Angler Use, Success, and Characteristics on Greers Ferry Tailwater, Arkansas, with Implications to Management

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Abstract: A roving creel survey was conducted on the Greers Ferry tailwater, Arkansas, from 1988 through 1992. Estimated angler use was high, averaging 295,319 angler hours and 1,006.5 angler hours per hectare annually. Estimated harvest of rainbow trout was high and consisted of mostly catchable size, stocked fish. Only 25% of rainbow trout caught were released. Catch of trophy size brown trout declined after the implementation of a 406-mm (16-inch) minimum length 2 fish per day creel limit in January 1990.

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The upper White River system in northern Arkansas and southern Missouri, including its tributaries, has been impounded at several locations by the U.S. Army Corps of Engineers (USACE) to create hydropower/flood control reservoirs. The dams impounding each of these reservoirs discharge hypolimnetic water into the downstream tailwater resulting in coldwater habitat suitable for management of a trout fishery (Baker 1959, Fry 1962, Brown et al. 1967,

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Fry and Hanson 1968). These tailwaters make up 219 km of Arkansas' 241 km of trout streams and receive 79% of all trout fishing (Hudy and Rider 1989, Rider et al. 1989).

One of these tailwaters is below Greers Ferry Dam on the Little Red River in central Arkansas; it receives approximately 19% of all trout fishing in the state (Hudy and Rider 1989). This tailwater is unique among Arkansas' tailwater trout fisheries in that it supports a wild population of brown trout which is sustained totally through natural reproduction. It has produced the current world record brown trout at 18.26 kg (40 lbs. 4 oz.).

The Greers Ferry tailwater trout fishery is managed primarily through regulation and stocking. The put-grow-and-take rainbow trout fishery is sustained by stocking catchable size (229 and 304 mm) rainbow trout from the U.S. Fish and Wildlife Service (USFWS) Greers Ferry National Fish Hatchery and the Arkansas Game and Fish Commission (AGFC) Spring River State Fish Hatchery at Mammoth Spring, Arkansas. A creel limit of 6 trout per day regulates overall harvest. A 406 mm (16-inch) minimum length 2 fish per day bag limit was placed on brown trout in January of 1990, after studies indicated that trophy size brown trout were declining in other Arkansas tailwaters (Hudy 1990). In January 1993, the same regulation went into effect for cutthroat trout which were introduced to the tailwater in 1990 from the Norfork National Fish hatchery at Norfork, Arkansas.

In order to maintain a quality tailwater trout fishery, fishing pressure and harvest must be known in order to stock trout at the proper rate and time and to evaluate management practices (Axon 1975). Arkansas trout tailwaters experience extremely high fishing pressure which has been estimated as high as 1,435,603 angler hours per year and 17,993 angler hours per kilometer on Bull Shoals and Norfork tailwaters (Oliver 1984). In 1972 (March–December), fishing pressure on the Greers Ferry tailwater was estimated at 219,735 total angler hours (Perrin 1975). At that time, the fishery only consisted of a put-grow-and-take rainbow trout fishery. Because fishing pressure was believed to have increased with time due to the evolution of the brown trout fishery and the annually increasing stocking rates for rainbow trout, a 5-year creel survey was initiated on the Greers Ferry tailwater in 1988. The survey was conducted to achieve the following: 1) evaluate current angling pressure, angler success, and catch-and-release angling, 2) gather information on anglers such as angling methods and demographics, and 3) evaluate effects of recent management practices on angler success in order to change or improve future management.

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Methods

The Little Red River is a tributary of the White River and drains a portion of the Ozark National Forest in central Arkansas. Greers Ferry Dam is located on the Little Red River at Heber Springs, Arkansas. The hypolimnetic discharge from the dam created a 47-km cold tailwater which altered the native, warm-water smallmouth spotted, largemouth bass fishery to a cold-water trout fishery. Hydropower generation discharges from Greers Ferry Dam range from approximately 2 to 170 m^3/s (70 to 6,000 cfs) which causes rapid changes in water surface elevation and current velocity.

