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Newsletter from the San Francisco Bay Area Chapter of
Trout Unlimited, P.O. Box 2046, Custom House,
San Francisco

President's report on the Middle Fork of the Feather: The battle lines are drawn. Plumas County, the State Department of Fish and Game, and the State Department of Water Resources recently filed suit against the State Water Rights Board. The San Francisco Bay Area Chapter of Trout Unlimited, with the Sierra Club, has filed a petition to the court in Plumas County to appear in this action under a legal doctrine known as "amicus curiae" (friend of the court). The petition has been approved by the court, and our brief is being prepared. This most likely will delay the hearings before the Federal Power Commission, but your letters to the FPC, Senators and Congressmen still are in order. More letters will be needed later.

Points to remember about the Middle Fork:

This river has been proposed for inclusion in both State and Federal Wild River Plans.

Oroville Dam, now under construction, will back up ample irrigation water in the huge Oroville Reservoir. Water from the Middle Fork Project (known as Project No. 2134 to the agencies) really is not needed, but the prime reason the project is being pushed by the rice farmers of the Richvale Irrigation District is that Project 2134 water will be cheaper than that from the Oroville Reservoir.

Power generated by the project will be expensive and will be sold to lower the cost of the water. Hydroelectric plants are used primarily to generate "peaking power" - power when it is needed at times of greatest demand. Many such plants are now in operation, but the bulk of the power (known as the "base load") comes from other sources, mostly steam generators. Thermonuclear power now is being produced at competitive cost. While thermonuclear plants have not yet been adapted to supply peaking power, this should not be an insurmountable engineering problem. If and when this is done, it will make hydroelectric dams obsolete. With seawater conversion perhaps no dams will be necessary - we hope.

Most important, the beautiful unspoiled canyon, including essential deer range, and 40 miles of one of the West's last free-flowing native trout streams will be annihilated.

In summary, the project is not in the public interest. If this stream goes, it goes forever, and is lost to untold future generations.

Andre M. Puyans, National Director
President, San Francisco Bay Area
Chapter of Trout Unlimited

AMP/ds

On May 25th, the State Senate Committee on Natural Resources held a hearing on Assembly Concurrent Resolution No. 31 relative to a study of the designation of the Middle Fork of the Feather as a wild river. SFBATU went on record as favoring this resolution.

On the same day the State Assembly adopted a resolution asking for a study on preserving the Middle Fork of the Feather as a wild river. (HR 414, Assemblywoman Pauline Davis).

On April 19th, SFBATU held its first annual general meeting at the Press Club in San Francisco. The guest speaker was Dr. Alex Calhoun, Chief of the Branch of Inland Fisheries, California Department of Fish and Game. Dr. Calhoun, with color slides, graphically illustrated the damage to streams from poor forest practices. It made you want to cry. It was pointed out, that trout fishermen and conservationists do not attend meetings of the District Forest Practices Committees when they meet in each of the four state districts. (Why not? Apathy? Ignorance? Ed.) It is true that these committees are "industry oriented", nevertheless, they are public servants and will listen to you - and you - and you - if you will make yourselves heard. (It is expected that our newly formed Forest Practices Committee will see that a representative from TU attends each of these meetings. Ed.)

Fish and Game Department representatives met with each of the four Forest Practices Committees recently and asked for specific measures to prevent stream damage. Dr. Calhoun told us about these recommendations, and the following resolution was passed by the membership on the spot:

WHEREAS, It is the policy of the San Francisco Bay Area Chapter of Trout Unlimited to immediately strengthen the California Forest Practices Act to prevent further damage to trout and steelhead fisheries through siltation, stream blockage, and destructive logging practices on private timberlands and to place direct responsibility on private landowners for protection of streams and watersheds; and

WHEREAS, The California Department of Fish and Game shares Trout Unlimited's concern with effects of destructive logging practices on trout, steelhead, and salmon habitat in the Redwood Forest District, the Coast Range, Pine and Fir Forest District, and the North and South Sierra Pine Forest Districts, and

WHEREAS, The California Department of Fish and Game has new recommended amendments to Forest Practices Rules, requiring construction of more water breaks on tractor roads, tractor skid trails, and abandoned logging truck roads; calling for establishment of a protective strip of at least 50-feet along margins of all permanently flowing streams, and removal of logs away from streams by cable; and limiting the number of stream bed crossings for timber operations and prohibiting use of stream beds or portions of stream beds as roadways, logging skid trails or log landings; now, therefore, be it

RESOLVED, That the San Francisco Bay Area Chapter of Trout Unlimited commends the California Department of Fish and Game for their awareness and diligence in protecting California's streams and watersheds against further damage from destructive logging practices; and, be it

FURTHER RESOLVED, That the San Francisco Bay Area Chapter of Trout Unlimited officially endorses these proposed amendments and additions to the Forest Practices Rules and urges the California Division of Forestry to adopt and enforce the proposed new amendments and additions to the Forest Practices Rules as soon as possible to protect wild trout, steelhead, and salmon fisheries of California.

Dr. Calhoun also discussed the catchable trout program and stated that it is here to stay. He said that the natural wild trout habitat for improvement in California is that of the steelhead. (Hooray! We're for that. Ed.)

Finally, Dr. Calhoun congratulated SFBATU on its policy and resolution on forest practices and stated that this is the first time the department has had this kind of support.

President Andy Puyans announced the goals for 1966 for Trout Unlimited in California. 1. 1,000 members. 2. New Chapters in each of the five Fish and Game Districts. 3. Active committees and member participation in projects.

MEMBERSHIP: We have almost 600 members in this chapter!

We must have more. Write Trout Unlimited, P.O. Box 2046, Custom House, San Francisco, for brochures and applications. Also copies of our Policy for California, which are available in limited quantity. This tells exactly what we are shooting for.

The trout season is on. You will be seeing your old friends and making new ones on the streams. SIGN 'EM UP. Carry the literature with you and spread the word.

MEMBERSHIP RENEWAL: We have now been in existence for one year. It is vitally important that all memberships are renewed. In order to remain active and effective, we must retain our old members as well as gain new one. Please do not fail to renew your membership.

NEW CHAPTERS: are under way in Burney and Los Angeles. Some of our directors have traveled to both cities and devoted much time and effort. We hope to have other chapters started in California soon.

TWO NEW COMMITTEES have been appointed - the Forest Practices Committee, with Phil Berry as chairman, and the Water Resources Committee, with Andy Gumpertz, chairman.

RUSSIAN RIVER: We have been studying a gravel mining project which is planned for the lower Russian River by the Utah Construction Company. So far, we have been unable to obtain the entire story, but we shall keep you informed and propose appropriate action when we learn more about it.

Also, we learned that the Russian is being polluted from sewage and industrial wastes dumped into Mark West Creek at Santa Rosa and entering the river just above Mirabel Park! More about this as soon as we get the information.

BY-LAWS: The following amendments to the by-laws were made at the April 19th meeting: Article V. Section 1, (1st Sentence). The Executive Officers of the Chapter shall be a President, Vice-President, Secretary, and Secretary-Treasurer, all of whom shall be members of the Board of Directors. Relative to this amendment, Richard H. May of Daly City and Joseph Paul of San Francisco were elected by the Board of Directors to serve in the posts of Secretary-Treasurer, and Secretary, respectively.

Section V was revised to require two officers' signatures on all checks.

On April 11th, at the invitation of Charlie Selover, some of our SFBATU directors met with officers of Fly Fishermen for Conservation, of Fresno, and California Fly Fishermen, Unlimited, of Sacramento. We met in Sacramento, informally, and discussed our common interests and goals. It was agreed that there are areas in which our groups can work together toward common objectives and that we should maintain liaison to this effect. The meeting served as an introduction in which we had the opportunity to become acquainted with these truly dedicated anglers. Further meetings should be held.

Here are the results of the questionnaires handed out at the Trout Unlimited Booth at the San Francisco Sport and Boat Show last February.

1.	Are you a trout or steelhead fisherman?	Yes	425	No	0
2.	Do you feel that California trout fishing is all it should be?	Yes	21	No	404
3.	As a trout fisherman, are you concerned about the future of trout fishing?	Yes	21	No	3
4.	There will be approximately 2 million licensed fishermen on California trout waters this season. With 4 million projected for 1980, do you feel that trout fishing is in jeopardy?	Yes	413	No	12
5.	Which would you rather catch? A. Hatchery Reared Trout? B. Wild Bred Trout?	A.	9	B.	416

6. Would you favor a balanced program of quality trout fishing over the current policy of put-and-take fishing for planted fish? Yes 417 No 8

7. Regarding such a balanced program, the Department of Fish and Game agrees in principle but needs popular support. As an individual trout fisherman, would you support a balanced trout program? Yes 421 No 4

8. Do you agree with the California legislator who was recently quoted as stating that sportsmen are "gutless", "disorganized", and an "Unimportant voting bloc"? Yes 99 No 297 Not answered 29

9. Do you believe that if trout fishermen were to organize as a politically powerful group, they could bring about needed change? Yes 401 No 24

Speak for itself?

April 7th we were initiated into the wondrous ways of government in Sacramento when we attended the meeting of the Assembly Interim Committee on Conservation and Wildlife in the state capital building. The purpose of the meeting was to hold hearings on the Proposed California Fish and Wildlife Plan - the huge five volume compendium, which contains many of the features of our 10 point policy for trout. Strong words were uttered by such diverse groups as the Mohair Association, The Humane Society, the Konocti Rod and Gun Club, etc., etc. (31 groups in all), but we managed to get our 10 point program into the minutes.

Walter Shannon, head of the Fish and Game Department, spoke of recent changes in the Plan: Pertaining to trout, he stated that the department plans to utilize electronic data processing in trout management. (We hope to learn more of this. Ed.) He said the Plan still requires study and alteration, but much is an extension of old existing regulations and plans. The Plan will require final approval by the State Office of Planning and must go through the legislature, the governor, and the Commission - not necessarily in that order. (There will be many hurdles along the way before it goes into effect, and it could be chopped to pieces. Ed.).

Henry Clineschmidt, a Fish and Game Commissioner, stated that items in the plan which are of immediate pertinence will be considered first by the Commission, and that the Commission will try to hold meetings in the areas concerned with specific problems. (Trout Unlimited must be on the mailing list of the Commission in order to get on the agenda of these meetings. It is imperative that we are represented. Ed.).

Walt Radke, bless his heart, gave us a good plug in the April 25th San

Francisco Examiner - printed the 10 point policy en toto. Thank you, Mr. Radke!

Thanks also to the Tioga Construction Company for donating an Address-o-graph machine to the chapter. This was indeed generous and is greatly appreciated.

SFBATU gave a no-host cocktail-reception at the Fairmont Hotel on June 8th, in honor of Ms. Charles C. Ritz. The world-famed Parisian angler, author, and hotelier charmed the many guests with a talk and demonstration of his "high speed-high line" fly-casting technique. The technique is especially useful in teaching beginners. Helpful points for beginners from Ms. Ritz: stand at about 45 degrees with the right foot back instead of facing forward - so the head can be turned back to watch the backcast; watch the back-cast until the correct timing can be learned; keep the back-cast high; keep the left hand (holding the line), low and away by the hip - rather than near the reel. This gives speed to the line.

Ms. Ritz graphically demonstrated the wrist, arm, and elbow casting motions by using a series of small lights extending from shoulder to rod-tip. All in all, a memorable and enjoyable evening with a most remarkable man.

Many thanks to Jon Tarantino, the Willie Mays of tournament casting, for arranging this gala affair.

BULLETIN SHEET

Miking some German processed leader material along with domestic stuff by comparison:

		German	American
Weight Test	20#	.018"	.021"
	6#	.010"	.010"
	4#		.0085"
	4.4#	.008"	
	3.5#	.007"	

Usually the German is smaller in diameter in the same weight test, more brittle and stiffer. None of the German or American is absolutely uniform. Flies tend to pop off easier and knots hold less well with the German.

Here is a trout leader formula, using the German product, which some of our fussier friends tout highly. It is modified after Ritz, the master: 5' of 19#, then 6" each of 14#, 12#, 9#, 7.7#, 6#, 4.4#, 3.5#, and 2.4# if desired. The last segment is tied as a tippet wherever you wish to stop before reaching the lighter stuff, with tippets from 18" to as long as 5'. Some prefer a heavier butt, (for steelhead we use a 3' butt of U.S.A. .027", 40#.) The German mono does not kink as badly as ours when taken off the reel, but we find a small piece of old inner tube handy for rubbing out kinks.

We realize this is the trout season, that shooting heads are out, double tapers are in but the shad are here. Some time ago, one of our friends asked if we thought there was a need for 25' heads. We had no answer then, but we do now. Yes - especially with shorter rods. We made up a 26' Dacron head of 2-3 grains. On a $7\frac{1}{2}$', $3\frac{1}{4}$ ounce rod it casts great. The shorter heads cast a bit "jerky", but we do not find this objectionable. They are much easier to pick up, hence less tiring than the heavy 30' heads on 9' rods. Of course distance is reduced, but we believe we are casting past too many fish anyhow. We also think a floating shooting head is useful, but fish are harder to hook, and many strikes messed with the floater.

Two of our better California fly fishermen went to Newfoundland last summer for Atlantic salmon and landed 68 fish in eight days - not to mention numerous searun brookies!

Incidentally, Newfoundland puts out a booklet with greatly detailed information on each of their many rivers, including reports on every stream for each of the past five years. Typical random sample: 1963 report from the Gander River: in 1503 rod days anglers took 872 fish (Atlantic Salmon) with an average weight of 4.7 pounds - 318 were under 4; 419 between 4 and 6; 96 between 6 and 10; 34 between 10 and 15; and 5 over 15. The heaviest weighed 18 pounds. (Fishing in Newfoundland and Labrador, issued by the Newfoundland Tourist Development Division.) We had thought Atlantics ran larger. They do, but not in Newfoundland.

Every fish is recorded! Would that we had such details available from our California rivers. We could ----

Avid S. Gairdnerian
P.O. Box 2046
Custom House
San Francisco, California

Graff & Hollender: 137-

p. 138: "We have declared a moratorium on the designation of any more special regulations areas until we can sort out the facts and determine what we want to accomplish."

A. Falling Springs Branch

brook, brown, rainbow = 800 kg/ha (714 lb/acre)
70% brown trout. — minimum size limit 20 inches.
No fish found more than 19.3 in. — larger fish in poor condition

B. Big Spring Crk.

brook, brown, rainbow; 15 in. size limit
brook trout drastic decline. — brwn, rb. replacing brook. (brook trout is only native sp.)

C. Penns Crk. - mainly brown trout - 20in size limit
3 x density of normal regulation area but much slower growth. — * Only ex. w/ comparative data: normal + spec. reg. - -

Movement.
- Yellowstone
- S. Platte
- Any. Pm

[C4R]

THE ST. JOE RIVER CUTTHROAT FISHERY - A CASE HISTORY OF ANGLER PREFERENCE*

T. C. Bjornn

Leader, Idaho Cooperative Fishery Research Unit
University of Idaho

INTRODUCTION

Until the early 1970's many anglers viewed the St. Joe River as a stream in northern Idaho with a declining population of native cutthroat trout (*Salmo clarki*). Stocking larger numbers of catchable rainbow trout (*Salmo gairdneri*) seemed to be the only way to maintain satisfactory fishing and retain the daily bag limit of 15 fish. Angler complaints of the reduced abundance and smaller size of the cutthroat led to a pond rearing program in an attempt to supplement the native stocks of fish and a squawfish removal program to remove a potential predator and source of mortality. After initial results, fishery managers decided neither of these programs would reverse the decline in abundance of the cutthroat population.

Fishery managers had witnessed the virtual elimination of cutthroat populations in other large river systems in Idaho and they wondered if replacement of the native cutthroat with hatchery rainbow trout was the only alternative available for the relative infertile streams of northern Idaho. In 1968, they requested personnel of the Idaho Cooperative Fishery Research Unit to assess the status of the cutthroat stocks in the St. Joe River and determine which management alternatives might be available. In this paper, I report on the status of the stocks, the management alternatives considered, the preferences of the anglers and the results of the revised management program.

STATUS OF THE STOCKS 1969-1970

The St. Joe River originates near the Idaho-Montana border and flows nearly 100 miles across the state where it empties into Coeur d'Alene Lake. We found three life history - migration patterns in St. Joe River cutthroat trout. Nearly all spawning takes place in the tributary streams. One type of cutthroat resides in the tributary streams of the river its entire life and matures at age 4-6 at 180 to 250 mm in length. A second type of cutthroat rears in the tributary streams for 1-3 years before entering the river where they remain until mature at age 4-6 and a length of 250 to 350 mm. A third type of cutthroat rears in the tributary streams 1-3 years and then migrates into the river and downstream into Coeur d'Alene Lake where they remain until mature at age 4-6 and a length of 300 to 350 mm. We are not sure if these three life history - migration patterns represent genetically distinct stocks of cutthroat within the St. Joe drainage.

*Presented to the Western Association of State Game and Fish Commissioners - 1975

In addition to the cutthroat trout, other indigenous fish species include the whitefish (*Coregonus williamsoni*), squawfish (*Ptychocheilus oregonensis*), sucker (*Catostomus* sp.), and sculpins (*Cottus* sp.). Introduced species include the brook trout (*Salvelinus fontinalis*), the rainbow trout (*Salmo gairdneri*), and the yellow perch (*Perca flavescens*). Suckers and squawfish normally inhabited only the lower half of the river and brook trout were found only in tributaries in the lower end of the drainage. Rainbow trout and a few cutthroat-rainbow hybrids were present throughout the lower three-fourths of the drainage as long as stocking continued. All but the upper 17 miles of the river was available by road access.

After considering a number of techniques, we assessed the abundance of fish in the river by counting the number of fish in permanently selected transects using snorkeling gear. A transect consisted of a pool bounded on either end by riffles. Because of the low fertility of the St. Joe River water, visibility was good and it was not difficult to count all of the fish in each transect.

In 1969 and 1970, we counted less than one cutthroat per transect in the lower portion of the study area from Avery upstream to Prospector Creek (Figure 1 and Table 1). In the river section from Prospector Creek upstream to Spruce Tree Campground, we counted approximately five cutthroat per transect. In the section of the river upstream from Spruce Tree Campground, not accessible by road, we counted 23 cutthroat per transect. Rainbow trout ranged up to eighteen fish per transect depending on the number stocked and location of release.

In 1968 anglers caught nearly 7,000 fish from the river between Avery and Spruce Tree Campground. Cutthroat comprised 46% of the fish caught and rainbow the remainder. The catch rate of the anglers in 1968 was less than one fish per hour.

The mean total length of cutthroat caught from the Avery to Spruce Tree section of the river was 188 mm. The average fish caught by the anglers was in its third summer of life and its first summer after entering the river from the tributaries.

I calculated the annual mortality rate of age III and older cutthroat trout from age-frequency data. In the Avery to Spruce Tree section of the river with road access, I calculated mortality rates of 72 and 84% in 1969 and 1970, respectively. In the river upstream from Spruce Tree Campground with access by trail the mortality rates were less (44 and 64% for 1969 and 1970).

Although we found few large mature fish to examine, we thought most fish matured and spawned for the first time by the time they were 300-350 mm in length and 4-6 years of age. In 1969 and 1970, only 2.5% of the 805 fish we measured were larger than 250 mm (10 inches) and less than 0.1 were larger than 325 mm (13 inches).

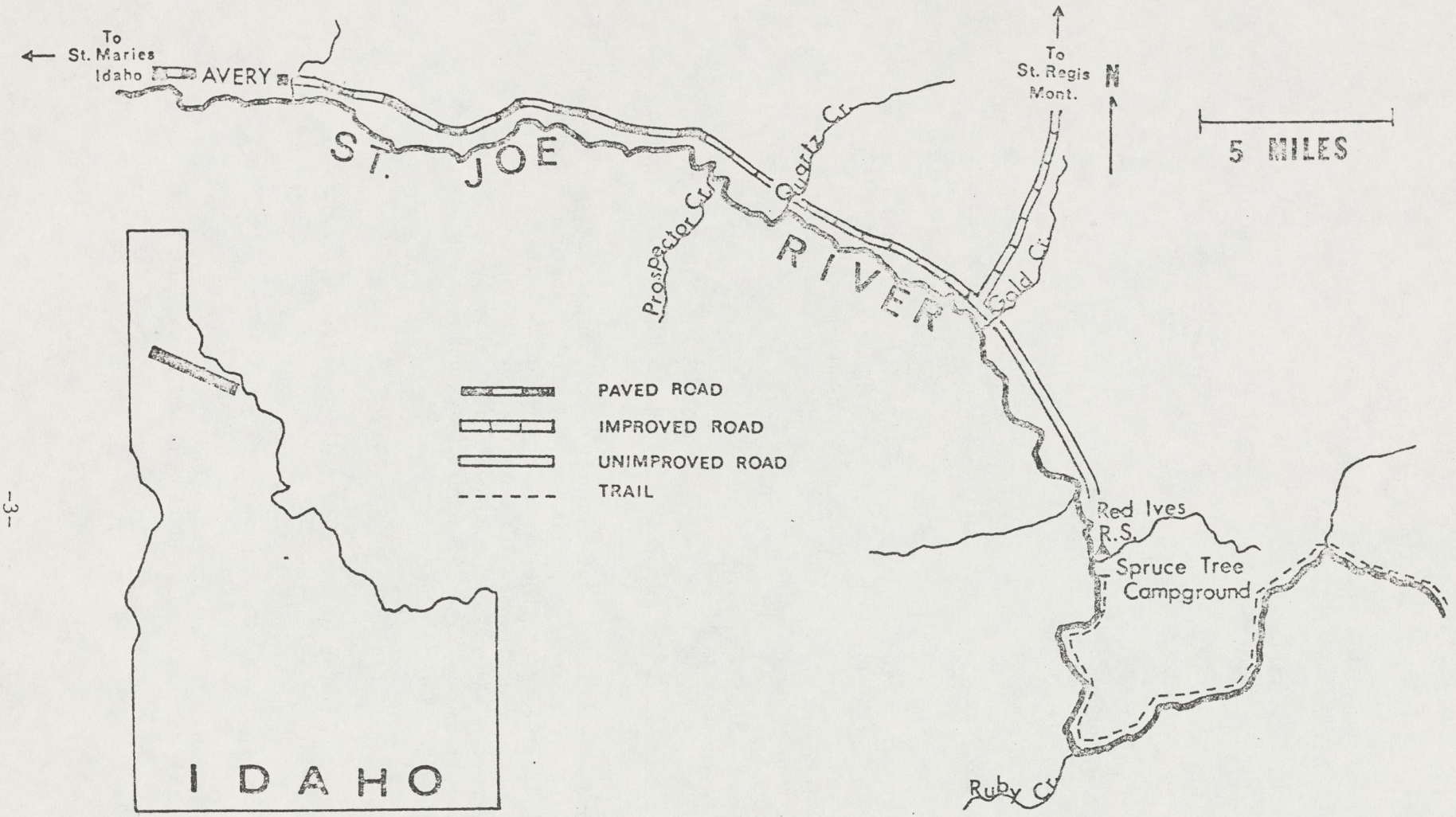


Figure 1. Location of the St. Joe River study area showing type of access. The St. Joe River below Prospector Creek is under a standard (10 fish bag, no size limit) regulation and is supplementally stocked with rainbow trout. Above Prospector Creek, a special (trophy-fish) regulation is in effect which sets a 3 fish daily bag limit provided each fish in the bag is 13 inches in length or longer.

Table 1. The mean number of trout counted in established transects in the St. Joe River from Avery to Ruby Creek.

Section of river	Number of transects	1969	1970	1971	1972	1973	1974
				Cutthroat			
Standard regulations Avery to Prospector Creek	7	0.5	0.0	2.0	0.5	0.6	5.2
Special regulations Prospector Creek to Spruce Tree Campground	15	4.6	5.8	11.1	11.2	13.9	26.5
Spruce Tree Campground to Ruby Creek	6	22.8	22.3	23.5	31.8	30.8	58.8
				Rainbow			
Standard regulations Avery to Prospector Creek	7	3.3	5.3	10.1	10.1	6.4	18.7
Special regulations Prospector Creek to Spruce Tree Campground	15	4.8	17.8	15.6	1.0	1.7	3.2
Spruce Tree Campground to Ruby Creek	6	1.3	5.0	0.5	0.2	0.0	0.0

In summary, we concluded that the population of cutthroat trout in the upper half of the St. Joe River was relatively small, that the fish were harvested soon after entering the river from the tributaries, a large portion of the large annual mortality rate was due to angling and that the drainage was inadequately seeded because few fish survived long enough to mature and spawn the first time. In short, we concluded the cutthroat population was being overexploited.

MANAGEMENT ALTERNATIVES

We considered a number of management alternatives but only two appeared to be viable in 1970.

1) Continue the present management policy

   a) Bag limit 15 fish (no size limit)
   b) Stock catchable size rainbow trout to replace cutthroat

2) Change the management policy - save the cutthroat trout

a) Restrict the harvest to reduce the annual mortality rate

b) Discontinue the stocking of catchable size trout

To maintain the cutthroat trout population in the St. Joe River, it was necessary to reduce the mortality rate. The harvest was the only portion of the mortality which we could alter, and it was therefore, necessary to consider various types of reduced harvest. Since the average catch of anglers was less than five fish, the bag limit had to be substantially less than five to significantly alter the mortality rate.

We thought the department should discontinue the stocking of hatchery trout because of their potential, but unproven, competition with cutthroat and because many anglers could not tell the difference between rainbow and cutthroat trout, we could not expect them to selectively harvest only the hatchery trout.

PUBLIC PREFERENCE

Once we had assessed the status of the stocks and formulated the management alternatives we had reached the point where a value judgement had to be made. Since the fishery resources in the St. Joe River belong to the public we reasoned that the public should choose between the management alternatives. Our training as fishery scientists did not make us any better prepared to make such a value judgement than the average angler. As fishery scientists, it was our responsibility to determine the biological constraints and make sure the public understood the trade-offs associated with each alternative under consideration.

To assess public preference for the alternatives, we contacted anglers while they were fishing the river and held public meetings in communities adjacent to the river. During these contacts we described the status of the stocks, the alternatives as we saw them, and the trade-offs associated with each alternative. We then asked the anglers which alternatives they preferred: 1) continue the present management program, or 2) change the management program to save the cutthroat trout.

A surprisingly large percentage (88%) preferred to save the cutthroat trout even though the bag limit might be reduced to zero as we explained in the trade-offs. Anglers who fished the St. Joe River preferred to catch the native cutthroat trout even though they might have to release all the fish they catch.

RESULTS OF CHANGE IN MANAGEMENT

As a result of the studies conducted and the preferences expressed by the anglers, the Idaho Fish and Game Commission, in 1971, instituted regulations on the upper half of the St. Joe River designed to save the

cutthroat trout population. The bag limit was reduced to three fish, but those three fish had to be over 13 inches in length. No fishing with bait was allowed because most of the fish caught would be less than 13 inches and would have to be returned to the river. The Fish and Game Department discontinued the stocking of catchable size rainbow trout in the upper half of the river in 1971.

After four years of the special regulations on the St. Joe River upstream from Prospector Creek, we counted up to five times more cutthroat in the snorkeling transects than during the pre-special regulation period of 1969-70 (Table 1). The largest increase in cutthroat abundance occurred in the section of river from Prospector Creek to Spruce Tree Campground. Prior to the special regulations we counted an average of only 5 cutthroat per transect in this section of the river with road access compared to 26 cutthroat per transect in 1974. The section of the river upstream from Spruce Tree Campground, without road access, contained more cutthroat prior to the special regulations (23 per transect) than the section with road access, but even there the abundance had increased to 59 fish per transect by 1974. The abundance of cutthroat in the Avery to Prospector Creek section of the river with standard fishing regulations increased to five fish per transect in 1974 compared to an average of less than 1 fish per transect in previous years. Cutthroat saved in the upstream special regulation area probably contributed to the increase in abundance in the Avery to Prospector Creek section of the river in 1974.

The hatchery rainbow trout virtually disappeared from the St. Joe River upstream from Prospector Creek when the Fish and Game Department discontinued stocking in 1971 (Table 1). The 15.6 rainbow trout we counted in the Prospector Creek to Spruce Tree Campground section of the river in 1971 came from trout stocked near the special regulations boundary and which had swam upstream into the lower transects of that section of the river. The number of rainbow trout counted in the transects in the Avery to Prospector Creek section of the river varies each year and depends on the number stocked and the location of release.

The mean length of cutthroat caught by anglers and project personnel from the upper half of the St. Joe River has increased from 189 mm in 1969-70 to 226 mm in 1974 (Table 2). In 1974, 32 percent of the cutthroat trout caught by project anglers were larger than 10 inches compared to only 3 percent in 1969-70. Fish which exceeded the 13 inch minimum size limit comprised 3% of the angler catch in 1974 versus 0.1% in 1969-70. The slight decrease in mean length in 1974, if real, might be the result of the increased abundance of age II and III fish in the river in 1974.

Table 2. Mean total length and sample size of cutthroat trout caught from St. Joe River upstream from Avery by anglers (1969-70) and project personnel (1971-74).

Year	Number measured	Mean length
1969-70	1476	188.5
1971	52	189.1
1972	322	237.9
1973	139	235.4
1974	580	226.3

By 1974 the annual mortality rate calculated from age composition data, had decreased to 52% in the section of the river with road access and to 31% in the section of the river with trail access. In 1969 and 1970 the mortality rates in those two areas was 72-84% and 44-64%, respectively (Table 3). The increased abundance and size of cutthroat in the St. Joe River, directly reflect the reduced mortality rate.

