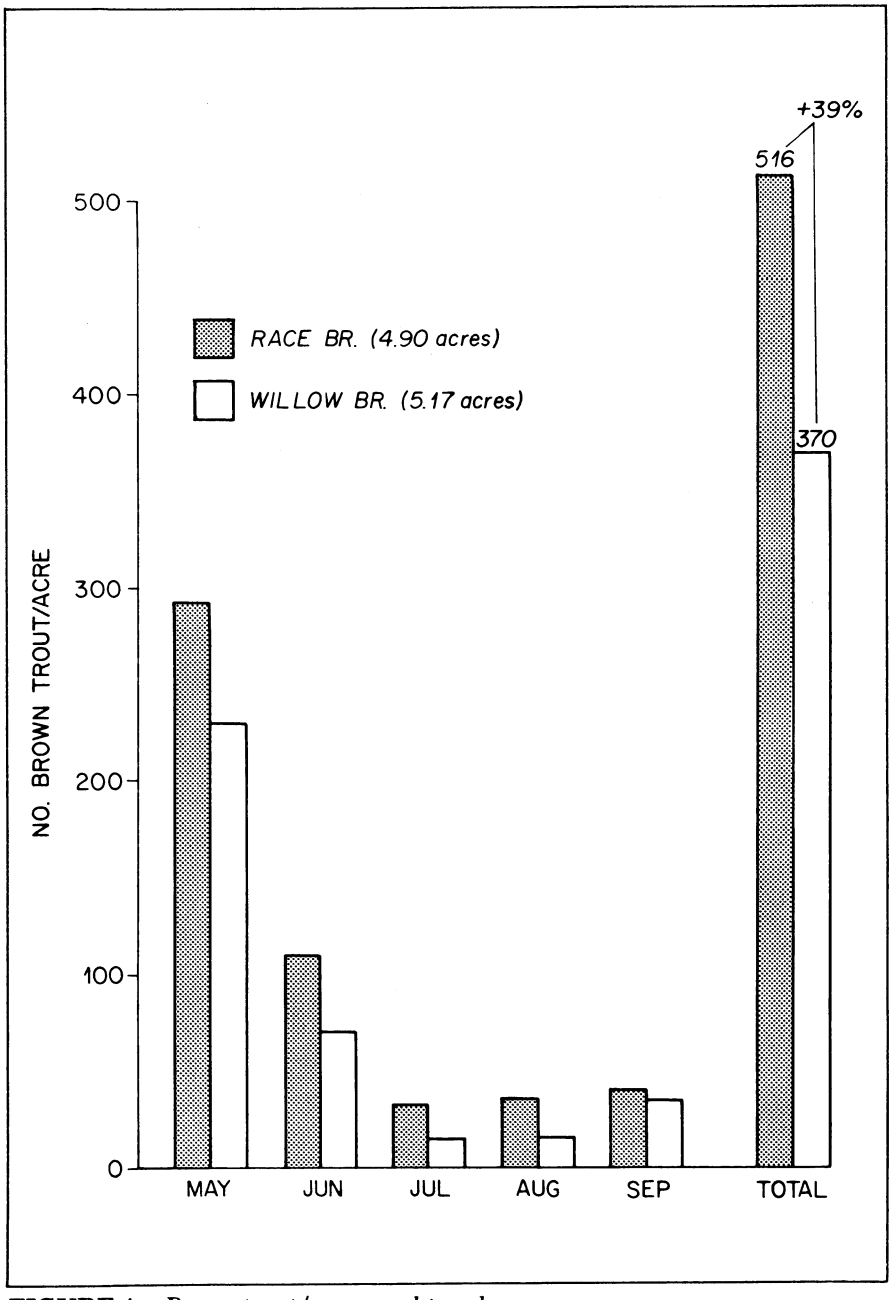


FIGURE 4. *Brown trout/acre caught and released in the Race Br. and Willow Br. study zones during each month of the 1976 trout fishing season.*

For the 1977-79 seasons as a whole, 1% more trout were released per season than were released in 1976 (Table 2).

Catch Rates, Ratios, and Exploitation

Two indexes of hourly catch rate were calculated for each fishing season. The rate for trout creeled/hour was 0.30 in 1976 for the Race Br. fishery. This rate subsequently declined to less than 0.01 during each of the 1977-79 fishing seasons as a result of imposing special regulations (Table 2). Anglers in 1976 fished an average of 3.2 hours to creel one trout; during 1977-79, an average of 202 hours were expended to creel one trout. Catch rate for trout released was 0.58 trout/hour in 1976. This index of fishing quality subsequently increased each special regulation season — to 1.08 in 1977, 1.46 in 1978, and 1.48 in 1979. During these three seasons it was the added dimension of catches of rainbow trout that helped to raise the rate above 1.0/hour.

For the Willow Br. the catch rate for trout creeled decreased to 0.26 in 1977 from the 0.28 rate recorded in 1976. In 1978, trout were creeled at a rate of 0.35/hour, the highest such seasonal value observed during the four-year study. During the last season of the study this index was 0.31 trout/hour (Table 2). Translated into hours of fishing per trout creeled, 3.6 hours were expended in 1976; the average for 1977-79 was 3.2 hours. Fishing quality as reflected in the hourly rate at which trout were released also improved on the Willow Br. during 1977-79 as compared to 1976, but not nearly to the degree that occurred on the Race Br. where the regulations were designed to enhance this aspect of the fishery. Because of the much greater harvest of trout from the Willow Br. than from the Race Br. during 1977-79, there simply were not as many trout available as the seasons progressed to be caught and released in the Willow Br. as in the Race Br.

Changes in the seasonal ratios of trout released to trout creeled provided another dramatic insight into the impact that special regulations had on the sport fishery in the Race Br. during 1977-79. From a ratio of 2:1 in 1976, this index jumped to nearly 200:1 in 1977, to 364:1 in 1978 and 294:1 in 1979 for a three-season average of 268:1 (Table 2).

For the Willow Br., the 1977-79 average for this index was 2.0:1; the 1976 ratio was 1.6:1. The highest ratio observed for this study zone was in 1978 when 2.4 trout were released for every trout creeled.

Angler exploitation rates for the Race Br. declined from the 60% level recorded in 1976 to 1% or less during the 1977-79 seasons. For the Willow Br., exploitation rates of brown trout stocks averaged 47% during 1977-79 compared to a rate of 59% in 1976. Rainbow trout in the Willow Br. proved to be more vulnerable than brown trout all three seasons they were a part of the fishery. Average exploitation of rainbow trout during 1977-79 was 55% (Table 2).

Angler Residency Characteristics

Nonresident anglers made more fishing trips in both study zones all four seasons than did resident anglers, accounting for 68-84% of the trips/season on the Race Br. and 60-80% of the trips/season on the Race Br. and 60-80% of the trips/season on the Willow Br. Use of the Willow Br. by resident anglers was higher in 1976 than in any of the following seasons, a possible negative response to the application of special regulations on the adjacent Race Br. Highest nonresident use of either zone occurred on the Race Br. during the 1977 season when they accounted for 84% of the total trips during the first season of special regulations (Table 2).

Changes in Distribution of Angling Effort — By Month and Season

Distribution of angling effort during the 5-month fishing seasons was distinctly altered on the Race Br. by the change to catch and release regulations. Less change occurred on the Willow Br. in 1977-79 as compared to 1976 (Fig. 8). Of the total hours of angling on the Race Br. for the 1976 season, 55% occurred in May. On the Willow Br. angler hours in May 1976 comprised 62% of the total for the season. By the end of June 78% and 82% of the total hours/zone had been logged on the Race Br. and Willow Br., respectively.

By contrast, during the 1977-79 seasons only 22% of the total hours of effort occurred in May and less than half by the end of June on the Race Br. Similarly on the Willow Br. proportionately less of the total effort for these three seasons took place in May (37%) and by the end of June (57%).

In terms of actual hours fished on a month-by-month basis, a wide disparity in seasonal patterns is also evident as a result of changing to catch and release regulations (Fig. 9). For the first month of each of the 1977-79 seasons, average fishing pressure on the Race Br. was 63% less than that for May 1976. For the other four months, however, greater average use occurred during the 1977-79 seasons than occurred in 1976 (Table 5). These higher use totals for the last four months did not quite offset the 63% decline in angler hours during May. Consequently, total hours of fishing for the entire fishing season fell 5% short in 1977-79 from the hours of angling on the Race Br. in 1976.

Anglers fishing the Willow Br. during 1977-79 spent more time there on the average during the months of July, August and September than for the same three months in 1976, but this change did not offset the much lower frequency of use during the first two months of the 1977-79 seasons as compared to that in 1976. Hours of angling/month differed by 55% in May in favor of 1976. This gap was gradually diminished each month thereafter but for the season as a whole, an average of 23% fewer hours were fished during 1977-79 than during 1976 (Fig. 9).

As previously indicated, the three seasons of special regulations were a period when more angler trips/season were made to the Race Br. than were made in 1976 despite an average decrease in hours fished. Trips/acre/month for 1976 and the monthly averages for the 1977-79 seasons are plotted in cumulative fashion in Figure 10.

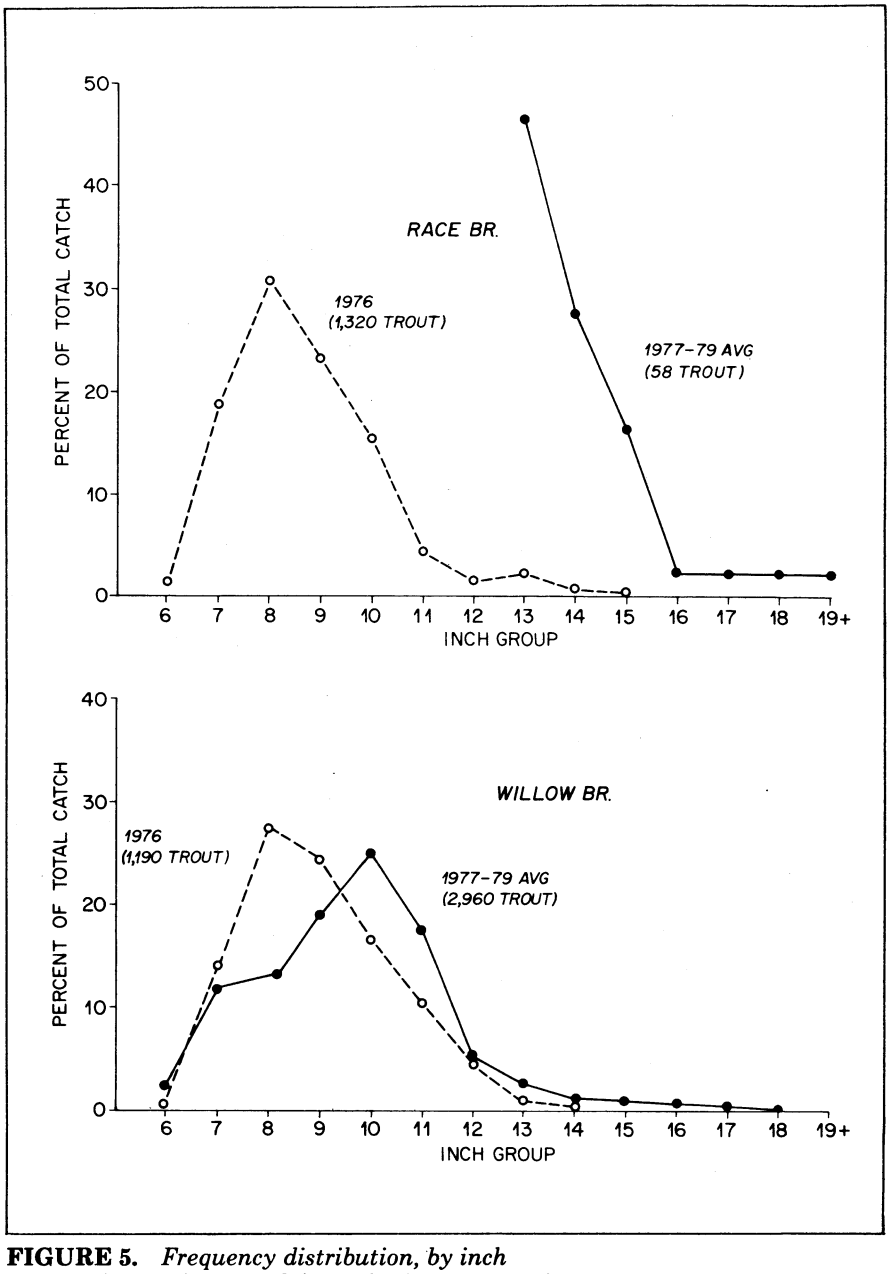


FIGURE 5. *Frequency distribution, by inch group, of trout harvested from the Race Br. and Willow Br. study zones, during the 1976-79 trout fishing seasons.*