A roving creel survey was conducted using angler interviews to estimate angler success and aerial counts to estimate fishing pressure (Malvestuto 1983, Van Den Avyle 1986, Robson 1991). To conduct this type of survey, the tailwater was divided into 3 sections (upper, middle, and lower) of approximately 16 km each. Due to the large size of the sections and natural obstructions (i.e., impassable shoals during low water), 2 sample starting points were designated in each section. Sample periods were of 4-hour duration with morning and afternoon times weighted equally. Sample days were divided into week days and weekend days (weekend days included holidays). The number of days sampled each month was weighted by season with fewer sample days during winter months. Sample starting points, days, and times were randomly generated.

The creek clerk interviewed parties in the act of fishing and after completed trips (Malvestuto 1983, Van Den Avyle 1986, Robson 1991). On a typical creel day in this survey, the clerk would begin at the starting point scheduled for that day, traverse as far upstream and downstream from that point as possible by boat and/or by wading, and interview every angler or party encountered. Information gathered included angler starting time and ending time, number in party, county/state of origin, angling method (boat, bank, or wade), bait (natural, artificial, or both), and angler satisfaction. Species, length, and weight were recorded for harvested fish along with species and length group (<300 mm, 300–375 mm, >375 mm) of released fish. Natural bait was defined as anything of an organic nature such as corn, salmon eggs, worms, minnows, and power bait.

Fishing pressure was estimated from aerial flight counts. A flight schedule was randomly generated which consisted of approximately 6 flights each month during spring, summer, and fall and 2 flights per month during winter. During each flight, the pilot and observer covered the entire 47-km stretch of river recording number of boats, number of boat fishermen, and number of bank fishermen.

The "creel year" did not follow the calender year and data was lumped seasonally. Months were grouped into seasons according to the following: spring = March, April, May; summer = June, July, August; fall = September, October, November; winter = December, January, February; therefore, data reported in this survey for any given year is actually for March of that calender year through February of the following calender year.

Data from angler interviews and aerial counts were combined to provide

estimates of pressure, catch, release, harvest, and rates of catch and harvest using the "total ratio estimator" method (Malvestuto 1983, Crown and Malvestuto 1991). Differences and relationships among variables were analyzed using ANOVA and correlation functions in CoHort/CoStat Software at the 5% level.

Results and Discussion

Angler Use

During the 5-year creel survey, estimates averaged 295,319 total angler hours, 1,006.5 angler hours per hectare, 6,396.1 angler hours per kilometer, and 72,044 total angler trips. Estimates of angler use in the form of total angler hours, angler hours per hectare, and total angler trips were highest in 1988 and lowest in 1989 and 1990 (Table 1).

Estimates of total angler hours were highest during the summer and lowest during the winter during each of the 5 years of the survey. However, in 1990, summer use (79,552 angler hours) was barely higher than the fall use (79,264 angler hours), probably due to high amounts of rainfall and discharge that summer.

Of the 3 study sections, the upper section of the tailwater received the most pressure annually averaging 63.7% of estimated total angler hours and 1,858.3 hour/ha over the 5 years. The middle section averaged 18.7% of angler hours and 608.5 hour/ha, while the lower section averaged 17.5% of angler hours and 512.8 hour/ha. The percentage of angler hours in each section did not significantly vary seasonally.

Table 1. Comparison of estimated angler (ang) effort and success for rainbow trout among 5 years of creel survey on Greers Ferry tailwater, Arkansas.

