# COMPARISON OF ANGLER USE AND CHARACTERISTICS AT THREE CATCHABLE TROUT FISHERIES IN VIRGINIA

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*Abstract:* Creel census data for 3 catchable trout fisheries in Virginia revealed that desirable attributes of the fisheries increased from a lightly-stocked stream to a lightly-stocked lake to a heavily-stocked stream. Total effort, participation by non-local anglers, evenness of seasonal use, catch rate, and return rate all were higher for the heavily-stocked stream than for the lightly-stocked stream. For the trout lake, total effort and participation by non-local anglers were similar to the heavily-stocked stream, but catch per effort, return rates of stocked fish, and seasonal distribution of effort were similar to the lightly-stocked stream. Most anglers at the lake fished from shore, so that a large portion of the potential fishing area was not utilized. Management of catchable trout fisheries may provide higher fishing value if streams are managed so that stocking density, stocking frequency, accessibility of angling, publicity, and opportunities for associated outdoor recreation are maximized.

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Efficiency is a management criterion applied more directly to catchable (i.e., put-and-take) trout fisheries than to any other type of recreational fishery. Facts such as percentage of stocked fish caught and number of trips per hectare are regularly reported for stocked trout streams. Part of this emphasis on rate of use relies on ease of calculation; for example, production costs in the hatchery can be measured precisely and the bulk of angler use of a stream can be monitored in a few days at easily accessible points. A legitimate part of the emphasis, however, also reflects the nature of the fishery. First, an accurate assessment of angler satisfaction probably is reflected by catch rate. Weithman and Anderson (1978) considered catch rates, size of fish, species of fish, and diversity of catch as determinants of "trip quality" for anglers. For streams stocked with catchable-sized trout, catch rate is the only criterion of quality that can vary among anglers. Second, using a stream or lake that would not support trout all year long abolishes concern for in-stream reproduction and justifies the management concept that an uncaught trout is a wasted trout.

Improving efficiency has been well-studied with regard to certain elements of management. What species, sizes, times, and densities for stocking can be selected for a desired end. Regulations are adapted to manage effort, distribution of effort, and catch rate. In this paper, we consider the effects which certain overall aspects of catchable trout fisheries have on the relative value, reflected in use patterns, of 3 types of trout fisheries.

The hypothesis for this analysis is that the relative value of catchable trout fisheries will vary under different conditions. Value of the fisheries is represented here by (1) the amount of use on a per ha basis and (2) the proportional use by non-local anglers. Use by non-local anglers means that anglers are willing to spend the necessary travel expense and thus value the stream more highly than another with lower non-local use (Bell 1978). Comparisons are made among a lightly-stocked stream (Brumley Creek), a heavily-stocked stream (Big Stony Creek), and a lightly-stocked lake (Hidden Valley Lake) in

Virginia. Specific qualifying data will be given below for our hypothesis that general angling quality increases in sequence from Brumley Creek to Hidden Valley Lake to Big Stony Creek. Measures of the relative value of these areas to users are based on creel censuses which determined total effort, distribution of effort, residence of users, catch rate, and return rate of stocked fish.

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## METHODS

### Big Stony Creek

Big Stony Creek is located in Giles County, Virginia, near the town of Pembroke. The creek is second order and drains into the New River. Typical of the ridge and valley province of southwestern Virginia, the stream has a steep gradient, pebble-cobble substrate, and abundant riparian vegetation. Approximately 13.7 km of its length flows through the Jefferson National Forest, where the stream is accessible from a parallel paved 2-lane road. The stream is stocked heavily (Table 1) by the Virginia Commission of Game and Inland Fisheries (VCGIF). In 1979, the stream was stocked with 8600 fish in March (before the season opening on April 7), 4200 fish in May (during a week-long closure for restocking), and 2000 fish each in June, July, September, and October (all during the fishing season). The upper 5.5 km of stream were used for this study because a related study concerning movements of stocked fish was being conducted concurrently in this area (Kendall 1980).