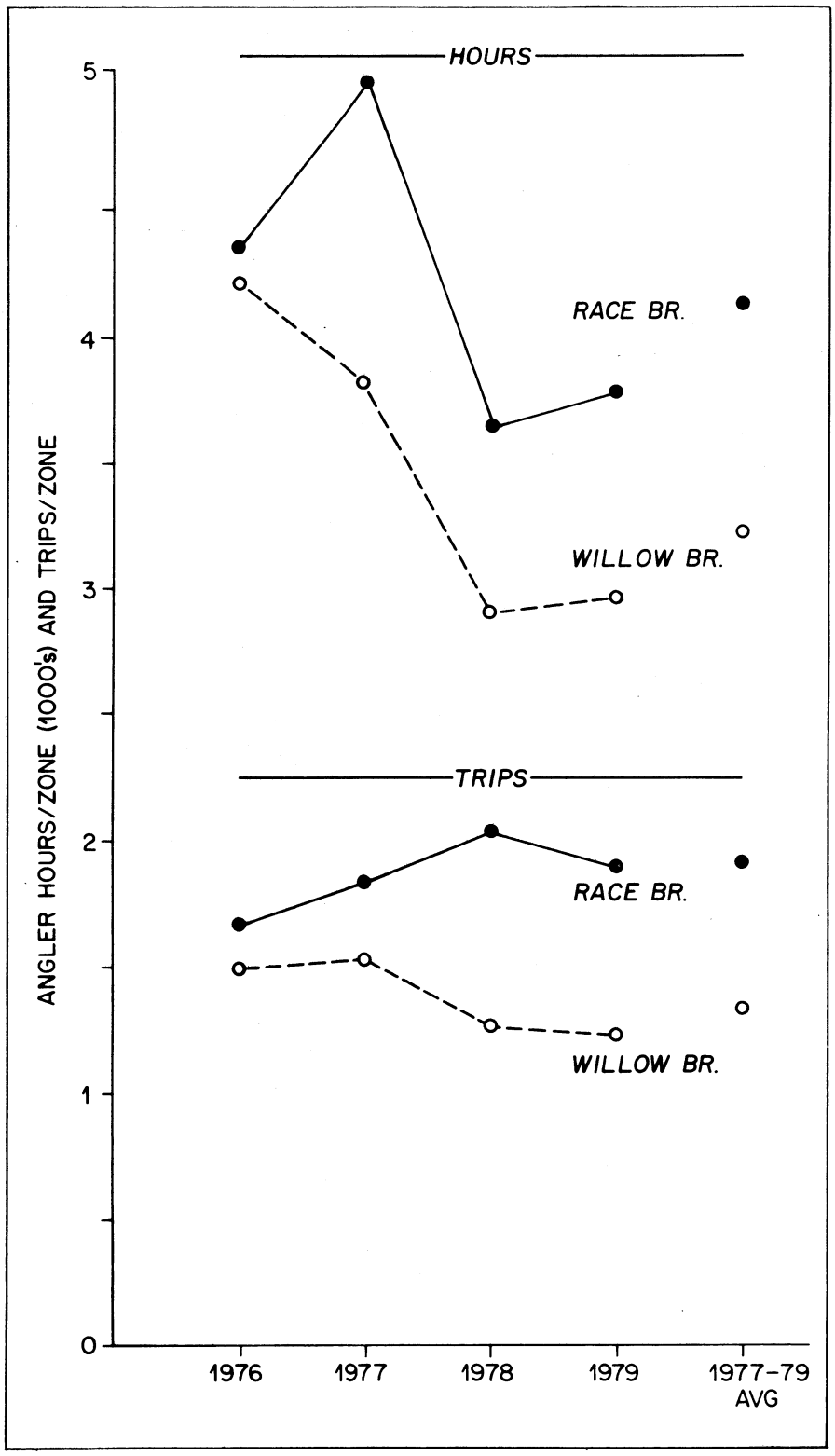


FIGURE 6. *Angling hours/zone and angler trips/zone in the Race Br. and Willow Br. study zones, during the 1976-79 trout fishing seasons.*

Despite 55% fewer trips on the Race Branch in May 1977-79 as compared to May 1976, this gap had been closed and the trends reversed by the end of August.

The pattern of cumulative trips/month for the Willow Br. during 1977-79 also reflected, as did the monthly accumulations of hours fished, the shift in angler use from less use in May and June to greater use in July-September of 1977-79. Cumulative trips/acre during the 1977-79 seasons never attained the degree of use that occurred in 1976 (Fig. 10).

Bag Limit Characteristics

During the 1976 season, 40% of the anglers interviewed on the Race Br. kept at least 1 trout during May when the bag limit was 5 and the length limit was 6 in. Limit catches were made on 6% of the trips. During June-September, when the creel limit was increased to 10/day, 22% of the anglers interviewed at the end of their fishing trip had kept 1 or more trout, only 2% had creeled 5 or more trout and only 0.4% left with limit catches (Table 3). For the season as a whole, at least 1 trout was creeled on 32% of the angling trips.

During the next three seasons the bag limit of 1 trout over 13 in. was achieved on only 0.9% of the angling trips. A few trout over 13 in. were also reported caught and released by anglers interviewed.

On the Willow Br., where regulations did not change during 1976-79, proportionately more anglers kept at least 1 trout during 1976 than during 1977-79 despite the presence of stocked rainbow trout during 1977-79 to augment the brown trout fishery.

Anglers successful in catching and releasing at least 1 trout/trip on the Race Br. increased from 38% of the trips in 1976 to an average of 60% of the trips in 1977-79 (Table 6). Those releasing 10 or more trout/trip increased from 2.6% to 7.0%. Catch and release success also improved on the Willow Br., increasing from 32% in 1976 to an average of 42% in 1977-79.

Bait Type Influences

Anglers using live bait (principally worms) accounted for 38% of the angler trips made to the Race Br. during 1976. Fly fishing anglers accounted for 46% of the total trips; those using artificial lures comprised 9% of the total trips. With the elimination of bait fishing during the 1977-79 seasons, the proportion of anglers using flies jumped to 84% and the proportion using artificial lures rose to 15% (Fig. 11).

On the Willow Br. live baits were employed exclusively on 42% of all angler trips in 1976. Artificial flies were second in popularity, used exclusively on 37% of the total trips. Live baits were proportionately less popular during the 1977-79 seasons, whereas artificial flies increased in popularity being the exclusive bait used on 46% of the angler trips.

TABLE 4. *Angler effort, catch and catch rates in the Race Br. and Willow Br. study zones according to bait types used during the 1976-79 trout fishing seasons.*

	Race Br.								Willow Br.							
	Live Bait		Fly		Lure		Combination		Live Bait		Fly		Lure		Combination	
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total
1976 fishing season																
Trips	631	38	764	46	150	9	107	7	641	42	564	37	199	13	110	7
Hours	1790	41	1990	46	302	7	278	6	1800	43	1450	34	644	15	314	7
Trout creeled	893	68	185	14	181	14	64	5	685	57	294	25	133	11	84	7
Trout released	328	13	1970	78	116	5	113	4	322	17	1160	61	209	11	218	11
Avg. length creeled (in.)	8.9		9.2		9.8		9.1		9.1		10.1		9.0		9.5	
Catch per hour																
Creeled	0.30		0.09		0.60		0.23		0.38		0.20		0.21		0.27	
Released	0.18		0.99		0.38		0.41		0.18		0.80		0.32		0.69	
Total	0.48		1.08		0.98		0.64		0.56		1.00		0.53		0.96	
1977-79 fishing seasons																
Trips	*		1622	84	290	15	17	1	424	31	619	46	183	14	127	9
Hours	*		3582	86	538	13	32	1	1050	33	1460	45	413	13	309	10
Trout creeled	*		7	36	12	64	0	0	487	53	239	26	117	13	76	8
Trout released	*		4920	90	542	10	10	<1	551	28	1060	55	220	11	105	6
Avg. length creeled (in.)			13.6		13.9				9.3		9.5		10.1		10.1	
Catch per hour																
Creeled	*		<0.01		0.02		0.00		0.45		0.16		0.28		0.25	
Released	*		1.37		1.01		0.30		0.51		0.72		0.53		0.34	
Total	*		1.37		1.03		0.30		0.96		0.88		0.81		0.59	

*Use of live bait was prohibited in the Race Br. during the 1977-79 trout fishing seasons.

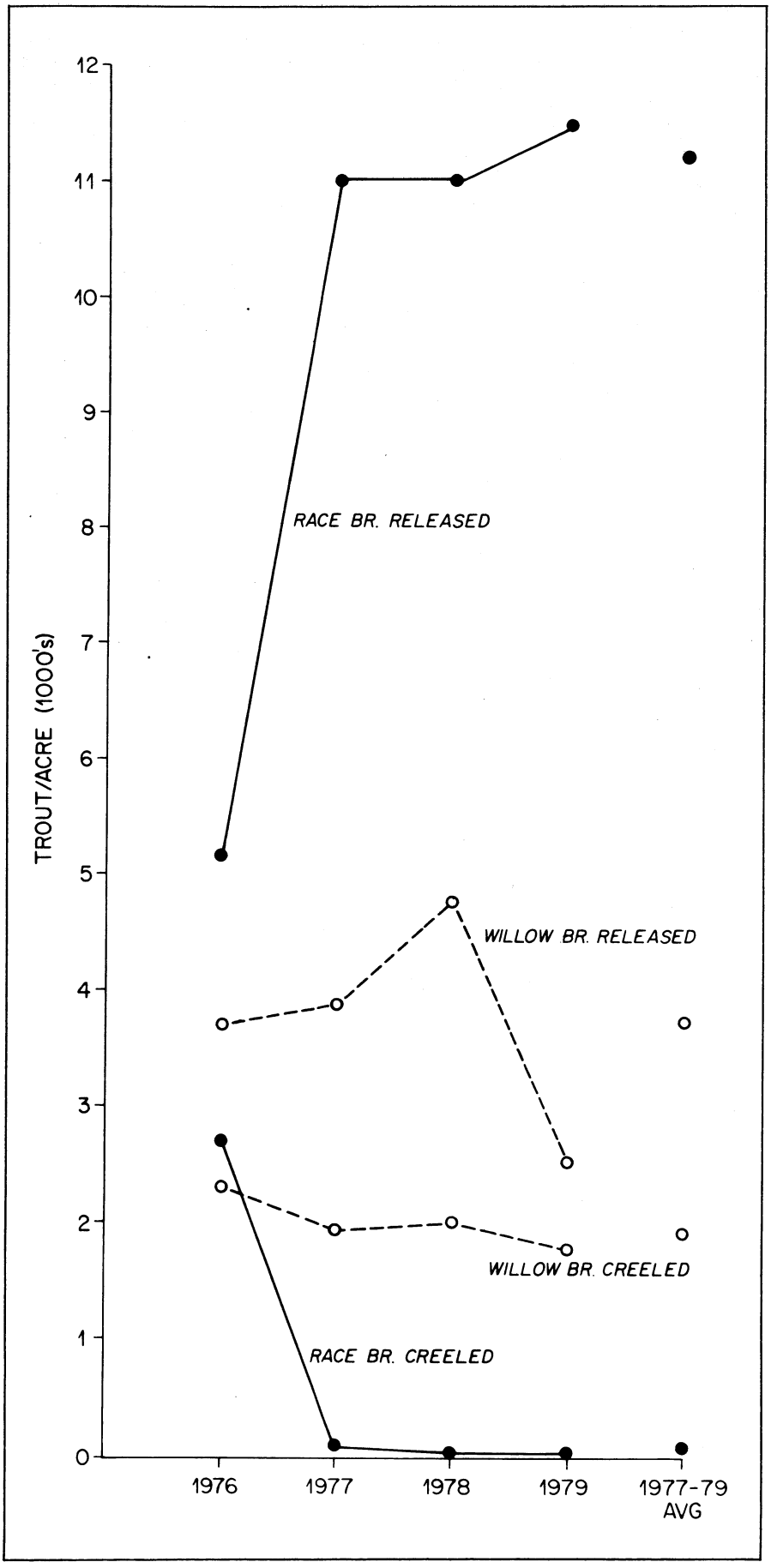


FIGURE 7. *Number of trout/acre creeled and number/acre released in the Race Br. and Willow Br. study zones during the 1976-79 trout fishing seasons.*

