LITERATURE CITED

Cairns, J., and K. L. Dickson. 1971. A simple method for the biological assessment of the effects of waste discharges on aquatic bottom dwelling organisms. J. Water Pollut. Control Fed. 43:755-772.

Hinshaw, R. N. 1973. Pollution as a result of fish cultural activities. EPA-R3-73-009, U.S. Environmental Protection Agency, Washington, D. C. 209 p.

Liao, P. B. 1970. Pollution potential of salmonid fish hatcheries. Water Sewage Works. 117(8):291-297.

Lindsay, W. K. 1971. Impact of fish hatchery effluents on receiving streams. M.S. Thesis. Ohio State University, Columbus, Ohio. 57 p.

Mackenthun, K. M. 1966. Biological evaluation of polluted streams. J. Water Pollut. Control Fed. 38:241-247.

Szluha, A. T. 1974. Potamological effects of fish hatchery discharge. Trans. Am. Fish. Soc. 103(2):226-234.

Weber, C. I. editor. 1974. Biological field and laboratory methods for measuring the quality of surface waters and effluents. EPA-670/4-73-001, U. S. Environmental Protection Agency, Cincinnati, Ohio. 176 p.

Wilhm, J. L. 1967. Comparison of some diversity indices applied to populations of benthic macroinvertebrates in a stream receiving organic wastes. J. Water Pollut. Control Fed. 39:1673-1683.

Wilhm, J. L., and T. C. Dorris. 1968. Biological parameters for water quality criteria. Bioscience. 18:477-481.

WATERS CREEK — A TROPHY TROUT STREAM

by

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ABSTRACT

A 4.3 km section of Waters Creek in Lumpkin County, Georgia, was managed for trophy trout with supplemental feeding under restrictive regulations, including 22 inch minimum size. Complete creel data for 3 years reveal a mean daily pressure of 31.9 anglers, and an annual mean catch rate of 0.18-0.24 fish/hr. Total anglers decreased 13.5% and total hours increased 18.0% 1972-1973. Trip length increased from 3.1 to 4.7 hr 1972-1974. An analysis of variance of catch rate means provided evidence of differences in catch rates with total daily effort. The mean catch rate of 0.51 fish/hr at 26-50 hr daily effort was significantly higher than catch rates at higher pressure. The cumulative frequency distribution of trophy catch rates was influenced by initial stockings. The mean standing crop (44.7 kg/ha) between feeding points and high density of sub-legal fish at feeding points indicate that natural recruitment may sustain the fishery. The program cost is comparable to cost of management of a put-and-take stream under equal pressure.

INTRODUCTION

Trout fishing in Georgia is limited to the mountainous area of a few northern counties. Although many streams in this area provide excellent fishing for stream-reared trout, and many others are heavily stocked, the average angler has had little opportunity to catch a trophy-size trout. With this in mind, members of the Chattahoochee Chapter of Trout Unlimited appraoched state fisheries biologists with the idea of designating a stream for the production of trophy trout.

[1]A contribution of Dingell-Johnson Federal Aid to Fish Restoration Project F-25-2.

Fisheries workers in North Carolina have attempted to increase the carrying capacity of trout streams by supplemental feeding (Ratledge, Bonner, and Crowell, 1971). The results were inconclusive and the study was abandoned due to mechanical problems with automatic feeders, rising labor costs, and road construction activities within the experimental watersheds (Hayden Ratledge, personal communication).

Private clubs in several states maintain a dense population of large trout in streams by supplemental feeding, strict protection, and restrictive angling regulations. These clubs are generally very exclusive and limited to a few individuals who can afford the substantial capital outlay required to manage the stream and protect it from poaching.

This paper presents the results of a trophy trout management program with supplemental feeding initiated in 1972 in Georgia.

STUDY AREA AND METHODS

Waters Creek, in the Chestatee River watershed, lies within the Chattahoochee National Forest in Lumpkin County, Georgia. It is entirely within the Chestatee Wildlife Management Area. The stream is accessible via a dead-end United States Forest Service system road which parallels it for most of its length. This road begins directly in front of the area manager's residence. The road access pattern and rugged topography of the area permit adequate enforcement and control over the project stream.