Table 3. Calculated annual mortality rates of age III and older cutthroat trout in sections of the upper St. Joe River.

Year	Prospector Creek to Spruce Tree Campground (road access)	Spruce Tree Campground to Ruby Creek (trail access)
1969	.72	.44
1970	.84	.64
1974	.52	.31

The effect of the special regulation on angler effort, fish caught and catch per hour is best illustrated by the data we have on the Gold Creek to Spruce Tree Campground section of the upper St. Joe River (Table 4). Census boundaries chosen for the 1968 census do not allow us to present completely comparable data for the entire section of river under the special regulations. Angler effort decreased in 1971 when the special regulations were put into effect, but by 1973 the number of hours fished had increased to near the pre-1971 level. Although we did not conduct a census in 1974 there was an obvious increase in fishing effort over 1973.

In 1968 anglers caught and kept 1,800 fish in the Gold Creek to Spruce Tree Campground section of the upper St. Joe River. Half of these fish were cutthroat trout and the other half were hatchery rainbow trout. A few anglers released some of the fish they caught but this would not increase the total number of fish caught by a significant amount. In 1973, even with the shortened season by a fire closure, anglers caught 8,100 fish

(four times more than in 1968) but kept only 324 fish (about 1/3 the number of cutthroat kept in 1968) (Table 4). In 1973, 99% of the fish caught were cutthroat trout compared to only 50% in 1968.

Table 4. The number of hours fished, fish caught, fish kept and catch per hour of anglers fishing the Gold Creek to Spruce Tree Campground section of the upper St. Joe River with special regulations starting in 1971.

	1968	1971	1972	1973[1/]
Hours fished	2,200	600	1,300	1.700
Fish caught	[2/]	[2/]	3,600	8,100
Fish kept	1,800	60	82	324
Catch per hour	0.82	-	2.77	4.76

[1/] 1973 fishing season shortened by a forest fire closure on August 8.

[2/] In 1968 a few fish were released but most were caught and kept. In 1971, we did not record the number of fish caught and released.

The catch per hour of anglers fishing the Gold Creek to Spruce Tree Campground section of the upper St. Joe River in 1968 was less than 1 fish per hour (Table 4). In 1973 the catch rate had increased to 4.8 fish per hour and in 1974 the catch rate of project anglers was 5 fish per hour.

CONCLUSIONS

We concluded from our studies of stock status that the abundance of cutthroat trout in the St. Joe River was being reduced in abundance through overexploitation. Anglers, when presented the alternatives and trade-offs associated with those alternatives, chose to preserve the cutthroat trout population. Special regulations designed to reduce the mortality rate in the cutthroat population have succeeded in increasing the abundance and fishing success. Angler support of the special regulations has been enthusiastic even though they were unable to keep most of the fish they caught.

We do not expect recovery of the population to full abundance until the late 1970's when off-spring of fish saved in 1971-72 have had a chance to spawn and contribute to the population.

Initially we were unsure if the proposed regulations would reduce the mortality sufficiently to allow the population to recover. We feared that hooking mortality alone might be more than the population could withstand. So far a least, the mortality associated with catching and releasing cutthroat trout has not been excessive. Once the population has fully recovered we anticipate that anglers will want to examine the options of retaining the present regulations or liberalizing the regulations to allow anglers to keep more fish.

Bjornn

PROCEEDINGS OF A NATIONAL SYMPOSIUM ON

WILD TROUT MANAGEMENT

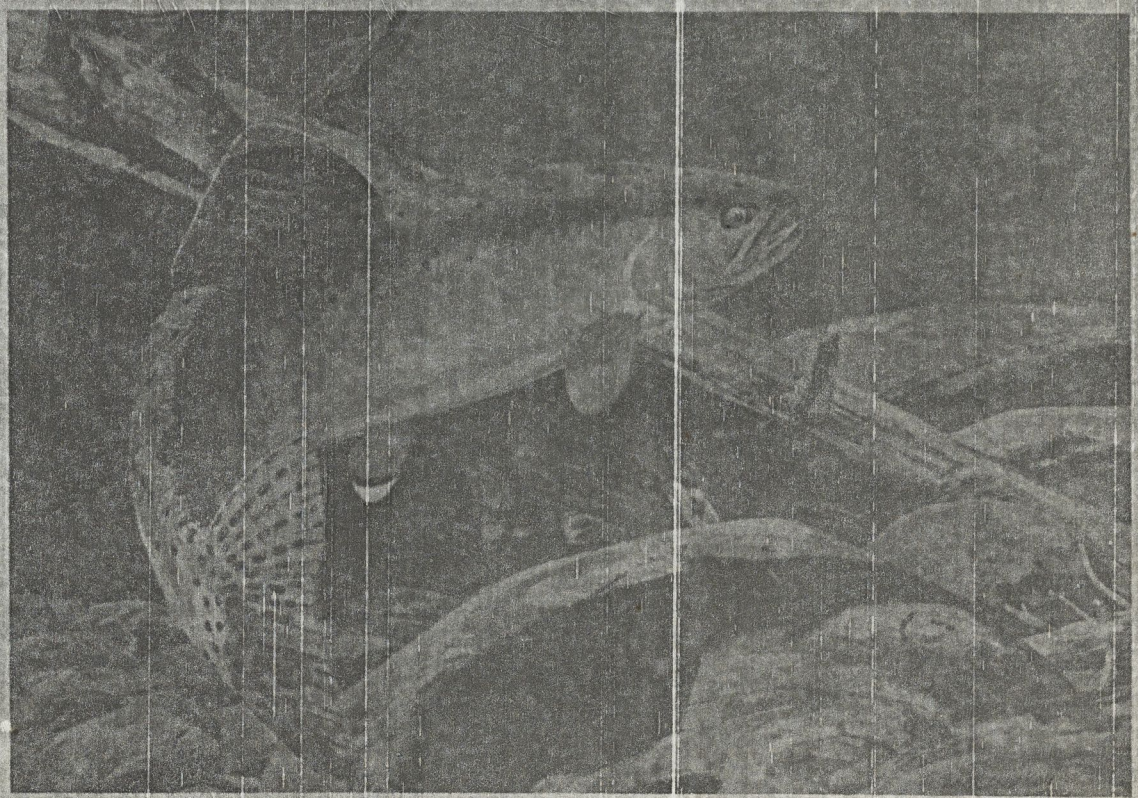
Sponsored by

CALIFORNIA TROUT, INC.

and

THE AMERICAN FISHERIES SOCIETY

San Jose Hyatt House • San Jose, California • February 3, 1977



WILD TROUT MANAGEMENT, AN IDAHO EXPERIENCE

by

T. C. Bjornn and T. H. Johnson
Idaho Cooperative Fishery Research Unit
University of Idaho
Moscow, Idaho 83843

In 1970, the Idaho Fish and Game Commission approved a change in the management of the native cutthroat trout (*Salmo clarki*) populations in the upper St. Joe River and Kelly Creek. Anglers wanted to halt the decline in the abundance of the native cutthroat trout population and were dissatisfied with the catchable-sized rainbow trout (*Salmo gairdneri*) stocked in the streams to replace the cutthroat. The Commission adopted special angling regulations designed to reduce mortality rate in the wild trout populations and discontinued stocking hatchery reared trout. The cutthroat trout populations responded to the reduced angler harvest with an increase in both abundance and mean size.

Prior to 1970 the St. Joe River, Kelly Creek, and the North Fork of the Clearwater River, (which served as a control stream), all had the standard statewide angling regulations of a 15 fish bag limit with no size restriction and all were stocked with hatchery reared rainbow trout. In 1970, a catch-and-release angling regulation was put into effect for the Kelly Creek drainage. A trophy fish regulation (three fish bag, 13-inch minimum size limit) was initiated on the St. Joe River drainage upstream from Prospector Creek in 1971. The North Fork of the Clearwater River drainage, upstream from Kelly Forks, had the standard angling regulations until 1972, when a three fish bag, no size limit regulation was put into effect.

Personnel of the Idaho Cooperative Fishery Research Unit began studying the fish populations in Kelly Creek and the North Fork, and St. Joe rivers in 1969. The initial studies were designed to assess the status of the stocks and determine the reasons for the decline in the abundance of cutthroat trout.

THE WILD FISH STOCKS

The St. Joe River, Kelly Creek, and the North Fork are relatively large streams (400-800 cfs summer flow) which originate in the Bitterroot Mountains near the Idaho-Montana border and flow through mountainous, coniferous forested watersheds (Figure 1). We would consider the stream habitat to be in near pristine conditions with the exception of some tributary streams with roads located adjacent to the stream. We studies 22 miles of Kelly Creek, 23 miles of the upper North Fork of the Clearwater River, and 44 miles of the upper St. Joe River. We divided each study stream into sections based upon the presence of roads or trails along the stream.

In addition to the native cutthroat trout and the hatchery reared rainbow trout stocked into the study streams, mountain whitefish (*Prosopium williamsoni*), largescale sucker (*Catostomus macrocheilus*), northern squawfish (*Ptychocheilus oregonensis*), redside shiner (*Richardsonius balteatus*), and Dolly Varden (*Salvelinus malma*) were also present in all three study streams. Before 1970, steelhead trout (*Salmo gairdneri*) spawned in the North Fork of the Clearwater drainage, including Kelly Creek, and residual steelhead were present in those two streams but not in the St. Joe River. In Kelly Creek, mountain whitefish and largescale suckers outnumbered cutthroat trout and in the North Fork, residual steelhead trout also outnumbered the cutthroat trout. In the upper St. Joe River, cutthroat trout were the most abundant fish species, followed by mountain whitefish.

Cutthroat residing in the study streams have three life history types. Nearly all spawning takes place in the tributary streams. One type of cutthroat resides in the tributaries of the study streams its entire life and matures at age IV-VI at 7 to 10 inches. The second type of cutthroat spends 1-3 years in the

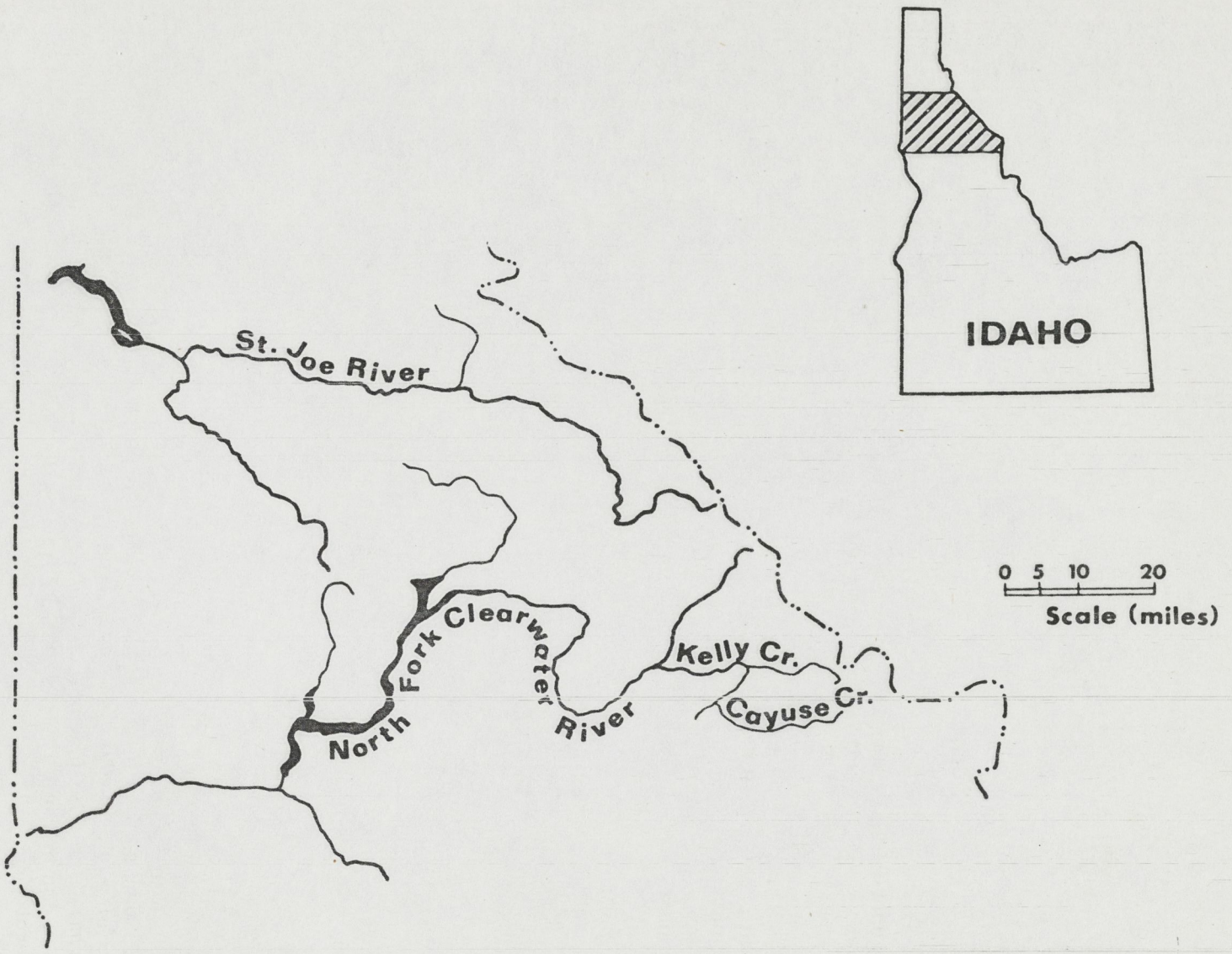


Figure 1. Map of the St. Joe River, Kelly Creek and the North Fork of the Clearwater River study streams in north central Idaho.

tributary streams before entering the river and remains there until mature at age IV-VI and a length of 10 to 12 inches. A third type of cutthroat spends 1-3 years in the tributary streams and then migrates into the river and downstream into Coeur d'Alene Lake or Dworshak Reservoir, where it remains until mature at age IV-VI and a length of 12 to 14 inches. We suspect that these three life history types of cutthroat are genetically distinct stocks of cutthroat.

In 1969, we began assessing the abundance of cutthroat trout in the rivers by counting the fish in permanently established transects using snorkeling gear. A transect consisted of a pool bounded at either end by riffles. Because of the low fertility in the study streams, visibility was good and all fish in each transect could be counted. In 1969 and 1970, we counted less than one cutthroat per transect in the North Fork and Kelly Creek and six to eight cutthroat per transect in the St. Joe River (Figure 2).

Anglers caught nearly 2,000 fish from the upper end of the St. Joe River (1968), 5,500 fish from Kelly Creek (1969), and 2,700 fish from the North Fork (1969) (Figure 2). In all three streams, most of the fish caught were kept by the anglers. In the St. Joe River, half of the trout caught were hatchery rainbow trout and half were cutthroat. In Kelly Creek and the North Fork, most of the trout caught were juvenile steelhead trout and only a few were cutthroat.

Cutthroat trout caught from the upper portion of the St. Joe River in 1969-70 averaged 7.4 inches while those caught from Kelly Creek averaged 8.7 inches and from the North Fork, 8.5 inches (Figure 3). We calculated annual mortality rates of age III and older cutthroat from age-frequency data and found that the mortality rates averaged close to 75% in both Kelly Creek and the St. Joe River (Figure 2). In 1969 and 1970, only 2.5% of the fish we observed from the St. Joe River were larger than 10 inches. Of the fish observed from Kelly Creek in 1970, 20% were larger than 10 inches.

After our studies in 1969 and 1970, we concluded that populations of cutthroat trout in the St. Joe River and Kelly Creek and the North Fork were relatively small, that fish were harvested soon after entering the river from the tributaries, and a large portion of the annual mortality was due to angling. Because of the large annual mortality rate, few fish survived long enough to become mature and spawn and we concluded that the drainages had inadequate numbers of cutthroat fry.

The catch-and-release angling regulations were put into effect on Kelly Creek in 1970 with only minimal public input regarding the change in regulations. Anglers fishing Kelly Creek and the North Fork in 1969 were asked if they preferred to catch a few large fish or many small fish and the majority stated they preferred to catch a few large fish. In addition, we had just completed a statewide survey in 1969 (Gordon, Chapman, and Bjornn 1970) in which we found that half of the anglers thought native trout populations should be maintained, 60% thought catch-and-release regulations should be tested, and 49% agreed to try fishing in areas with catch-and-release regulations.

The trophy fish regulations on the St. Joe River were not put into effect until 1971, after we had an opportunity to discuss the status of the stocks and alternatives for future management with anglers fishing the St. Joe River. We considered a number of management alternatives for the St. Joe River, but only two appeared viable in 1970.

1) Continue the present management policy (bag limit 15 fish, no size limit) and stock catchable-sized rainbow trout to replace cutthroat trout.

2) Change the management policy to save cutthroat trout. Restrict harvest to reduce the annual mortality rate and discontinue stocking of hatchery reared rainbow trout.

To maintain the cutthroat trout population in the St. Joe River and Kelly Creek, we believed it was necessary to reduce the mortality rates. The harvest was the only portion of the mortality rate which we could alter. Therefore, it was necessary to consider various types of reduced harvest. Since the average catch of anglers was less than five fish, the bag limit had to be substantially less than five to significantly alter the mortality rate. We suggested that the Idaho Fish and Game Department discontinue stocking

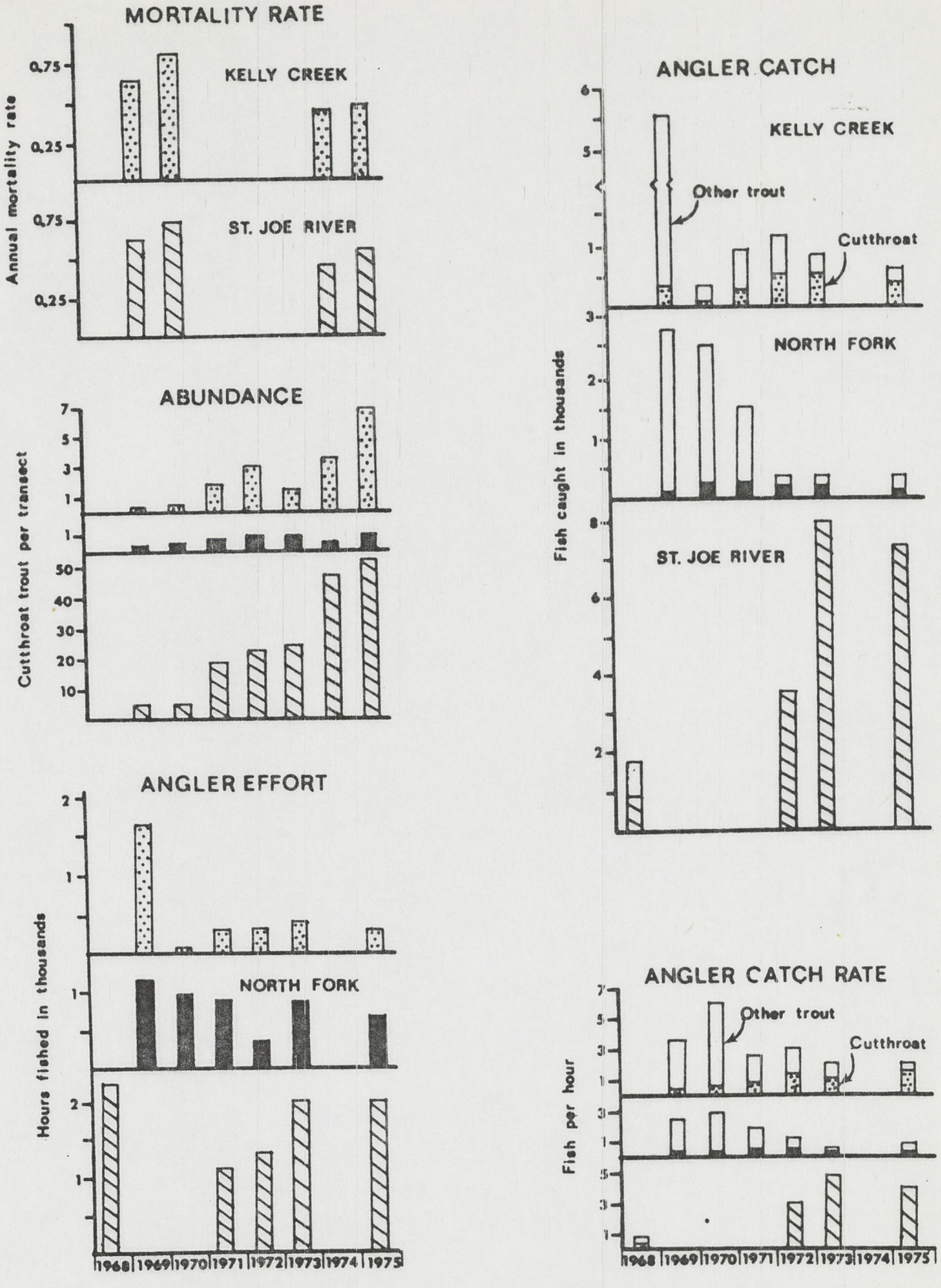


Figure 2. The annual mortality rate, cutthroat counted per transect, hours fished by anglers, catch of cutthroat and other trout by anglers and the catch rate for cutthroat and other trout in the St. Joe River, Kelly Creek and the North Fork, 1968--1975.

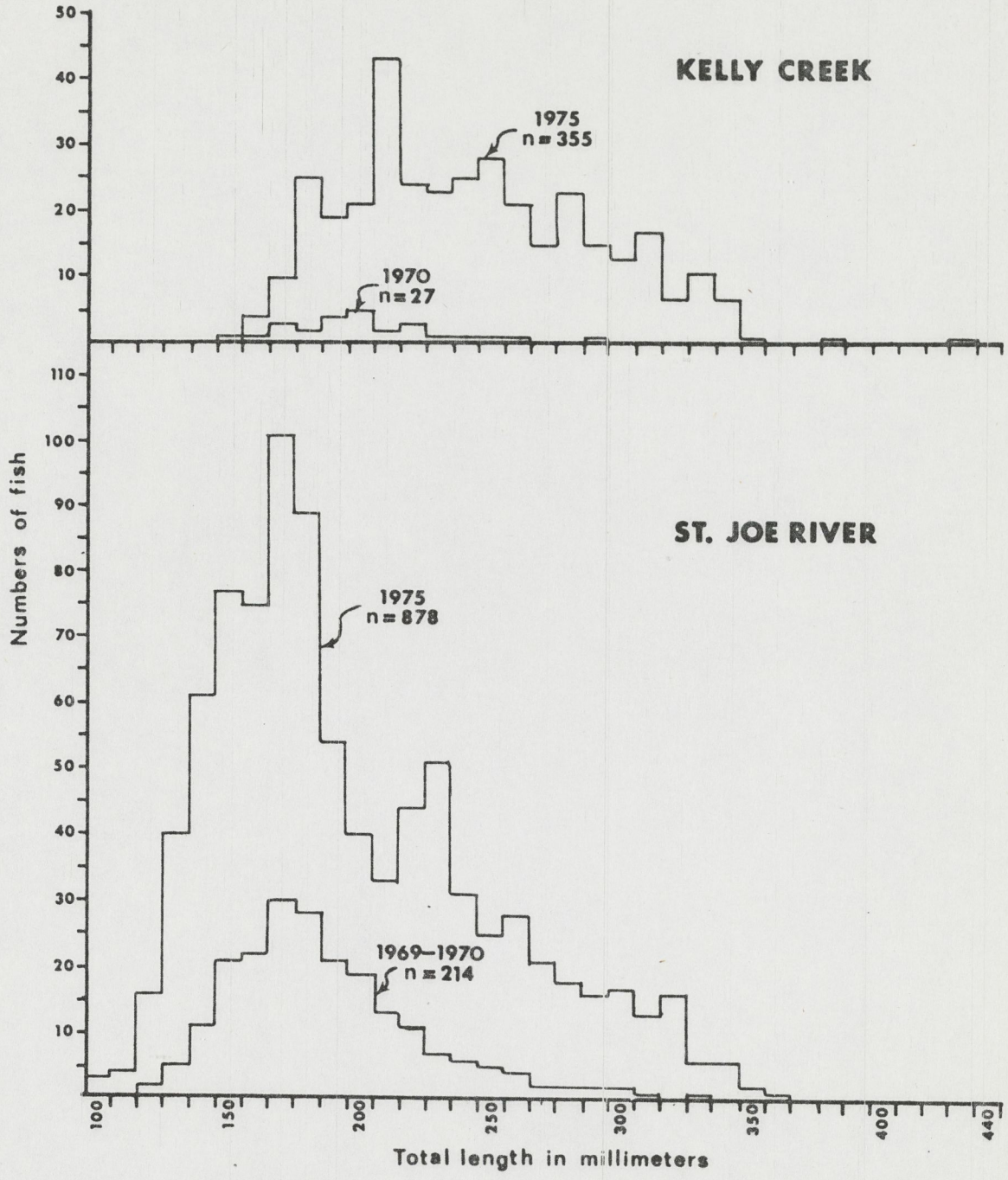


Figure 3. The number and size of cutthroat trout in representative transects in the St. Joe River and Kelly Creek, 1959-70 versus 1975.

hatchery trout because of their potential, but unproven, competition with cutthroat. Many anglers could not tell the difference between rainbow and cutthroat trout, thus we could not expect them to selectively harvest only hatchery trout.

Once we had assessed the status of the stocks and formulated the management alternatives, we had reached the point where value judgments had to be made. We contacted anglers while they were fishing the St. Joe River and held public meetings in communities near the river to determine public preference for the alternatives. During these contacts, we described the status of the St. Joe River cutthroat stocks, the alternatives as we saw them, and the tradeoffs associated with each alternative. We then asked the anglers which alternative they preferred: 1) continue the present management program, or 2) change the management program to save the cutthroat trout in the St. Joe River.

A suprisingly large percentage (88%) preferred to save the cutthroat trout, even though the bag limit might be reduced to zero. Anglers who fished the St. Joe River preferred to catch the native cutthroat trout even though they might have to release all the fish they might catch. As a result of the studies conducted and the preferences expressed by the anglers, the Idaho Fish and Game Commission instituted regulations in 1971 on the upper part of the St. Joe River designed to save the wild cutthroat trout populations. The bag limit was reduced to three fish but those three fish had to be over 13 inches in length. No bait fishing was allowed because most of the fish caught would be less than 13 inches and would have to be returned to the river. The Fish and Game Department discontinued the stocking of catchable-sized rainbow trout in the upper half of the river starting in 1971.

RECOVERY OF THE WILD TROUT POPULATIONS

The cutthroat populations in Kelly Creek and the St. Joe River increased in abundance after the special regulations were put into effect, but the cutthroat population in the North Fork Clearwater River did not increase in abundance (Figure 2). We counted 13 times more cutthroat in Kelly Creek in 1975 than in 1970 (Figure 3). In the upper St. Joe River, we counted 4 times more cutthroat in 1975 than in 1969-70. Rainbow trout of hatchery origin virtually disappeared from the upper St. Joe River after stocking was discontinued in 1971. The abundance of juvenile steelhead in 1975, now termed residual steelhead, was only one third that of 1970 in Kelly Creek and the North Fork.

Angler effort declined on Kelly Creek and the St. Joe River following initiation of the special angling regulations (Figure 2). In Kelly Creek, anglers fished very few hours in 1970, the first year of the catch-and-release regulation. In recent years, angling effort has stabilized at about 20% of the effort on the St. Joe River declined initially when the trophy fish angling regulations were put into effect in 1971 but has since increased to 1968 levels.

In 1975, the average size of cutthroat caught in Kelly Creek had increased to 9.6 inches compared to 8.66 inches for fish caught in 1970 (Figure 3). Cutthroat caught from the upper portion of the St. Joe River in 1975 averaged only slightly larger (7.8 inches) than the fish caught in 1969-70 (7.4 inches) (Figure 3). The average size of cutthroat caught from the St. Joe River increased in the years immediately after the trophy fish regulations were put into effect, as fish survived and grew to larger size, but then declined as large numbers of juvenile cutthroat entered the population. In 1975, 42% of the cutthroat caught from Kelly Creek were larger than 10 inches vs. 20% in 1970. In the St. Joe River, 18% of the cutthroat caught in 1975 were larger than 10 inches vs. 2.5% in 1969-1970.

In both Kelly Creek and the St. Joe River, the total annual mortality rate which we calculated from age-frequency data was smaller in 1974 and 1975 than in 1969 and 1970 (Figure 2). Since the population was increasing in abundance in 1974 and 1975, our estimates of the annual mortality rate are probably over-estimates, but they do illustrate that the total mortality has been reduced by the special angling regulations.

Both the angler catch rate and the catch of cutthroat trout from Kelly Creek and the St. Joe River has increased since initiation of the special regulations. In Kelly Creek, the angler catch rate for all species

combined has actually decreased because of the decrease in abundance of juvenile steelhead (Figure 2). The catch rate for cutthroat trout increased from 0.2 fish/hour in 1968 to 2.5 fish/hour in 1975. The angler catch of cutthroat from Kelly Creek increased after 1970 but was still relatively small because of the reduced fishing effort by anglers in Kelly Creek. The catch of cutthroat trout from the St. Joe River increased 7-8 fold after 1971, but few of the fish caught were large enough to be kept by the anglers.