Although anglers using live bait accounted for 41% of the angler hours on the Race Br. in 1976, they removed 68% of the trout creeled at a catch rate of 0.30/hour. Meanwhile fly fishing anglers were logging 46% of the total hours but only 14% of the total harvest at a catch rate of 0.09 trout/hour (Table 4). Catch rate for trout released, however, was 5.5 times greater for fly fishing anglers than for live bait anglers (0.99/hour vs. 0.18/hour).

Of the legal-sized trout removed from the Race Br. during the 1977-79 seasons, 36% were caught on flies and the remaining 64% on artificial lures even though fly fishers accounted for 86% of all the hours. Approximately 90% of the trout released by anglers on the Race Br. during 1977-79 had been taken on flies. The average 3-year catch rate for trout released was 1.37/hour for fly fishers and 1.03/hour for artificial lure fishers (Table 4).

Anglers using live bait fished 40% fewer hours/season during 1977-79 than in 1976 on the Willow Br. and their take-home catch declined by 29%. Despite the substantial reduction in hours fished, the number of trout released after being caught on live bait increased by an average of nearly 71% in 1977-79 vs. 1976. Fewer trout/season were creeled by fly fishers on the Willow Br. during 1977-79 than during 1976. This was also true for the group of anglers choosing to fish with artificial lures. Fewer trout were also released/season in this study zone by anglers using flies during 1977-79 than were released during 1976. Anglers using artificial lures released slightly more trout/season in 1977-79 than in 1976 (Table 4).

Angler Attitudes

Of 233 angler attitude surveys distributed, only 77 (33%) were returned. One-third of these, in turn, were from resident anglers. Male anglers over 16 years old contributed 95% of the forms returned. Approximately 38% of the responding anglers had fished only the Race Br. on their most recent trip, while 30% had fished on the Willow Br. only. Fly fishers returned 71% of the questionnaires while anglers who had fished with live bait provided only 4% of the completed forms. Nearly 75% of the anglers responding had fished one or both study zones several times (Table 7).

Subjective ratings of the 7 attributes or qualities of their most recent fishing trip were not all usable, varying from 68 to 75 ratable responses out of a possible 77. These responses are summarized in Table 7. The combinations of "highly satisfied" and "satisfied"

TABLE 5. *Angling hours/acre/month in the Race Br. and Willow Br. study zones during the 1976-79 trout fishing seasons.*

Year	Study Zone	Angling Hours/Acre May	June	July	Aug.	Sept.	Total
1976	Race Br.	503	190	58	63	75	889
	Willow Br.	509	158	33	34	81	815
1977	Race Br.	214	301	186	161	153	1,015
	Willow Br.	270	122	100	121	127	740
1978	Race Br.	182	144	158	94	174	752
	Willow Br.	217	127	90	61	78	574
1979	Race Br.	166	202	109	144	155	775
	Willow Br.	206	126	75	76	93	575
1977-79 Avg.	Race Br.	188	215	151	133	161	847
	Willow Br.	231	125	88	86	99	629

TABLE 6. *Frequency distribution of trout released/trip in the Race Br. and Willow Br. study zones during the 1976 trout fishing season and averages for the 1977-79 seasons.*

No. Released	Trips on Race Br. (%) 1976	1977-79 Avg.	Trips on Willow Br. (%) 1976	1977-79 Avg.
0	62.4	40.3	68.4	57.9
1	13.5	14.1	8.0	10.9
2	7.0	10.3	10.3	10.3
3	5.2	7.7	2.7	6.4
4	2.2	5.2	3.7	4.0
5	2.2	4.7	2.0	2.5
6	2.8	4.1	1.7	1.8
7	0.7	3.0	0.0	1.0
8	1.0	1.9	0.0	2.1
9	0.4	1.7	0.7	0.3
10	0.7	1.5	0.6	0.7
11-14	1.0	3.0	1.3	1.1
15-19	0.5	2.1	0.6	0.4
20+	0.4	0.4	0.0	0.6

TABLE 7. *Summary of results obtained from angler attitude survey forms distributed during the 1979 trout fishing season to anglers fishing the Race Br. and Willow Br. study zones.**

	No. Respondents	Percent Total
1. State of Residency		
Wisconsin	25	32
Minnesota	50	65
Other	2	3
2. Sex and age		
Male over 16	73	94
Female over 16	2	3
Male under 16	2	3
Female under 16	0	0
3. Study zone of primary fishing interest on most recent trip		
Race Branch	29	38
Willow Branch	23	30
Both	25	32
4. Type of bait used on most recent fishing trip		
Worms or other live bait	3	4
Artificial flies	55	71
Spinning lures	10	13
Combination of flies and lures	2	3
Other combination	7	9
5. Frequency study zones were fished in last 3 seasons		
Several times each season	56	73
Only 1 or 2 times each season	9	12
First time in either zone	12	15

Characteristic or Attribute to be Ranked for Most Recent Trip	Total No. Respondents	Percent Total Respondents: Highly Satisfied	Satisfied	Dissatisfied	Highly Dissatisfied
No. of trout hooked	70	28	53	16	3
Size of trout hooked	68	15	65	17	3
Fighting quality of trout hooked	67	33	63	3	1
Esthetic quality of stream	74	50	43	5	1
Lack of interference from other anglers	75	43	49	5	3
Overall quality of the trip	74	54	42	3	1

*Of 233 survey forms distributed, 77 were returned in preaddressed envelopes provided. All data on every form were not usable for every category, hence the differences in total numbers of respondents for various attributes assessed.

ratings accounted for 79 of 96% of the total ratings among the 7 items rated. Overall quality of their most recent fishing trip was ranked as "highly satisfactory" by 54% of the respondents. Most of the respondents were satisfied with the number of trout hooked; only 3% were "highly dissatisfied" (2 of 70 anglers). The greatest disparity in opinions involved the size of trout hooked. Although 65% were "satisfied", only 15% were "highly satisfied" and 3% were "highly dissatisfied" (2 of 68 anglers).

TROUT POPULATION DYNAMICS

Brown trout were about equally abundant in the Race Br. and Willow Br. in mid-April 1976, numbering 2,133/mile and 2,104/mile, respectively. In early October 1976, the Race Br. held approximately 38% more brown trout/mile than did the Willow Br. During the remaining three years of the study, encompassing six more assessments of the standing stocks of trout in each study zone, abundance of trout in the Race Br. always differed by an even greater positive percentage

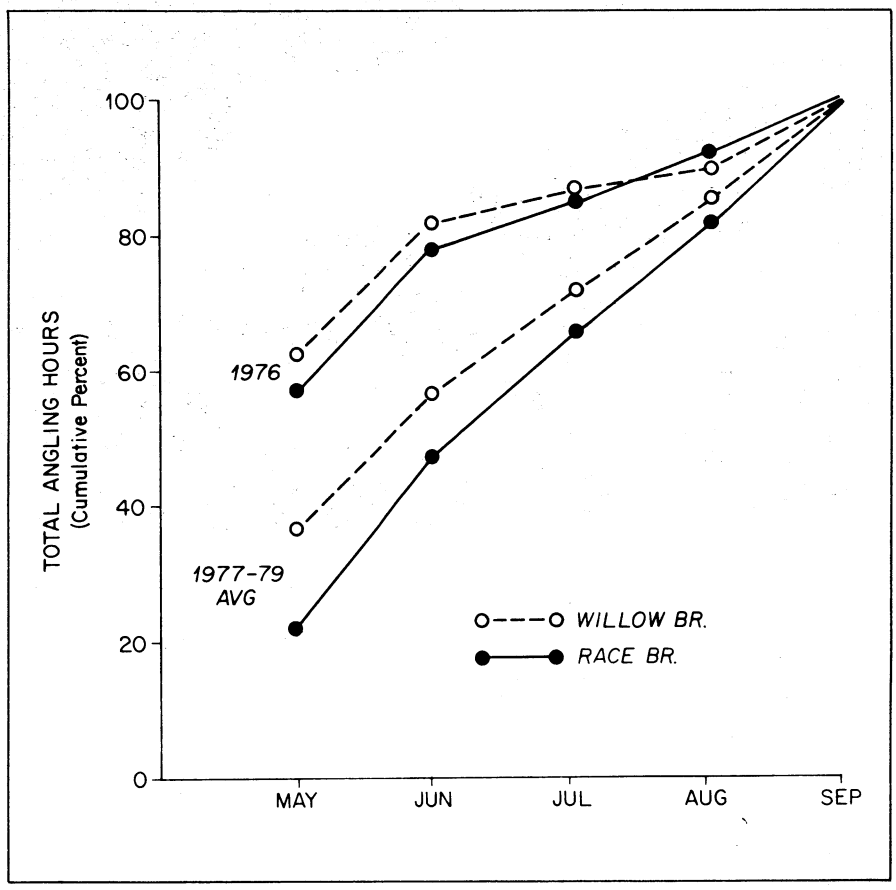


FIGURE 8. *Percentage distribution by month of the total hours of angling /fishing season in the Race Br. and Willow Br. study zones during the 1976 trout fishing season, and monthly averages for the 1977-79 seasons.*

from the abundance in the Willow Br. and reached a maximum difference of 124% in October 1979 (Fig. 12). April 1977-79 standing stocks in the two zones differed by an average of 57% in favor of the Race Br. as opposed to only a 1% difference in April 1976. Standing stocks in October 1977-79 averaged 95% greater in the Race Br. than in the Willow Br. as opposed to a 38% difference in October 1976.

Comparative differences within zones between the April 1976 standing stock and the average for April of 1977-79 also clearly favored the Race Br. over the Willow Br. Its average standing stock increased by 59% compared to the April 1976 baseline, whereas the comparable change for the Willow Br. was a positive 2% (Table 8).

The Willow Br. held proportionately more rainbow trout/mile than did the Race Br. in 2 of 3 Aprils and 1 of 3 Octobers, but the much greater abundance of brown trout in both study zones largely determined the divergence in standing stock histories after October 1976 for both species combined.

