

First Year Assessment of Delayed Harvest Trout Regulations

James C. Borawa, *North Carolina Wildlife Resources Commission, Division of Boating and Inland Fisheries, 512 N. Salisbury Street, Raleigh, NC 27604-1188*

Joseph H. Mickey, Jr., *North Carolina Wildlife Resources Commission, Division of Boating and Inland Fisheries, 512 N. Salisbury Street, Raleigh, NC 27604-1188*

Mark S. Davis, *North Carolina Wildlife Resources Commission, Division of Boating and Inland Fisheries, 512 N. Salisbury Street, Raleigh, NC 27604-1188*

Abstract: North Carolina implemented delayed harvest regulations in 1992 to diversify trout angling opportunities. Delayed harvest regulations allowed only catch-and-release fishing of stocked catchable-sized trout from 1 March–5 June 1992. Creel surveys were conducted on 2 streams to assess differences in angler trip characteristics, particularly catch rates, between delayed harvest and regular put-and-take (hatchery supported) trout streams. Catch rates of 3.16 and 6.54 trout per hour in delayed harvest areas were significantly higher than those of hatchery supported areas (1.87–2.52 trout per hour). The catch-and-release aspect of the regulation resulted in each stocked trout being captured an estimated 2.4–2.8 times. A higher percentage of nonlocal anglers used the delayed harvest areas and overall >75% of anglers rated their trips as good to excellent. The program was considered a successful addition to North Carolina's catchable trout program and expansion is being considered.

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Prior to 1989, the North Carolina Wildlife Resources Commission's (NCWRC) hatchery supported trout program consisted of only traditional put-and-take fisheries targeted at streams which provided limited angling opportunities. No consideration was given to providing other types of angling opportunities using catchable-sized trout. The NCWRC recognized the important role catchable trout would continue to play in its trout program when it prepared a strategic trout management plan in 1989 (NCWRC 1989). A major goal of the plan was to diversify trout fishing opportunities within its hatchery supported trout program.

A frequent problem with traditional put-and-take trout programs is that most stocked trout are caught and harvested within days of stocking, leaving few fish for anglers until the next stocking. While such a program may satisfy some anglers, the low catch rates of other anglers are not desirable. Pennsylvania and Virginia identified such a problem and initiated a regulation called delayed harvest (M. Marcinko, L. Mohn pers. commun.). This regulation involves a period when only catch-and-release angling using artificial lures is allowed for stocked trout. At the end of the catch-and-release period, harvest is allowed using relaxed creel and tackle restrictions. Fishery managers in Pennsylvania and Virginia report high angler satisfaction with delayed harvest, but have not evaluated the regulation. M. Marcinko (pers. commun.) indicated anglers fishing delayed harvest waters had catch rates of 2 trout per hour, while those fishing traditional put-and-take waters averaged 0.4 trout per hour.

North Carolina saw delayed harvest regulations as a way to improve the overall quality of the fishery by increasing catch rates and deemphasizing harvest. Anglers learning to fish with artificial lures or flies in delayed harvest areas would have a greater probability of having a positive fishing experience (i.e., catching trout) in spite of the frustrations of learning new techniques. It also was hoped these regulations would make better use of hatchery-reared fish through multiple captures of stocked trout. The objective of this study was to obtain angler trip characteristics for streams managed under delayed harvest regulations and to compare them to adjacent hatchery supported waters. This was necessary to determine their future role in North Carolina's catchable trout program.

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Methods

The East Prong Roaring River (EPRR) in Wilkes County and Nantahala River (NR) in Macon County, North Carolina, were evaluated for this study. Both streams had adjacent sections managed under delayed harvest and hatchery supported regulations. The delayed harvest section on the EPRR was 6.6 km long and extended from the confluence with Bullhead Creek to the lower Stone Mountain State Park boundary. The adjacent hatchery supported section was 8.0 km long and extended from the State Park boundary to Brewer's Mill on secondary road 1943. Average width of EPRR was approximately 9 m. The delayed harvest section on the NR was 6.0 km long and extended from Whiteoak Creek to the Nantahala Power and Light Company powerhouse discharge canal. The hatchery supported section was 5.2 km long and extended from secondary road 1401 to its confluence with Whiteoak Creek. Average width of NR was approximately 14 m. Both streams contained some wild trout.

Delayed harvest trout regulations in North Carolina consisted of a catch-and-release period from 1 March to 5 June 1992. Only artificial lures having a single hook were allowed. On 6 June (first Saturday) the streams reverted to hatchery supported regulations that allowed the harvest of 7 trout of any size and with no tackle restrictions.