In 1975, we interviewed anglers fishing Kelly Creek, the North Fork, and the St. Joe River to assess their attitudes regarding the special angling regulations which had been in effect for the past 4 or 5 years. Many of the anglers fishing Kelly Creek in 1975 had not fished Kelly Creek before 1970 when the standard regulations were still in effect. Most anglers who had fished Kelly Creek before 1970 thought fishing was better in 1975 than in 1970. Most of the anglers fishing in the North Fork in 1975 had fished the North Fork in the late 1960's and thought the quality of angling had declined on the North Fork in recent years. Most anglers fishing the upper St. Joe River in 1975 had fished the upper St. Joe River in the late 1960's and thought the fishing was better in 1975, especially in the special regulations area upstream from Prospector Creek.

Crowded conditions appear to detract from an angler's fishing experience. Anglers on the North Fork who thought fishing was better in 1975 thought so because there were fewer people fishing in 1975. The special angling regulations in effect on the Kelly Creek and the St. Joe River were acceptable to anglers fishing on those streams, as might be expected. In 1975, nearly all the anglers fishing the study streams preferred to catch native cutthroat. In 1969-1970, only 57% of the anglers interviewed preferred to catch cutthroat trout rather than hatchery reared rainbow trout.

DISCUSSION

In our studies we found that wild trout populations, particularly cutthroat trout in infertile streams, can be overfished. When the total mortality rate was reduced by reducing the mortality due to angling, the cutthroat populations increased in abundance and a larger number of the fish survived to reach maturity and spawn. In many Idaho streams, cutthroat trout populations have been overfished to virtual extinction. In other streams, the abundance of cutthroat has been reduced to the point where they no longer provide satisfactory fishing, although the population may continue to exist.

Both catch-and-release and trophy fish regulations allowed the cutthroat trout populations to recover and increase in abundance. In the first years after the trophy fish regulation was put into effect on the upper St. Joe River, few of the cutthroat present in the river were larger than 13 inches, thus the trophy fish regulation was, in effect, a catch-and-release regulation. In recent years, large cutthroat have become abundant enough so that anglers have a reasonable chance of catching a fish large enough to keep.

With the catch-and-release regulations on Kelly Creek, cutthroat trout survived longer and grew to larger sizes than in the St. Joe River, which had the trophy fish regulations (Figure 4). In the upper St. Joe River, anglers were allowed to keep cutthroat longer than 13 inches and thus there were few cutthroat longer than 13 inches in that stream. Cutthroat up to 17 inches or longer were found in Kelly Creek, where all fish had to be released by anglers.

Angler use of Kelly Creek, with the catch-and-release regulation, was less than the use of the St. Joe River with its trophy fish regulation. Although there were some differences in access and proximity to population centers, we believe the opportunity to catch and keep a fish or two in the St. Joe drainage was the major reason for the difference in angler usage. Anglers fishing Kelly Creek were fully in favor of the catch-and-release regulations but because fewer anglers were fishing Kelly Creek in 1975 than in 1969, we conclude that a substantial part of the angling public would prefer to fish in an area where they have an opportunity to keep some of the fish they catch.

In the future, as more people fish Kelly Creek and the upper St. Joe River, the juvenile trout will be caught and released many times and the mortality associated with catching and releasing fish may become

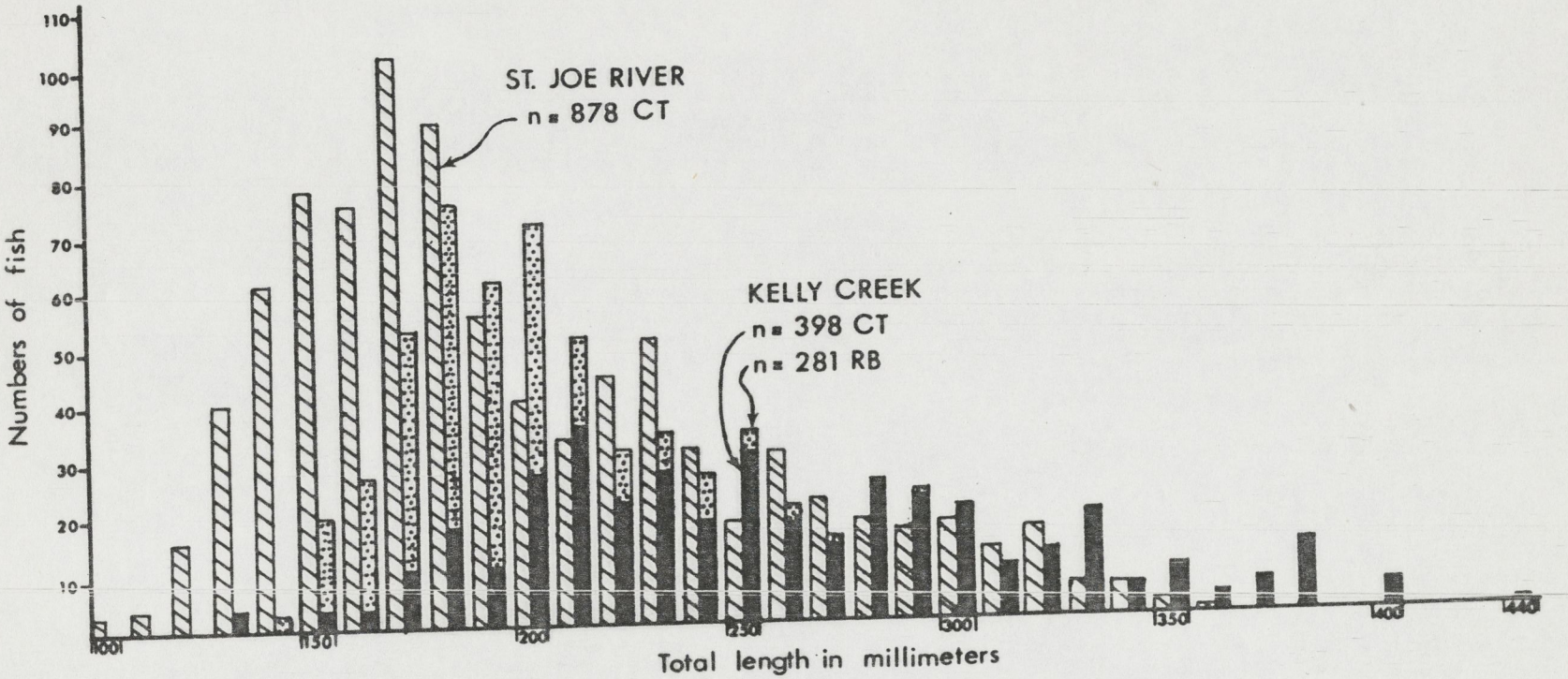


Figure 4. Comparative abundance and size distribution of cutthroat and rainbow trout in a similar number of transects in the St. Joe River versus Kelly Creek, 1975. Data from transect counts and fish caught and measured by project personnel.

significant. With the present fishing intensity, it appears that the cutthroat trout population could increase to near pristine levels of abundance and provide catch rates and catches of cutthroat like those in "the good old days" although few of the fish would be harvested.

Variations of the catch-and-release or trophy fish regulations, which we used on Kelly Creek and the St. Joe River, could be applied with similar results. For example, the minimum size limit might be 11 or 12 inches on the St. Joe, rather than 13 inches. With a 12-inch size limit, we estimate that most fish would still survive to spawn the first time and no more than an additional 10% of the fish population would be harvested.

The correct regulation to protect a wild trout population depends on the type of fishery preferred by the angling public. If the anglers want maximum catch rate and a maximum number of large fish from streams similar to the St. Joe and Kelly Creek, then a catch-and-release regulation would probably be most appropriate. If anglers are willing to accept reduced abundance and perhaps smaller fish in order to keep a few fish, then some form of trophy fish regulation would provide the desired results. In some areas, fishing intensity may be too high to allow even one fish per angler without seriously reducing the fish population. In this case, catch-and-release regulations would be needed to maintain a wild trout population at a high level of abundance. In streams with less intense fisheries, regulations which allow anglers to keep a fish or two and still maintain a high level of abundance would be preferred by a large number of anglers. Anglers are willing to release most of the fish they catch in order to maintain populations of wild trout, but many anglers still cherish cooking and eating a trout around a campfire.

In Idaho, the Department of Fish and Game has attempted to provide a wide variety of fishing opportunities. We do not expect the cutthroat populations of Kelly Creek or the St. Joe River to fully recover until 1980. At that time, a reevaluation of the management plan for those streams would be appropriate.

REFERENCES

Gordon, C. Douglas, D. W. Chapman, and T. C. Bjornn. 1970. The preferences, opinions, and behavior of Idaho anglers as related to quality in salmonid fisheries. Proceedings of the 49th annual conference of Western Association State Fish and Game Commissioners, pp. 98-114.

Willow Crk. Wis.

Spec. Reg.

brown Trout

8oz-9oo hrs. angler / acre

MEMBERS RESEARCH AND PROJECTS COMMITTEE
MEMBERS BOARD SCIENTIFIC ADVISORS

Enclosed is an application from the Kiap TU Wish Chapter of Trout Unlimited for $1500. This is a follow up on its application for four year funding of the Willow-Race regulation study which we funded for the first year.

I am sending a copy to the Scientific Advisory Board this year because I believe I was wrong last year in not including them. This is a rather inclusive study with an unusual water set up and a hired creel census provided. They might offer light also by knowledge of other studies of the same nature.

We have approved the Santa Ynez river project of the Central Coast Chapter for $2000. as the last part of Phase one of operation Restore. At the suggestion of Richardson we are asking them to seek their plants ($700) from the Forest Service, and if they succeed to return the $700. to the Mellon Fund.

We have also approved the $2500. request from the Smokey Mt. Chapter submitted by Joe Congleton for their Little Tennessee River project. Joe has been advised our budget funds may not be equal to the task though we will try our best.

June 1, 1977

Respectfully yours

Nash Williams

Nash Williams, Chr.
Research and Projects Committee
2400 Waunona Way
Madison, Wisconsin
53713

TROUT UNLIMITED

KIAP-TU-WISH CHAPTER
1004 So. Front St.
Hudson, WI 54016

COPY

May 23, 1977

National Trout Unlimited
Research and Projects Committee
c/o Nash Williams, Chairman
2400 Waunona Way
Madison, Wisconsin 53713

Subject: Funding for Race-Willow River
Wisconsin DNR Quality Fishing Research
Project near Hudson, Wisconsin

Gentlemen:

This letter is a request for $1,500 in matching funds for the creel census and fisherman attitude portion of the subject project. The annual cost of this portion of the project is $3,000. Our chapter to date this year has donated $1,000 and has just received a $500 donation from the Margaret H. and James E. Kelley Foundation making a total of $1,500 for the required matching funds.

The subject project is in its second year of a four year project and is the same project we applied for $1,400 and received $750 last year.

A complete progress report on this project was sent to Mr. Herbert Beattie on May 3rd with a copy to Mr. Nash Williams.

We are attaching a performance report by Mr. Robert L. Hunt, Coldwater Research Group Leader for the Wisconsin DNR, who is conducting the project.

Our chapter will be grateful for your serious consideration of this request.

Very truly yours,

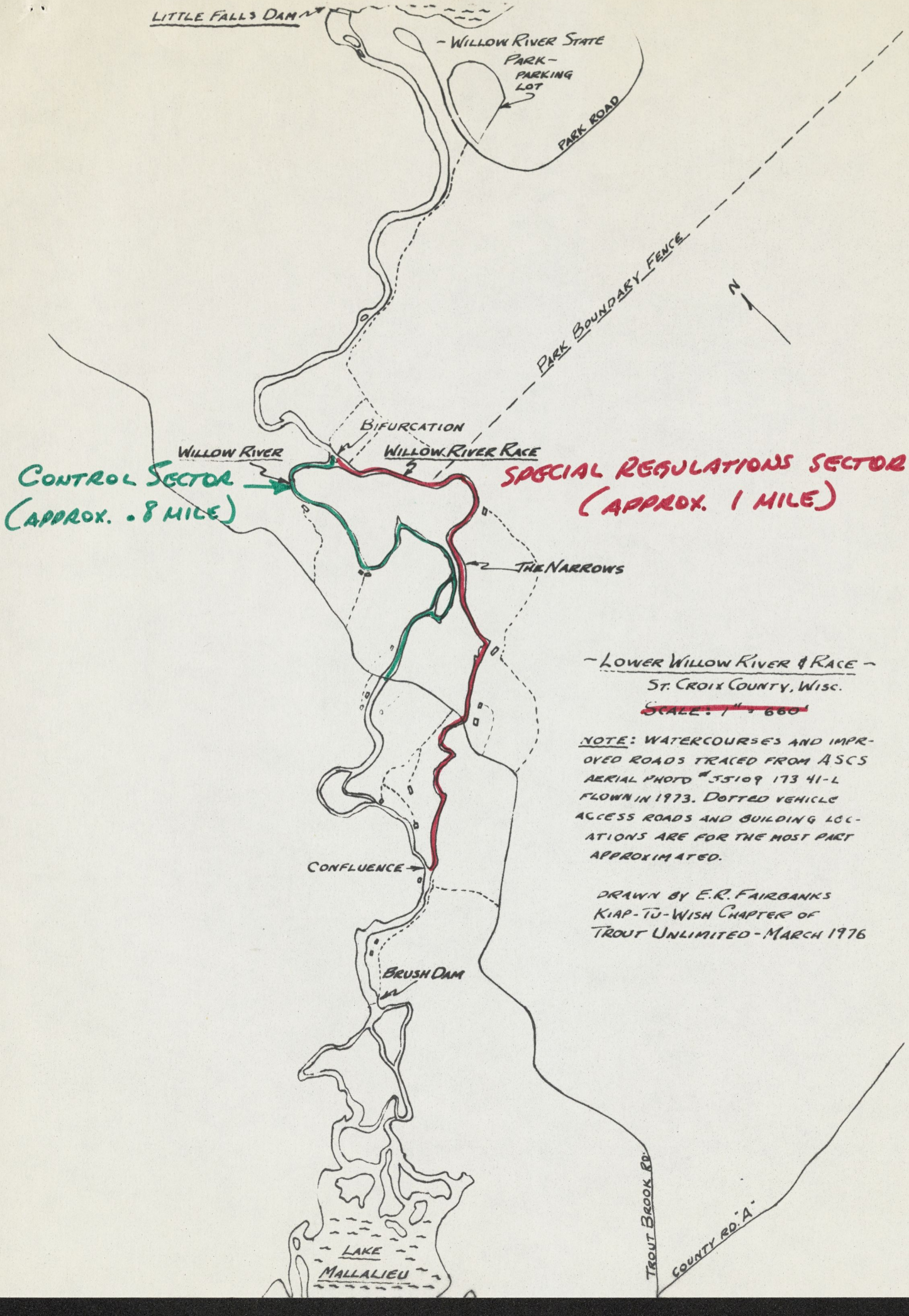
Wisconsin Trout Unlimited
KIAP-TU-WISH Chapter

Earl R. Fairbanks
Executive Secretary

ERF/rf

Encl. Performance Report

c: National TU Office
Nash Williams (12)
Chapter Officers & Directors
File



- LOWER WILLOW RIVER & RACE -
ST. CROIX COUNTY, WISC.
~~SCALE: 1" = 660'~~

NOTE: WATERCOURSES AND IMPROVED ROADS TRACED FROM ASCS AERIAL PHOTO # 55109 173 41-L FLOWN IN 1973. DOTTED VEHICLE ACCESS ROADS AND BUILDING LOCATIONS ARE FOR THE MOST PART APPROXIMATED.

DRAWN BY E.R. FAIRBANKS
KIAP-TU-WISH CHAPTER OF TROUT UNLIMITED - MARCH 1976

Department of Natural Resources
Bureau of Research
Route 1, Box 203
Waupaca, WI 54981

TO: Roger Fairbanks

FROM: Bob Hunt

DATE: 4/28/77

____ Answer and return with copy
____ Confer with me
____ For your approval
____ For your comments
____ Note and return
____ For your info and filing
____ Note and forward to _____
____ Follow through

As requested.
Deer removal program reports
need rather strongly. They
cover ~~a~~ July 1 to June 30
reporting period but field
data are for Jan 1 - Dec. 31

You already have copies
of Tables 3+

Wisconsin Department of Natural Resources
Bureau of Research
Box 7921
Madison, Wisconsin 53707

PERFORMANCE REPORT

State: Wisconsin Project Title: Evaluation of Catch and Release Regulations for Managing Stream Trout Fisheries

Cooperators: None

Project No.: F-83-R-12

Study No.: 111

Period Covered: July 1, 1976-June 30, 1977

CONTENTS

JOB 111.2: TROUT POPULATION INVESTIGATIONS

OBJECTIVE

Determine the size, age and biomass distribution by inch group of the brown trout populations in the Reference and Treatment Zones of the study stream each spring and fall, before and after the trout fishing season.

PROCEDURES

During the July 1, 1976-June 30, 1977 period, D.C. electrofishing gear was used to make Petersen-type mark and recapture censuses of the brown trout population in each study zone in October, 1976 and April, 1977. All trout captured were measured to the nearest 0.1 inch and weighed to the nearest gram. Numbers of trout/inch group were calculated by using the Chapman modification of the Petersen estimate formula.

On September 10, 1976, about three weeks prior to the fall electrofishing inventories, 1,000 young-of-year rainbow trout and 2,000 young-of-year

brown trout were scatter-planted through each study zone. Prior to stocking, all of these trout were marked with an adipose fin-clip at the hatchery and held overnight there. Representative lots of each species were measured to determine mean lengths and weights.

On the same date, 4,500 young-of-year brown trout were scatter-planted in the 1.25 mile reach of the Willow River above the study zones and the 0.5 mile reach below the study zones. These stocked trout were not adipose-clipped.

To reduce by several thousand the number of trout handled by the electrofishing crew during the October, 1976 population census, only trout over 7 inches (age I and older) were collected (except for a deliberate collection of several dozen of the recently stocked trout to obtain information on growth since stocking). Consequently, no estimate of abundance of wild young-of-year brown trout of the 1976 year class was obtained. Based on previous studies, wild young-of-year were always so sparsely present in the study zones that they contributed little to total population abundance or biomass.

The April, 1977 population inventories included estimates of all sizes of trout, including overwinter survivors of the 1976 year classes, both stocked and wild in origin, both rainbow and brown. Data on the April, 1977 stocks will be included in the annual performance report for July, 1977-June, 1978.

FINDINGS AND DISCUSSION

Spring, 1976

On April 12, 1976 the standing stock of brown trout in the Race Branch

study zone (1.03 mi., 4.90 acres) numbered 448/acre and weighed 112.3 lb/acre (Table 1). Approximately 98% of the stock exceeded 6 inches (legal size) and 2% (34 individuals) exceeded 13 inches - the proposed experimental size limit to be tested during the 1977-79 trout fishing seasons.

The Willow Branch study zone (0.77 mi., 5.17 acres) on the same date held 395 brown trout/acre weighing 112.1 lb/acre, nearly the identical biomass/acre but 12% fewer trout/acre. Less than 1% of the stock was not legal-sized and 42 (2%) exceeded 13 inches.

Yearlings of domestic origin (stocked in September, 1975) accounted for 69% of the population in the Race Branch and 68% of the population in the Willow Branch.

Trout of all sizes in the Willow Branch were in consistently better condition than those in the Race Branch (Fig. 1). In both zones, condition factors tended to decrease with an increase in length.

Fall, 1976

On October 4, 1976, the standing stock of brown trout over 7 inches long in the Race Branch numbered 176/acre and weighed 86.2 lb/acre (Table 2). The Willow Branch held 113 brown trout/acre weighing 57.8 lb/acre, a standing stock 36% less by number and 33% less by weight than that in the Race Branch.

During the April 12-October 4 interval, standing stocks declined numerically by 61% and 71% in the Race and Willow Branches respectively. Biomass declines during the period were 23% in the Race Branch and 48%

in the Willow Branch (Fig. 2).

Despite these substantial reductions in number of trout in both study areas, the number of trout over 13 inches increased by 74% in the Race Branch (from 34 to 59) and by 45% in the Willow Branch (from 42 to 61). Some of this increase is attributed to in-migration, most probably from downstream in association with a spawning migration. Seven brown trout over 18 inches (including an impressive male specimen of 26.5 inches weighing at least 8 pounds) were captured in the Race Branch and six over 18 inches were collected in the Willow Branch. No trout of this size were collected in the Race Branch during the April electrofishing census and only one individual in the 18-inch group was taken in the Willow Branch. The probability of failing to capture trout of this size, if present, is low. Of the estimated number over 12 inches long (266) in October, 77% were captured on one or both electrofishing runs.

Condition factors of brown trout on October 4 were generally lower in both study areas in comparison to condition factors on April 12, and in contrast to the pattern shown in April, brown trout in the Race Branch were in generally better condition than those in the Willow Branch with the exception of fish in the 13-inch size group (Fig. 3).

1976 Year Classes of Stocked Trout

On the day prior to stocking the 4,000 brown trout and 2,000 rainbow trout in the study zones, approximately 250 individuals of each species were individually measured for length and weight.

Brown trout fingerlings (reared at the DNR St. Croix Falls Hatchery) averaged 4.8 inches and 22 grams. Rainbow trout (reared at the nearby

DNR Osceola Hatchery) averaged 4.3 inches and 14 grams. Biomass stocked was, therefore, 417.5 pounds of brown trout and 59.5 pounds of rainbow trout divided equally between the two study zones and constituting a stocking rate of 48.9 lb/acre in the Race Branch and 46.1 lb/acre in the Willow Branch.

RECOMMENDATIONS

Continue as conducted in 1976-77 except delay stocking of young-of-year marked trout until the fall electrofishing inventory is complete through the field phase.

JOB 111.3: QUANTITATIVE AND QUALITATIVE CHARACTERISTICS OF THE SPORT FISHERY

OBJECTIVE

Determine the amounts of angler use, catch (both of trout creeled and released), rates of angler exploitation, angler attitudes toward special regulations and other sport fishery characteristics that will help to evaluate the management utility of special regulations that emphasize releasing all or nearly all trout caught.

PROCEDURES

A season-long partial creel census was conducted on a 40 hour/week basis during 1976 and 1977. It combined periodic counts of anglers in each study zone with personal interview contacts. Emphasis was placed on contacting anglers who had finished fishing. One 8-hour census period/weekend and four 8-hour census periods/5 weekdays were selected randomly. During each period, counts of anglers were made at 2 hour intervals starting at 7 a.m. or 1 p.m. (except opening weekend when counts started at 5 a.m. and continued to 9 p.m.). Starting times were also randomly

selected from the two choices. Interview information and data on trout caught or released was coded on creel census forms designed for summary and tabulation by computer processing procedures.

Summarized partial census data were expanded to derive estimates of desired sport fishery statistics for each zone for each month and the entire season. Weekend data and weekday data were expanded separately and then summed for each month. Holidays censused were grouped with weekend data.

Similar census procedures were followed during the 1977 trout fishing season when the following special regulations were imposed on anglers choosing to fish the Race Branch:

1. A minimum size limit of 13 inches.
2. A daily bag limit of 1 trout.
3. Use of artificial lures only.

In the Findings and Discussion section that follows, only results from the 1976 trout fishing season are presented and discussed. Information collected in May and June, 1977 will be presented in next year's performance report along with data for the remainder of the 1977 trout fishing season.

FINDINGS AND DISCUSSION

During the 1976 trout fishing season, when normal trout fishing regulations applied to both study zones, counts and interviews of anglers were made on 110 days of the 153 day season. Assuming a 16 hour "angling day" for the first two days and a 15 hour "angling day" thereafter, the on-stream census covered 39% of the total fishing hours.

Interviews were made with 761 anglers who had completed fishing and 170 who had not. Interviewed anglers reported keeping 609 brown trout and releasing 1,213 during 2,385 hours of fishing. These data from our partial census represent 29.4% of the estimated total angling trips, 27.8% of the estimated angling harvest and 27.3% of the estimated number of trout released based on expansion of the partial census data.

Several of the most diagnostic characteristics of the 1976 sport fishery are summarized in Table 3 for each study zone. Of these, the most surprising to me is the very high proportion of angling trips accounted for by non-residents who tallied 75% of all trips on the Race Branch and 60% of all trips on the Willow Branch.

Angling effort, expressed in hours/acre/zone, is also noteworthy. Estimated season-long efforts of 889 hours/acre on the Race Branch and 814 hours/acre on the Willow Branch are among the highest recorded for Wisconsin trout stream fisheries.

With the exception of average length of trout creeled, the fishery statistics in Table 3 reflect a more intensive and higher quality sport fishery on the Race Branch: 15% more angling trips/acre, 9% more hours/acre, 17% more trout creeled/acre, 39% more trout released/acre, 19% higher ratio of trout released to trout creeled, 7% higher catch/hour of trout creeled and 29% higher catch/hour for trout released.

In both fishing zones, it is likely that some trout were caught more than once ("recycled"), especially in the Race Branch. The combined catch of trout creeled and trout released in this zone was 786/acre, a figure 75% greater than the estimated abundance of 448/acre in April.

Moreover, since only 2% of the April stock was not legal-sized, most of the released trout could have been kept. The same kind of recycling process must have occurred on the Willow Branch, too. In this study zone, an even greater proportion of the April stock was legal-sized (99.6%) and the total catch (600/acre) exceeded springtime abundance (395/acre) by 52%.

Total harvest/zone amounted to 72.0 lb/acre for the Race Branch and 73.5 lb/acre for the Willow Branch. These values are equivalent to 64.1% and 65.6% of the April biomass in the Race and Willow zones respectively.

Monthly patterns of angler use (Fig. 4) and harvest (Fig. 5) 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 Branch than on the Race Branch during May and September but over the season, total angling hours/acre were 9% more on the Race Branch. Harvest/acre/month was higher on the Race Branch every month but September and was 17% greater for the season.

Monthly catches of brown trout released were consistently higher on the Race Branch all season and exceeded the seasonal catch on the Willow Branch by 39% (Fig. 6). As with angling effort and harvest, more than half of the trout caught and released during 1976 were taken in May (see also Table 4).

Average length of 1,323 brown trout harvested from the Race Branch was 9.1 inches. Trout in the 8-inch group comprised the most dominant

inch-group in the harvest (30.0% of the total). In the Willow Branch, average length of trout creeled was 9.5 inches but those most numerous were also in the 8-inch group (27.5% of the total harvest). In the Willow Branch, a greater proportion of the total harvest consisted of brown trout in the 9-12 inch size groups than was true for the harvest from the Race Branch (Fig. 7).

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

Among the three most common baits used (worms, artificial flies, spinning lures), the greatest proportion of angling hours (48.8%), the greatest proportion of angling trips (49.4%) and the greatest proportion of trout released (81.8%) were accounted for by anglers using flies on the Race Branch (Table 6). More trout were caught on worms and kept (70.7%) than on flies (14.9%) or spinning lures (14.4%) on the Race Branch. On the Willow Branch anglers using worms accounted for the greatest proportions of hours fished (44.3%), angling trips (45.7%) and trout harvested (61.5%). More trout were released in this zone after being caught on flies (68.0%) than by any other type of bait.

On the Race Branch, trout caught on spinning lures and kept averaged 9.8 inches vs. an average length of 9.2 inches for fly-caught trout and 8.9 inches for worm-caught trout (Table 7). Trout caught and kept by fly fishermen on the Willow Branch averaged 10.1 inches; those taken on

worms averaged 9.1 inches; those taken on spinning lures averaged 9.0 inches.

The very low catch rates/hour for trout harvested by fly fishermen in both zones as compared to their catch rates for trout released (Table 6) substantiate the observation that on these two study zones, many anglers were voluntarily releasing trout that could have been legally kept. These study zones already have a clientele of anglers (most of whom reside in Minnesota) who appear to be ready to accept the kind of severe regulation restrictions on harvest that will be imposed during 1977-79 on the Race Branch.

RECOMMENDATIONS

Continue Jobs 111.2 and 111.3 as planned.

Prepared by: _____
Robert L. Hunt

Table 1. Population and Biomass Estimates of Brown Trout in Two Study Zones of the Race-Willow River, St. Croix County, on April 12, 1976.*

Inch Group	Race Branch		Willow Branch	
	No.	Wt.(lb.)	No.	Wt.(lb.)
4	6	0.2	--	--
5	47	2.0	9	0.6
6	171	17.3	114	12.6
7	782	124.0	883	143.2
8	468	102.9	394	89.6
9	296	79.0	239	77.0
10	243	105.8	259	115.9
11	89	48.7	89	50.3
12	61	39.6	62	45.6
13	21	16.3	23	20.5
14	9	8.6	9	9.7
15	2	2.4	8	10.7
16			--	--
17	2	3.4	1	1.7
18			1	2.0
Zone Totals	2197	550.2	2041	579.4
No./Acre	448		395	
Lb./Acre		112.3		112.1

* Based on size frequency and external apperance, 2847 of these brown trout weighing 511.7 pounds were estimated to be yearlings stocked as young-of-year in September, 1975.

