

## Preferences, Specialization, and Management Attitudes of Trout Anglers Fishing in Tennessee Tailwaters

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*Abstract.*—Efforts to manage several trout fisheries in Tennessee have been stymied by conflicts between management agencies and angler groups. To assist in preventing such conflicts in the future, we examined attitudes and motivations of trout anglers who fished eight tailwater fisheries in Tennessee during 2001–2002. Using a stratified random sampling design, anglers were contacted and interviewed on site ( $n = 2,643$ ). Those anglers who agreed to complete a questionnaire ( $n = 1,942$ ) were mailed a 10-page survey. Response rate to the mail survey was 55% after excluding surveys that were undeliverable. Angler subgroups were created using hierarchical cluster analyses of 14 variables related to experience, resource use, investment, and centrality of fishing to their lifestyle. Five subgroups of minimally to highly specialized anglers were identified, and nonhierarchical cluster analysis determined the size of each group ( $n = 178$ –369 anglers/group). Subgroups differed in the importance they attached to harvesting trout and catching trophy trout. The most disparate mean ratings among subgroups were for the motive of “obtaining fish to eat.” Specialized anglers placed greater importance on catching a trophy fish, experiencing the catch, developing their skills, releasing fish, and restrictive regulations than did less-specialized anglers. Mean ratings for most of nine fishing regulations presented to anglers differed among tailwaters; however, bait restrictions and closed seasons received little support across all rivers. The Caney Fork, Clinch, and Hiwassee rivers had the most uniform distributions of anglers among the five subgroups and thus had a relatively high potential for conflicts over management decisions. The fisheries on the Elk, South Fork Holston, and Watauga rivers were dominated by the most specialized subgroups, indicating that the majority of anglers on those rivers would accept restrictive regulations.

Fisheries have three common components: the aquatic organism of interest, the habitat they live in, and the people that pursue them (Nielsen 1993). All three components are capable of affecting each other and can be manipulated to benefit a fishery. Unfortunately, the effects of the people (i.e., anglers) involved in a sport fishery are often oversimplified. In the past, most studies that examined anglers viewed them as a homogeneous group in an attempt to define the average angler (Hendee and Bryan 1978). However, over the last 25 years, many researchers in the fields of human dimensions and fisheries management have concluded that the “average angler” does not exist and that angler populations actually contain heterogeneous subgroups with a wide range of often conflicting motivations and expectations (McFadden 1969; Bryan 1976). Quanti-

tatively defining these subgroups and their differing preferences can be of great use to fisheries managers when making management decisions (Ditton 1977), whereas ignoring the differences between existing angler subgroups can lead to unforeseen conflicts over management decisions.

In the 1990s, high-profile disputes arose between some stakeholders and the Tennessee Wildlife Resources Agency (TWRA) over the management of several tailwater trout fisheries. In one instance, a grass-roots organization of landowners and anglers was formed, lawyers were hired, and remedies were sought through legislation. A paucity of quantitative information existed in the mid-1990s on the biological resources in most of the tailwaters managed by the TWRA, and even less information existed on the human dimensions of these recreationally and economically important fisheries. This lack of data led TWRA to fund a large effort to quantify the biological and human components of the trout fisheries in the state’s tailwaters with the goal of developing defensible management plans that were biologically feasible and met the needs of the diverse angler clientele using these

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fisheries. This paper details the findings of the human dimensions component of this extensive study.

The conceptual framework of recreational specialization developed by Bryan (1977) has proven to be a useful method of examining angler heterogeneity. The definition of recreational specialization proposes that anglers can be divided into subgroups along "a continuum of behavior from the general to the particular." At one end of the continuum is the novice angler, who only fishes occasionally and whose fishing preferences are very broad in nature (Bryan 1979). At the other end of the continuum is the highly specialized angler, who fishes frequently and has very specific preferences about where, how, and what he or she pursues when fishing. As a participant's level of specialization increases, their orientation to the resource tends to shift from one of consumption to one of preservation and greater consideration of the overall experience (Bryan 1977). For anglers, this shift involves a move from harvesting fish to practicing catch and release. Bryan's (1977) initial research on the subject was based on qualitative data, but his work has since encouraged empirical studies into angler heterogeneity that have verified his framework (Graefe 1980; Chipman and Helfrich 1988; Ditton et al. 1992; Fisher 1997).