Angler effort and success	1988	1989	1990	1991	1992
Ang hrs	329,563	282,551	249,000	296,286	319,195
Ang hrs/ha	1,123.3	963	848.7	1,009.8	1,087.9
Ang hrs/km	7,593.6	5,995.1	5,306.8	6,304.1	6,780.7
Ang trips	82,538	61,605	63,568	80,212	72,299
Catch rate (*N*/hr)	0.71	0.58	0.67	0.86	0.81
Total catch	232,847	164,334	166,872	254,142	259,349
Total released	82,882	33,101	32,798	69,772	56,790
% released	35.6	20.1	19.7	27.5	21.9
Harvest rate (*N*/hr)	0.46	0.47	0.54	0.62	0.64
Harvest rate (kg/hr)	0.11	0.11	0.15	0.17	0.15
Total harvest (*N*)	149,965	131,233	134,074	184,370	202,559
Total harvest (kg)	35,210	28,860	37,439	50,076	47,347
Total stocked (*N*)	251,943	242,774	259,600	297,184	333,104
Total stocked (kg)	41,122	39,514	45,880	53,700	65,815
*Eqv. harvest (%*N*)	59.5	54.1	51.7	62	61
*Eqv. harvest (%kg)	85.6	73.0	81.6	93.3	71.9

*Equivalent harvest = *N* fish harvested/*N* fish stocked.

Angler Profile

Greers Ferry tailwater anglers were from all across the United States including 35 states and the District of Columbia. Anglers from states other than Arkansas constituted 25% of all anglers with 54.4% of these coming from Tennessee.

Angling method and bait use varied over the 5-year survey; however, overall trends were consistent. Most of the anglers (Total N anglers = 4,589) fished from a boat (59.9%) followed by 32.8% who fished from the bank, and 7.4% who waded. Natural bait was used by most (52.3%) of the anglers (N = 4,561); 18.5% used artificial lures whereas the remaining 29.2% used both natural and artificial bait (Fig. 1). Only 7.9% of anglers (N = 4,436) used a guide on that particular trip.

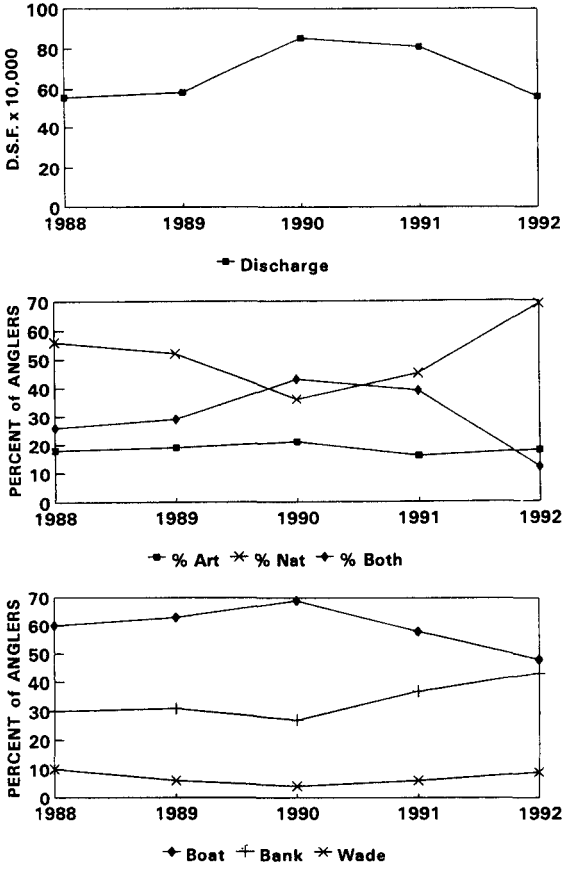

Figure 1. Percentage of anglers fishing from boat, bank, or wading, and percentage of anglers fishing with natural bait (Nat), artificial lures (Art), or both, compared to total annual discharge (1 day-second-feet = 2,446.3 m^3) among 5 years of creel survey on Greers Ferry tailwater, Arkansas.

Angler Success

It should be noted that the creel survey attempted to estimate the amount of voluntary catch-and-release fishing. Therefore, angler success is reported in 2 ways. Results reported as "catch" and "catch rate" include fish that were harvested plus fish that were caught and released. Results reported as "harvest" and "harvest rate" represent only the fish that were harvested.