In terms of relative biomass, differences between zones were noticeably greater after application of special regulations to the Race Br. than were the differences in April and October 1976 (Fig. 13). Both zones held approximately 112 lb/acre of trout in April 1976. The average April biomass during the following three years was 69% greater in the Race Br. than in the Willow Br. (164 vs. 97 lb/acre). In October 1976, the biomass/acre differed by 49% in favor of the Race Br. This difference increased to 119% as an average for the Octobers of 1977-79 (138 vs. 63 lb/acre). Of the 8 biomass estimates/zone, the highest value for the Race Br. was 180 lb/acre in April 1978. Rainbow trout accounted for 13 lb/acre of this total. Maximum biomass noted for the Willow Br. was 112 lb/acre in April 1976 (Table 8). All 6 of the last 8 estimates of biomass of brown trout in the Race Br. exceeded the 2 estimates made in 1976. This pattern was not true for brown trout in the Willow Br. The highest estimate of the 8 was the first one and the lowest was the last one in the series, October 1979.

Patterns of spring and fall densities of trout over 13 in. in each study zone did not clearly separate from each other, as was the case for total stock numbers or biomass (Fig. 14). In both zones, the lowest density of trout 13 in. or larger was found in April 1976, with the Race Br. having fewer such trout than the Willow Br. Trout of this size increased from a density of 33/mile in the Race Br. in April 1976 to an average April density of 76/mile in 1977-79, a 131% increase. In the Willow Br. the corresponding change was from 43/mile to an average of 79/mile, an 83% gain even though no special regulations were in effect to encourage such a buildup (Table 8).

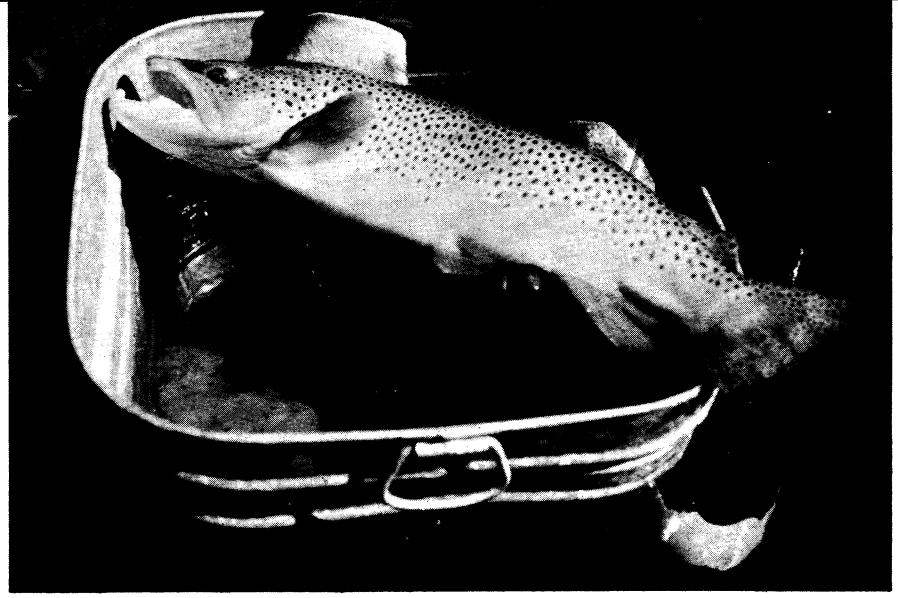
Average densities of trout over 13 in. in October increased 12% in the Race Br. and decreased 15% in the Willow Br. comparing the same two time periods.

Only 4 of 3,000 rainbow trout stocked in the Race Br. during the study were known to have attained a length of 13 in. and all 4 were creeled. Of the 3,000 stocked in the Willow Br., only 1 was captured during electrofishing activities that was larger than 13 in. and none of this size showed up in the harvest.

No trout over 20 in. were collected during the four electrofishing inventories in April. Only 6 trout of this size were collected during the four inventories in October, 3 in each study zone. The largest individual collected was a 27-in. male brown trout in the Race Br. in October 1976. Ten months later this trout was creeled by a spin-fishing angler in this study zone.

Not all of the trout temporarily "saved" as a result of being released rather than creeled survived until the end of the fishing season. However, April-to-October survival rates in the two study zones clearly support the conclusion that more trout were present in the Race Br. in the Octobers of 1977-79 than would have been there if catch and release regulations had not been applied. Average survival of age I and older trout for the April-October peiods of 1977-79 was 56%. The 1976 value for that period was 39%.

In the Willow Br. where exploitation of brown trout declined during the 1977-79 seasons as compared to the 1976 season, April-to-October survival rate was also enhanced, increasing from 29% in 1976 to an average of 39% in 1977-79.



The largest trout collected during the 4-year study was a 27-inch brown trout in October 1976. It was caught and kept during the 1977 fishing season by an angler fishing on the Race Branch.

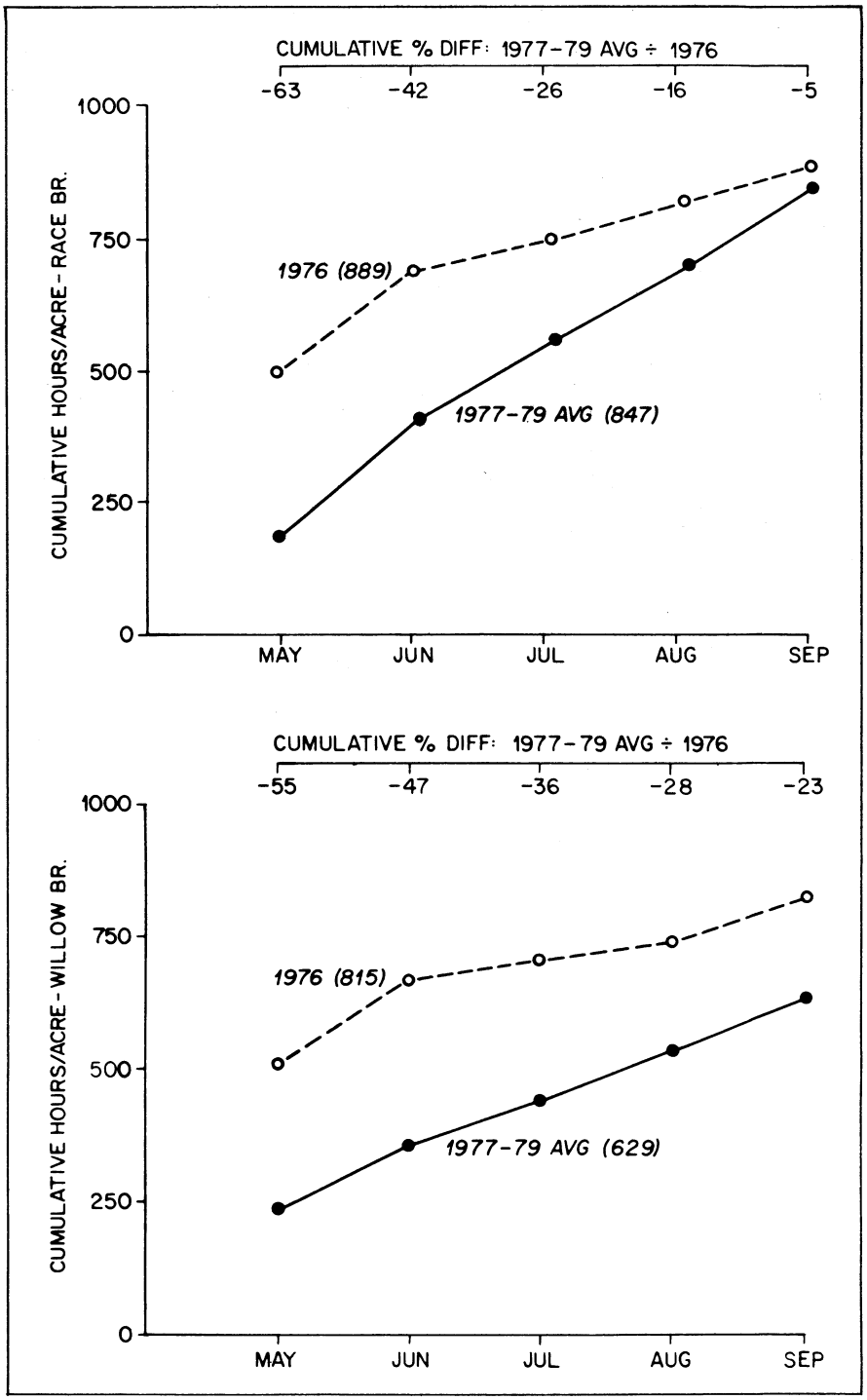


FIGURE 9. *Cumulative hours of angling/acre in the Race Br. and Willow Br. study zones each month of the 1976 trout fishing seasons and averages for each month of the 1977-79 seasons.*

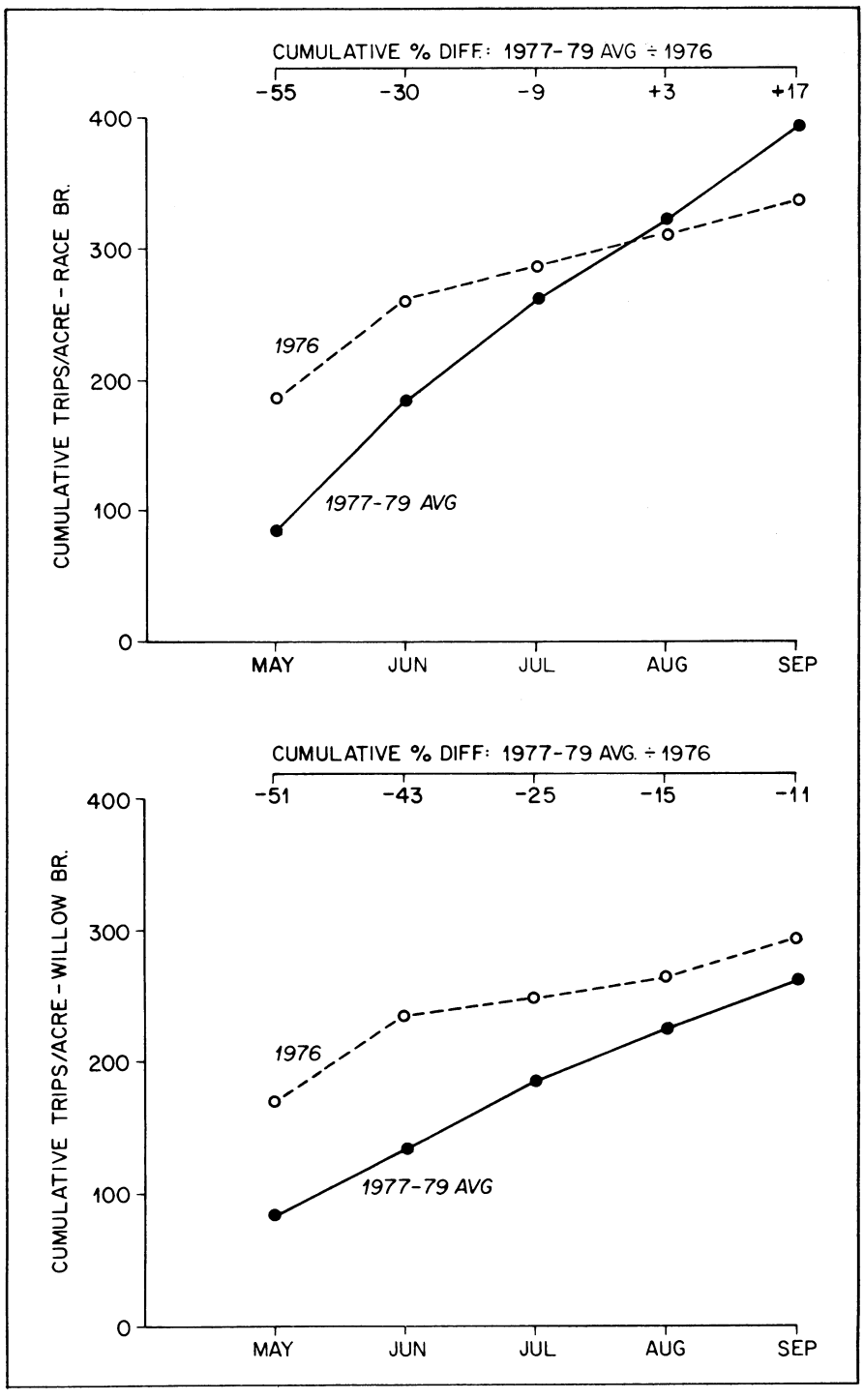


FIGURE 10. *Cumulative angler trips/acre in the Race Br. and Willow Br. study zones each month of the 1976 trout fishing season and averages for the 1977-79 seasons.*