Waters Creek is approximately 5.6 km in total length, of which about 4.3 km are suitable for management under this project. Mean gradient is approximately 64 m/km while that on the managed section is about 34 m/km. Total hardness is extremely low—around 4 to 5 ppm CaCo3. Average discharge is about 0.28 m^3/sec, with a low of about 0.14 m^3/sec. Late summer daily maximum water temperature range 17-19C.

In past years, Waters Creek has been open under general management area regulations and has been stocked with rainbow (*Salmo gairdneri*), brown (*S. trutta*), and brook trout (*Salvelinus fontinalis*). All three species exist as reproducing populations in the stream system.

An initial stocking of 258 brown trout was made on 30 November 1971. These were brood stock obtained from a United States Fish and Wildlife Service hatchery with a mean weight of 2.18 kg. In January 1972, an additional 457 brown trout averaging 11-12 inches and 332 rainbow trout averaging 13-15 inches were stocked.

Immediately after the initial stocking, supplemental feeding commenced on a regular basis. Floating pelletized trout feed was manually distributed by the project laborer or area wildlife manager. Six feeding points were selected at convenient access points. The four lowermost feeding points were located at about 0.4 km intervals; the fourth and fifth were about 1.1 km apart; and the upper station was approximately 1.9 km above the fifth.

Initially about 11 kg of feed were distributed every other day. The amount was raised to about 16 kg as water temperature increased. Beginning the first of April, 9-11 kg were fed daily. During the second winter, 11 kg were fed about every 3 days. Total feed used during the first year amounted to 3028 kg.

In 1973 feeding rates varied from about 7 kg every 3 days during the colder months to 11 kg every other day during the fishing season. A total of 1687 kg was fed during the second year. Feeding continued at about the same rates in 1974.

The management area trout season opened 29 April 1972. Special regulations in effect consisted of artificial lures only with a single barbless hook, size limit of 22 inches, and daily creel limit of one fish. The stream was open every weekend during the regular management area trout season and on Memorial Day, July 4th and Labor Day.

All fishermen were required to check in with the creel clerk at the entrance to the access road near the stream mouth. Fishermen were required to surrender their fishing licenses and were issued use permits.

During 1973 a laborer was again hired to check creel and feed. Regulations were modified to limit hook size to #6 or smaller, and a $1.00 daily fee was charged. The size limit on brook trout was reduced to 18 inches.

Population sampling with electric seine was conducted in March 1974 at six 76.2 m stations spaced at approximately 0.6 km intervals. Block nets were used at each end and two passes made through each station. Fish taken were identified, measured, weighed, and tagged.

In addition to the measured stations, two large pools lying directly below feeding points were sampled. The captured fish were weighed, measured, and tagged for future growth studies.

RESULTS

Angler Use

Waters Creek was open 41 days (19 weekends and 3 holidays) each year during the trout season (Table 1). The number of anglers dropped 13.5% in 1973, the second year under trophy management. However, total effort increased 18.0%. The total pressure throughout the season was 348 and 301 anglers/km in 1972 and 1973, respectively. Preliminary results of the 1974 creel census indicate a continued downward trend in the number of anglers fishing the stream.

Table 1. Summary of creel census data from Waters Creek, 1972-1974.

	1972	1973	1974[a]
Days Open	41	41	30
Total Anglers	1513	1309	757
Anglers/day	36.9	31.9	25.2
Trout Caught	1117	983	772
Trout Retained	14	38	25
% Successb	29.2	31.4	34.6
Fished Stream Before			
Yes	573	636	398
% Success	41.5	44.8	47.7
No	940	673	359
% Success	21.7	18.7	20.1
Total Effort (hr)	4700	5547	3524
Hours/Trip	3.1	4.2	4.7
Catch/Trip	0.74	0.75	1.02
Catch/Hour	0.24	0.18	0.22
Hours per Retained Trout	336	146	141
Anglers/km (season mean)	348	301	–

(a)1974 data summarized through July.
(b)% anglers catching at least one trout on date censused.