Table 2. Population and Biomass Estimates of Brown Trout in the Study Zones of the Race-Willow River on October 4, 1976*

Inch Group	Race Branch		Willow Branch	
	No.	Wt.(lb.)	No.	Wt.(lb.)
7.0-7.9	10	1.6	2	0.3
8.0-8.9	51	11.6	45	9.8
9.0-9.9	218	69.1	137	39.5
10.0-10.9	279	119.6	126	51.3
11.0-11.9	174	97.2	137	71.8
12.0-12.9	69	47.0	77	49.9
13.0-13.9	36	30.0	29	27.4
14.0-14.9	6	6.5	17	18.8
15.0-15.9	4	6.2	4	5.8
16.0-16.9	--	--	2	3.2
17.0-17.9	6	11.3	3	5.4
18.0-18.9	2	4.1	--	--
19.0-19.9	3	7.0	3	6.9
20.0-20.9	--	--	2	4.8
21.0-21.9	--	--	--	--
22.0-22.9	1	3.1	--	--
23.0-23.9	--	--	1	3.5
24.0-24.9	--	--	--	--
25.0-25.9	--	--	--	--
26.0-26.9	1	8.0	--	--
Zone Totals	860	422.3	585	298.4
No./Acre	176		113	
Lb./Acre		86.2		57.8

* Estimates of trout under 7 inches are not included because a stocking of 2000 brown trout fingerling and 1000 rainbow trout fingerling (all under 7 inches) had been made 3 weeks earlier in each study zone. To avoid handling most of these small trout during electrofishing operations, trout of this size, including a sparse number of wild young-of-year brown trout, were not collected.

TABLE 3. Summary of Some Important Creel Census Statistics for the Race and Willow Study Zone in 1976.

Item	Race Branch	Willow Branch
Anglings trips/acre	337	293
Angling hours/acre	889	814
Trout Creeled/Acre	270	230
Trout Released/Acre	516	370
Total Catch/Acre	786	600
Released: Creeled Ratio	1.9:1	1.6:1
Catch/hr-creeled	0.30	0.28
Catch/hr-released	0.58	0.45
Total Catch/hr	0.88	0.73
Avg. Length creeled (in)	9.1	9.5
% Exploitation of Spring Population	60	59
% Resident Angling Trips	25	40
% Nonresident Angling Trips	75	60

TABLE 4. Angling Hours/Acre, Brown Trout Creeled/Acre and Brown Trout Released/Acre in the Race and Willow Study Zones During the 1976 Trout Fishing Season.

	MAY	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL
Angling hours/a						
Race Br.	503.3	189.6	58.0	62.9	74.9	888.6
Willow Br.	508.7	157.6	32.9	34.2	81.2	814.7
Trout Creeled/a						
Race Br.	152	58	18	19	23	270
Willow Br.	143	45	9	10	23	230
Trout released/a						
Race Br.	293	110	33	37	43	516
Willow Br.	231	71	15	16	37	370

TABLE 5. Frequency Distribution of Various Bag Sizes During the 1976 Trout Fishing Season on the Race and Willow Study Zones.

No. of Trout Creeled/Trip	% of trips in May*		% of trips in June-Sept*	
	Race Br.	Willow Br.	Race Br.	Willow Br.
0	60.3	55.6	78.2	70.4
1	16.0	15.5	11.3	18.2
2	9.8	16.2	5.2	2.5
3	4.6	6.3	2.2	4.4
4	3.1	3.5	0.8	1.9
5	6.2	2.8	1.9	1.3
6				1.3
7				
8				
9				
10			0.4	
Number of Completed Trips	194	142	266	159

*During May the daily bag limit was 5. During June-Sept. the daily bag limit was 10.

Table 6. Angling Hours/Acre, Angling Trips/Acre, Brown Trout Creeled/Acre, Brown Trout Released/a and Catches/Hour According to the Type of Bait Used in the Race and Willow Study Zones During the 1976 Trout Fishing Season.

	Race Branch			Willow Branch		
	Worm	Fly	Lure	Worm	Fly	Lure
Angling hours/a	364.4	405.9	61.7	349.1	280.1	124.6
Angling trips/a	128.9	155.9	30.6	124.1	109.2	38.5
Trout creeled/a	176	37	36	131	56	26
Trout released/a	65	401	24	65	225	41
Catch/hour:						
creeled	0.38	0.07	0.46	0.37	0.20	0.20
released	0.17	0.95	0.37	0.19	0.80	0.32
Total	0.55	1.02	0.83	0.56	1.00	0.52

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

8/7/81

Carroll D. Besadny
Secretary

IN REPLY REFER TO: _____

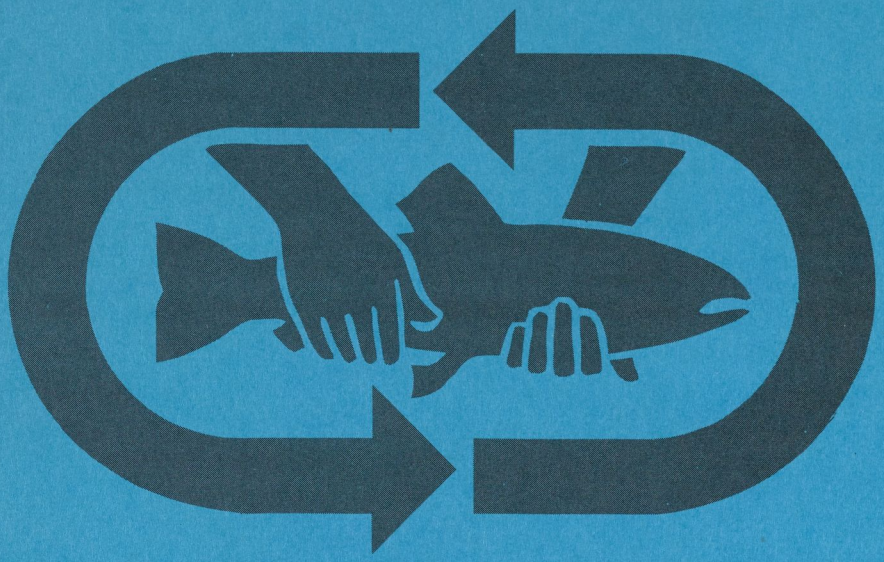
Dr. Robert Behnke
Dept. of Fish & Wildlife Biology
Colorado State University
Fort Collins, CO 80523

Dear Bob:

If you can secure a copy of the most recent "Proceedings of the Western Assoc. of Fish & Wildlife Agencies" I would greatly appreciate it. Some like these are usually articles in it that I am interested in having as resource references.

Sincerely,

Bob Hunt



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

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1981

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.

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

By
Robert L. Hunt

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DEPARTMENT OF NATURAL RESOURCES
P.O. Box 7921
Madison, Wisconsin 53707

1981

CONTENTS

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.

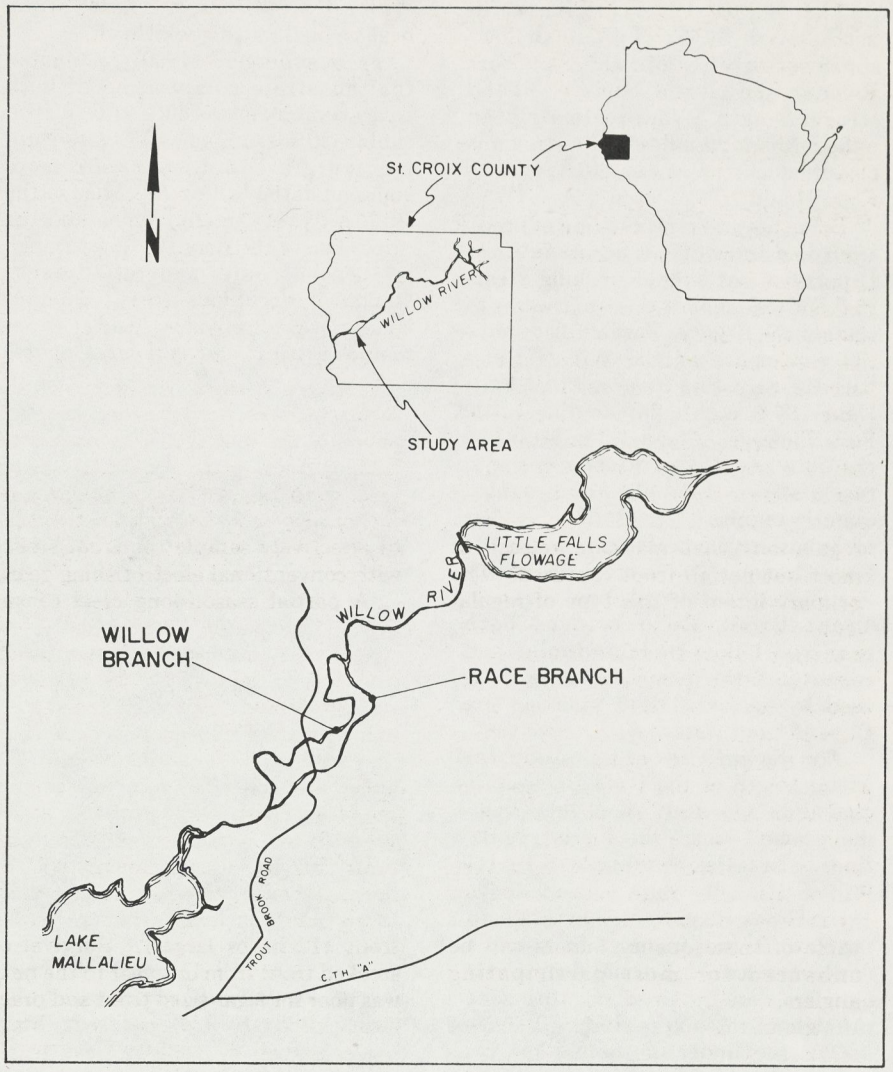


FIGURE 1. *Locations of Race Br. and Willow Br. study zones.*

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.

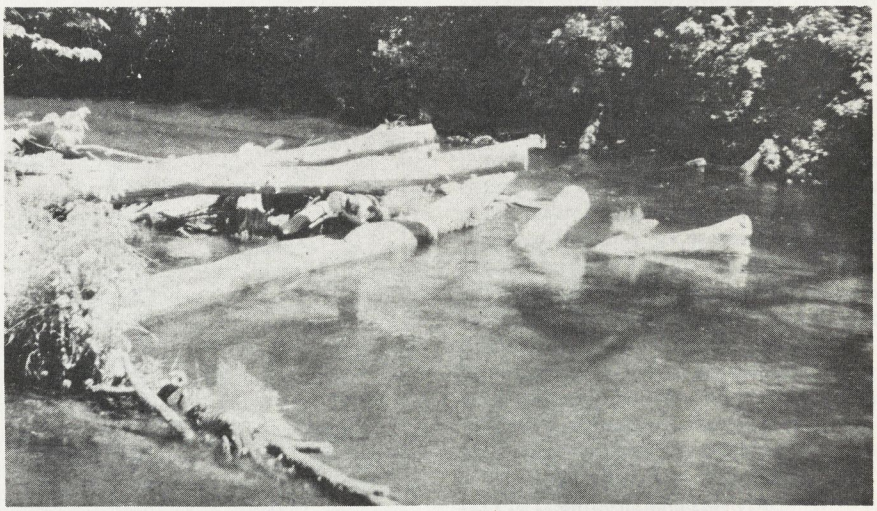
For the purposes of this study, the entire length of the Race Br. was included as one study zone, the "treatment zone", where the special regulations to be tested were applied. On the Willow Br. only that portion above Trout Brook Road to its juncture with the Race Br. was included for use as a "reference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

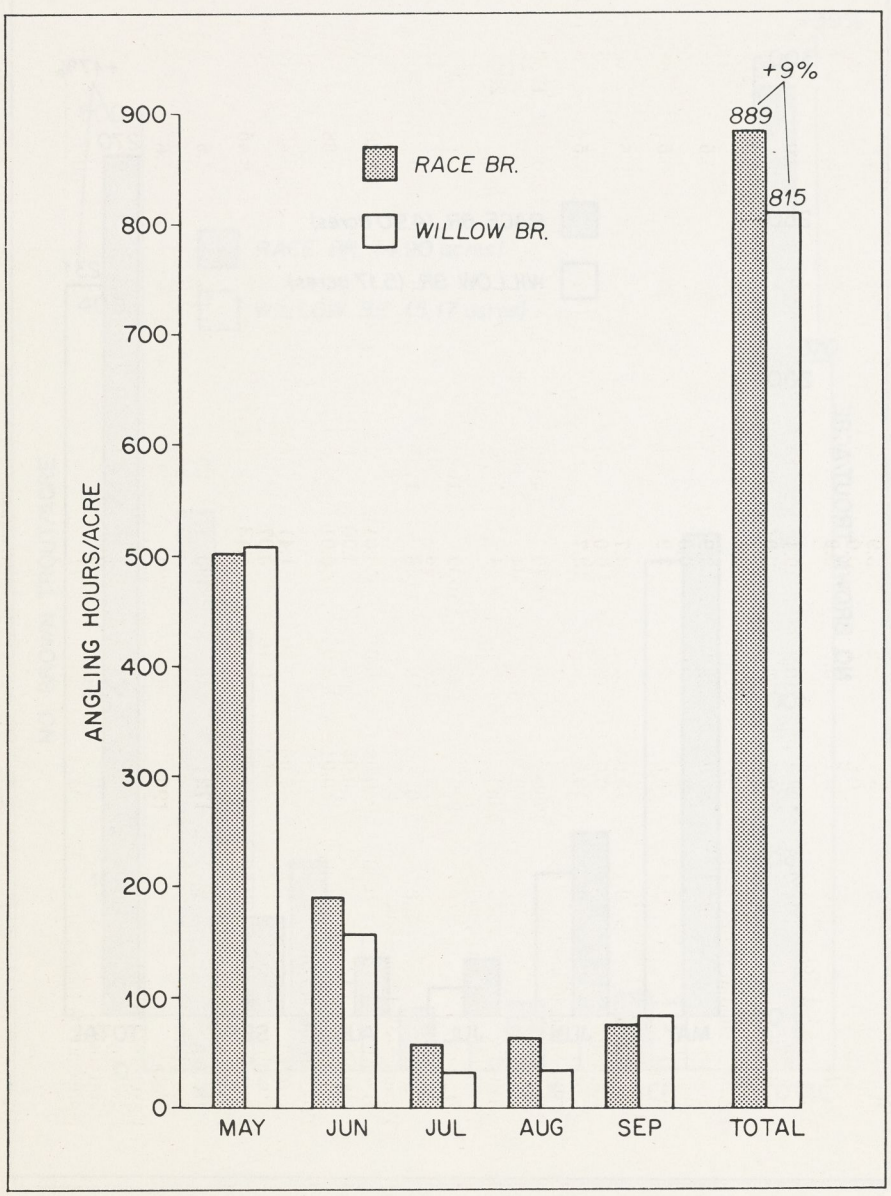


FIGURE 2. *Angling hours/acre in the Race Br. and Willow Br. study zones, during each month of the 1976 trout fishing season.*

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

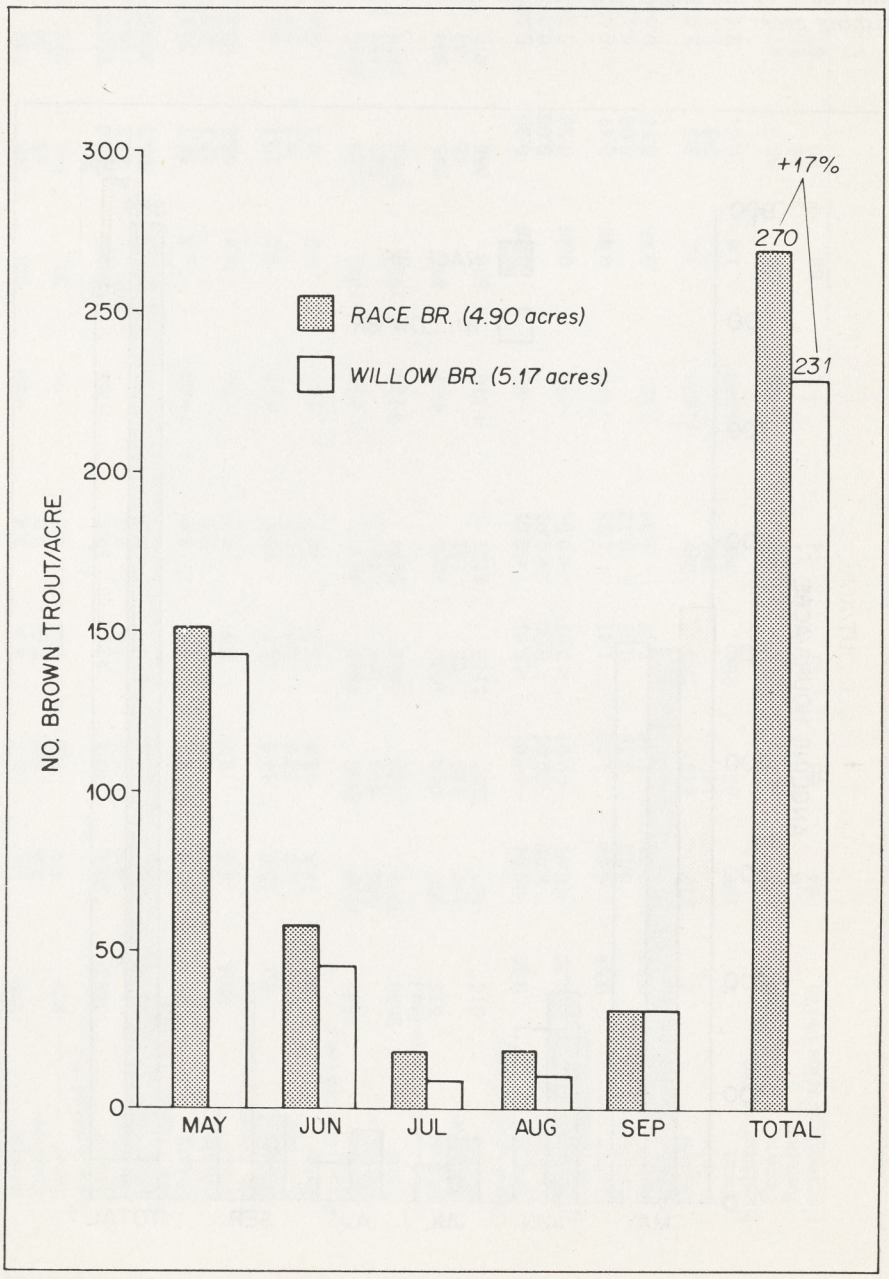


FIGURE 3. *Brown trout/acre harvested in the Race Br. and Willow Br. study zones during each month of the 1976 trout fishing season.*

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).

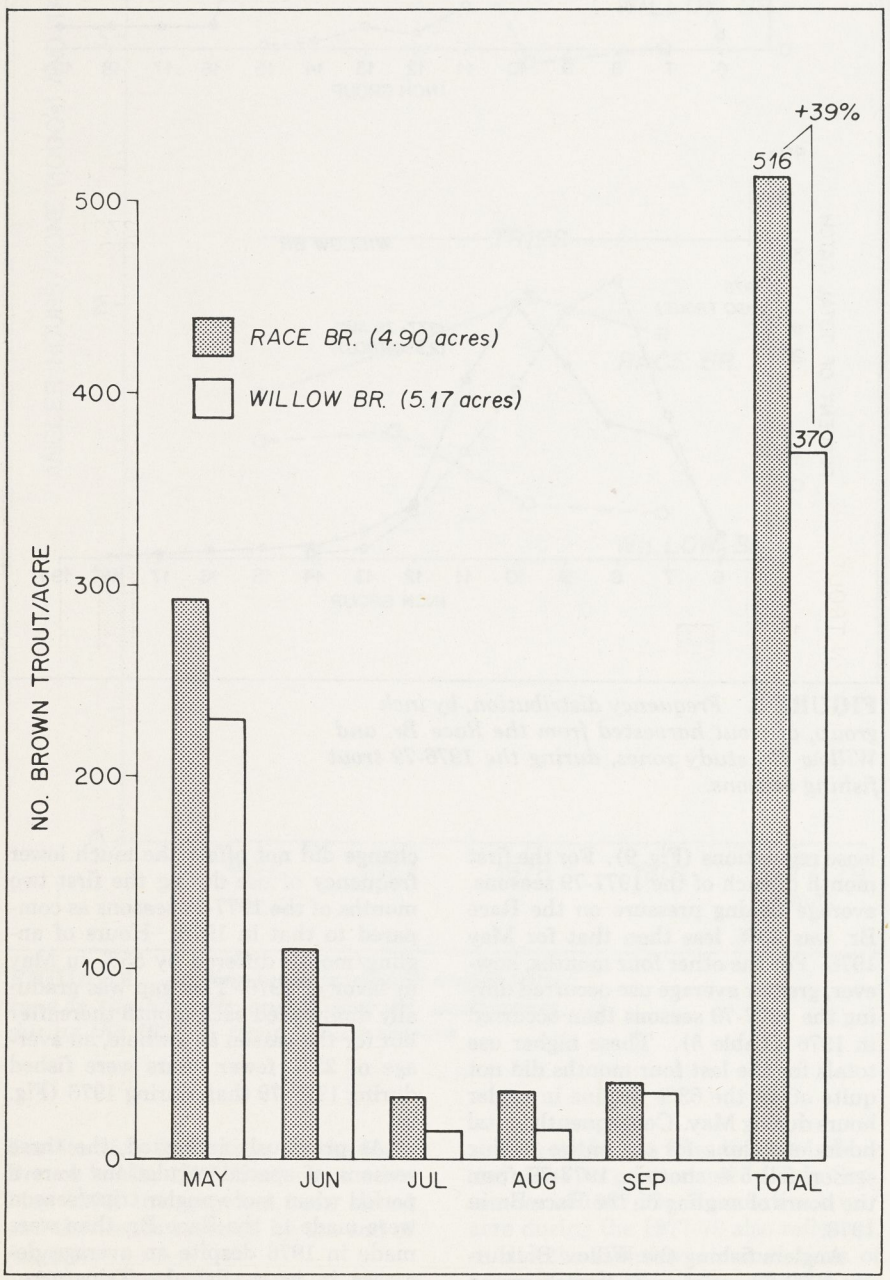


FIGURE 4. *Brown trout/acre caught and released in the Race Br. and Willow Br. study zones during each month of the 1976 trout fishing season.*

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.

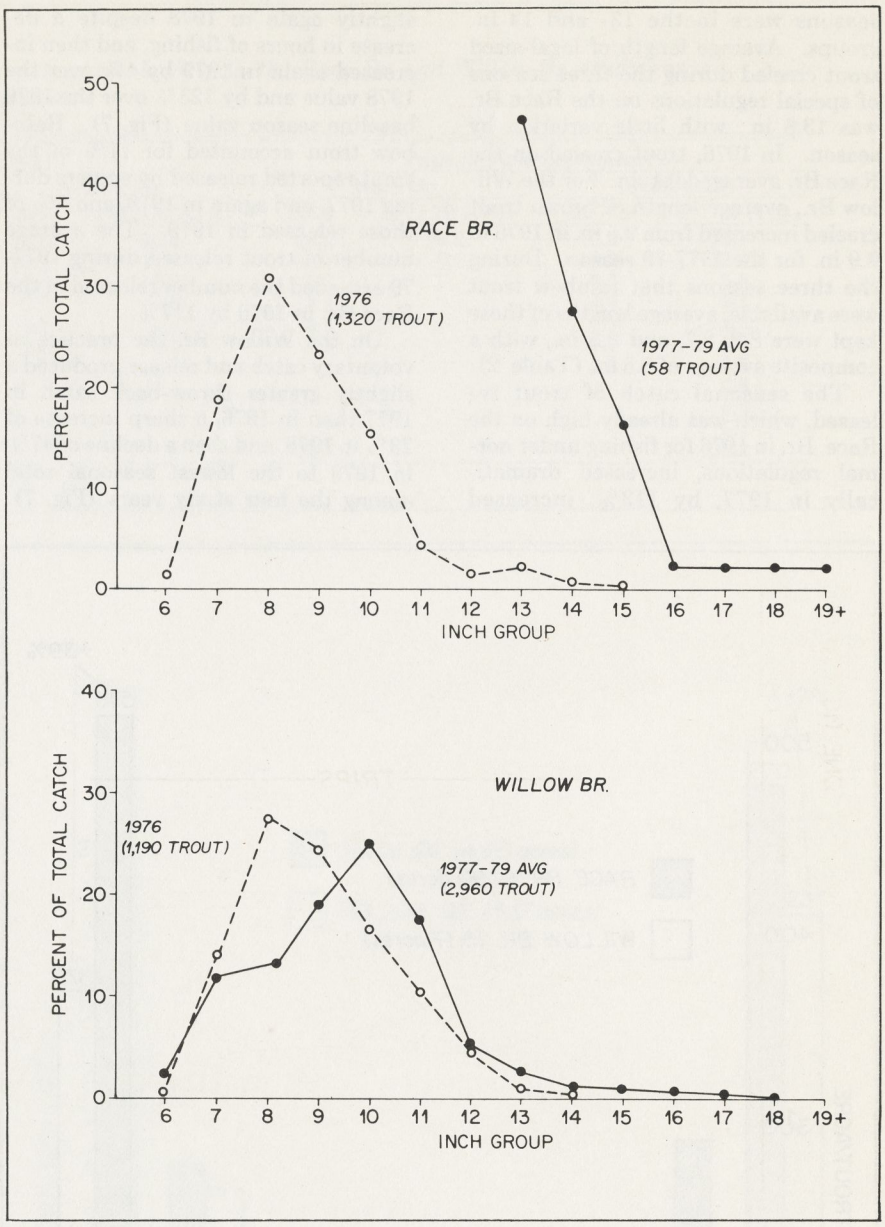


FIGURE 5. *Frequency distribution, by inch group, of trout harvested from the Race Br. and Willow Br. study zones, during the 1976-79 trout fishing seasons.*

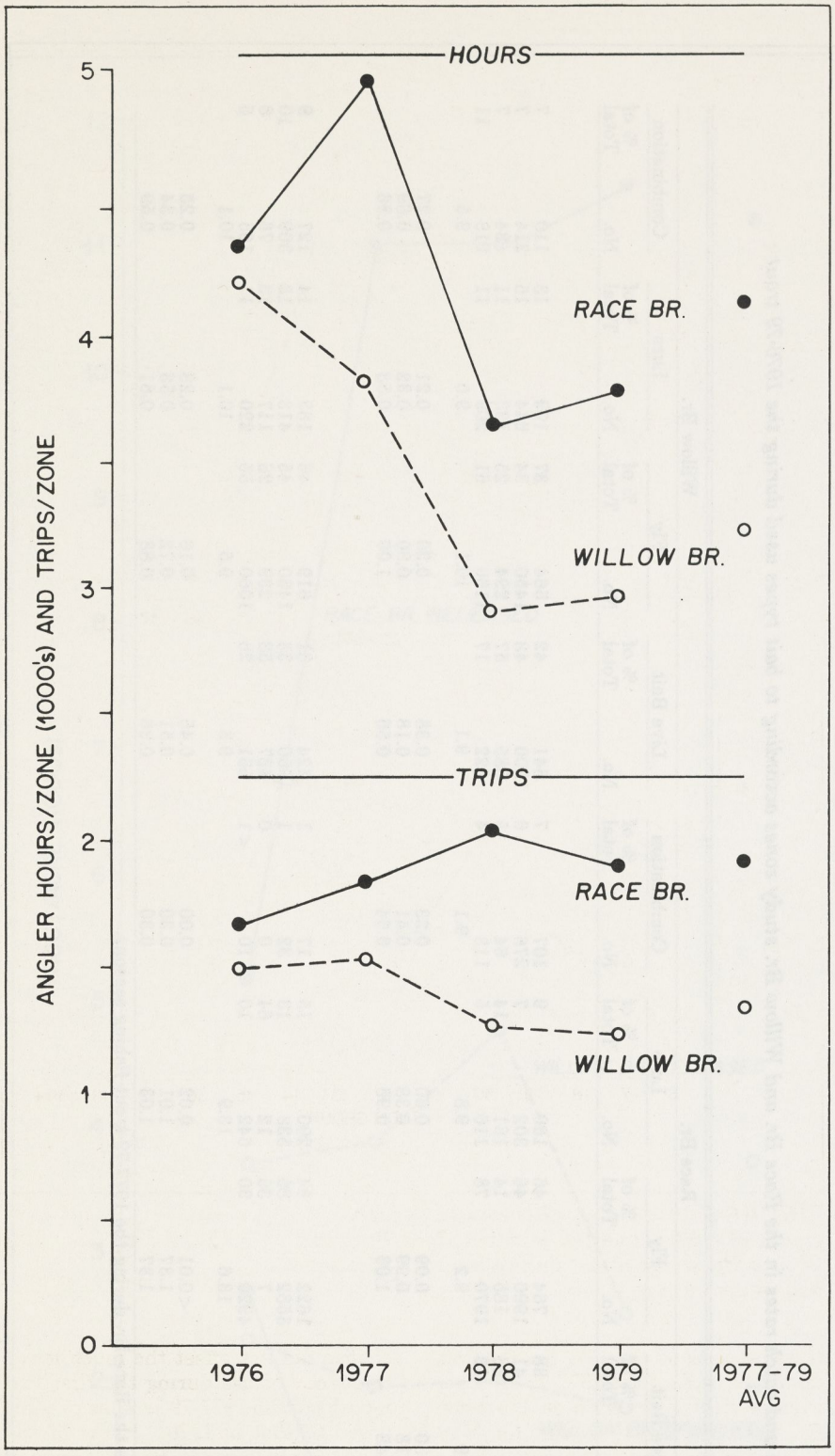


FIGURE 6. *Angling hours/zone and angler trips/zone in the Race Br. and Willow Br. study zones, during the 1976-79 trout fishing seasons.*

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 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, but 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.