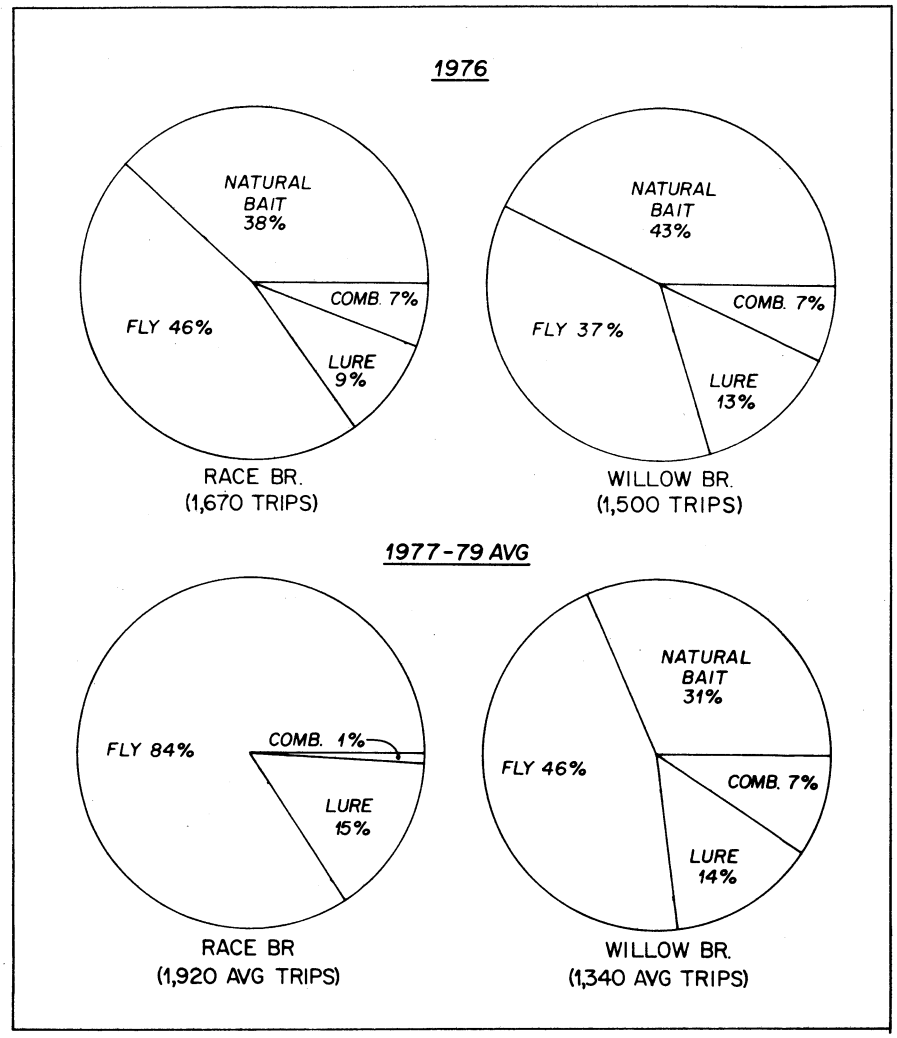


FIGURE 11. *Percentage distributions of the total angler trips according to the type of bait used in the Race Br. and Willow Br. study zones during the 1976 trout fishing season and as averages for the 1977-79 seasons.*

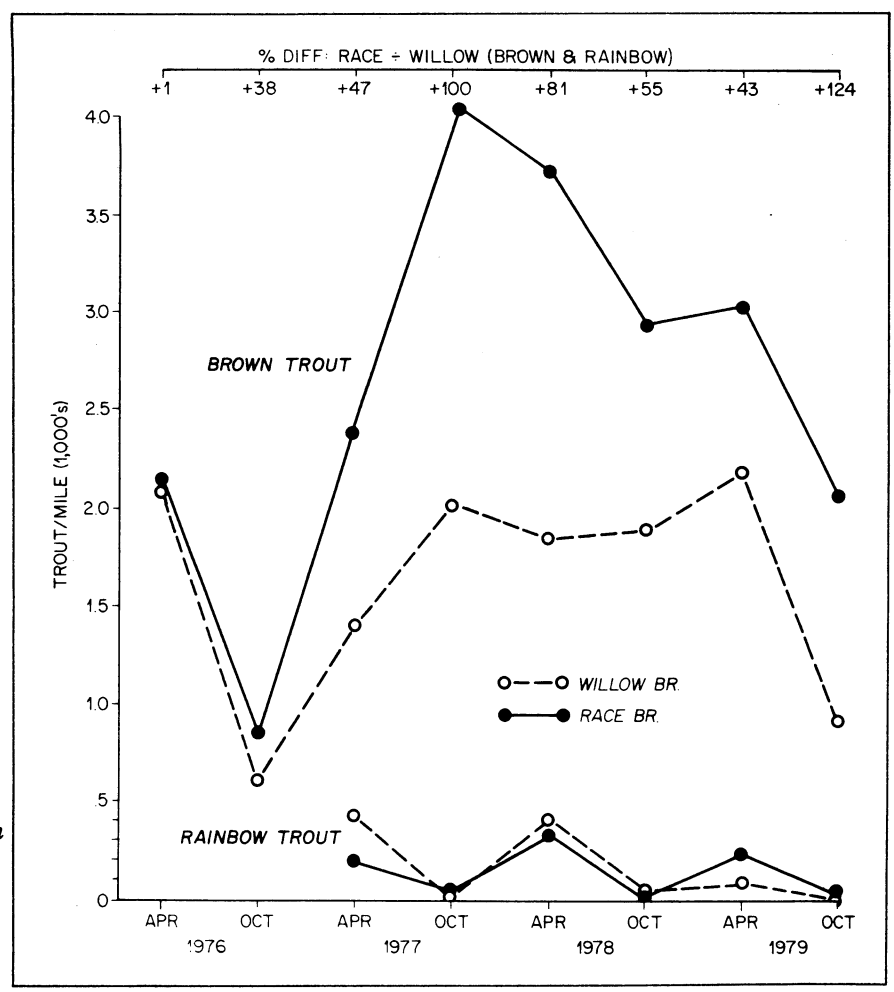


FIGURE 12. *Number of brown trout/mile and rainbow trout/mile in the Race Br. and Willow Br. study zones each April and October of 1976-79.*

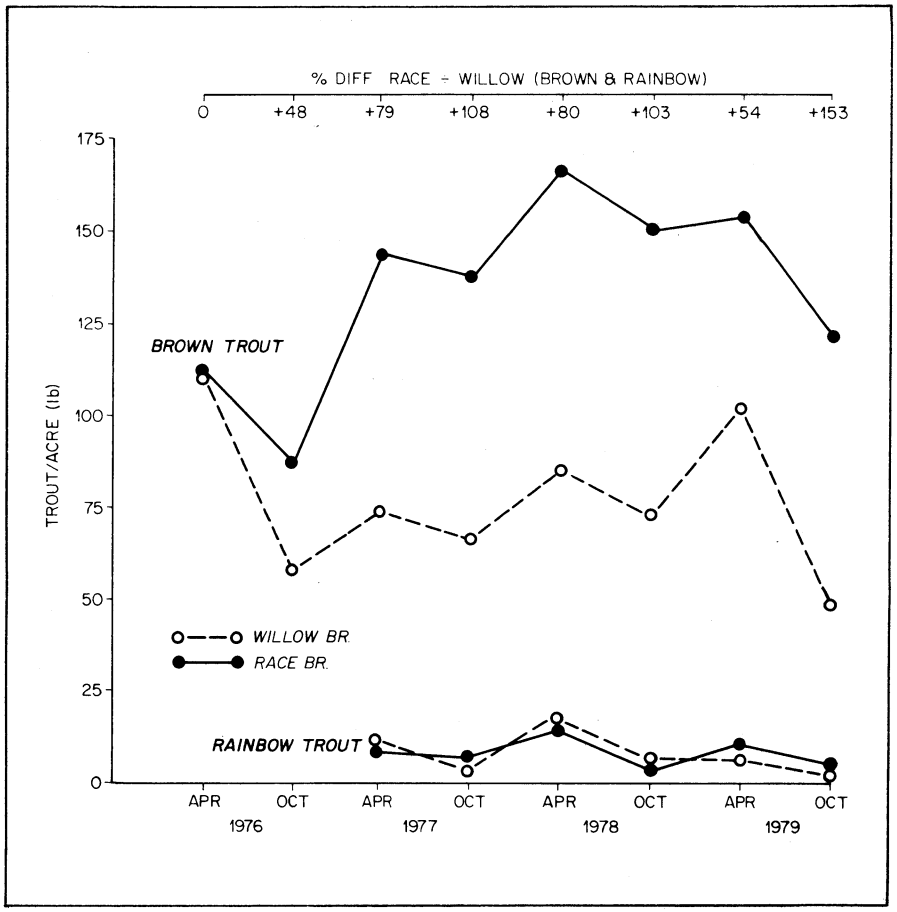


FIGURE 13. *Biomass of brown trout/acre and rainbow trout/acre in the Race Br. and Willow Br. study zones each April and October of 1976-79.*

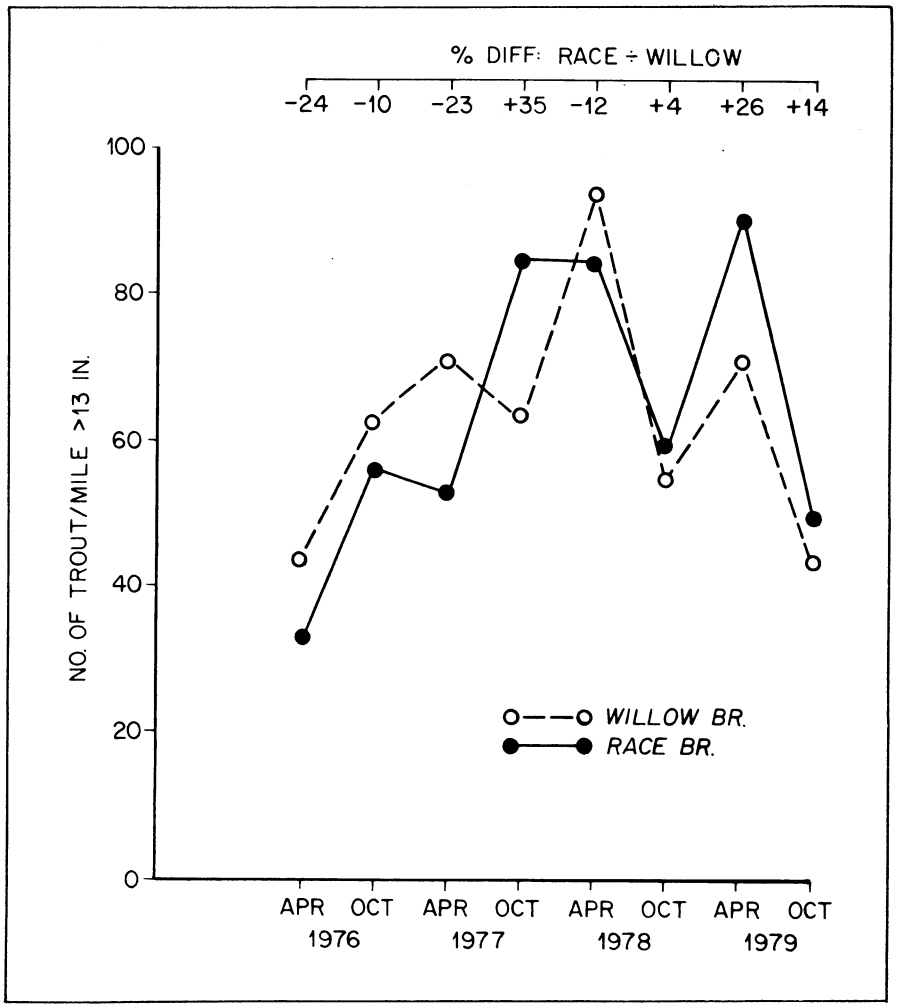


FIGURE 14. *Number of trout/mile over 13 in. in the Race and Willow Br. study zones each April and October of 1976-79.*