Graefe (1980) first proposed using fishing frequency (number of days fishing in the previous 12 months) as a univariate measure of angler specialization, as increased participation in a sport is a characteristic of higher specialization. One of the objectives of Graefe's (1980) research was to examine the relationship between specialization and angler motives and attitudes about the fishing experience. He found that anglers that fished more frequently gave higher ratings to activity-specific (catch-related) motives than for activity-general (noncatch) motives (Graefe 1980). Activity-specific aspects of fishing include the species, number, or size of fish caught, the disposition of the catch, the setting for the fishing trip, and the methods used to catch fish. Activity-general aspects of fishing include relaxation, getting outdoors, and being with friends and family, all benefits that could be obtained through almost any recreational activity (Driver and Cooksey 1977). This greater emphasis on catch-related motives led Graefe (1980) to conclude that anglers that fish more frequently were more dependent on the resource than their counterparts that fished less often, suggesting that fishing frequency is a feasible measure of specialization. Ditton et al. (1992) also used fishing frequency as a measure of specialization when they empirically tested several theoretical propositions central to the specialization framework. Ditton et al. (1992) concluded that the importance placed on

catching trophy fish by highly specialized anglers showed that they exhibited higher levels of resource dependency than did low-specialization anglers. Ditton et al. (1992) also concluded that high-specialization anglers rated activity-general aspects of fishing higher than did low-specialization anglers, suggesting a greater appreciation for the overall experience of angling.

Other researchers have adopted a multivariate approach to distinguishing levels of specialization, feeling that a univariate approach is too simplified (Fisher 1997). Chipman and Helfrich (1988) examined specialization among Virginia river anglers using a multivariate approach and cluster analysis to develop angler typologies. Their study used data on each individual's angling behavior to divide anglers into subgroups with cluster analysis. Chipman and Helfrich (1988) categorized angling behavior into four dimensions: the angler's use of the resource, angling experience, monetary investment in fishing equipment, and the centrality of angling to the angler's lifestyle. Resource use questions examined fishing techniques, preferred species, and harvesting frequency. The experience dimension concerned years of fishing experience and fishing frequency. The investment dimension described equipment ownership and overall monetary investment in the sport of angling. The centrality dimension examined the role of angling in the respondent's lifestyle, which could include club membership, fishing vacations, and social setting. Chipman and Helfrich (1988) generated scores for the four dimensions based on angler responses and used those scores in a cluster analysis to divide the anglers into separate subgroups with varying levels of specialization.

Chipman and Helfrich's (1988) four-dimensional analysis identified six angler subgroups of low to high levels of specialization. They found that anglers with high levels of specialization were more supportive of catch and release and that their standards for quality-sized smallmouth bass *Micropterus dolomieu* were greater than the standards set by less-specialized anglers. Fisher (1997) found similar results when he used a multivariate approach to determining specialization. Fisher (1997) found that highly specialized angler subgroups placed greater importance on the size of fish caught and the practice of catch and release, a shift that is important to fisheries managers making decisions involving the proper allocation and management of fishery resources.

Bryan (1977) treated the specialization continuum as a linear progression that anglers would naturally follow with increased experience in the sport, but research has suggested that progress along the specialization

TABLE 1.—General characteristics of eight tailwater trout fisheries at which anglers were surveyed in Tennessee. Operators are the U.S. Army Corps of Engineers (USACE) and Tennessee Valley Authority (TVA).

River	Dam	Operator	Maximum turbine discharge (m <sup>3</sup> /sec)	Reach sampled (km)	Number of trout stocked in survey year <sup>a</sup>
Caney Fork	Center Hill	USACE	350	26	123,708
Clinch	Norris	TVA	230	20	53,305
Duck	Normandy	TVA	0	15	52,951
Elk	Tims Ford	TVA	100	22	60,133
Hiwassee	Apalachia	TVA	80	30	117,500
Obey	Dale Hollow	USACE	100	7	62,500
South Fork Holston	Holston	TVA	68	22	68,734
Watauga	Wilbur	TVA	75	26	59,720

<sup>a</sup> Only "catchable" (>200 mm TL) brown trout *Salmo trutta* and rainbow trout *Oncerhynchus mykiss*.

continuum is more discrete in nature (Kuentzel and McDonald 1992; Fisher 1997; Scott and Shafer 2001). Empirical research has suggested that progression of specialization can be impeded or accelerated by an individual's socio-economic status, manner of introduction to the sport, and occurrence of life events (Kuentzel and McDonald 1992; Scott and Shafer 2001). The complicated nature of the specialization framework further illustrates the need for a multivariate approach.