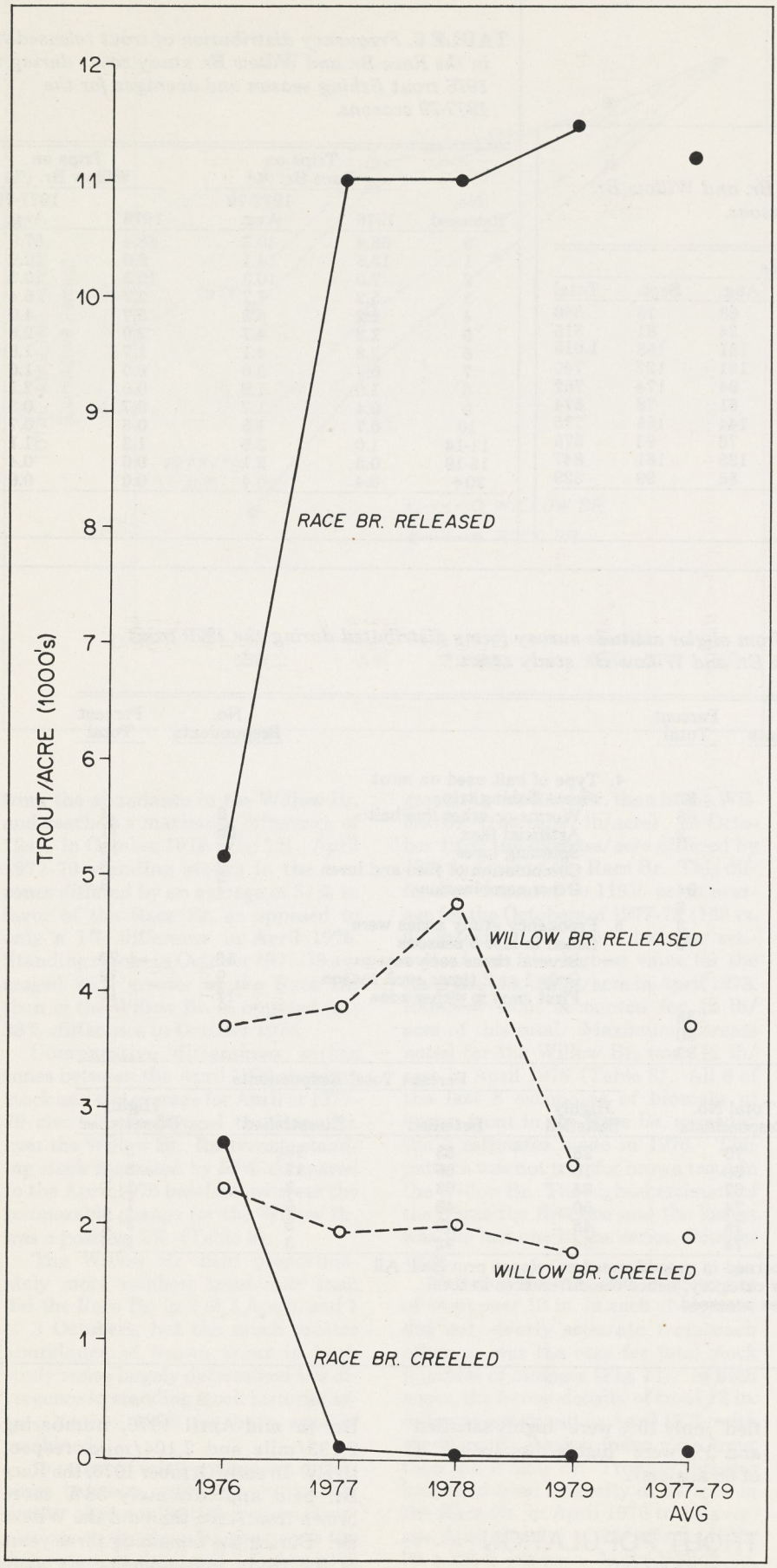


FIGURE 7. *Number of trout/acre creeled and number/acre released in the Race Br. and Willow Br. study zones during the 1976-79 trout fishing seasons.*

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

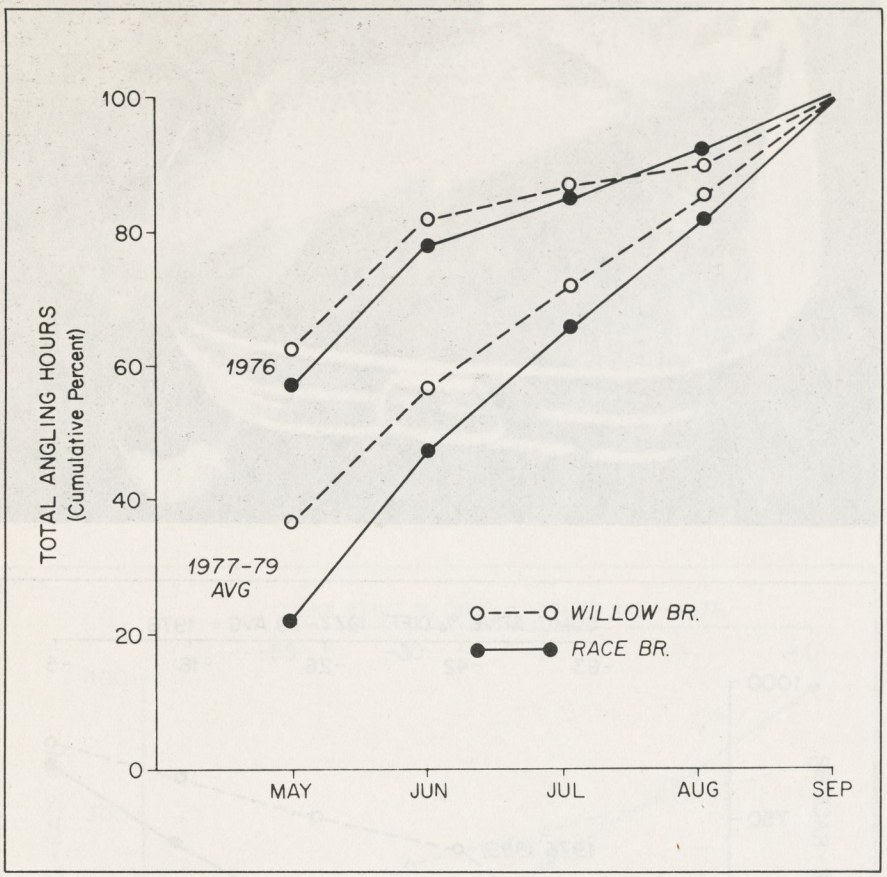


FIGURE 8. *Percentage distribution by month of the total hours of angling /fishing season in the Race Br. and Willow Br. study zones during the 1976 trout fishing season, and monthly averages for the 1977-79 seasons.*

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).

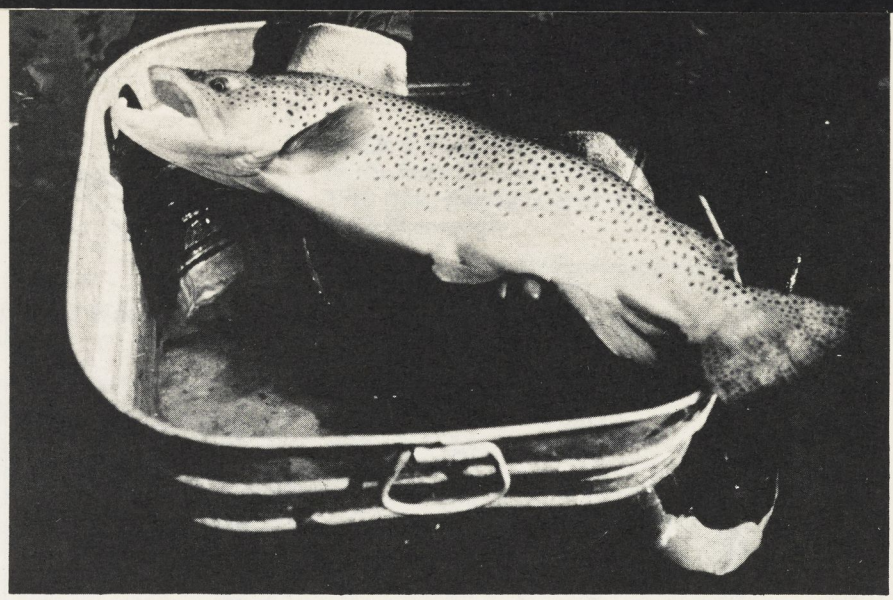
Average densities of trout over 13 in. in October increased 12% in the Race Br. and decreased 15% in the Willow Br. comparing the same two time periods.

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.

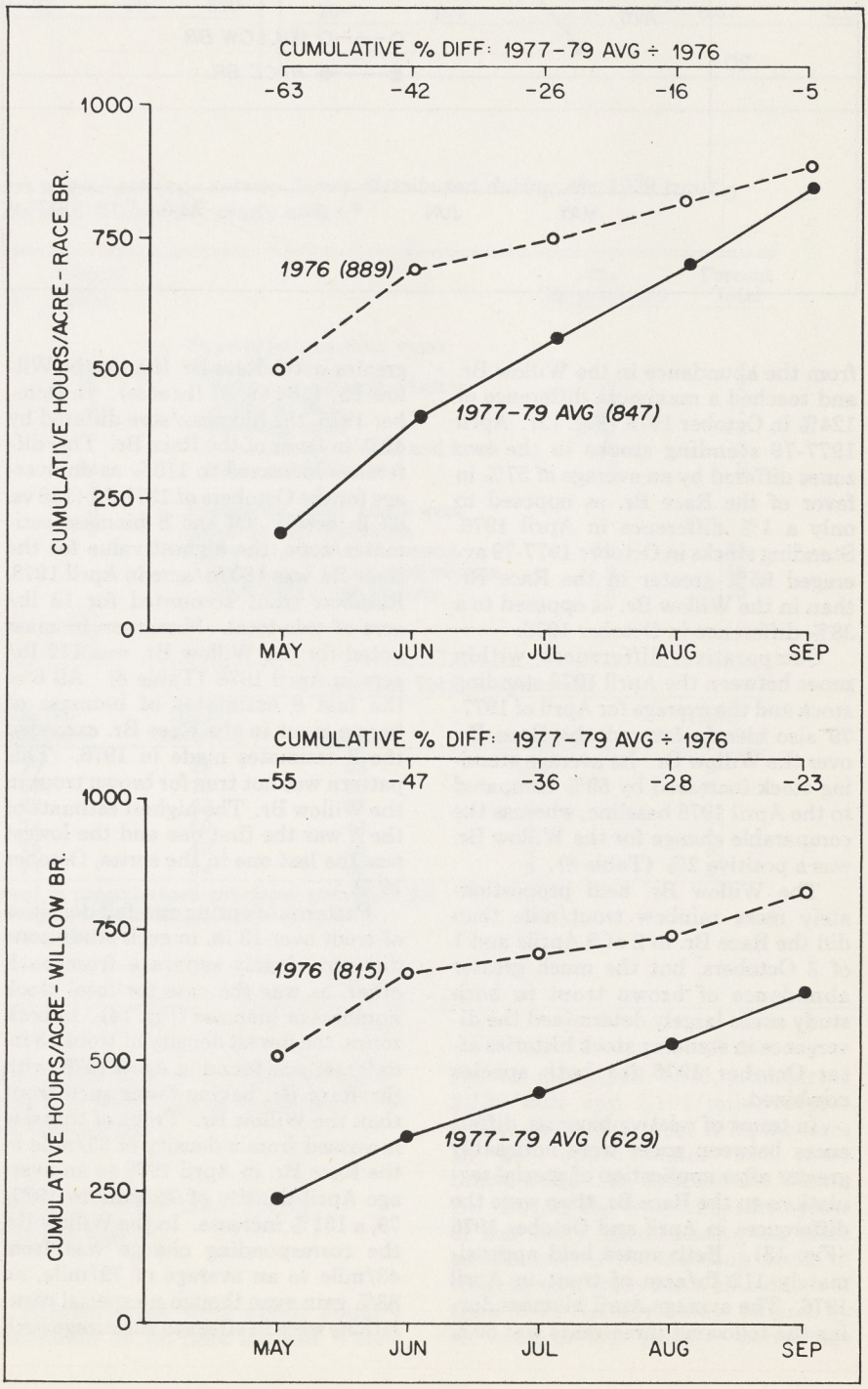


FIGURE 9. *Cumulative hours of angling/acre in the Race Br. and Willow Br. study zones each month of the 1976 trout fishing seasons and averages for each month of the 1977-79 seasons.*

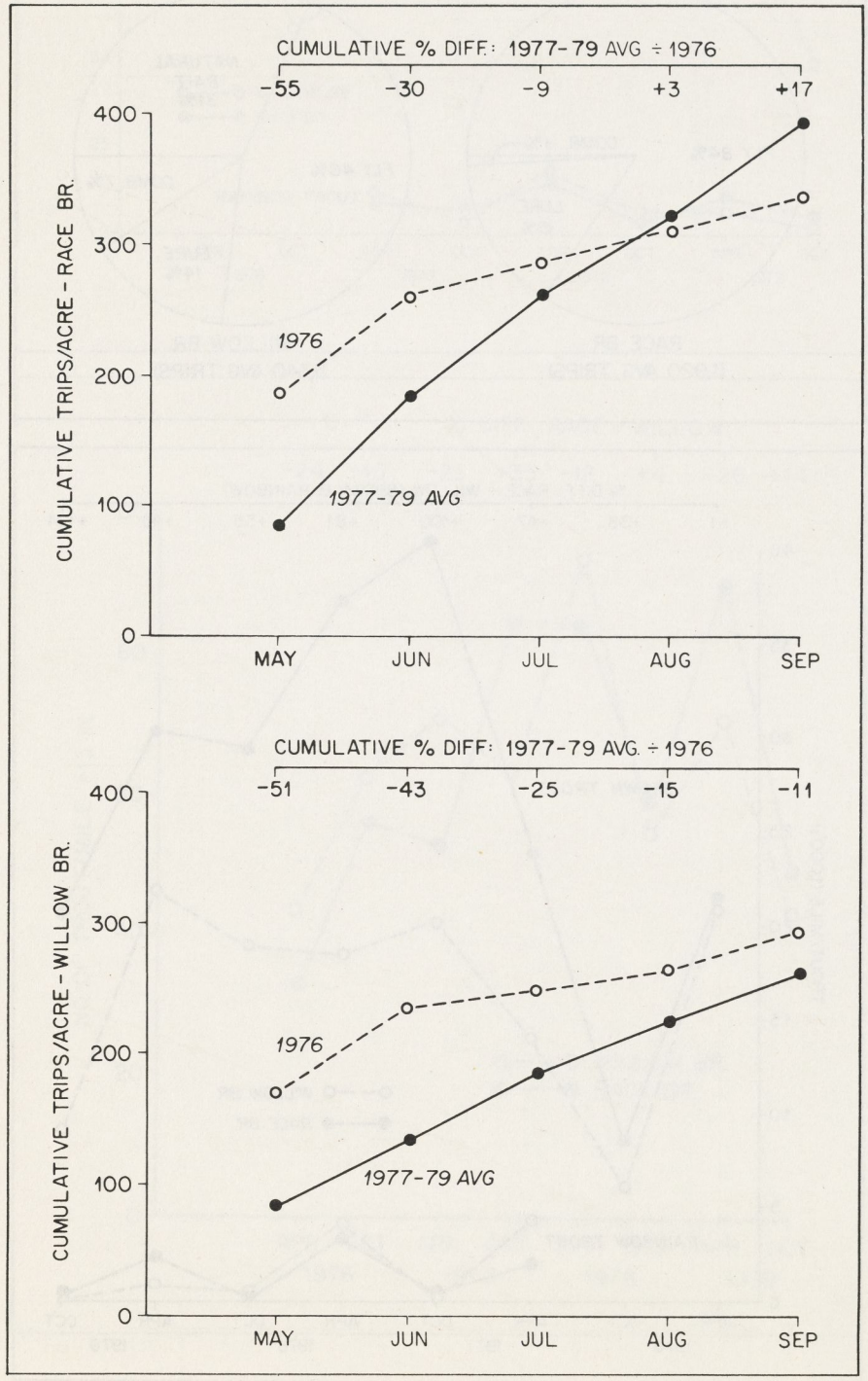


FIGURE 10. *Cumulative angler trips/acre in the Race Br. and Willow Br. study zones each month of the 1976 trout fishing season and averages for the 1977-79 seasons.*

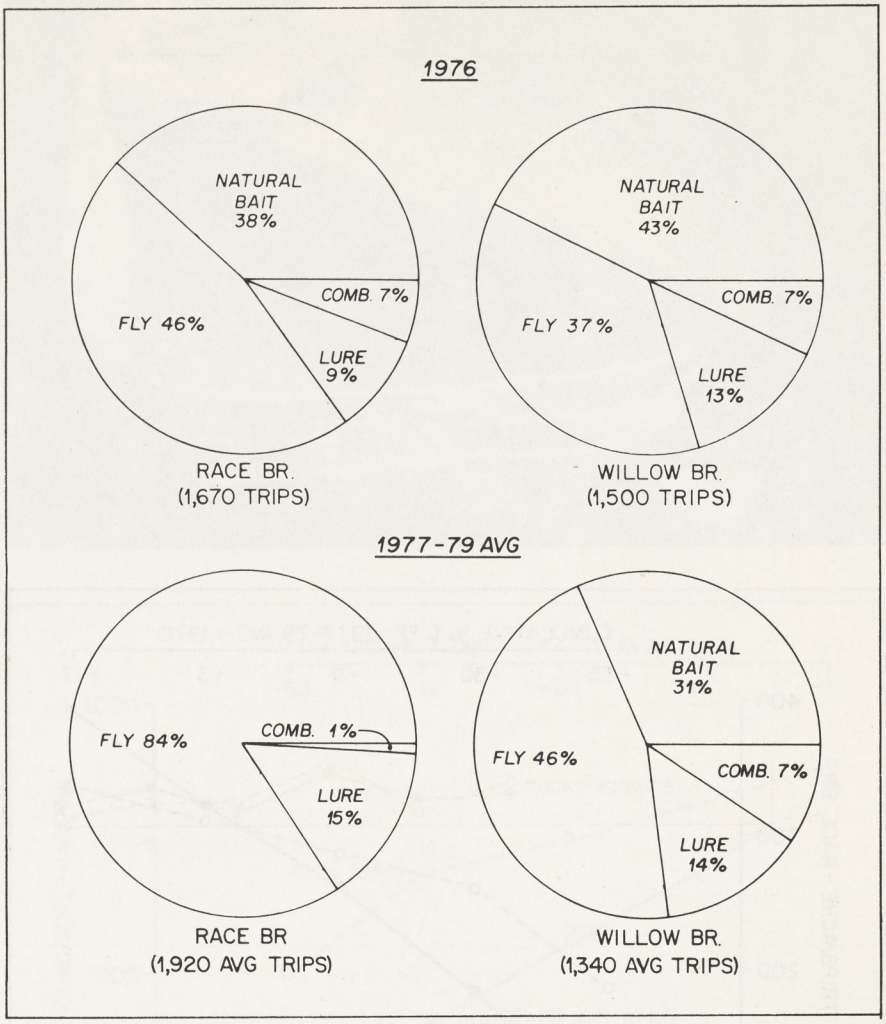


FIGURE 11. *Percentage distributions of the total angler trips according to the type of bait used in the Race Br. and Willow Br. study zones during the 1976 trout fishing season and as averages for the 1977-79 seasons.*

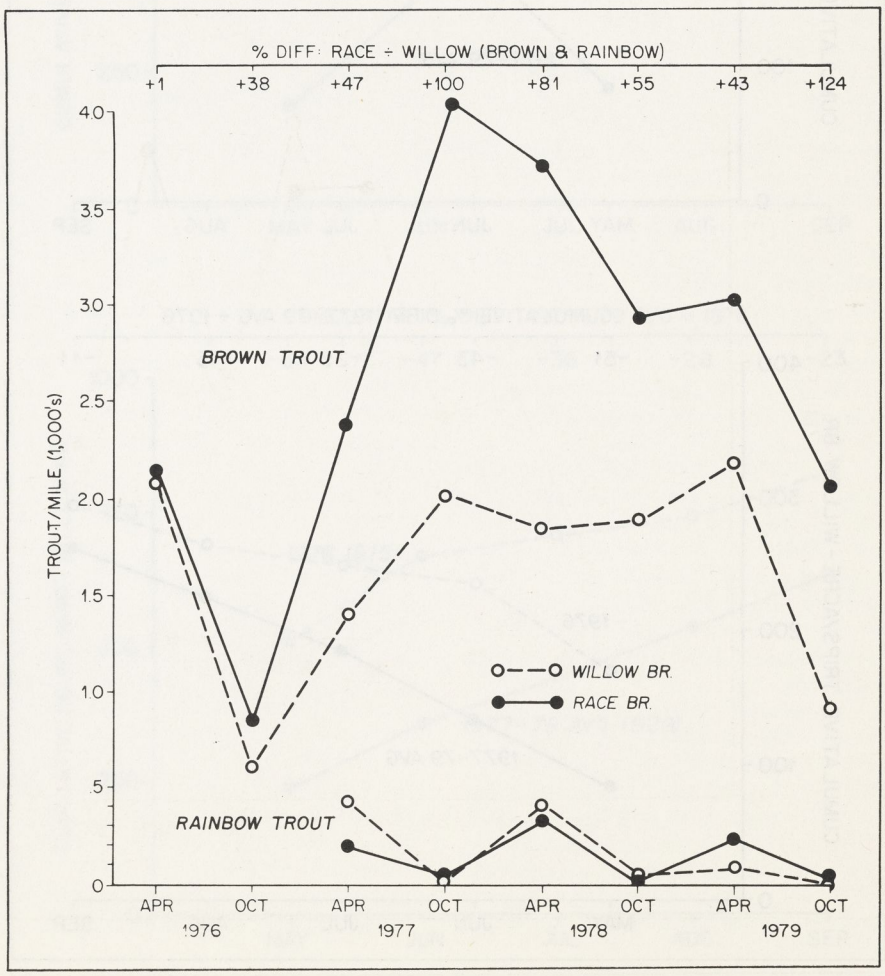


FIGURE 12. *Number of brown trout/mile and rainbow trout/mile in the Race Br. and Willow Br. study zones each April and October of 1976-79.*

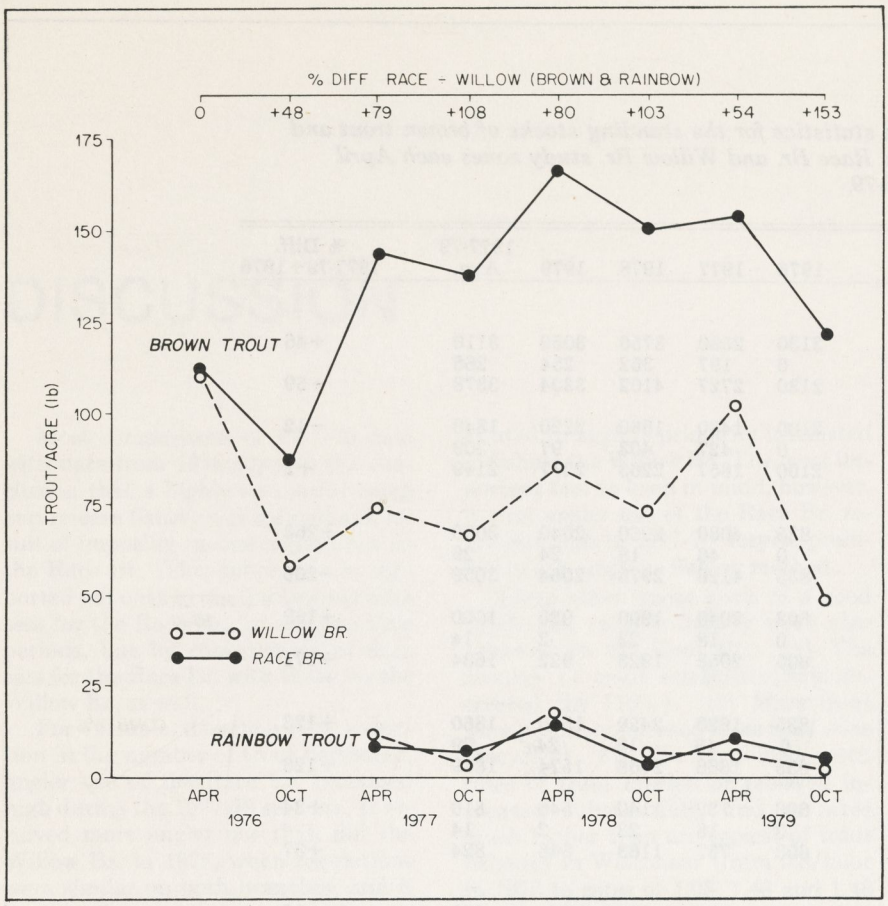


FIGURE 13. *Biomass of brown trout/acre and rainbow trout/acre in the Race Br. and Willow Br. study zones each April and October of 1976-79.*

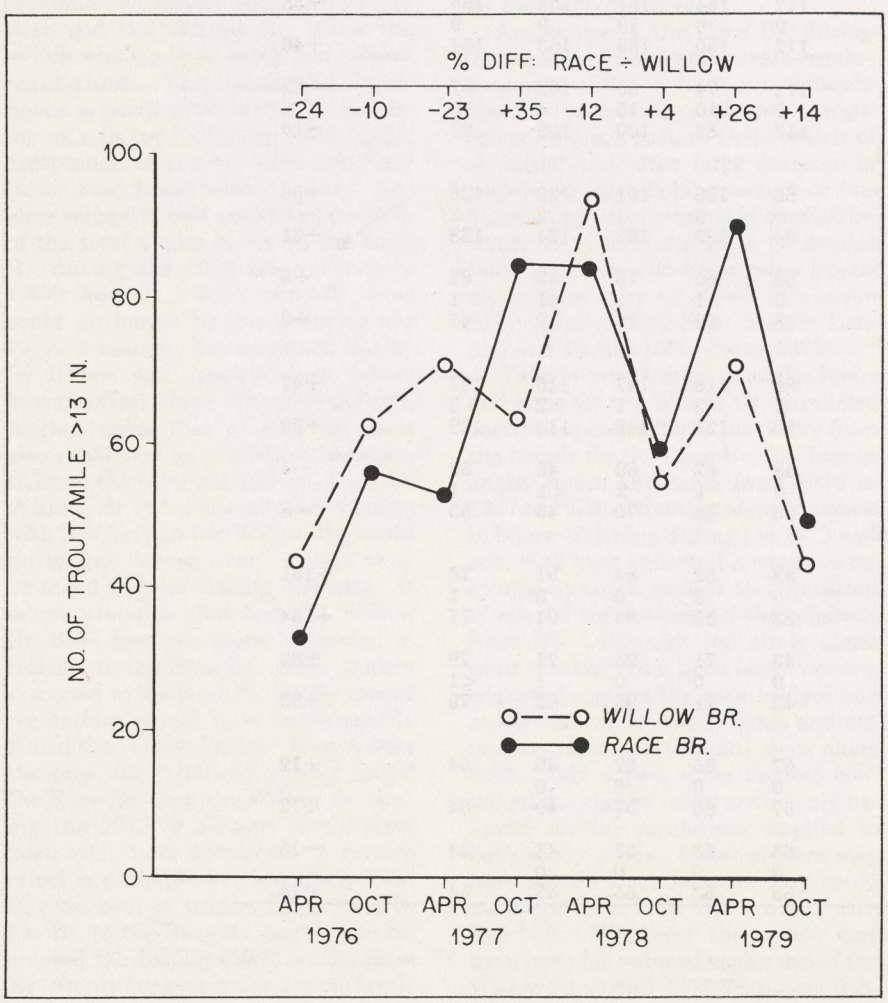


FIGURE 14. *Number of trout/mile over 13 in. in the Race and Willow Br. study zones each April and October of 1976-79.*

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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About the Author

Robert L. Hunt is a trout biologist with the Department of Natural Resources, and Leader of the Cold Water Group in the Bureau of Research, Emmons Creek, Wisconsin. (Rt. 1, Box 589, Waupaca, WI 54981).

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Catch & Release Limits

No-kill may sometimes mean no-catch

BOB KRUMM

I can see the old photos in my mind's eye—two successful anglers holding up a meat pole of 30 or more trout ranging from two to eight pounds in size. Such catches were common in the West at the turn of the century; it makes me wonder what fishing would be like today if our ancestors had been less greedy.

Over-fishing, pollution and loss of habitat caused a decline in fisheries throughout most of North America during the 20th Century. Fortunately for most freshwater anglers, catch-and-release finally caught on (pardon the pun).

Catch-and-release has worked in many instances. For example, Eastern and California streams near population centers have been able to sustain trout populations despite heavy angling pressure, and the practice has enabled the cutthroat trout in Yellowstone National Park to bounce back and flourish. It has also allowed the rainbow trout in the special-regulations stretch of the Bighorn River to exceed management objectives.

Some species of fish are ideally suited to catch-and-release. Cutthroat trout, for instance, are very susceptible to angling. Biologist Robert Behnke pointed out in 1987 that it takes only 10 angler-hours per year to catch a cutthroat twice. Cutthroat also have low hooking mortality rates and live for up to 11 years. Ronald Jones, in a paper delivered at the Wild Trout III symposium in 1987, reported that cutthroat trout in the Buffalo Ford area of the Yellowstone River had a .3-percent hooking mortality rate per capture and a population mortality rate of three percent based on an average capture rate of 9.7 times (that's each fish!) per 108-day season.