TABLE 8. *Population statistics for the standing stocks of brown trout and rainbow trout in the Race Br. and Willow Br. study zones each April and October of 1976-79.*

	1976	1977	1978	1979	1977-79 Avg.	% Diff. 1977-79÷1976
Trout/mile in April						
Race Br.						
Brown	2130	2530	3750	3050	3110	+46
Rainbow	0	197	352	254	268	
Total	2130	2727	4102	3304	3378	+59
Willow Br.						
Brown	2100	1430	1860	2220	1840	−12
Rainbow	0	427	403	97	309	
Total	2100	1857	2263	2317	2149	+2
Trout/mile in Oct. (0+)						
Race Br.						
Brown	835	4080	2960	2040	3030	+263
Rainbow	0	46	18	24	29	
Total	835	4126	2978	2064	3059	+266
Willow Br.						
Brown	603	2040	1900	920	1620	+169
Rainbow	0	18	23	2	14	
Total	603	2058	1923	922	1634	+171
Trout/mile in Oct. (I+)						
Race Br.						
Brown	835	1620	2450	1500	1860	+123
Rainbow	0	46	18	24	29	
Total	835	1666	2468	1524	1889	+126
Willow Br.						
Brown	603	739	1140	546	810	+34
Rainbow	0	18	23	2	14	
Total	603	757	1163	548	824	+37
Pounds/acre in April						
Race Br.						
Brown	112	144	167	154	155	+38
Rainbow	0	6	13	9	9	
Total	112	150	180	163	164	+46
Willow Br.						
Brown	112	74	85	102	87	−22
Rainbow	0	10	15	4	10	
Total	112	84	100	106	97	−14
Pounds/acre in Oct. (0+)						
Race Br.						
Brown	86	136	151	122	136	+58
Rainbow	0	3	1	2	2	
Total	86	139	152	124	138	+61
Willow Br.						
Brown	58	65	73	49	62	+8
Rainbow	0	1	2	<1	1	
Total	58	66	75	49	63	+9
Pounds/acre in Oct. (I+)						
Race Br.						
Brown	86	118	147	116	127	+47
Rainbow	0	3	1	2	2	
Total	86	121	148	118	129	+50
Willow Br.						
Brown	58	52	68	45	52	−4
Rainbow	0	1	2	<1	1	
Total	58	53	70	45	53	−8
No/mile > 13 in. in April						
Race Br.						
Brown	33	52	84	91	76	+131
Rainbow	0	3	0	0	1	
Total	33	55	84	91	77	+134
Willow Br.						
Brown	43	71	95	71	79	+82
Rainbow	0	0	0	1	<1	
Total	43	71	95	72	79	+83
No/mile > 13 in. in Oct.						
Race Br.						
Brown	57	85	57	49	64	+12
Rainbow	0	0	0	0		
Total	57	85	57	49	64	+12
Willow Br.						
Brown	63	63	55	43	54	−15
Rainbow	0	0	0	0		
Total	63	63	55	43	54	−15

DISCUSSION

Most comparisons of 1977-79 data with data from 1976 support the conclusion that a highly successful catch and release fishery was created as a result of imposing special regulations on the Race Br. This conclusion is supported not only by comparisons of data sets for the Race Br. for the two time periods, but by comparisons of data sets for the Race Br. with those for the Willow Br. as well.

For example, despite a 99% reduction in the number of trout harvested, angler use of the Race Br. remained high during the 1977-79 seasons. It received more angler use than did the Willow Br. in 1976, when regulations were similar on both branches, and it continued to receive more angler use than did the Willow Br. when the switch was made to catch and release regulations. This continued dominance is particularly worth emphasizing as a factor indicating solid public acceptance of setting aside the Race Br. as a catch and release fishery. Anglers using live bait accounted for 41% of the total angler hours on the Race Br. during the 1976 season (nearly 1,800 hours). Such contributions could no longer be made during the 1977-79 seasons, but increased use by fly fishers and artificial lure fishers largely offset these potential deficits. Anglers using flies or artificial lures also continued to contribute substantially to the total use and catch on the Willow Br. whereas anglers fishing with live bait on the Willow Br. could no longer "cross over" unless they switched to legal fishing methods. It seems probable that had the Willow Br. been less conveniently located in relation to the Race Br., fewer anglers attracted to the Race Br. by the special regulations would have subsequently fished the Willow Br. too. If such were the case, the relatively greater use of the Race Br. than the Willow Br. during the 1977-79 seasons would have been even more divergent. A reverse effect is probable but less likely, that is, cross over of anglers from the Willow Br. to the Race Br. could have increased the fishing effort on the Race Br. simply because it was conveniently located to anglers primarily interested in fishing the Willow Br. The most important fact to keep in mind, however, is that angler use of the Race Br. remained high in 1977-79 despite prohibition of a popular fishing method.

Three other major goals of a good catch and release fishery were also achieved on the Race Br.: (1) The number of trout released/season increased (by 116%). (2) More trout were probably released more than once (recycled). (3) The combined catch rates of trout creeled or released increased substantially and to rates much higher than are typical of trout fisheries in Wisconsin (from 0.8/hour in 1976 to rates of 1.08, 1.46 and 1.48 for the 1977-79 seasons).

Angler use of the Race Br. during the seasons of catch and release regulations also differed from a commonly observed pattern for such special regulation waters, a pattern that consists of an initial and often large decrease in angler use for a fishing season or two followed by a few seasons of gradual increase to a level equal to or greater than that observed when more liberal regulations were in effect (Anderson 1977; Johnson and Bjornn 1978; Lennon and Parker 1960; Pettit 1977).

Year by year trends in angler hours and trips for the Willow Br. paralleled each other and differed markedly from the trends for the Race Br. Declines in angler hours and trips from 1976 to 1977 to 1978, and only a slight increase in hours of fishing during the 1979 season, may have reflected a negative response by some anglers to imposition of special regulations on the adjacent Race Br. Although the study zones were marked with both large wooden engraved signs at the road bridges and at the ends of the study zones and numerous smaller cardboard signs along both study zones, some anglers contacted during the study mistakenly believed special regulations applied to both study zones. Other anglers may have stayed away because they could no longer fish both study zones with live bait. Whatever the resons may have been for reduced angler use of the Willow Br. during 1977-79, poorer fishing success was not one of them. Hourly catch rates for both trout creeled and trout released were better those years than in 1976.

Abnormally poor conditions for fishing during the 1978 and 1979 seasons may have contributed to declines in angler use of both study zones. Although unsubstantiated by objective measurements, many anglers indicated during creel census interviews that much higher than normal stream flow during several weeks of both the 1978 and 1979 seasons was a discouraging factor. Discharge in both study zones is influenced not only by rainfall in the watershed but by manipulations of outlet spillways on two upstream dams, one of which is used for electricity generation and the other to adjust water level in Little Falls Flowage for public users at Willow River State Park. A severe drawdown of the Flowage during the summer of 1979 to allow repairs of the dam also produced undesirable fishing conditions in the study zones for several days.

Due in large part to the proximity of the metropolitan complex of Minneapolis-St. Paul, few trout streams in Wisconsin receive as much angler use as that recorded for the Race and Willow study zones during this study. In fact, the maximum intensity of use recorded for the Race Br. in 1977, amounting to 1,015 hours/acre, is the highest such value documented for a Wisconsin trout stream (Table 12, Append.).

The high intensity of angler use the Race and Willow system received during the study is shown by the comparison of angler use data for this system with that collected by Avery (pers. comm.) during 1979 at 18 Mile Creek, a Class I stream in northwestern Wisconsin, and at N. Br. Beaver Cr., another Class I stream in northeastern Wisconsin. Both were selected for study as typical examples of wild brown trout streams in the northern half of the state. Hours/acre were approximately 12-20 times greater on the Race-Willow system during 1976-79 than was the average for the two Class I streams in 1979 and seasonal trips/mile differed by factors of 22-32 times

TABLE 9. *Anglers, trips, hours, catch and catch rates summarized according to the number of angling trips made/season to the Race Br. and Willow Br. study zones during 1976-79.*

Trips/ Season	Percent Total Anglers		Total Trips		Total Hours		Trout Creeled		Trout Released		Catch/hour Creeled		Catch/hour Released	
	Race	Willow	Race	Willow	Race	Willow	Race	Willow	Race	Willow	Race	Willow	Race	Willow
1976 trout fishing season														
1	73.3	74.8	45.0	53.8	42.5	56.9	49.0	51.6	25.2	39.6	0.29	0.25	0.35	0.31
2	16.3	12.6	19.9	18.2	19.3	17.0	20.8	14.2	10.7	12.6	0.27	0.23	0.32	0.33
3	3.9	4.7	7.1	10.1	6.2	8.7	5.4	11.1	10.8	9.6	0.22	0.35	1.03	0.50
4	1.9	3.7	4.8	10.8	4.6	11.1	4.7	12.9	5.4	25.1	0.25	0.32	0.68	1.02
5	1.9	1.4	6.0	5.1	4.7	4.6	3.4	5.8	4.1	4.1	0.18	0.35	0.51	0.40
6-9	1.6	2.8	6.9	2.0	6.1	1.7	9.7	4.4	5.8	9.0	0.43	0.70	0.49	2.32
10-14	0.4		2.4		5.6		0.0		11.5		0.00		1.19	
15-19	0.8		7.9		11.0		7.0		26.5		0.19		1.40	
1977-79 trout fishing season (avg.)														
1	73.2	75.1	40.4	50.1	33.7	47.8	43.8	37.2	25.0	34.4	0.01	0.25	1.10	0.49
2	12.4	15.7	13.8	21.0	13.0	20.9	18.7	29.4	12.5	31.4	0.01	0.43	1.47	0.94
3	5.5	3.6	9.1	7.0	9.9	6.6	25.0	6.9	9.5	6.4	0.02	0.32	1.41	0.61
4	2.2	1.5	4.6	3.9	5.5	3.7	12.5	2.9	4.2	5.6	0.02	0.29	1.00	1.02
5	2.2	1.1	6.0	4.1	5.3	2.9		2.7	11.2	2.7		0.28	3.20	0.66
6-9	2.6	1.7	10.2	7.4	11.3	8.5		9.1	11.4	10.5		0.35	2.78	0.86
10-14	1.2	1.3	8.6	6.5	9.6	9.6		11.8	9.6	9.0		0.41	1.36	0.56
15-19	0.5		4.5		3.8				5.2				1.97	
20+	0.2		2.8		7.9				11.4				2.04	

greater.