Return visits during 1972 were made by 573 anglers (37.9%). The majority of the anglers (81%) traveled less than 100 miles to the stream. Twenty-six nonresidents from 6 states utilized the stream in 1972.

During 1973, 673 anglers (51.4%) had not previously fished Waters Creek under trophy management. As in 1972, 81% had traveled less than 100 miles from home. The number of nonresidents increased to 70 in 1973, coming from 10 states.

Catch Rates

Mean catch/hr caried from 0.18 to 0.24 from 1972 to 1974 (Table 1). However, catch/trip increased from 0.74 to 1.02 with the increase in trip length from 3.1 to 4.7 hr over the same period.

Successful trips increased from 29.2% to 34.6% 1972-1974. The percent success of anglers that fished more than once under the trophy trout management program was double that of anglers unfamiliar with the stream.

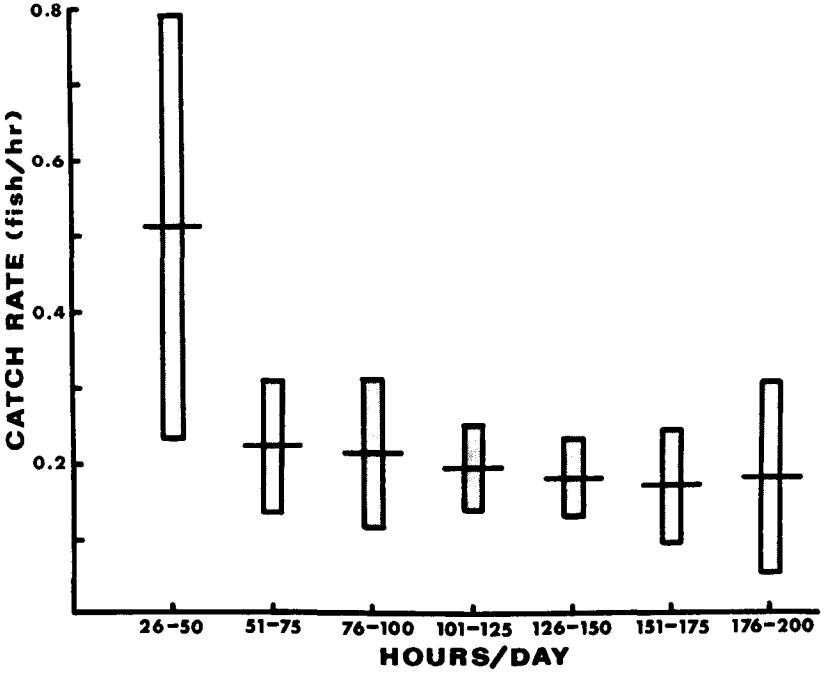

Figure 1. Confidence intervals (t.05sx) of catch rate means (fish/hr) at various total daily pressures on Waters Creek, 1972-1973.

An analysis of variance of the mean daily catch rates grouped in 25 hr intervals of daily pressure provided evidence of differences in catch rates at the .01 probability level (Fig. 1). The mean catch rate (0.51 fish/hr) for a total daily effort of 26-50 hr was determined to be significantly higher than catch rates at total daily effort exceeding 50 hr by using Kramer's (1956) modification of Duncan's (1951) multiple-range test. Other differences between individual means were not determined due to the inherent problems of unequal replication.

Trophy Trout Creeled

During the first year under trophy management, 13 brown and 1 rainbow trout of legal size were taken from Waters Creek (Table 2). In 1973 the number of "keeper" trout increased to 38, predominantly rainbow (60.5%). Data through July 1974 show a predominance of brown trout (56.0%) in the catch, with fewer fish being taken than in 1973. Mean weights of fish creeled 1973-74 are greater than fish of comparable length creeled in 1972.

Table 2. Length and mean weight (kg) of trout creeled on Waters Creek, 1972-1974 (number of fish in parentheses).