Rainbow Trout.—Rainbow trout were the most abundant species in each year of the creel survey. From 1988 through 1992, 1,384,605 rainbow trout weighing 246,031 kg were stocked in the Greers Ferry tailwater. Numbers and weight of stocked fish were lowest in 1989 consisting of 242,774 rainbows weighing 39,514 kg. Production and/or stocking allotment increased each subsequent year to a high of 333,104 rainbows weighing 65,815 kg in 1992. Total catch and total harvest (N) followed the same trend (Table 1).

Rainbow trout were stocked in the greatest numbers during the summer and in least numbers during the fall or winter in each year. Seasonally, rainbow trout total catch ($r = 0.58$) and total angler hours ($r = 0.58$) were significantly correlated with number of rainbow trout stocked (Fig. 2). With little natural reproduction, rainbow trout stocking is obviously of vital importance to the put, grow, and take aspect of this fishery.

Annual mean catch rates ranged from 0.58 fish/hour in 1989 to 0.86 fish/hour in 1991. Total catch of rainbow trout was also lowest in 1989 and highest in 1992; 164,334 and 259,349, respectively (Table 1).

Mean catch rates were highest in the lower section (0.85 fish/hour). This differed significantly ($P = 0.0198$) from the middle section which displayed the lowest catch rate (0.56 fish/hour). Mean catch rate in the upper section (0.76) did not differ significantly from the 2 downstream sections.

Voluntary catch and release fishing was not prevalent with this species. Overall, approximately 24% of the estimated rainbow trout caught were volun-

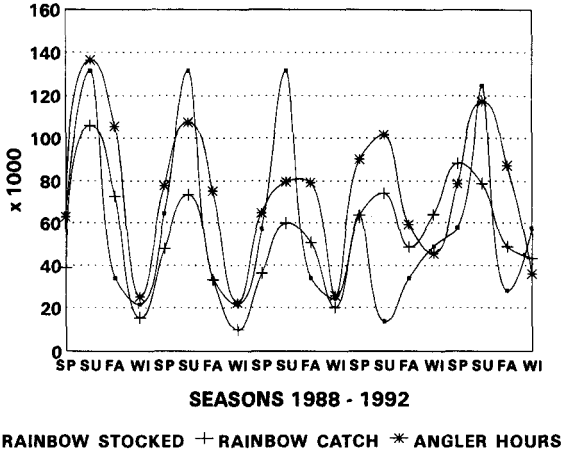

Figure 2. Relationship of rainbow trout stocked, estimated rainbow trout catch, and estimated angler hours, by season during a 5-year creel survey on Greers Ferry tailwater, Arkansas.

tarily released. This resulted in harvest estimated at a high of 202,559 fish weighing 48,347 kg in 1992, which was 61% of number of rainbow trout stocked that year. Anglers were most efficient in 1991 when 62% of number of stocked fish were harvested (Table 1).

Mean harvest rate and equivalent harvest (Oliver 1984) were lower in this survey than in a creel survey conducted in 1972 and 1973 on Greers Ferry (Perrin 1975). This may indicate that catch-and-release style of angling is more popular now than it was then. A more likely possibility is that more of the rainbows are lost to predation and/or competition now than were lost 20 years ago due to the presence of a large brown trout population that did not exist during the earlier creel survey. This would leave less rainbows to contribute to the angler's creel. Also, with more effort concentrated on brown trout, less relative effort is probably exerted toward rainbow trout which may explain the decrease in harvest rates.