Big Stony Creek is among the most heavily-stocked streams in Virginia. For example, in 1978, streams in 15 counties of west central and southwest Virginia were stocked at about

Table 1. Physical features and stocking data for study sites.

| Characteristic | Big Stony Creek | Brumley Creek | Hidden Valley Lake |
|---|---|---|---|
| Stocked length (km) | 13.7 | 3.1 | - |
| Average width (m) | 7 | 7 | - |
| Stocked area (ha) | 9.6 | 2.2 | 25.5 |
| Number stocked | | | |
| Rainbow | 14,500 | 1,450 | 6,000 |
| Brook | 2,900 | 450 | 0 |
| Brown | 3,400 | 0 | 0 |
| Total | 20,800 | 1,900 | 6,000 |
| Stocking density (No/ha) | 2,167 | 864 | 235 |
| Average trout length (mm) | 270 | 240 | 260[1] |
| Percent access by road | 100 | 90 | 75 |
| Number of stocking dates | 6 | 3 | 1 |

[1]Average length during August, 1978.

890 trout per km of stream length, and Big Stony Creek was stocked at 1365 per km, or 53 percent higher than the average density. In 1978, Big Stony represented 70 percent of the stream length stocked in Giles County and received 66 percent of the fish stocked in the county; within the surrounding 5-county area, Big Stony represented 10 percent of the stream length stocked and 14 percent of the fish stocked.

### Brumley Creek

Brumley Creek is a second order stream located in Washington County, Virginia. The stream is approximately 18 km long, originating at Hidden Valley Lake and draining into the North Fork Holston River. Like Big Stony Creek, Brumley Creek has a steep gradient, primarily pebble-cobble substrate, and heavily vegetated stream banks. The lower 3.1 km are public waters, and about 90 percent of the stream is accessible from an unpaved 2-lane road (Table 1). For this study, the entire 3.1-km length was censused.

The section paralleling the road is stocked by the VCGIF at about 40 percent the density of Big Stony Creek. In 1978, when this study was conducted, the VCGIF stocked 1200 trout in March (pre-season), 450 in May (1-week closure), and 250 in June (during season). Brumley Creek represents 12 percent of the 24.9 km of streams stocked with catchable trout in Washington County and received 7 percent of the trout stocked in the county in 1978.

### Hidden Valley Lake

Hidden Valley Lake is a 25.5-ha impoundment located in the Hidden Valley Wildlife Management Area operated by the VCGIF in Washington County. The lake was formed in 1957 by impoundment of the upper end of Brumley Creek (Wollitz and Jesse 1969). Average depth is 4.6 m and maximum depth is 7.4 m. The lake is oligotrophic, slightly acidic, and generally stratified in summer; surface temperature reaches a maximum of about 25°C in mid-summer. The lake is accessible by a single 2-lane paved road to the entrance of the area and an unpaved road which extends around 75 percent of the lake perimeter.

The lake has been managed primarily for trout fishing since the early 1960's (Wollitz and Jesse 1969). In 1977, the lake was drained and rotenone was applied to eliminate introduced rock bass. In fall of 1977, 6000 catchable-sized trout were stocked in the lake for the fishing season beginning on April 1, 1978. No other fish were stocked during the 1978 fishing season. Hidden Valley Lake is 1 of only 2 trout fishing lakes managed by the VCGIF (Wollitz 1978) and is considered by management personnel a valuable resource because of this uniqueness.

### Relative Angling Quality

For the purposes of this study, we hypothesize that the angling quality of these 3 areas increases in order from Brumley Creek to Hidden Valley Lake to Big Stony Creek. This presumption is based on the following: (1) Brumley Creek represents a relatively short stream stretch, is stocked at a below average density for Virginia, and is a small percentage of the stocked waters in the area; (2) Hidden Valley Lake is an unusual trout fishing environment (G. Martel, VCGIF, pers. comm.), offers opportunities for other outdoor recreation such as picnicking, hiking, and camping, but is stocked at a low density only once about 6 months before the season opens; (3) Big Stony Creek is a long stream stretch, is stocked at above average density for Virginia, was stocked 6 times during the 1979 season, and represents a large portion of the stocked waters within its county and the vicinity.

Creel censuses were conducted at Brumley Creek and Hidden Valley Lake during the 1978-1979 trout fishing season, which began at noon on 1 April 1978 and ended on 15 February 1979. The creel census at Big Stony Creek was conducted during the 1979-1980

season, which began at noon on 7 April 1979 and ended on 15 February 1980. In both years, the season was closed during 1 week in May while streams were re-stocked.