Roving creel surveys were conducted from 1 March to 21 June 1992. Delayed harvest and hatchery supported sections were surveyed concurrently, but angler trip characteristics were estimated separately. The creel schedule was divided into approximately 2 week periods. All weekend days and holidays were creeled, as were 3 weekdays per week. Work days were divided into morning and afternoon periods with equal probability (0.5) of selection. Morning work periods were defined as sunrise until midday, whereas afternoon work periods extended from midday to 0.5 hour after sunset. Strata included weekdays, weekend days (including holidays), opening days (April 4 and 5), afternoon work periods of stocking days, and morning work periods of stocking days. All afternoon work periods on stocking days were sampled. Data for morning work periods on stocking days utilized substitute data from the previous like kind work day with valid data. All selections were made randomly.

The means of 2 instantaneous angler counts from each work period were used in estimating pressure. Pressure estimates combined with catch rates were used to estimate total catch. The starting point of the counts was randomly selected.

While walking the streams, clerks interviewed anglers in both delayed harvest and hatchery supported sections during each work period. Clerks collected data on time spent fishing, numbers of fish caught, number of fish kept, age (<16 or ≥16 years of age), type of terminal tackle used (artificial flies, artificial lures, natural bait), residency (local resident, other North Carolina resident, nonresident of state), and rating of fishing trip (poor, fair, good, or excellent).

Delayed harvest sections were stocked at 371 trout per hectare once per month. Hatchery supported sections were stocked at about 110 trout per hectare during the first 2 stocking periods and at 55 per hectare the last 3 stocking periods. Hatchery supported sections were stocked twice a month. Early season stockings were evenly divided between rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*). Later stockings were comprised of various numbers of brown and rainbow trout with few or no brook trout stocked. The proportions of the species stocked were kept approximately the same for both sections of stream.

Both creel design and data summaries were prepared by the North Carolina State University Institute of Statistics. Estimates of number of fish caught and number of fish harvested were calculated by strata and period. Totals were obtained by summing strata and period estimates. No effort was made to account for wild fish. Catch rates in trout per hour were calculated as the mean of individual trip values (Hayne 1991).

Data from the delayed harvest catch-and-release period (1 Mar–5 Jun) were compared to hatchery supported data from 4 April–21 June for catch rates and

angler characteristics. The delayed harvest regulation and associated stocking rates were to be considered successful if catch rates approximated 4 trout per hour during the catch-and-release period. Estimates of catch for the delayed harvest section after reversion to hatchery supported regulations (6 Jun–21 Jun) were used to determine total catch and percent harvest of those fish originally stocked. Catch rates for the delayed harvest and hatchery supported sections were tested for significant differences using *t*-tests. An estimate of the number of times each trout was caught in the delayed harvest section was calculated by adding the number of fish caught during the catch-and-release period to the number kept during the harvest period and dividing by the number of trout stocked. The same estimate for the entire season on hatchery supported sections was obtained by dividing the total number of fish caught by the total number of fish stocked. Pearson correlation coefficients for trip rating versus total trout catch were calculated using SYSTAT (Wilkinson 1990)

Results

Mean catch rates for trout on delayed harvest sections of EPRR and NR were 3.16 and 6.54 trout per hour during the catch-and-release period. This compared with catch rates on the hatchery supported sections of 1.87 and 2.54 trout per hour for EPRR and NR (Table 1). These estimates were statistically different ($P \leq 0.01$) for both streams.

Trout stocked on EPRR and NR delayed harvest sections were captured an estimated 2.8 and 2.4 times each, whereas those stocked in the hatchery supported sections were captured only 1.1 and 1.2 times each (Table 2). Of the total number of fish stocked into delayed harvest sections, 51% and 46% were harvested on the EPRR and NR, respectively, during the 2-week period following the end of the

Table 1. Mean angler catch rates in trout per hour, standard errors (SE), and sample sizes (*N*) for the East Prong Roaring River (EPRR) and Nantahala River (NR) delayed harvest and hatchery supported study reaches. Delayed harvest calculations included the period 1 March–5 June 1992, whereas hatchery supported included the period 4 April–21 June 1992.

| Section and stream | Mean catch rate | SE | <i>N</i> |
|--------------------|-----------------|------|----------|
| Delayed harvest | | | |
| EPRR | 3.16 | 0.16 | 585 |
| NR | 6.54 | 0.40 | 362 |
| Hatchery supported | | | |
| EPRR | 1.87 | 0.21 | 282 |
| NR | 2.52 | 0.29 | 159 |