Although confinement of the catch and release regulations to only 1 mile of stream probably increased angler density/mile over that which would occur if the study zone had been longer, the index of anglers/mile is an easily visualized one for comparing relative use of two or more trout streams. It also can be readily translated into another conceptually helpful index of angler use — the average number of anglers/mile/day over the course of a fishing season. Chances of encountering another angler while fishing the Race Br. or Willow Br., for example, are quite high. An average of 11 anglers fished each of these mile-long study zones each day of the study. By contrast, chances of seeing another angler while fishing on 18 Mile Creek or the N. Br. of Beaver Cr. are quite low. In 1979 the average number of anglers/mile/day was only 0.4 on these two streams. (Study zones were 5.3 and 3.4 miles long.)

Much of the success of the catch and release fishery that evolved on the Race Br. was probably due to the unusually large clientele of anglers voluntarily releasing legal-sized fish in both study zones prior to designation of the Race Br. as a special regulations site and their subsequent continued use of this site during 1977-79.

Fly fishing anglers comprised an exceptionally high proportion of the anglers using each study zone in 1976, compared to that on other Wisconsin trout streams (Hunt 1970; Meyers and Thuemler 1976) and this proportion was greater on the Race Br. than on the Willow Br. (46% vs. 37%). The number of trout released in proportion to numbers creeled was also unusually high for both study zones in 1976, particularly in view of the fact that most of the released trout probably were legal-sized. Most of these released trout had been caught by fly fishers. Such anglers continued to predominate on the Willow Br. even during the years when special regulations to encourage use of flies applied to the adjacent Race Br. They accounted for 46% of the total trips on the Willow Br. during 1977-79 and caught 55% of all trout released but only 26% of all the trout creeled (caught and kept), an indication that voluntary catch and release continued to be an important factor on the Willow Br. all years of this study.

A substantial portion of the anglers fishing the Race and Willow study

TABLE 10. *Number of brown trout/mile over 13 in. in the Race Br. and Willow Br. study zones each April and October of 1976-79 and the rates of exploitation of the April stocks of these trout during the 1976-79 trout fishing seasons.*

	1976	1977	1978	1979	1977-79 Avg.
No./mile in April:					
Race Br.	33	52	84	91	76
Willow Br.	43	71	95	71	79
No./mile in October:					
Race Br.	57	85	57	50	64
Willow Br.	63	63	55	43	54
No./mile creeled:					
Race Br.	45	27	11	18	19
Willow Br.	12	82	54	21	46
Percent Exploitation					
Race Br.	136*	52	13	20	28
Willow Br.	29	116	56	29	67

*Harvest of trout over 13 in. exceeded the number present in April, due to recruitment of additional trout of this size via growth and/or in-migration.

zones during 1976 chose to fish both zones the same day. These "crossover" anglers accounted for 16% of the total trips to the Willow Br. and 17% of the total trips to the Race Br. Among these crossover anglers, live bait was used on 37% of the trips, flies were used on 44% of the trips and artificial lures on 9%. During the 1977-79 seasons, the proportions of crossover trips increased to 22% for the Race Br. and 32% for the Willow Br. even though bait fishing anglers could no longer fish both study zones. Evidently the thought of "competing" with anglers using live bait on the Willow Br. was not a strong deterrent among most fly fishers and artificial lure fishers attracted to the Race Br. by the special regulations or previously familiar with the Willow Br. Such was not the case when fly–fishing–only regulations were applied to 2 of 4 study zones of Lawrence Creek in central Wisconsin. Approximately 89% of the fly fishing anglers chose to fish the study zones reserved for them during the 1961-67 seasons (Hunt 1970).

Addition of stocked rainbow trout to both study zones accomplished its purposes of diversifying the fishery and increasing catch rates, but only 4 of the 3,000 rainbow trout stocked in the Race Br. contributed to the catch of legal-sized trout. Survival of the 3 age 0 stocks from October to the next April was reasonably good, averaging 25% in the Race Br. and 28% in the Willow Br. Survival until the next April (age II), however, was poor, averaging only 2%. All of these survival rates are minimum values representing not true survival but "residency survivals" of those rainbow trout that remained in the study zones after being stocked there (Table 13, Append.). Several anglers who fished the study zones reported catching rainbow trout in portions of the Willow River above and below the study zones, too.

In proportion to their numbers present, rainbow trout contributed slightly more to both the catch and release fishery on the Race Br. and the catch-to-eat fishery on the Willow Br. than did brown trout:

(1) 1.9 rainbow trout were released for each one present in April vs. release of 1.6 brown trout for each one present in April in the Race Br. (Table 14, Append.).

(2) Angler exploitation averaged 55% for rainbow trout vs. 47% for brown trout on the Willow Br.

Anglers interviewed in the study zone only once per season accounted for surprisingly high proportions of the total numbers of anglers interviewed. For example, in 1976 such anglers on the Race Br. accounted for 73.3% of the total number of anglers and 45.0% of the total trips.

Anglers interviewed only once were even more prominent on the Willow Br. in 1976 when they comprised 74.8% of those contacted and logged 53.8% of all trips (Table 9).

During the 1977-79 seasons an important change noted was the number of anglers fishing 10 times or more/season on the Race Br. In 1976, 20 anglers were estimated to have fished the Race Br. at least 10 times. During the 1977-79 seasons an average of 36 anglers did so and a few anglers fished the zone 20 or more times each season. Fewer anglers made multiple trips/season to the Willow Br. during the 1977-79 seasons by comparison to the record for this zone in 1976 or in comparison to the record for the Race Br.

Another unusual feature of the sport fishery on the Race Br. during the special regulation seasons was the fact that none of the 62 legal-sized trout creeled were taken by anglers who fished 5 or more times/season even though they caught nearly half of the trout released. These results would suggest that this group of anglers preferred to keep no trout since it is likely that a few of the estimated 1,730 trout released by these anglers were legal-sized.

The most disappointing outcome of the study from a management viewpoint was the failure of the trout population in the Race Br. to display a major increase in the number of trout over 13 in., and more specifically to show a year by year accumulative trend during the years of catch and release regulations. Although the average number of trout over 13 in. in the Octobers of 1977-79 was 12% greater than the number of such trout present in October 1976, there were fewer trout of this size in the Race Br. in October 1979 than were there the previous 3 Octobers (Fig. 14).

In relation to concomitant trends in spring and fall abundance of trout over 13 in. in the Willow Br., it is likely that the special regulations on the Race Br. had some benefit in stockpiling a few more larger trout but not to the degree expected. Consequently, the excellent catch and release fishery for 8- to 12-in. trout did not acquire the added desirable quality of a much improved "trophy trout" fishery.

Failure to build up a strong stock of trout over 13 in. in the Race Br. cannot be attributed to excessive harvest of such fish during the 1977-79 seasons. On the average, fewer trout of this size were removed during these 3 seasons than during 1976 (Table 10). Furthermore, in relation to the number of such trout present in April, the exploitation rate (assuming no recruitment due to growth or in-migration during the fishing season) averaged only 28% in 1977-79 compared to a rate of 136% for the 1976 season (during 1976 more trout over 13 in. were creeled than were present in April). In other words, most of the trout of 13 in. or more were not being promptly caught and kept as they attained legal size or happened to move into the Race Br. during 1977-79.

Average length of the trout creeled each season of this special regulation study is another indication that overharvest was not a deterrent to the anticipated buildup of legal fish. Creeled trout averaged 14.0 in. in 1977, 13.7 in. in 1978 and 13.8 in. in 1979.

Density dependent decreases in growth of trout in the Race Br. is another possible reason for lack of dramatic buildup of legal trout, but I was not able to clearly substantiate whether such a depensatory response occurred. Four factors frustrated age and growth analyses:

(1) All year classes were comprised of both wild and domestic individuals, many of which could not be positively distinguished as to origin after their first year of life.

(2) Average size of age 0 stocks of domestic origin differed at the time of stocking and most of those stocked were larger than wild age 0 trout.

(3) Unmarked stocked trout moved into the study zones. These trout had not been as closely graded to reduce variation in size spread as had the lots of trout counted and fin-clipped prior to stocking in the study zones.

(4) Most of the scale samples collected from trout of unknown age proved to be unusable for verifying age-length relationships. This complication in particular nullified efforts to verify age composition of standing stocks inventoried in 1976, the baseline year of study, when only age I could be clearly recognized on the basis of size frequency and known-age fin-clip marks.

Despite these confounding variables, average lengths of ages I, II and III brown trout (domestic and wild combined) were derived for April and October of 1977-79 (Table 15, Append.). About the only useful conclusion that can be inferred from these data is that brown trout tended to grow better in the Willow Br., at least through age III, but no insight is provided to either verify or reject reduced growth rates in either zone in response to increased trout density.

Examination of several tabulations of condition factors (R) led to the same conclusion. Trout tended to weigh more at a given length in the Willow Br., especially in April, but no year to year trends were apparent that suggested density dependent changes in length-weight relationships in either study zone (Table 16, Append.).

MANAGEMENT CONSIDERATIONS AND RECOMMENDATIONS

This study fulfilled its basic management goal: providing the first comprehensive, in-depth analysis of impacts that catch and release regulations have on a trout population and sport fishery in a Wisconsin stream. Based on the outcome of this study, I recommend modest expansion of the "management for quality" concept through use of catch and release regulations on a few other trout waters. Such expansion should continue to be tempered with caution, however. Probably few (if any) other trout streams in Wisconsin presently have as large a clientele of user anglers as "ready made" for adapting to the changes that accompany special regulations status as did the Race-Willow system. Consequently, desired goals are not likely to be achieved as quickly or completely, in either qualitative or quantitative terms, as they were in this study.

Combined with such precaution, however, results from this study can be used to convey to the angling public what consequences to expect when special regulations are applied. As Driver and Cooksey (1977) recommend, such educational efforts should be viewed by fishery managers as an important task that provides anglers with "better market information on which to base their decisions" and also "enhance the credibility" of the managers with the angling public they serve.

Some of the likely consequences to expect would include: (1) maintenance or even an increase in the number of anglers using a stream designated for catch and release management despite elimination of bait-fishing anglers; (2) a more even distribution of angling effort over the course of the season; (3) an increase in the number of anglers fishing such a stream several times/season; (4) drastically reduced harvest and eventual loss of such trout to natural mortality causes; (5) a much improved catch rate ("shortening the time between bites"), counting catch as those released and/or creeled; (6) a higher rate of "success" in catching at least one trout/trip, even though it will probably have to be released; (7) more trout caught more than once (recycling); and (8) a buildup in the number and biomass of trout, particularly from spring to fall.

Prominent posting of such special regulation reaches of stream, greater public relations educational efforts locally to alert anglers to the new management emphasis and advance planning to obtain increased law enforcement surveillance are also recommended procedures to enhance prospects for success of a catch and release fishery.

To provide a more balanced availability of such specially managed streams in Wisconsin (to both resident and nonresident anglers), consideration should be given to selection of a stream in Dane or Iowa Co., another in Waushara or Waupaca Co. and a third in Sawyer or Washburn Co. Updated evaluations should also be initiated of the special regulation fisheries on the Peshtigo River and Wolf River. If the present zones are to be continued as special regulation waters, with or without an updated evaluation, consideration should be given to substituting an "artificial lures only" restriction for the present "fly fishing only" constraint. Ample evidence has now been accumulated to show that rates of hooking mortality of released trout are similar for both of these fishing methods (Wydoski 1977). From a biological perspective, therefore, a flies-only rule is no longer justified.

Continuation of the present catch and release regulations on the Race Br. is also strongly recommended. Public acceptance has been excellent and angler use will probably continue to increase in view of the proximity of the location to a major urban population.

Although the evidence is largely circumstantial, deficiencies in the physical environment may be the critical factor limiting accumulation of more large trout in the Race Br. This deficiency, if real, could be ameliorated by carrying out an appropriate program of instream habitat enhancement, a step I recommended not only to provide more niches for large trout but to also improve aesthetic quality of the Race Br. by remodeling or replacing many of the existing unattractive habitat improvement structures. Most of these structures are in need of repair. If such renovation or replacement would largely eliminate the bottleneck circumventing buildup of trout in the 15-20 inch range, a major advance in fishing quality would be achieved.