	Inch Group	1972	1973	1974a
Brown	22	1.73 (3)	2.22 (5)	2.27 (4)
	23	1.86 (8)	2.72 (4)	2.30 (4)
	24	2.32 (2)	2.54 (2)	2.46 (3)
	25		3.63 (1)	2.61 (2)
	26		2.95 (1)	3.86 (1)
Rainbow	22	1.82 (1)	2.18 (8)	1.93 (4)
	23		2.41 (11)	2.67 (2)
	24		2.68 (4)	2.04 (2)
	25			2.61 (2)
Brookb	18			1.36 (1)
	19		2.09 (2)	
Totals		1.90 (14)	2.44 (38)	2.34 (25)

(a)1974 data summarized through July.
(b)Size limit 22 inches in 1972 and 18 inches in 1973-74.

The cumulative catch rate decreased sharply with progression of the 1972 season (Fig. 2). These were brown trout except for one rainbow creeled at the end of the season. The catch rate of brown trout fluctuated during the 1973 season, decreasing slightly after mid-season, and increasing during 1974. The total catch rate exhibited a gradual increase during 1973 and 1974, influenced by the increased creeling of rainbow over this period, and by brook trout entering the creel at about mid-season in 1973.

During 1973 a new state record brook trout was creeled. The fish measured 19 inches total length and weighed 2.47 kg.

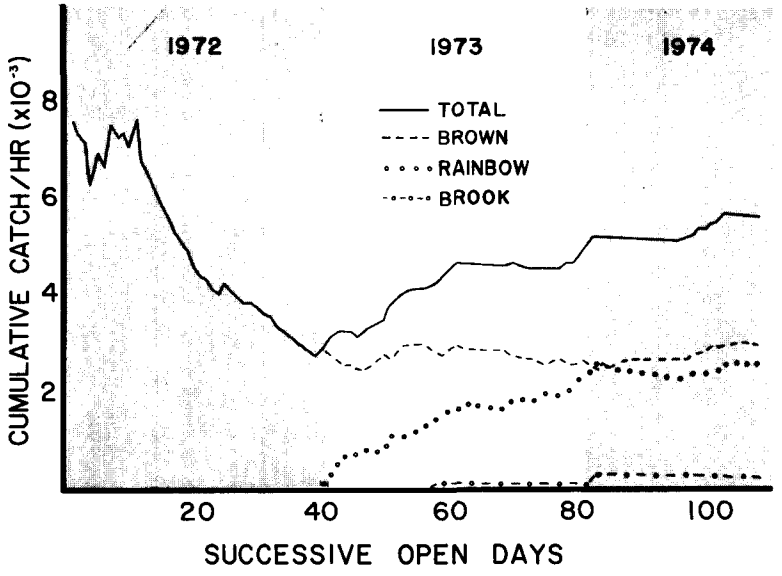

Figure 2. Cumulative frequency distribution of catch rates of trophy brown, rainbow, and brook trout creeled with progressive angling days on Waters Creek, 1972-1974.

Population Density

A total of 49 trout 4-22 inches total length were collected at the 6 sampling stations (Table 3). Standing crop varied from 17.0 kg/ha at the lower station to 104.4 kg/ha at the second station upstream. *Notropis* sp. and *Nocomis* sp. occurred at 2 stations.

Twenty-four trout were collected from 2 large pools directly below feeding points. These ranged from 10 to 25 inches, with a combined weight of 33.7 kg.

Program Economics

The cost of managing Waters Creek as a trophy trout stream with supplemental feeding (Fig. 3) includes pelletized trout feed at state contract prices, feed transport to the stream, area manager's time devoted to feeding, and laborer's salary for feeding and conducting the creel survey. The gross cost was $4159 and $3017 in 1972 and 1973, respectively.

Table 3. Length frequencies and mean weight (g) of trout collected from six 76.2-m stations on Waters Creek, March 1974.