Table 2. Total numbers of trout stocked, estimated number caught, number kept, and times captured for the East Prong Roaring River (EPRR) and Nantahala River (NR) delayed harvest and hatchery supported study sections between 1 March and 21 June 1992.

| Section and stream | <i>N</i> stocked | Estimated <i>N</i> | | % harvested | Times caught |
|--------------------|------------------|--------------------|-------|-------------|--------------|
| | | Caught | Kept | | |
| Delayed harvest | | | | | |
| EPRR | 6,525 | 18,492 | 3,307 | 51 | 2.8 |
| NR | 9,900 | 23,976 | 4,568 | 46 | 2.4 |
| Hatchery supported | | | | | |
| EPRR | 2,801 | 3,082 | 2,784 | 99 | 1.1 |
| NR | 2,625 | 3,037 | 2,853 | 100 | 1.2 |

catch-and-release regulation. Essentially 100% of the trout stocked in the hatchery supported sections were harvested during the study.

Anglers ≥ 16 years of age dominated both delayed harvest and hatchery supported sections on both streams. The percentage of anglers < 16 years of age exceeded 10% only on the hatchery supported section of the NR where it was estimated they comprised 15% of all anglers (Table 3).

On the delayed harvest sections of both study streams natural bait was used by only about 2% of anglers. Artificial flies were used more frequently than were other artificial lures within the delayed harvest sections. On the hatchery supported sections natural baits were used most often (Table 3).

Over 70% of anglers fishing the hatchery supported sections were local residents, whereas they comprised only 51%–62% of anglers fishing the delayed harvest sections. On the NR approximately 16% of anglers were nonresidents of North Carolina, while $< 2\%$ fishing EPRR were nonresidents (Table 3).

Fishing trips on delayed harvest sections were rated as good to excellent in $> 75\%$ of the cases, whereas $< 6\%$ of trips were rated as poor. On hatchery supported sections, 63%–72% of anglers rated their trips as fair to good and 16%–20% rated their trips as poor (Table 3). Correlation coefficients of trip rating versus total number of trout caught found a stronger relationship for anglers fishing the hatchery supported sections (EPRR - 0.651, NR - 0.492) than for the delayed harvest sections (EPRR - 0.471), NR - 0.307).

Discussion

When measured against the hatchery supported catch rates, the delayed harvest regulations allowed us to meet our objective of having catch rates of 4 trout per hour. The estimated catch rates of 3.16–6.54 trout per hour should decline as the program becomes more familiar to the public and fishing pressure increases. This is especially true of the Nantahala River where the number of anglers interviewed, a reflection of fishing pressure, was lower.

Table 3. Ratio estimators in percent for age, type of bait used, residency, and trip rating for anglers fishing the delayed harvest and hatchery supported study reaches of the East Prong Roaring River (EPRR) and Nantahala River (NR). Delayed harvest included the period 1 March–5 June 1992, whereas hatchery supported included the period 4 April–21 June 1992.

| Characteristic and stream | | Delayed harvest | Hatchery supported |
|--------------------------------|-------------|-----------------|--------------------|
| Age of anglers | | | |
| EPRR | ≥16 years | 93.4 | 91.9 |
| | <16 years | 6.6 | 8.1 |
| NR | ≥16 years | 94.1 | 85.0 |
| | <16 years | 5.9 | 15.0 |
| Type of bait used ^a | | | |
| EPRR | Flies | 49.3 | 2.2 |
| | Lures | 48.4 | 9.7 |
| | Natural | 2.3 | 88.1 |
| NR | Flies | 63.5 | 12.7 |
| | Lures | 34.8 | 31.0 |
| | Natural | 1.7 | 56.3 |
| Residency ^b | | | |
| EPRR | Local | 51.2 | 72.4 |
| | Nonlocal | 46.9 | 27.6 |
| | Nonresident | 1.9 | 0.0 |
| NR | Local | 62.3 | 70.2 |
| | Nonlocal | 21.5 | 25.3 |
| | Nonresident | 16.2 | 4.5 |
| Trip rating | | | |
| EPRR | Excellent | 36.9 | 11.8 |
| | Good | 39.5 | 36.8 |
| | Fair | 19.2 | 35.4 |
| | Poor | 4.4 | 16.0 |
| NR | Excellent | 53.4 | 16.4 |
| | Good | 30.3 | 33.3 |
| | Fair | 10.7 | 30.2 |
| | Poor | 5.6 | 20.1 |

^a Flies = single hook artificial flies, lures = single hook artificial lures other than flies, natural = baits which can be beneficially digested.