On days when censusing was conducted, a creel clerk, or a group of clerks on opening dates for Big Stony Creek, attempted to interview all anglers using a fishery. The clerk remained at the stream or lake throughout the angling day (sunrise to sunset) and continuously traversed the fishing area. Each angler was asked questions concerning number of fish caught, length of fishing trip, and county of residence. Creel clerks estimated than an unknown, but small, percentage of fishermen were not interviewed, based on their qualitative assessment of the frequency with which they repeatedly interviewed the same people, the lengths of time anglers fished, and observations of traffic in the area. Two exceptions to this confidence level occurred. First, opening day creel on Brumley Creek began at 2 p.m., rather than at noon. Consequently, a portion of anglers which caught their limit and departed within 2 hours of opening were missed; we estimate that no more than 20 percent of all anglers were missed, based on length of fishing trips and angler success rates. Second, clerks estimated that on opening day for Big Stony Creek only about 50 percent of anglers were interviewed because of the large number of anglers present. The data have not been adjusted to reflect differences in completeness of creel census. For the purposes of this study, calculations are based on interview data only for each censusing date. Thus, estimates of total effort and return rate of stocked fish should be considered conservative for comparison with other studies. In general, confidence regarding the completeness of censusing decreases from Hidden Valley Lake to Brumley Creek to Big Stony Creek, based on access, size of study area, and observations of creel clerks.

For Brumley Creek and Hidden Valley Lake, censusing was conducted on each of the first 9 days after the April opening and the first 10 days after the May re-opening. During the remainder of the season, censusing was conducted on all holidays and on a minimum of 2 weekdays and 2 weekend days per month. Dates were chosen with a random number table. Brumley Creek was not censused from July 20 to August 30 and from November 15 to January 1 because of considerations unrelated to this study. In total, 11 sampling dates were lost. No use was recorded at Hidden Valley Lake for those periods, and, therefore, use was assumed zero for Brumley Creek; these periods also represent the times of lowest use of Big Stony Creek (Table 2). Fifty-one and 67 days were censused at Brumley Creek and Hidden Valley Lake, respectively (Table 2).

For Big Stony Creek, the first 3 days and 4 of the next 6 days after the April opening were censused. The first 4 days and 3 of the next 5 days after the May re-opening were censused. During the remainder of the season, all other stocking days and a random selection of weekdays and weekend-holidays were censused. Censusing was stopped at the end of November because use had dropped to zero and was expected to remain zero through the winter. A total of 62 days were censused (Table 2).

Estimates of total angling pressure and catches were made by expanding data for individual censusing days, similar to Thurow (1978), Carl et al. (1976) and James et al. (1971). Days during a month were categorized as (1) special days (i.e., opening days, days soon after opening, and holidays for Brumley Creek and Hidden Valley Lake), (2) weekend days (and holidays for Big Stony Creek), and (3) weekdays. For each month, totals ($X_t$, where X = hours fished or fish caught) were calculated as:

$$X_t = \sum_{i=1}^{n} (TS)_i + \overline{X}_{WD}(WD) + \overline{X}_{WE}(WE),$$

where

TS = total of X for the i special day
n = number of special days

$\bar{X}_{WD}$ = average X for censused weekdays
WD = number of non-special weekdays in month
$\bar{X}_{WE}$ = average X for censused weekend days
WE = number of non-special weekend days in month

## RESULTS

### Amount and distribution of effort

Expanded estimates of total effort increase in the presumed order of fishing quality for the 3 areas (Table 2). Effort on Brumley Creek was about 25 percent of the effort on Hidden Valley Lake and about 20 percent of that on Big Stony Creek. Given that the population within 50 km of Big Stony Creek is about one-fourth larger than for the other 2 fisheries, the effort per unit of population is approximately equal for Big Stony Creek and Hidden Valley Lake and substantially higher than for Brumley Creek.

The temporal distribution of effort from Brumley Creek and Hidden Valley Lake follow the typical patterns for put-and-take trout fisheries, in which effort and catch are concentrated around stocking and opening dates (e.g. Butler and Borgeson 1965; Table 2 and Fig. 1). Sixty-five percent of the total effort on Brumley Creek occurred in April and 98 percent occurred in April and May. Similarly, 78 percent and 18 percent of total measured effort on Hidden Valley Lake occurred in April and May, respectively, and only 4 percent occurred in the remaining 9 months of the season.

We expected that effort on Hidden Valley Lake would be spread more evenly throughout the season because the quality of the area would attract anglers throughout the summer and fall. Although people continued to use the lake for picnicking and camping during the summer, few people fished. Low catch rates and small fish were frequent comments made by anglers, and these reasons may account for low use during the latter part of the season.