A specific appraisal of unused carrying capacity for large trout and/or the potential cost to develop additional such habitat should also be a criterion to include whenever a stream is being assessed as a candidate for management with catch and release regulations.

Due to the unusual physical attributes of the Race-Willow system and the backlog of information available on its trout stocks and sport fishery, the system also has much potential as a site for additional research studies. Obvious studies that could be initiated are those aimed at testing other combinations of catch and release regulations, evaluation of additional benefits to be derived from the recommended trout habitat improvement work and assessments of a variety of stocking measures to enhance such a fishery by altering the present quota in terms of species used, sizes and numbers stocked. The site is also one which is particularly well suited to studies of angler attitudes about their sport and about sharing their resource with other recreational users. Such information will become increasingly important in formulating future management plans for the trout resource of Wisconsin as will another category of now scarce information that could be readily acquired through an appropriate study at the Race-Willow site: the economic values of a trout fishery managed under normal fishing regulations vs. the economic values associated with a trout fishery managed with catch and release regulations.

That "quality moment" which is the focus of catch and release fishing, an event experienced nearly 15,000 times during the three seasons of testing catch-and-release regulations on the Race Branch.

SUMMARY

The Race Branch is a mile-long side channel of the Willow River in west central Wisconsin. The portion of the Willow R. flowing parallel to the Race Br. is called the Willow Br. All of the Race Br. and the upper two-thirds (also one mile long) of the Willow Br. were selected as study zones to evaluate the impact on the sport fishery of experimental regulations that required release of nearly all trout caught during 3 successive fishing seasons. Anglers using the Race Br. during 1977-79 were required to use artificial flies or spinning lures and could keep 1 trout of 13 in. or larger per day. Normal and much less restrictive regulations remained in effect on the Willow Br.

Field data were obtained via two primary sources: electrofishing inventories of trout stocks each April and October of 1976-79 and a 40 hour/week creel census throughout the 1976-79 trout fishing seasons (May through September).

Trout populations in both study zones were primarily sustained by annual stocking of age 0 brown trout in the Octobers of 1975-78 plus supplemental stocking of age 0 rainbow trout in the Octobers of 1976-78. Rainbow trout were added to provide a two-species diversity to the sport fishery. Some natural reproduction of brown trout also occurred each year in both study zones.

The catch and release fishery on the Race Br. during 1977-79 was judged to be highly successful: (1) Angler use remained high in comparison to that during the 1976 baseline season; a 5% reduction in angler hours (to an average of 845/acre) but angler trips/season increased by an average of 15% (to 392/acre). Angler use during 1977 amounted to 1,015 hours/acre, the highest known value on a Wisconsin trout stream. (2) The number of trout creeled was reduced by 99%, averaging 4.2/acre, while the number released increased by 116% to 1,121/acre. The 3-season average of trout released to trout creeled was 268:1 as compared to a ratio of 2:1 in 1976. (3) Some trout were probably released more than once per season since the catch of trout creeled or released exceeded the number present in April. Such recycling was higher for rainbow trout than for brown trout. (4) In response to the catch and release regulations, more anglers fished 10-20 times/season and the frequency of releasing more than 10 trout/trip increased. (5) Distribution of angling effort over the course of the season was more even. (6) The combined catch rates (creeled or released) increased to atypically high values for Wisconsin — from 0.8/hour in 1976 to 1.08, 1.46 and 1.48 in 1977-79.

On the Willow Br. angler use decreased during 1977-79 as compared to 1976; hours declined by an average of 23% (to 625/acre) and trips declined by an average of 11% (to 259/acre). Harvest decreased by 17% (average of 191/acre) while the average number of trout released remained the same as in 1976. Exploitation rate of brown trout averaged 50% for 4 seasons; that for rainbow trout was 55% for 3 fishing seasons.

Nonresident anglers were dominant in both study zones, accounting for 68-84% of the trips/season on the Race Br. and 60-80% of the trips/season on the Willow Br.

Abundance, biomass and survival rate characteristics all changed more favorably for trout in the Race Br. than for those in the Willow Br. based on average values for 1977-79 vs. 1976 data. In the Race Br. the number of I+ trout increased in April by 58% (to 3.379/mile) and April biomass increased by 46% (to 164 lb/acre). The average number of I+ trout in October increased by 126% (to 1,889/mile) and their biomass increased by 50% (to 129 lb/acre). In the Willow Br. average abundance of I+ trout in April in-

creased only 2% (to 2,149/mile) and average biomass decreased by 23% (to 97 lb/acre). Average October abundance of I+ trout increased by 37% (to 824/mile) and average biomass was 9% less (53 lb/acre) than it was in October 1976. April to October survival of I+ trout averaged 56% in the Race Br. during the special regulation seasons vs. 39% survival in 1976. In the Willow Br. comparable survival rates were 39% for 1977-79 and 29% in 1976.

Abundance of trout over 13 in. in early October (week after close of the fishing season) increased an average of only 12% in the Race Br. during 1977-79. The successful catch and release fishery that evolved was not augmented by a much improved "trophy trout" fishery. Lack of suitable habitat for such trout may have been the principal factor preventing a greater buildup. In the Willow Br. during the same period trout over 13 in. decreased in average abundance by 15% despite some reduction in exploitation rate in that study zone, too.

Managment recommendations include: (1) continuing the catch and release regulations on the Race Br. as a highlight feature of the management plan for trout streams in west central Wisconsin, and (2) initiation of a modest expansion of catch and release regulations on a few other trout waters in Wisconsin to further diversify the variety of trout angling opportunities in each management District and strengthen the "management for quality" concept that is a basic component of the present DNR trout management policy.

APPENDIX

TABLE 11. *Common and scientific names of fishes known to inhabit the Race Br. and Willow Br. study zones.*

Common Name	Scientific Name
Brown trout	*Salmo trutta*
Rainbow trout	*Salmo gairdneri*
Brook trout	*Salvelinus fontinalis*
Walleye	*Stizostedion vitreum*
Yellow perch	*Perca flavescens*
Largemouth bass	*Micropterus salmoides*
Rock bass	*Ambloplites rupestris*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Green sunfish	*Lepomis cyanellus*
Northern pike	*Esox lucius*
Black bullhead	*Ictalurus melas*
Logperch	*Percina caprodes*
Johnny darter	*Etheostoma nigrum*
Rainbow darter	*Etheostoma caeruleum*
Central mudminnow	*Umbra lima*
White sucker	*Catostomus commersoni*
Greater redhorse	*Moxostoma valenciennesi*
Carp	*Cyprinus carpio*
Blacknose dace	*Rhinichthys atratulus*
Creek chub	*Semotilus atromaculatus*
Common shiner	*Notropis cornutus*
Brook stickleback	*Culaea inconstans*
Mottled sculpin	*Cottus bairdi*

TABLE 12. *Angler use indexes for some Wisconsin trout streams.*

Stream	County	Class	Hours/Acre	Trips/Mile	Reference Source
Race Branch	St. Croix	II	847-1015	1605-1953	This study
Willow Branch	St. Croix	II	575-815	1310-1562	This study
Lawrence Creek	Adams	I	88-679	77-523	Hunt (1971)
Little Plover River	Portage	I	155-283		Hunt (1979)
N. Br. Beaver Cr.	Marinette	II	458		Meyers and Thuemler (1976)
N. Br. Beaver Cr.	Marinette	I	75	52	Avery, E.L. (pers. comm.)
18 Mile Creek	Bayfield	I	44	69	Avery, E.L. (pers. comm.)
Radley Creek	Waupaca	I	324-337		
Emmons Creek	Waupaca	I	333-354		
Mecan River	Waushara	I	376-400		Avery (1981)
S. Br. Wedde Creek	Waushara	I	322-534		
Seas Branch Creek	Vernon	II	214-290		Avery (1978)
Elk Creek	Dunn	II	802		Wis. DNR Files
Brule River	Douglas	I	224		Wis. DNR Files
McKenzie Creek	Polk	I	189-216	164	Lowry (1971)
Big Roche a Cri	Waushara	I		82-99	White (1972)

TABLE 13. *History of domestic rainbow trout stocks released in the Race Br. and Willow Br. study zones.*

Item	Race Br.				Willow Br.			
	1976	1977	1978	1979	1976	1977	1978	1979
No. stocked in Oct.	1000	1000	1000		1000	1000	1000	
No. following April		203	313	242		413	352	75
No. creeled		0	4	0		238	202	51
Percent exploitation		0.0	1.3	0.0		57.6	55.8	68.0
No. released		598	598	284		222	434	88
No. in October		47	19	25		17	22	2
April to Oct. Percent survival		23.2	6.1	10.3		3.8	6.1	2.7

TABLE 14. *Ratios of trout caught, both those creeled and those released, to the preseason abundance of trout in the Race Br. and Willow Br. study zones during 1976-79.*

Year	Ratios For Race Br.			Ratios For Willow Br.		
	Brown	Rainbow	Total	Brown	Rainbow	Total
1976	1.3	*	1.3	1.5	*	1.5
1977	1.9	2.9	1.9	1.8	1.1	1.7
1978	1.2	1.7	1.3	1.6	1.6	1.6
1979	1.7	1.1	1.7	1.0	1.5	1.0
1977-79 Avg.	1.6	1.9	1.6	1.5	1.4	1.4

*No rainbow trout present in either zone until after the close of the 1976 trout fishing season.

TABLE 15. *Average lengths (inches) of ages I-III brown trout in the Race Br. and Willow Br. study zones each April and October of 1977-79.*

	Race Br.			Willow Br.		
	I	II	III	I	II	III
April of:						
1977	6.5	10.7	11.5	6.4	11.1	11.7
1978	6.4	9.6	11.8	6.5	9.8	11.3
1979	6.2	8.9	10.5	5.9	10.3	11.6
October of:						
1977	8.7	11.5	12.4	8.6	11.5	12.9
1978	8.3	10.0	12.0	8.6	10.8	11.6
1979	9.4	10.2	12.8	9.8	10.5	13.8

TABLE 16. *Coefficient of condition factors (R)* for brown trout on the Race Br. and Willow Br. study zones each April and October of 1976-79.*

Year	Month	Zone	Inch Group					
			8	9	10	11	12	13
1976	April	Race	1.70	1.58	1.65	1.62	1.54	1.52
1977	April	Race	1.76	1.69	1.72	1.74	1.71	1.73
1978	April	Race	1.59	1.61	1.61	1.58	1.58	1.58
1979	April	Race	1.51	1.57	1.50	1.46	1.52	1.53
1976	April	Willow	1.80	1.74	1.77	1.78	1.73	1.67
1977	April	Willow	1.75	1.64	1.76	1.71	1.71	1.70
1978	April	Willow	1.73	1.63	1.62	1.64	1.72	1.63
1979	April	Willow	1.60	1.58	1.52	1.58	1.56	1.54
1976	October	Race	1.65	1.67	1.70	1.70	1.67	1.62
1977	October	Race	1.52	1.47	1.59	1.60	1.51	1.61
1978	October	Race	1.60	1.60	1.66	1.61	1.55	1.51
1979	October	Race	1.68	1.56	1.58	1.59	1.60	1.47
1976	October	Willow	1.52	1.54	1.60	1.60	1.56	1.75
1977	October	Willow	1.54	1.50	1.58	1.66	1.51	1.55
1978	October	Willow	1.59	1.64	1.60	1.63	1.61	1.50
1979	October	Willow	1.58	1.58	1.57	1.65	1.58	1.49

*R = 10 × weight in grams ÷ total length to nearest 0.1 in.

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