The objectives of this study were to (1) use the concept of recreational specialization to classify trout anglers at eight tailwater fisheries in Tennessee into subgroups based on their angling behavior; (2) define primary motivations for each subgroup; (3) describe the angling preferences of subgroups; and (4) compare angler subgroup acceptance and support for various management options.

### Study Area

This study examined eight tailwaters in middle and eastern Tennessee (Table 1). All of the dam projects except one provided peaking hydroelectric power; Normandy Dam on the Duck River was not equipped with a turbine house. Maximum turbine discharges ranged from 80 m<sup>3</sup>/s or less in the Watauga, South Fork Holston, and Hiwassee rivers to more than 230 m<sup>3</sup>/s in the two largest rivers, the Clinch and Caney Fork rivers. Wade fishing is not possible, and bank fishing is severely curtailed in all of the tailwaters during hydroelectric power generation; drift boat fishing occurs regularly on the three smallest tailwaters during power generation and to a lesser extent on the Clinch River.

Throughout five of the eight rivers, the trout fisheries were managed with statewide trout regulations (i.e., 7-fish/d creel limit; no size limit; no bait or terminal tackle restrictions). Trout fishing in the South Fork Holston River was regulated with a protected slot limit (406–559 mm total length [TL]) for rainbow trout and

brown trout and a 7-fish/d creel limit (daily limit of 1 fish exceeding 559 mm TL). Also, fishing was prohibited in two short reaches of the South Fork Holston River to protect spawning trout each winter. In short reaches of the Hiwassee and Watauga rivers, quality trout fishing (QTF) regulations were in effect during this study. In those reaches (one per river), anglers could not use bait, the creel limit was 2 trout/d, and no fish shorter than 356 mm TL could be kept; statewide trout regulations were applied to the reaches above and below the QTF reach in each river. Attempts in the mid-1980s and early 1990s to establish QTF reaches on the Caney Fork and Clinch rivers failed because of unexpected stiff opposition by local landowners. Previous creel surveys conducted on the eight tailwaters have revealed that the majority of anglers are from the local counties.

### Methods

*Survey design and implementation.*—Anglers fishing for trout on the eight rivers were contacted on site between February 2001 and January 2002. Sampling was conducted using a roving creel survey. A clerk sampled three weekend days and three weekdays chosen randomly each month. Each sample day was divided into morning and afternoon work shifts that had equal probabilities of being sampled. Anglers were intercepted at access sites used by trout anglers as determined by creel surveys conducted on each study river during the previous 5 years. Clerks were instructed to contact all anglers present when possible. The creel clerk was instructed to approach every other party if there were too many anglers present to interview all of them in the time allowed.

Anglers who agreed to participate were asked several questions relating to the economic value of the fisheries as part of a concurrent study. When the on-site survey was completed, they were asked if they would be willing to participate in a follow-up mail survey that included the questions examined for this

study. Those that agreed to participate were sent a 40-item questionnaire and a cover letter within 2 months of initial contact. Survey questions, format, and administration followed Dillman's (1978) total design method. Two reminders were mailed out about 10 and 30 d after the first mailing. The last reminder included a new survey in case the original survey was misplaced.

*Angler specialization.*—The 10-page mail survey was used to collect data on an individual's angling behavior and experience, equipment investment, fishing preferences, motivations, opinions on fisheries management options, and general demographic information. Data from 15 of the 40 questions were used to generate angler subgroups, and the questions were broken into four categories devised by Chipman (1986): resource use, experience, investment, and centrality of angling to lifestyle. Resource use questions examined the percentage of an angler's fishing effort directed at trout, species preferences, and how often the angler harvested trout (Bryan 1977; Chipman 1986). The experience questions addressed the number of years of trout fishing and the number of trout fishing trips made in the previous year (Chipman 1986). The investment questions examined monetary investment in trout fishing equipment (Wellman et al. 1982; Chipman 1986). The questions on centrality of angling to lifestyle examined length of fishing vacations, maximum distances traveled to fish, and the role of fishing in the angler's life (Bryan 1980; Wellman et al. 1982; Chipman 1986).