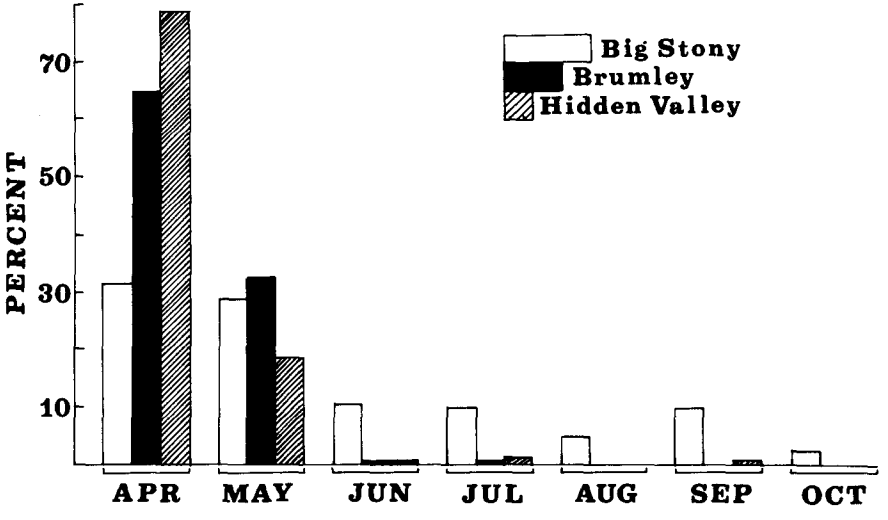


Fig. 1. Distribution of angler effort over the season as percent of total effort for each study area.

Table 2. Creel census data and expanded angling effort during the 1978-1979 trout season at Brumley Creek and Hidden Valley Lake and the 1979-1980 season at Big Stony Creek.

| | Big Stony Creek | | | Brumley Creek | | | Hidden Valley Lake | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Days Censused | Number Interviews | Angling Effort(hr) | Days Censused | Number Interviews | Angling Effort(hr) | Days Censused | Number Interviews | Angling Effort(hr) |
| April | 8 | 236 | 815 | 13 | 133 | 338 | 13 | 471 | 1612 |
| May | 10 | 231 | 715 | 14 | 73 | 171 | 14 | 252 | 372 |
| June | 9 | 45 | 289 | 4 | 1 | 7 | 4 | 8 | 21 |
| July | 8 | 42 | 244 | 3 | 1 | 1 | 6 | 14 | 35 |
| August | 4 | 2 | 134 | 0 | 0 | 0 | 5 | 0 | 0 |
| September | 10 | 40 | 225 | 4 | 0 | 0 | 4 | 13 | 17 |
| October | 10 | 12 | 97 | 4 | 0 | 0 | 4 | 0 | 0 |
| Nov-Feb. | 3 | 0 | 0 | 9 | 0 | 0 | 17 | 0 | 0 |
| Total | 62 | 608 | 2519 | 51 | 208 | 517 | 67 | 758 | 2057 |

Effort on Big Stony Creek was distributed more evenly across the fishing season, as we expected for a fishery of higher angling quality. Effort levels in April and May were higher than in other months, representing about 60 percent of the total, but monthly effort remained at or near 10 percent of the total effort in 3 additional months. Relatively high use in June, July and September was directly related to intense fishing that occurred simultaneously with in-season stocking. Kendall (1980) estimated that 50 percent of the total effort for the season occurred on the opening, re-opening and four in-season stocking dates. In contrast, the June stocking of Brumley Creek attracted few anglers and insignificant fishing effort occurred during June.

Residence of Anglers

We presumed that as the angling quality of a fishery increases, the proportion of non-local anglers should increase because more non-local anglers would be attracted to the fishery. Proportions of non-local anglers (i.e., those living in counties beyond a 50-km radius of the fishery) did increase from Brumley Creek to Hidden Valley Lake to Big Stony Creek (Table 3), although local anglers represented more than 80 percent of the total for all 3 areas. These percentages are not strictly comparable because the local population for Big Stony Creek was about one-third larger than for the other 2 sites, and because Big Stony Creek is located somewhat more-centrally in the state. Because most effort is local, the larger local population for Big Stony Creek suggests that the percentage non-local use is underestimated relative to Brumley Creek and Hidden Valley Lake.