	Rainbow Trout		Brown Trout	
Inch Group	Number	Mean Weight	Number	Mean Weight
4	3	13	–	–
5	3	23	5	24
6	3	34	–	–
7	2	65	–	–
8	3	114	–	–
9	3	128	2	125
10	6	155	1	188
11	4	174	2	238
12	–	–	2	263
13	1	235	–	–
14	1	428	–	–
15	2	423	–	–
17	–	–	2	937
19	1	965	–	–
20	2	1306	–	–
22	–	–	1	1958

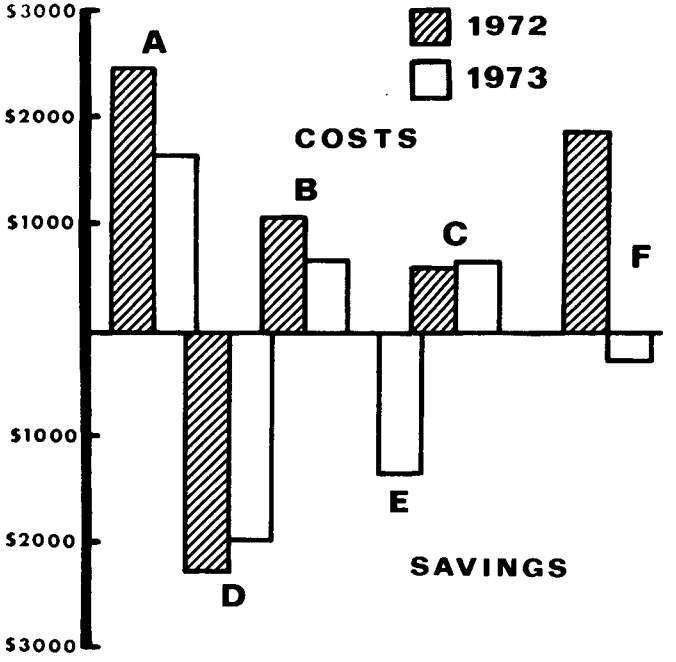

Figure 3. Economics of the Waters Creek trophy trout program, 1972-1973. (A) Laborer's salary for checking creel and feeding, (B) Feed cost and transport to stream, (C) Area manager's salary for feeding, (D) Cost of managing as a put-and-take fishery, (E) Permit sales, (F) Net cost or savings.

The cost to manage the stream as a put-and-take fishery to sustain equal fishing pressure was calculated on a cost per angler basis assuming mean catch/trip of 4 fish, mean composition of the creel of 89.4% stocked fish, and mean creel return of stocked fish of 75% (Hastings et al., 1968; England, 1974a); mean stocking weight of 151 g, and mean cost/kg of rearing and stocking of $2.09. The cost to maintain the mean catch/trip was approximately $1.51/angler. In 1973, the operational cost was also offset by the daily permit fee.

The net operational cost in 1972 was $1874. The following year, with the permit fee and a reduction in the amount of feed, a net savings of approximately $269 was realized in comparison with the cost of operation under put-and-take management.

DISCUSSION

The annual fishing pressure on Waters Creek averaged 324 anglers/km for 1972 and 1973. This pressure is high compared to 41 anglers/km per year on Noontootla Creek for 1964-1969, managed as a "catch-and-release" stream (Fatora, 1970). These anglers had little opportunity to take home a fish with a 16 inch size limit in effect.

However, the annual pressure on the Tallulah River, intensively managed as a put-and-take fishery, and probably Georgia's most heavily utilized trout stream, was estimated at 8100 anglers/km during 1973 from USFS use survey data. The annual pressure on Jones Creek, managed for its excellent native brown trout fishery, averaged 34 anglers/km from 1971 to 1973 (England, 1974a).

Waters Creek does not sustain the intensive annual use of the high-use put-and-take streams. It would not be desirable to attempt to maintain this high density use. However, when compared to a high quality stream under native management, or a "catch-and-release" stream, the annual pressure sustained was nearly nine times as much.

The annual pressure on Waters Creek decreased 13.5% from 1972 to 1973, with a corresponding increase in total hours fished (18.0%). The higher use the first year is probably somehwat attributable to curiosity created by the new program. The high number of return visits the first year (37.9%) and the number in 1973 that had fished the stream previously (48.6%) indicate that this program is developing a clientele.

The 3 year mean catch rate of 0.21 fish/hr on Waters Creek was low compared to 1.30 fish/hr on Noontootla Creek under "catch-and-release" regulations (Fatora, 1970). The catch rate on the native brown trout managed Jones Creek was 0.57 fish/hr from 1971-1973 (England, 1974a). The success (31.7%) was also lower on Waters Creek than on Noontootla (61.2%, Fatora, 1970), or Jones (41.8%, England, 1974a).