But not all trout fisheries respond well to catch-and-release regulations. According to a paper reviewing special regulations, published by biologist Frank Rahel of the University of Wyoming, "Catch-and-release regulations should be applied with great care to thriving fisheries because they have the potential to cause a reduction rather than an increase in the number of big fish present. This happens when recruitment is high and harvest restrictions reduce the population thinning that occurs under standard angling regulations. The increased abundance of fish results in increased intraspecific competition and consequently a reduction in fish growth and condition."

What Rahel is saying is that catch-and-release is not a panacea. While the practice has benefited the population and average size of cutthroat trout in Yellowstone Park, brown trout don't benefit in the same way from catch-and-release. Each brown requires anywhere from 400 to 1,900 angler-hours per year to be caught twice. Most studies have concluded that catch-and-release is generally not a good management scheme for browns in productive waters where they have good recruitment. Rainbow trout are intermediate on the scale of catchability—they are harder to catch than cutthroats but easier than browns. They can flourish under catch-and-release regulations.

Because catch-and-release has been so successful in a variety of situations, many anglers feel that since they practice it they can do no wrong. In essence, catch-and-release has created a new breed of fish hog—the numbers angler. On the Bighorn River this type brags about catching 30 to 100 trout in a day. And the Bighorn isn't the only heavily fished river where high scores are common: The Green, San Juan, Yellowstone, Delaware, Pere Marquette and many other famous streams are on the list too.

More than bragging results from anglers catching and releasing high numbers of fish. First, they kill fish. Many studies on hooking mortality have shown that bait fishing has an average mortality rate of 25 percent for salmonids caught and released, while lures cause an average mortality rate of 6.1 percent. Although flies produce a mortality rate of only 4.05 percent, this still means that if an angler caught and released 25 trout properly, he would still kill at least one of them. And the mortality rate rises when the fish aren't handled properly, when the water is above 68 degrees and when the fish have been overly stressed. Repeated hooking is a major source of stress and, on heavily fished waters, there will be some fish that are repeatedly caught and released—with the odds in favor of their survival dropping each time.

It is ironic that lure fishermen who keep their fish have less of an impact on the

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The gentle release

To increase the survival rate of the fish you catch and release, make sure to land them before they are totally exhausted. Use as heavy a leader as possible and fight the fish as hard as possible. If you can, remove the hook with forceps while the fish is in the water. Don't squeeze the fish, especially around the pectoral fins and gills. While many fly fishers recommend barbless hooks, there is no statistical difference in mortality rates of single barbed or barbless hooks (although you might find your releases easier on the fish with barbless hooks).

I can land fish faster with a net; I use one whenever possible. A rubber-coated net bag is very gentle on trout, cotton is less gentle and nylon netting is the worst. A net also enables you to keep a fish in the water while you're removing the hook.

If you must take a photo of your fish, grasp it firmly around the base of the tail and put your other hand under its belly; if the fish squirms, let it go. Always try to take the photo while the fish is still halfway in the water.

If you are fishing for trout, and the water is 70 degrees or warmer, don't fish!

—*BK*

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LIMITS

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Bighorn River than fly fishers racking up high totals, because they catch their limit of five browns and go home while the anglers who ridicule others as fish killers remain there hour after hour, destroying a percentage of their fish and preventing anyone else from getting on the water.

Before I get into trouble here, let me explain that an historical problem the Bighorn fishery has had is *too many* brown trout. (This is not true of all crowded streams, and the case for catch-and-release or other special regulations must be decided on an individual basis.) Montana fisheries biologists have proven that when there are high numbers of age-class II brown trout (about two years old) in the river, class IV and older browns (the real biggies) suffer high mortality rates from starvation. It is actually a help to the brown trout population to keep a couple of the smaller browns. (The limit is five—only one of which can be over 18 inches.)

Perhaps the worst effect of chasing numbers is that the angler loses sight of the aesthetics of fly-fishing. Whenever he hears someone bragging about catching a large number of trout, Mike Craig, who owns the Bighorn Angler, often responds, "Which one was the prettiest? Which one fought the hardest? Which one was the ugliest?"

When an angler chases numbers, he will often appreciate neither the beauty nor the fight of each individual fish. Neither will he take time to enjoy the vista or marvel at the sunset, the wildflowers, the birds. Chasing numbers robs an angler of what makes fly-fishing special. Ideally, fly-fishing is a slow-down, stop-and-smell-the-roses, aesthetically pleasing way of fishing.

For the betterment of the fisheries involved, I urge catch-and-release fly fishers to limit their catches. On productive, heavily fished trout streams such as the Bighorn, Green and Bow, I suggest that we limit our catch to no more than 15 fish. And on less productive streams, and smaller streams like the Pere Marquette, I recommend a six-trout catch-and-release limit. On waters that experience less pressure, local fly-fishing clubs could help design limits for each body or stretch of water. For species such as steelhead or salmon, three landed or six hooked in a day should be plenty for any fly fisher.

While catch-and-release limits could never be enforced, peer pressure could make them work. There are creel limits on many streams such as the Bighorn, but seldom do fly fishers kill any fish, because of the catch-and-release credo being enforced by peer pressure.

By limiting the number of fish that you catch and release, you will help to alleviate crowding, lessen the number of accidental fish mortalities and reduce the number of diseased, scrawny and scarred fish in the stream. Best of all, you will better appre-

ciate each trout that you catch. And you might actually come back from a fly-fishing trip rejuvenated and relaxed, instead of bragging about your score. ❑

What's your foot doing in my redd?

It will happen soon: The rainbow trout will start to spawn in the Bighorn River, and fly fishers will fish for them. If you were to question the anglers fishing for the spawning fish about the propriety of their actions, they would probably respond, "I'm not hurting them. I'm catching and releasing them."

Meadow muffins.

Let's look at the genetic ramifications. The male rainbows that usually fertilize the eggs are the bigger, more aggressive ones. When a male rainbow has paired off with a female, he will chase off smaller males. If an angler catches the male, the trout will not return immediately to the redd—it may take three days for him to recover. Meanwhile, genetically inferior males spawn with the female.

And when redds are fished hard, the females may get caught so often that they never get a chance to spawn at all. According to Wyoming Game & Fish Story Hatchery superintendent Dave Ackerman, rainbow trout only have about a two-week window of opportunity once they are ripe to spawn.

And then there's the stress of being caught. A study on the Henry's Fork determined that hook-scarred trout were in poorer condition than unscarred trout. Other studies have shown that the effects of stress are cumulative for trout and one that is repeatedly stressed may or may not have enough energy to complete spawning. Keep in mind that the average mortality rate for trout caught on flies is about four percent. Catch 25 trout in a day's fishing and statistically you've killed one of them: that's one dead *spawning* fish out of 25. And the other fish you handled may have lost some of their eggs or milt.

Another factor in the equation is that many anglers walk on the redds. In a 1988 study, Roberts found that trampling a redd just prior to hatching can cause 43.4-percent mortality for the developing rainbow embryos. If the eggs are trampled twice daily throughout the course of their development, mortality can range as high as 96 percent.

With a fishery's future at stake, it seems very selfish to fish the redds. It's also unnecessary, since only a portion of the population spawns at a particular time. Many fish are either getting ready to spawn or have just completed the spawn; why not fish for those instead? Then, too, on the Bighorn there are still plenty of eager and willing browns in the river; go after them. If you want quality rainbow trout fishing in the years to come, show restraint now. —*BK*

Killing Your Share

A trout conservation message

ZED NEWLAND

Have you been killing your proper share of trout lately? If you haven't, there's a chance you're a management problem for biologists and other planners who are trying to improve your trout fishing.

"Say what?" you say.

There was a day, not so many years ago, when voluntary catch-and-release by trout fishing trend setters was the only kind of harvest control around because state management agencies (feds in the national parks) were generally far behind in recognizing the significance of angler harvest. They didn't feel it was a factor, but anglers knew better. Bass grabbers and trout fishers (especially the fly-fishing trout crowd) led the way until finally "special" regulations emphasizing catch-and-release became commonplace and accepted.

Trouble is, like many good ideas it's gone too far, and well-meaning but zealous fly fishers now are fouling the works by resolutely refusing *ever* to kill a trout. On a lot of managed trout waters, the 100-percent no-kill crusade has turned into a perversion—perverse because a zero limit is a restriction only rarely desirable or justifiable. That's why it's seldom imposed by regulators. The hard-line no-killers may be mindlessly killing us all by not thoughtfully killing some trout.

Most states that support good trout populations have developed a menu of "wild trout" or similarly named blue-ribbon waters with severely restricted harvests. Anglers on these streams face complex sets of regulations painstakingly designed to help optimize the fishery. This is fine, but it can only work to maximum advantage if anglers crop trout to the extent the bag limits allow. Usually the rules allow two, three, maybe even five trout per day per angler, and generally fish of only a certain size may be included in the bag. This combination of harvest parameters is intended to manage human beings as predators and to manipulate human predation so as to actually *improve* the size and structure of the trout population. We must assume in cases where biologists are doing a good job (and political considerations aside) that if they wanted *no* fish killed they would impose that very *no-kill* rule.

The Yellowstone River in America's "First Park" is a good example of where no-kill is intended, has been invoked and works very well to protect a population of good-size—if very gullible—cutthroat trout. On California's Hot Creek, however, the policy has produced mixed results—results that follow a pattern closely correlated to natural mortality and annual spawning success, both of which fluctuate widely. On Hot Creek, no-kill is not the best treatment every year, yet it is in effect every year. This suggests that we should use a more flexible approach to harvest regulation.

Perhaps the best example of sophisticated rules that depend on significant angler harvest in order to work properly is Montana's Bighorn River. The 'Horn has a thin population of rainbow trout, but they grow like crazy, attain great size and provide dynamite sport. The regulation for rainbows is no-kill. However, the river's trout population is composed primarily of prolific browns and the stream annually produces a huge group of 16-inchers. Through intensive study, biologists learned that these numerous adolescent trout were so active and competitive they made life difficult for larger browns trying to get larger; since the objective was to manage the Bighorn for trout of exceptional size, the harvest regulation permits fishermen to konk a few browns measuring less than 18 inches. And that harvest is expected and encouraged. The whole scheme seems to work wonderfully and also makes the point that, absent some harvest of those pesky teenagers, the catch-and-release fishing for Kodachrome trophies would suffer.

The emergence of the maximum-size bag restriction as the rule of choice in appropriate circumstances (such as on the Bighorn) has met with less success in California, where fly fishermen have been brainwashed into falsely believing the killing of trout is universally abhorrent. One influential biologist in the state is quickly losing interest in sophisticated special regulations because, "The fly fishermen turn everything into defacto no-kill, so they just don't work."

Such discouraging words illuminate a real danger: Although total no-kill can only rarely be justified biologically, fisheries managers might conceivably abandon all artificials-only, limited-harvest regulations as pragmatic failures. And what a revolting development that would be in a state like California, which arguably has led the nation in developing a full array of exquisitely sophisticated trout fishing regulations.

And there's another reason to kill trout: They are excellent food and many people enjoy eating them. If people can indulge their taste without having a negative effect on the quality of sport for others, indeed perhaps even improve it, who's to complain?

No-kill zealots go ballistic at this thought, typically contending that a dead trout is a dead trout and the removal of any trout from the fishery is obviously going to harm it. But the 100-percenters are wrong; they are ignorant of the biological dynamic of *compensatory mortality.* Anglers generally understand that there are a lot of natural deaths within wildlife populations. In fish populations, the percentage of natural deaths at all stages of life is enormous. Only a very small percentage of baby trout become infants, only a small percentage of infants become juveniles, only a small percentage of juveniles become adolescents, only a few adolescents become adults and only a few adults become old adults, i.e., real trophies. This happens even without fishermen; when

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KILLING YOUR SHARE

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fishing is added to the equation and the natural survival percentages fall, biologists term the additional loss *additive mortality*.

But when the harvest is restricted in the numbers and sizes of fish that can be killed to ensure that, in spite of a few fish fries, the survival rates mirror the natural survival rates, then the harvest is termed *compensatory mortality*. What this means is that the trout in the frying pans were doomed anyway or that their removal will allow the survival of otherwise doomed trout; in either case the net loss to the population—from fishing—is zero. This is important esoterica for anglers to understand.

Biologists and managers make decisions on whether to permit additive mortality or only compensatory mortality based on their goals for the fishery. For example, California's Yellow Creek was managed for several years to restore the brown trout population; the creek carried a 16-inch minimum size limit. Within a few years we learned that the protective regulation had achieved its purpose and that the creek was chock-a-block full of trout, most of them small. The Dept. of Fish and Game and officials of California Trout, the state's wild trout advocacy group responsible for the original 16-inch regulation, then agreed that small trout needed less protection and large fish more. A 10-inch maximum size limit was invoked in hopes of thinning out the dinks, thereby reducing competition pressures on the larger trout. But there are indications the plan is failing because of knee-jerk no-killers; fly anglers are undermining the fishery by failing to crop out the overblown population of juvenile and pre-adolescent trout. One could pose the question: Is it time to invite the bait dunkers back to do this job?

I'm not just in favor of picking on the little guys; big, old trout deserve El Bonko from time to time too. In some fisheries, for instance, managers know that trout in the population only live a certain maximum number of years and that fish at the end of their lives almost always attain a predictable size. This allows them to set a size regulation permitting cropping of these doomed-anyway specimens that will have little practical effect on fishing quality. Such a policy lets anglers take a few trophies without harming the fishery. When necessary, this harvest of old timers could be delayed to the final weeks of the fishing season so as to have even less effect.

So, you're still an advocate of 100-percent no-kill? Sorry, friend, there's no such thing. Even with the most careful handling, a certain percentage of released fish will die. The slight danger from hook penetrations is exacerbated by the "natural deaths" caused by the stress of the fight (on them, not you). While the mortality rate may be small, in fisheries where trout are caught and re-caught many times—like the Yellowstone—the seasonal odds mount up.

So where does all this lead the sophisticated angler who wants to help our trout fisheries? Well, you probably already know you should support, with your spirit and your wallet, conservation groups that constantly press their state agencies to "sophisticate" the harvest regulations on each individual trout water. I think California Trout can be considered a model for the nation.

But another thing you can do is to take a look at the angling regulations on the waters you fish, think through what they are apparently trying to achieve and, if you're satisfied that the goals are being reached, go ahead and *kill accordingly*. Throw a frying pan and a burner into your vehicle when you go fishing and don't feel guilty. There's nothing like the taste of a wild trout fresh from the stream, especially when you know you have helped make life better for the critters that remain.

Be a *thinking* fly fisher and conservationist, not a no-kill zealot. ❑

– US FWS Coop Unit
re opp. IFIM
HEP
Nat. Ecol. Cntr.
Ft. Clln

525 So. 5th St. E. Apt. 6A
Missoula, Mt. 59801
March 26, 1990

– Appl.

I can stop
in
mtgs

Dear Dr. Behnke,

I am the retired naval officer and current University of Montana student who stopped in at your office, uninvited and unannounced, during exam week in December.

I enjoyed the conversation which delt, in part, with catch-and-release regulations and your article in the autumn '89 issue of Trout.

Enclosed is a paper of mine on the relationship between catch-and-release and bait fishing. Since one of the points in the paper is an extrapolation of one of your ideas, I would appreciate any comments you might have on it. Also, a couple of people here have suggested submitting the paper for publication;

no criticism would be welcome.

On an unrelated subject, I have applied to CSU for admission as a graduate student in Fishery Biology. The only person I know in the department is Jere Lecher, who, of course, is not a fisheries person.

If you have any suggestions on whom I should contact in the department, I would appreciate it. My interest is in stream ecology, particularly the quantification of requirements for maintenance of healthy salmonid populations.

Sincerely,

Harry Allen

[14905]

THE CONFLICT BETWEEN CATCH-AND-RELEASE AND BAIT FISHING

Harry C. Owen III

Introduction

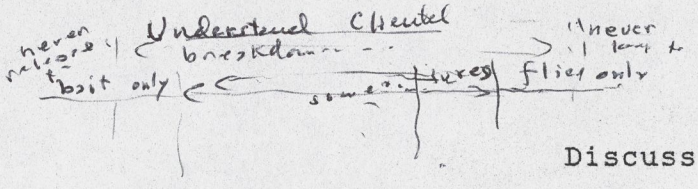
When fishing quality declines because of low catch rates or the small size of the fish caught, several methods are available to the fisheries manager to improve fishing quality. Common remedies are placing restrictions on the number or size of the fish which may be creeled, instituting catch-and-release regulations, or limiting the type of terminal tackle which may be used. Frequently these restrictions are combined.

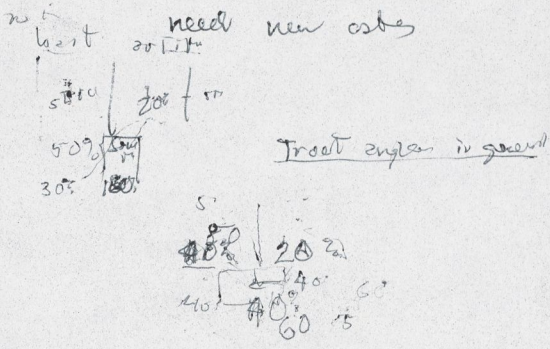
Prohibiting fishing with bait, as opposed to flies and lures, is intended to reduce mortality when fish are released after being hooked. Unfortunately, prohibiting bait fishing may eliminate fishing participation by a large number of anglers, including children and other beginners.

As the number of streams where bait fishing is prohibited grows, bait fishermen can be expected to become more and more hostile to such restrictions. The hostility may take the form of litigation. For example, during the summer of 1989 bait fishermen obtained a court injunction to prevent implementation of new regulations which would have banned bait fishing in sections of the Big Wood River in Idaho (*Times-News*, 1989; *Wood River Journal*, 1989). Even where court action is not sought, alienation of a

large number of anglers may lead to undesirable political repercussions.

It is important for fisheries managers, fish and game commissions, and other agencies, state and federal, which control fishing regulations to understand whether, or to what extent, fishing with bait may be incompatible with catch-and-release regulations.





Discussion

How many stream fishermen use bait?

Preliminary studies on the Big Blackfoot River in western Montana included angler surveys. Sixty-three percent of those sampled stated they used bait (Peters and Spoon, 1988).

On the Meramec River and the North Fork of the White River, both in Missouri, bait fishermen comprised 50% and 38%, respectively, of the angling populations (Turner, 1986). Figures for the Meramec were obtained prior to proscription of bait fishing in 1982.

Seamans (1959) reported that bait fishermen accounted for 67.9% of all anglers in the Saco, N.H. watershed in 1957 and 87.3% in 1958.

It appears that bait fishermen are a substantial proportion of the angling population, although that proportion may vary from region to region and from stream to stream.

Do bait fishermen switch to flies or lures when bait fishing is prohibited?

Wydoski (1977) notes that, although there is a tendency for some beginning fishermen to shift from the use of bait to artificial lures and flies, most will continue to use bait where it is allowed. However, since most people initially enter the sport using bait, an important implication is that bait fishermen form the pool from which lure and fly fishermen are recruited.

The average number of fishing trips per year to the Meramec River dropped 61% after bait fishing was banned (Turner, 1986). The decrease was ascribed to adverse weather. However, during the same period on the North Fork of the White River, which had similar regulations but allowed fishing with bait, the number of trips increased by 35%. Data were not available in the Turner study to determine whether the decline in Meramec trips was caused by the exclusion of bait fishermen who were unwilling to change fishing methods. That presumption is supported indirectly by angler surveys. In 1979 and 1980, 28% and 42%, respectively, of those surveyed indicated they would fish less if bait fishing

were prohibited (Turner, 1983).

Special fishing regulations, including a creel limit reduction and a prohibition on use of bait, were implemented on Rock Creek in 1979. The number of anglers fishing the creek dropped sharply (Peters, 1989). However, by 1981, the next year a census was taken, the numbers had increased from 6,361 fishermen in 1978 to 9,238 (Peters, 1987). This increase in useage was probably due to dramatic improvement in the size and number of fish caught after the special regulations went into effect. Similar increases in fishing pressure were reported by Barnhart (1989) in streams where catch-and-release regulations were successful in improving catch rate.

Angler surveys on Rock Creek (e.g., Peters, 1987) have not included questions which would indicate how many fishermen who used to use bait on that creek have changed to flies or lures. This is a question which is worth asking.

Does bait fishing kill more fish than are killed with flies and lures?

The most exhaustive review of the literature on hooking mortality was conducted by Richard Wydoski (1977). He computed mean mortality rates based on over 9,000 cases reported in the studies he reviewed. Wydoski found 4% mortality for fish released

after being caught on flies, 6% on lures, and on bait 25%. Hunsacker, Marnell, and Sharpe (1970) reported mortality of Yellowstone River cutthroat trout to be 4% with flies and lures and over 48% with bait. Atlantic salmon mortality after release was about 4% for flies and lures and from nearly 6% to as much as 35% on bait (Warner, 1979). The lower figure, 5.7%, occurred in hatchery experiments and the higher number, 35.0%, in a river. Table 1 summarizes the results of several studies.

AUTHOR	SPP	METHOD	WATER TYPE	% MORTALITY Fly	Lure	Bait
Shetter, Allison (1955)	EB	f,b	S	3.3		42.4
	Rb	f,b	S	11.3		35.4
	LL	f,b	S	0.0		20.3
Stringer (1967)	Rb	f,l,b	L	8.9	2.8	*
Hunsacker, *et al.* (1970)	CT	f,l,b	R	<--4.0-->		48.4
Wydoski (1977) @		f,l,b		4.0	6.1	25.0
Warner (1979)	AS	f,b	H	4.1-4.6		5.7
	AS	f,b	R	4.0		35.0
Schill, Griffith (1986)	CT	f,l	R	<--3.0-->		

SPP(Species)
AS - Atlantic salmon
CT - Cutthroat trout
EB - Eastern brook trout
LL - Brown trout
Rb - Rainbow trout

METHOD
b - bait
f - fly
l - lure

WATER TYPE
H - Hatchery
L - Lake
R - River
S - Stream

* - 35.3-45.6% @ - averages based on literature review

Table 1.
Comparison of hooking mortality rates for salmonids from six studies.

The numbers seem to make a clear case: bait fishing kills many more fish than flies and lures. But there are a number of variables to consider, including fish species and size, type of hook, water temperature, length of time played, and (when evaluating studies) experimental handling and holding procedures (Schill and Griffith, 1986). To this list, Wydoski (1977) adds type of bait used, anatomical site of hooking, and angling technique.

Fish species. Shetter and Allison (1955) reported mortality rates for worm fishing of 20% for brown trout, 35% for rainbows, and 42% for brook trout. Mortality rates for adult winter-run steelhead caught on bait are low (Mongillo, 1984). Cutthroat trout appear to take flies and lures more readily than bait (Clancey, 1989). As a result, cutthroat bait hooking mortality may be less than might otherwise be expected.

Hook type. Larger hooks and treble hooks reduce mortality (Mongillo, 1984; Shetter and Allison, 1955).

Water temperature. Hooking mortality increases with water temperature. The percentage decrease in mortality as water temperature decreases is pronounced for bait fishing when the bait is not swallowed (approximately 25% mortality at 15.5° C and about 2% at 5.7° C) (Hunsacker, et. al.,1970). Other studies,

however, have shown no relationship between temperature and mortality (Mongillo, 1984). See my paper Barnicek

Anatomical site of hooking. Mongillo (1984), summarizing 34 hooking mortality studies, reported that fish hooked in the gills, esophagus, tongue, or eye were about four times more likely to die than those hooked in the mouth or jaw. He estimated that bait fishing results in fish being hooked in these critical areas about 50% of the time, whereas flies and lures penetrate these areas less than 10% of the time. In one study, 83% of the gill-hooked and 72% of the throat-hooked fish died (Warner, 1979). Warner went on to estimate that 33% of deep hooked Atlantic salmon will survive if the leader is cut rather than removing the hook. In another study, only 34% of deep hooked rainbow trout died when the leader was cut, while 88.5% died after the hook was removed (Mason and Hunt, 1967).

Angling technique. There was a very large difference in bait hooking mortality rates reported by Warner(1979). In hatchery experiments, nearly all the fish were hooked in the jaw or mouth and only 5.7% died. In river experiments, 37% of the fish were hooked in the throat and 4% in the gills. Thirty-five percent of all fish caught subsequently died. Warner explained that in the hatchery the fish could be seen, and, as soon as they took the bait, the hook was set. By contrast, in the river the fish were not usually seen, and there was a better chance the

fish would swallow the bait before the hook was set.

Summary. There is a large number of variables which may appreciably affect hooking mortality study results. These variables are not accounted for in some of the studies. As a result, comparisons of data from different studies must be made with caution, and the relevance of the studies to a particular stream may be small.

Two conclusions are inescapable. Bait fishing results in higher mortality rates than flies and lures, and there are many factors which may reduce bait fishing mortality, chief among them being angling technique.

Is bait fishing incompatible with catch-and-release or limited harvest regulations?

There are not many studies available which allow direct comparison of the effects bait fishing has on a fishery. Prohibitions of bait fishing are frequently accompanied by other restrictive regulations, such as changes in numbers and size of fish which may be kept. Two recent studies are of particular interest.

Trophy trout sections of the Meramec River and the North Fork of the White River were studied by Turner (1986) over a

three year period, 1982-1984. Harvest regulations were the same for both sections -- 3 trout 15 inches or longer per fisherman per day. Bait fishing was prohibited in the trophy trout section of the Meramec but was allowed in the North Fork. Trout densities were similar in the two sections (893/mile in the Meramec and 873/mile in the North Fork). Although the Meramec was more heavily stocked (4,000 trout per year vs. 3,000 per year) the North Fork experienced 8% greater fishing pressure. Catch and release mortality averaged 4% in the Meramec and 20% in the North Fork. Nevertheless, over the three years of the study, the fall population of trout in the Meramec, after most of the fishing pressure had waned but before stocking occurred, declined 42% (1,089 trout per mile in 1982 to 636 in 1984) while the fall trout population in the North Fork increased 69% (684 trout per mile in 1982 to 1,155 in 1984). Legal trout (at least 15") increased 43% (35 in 1982, 50 in 1984) in the Meramec and 159% (22 in 1982, 57 in 1984) in the North Fork. The vast majority of trout mortality was unexplained, 95% in the Meramec and 69% in the North Fork. Table 2 summarizes the data.

	MERAMEC (bait prohibited)	NORTH FORK (bait allowed)
Density (trout/mile)	893	873
Fishing Pressure (hours/year) ~~mile~~ ?	10,851	11,740
Stocking (trout/year)	4,000	3,000
Catch/Release Mortality (% of total mortality)	4%	20%
Harvest (% of population)	2%	11%
Fall Trout Population (three year trend)	-42%	+69%
Trout ≥ 15" (three year trend)	+43%	+159%

Table 2.
Comparison of two trophy trout rivers in Missouri, one where bait fishing is prohibited and one where it is allowed.

One conclusion which can be drawn from the data is that bait fishing is not having any appreciable effect on the North Fork fishery. Although losses to catch-and-release mortality are five times higher in the North Fork than in the Meramec, the losses are being compensated by a decrease in unexplained mortality (my conclusion not Turner's). compensatory

In another study, not yet completed, population estimates were taken on four sections of the upper Yellowstone River in Montana from 1984 to 1989 (Clancey, 1989). Two of the sections, Mill Creek and Corwin Spring, are of interest. Catch-and-release regulations were implemented for both sections in 1984. At the

same time, bait fishing was proscribed in the Mill Creek section but continued to be allowed in the Corwin Spring section of the river. From 1985 to 1988 the population of cutthroat trout larger than 12" in the Mill Creek section increased 51% while the population in the Corwin Spring section (bait permitted) increased 59%. If 1989 data are included, the 12" cutthroat population increased 66% in the Mill Creek section and 130% in the Corwin Spring section. Clancey stressed that the 1989 Corwin Spring datum may be an anomaly. If 1988 populations of cutthroat over 12" are compared with the mean populations present during the three years before the new regulations showed any effect (1982-1984), the Mill Creek population increased 80% and the Corwin Spring population rose 88%.

The two sections are dissimilar, Clancey pointed out. The principal difference is that the Corwin Spring section contains spawning tributaries and has excellent recruitment potential, whereas the Mill Creek section does not. Since the two sections are not far apart, it appears that the Corwin Spring section may be providing recruitment for the Mill Creek section and, indeed, for other sections of the river further downstream.

The Turner and Clancey studies consider sections of rivers with markedly different characteristics. But the data from neither study will support the contention that bait fishing is always incompatible with catch-and-release regulations.

Conclusions and Recommendations

Prohibition of bait fishing probably reduces angling opportunity for a substantial fraction of the fishing public. By doing so, the number of people who are recruited into fishing and who subsequently become lure or fly fishermen may be reduced.

If bait fishermen continue to lose access to increasing stretches of fishable waters, there is a good chance that they will seek judicial or political remedies. As a result, fishing regulatory agencies need to assure themselves that there is an objective and verifiable justification for each decision to close waters to bait fishermen.

Historical studies which show increased fish mortality resulting from bait fishing do not provide adequate justification, in and of themselves, to bar use of bait on a particular river or stream. The study results are applicable only for the experimental conditions under which they were conducted. The conditions of the experiment may be appreciably different from the conditions of the stream for which restrictive regulations are being considered. Robert Behnke (1989) makes a similar argument with regard to "special" regulations: what works in one stream, or even in one section of a stream, may not work

in another because the conditions are different. Prior experience which shows increased fishing quality when restrictive regulations are imposed is also inadequate. In most cases, bait fishing prohibitions were imposed in conjunction with more restrictive creel limits, and the effects of the two cannot be separated.