Stocked size fish (<300 mm) dominated the rainbow trout catch each year of the survey averaging 77.3% of the catch. Slightly larger rainbows, between 300–375 m, ranged from 13.9% in 1989 to 28.3% of the catch in 1990. Rainbows >375 mm were rare and ranged from only 1.8% in 1992 to 5.1% of catch in 1990 (Fig. 3). Rate of fish caught and released was usually highest for the <300-mm size class and lowest for the larger size classes (300–375 mm and >375 mm) during each season. However, from 1988 to 1990, the larger size classes experienced relatively high release rates in fall and/or winter.

Brown Trout.—An estimated total of 117,006 brown trout were caught during this creel survey, but only 8,058 were harvested. The estimated total brown trout catch increased an average of 32% annually from 1988 through 1990. The estimated total brown trout catch decreased 28% the following year (1991), and in 1992, the estimated catch decreased another 49% to the lowest levels of the

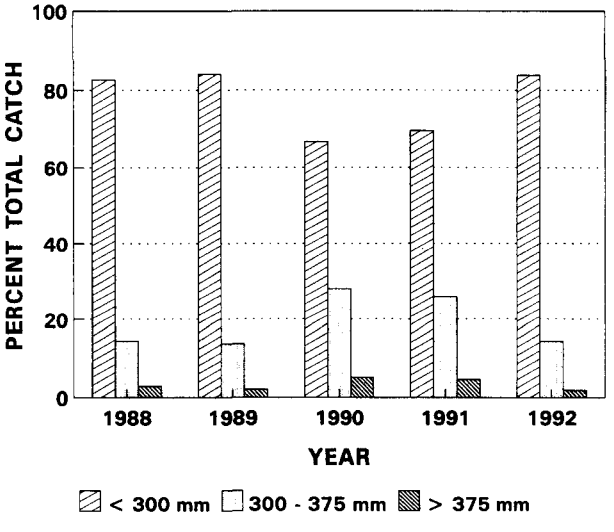

Figure 3. Percent of estimated rainbow trout catch in each length group during a 5-year creel survey on Greers Ferry tailwater, Arkansas.

5-year creel. The total catch of brown trout >375 mm in length increased an average of 53% from 1988 through 1990 when the number was estimated at 7,020, an indication of the build-up of a quality fishery. But, as with total catch estimates, the number of browns >375 mm decreased 5% from 1990 to 1991 and then decreased 75% to an estimate of only 1,687 in 1992 (Table 2). The percentage of >375-mm brown trout catch increased from 9.1% in 1988 to 25.2% in 1991, but fell to 12.6% in 1992 (Fig. 4).

Prior to the 1990 implementation of a 406-mm (16-inch) minimum length/2 fish per day bag limit, voluntary release of brown trout averaged 88% of fish caught annually and harvest averaged 2,369 fish annually. The effects of the regulation can be seen in catch-and-release and harvest data (Table 2). The per-

Table 2. Comparison of angler success for brown trout among 5 years of creel survey on Greers Ferry tailwater, Arkansas.

Angler success	1988	1989	1990	1991	1992
Catch rate (*N*/hr)	0.05	0.08	0.15	0.09	0.04
Catch rate >375mm	0.005	0.012	0.028	0.022	0.005
Catch	16,903	23,732	36,624	26,390	13,357
Catch >375mm	1,530	3,305	7,020	6,646	1,687
% released	87.9	88.7	96.9	96.5	91.1
% released >375mm	92.5	80.8	84.1	84.8	29.3
Harvest rate (*N*/hr)	0.006	0.01	0.005	0.003	0.004
Harvest rate (kg/hr)	0.002	0.004	0.007	0.004	0.003
Harvest (*N*)	2,047	2,690	1,115	1,013	1,193
Harvest (kg)	597	1,169	1,853	1,025	1,061
Harvest >375mm (*N*)	115	635	1,115	1,013	1,193
Harvest >375mm (kg)	96	501	1,853	1,025	1,061