The lower catch rate on Waters Creek with its much higher standing crop is probably attributable to the higher fishing intensity on this stream. The catch rate on Waters Creek is definitely influenced by the daily pressure. The catch rate at a total daily effort of 26-50 hr is significantly higher than catch rates with higher pressures. This suggests that the optimum daily use for the 4.3 km managed section is approximately 12 anglers, a very low density use for the maintenance of "good fishing".

Kiefling (1972) suggested that catch rates of boat fishermen on cutthroat trout (*Salmo clarki*) on the Snake River were greater than bank fishermen because they could reach areas having less fishing pressure. A hypothetical example of depression of catch rate by increased fishing pressure was illustrated by Von Geldern (1961), based on field observations. Ratledge (1966) concluded that increased fishing pressure resulted in decreased catch/hr on stocked trout streams.

Although the fish in the original stockings were not tagged, the cumulative frequency distribution of the catch rates of the trophies creeled suggest their origin. The brown trout creeled in 1972 were undoubtedly from the initial stocking on 30 November 1971. Length-weight data from these creeled trophies revealed a decline in condition following release, indicating either a poor adjustment from hatchery conditions to the stream or stocking at too high a density.

The rainbow trout that comprised the majority of trophies creeled in 1973 were probably from the 13-15 inch fish released January 1972, increasingly entering the creel as they attained legal size. The increasing catch rate of brown trout in 1974 was probably influenced by the 11-12 inch fish stocked January 1972.

It is hoped that recruitment and rapid growth of stream-reared fish will be sufficient to sustain the trophy fishery. The majority of the fish creeled have probably resulted from the initial stockings. However, the increased standing crop between feeding points revealed by sampling, and the high density of sub-legal fish visually observed at the feeding points, indicate that natural recruitment and growth may sustain the fishery. If additional supplemental stocking becomes necessary, 12-15 inch fish are preferable over larger sizes due to their apparent ability to better adjust to supplemental feeding.

Standing crop varied widely among sample stations. The mean (44.7 kg/ha) was high compared to comparable southern Appalachian streams under conventional native trout management. Estimated standing crop in a 3.5 km section of the Coleman River was 9.1 kg/ha, based on the biomass of fish recovered from a stream renovation project (Fatora, 1973). England (1974b) reported 13.7 kg/ha from a renovated portion of the Chattahoochee River headwaters, while 9.8 kg/ha was reported from Cheohee Creek, South Carolina (Archer, 1972).

Estimated standing crop in Waters Creek was nearly double that in Steels Creek (23.8 kg/ha) after 9 months of supplemental feeding (Ratledge, Bonner, and Crowell, 1971).

The standing crop estimate for stream sections between feeding points definitely is a conservative estimate of the mean standing crop for the managed portion because of the high density populations maintained below feeding points.

The validity of management of a stream under a program of this type is questioned by both managers and the fishing public. The philosophy underlying Georgia's trout management program is to provide a variety of management programs for the trout angler, from high intensity use put-and-take streams to streams under native stream management, "catch-and-release", and the trophy trout program.

The cost of management under a trophy trout program is not as expensive as first appears. Compared to the cost of management of a put-and-take stream for equal pressure, the total expense is equal or somewhat less when supplemented by the daily fee.

The percentage of the area manager's time devoted to patrolling the stream was not added to the cost of management. If was difficult to estimate the additional enforcement time necessary under this program over that required for a put-and-take stream. However, had the area manager not been available, the additional cost of this program would be the salary of a manager to protect the stream from poaching. Following preliminary evaluation, additional savings can be realized by elimination of the creel census.

ACKNOWLEDGEMENTS

Mrs. Linda Adams and Mrs. Beverly Loggins were responsible for manuscript preparation. Mr. Leon Kirkland deserves special credit for project guidance and critical review of the manuscript. Mr. Dan Holder also reviewed the manuscript. Mr. Roosevelt Key (Wildlife Area Manager) certainly deserves thanks for his continued efforts in helping to make this project a successful venture.