Regulatory agencies are left with a dilemma. They may impose a bait ban based on the historical studies and open themselves to political interference or litigation. Or they may conduct independent studies, which have the disadvantages of being both time consuming and expensive.

A third and, perhaps, more prudent and cost effective alternative is to attempt to improve fishing quality with creel limits alone, without any restrictions on terminal tackle. If fishing quality does not improve to a designated target level within a designated length of time, a temporary bait fishing prohibition could be imposed for another specified period. If the fishing quality goals are met, or substantial improvement in quality occurs, during this second period, clear justification would exist to continue terminal tackle restrictions. If a substantial improvement in fishing quality does not occur and creel limits are considered sufficiently restrictive, the proscription on bait fishing should be lifted. Lack of improvement of quality would then have to be laid to factors

other than harvest and catch-and-release mortality.

The studies indicate that hooking mortality can be reduced if angling technique is modified, no matter what terminal tackle is employed. Reductions should be especially apparent, however, where bait is allowed.

a. Deep hooked fish should be released by cutting the line or leader rather than by removing the hook.

b. Larger hooks and treble hooks are preferable to smaller, single hooks.

d. Heavier weight lines should be used to reduce playing time, particularly when water temperatures are elevated.

e. Fishermen should strike the hook at the first indication of a take.

Since some of these techniques run counter to ingrained practice and conventional wisdom, a substantial educational program will be needed if they are to gain acceptance.

Where a clear, *a priori* case cannot be made that bait fishing mortality is a prominent cause of low fishing quality, a strong argument exists for taking a measured approach to the imposition of restrictive regulations. Regardless of the level of fishing quality, educating all fishermen in techniques to reduce hooking mortality should benefit all anglers.

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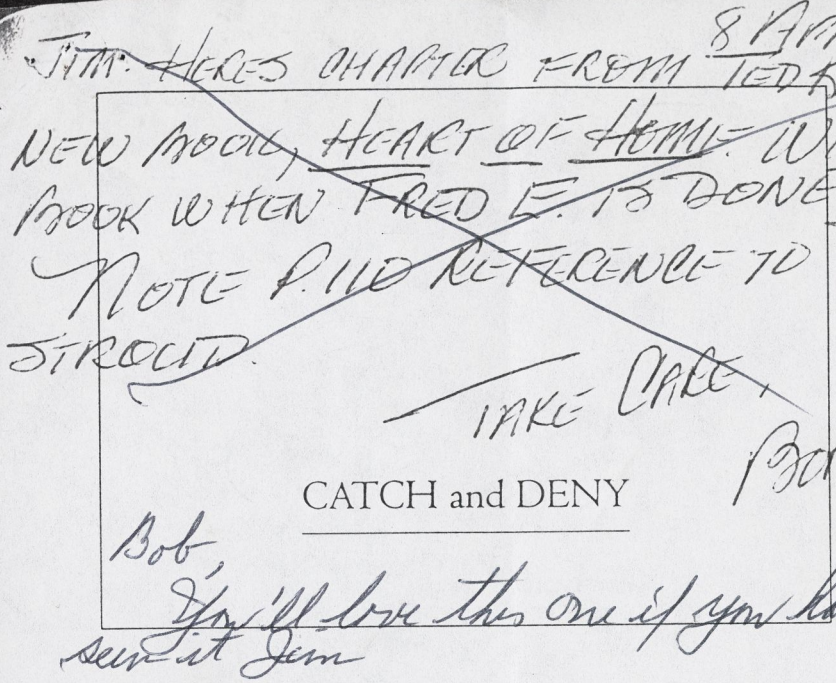


Jack Turner, who looks like a cross between a jolly medieval monk and the Buddha, gave up trout fishing because of birds.

"It was in Berkeley," he says, "maybe '88 or '89. I heard this recording done by the Royal Academy or someone like that. It was of fish being caught and trying to escape. You didn't have to be an expert to know that these were creatures in distress. The only thing I could think of was birds."

It's after dinner, and we're standing on the town square of Jackson, Wyoming, which is virtually empty because it's April and off-season. Turner, one of the principal guides at the Exum School of Mountaineering, based just north of town in Grand Teton National Park, wears his usual tweedy coat, T-shirt, and shortly trimmed white beard, making him look both weathered and wise. Besides having led hundreds of climbers up the Grand Teton, Turner is also known for his mountain explorations (he was the first American to reach the north side of K2), his retrospects of the early days of Yosemite climbing, and lately his lyric writings on everything from Buddhism to the lives of white pelicans. He has also been a fishing junkie since the age of four.

"Trout, eels, everything," he says. His grandfather was half-owner of a Pennsylvania fishing and hunting lodge, and Turner grew up with a rod in his hand before turning to the mountains and teaching philosophy. It was his bent for philosophy, for making unusual connections and disquieting comparisons, that finally caught up to him.

"When I first read defenses of catch-and-release fishing," he explains, "when it became really popular maybe fifteen years ago, I had my first inkling that I didn't want to do it. It seemed like a continuation of a utilitarian philosophy that maximizes value for the group and ignores the individual. It's the perennial scientific attitude as well. Biologists don't worry about individuals. They worry about species, ecosystems.

"Then I heard that recording and it made me imagine using worms and flies to catch mountain bluebirds or pine grosbeaks, or maybe eagles and ospreys, and hauling them around on fifty feet of line while they tried to get away. Then when you landed them, you'd release them. No one would tolerate that sort of thing with birds. But we will for fish because they're underwater, out of sight."

Sometime after listening to the recording, Turner sold his fishing gear—Winston rods mounted with Hardy reels, the best of fine trout tackle. "It breaks my heart to talk about it," he says flatly.

The renunciation was too much too soon. He bought back his rods, used them for two more seasons, and couldn't stand how he felt about what he was doing to fish. He sold everything again. Even so, he's not sure the sale is final.

"I may buy back my nine-foot-six Winston and go out for a trout dinner, or catch whitefish for a stew, going out with the idea specifically to hunt a fish to eat it. I'm not opposed to hunting—

killing fish for food. In fact, I don't think hunting to eat is immoral—to go out, for instance, with a shotgun to kill a dove and eat it—because all life survives by killing and consuming other life. But this idea of playing with things for our own enjoyment while they go through great anguish and suffering strikes me as wrong."

Turner is a member of a Zen Buddhist school that doesn't value life-forms by their sentience. Insects, shrimp, cows, people, trees, rocks, and mountains "all deserve our care and attention." He does, however, distinguish between instrumental and gratuitous pain—killing a fish to feed your gut and playing with a fish to feed your ego.

He now throws open his hands, taking in the town square, the valley, and places beyond. "As a culture we're addicted to fun," he says, "and have a hard time placing amusement in a secondary place to other values, the good of the environment for instance, or the suffering of other beings, even when we recognize those values as important."

Turner isn't alone in feeling uncomfortable about catch-and-release fishing. A few days later, I'm in Montana, talking with David Quammen, whose quirky and poetic essays on nature have appeared in *Outside* for years. Like someone going through a divorce or a serious illness, I'm looking for a support group, people who have lived and lusted for fishing and are now going through the same sort of withdrawal that I've been experiencing.

Quammen and I sit in the old Chico Hot Springs Lodge, commanding a bench above the Yellowstone River where it meanders through Paradise Valley. It's one of those April evenings when the last bit of warm sun makes you believe that winter is really coming to a close. As with Turner, I ask Quammen the

question that no one in the fishing world really likes addressing because of the Pandora's box it opens: If fish do feel pain, as some evidence has begun to suggest, what does the catch-and-release angler do with that knowledge?

Quammen, whose writings explore the givens of nature and the ambiguities of the human soul, answers slowly, almost tortuously, as if mirroring the hard journey he's traveled while thinking about this subject. "I've had more and more trouble with catch-and-release fishing as time goes on. I haven't stopped completely . . . and I haven't decided that one shouldn't fish," he adds quickly, making sure I understand that he's not about to offer any moral prescriptions. "But I've concluded that it's speciesist to tell ourselves that it's a game to the fish. It's deadly mortal serious to them. These animals were hysterically fighting for survival, and it didn't matter whether you had your barbs bent down."

He pauses. His black shirt, flowered tie, and long hair pulled back in a ponytail make him look like a rock musician or an eccentric physicist. This is a man who once criticized cougar hunting in print, then, several years later, at the invitation of a cougar hunter who wrote him about the flaws in his argument, accompanied the man and his dog through Montana's mountains. Eventually, Quammen ate a dinner of lion meat and wrote in another column, "Whatever arguments might be made against the hunting of mountain lions, inedibility isn't one of them." He also wrote, "Nor would I argue for any absolute ethical distinction between the killing of a mountain lion and the killing of a trout."

As a slogan, "catch and release" was first used in the early 1960s by Richard Stroud, the head of the Sport Fishing Institute, an organization funded by fishing-tackle manufacturers. It almost immediately replaced what fish and game departments had been

calling "fishing for fun," a phrase coined in the late 1950s by Albert Hazzard, the assistant executive director of the Pennsylvania Fish Commission, for a program of catching trout and putting them back in Clinton County's Old Woman's Creek. As Stroud recalls, "I gave a speech in which I said, 'I don't like the term "fish for fun." All fishing is fun. So I'll use the term "catch and release." ' "

**** If inventing a byword insures immortality, Stroud's future is secure. In terms of societal recognition, "catch and release" is right up there with "thermos" and "Scotch tape." What "catch and release" doesn't address, of course, is "incidental kill"—the 5 to 10 percent of the trout that die from stress no matter how carefully they're handled. Warm-water fish, such as bass, suffer ever-higher rates of incidental kill. Least addressed in both the popular and professional literature is whether fish—caught and killed fish or caught and released fish—feel pain during the process. Which is Michael K. Stoskopf's whole point.

Stoskopf's easiness belies the enormity of his message. He is a department head at the College of Veterinary Medicine at North Carolina State University in Raleigh. Today, he has flown across the country to speak at the annual meeting of the Colorado Wildlife Society in Fort Collins. Stoskopf's late-in-the-day presentation is a summary of a paper he authored called "Pain and Analgesia in Birds, Reptiles, Amphibians, and Fish." Of the 14,406 references to fish that he surveyed in the literature, only twenty-four matched fish and pain; of those, nineteen were about pain in humans caused by diseases contracted from fish. Of the remaining five references, none discussed the fact that fish might actually feel pain. Stoskopf concluded that the scientific community, like the public, has a serious misconception.

"Pain and pain perception in nonmammalian species must be unimportant," he says, "or at least so intrinsically different from the process in mammals that we need not apply our basic knowledge of mammalian nociception to birds, reptiles, amphibians, or fishes." But when Stoskopf applied basic knowledge of mammalian nociception—the ability to react to painful or injurious stimuli—to nonmammals, he found that they exhibited the four basic responses that mammals do: rapid startle reactions; simple nonspecific flight; vocalization; and "coordinated reaction," a bit of jargon meaning that the test individual bites the source of pain.

As for fish, they not only exhibited "pronounced reactions to contact with irritants or acute stimuli, including strong muscular and behavioral avoidance" (what makes our fishing reels sing their arias when we haul a fish toward shore), but they also showed unfamiliar responses such as color changes and subtle alterations in posture and in the habitats that they chose. The biochemical evidence for pain perception in fishes was also hard to discount: The nervous systems of teleosts (bony fishes that include trout and salmon) produced compounds related to those that mammals produce when subjected to pain.

Turning off his slide projector, Stoskopf smiles at the glum audience. "As you might suspect," he says, "these findings have profound implications for the fishing community, especially the catch-and-release segment of that community, which bills its sport as qualitatively different and somehow less injurious than hunting." Though his words make him seem antifishing, he isn't. "The danger," he explains, "is being in denial about what you're doing and then finding yourself in an indefensible position.

"It's also not bad to have fun," he adds with a grin, "because a lot of the economy's power to implement important habitat

benefits comes from people enjoying themselves. That may mean inflicting pain in a variety of ways to individuals. It benefits the species, and it's certainly different from being cruel."

When told of Stoskopf's data, people like Ted Williams go ballistic. "I don't believe it," he says, voice rising. The conservation editor for *Fly Rod and Reel* and a take-on-anyone columnist for *Audubon*, Williams regularly infuriates both the left and the right. Trying to keep his tone level, he says, "I've caught bluegills off their nests four and five times within an hour. If it hurt them that bad they wouldn't be behaving this way." Williams is tired and disgusted with this entire discussion. "Needless guilt and contemplating our navels," he calls it. Then he says, "It's as simple as this. I'm a person, it's a fish. A friend likened catch-and-release fishing to lassoing a white-tailed deer and hauling it in until it's exhausted. But it's not analogous. If we're going to believe that, we should apply it further. We shouldn't be putting DEET on our skin because it disrupts the feeding activity of mosquitoes."

"But the deer analogy is about deriving pleasure from another's pain, while putting DEET on is to stop someone from hurting us," I reply. Long pause. "I guess so," he says, searching for another comparison. "It's like the Puritan sex ethic. Sex is only good if you don't enjoy it."

Before I mention that enjoyable sex is usually between consenting partners, Williams lets fly with catch and release's broadside. Citing the story of the threatened greenback cutthroat trout living in Rocky Mountain National Park, he turns our discussion to the issue of species and habitat preservation. The greenback cutthroat trout was originally listed as "endangered," but its recovery program "went nowhere," he says, "because no one could fish for it." Downlisting the trout to "threatened" and al-

lowing catch-and-release fishing for it created a constituency. Money poured in and greenbacks increased.

This story has now become a classic and powerful ecological justification for catch-and-release fishing. It also doesn't stand by itself. After catch-and-release regulations were instituted on Yellowstone Lake and its feeder streams in 1973, cutthroat trout numbers increased as much as fourteen times in some of the creeks, creating profound ripple effects. In 1975, grizzly bears fished for cutthroats in 19 percent of the lake's feeder streams; by 1980, the bears were using 61 percent of the streams, an increase that John Varley, director of the Yellowstone Center for Resources and a man whom Williams likes to quote, attributes directly to catch-and-release regulations. Later, when I talked with Varley at park headquarters in Mammoth Hot Springs, he said, "If eagles and ospreys and grizzly bears and otters were going to vote on catch and release as opposed to catch and kill, we would get unanimous support for the former."

"We need to be saving habitat," Williams repeats, echoing Varley, "not worrying whether the cutthroat likes being pulled in and released." Having fired his big guns on the habitat issue, Williams now makes a conciliatory gesture. "The people who say we need to kill fish and eat them, they are absolutely right, absolutely. When I was on the Thorne River, one of America's ten most endangered, by the way, because of logging, I was walking along the stream bank one morning. I heard what I thought was a rattlesnake. It was a coastal cutthroat jumping in the air and shaking its fins. Feeding on pink salmon fry. Hot fish right out of the cold Pacific. The first one I caught jumped five times and broke me off. And all we had brought for breakfast were sticky buns, and by God it was pretty nice to kill a couple of those cutthroats and fry them in butter and eat them. If we

hadn't done that, that fishing experience wouldn't have been as powerful for us. And we released about fifteen that we didn't kill."

His voice becomes reflective. He's getting to the denouement, what really counts for him. "The reason I've stayed with catch and release is—it's not the fight. It's seeing the fish come up, sip the fly. Just to see that. It's pretty neat. Being in Yellowstone is being part of the ecosystem, watching the flies dimple the water, looking at the sky. I don't go to fight them. I go to join them."

If that's it—just wanting to be part of things as Williams and the rest of us have claimed—why not clip off the bend of the hook and simply cast the harmless fly?

John Betts, the renowned flytier and angling scholar, not only thought of the question before I did, he thought of the answer. Disturbed by the small but inevitable percentage of trout injured while being released, Betts began to fish with flies from which the hook bends had been cut. Trout would rise to these hookless flies three, four, even half a dozen times. Damage to the fish was zero, but Betts was disappointed. "Missing was the adrenaline surge that came from the anticipation, take, and initial runs and jumps," he wrote in *American Angler*, a journal devoted to fly-fishing and fly-tying.

Still needing some connection with the fish, albeit brief, Betts started to tie "tag" hooks, standing for "touch and go." They have a ringed eye at both ends. The business end can't penetrate the fish's mouth but will hold the fish long enough for the angler to feel it on the end of his or her line, see it jump, maybe even get a run or two out of it. "My need to touch whatever I've caught," Betts reflected, "originated in lessons learned millions of years ago for reasons other than sport. Touching is one of the

last vestiges of our past and may now seem our only way to keep in contact with it. It also provides a sense of validity for ourselves at the moment and later, when we tell others about what we've done. My need to touch is now tempered by the realization that resources are limited and that what I touch is becomingly increasingly scarce."

Betts's little essay generated a loud response. Half of the letters to the editor offered a variation on "Kudos for this courageous article." Half said, "Let me puke." Most people entirely missed Betts's point about how catch-and-release fishing is being used to provide angling in a time when most places have quite literally run out of fish.

Not far from where Betts fishes on Colorado's South Platte River, another angler, Bob Behnke, professor of fishery biology at Colorado State University, ponders many of the same questions, particularly the biblical one of transforming few fish into many to feed the hungry masses. His work and his popularization of others' research has undermined two popular angling myths—namely, that barbless hooks are necessary for successful catch-and-release fishing and that the single hook is less injurious than the treble hooks used on spinning lures. Behnke cites controlled studies in which mortality did not increase with barbed hooks or with treble ones. Such evidence infuriates the purists with their hat brims studded with expensive flies, their barbs bent down.

People in the animal-rights movement are also angry at Behnke, for he maintains that fish don't experience the sort of pain that a human might experience with a hook in its mouth. "If it *was* an experience of extreme trauma, comparable to a human's being taken to a hospital after a severe injury," he says, "you would not likely do it again within a day. Yet you can catch

the same fish every day by dangling a lure in front of it. Cutthroats are caught and released about ten times each season in the Yellowstone River within the park. They would learn not to be caught again if they were experiencing extreme pain."

He does note that cutthroats are notoriously easy to catch as compared to brown trout, with rainbows ranked someplace between the two species. Do brown trout thus feel more pain than cutthroats do? Or are they just smarter?

Since fish can't tell us about what they're feeling, Behnke suggests that we have to make inferences about their pain thresholds from circumstantial evidence. Citing electroshock sampling methods, used across the nation by fishery biologists to gather information about trout populations, he says, "Those fish are hit again and again, several times in one year, with electric shock that makes them stiff as a board. We know that the shock causes hemorrhaging and fracturing of the vertebrate column. But as far as the trout's continued survival and growth, there's no indication that the shocking is damaging them. Some of our most famous trout waters would never support the numbers of trout they do if electroshocking were really harming the fish.

"Or take tagging," he goes on, "where numbered tags are inserted with wires right through the fish's body with no evidence that it's harming their survival, growth, or well-being. In fact, they carry these tags for years. Or here's another example of the difference between fish and humans: In coastal waters, salmon are routinely attacked by sea lions; you see the fish swimming upstream with wounds that would be lethal to a person."

But what about Stoskopf's contention that fish feel pain because their physiological reactions to stress are similar to those of mammals? "Similarities don't mean that they're feeling the same kind of pain," Behnke counters. Then, like Williams, he points out that whether individual fish actually feel what we

know as pain is really not the issue we should be discussing. "Catch and release is a management tool. Without catch and release you wouldn't be able to maintain quality fishing."

Lee Wulff, indisputably one of the greatest fly anglers of this century, said the same thing more simply in 1939: "Game fish are too valuable to be caught only once." From a biological, political, and economic standpoint such reasoning can't be faulted. Catch and release maintains fish populations and pleases anglers. Anglers vote and they buy fishing licenses, helping to keep fish and game departments in business. They also buy tackle and clothing, stay in motels, eat in restaurants. There isn't a chamber of commerce in the land that weighs a fish's pain against its community's annual revenues.

You have to seek out someone like Jack Turner to see the crack in this utilitarian armor. "We're dealing with a group of people," he says, "fishermen, climbers, boaters, for whom fun and sport are more important than virtually anything else and who lack restraint. We could further limit access to the resource. Maybe have a lottery like in the Grand Canyon. Raise the cost of licenses. We don't have to give everyone unlimited fishing opportunities. Maybe this is something that can't be done everyplace. But it could be done in Yellowstone and Grand Teton parks, which already prohibit river running. Ultimately, people will have to restrict their use of nature."

When I point out to Turner that this would turn America into Europe, where only the wealthy get to fish for trout (and where trout are killed and eaten), he sighs. His calling is principles, not politics.

The rivers clear, the summer warms and turns to fall. I digest—not trout but ideas about trout. Like everything else in nature,

these beautiful fish, their backs like fields of wildflowers, stand not for themselves but as an interface between humans and the primal world.

Not a single one of us has to catch a trout to eat. Nor, for that matter, do those of us who hunt big animals like moose or elk and feed our families for a year have to kill them to survive. We're making choices—more spiritual than economic—about grounding our souls in landscape through participation, about becoming participatory citizens of a home place through the eating of what that landscape produces. The wading, the casting, the stalking, the picking, the plowing, are the ceremonial means to procure nature's Eucharist.

I wade up the Gros Ventre River, my home river, as it flows out of its canyon and debouches before the Tetons. Year after year, it continues to produce as many whitefish as cutthroats, but this evening, the sun slanting onto the canyon walls, the water a deep malachite green, I hook neither. Still, I'm out again, trying to resolve my feelings about angling.

I wade upstream, between the silver flumes, hearing the rush of the water and immersed in spray, and loving the feel of the line—its tumescent load and spring, load and spring—as I cast. Everyone who talks about the catching of fish being secondary is right: simply being in the river is sensuous enough.

Almost enough.

If it were just the casting, the noise of the falling water, and the slanted evening light, there would be no reason to put a fly on the end of the line. We could just wade and cast. Few do. Most of us want a connection to the wild heart of the river, even if it is no more tenuous than seeing the fish come up to a hookless fly—the heart of the heart of the river made manifest in its most essential gesture: stalking and eating prey. After all, trout

are essential in the way we cannot be. They live seamlessly within their homes, within their actions, and within their brains. They are not removed. Maybe catching them, even only hooking them, allows the angler to enter their pure state of being for a moment, the nonreflective alpha and omega of existence. It is what well-practiced hunting and fishing are all about—focusing one's attention until the awareness of attention disappears.

The beauty of catch-and-release fishing, in an age that has grown dubious about causing harm to other life-forms, is that it focuses that attention without dire consequences to the creatures toward whom that attention is directed (at least 90 percent of the time, when the species is a cold-water one like trout and the fish is released quickly, in the water).

When we consider that we're products of a century that has spawned many legal manifestations of justice to the unempowered—woman's suffrage, citizenship for Indians, civil rights legislation, the Endangered Species Act, and global human rights—the action of releasing subdued fish resonates deeply in our psyches. Releasing what we have caught, we can then indulge ourselves in all the uplifting emotions of the kind steward's noblesse oblige—the shackled is set free and, in freedom, gives life to other residents of the ecosystem; grizzly bears and eagles. In economic terms, this is a "trickle up" effect. What is good for the trout is also good for the environment, and, no small benefit, good for the angler's soul since the actual death of the fish is perpetrated by another creature.

The tip of my line darts. I lift the rod in a gesture now practiced since I was a boy, and the weight of the fish is sudden, absolute, and amazingly sweet. The cutthroat splashes across the pool and rolls on the surface, the little reel singing like a dive[illegible]

minute, I just hold the trout because I'm using a two-pound-test tippet and the fish is nearly that big.

Finally, the fish tires and I pump it closer, letting the rod and the current do the work. After one more short run, I coax the fish close and bring my hand under its belly. Tucking the rod under my arm, I slide my hand down the leader and pause. After a whole year of thinking about these fish and talking to people who think about these fish (who actually think about these fish more than they do about a massacre in Rwanda or Bosnia), I should bop it on the head and take it home to eat. I should because I believe to the bottom of my soul that taking responsibility for some of the deaths we cause by our eating is one of the key elements of right living.

But I flick the hook out of the corner of its mouth (despite Behnke's evidence, I bent down the barb) and let it swim away. I don't want to keep it. Nor am I comfortable with letting it go. I head toward the shore, thinking, admitting that, in the end, we angle because we like the fight—otherwise all of us would be using hookless hooks. Not one angler in ten thousand does. The hook allows us to control and exert power over fish, over one of the most beautiful and seductive forms of nature, and then, because we're nice to the fish, releasing them "unharmed," we can receive both psychic dispensation and blessing. Needless to say, if you think about this relationship carefully, it's not a comforting one, for it is a game of dominance followed by cathartic pardons, which, as a nonfishing friend remarked, "is one of the hallmarks of an abusive relationship."

Hooking the fly into the line keep, I step onto the rocky bank. No one likes to hear his friends make those allusions about his fishing, especially when they have the slight ring of truth and es-

fishing. Hiking up the bank, my old waders leaking water, I wish I could lay it all to rest as easily as one of my neighbors, Yvon Chouinard, does. "You know fish feel some pain," said the old mountaineer turned master angler when I raised the issue with him, "because when you set the hook they explode. But they keep on striking," he explained, "so I think it's no big deal."

His voice gaining the slightest edge of discomfort, he added, "Shit . . . causing pain. If you want to know about pain, go run a marathon. Not all pain is negative. Not that these fish seek out pain, but it's not bugging them."

It's as good an answer as any, if you can really believe it.

and tribal interests: netters, loggers, hatchery programs, the usual suspects. With the commission now expanded to nine members, he simply did not have the support within. The 1998 debacle in the commission and department has contributed directly to a changed reality in Washington's fish politics. The governor no longer has the authority to appoint and fire the F&W director, even though he continues to appoint the commissioners who do. Thus both the governor's office and the legislature are more inclined to try to influence fish management, a job which by law belongs to the commission and the department.

With the threat of endangered listings and federal intervention, trying to "save salmon" is the popular hot ticket for politicians. But the governor and the legislature no longer have *responsibility* and can seek cover whenever they need it by pointing to the commission-plus-department alliance as the guilty party. And the legislature still grips a powerful hammer: funding the commission and departmental budgets.

"The 1998 debacle in the commission and department has contributed directly to a changed reality in Washington's fish politics."

So in this climate it is little wonder that senators and representatives are more than willing to consider poorly-written and ill-considered legislative proposals. Still, it remains a huge pain in the waders to try to put out these brush fires by showing up at hearings, phoning and e-mailing legislators and all the other time-consuming stuff that volunteer activists simply must do.

As we have heard many times, if only the fish could vote.

Editor's note: On March 3, 1999, Washington's Senate Natural Resources Committee voted (five to four) to pass the revised version of SB 5104 to the Senate Rules Committee. Thankfully the bill was not deemed worthy enough by floor managers to be selected for a vote. This fact should mean that SB 5104 is officially dead. But fly fishers learned again this year how easily bills can float in and out of existance.

Like a chronic disease, these bills will retreat only to rise again. Fly fishers must unite to support catch and release as a viable management tool.▲

REMINISCENCE: PUTTING FISH BACK

Roderick Haig-Brown

Some fishers are killers by nature. They love to feel the life trickle out of their quarry. Others can desensitize themselves to the death of a fish by simply not thinking much about it. Still others get a rush from releasing a big wild fish back into its beautiful blue-green river. As hard as one group might try to influence another, they cannot. And we are foolish if we entertain the notion that modern fly fishing is a no-kill sport. The fact is that fishing is a blood sport.

So it was fifty years ago when Roderick Haig-Brown roamed Vancouver Island, bamboo in hand, knowing how much his family would love a fresh fish for the night's dinner. But long before catch-and-release was an accepted management tool for recovering fisheries, Haig-Brown was asking all the right questions. Perhaps his words are even more applicable now than they were in 1951.

I decided to wonder the other day just how many fish a year I kill to make my sport. So I looked back over records, missing out most of the war years and stopping short of those years when I was working hard to try and learn about fish — how they grow, when they spawn, what they feed on, why they are fat or lean or dark or light. The answer seems to be, from ten to twenty steelheads, summer and winter; about a dozen salmon; a little less than fifty cutthroat and rainbow trout.

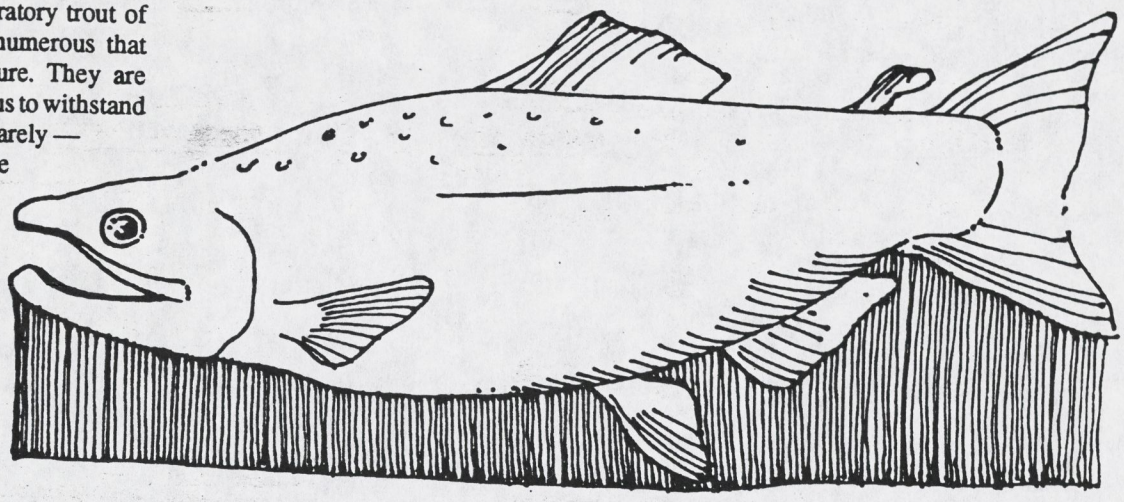
These are not big figures. I knew a man who used to kill every year over a thousand trout in two months' fishing on a big lake; later in the year he used to kill around three hundred salmon, sometimes in catches of thirty or forty in a single day. He always fished from a boat, always with a fly, usually with two rods. And he liked to kill fish. I think he was nuts; he thought I was nuts. If the point of going fishing is to catch and kill fish, undoubtedly he was right. If the point of going fishing is to have a good time with a minimum of destruction, maybe I have a point.