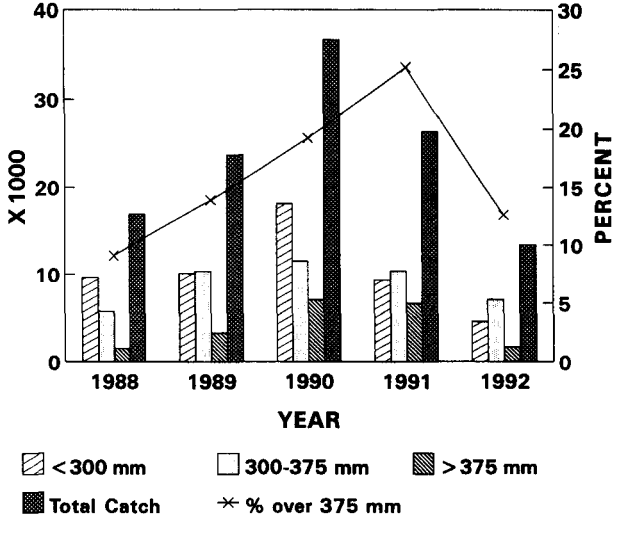

Figure 4. Estimated catch of brown trout in each length group and percentage of brown trout >375-mm length, during a 5-year creel survey on Greers Ferry tailwater from 1988–1992.

centage of brown trout released averaged 88% of brown trout catch in 1988 and 1989 before regulation implementation. Also during 1988 and 1989, release of brown trout >375 mm averaged 87% of those caught. Therefore, pre-regulation annual harvest estimates averaged only 2,369 brown trout including only 525 fish >375 mm. This demonstrates that voluntary release of brown trout, and especially quality (>375 mm) browns, was very high without any regulation. After regulation implementation in January 1990, release increased to an average of 95% of all brown trout caught; however, release of quality browns (>375 mm) fell to an average of only 66% of those caught. And, in 1992, only 29% of quality size browns caught were released. Therefore, overall harvest was reduced 53% from an annual average of 2,369 pre-regulation to 1,107 post-regulation. Due to the regulation, all 1,107 fish were >375 mm which means that harvest of quality size browns increased 52% from an average of 525 pre-regulation.

The percentage of brown trout in the 300–375 mm group increased, and percentage in the >375 mm group decreased after 1990. By 1992 the 300–375 mm group comprised 40% more of the catch than the >375 mm group. The percentage of the catch that was made up of brown trout >375 mm increased steadily from 9.1% in 1988 to 25.2% in 1991, once again indicating the build-up of a quality fishery. But in 1992, as with total brown trout catch, the percentage of browns >375 mm fell to only 13% of estimated catch. Also in 1991 and 1992, the fish in the 300–375 mm group increased to extremely high levels in 1992, indicating a build-up of fish just under the length limit (Fig. 5).

Brown trout catch rates were much lower than those for rainbow trout. The highest annual average catch rate was 0.15 fish/hour in 1990 when annual total catch was also the highest at 36,624. The poorest brown trout angling occurred in 1992 when only 13,357 were caught at a rate of 0.04 fish/hour (Table 2).

Mean catch rates were highest in the middle section (0.18 fish/hour) and lowest (0.02 fish/hour) in the lower section. Mean catch rate in the upper section was 0.09 fish/hour and there were no significant differences among the 3 study sections. The extremely low catch rate in the lower section is probably due to increasing downstream water temperatures which can decrease brown trout catch rates (McMichael and Kaya 1991) and the population being less dense due to the distance from the upper section where spawning occurs.

Seasonally, total brown trout catch was highest in the fall of each year, and harvest varied. Percentage of fish released within each size class was usually highest in fall and/or winter especially for the larger size classes.