LITERATURE CITED

Archer, D. L. 1972. Quantitative trout stream population studies, Job I-A, p. 2-13. *In* Fisheries investigations in lakes and streams, District 1, Project Annual Progress Report F-10-7 S.C. Wildl. and Marine Res. Dept. 56 p.

Duncan, D. B. 1951. A significance test for differences between ranked treatments in an analysis of variance. Va. J. Sci. 2:171-189.

England, R. H. 1974a. Trout stream creel census, Study XV, Job 2. *In* Statewide fisheries investigations, Project Final Report F-21-5, Ga. Game and Fish Div. In press.
England, R. H. 1974b. Renovation of trout streams, Study IV, Job 4. *In* Statewide fisheries investigations, Project Final Report F-21-5, Ga. Game and Fish Div. In press.
Fatora, J. R. 1970. Noontootla—a sixteen-year creel and use history of a southern Appalachian trout stream under changing management regulations. Proc. Ann. Conf. S.E. Assoc. Game and Fish Comm. 24:622-637.
Fatora, J. R. 1973. Renovation of trout streams, Study IV, Job 4. *In* Statewide fisheries investigations, Project Progress Report F-21-3. Vol. 1 (Studies I through V). Ga. Game and Fish Div.
Hastings, C., M. Bowling, D. Johnson, and J. R. Fatora. 1968. Northern region fisheries investigations. Project Final Report F-17-R-3, Ga. Game and Fish Comm. 220 p.
Kiefling, J. W. 1972. An analysis of stock densities and harvest of the cutthroat trout of the Snake River, Teton County, Wyoming. M.S. Thesis, Univ. Wy., Laramie. 184 p.
Kramer, C. Y. 1956. Extension of multiple range tests to group means with unequal numbers of replication. Biometrics 12:307-310.
Ratledge, H. M. 1966. The impact of increasing fishing pressure upon wild and hatchery-reared trout populations. Proc. Ann. Conf. S.E. Assoc. Game and Fish Comm. 20:375-379.
Ratledge, H. M., W. R. Bonner, and T. Crowell. 1971. The bio-economics of supplemental feeding of "native trout" waters. Statewide fisheries research, Project Summary Report F-19-3, Study XI, Job B, N.C. Wild. Res. Comm. Div. Inland Fish. 10 p.
Von Geldern, C. E. 1961. Application of the DeLury method in determining the angler harvest of stocked catchable-sized trout. Trans. Amer. Fish. Soc. 90(3):259-263.

REVIEW OF COLDWATER FISH MANAGEMENT IN TAILWATERS

by

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ABSTRACT

A trend in the stocking procedure of trout in tailwaters has developed as an outcome of increasing fishing pressure. Fingerling stocking of trout was initially recommended in tailwaters where an adequate food supply was available, and predation by predatory fish was not considered a problem. Eventually, fishing pressure increased and the fingerling trout were harvested before reaching a desirable size necessary to maintain a quality put-grow-and-take fishery. Consequently, stocking of larger catchable-size trout was resorted to; this procedure resulted in a quality put-and-take fishery. Several basic concepts pertaining to the development of trout fisheries in tailwaters were conceived after intensive investigation. The fishing pressure and harvest must first be known in order to stock trout at a proper rate and at the proper time to sustain a quality fishery. One technique that has had a great impact on the harvest in tailwaters that are relatively inaccessible to bank and wading anglers is the development of boat fishing. The major problem of most tailwater trout fisheries is that of erratic flow; a more sustained flow would provide better fishing conditions, alleviate periods of low-dissolved-oxygen levels and elevated water temperatures that are detrimental to trout, and prevent periods of high flow that can retard bottom fauna productivity and consequent trout growth.

INTRODUCTION

With the advent of multilevel intake structures in dams, the tailwater fishery can be manipulated by the selection of desirable water temperatures for the discharge, whether it be for the management of warmwater fishes, or coldwater fishes, or both. One of the first dams to be constructed (by the U. S. Corps of Engineers, Louisville District) with the capabilities of selective withdrawal was Nolin Dam, in 1963, on the Nolin