Comparison of percent local and non-local use between Brumley Creek and Hidden Valley Lake are directly comparable because both are located in Washington County. Proportional use by non-local anglers was more than twice as large at Hidden Valley Lake than at Brumley Creek. Additionally, almost 70 percent of local anglers using Brumley Creek lived in Washington County, while less than 45 percent of Hidden Valley Lake anglers lived in the county. Fishing at the lake clearly was a more sought-after experience than fishing at Brumley Creek.

Catch and return rates

Catch rates increased in order from Hidden Valley Lake to Brumley Creek to Big Stony Creek (Fig. 2). The lowest catch rate at Hidden Valley Lake departs from our expectation that fishing quality in the lake was intermediate between the streams. Low catch rates may have occurred because only 6 percent of anglers at Hidden Valley Lake fished from boats, and thus a sizeable portion of the offshore area received only negligible effort. In concurrent sampling of the fish fauna, we collected no trout by electrofishing in shallow water, but captured trout with gill nets in open water. Stomach contents of these trout were dominated with *Chaoborus* larvae, characteristic of open water. These observations suggest that anglers at Hidden Valley Lake might have achieved higher catch rates had they used fishing methods more appropriate for the off-shore habitat.

Angler catch rate was higher in Big Stony Creek than in Brumley Creek, as we expected based on presumed angling quality of the streams. This difference is more striking when the available fish per hour of expended effort is compared based on densities of stocking (fish stocked/ha) and angler use (hr/ha). Approximately 4 fish were available for every hour of effort expended on Brumley Creek, while about 3 fish were available for every hour of effort on Big Stony. Thus, the fish were about one-third more dense in Brumley Creek than in Big Stony Creek, but catch/effort was about one-quarter lower. Reasons for this difference cannot be demonstrated, but possible influences include more skillful anglers, the increased effort which accompanied later stocking dates, and more complete access at Big Stony Creek.

Return rates followed the same pattern as catch rates and effort per ha (Fig. 2). The return to the creel was lowest in Hidden Valley Lake, presumably because angling effort was concentrated in areas of low fish density and because a portion of the trout may have

Table 3. Residence of anglers fishing in Big Stony Creek during 1979 and Brumley Creek and Hidden Valley Lake during 1978.

| Angler Category | Big Stony Creek | | Brumley Creek | | Hidden Valley Lake | |
|---|---|---|---|---|---|---|
| | Percent of Interviews | Total Population | Percent of Interviews | Total Population | Percent of Interviews | Total Population |
| Same County[1] | 59.0 | 16,500 | 68.9 | 41,000 | 43.7 | 41,000 |
| Counties within 50-km radius[2] | 23.2 | 184,000 | 24.7 | 104,000 | 41.5 | 104,000 |
| Total local | 82.2 | 200,500 | 93.6 | 145,000 | 85.2 | 145,000 |
| Non-local | 17.8 | - | 6.4 | - | 14.8 | - |
| Number Interviews | 608 | - | 208 | - | 758 | - |

[1]For Big Stony: Giles; for Brumley and Hidden Valley: Washington

[2]For Big Stony: Montgomery, Pulaski, Radford and Mercer W.V.; for Brumley and Hidden Valley: Smyth, Russell and Tazewell.

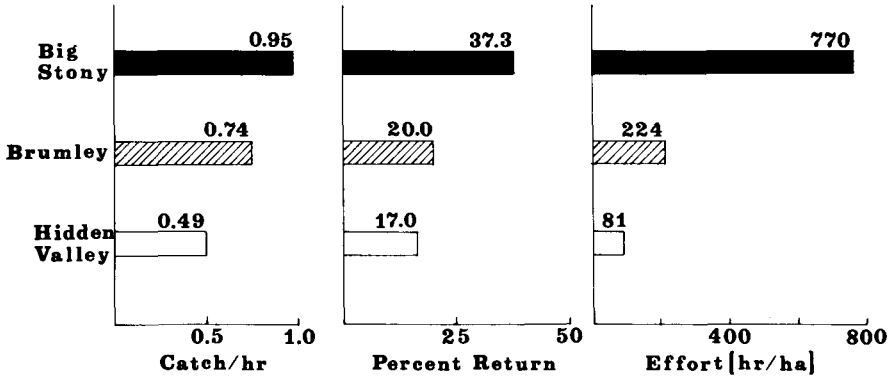


Fig. 2. Relationship among catch per effort (number fish caught per hour), return of stocked fish to the creel (percent of stocked fish), and density of total angler effort for season (hours per hectare) for 3 study areas.

died overwinter between stocking in the fall and opening the following April. The highest return rates at Big Stony Creek reflect the relatively high effort and catch rates at that fishery.