"If the point of going fishing is to have a good time with a minimum of destruction, maybe I have a point."

Even so, my figures are probably larger than they need be. Having a wife and four children who like to eat fish, I undoubtedly kill a few each year that might otherwise have been turned back. And I still occasionally kill a fish because I want to learn something about him that I do not think I can learn in any other way.

It is reasonable to ask at this point: Why such reluctance in a professed fisherman to kill fish? The main reason, I suppose, is that I don't enjoy killing anything, so I cannot see that doing so adds to the sport of going fishing. But I also have the feeling that there are not and cannot be enough fish of the kinds I am mainly interested in to go around the steadily increasing numbers of anglers. I know there are places where trout are so numerous that a heavy intensity of fishing is needed to keep them at a worthwhile size and prevent deterioration of their food resources; but I do not often fish such places, and if I did so I should feel reasonably certain that there would be plenty of other fishermen all too willing to apply the necessary pressure.

Really worthwhile fish, like migratory cutthroats and rainbows, Atlantic salmon,



Pacific salmon and non-migratory trout of good size, are nowhere so numerous that they threaten their own future. They are nowhere sufficiently numerous to withstand unlimited fishing. And only rarely — never in waters easily accessible by road — are they able to hold their own against the determination of anglers to kill them, and of industry to poison them or bar them out or dry up their water supply. If one is convinced of this, as I am, some thought of limiting one's own killing is inevitable.

The first and most obvious limitation is by method— limiting oneself to artificial lures only or to fly only or to particularly fine tackle — and from this there is an immediate gain in improved sport. But it does not go far enough; fly only, even dry fly only, in the right hands and under the right conditions can kill a lot of fish, as my fly-fishing friend showed when he counted his trout by thousands and his salmon by hundreds. Nor are the legal limits set on anglers by states and provinces even nearly good enough, as is clearly shown by the periodic downward revision as fishing intensity increases and the yields of sport grow slim. I have seen the British Columbia bag limit of trout reduced from twenty-four to fifteen to twelve within the space of twenty years, and shall undoubtedly see it reduced still further. And almost as surely, good fishing within the reduced limits will become harder and harder to find.

I think the wise fisherman, who knows what is good for the present and future of his sport, usually pays little attention to the size limits or the bag limits allowed by most game commissions. Six, or at most eight inches, is the usual minimum size for trout. But I have yet to see a six- or eight-inch trout that was worth a sportsman's while except to fill an immediate, frying-pan need; even nine- and ten-inch trout are pathetically small fish and I'm inclined to think that from a fisherman's point of view a trout hardly becomes a trout until it is at least ten inches long; below that size it is a creature of promise, not fulfillment.

I find I develop rather quickly a clear idea of what kind of trout I want from almost any water. Usually I can say I don't want anything smaller than twelve inches, and stay faithfully enough to that. Occasionally I settle for ten; more often fourteen seems about right. There is a sort of relationship here between size and numbers; roughly, I should say, twelve ten-inch trout make a good bag, or eight twelve-inchers, or six fourteen-inch fish. Which doesn't mean one has to go all out to kill such limits or must necessarily stop at them if they are below legal limits; simply that they are good controls to keep in mind. As often as not a brace of fourteen- or sixteen-inch fish is plenty to bring home; occasionally, for some special purpose, one may need a few more. But to kill a legal limit of fish every time it is possible to do so seems to me the height of folly and waste.

There are other ways of setting one's own limits. I shall never again kill three winter steelhead in one day, for instance, because I think that is too many, even though the law allows it. Two is a better limit, and one is all I usually bring home. One coho salmon is all I want from a stream in a day's fishing — if the fish happen to be taking well it is quite easy to turn them loose. Half a dozen sea-run cutthroats are enough for me or any other man in one day; estuary fish are too accessible for common sense to permit more killing than that.

I fish a good deal in one big lake that has seven tributary streams, all of which are good. Most of the streams are widely separated, and by row-boat it is a minor feat to fish more than two or three of them in a single day. With an outboard one can reach them all and fish them all within twelve or fourteen hours, and occasionally it is pleasant to do so. But there is an obvious obligation to recognize the improved transportation by some sort of limit. The one I have found most interesting is a limit of not more than one fish from each creek, the fish to be not less than fourteen inches and taken on a floating fly. It is not an easy limit to achieve, because one is almost certain to find at least one creek where the fish are determinedly off their feeding. And it is a limit that is certainly not going to harm anything if it is achieved.

But all bag limits are evil if they are regarded as a mark to fish for or shoot at, and this is almost invariably what happens to them. They are set as control, as the maximum not to be exceeded. Instead of using them in this way the hunter or fisherman tends to use them as a minimum measure of his sport; "I got my limit in a couple of hours," he will say. Or, if things didn't work out that well he will come home almost ashamed that his skill did not yield him every last measure of death the law allows, regardless of whether his day has been a good one. I have two hopes for the future. The first and lesser one is that game commissions will one day have sense enough to set limits that measurably reflect the sport safely available. The second and deeply urgent one is that we shall grow a race of sportsmen no one of whom will ever consider it a matter for pride to have killed a limit.

The fisherman's enormous advantage in the matter of bag limits is that he can limit his killing without appreciably limiting his sport, and he can also select what he does kill in a way that is seldom possible in other sports. True, the big game hunter can select for head or size with care; the duck hunter can wait for certain species and limit himself to drakes

only. But once the shot is fired the choice is made and there is no release from it for hunter or hunted. The fisherman can throw his fly, rise and hook and play his fish, even net him or beach him or hold him in his hands — and still return him unharmed to life.

It is often claimed that it is difficult to return a fish safely to the water. I am satisfied that it is not. A little knowledge is necessary, a little understanding of how a fish works, and a few reasonably precise and confident hand movements. Fish that have been netted will not die, as some people believe, "because the mesh has cut the slime and exposed the fish to disease." Fish handled with dry hands will not die from this alone. Fish dropped back into the water from a reasonable height will not die. These are tales spread by men who want an excuse for killing all the fish they catch, and experience simply does not bear them out.

"It is often claimed that it is difficult to return a fish safely to the water. I am satisfied that it is not. A little knowledge is necessary, a little understanding of how a fish works, and a few reasonably precise and confident hand movements."

As a generalization, it is safe to say that the smaller a fish is, the easier it is to give him his freedom. He will not exhaust himself so much as a larger fish, the hook frees more readily from his softer mouth, and his smaller body seems to react more promptly to renewed flow of water through his gills. It is also true that while a fly-fisherman should be able to release safely nearly a hundred percent of the fish he hooks, a bait-fisherman cannot hope to do nearly so well because of the tendency of the fish to take the bait farther down into their throats.

One of the most important rules in releasing fish is to do so with a minimum of handling. I have released hundreds of fish, including salmon and steelhead, without ever taking them out of the water — simply by reaching down, gripping the shank of the hook and twisting it out. This is hard on the fly, but never on the fish. When a fish must be handled, it is best to hold him by the tail or lower jaw if possible, and still without taking him out of the water. But I have freed many good-sized trout by netting them, lifting them out of the net by the lower jaw, freeing the hook with my other hand, then putting them gently back in the water, using an easy hold on tail or body with the second hand only after they are in the water.

The danger in handling fish is not, it seems, in the warmth or dryness of the hand, but in exerting pressure that damages vital organs. Some years ago I read of an experiment that tested the relative safety of handling fish with wet or dry hands. Of large numbers of fish handled in both ways, the percentage survival of those handled with dry hands was considerably greater, and the conclusion was that the greater pressure necessary to hold fish in wet hands had damaged vital organs and so caused the higher mortality. That is why I feel sure a minimum of handling is desirable and why I believe that pressure, when necessary, is best applied at the wrist of the tail, on the back or on the lower jaw.

A fish that has lost a considerable amount of blood probably will not survive; fish have small hearts and blood circulates slowly and at low pressure, so there is not much blood to be lost. A fish that cannot hold itself upright and swim away probably will not survive, especially if it is a large fish. Large fish like steelheads and salmon must often be completely exhausted before they can be beached and freed from the hook. To give them a chance it is essential to hold them upright in the stream while they gulp some water through their gills and regain enough oxygen to strengthen themselves. If they are slow to do this, it pays to draw them gently back and forth through the water to start the gills moving. Usually they will swim away after less than a minute of this treatment, but I have released them and grabbed them again to continue the treatment when they seemed unable to hold an even keel. I have never found again a fish that swam strongly away from me; I don't think I have ever failed to find again one that could not regain enough strength to hold itself upright, though I have sometimes left them in sheltered water in the hope they would recover.

The test of the survival of fish that have been handled is in the return of the thousands upon thousands of fish that have been marked or tagged. And any fisherman who wants to convince himself of the recuperative powers of fish has only to remember those he has caught with the healed scars of formidable wounds. I have caught healed and healthy fish whose eyes or jaws or both had been torn away by hooks, fish whose whole bodies were deeply net-scarred, fish so deeply bitten by seals and other predators that they seemed deformed. The prick of a hook, a few minutes of dancing on the end of a line, the gentle handling of skillful release, will not kill creatures designed to survive the batterings of a dangerous lifetime.

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CATCH-AND-RELEASE - THE LAST WORD

Robert J. Behnke
Colorado State University
Fort Collins, CO 80523

Abstract

Significant progress and widespread implementation of special regulations as a management tool has occurred during the past ten years. That is, the biological or fisheries management basis for special regulations, in addition to the sociological or people management aspect, has been generally recognized and accepted. A current problem concerns agency credibility (or lack thereof) and the proper communication of this credibility to the angling public.

Introduction

Since the first catch-and-release symposium was held ten years ago, a considerable amount of new information has been developed; significant progress has been made. There is yet, however, much to be accomplished, especially in regards to salmonid regulations, agency expertise, credibility, and public education. It is safe to assume that a third symposium in this series can be planned for 1997 without fear that all the issues and problems discussed in the first and second symposia will be fully resolved by then. It would be interesting to speculate on the range of papers which might be presented at a 1997 symposium. Comparing the contents of the 1977 and 1987 symposia, it is apparent that there has been increasing interest and use of catch-and-release as a management tool in warm-water fisheries and in big gamefish marine fisheries. With warm-water fisheries, we have seen special regulations expanded beyond bass to include such species as walleye and crappie. With the great increase in big gamefish tournaments concerning species of little or no food value, catch-and-release angling is a management tool whose time has come.

Because of limitations imposed by my background, I will restrict my discussion to special regulations governing trout fisheries, but the sociological or people management problems identified are applicable to regulations for all fisheries.

Progress and Problems

To document the progress and enlightenment that have occurred during the past ten years of trout fisheries regulations and also to examine some of the darker areas in need of enlightenment, I will discuss the contents of the proceedings of the 1977 symposium and other historical sources and compare them with present attitudes, perceptions, and programs. A point I wish to emphasize is that a fisheries agency must establish expertise and credibility on which to base a strong leadership

role for public acceptance and trust. Unless this leadership position is established and generally accepted, a leadership vacuum is likely to be filled by well meaning but misguided and narrowly focused extremist groups, typically devoted to the cult of no-kill regulations (and its corollary, single barbless hook flies only).

When the 1977 symposium was held, the use of special regulations in fisheries management was, by and large, viewed by most biologists and administrators as more in the realm of people management, rather than fish management. This reflected the general perceptions that sociological aspects dominate over biological aspects of regulations in sport fisheries. I suspect that because of this historical neglect of the biological or practical fisheries management aspect of special regulations, the organizers of the 1977 symposium entitled the symposium "Catch-and-Release Fishing as a Management Tool." Although the sociological aspect of regulations or people management is an important aspect of a management tool, without the biological evidence and understanding of the factors that determine success or failure of regulations to achieve a goal, an agency will lack the expertise and credibility for leadership; and the people management part of the management tool can become a nightmare of dissatisfaction and devisiveness.

The historical predominance of the sociological aspect of special regulations is apparent in the paper, "Catch-and-Release Fishing - The Pennsylvania Experience," in the 1977 proceedings. This paper discussed the results of the application of a 20-inch minimum size limit on some Pennsylvania trout streams. The streams or stream sections with this regulation did not produce increased numbers of 20+ inch trout in comparison to open areas under statewide regulations; thus, the special regulations were viewed as failures (although one stream section accumulated more than 700 pounds of trout per surface acre; and in the only comparison made between special regulation and open sections of the same stream, the special regulation section contained almost four times more trout between 10 to 20 inches -- i.e., if the goal of the regulations had been to increase the catch per hour rather than to increase the number of 20+ inch trout, they should have been great successes). The "failures" of the special regulations led to the following statement in the 1977 paper: "We have declared a moratorium on the designation of any more special regulations areas until we can sort out the facts and determine what we want to accomplish." Previously (Behnke 1980), I wrote that establishment of the "facts" (or the biological basis) and subsequent goal determinations are necessary antecedents to special regulations; and "a moratorium on special regulations in this time of need is analogous to declaring a moratorium on cancer treatment until we learn what cures work best." In regards to abdication of leadership, consider a high level spokesperson for General Motors declaring a moratorium on car manufacture until they learn how to make them better -- What would be the response of GM shareholders?

Also in 1977, the Colorado Division of Wildlife prepared a 10-year plan for the future, designed to develop management strategies to meet the demand from increasing numbers of sportsmen. In regards to trout fishing, only the unimaginative strategy of hatchery expansion was

considered as a viable option to meet the increasing demand (which ignored the fact that the most rapidly increasing trout fisheries demand is for wild trout, not hatchery trout). The management tool of maintaining and increasing the catch rate of trout by recycling them in special regulation fisheries was not considered worthy of mention as a possible option in the 1977 Colorado plans. Again, the problem concerns the common attitude of fisheries professionals in the 1970s of relegating special regulations to the domain of sociology rather than biology. What should be apparent with a bit of reflection is that successful special regulation programs cannot treat sociology and biology as unrelated and isolated entities. The key to people management and leadership concerns establishing the facts or the biological basis of special regulations and effectively communicating these facts along with the aura of agency expertise and credibility to the public.

I do not mean to stigmatize individuals or agencies as bad examples. The above-cited examples were predictable in 1977 when the prevailing opinion declared that special regulations concerned people management rather than fish management. As an indication of progress since 1977, it must be mentioned that in 1987 Pennsylvania and Colorado have established strong leadership positions in the use of special regulations as a management tool.

The 1977 symposium proceedings contained success stories where under special regulations trout populations manifested enormous increase, especially with great increases in larger, older fish, in the Yellowstone River and in northern Idaho rivers. The proceedings also contained clear examples of failures of special regulations to influence trout populations in any meaningful way in small Wisconsin streams. What the proceedings lacked, however, was an overall synthesis and summary clearly identifying the factors that determined the successes and failures described. This lack of clear identification and understanding of the factors -- the biological basis -- determining the success or failure of special regulations is still prevalent in 1987, and it inhibits more widespread implementation of special regulations.

I do not have the time or space allotment to provide a complete discussion on the determinant factors governing the success of special regulations, but a few obvious considerations apparent in the 1977 papers and verified in subsequent years can be highlighted.

1. Species-specific differences to angler catch. The early examples clearly indicating success of special regulations in Yellowstone Park and in northern Idaho rivers all were based on cutthroat trout (and on cutthroat populations with a potential for an older age structure with a moderately high proportion of the population consisting of 5, 6, and 7 year-old fish and exhibiting moderately good growth rates averaging about 3 inches per year). The cutthroat trout, of all species of trout, is the species most readily caught by angling. Cutthroat trout is the species that can be expected to most favorably respond to reduction of angling mortality. In my previous paper on special regulations (Behnke 1980), I cited studies on brown trout populations in the South Platte River, Colorado, and in Hot Creek, California, where 1900 and 3800 hours per acre of annual angling pressure were required to catch each brown trout

on average two and three times respectively in catch-and-release fisheries. In our present symposium, Bob Hunt presented data on brown trout special regulation fisheries in small Wisconsin streams which indicate each brown trout may be caught two or three times with about 400 to 800 hours of angling per surface acre. These differences in brown trout resistance or susceptibility to catch are most likely due to individual characteristics of the Wisconsin streams (small, open, lacking "refuge" areas not accessible to anglers -- and the skill level of the local anglers) and they demonstrate the necessity for site-specific data on catch statistics. Even the most readily caught brown trout populations, however, pale in comparison to cutthroat trout in regards to susceptibility to angler catch. Schill and Griffith (1986) described the no-kill regulation fishery for cutthroat trout in the Yellowtone River where each cutthroat trout is estimated to be caught about ten times during a six-week period with about 500 hours of angling per surface acre -- and each trout on average is caught twice with only about 10 hours or less per acre of angling. In Yellowstone Lake overexploitation of the cutthroat population occurred in the 1960s with only five hours of angling per surface acre (papers in this symposium, by Jones and by Greswell). With such catch statistics it does not require profound thought to realize that the catch-per-angler-hour will be much higher for cutthroat trout than for brown trout if their populations and environments are similar -- and that a cutthroat population will respond to the elimination or reduction in angling mortality more rapidly and with greater magnitudes than will a brown trout (or rainbow trout or brook trout) population.

2. Size-age structure of the population. The brook trout populations in the small Wisconsin streams discussed at the 1977 symposium are typified by high recruitment and a short life cycle (virtually no trout in population more than three years of age). Very few trout in these populations grow sufficiently rapidly or live long enough to attain a length of 10 inches. Most of the production and biomass of such populations are tied up in young (0 and 1 age groups) fish of subcatchable size. The characteristics of these populations of small brook trout (or any trout species existing under similar environmental restraints) are determined by the environments they live in, and no type of regulation can do much about it. Examination of data from short-lived populations of brook trout (and brown trout) in Wisconsin and Michigan studies reveal that when total annual mortality reaches ninety percent or greater during the year a fish ages from two to three years (or in some cases with brown trout from three to four), reduction in angling mortality will do little or nothing to reduce the finality of this massive mortality. Determination of this terminal age of a population is an important consideration for understanding the limitations governing the relative success of special regulations. The ultimate explanation of a population's size-age structure concerns fish energetics and optimal foraging theory. If all sizes and age groups in a population compete for a common food supply and there is good recruitment into the population creating a great abundance of 0 and 1 age fish, the larger, older fish will be at a severe disadvantage simply because they require much more food, if only for maintenance rations, than do the smaller fish. Unless recruitment is severely curtailed or unless there is habitat (such as large, deep pools) and a food supply of large organisms available such as

fish, crayfish, scuds, etc., to allow feeding segregation between smaller fish and larger fish, do not expect special regulations to duplicate the Yellowstone or northern Idaho experiences. What can be accomplished for shorter-lived populations with some type of catch-and-release regulations under high angling pressure is the recycling of the two- and three-year-old trout to maintain a high catch rate. For populations limited by a young terminal age class, however, no types of regulations can be expected to significantly increase the proportion of older age classes beyond the terminal age determined for each particular population by each specific environment, because at such high annual natural mortality levels, angling mortality will be almost entirely compensatory and not additive. The importance of older age classes for the success of special regulations is apparent from the fact that any consistent increase in survival is compounded annually. For example, consider a hypothetical river section that contains 1,000 age 2 trout. If annual mortality is 75%, then 250 age 3 fish are expected in the population. If the 75% mortality rate is reduced to 50%, then there would be 500 age 3 fish or a 100% increase in this age class. If these same mortality comparisons are constant through age 7, there would be twice as many age 3, four times more age 4, eight times more age 5, 16 times more age 6, and 32 times more age 7 fish with 50% mortality in comparison to the 75% rate. These considerations merely represent a common sense approach for assessing the potential for success or failure of special regulations -- but "common sense" has not been strikingly obvious in the history and literature of special regulations.

People Management

The importance of the sociological or the people management aspect of special regulations cannot be denied. The most important factor, however, for people management is to establish credibility and public trust for general acceptance of proposed regulations. This can be accomplished by establishing the biological evidence and by communication of this information to the angling public. I admit, however, that this is far easier said than done. Ideally, an agency should have an authoritative spokesperson, thoroughly knowledgeable about the factors determining the successes and failures of special regulations, who is admired and respected by the anglers and who makes frequent contact with angler groups to get the message across. An example I would cite is Barry Nehring of the Colorado Division of Wildlife. Most anglers in Colorado accept the special regulations on trout streams in Colorado and believe they are achieving a goal of producing better quality wild trout fisheries, because they believe the evidence presented by Mr. Nehring; they respect the biological expertise upon which these regulations are based.

It is much more difficult and potentially more damaging to one's ego to publicly disagree with an individual, real-life authority figure such as Mr. Nehring than with the Colorado Division of Wildlife (a faceless bureaucracy).

In regards to effective communication, fisheries symposia such as the present catch-and-release symposium, are, in theory at least,

designed to contribute both to fish management by promoting the exchange of information and to people management by involving sportsmen and publishing proceedings to communicate information to the public. It must be kept in mind, however, that progress in fisheries management is more of an evolutionary rather than a revolutionary process, slow and gradual; do not expect a quantum leap in progress as a result of bringing people together for topical discussion. Among the great diversity that makes up the American angling public, "cult" groups can be expected to promote with great enthusiasm their own narrow view of regulations (typically, no-kill, barbless flies only). The "cult" mentality is not receptive to new information or to information not supporting their preconceived ideas. They also can be expected to have zealous faith in the righteousness of their cause, so that any facts or evidence contrary to the cause is considered as blasphemy and piously ignored or attacked. The 1977 proceedings contained an article, "The Fly Fisherman's view of Catch-and-Release Fishing," which summarized the most frequently expressed convictions expressed in letters to "Fly Fisherman" magazine. One of the most common convictions of readers of the magazine was: "Barbed hooks increase fish-kill, as does mishandling of fish, making catch-and-release case restrictions almost worthless without a barbless hook requirement and the proper treatment of fish." Also in the 1977 proceedings, Dick Wydoski published a paper, "Relation of Hooking Mortality and Sublethal Hooking Stress to Quality Fish Management," in which he exhaustively reviewed and summarized many studies of hooking mortality of single, treble, barbed, and barbless hooks with different species and under different conditions. Wydoski's paper obviously addressed the concerns (or, more correctly, the "convictions") of the readers of Fly Fisherman magazine. His conclusion, based on all of the studies reviewed, was: "Use of barbless hooks does not significantly reduce mortality and restrictions requiring use of barbless hooks are not biologically justified." Mongillo (1984) also reviewed and updated the literature on hooking mortality to conclude: "There is no valid technical basis for requiring single barbless hooks." This matter was further discussed at Wild Trout Symposium III in 1984 with a similar conclusion. Last year one of my articles published in Trout magazine mentioned the consistent agreement among hooking mortality studies that demonstrate no significant differences in mortality of fish caught and released on single, treble, barbed, or barbless hooks. I received responses of disbelief and outrage. I certainly didn't intend to lead a crusade against barbless hooks, but only to point out that to achieve the broadest base of support for special regulations, unnecessary, discriminatory restrictions should be avoided. I believe the use of barbless hooks helps to promote a proper reverence for the sport, but their use should be a matter of individual choice, rather than mandated by law. The most appropriate method to encourage the more widespread use of barbless hooks is to establish evidence that a higher proportion of strikes are hooked and landed with barbless hooks in comparison to similar barbed hooks. Knutson (1987) compared catches of Chinook and Coho salmon caught with equal effort by two groups of anglers, one using barbed hooks and the other using barbless hooks. A total of 712 Chinook were landed on barbless hooks and 679 on barbed hooks. For Coho the results were 55 to 53 in favor of the barbless hooks. If similar studies are made on trout fisheries, perhaps with a view of developing the most

effective design for barbless hooks, and if the results consistently demonstrate an advantage of barbless hooks in the percentage of strikes hooked and landed, there will be no need for an unnecessary and discriminatory regulation that frequently makes honest but forgetful anglers into law breakers.

Some breakdowns of communication concern the selective filtering and distortion of information to conform to preconceived notions. Clark and Alexander (1984) presented a paper at Wild Trout III symposium and published it in the proceedings. It concerned the decline of the brown trout fishery in the Au Sable River, Michigan. In comparison to the 1950s and 1960s, brown trout growth rate and biomass significantly declined during the 1970s and 1980s, despite various types of special regulations imposed on the fishery. The cause of the decline is well known and was clearly stated by Clark and Alexander. In the early 1970s after the diversion of sewage effluent and closure of a large production hatchery and the loss of its effluents, artificial enrichment of the Au Sable ceased; nitrate levels were reduced by 70%, and this reduction was reflected in reductions of primary and secondary production and, predictably, in the trout population. Thus, Clark and Alexander (1984) concluded: "No change is fishing regulations is capable of returning the number of large brown trout observed there in the past. Brown trout growth has declined, and short of fertilizing the river with sewage again, we doubt if growth can be returned to its former levels." In the spring of 1986, a letter was published in Rod and Reel magazine, stating that the Federation of Fly Fishers' Board of Directors had passed a resolution supporting no-kill regulations on the Au Sable River -- and this resolution was "based on a comprehensive report by Michigan DNR given at the Wild Trout III symposium," i.e., Clark and Alexander (1984). The letter proceeds to completely distort what Clark and Alexander had attempted to communicate with some additional innovative fabrications. The final irony was a request for readers to write to the governor of Michigan to "urge long-term studies such as have been conducted in Montana." The fact of the matter is that Clark and Alexander's paper was based on what is probably the longest continual study on an American trout stream. These Michigan DNR studies provide a wealth of information on numbers, biomass, growth, mortality rates by year-class, angler catch, etc., based on more than thirty years of sampling and creel census. Despite the soundness of the biological basis for determining the most appropriate regulations for the Au Sable, the main Au Sable River (the "Holy Waters" section) has the distinction of generating the most bitter and long-lasting controversy over angling regulations. People management indeed dominates fish management on the Au Sable. The root of the problem here is likely to be found in the workings of the administrative structure of the Michigan Department of Natural Resources. By the time the facts, data, and information so excellently developed by the biologists are transformed and communicated through administrators and the information and education section to the public, a leadership vacuum is created and dissatisfaction and disagreements are institutionalized and expressed against the DNR (the faceless bureaucracy) rather than direct communication with a real-life authority figure.

In any event, the question of to have or not to have no-kill regulations in the "Holy Waters" section of the Au Sable is now in court.

The Michigan DNR in a court deposition officially recognized that the matter is a sociological issue and not a biological issue. Seeking a sociological resolution, the DNR contracted with Michigan State University for a survey in angler attitudes on no-kill regulations for the Au Sable. I recently received "A Report to the Au Sable River Anglers form the Department of Fisheries and Wildlife, Michigan State University - Findings of the 1986 Au Sable No-Kill Attitude Survey." It is clear from the survey that the controversy has gone on too long; sharp lines have been drawn, sides chosen, and minds firmly made up; and they are not going to change. I did note, however, that misleading biological questions were incorporated into the sociological survey. Anglers who were against no-kill regulations and who expressed a belief that no-kill regulations would not improve the Au Sable fishery were asked if they would change their position "...if biological evidence from the South Branch study indicated that no-kill would produce satisfactory results in the mainstream." This is a classic case of confusing apples with oranges. The South Branch Au Sable has much reduced recruitment, much higher invertebrate abundance, and a significantly higher growth rate of its brown trout population in comparison to the main Au Sable (Stauffer 1977) -- all factors that would favor success of no-kill regulations to produce a significant increase in larger, older trout. This misinformation exemplifies the danger of inductive reasoning and is a common phenomenon of special regulation controversies. If it works in the Yellowstone River, it will work in the Au Sable or Carp Creek, etc.

Finally, I would call attention to the first paper in the 1977 proceedings, "A Tribute to Roderick L. Haig- Brown" by Richard May. The passing of Haig-Brown left a leadership vacuum for an authority figure for anglers seeking advice and guidance on technical matters such as special regulations. Besides his ability to write about a subject in a learned and fascinating manner, what set Haig-Brown apart from many other angling authors was his deep interest in his subject matter which extended far beyond the tackle and tactics of catching fish. He avidly read and understood the scientific literature. He maintained a position of knowledge and authority based on "doing his homework." He was informed before he wrote. Haig-Brown, if he were still with us, might fish with barbless hooks because of personal preference, not because he knew he would kill fewer fish. He might be in favor of no-kill regulations on the Au Sable River, but certainly not because of the Clark and Alexander report given at the Wild Trout III symposium. Before he committed himself to print on a matter, he read, synthesized, and understood the technical background of a subject. There has been no angling author of such broad appeal and influence before or since Haig-Brown whose work contains a comparable ring of authenticity and honesty. Although he had a wonderful style, substance was never sacrificed. In regards to the future successes with people management, our prospects would certainly brighten with the emergence of a communicator of the calibre of Haig-Brown.

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