The decrease in overall brown trout catch and decrease in the percentage of catch made up of quality size browns is disturbing. Fish population samples conducted during this study and in 1993 demonstrate the same trend, indicating an increase in the number of fish under the size limit. This apparently results from a decrease in harvest of fish <375 mm in length, and an increase in harvest of fish >375 mm. Mortality of larger fish may also be high and/or survival low due to a density-dependent controlling factor. Special regulations on other wild brown trout streams have led to problems with harvest causing increased natu-

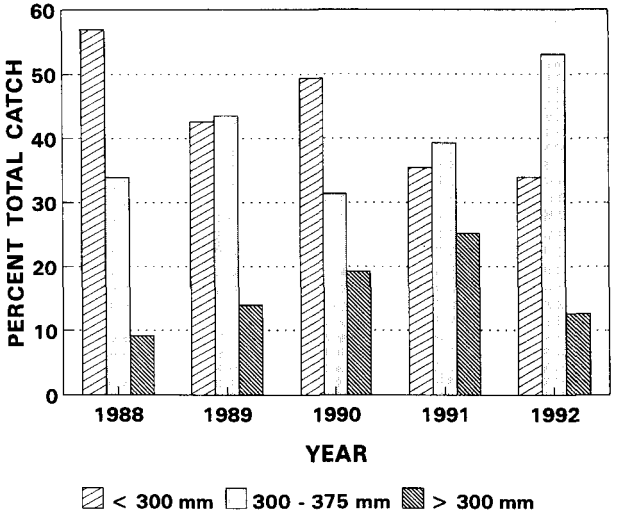

Figure 5. Percentage of estimated brown trout catch in each length group during a 5-year creel survey on Greers Ferry tailwater, Arkansas.

ral mortality and stockpiling of trout which caused reduced growth and poor fish condition (Clark and Alexander 1984, Billingsley and Haase 1990).

Environmental Effects

Erratic flow is the major problem with most tailwater trout fisheries (Axon 1975). Creel surveys on other Arkansas cold tailwaters have indicated that the amount of discharge from a dam has a significant impact on the downstream trout fishery with a strong negative relationship between discharge and angling pressure (Aggus et al. 1979, Oliver 1984). The Greers Ferry tailwater followed the same trend with lower angler use in years of high discharges.

Total annual discharge from Greers Ferry Dam varied widely among the 5 years of the creel survey. Annual discharge for 1988, 1989, and 1992 creel years averaged 568,231 d.s.f. (1 day-second-feet = 2,446.3 m^3) which is considered normal. Annual discharge was much higher in 1990 and 1991, averaging 833,005 d.s.f. with a high of 854,699 in 1990. This resulted from higher than normal discharges during the summer months of these years due to unusually high rainfall.

Over all, in years of high discharge, angler hours and rainbow trout catch decreased and brown trout catch increased (Fig. 6). Seasonal brown trout catch ($r = -0.71$) and seasonal brown trout catch rate ($r = -0.54$) demonstrated a significant negative correlation with seasonal discharge (Fig. 7). A higher percentage of the rainbow trout catch consisted of quality fish during the high discharge years also (Fig. 3).

Discharge also affected fishing methods. The number of wade and bank fishermen was lowest and boat fishermen highest in 1990 when total annual discharge was highest. Conversely, the number of bank fisherman was almost as great as the number of boat fishermen in 1992 when total annual discharge was back to normal volumes. This is due to the greater efficiency of boat angling

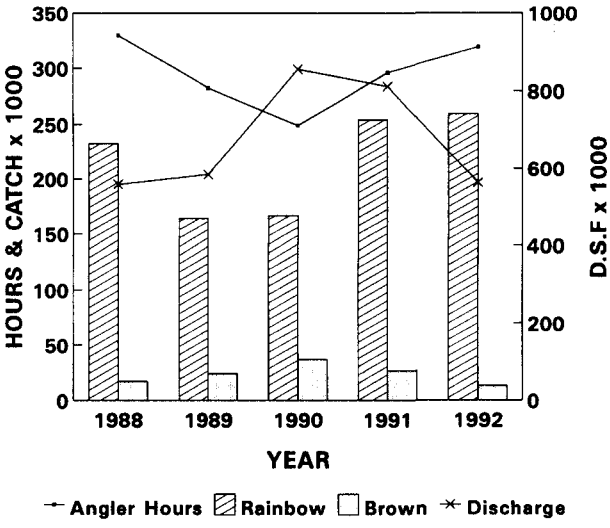

Figure 6. Comparison of annual discharge (1 day-second-feet = 2,446.3 m^3), estimated angler hours, rainbow trout catch, and brown trout catch, among 5 years of creel survey on Greers Ferry tailwater, Arkansas.