In general, return rates for all 3 areas are low compared to reports in the general literature (Cooper 1974) and for other streams in Virginia (Applegate et al. 1966). Two factors probably contribute to this phenomenon. First, these return rates are minimum estimates because interviewers missed some anglers during periods of high angler density, as described in the methods. Because high angler density coincided with stocking dates, catch rates of non-interviewed anglers presumably were high. Second, both streams receive the largest stocking allocation in the spring up to a month before the season opens. High spring flows, which occurred after stocking in both 1978 and 1979, may have contributed to movement of stocked fish out the area. For Big Stony Creek, we received reports of tagged fish caught as far as 4.5 km below the stocked area. Also, illegal removal of some trout may have occurred between stocking and opening dates. Trout are extremely tame just after stocking and may be especially vulnerable to illegal capture at this time.

## DISCUSSION

This comparison indicates that management of catchable trout fisheries which increases the presumed overall quality of the fishery will have desirable effects on the efficiency of management. Effort is distributed over a longer period, average angler catch rates are higher, and return of stocked fish to the creel is higher. A higher proportion of non-local use occurs, implying a higher economic value of the fishery in terms of consumer surplus and net value (Bell 1978). Such calculations recognize the greater cost incurred by anglers traveling longer distances to fish; thus, a larger proportion of non-local use indicates that even local anglers are enjoying a more desirable fishery. For states like Virginia, in which most state residents are considered non-locals for trout fishing (Wollitz 1978), management designed to enhance the perceived quality of catchable trout fisheries seems appropriate.

A review of literature on trout fisheries provides several strategies for implementing high quality catchable fisheries. Forshage (1975) demonstrated that stocking trout increased the net value of Texas fisheries based on rates of use by more distant anglers, and the corollary indicated here is that denser stocking contributes to higher total use and

higher proportional use by non-locals. The implication is that allocation of available fish to fewer streams at a higher stocking density may be desirable. Obviously, this idea cannot be taken to the extreme of stocking all fish in 1 location, but some objective criterion for evaluating optimal allocation would be appropriate. A concept of marginal benefit may be useful, in which the benefit of stocking more fish in 1 stream is balanced against the benefit of stocking a few fish in another stream.

Access has been shown to increase use in several studies (Hendee et al. 1977, James et al. 1971, Ratledge and Cornell 1952), and access may be important in attracting non-local anglers (Boles 1968). Reputation of the area was deemed important in attracting non-local anglers in Michigan (Carl 1977), and data from a group of South Dakota fisheries demonstrate that high rates of total use are accompanied by higher proportional use by non-local anglers (Montgomery and Thompson 1969). These studies support a statement by Martin (1965) that publicizing fishing on a few streams which are intensively managed may be a desirable tactic to increase use and maintain use throughout the season.

Type of habitat may also be a determinant of angling quality. In this regard, trout fishing lakes appear to have higher value than streams. Lakes are favored by anglers over streams or rivers because of the opportunity for other recreation and relatively easy access (Hendee et al. 1977). In this study, angler use of Hidden Valley Lake was 4 times greater than use of Brumley Creek, in terms of both total and non-local use. Zurbuch (1975) reported representative data for locations in West Virginia which showed that 30 percent of the harvest in a trout river was by local anglers but that only 3 percent of the harvest in a trout lake was local.

The failure of anglers to continue fishing at Hidden Valley Lake beyond May, the low catch rate, and the low return rate presumably could be remedied by more intensive management. Repeated stocking during the season, publicity of stocking dates, a boat rental concession, and semi-developed picnic areas could convert the lake into a general recreation area with higher quality fishing throughout the season. Interestingly, however, introductions of bait and warm-water game fishes by anglers have plagued Hidden Valley Lake (Wollitz 1978), and the VCGIF has initiated steps to change the lake from a stocked trout fishery to a self-sustaining smallmouth bass-rock bass fishery.

Concentrating catchable trout fisheries in fewer areas may also have a desirable effect for wild populations in non-stocked streams. Reallocation of stocking could be made so that streams capable of developing self-sustaining trout populations were not stocked while streams which have easy access were chosen for catchable fisheries. Given that non-game and endangered species questions will progressively favor native fauna in the coming years, reducing the number of stocked streams without reducing the total fishing effort and value of a state or region may become especially appropriate.

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