^b Local residents on EPRR = Wilkes, Alleghany, and Surry counties and on NR = Macon, Swain, Graham, and Cherokee counties; nonlocal residents = residents from other North Carolina counties; Nonresidents = anglers from outside of North Carolina.

The catch rate of the hatchery supported sections was higher than expected. A creel survey completed on the EPRR designed to evaluate catch rates and percent returns under high stocking rates where harvest was allowed found catch rates of 0.98 trout per hour (Mickey and Wingate 1981). Only rainbow and brown trout were stocked in that study, whereas in this study brook trout comprised 33% of the fish stocked early in the season. Brook trout are easily caught (McAfee 1966) and contributed to the higher catch rates found in this study. Species catchability should be a consideration in all catchable trout programs if catch rates are an important objective.

The average recapture of trout at 2.4–2.8 times in the delayed harvest sections show the regulation can be used to extend limited resources and support more angling. By focusing on catch, not harvest, delayed harvest regulations give agencies a way to enhance the quality of angling experiences without having to increase hatchery production.

One potentially undesirable aspect of the delayed harvest regulation was the large number of anglers present when the delayed harvest sections opened to harvest. Anglers had anticipated the accumulation of trout in these areas and crowded the streams on those days. Reducing the allowable creel limit once the streams open to harvest could reduce crowding and extend the harvest. A 2-fish creel limit is currently used on delayed harvest waters in Maryland (Bachman et al. 1989).

As was found in this study and Mickey and Wingate (1981), anglers were very efficient in harvesting stocked trout. Harvest of 97%–100% of the fish stocked can be considered a successful stocking program. The harvest of 41%–56% of the trout stocked in the delayed harvest section is excellent considering the number of times each fish was caught, the length of time between stocking and harvest, catch-and-release mortality, and illegal harvest. The percent return would have been higher if the creel had been extended for more than 2 weeks after opening to harvest.

The lower percentage of anglers <16 years of age using the delayed harvest areas as compared to the hatchery supported sections indicates there is a need to promote these areas as places for young people to learn to fish. As these areas become better known the number of younger anglers should increase.

The estimated 2% of anglers found using natural bait in the delayed harvest section during the catch-and-release period was considered excellent compliance for the first year of a new regulation. Early concerns of angler resistance to the new regulation and difficulty in enforcement abated quickly when anglers' responses were overwhelmingly positive. It also was unexpected to find the use of single-hook artificial flies exceeding the use of other single-hook artificial lures in the delayed harvest section. This may reflect local angler association of catch-and-release fishing to fly-fishing only regulations and that anglers who fly-fished were more willing to travel to delayed harvest streams to fish. We expect these percentages will change as anglers realize single-hook artificial lures of all types are allowed during the catch-and-release period.

The higher percentage of nonlocal residents (from both North Carolina and other states) using the delayed harvest sections can be partially explained by stream location. East Prong Roaring River is located in Stone Mountain State Park and the Nantahala River is located adjacent to a popular rafting and kayaking area. Both of these areas draw large numbers of nonlocal residents. Implementation of delayed harvest regulations has provided these visitors with an additional recreational opportunity which has a high probability of being a positive angling experience, a key objective of the program.

Although we were successful in increasing the catch rates of anglers using the delayed harvest areas, that alone did not provide an indication of how anglers rated their fishing trips. The positive response to the trip rating question confirmed that

a higher percentage of anglers were pleased with their trips on the delayed harvest areas than were those fishing the adjacent hatchery supported sections. The higher correlation coefficient for catch (\approx harvest) versus trip rating on the hatchery supported sections suggests harvesting fish is more important to those anglers when rating their overall trip. More detailed analysis of daily catch rates between stockings could provide further insight into the relationship of catch and harvest to trip rating.

Management Applications

Delayed harvest regulations are a positive addition to North Carolina's catchable trout management program and future expansion is being considered. Guidelines for selecting additional streams and criteria for success must be developed and formally incorporated into the state's Trout Management Plan. Creel surveys should be conducted within 3 years of the time a stream is brought into the program to ensure program objectives are being met.

The inherent flexibility in the delayed harvest regulation will allow it to be tailored to specific agency needs. As with other catchable trout programs, the desired objectives can be determined and then stocking rates and frequencies, catch-and-release periods, and restrictions during the harvest period can be adjusted to meet those objectives. *Delayed harvest regulations are an excellent way to diversify angling opportunities using hatchery-reared trout and should be considered for addition to an agency's program.*

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