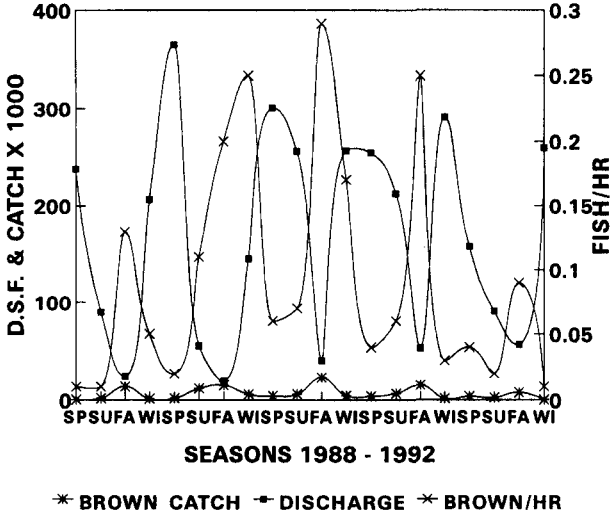

Figure 7. Relationship of seasonal (spring, summer, fall, winter) discharge (1 day-second-feet = 2,446.3 m^3), brown trout catch, and brown trout catch rates (*N*/hr) among 5 years of creel survey on Greers Ferry tailwater, Arkansas.

than bank angling in high flow (discharge) because a boat can drift with the rapid current allowing better bait presentation by the anglers. Also, bank anglers tend to fish with natural bait which is not conducive to fishing during high discharge (Fig. 1).

Number of anglers using natural or artificial bait followed the same trend: the number of anglers using natural bait was lowest in 1990 when discharge was high and number of bank anglers was low and highest in 1992 when discharge was normal and number of bank anglers was highest. Interestingly, during those years of high discharge when the number of anglers using natural bait de-

creased, the number of anglers using both natural and artificial bait increased. The number of anglers using strictly artificial baits did not change appreciably during the 5-year survey. Therefore, natural bait anglers are apparently more opportunistic than artificial bait anglers. Natural bait is fished passively, usually sitting still on the bottom or gently drifting in the current. During the periods of high discharge, this method of angling is difficult, and at those times natural bait anglers apparently switch to artificial baits which are fished actively through casting and retrieving (Fig. 1).

Management Recommendations

Several changes and proposed changes in management of this tailwater resulted from the results of this study along with data from recent population samples:

Knowledge of angler distribution is important to enhance stocking practices (Wydoski 1986). Anglers were not evenly distributed in the Bull Shoals tailwater and therefore, stocking rates were adjusted to compensate for the higher pressure in the upper reaches (Oliver 1984). As with Bull Shoals, the heaviest angling pressure was exerted on the upper section of the Greers Ferry tailwater where 64% of all angler hours occurred. In order to maximize the amount of rainbow trout available per angler, stocking rates were adjusted in 1994 to match angler use so that the upper section receives 64%, the middle section receives 20%, and the lower section receives 16% of total available rainbow trout.

A 330- to 406-mm (13- to 16-inch) slot limit has been proposed for rainbow trout to provide more quality size rainbow trout while still allowing ample put-and-take style harvest. A 406- to 533-mm (16- to 21-inch) slot limit (3 under/1 over) has been proposed for brown trout to increase harvest of numerous small brown trout and decrease harvest of quality size brown trout to produce a better trophy fishery. Another creel survey should be implemented in 5 years to determine if regulation changes effect angler use and success.

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