Answers to most questions followed an ordinal scale format; experience questions were left open-ended to provide continuous data (Chipman 1986). Final answers to the 15 questions used to generate angler subgroups were standardized to a minimum score of 0 and a maximum of 1. This was accomplished by subtracting each respondent's answer by the minimum answer value given to that question and then dividing the sum by the range of answer values given by the other respondents. These values were then inverted for variables that negatively correlated with specialization (i.e., harvest frequency). Standardized scores of 0 indicated low specialization, while scores of 1 indicated high specialization (Chipman 1986). Scores were summed within each of the four dimensions designed by Chipman and Helfrich (1988) and then standardized once again to a value between 0 and 1 to give each dimension equal weighting. The standardized dimension scores were then used in the cluster analysis to determine angler subgroups.

Cluster analysis techniques followed those used by Fisher (1997). Hierarchical cluster analysis was used to determine the number of angler subgroups. Two different methods were used to ensure that the number

of clusters formed was consistent: Ward's minimum variance and McQuitty's method (SAS Institute 1988). The number of angler subgroups was determined by plotting the number of clusters generated by each iteration against the cubic clustering criterion (i.e., value at which various groups of clusters are formed; Aldenderfer and Blashfield 1984; Fisher 1997). The size of angler subgroups was determined by nonhierarchical cluster analysis after the number of clusters had been determined by hierarchical cluster analysis. We used a convergence value of 0.02 to determine the seeds, or mean index values, for the clusters.

*Angler motivations and preferences.*—Four multiple-part questions were included in the survey to ask anglers about their motivations for fishing, angling preferences, and opinions on certain management regulations and practices. Each used a balanced, five-point, Likert-type scale to measure the importance or level of agreement an angler placed on a given point (Graefe 1980). The first question asked anglers about the importance of 14 possible sources of motivation for trout fishing. These questions included both general reasons for fishing (e.g., relaxation), and resource-oriented reasons (e.g., catching fish to eat). The second question examined angler agreement with 11 statements pertaining to an angler's catch and harvest preferences. This question determined the following factors' importance to the angler's satisfaction: catching lots of trout, size of trout caught, harvest or release of the trout caught, method with which the trout were caught, and type of trout caught.

The third question asked anglers if they would oppose or support nine types of potential fisheries regulations if implemented on the river they fished most often. The fourth question asked anglers how important they thought four management actions were to improving and maintaining trout fishing in Tennessee. Answers for these questions were averaged within angler subgroups and then compared between subgroups using analysis of variance (ANOVA) and the Bonferroni multiple comparison test (SAS 1988) with a tablewide significance of 0.05 to control the probability of falsely rejecting the null hypothesis.

*Demographics.*—Ten questions at the end of the survey collected demographic information about the anglers. These data were used to describe the demographics of the anglers that used different tailwaters and the anglers in different subgroups. Comparisons were made between tailwaters and subgroups using either categorical data models (Agresti 1990) with paired contrasts or ANOVA with Tukey's multiple comparison test, depending on whether the data were discrete or continuous in nature. All

TABLE 2.—Number and percent of survey respondents belonging to five trout angler subgroups as determined by cluster analysis of data from eight Tennessee tailwater fisheries, 2001–2002.

Angler group	Number of respondents	Percent of sample
1. Occasional trout anglers	253	18.9
2. Casual trout anglers	282	21.0
3. Fishing generalists	178	13.3
4. Consumptive specialists	369	27.5
5. Nonconsumptive specialists	259	19.3
Total	1,341	100.0

statistical analyses were performed in the Statistical Analysis System (SAS Institute 1988).

### Results

Clerks interviewed 2,643 trout anglers at the eight tailwaters between February 2001 and January 2002; 1,942 of these anglers agreed to participate in the mail survey. Of 1,864 deliverable surveys, 1,403 were returned with usable answers, giving us responses from 55% of the anglers originally interviewed on the tailwaters.

#### *Recreational Specialization*

Plotting the cubic cluster criterion against the number of hierarchical clusters formed by Ward's and McQuitty's clustering methods suggested that there were five distinct subgroups of anglers in the total sample of survey respondents. Nonhierarchical cluster analysis determined that the clusters ranged in size from 178 to 369 anglers (Table 2). Of the 1,396 anglers that responded to the survey, only the responses from 1,341 could be used in the cluster analyses because of missing data for 55 individuals. Table 3 summarizes the data for each of the five subgroups that were formed.

*Group 1.*—This group was unique in that it consisted of specialized anglers who were not specialists in trout angling. Only 14% of anglers in group 1 rated trout as their most preferred sport fish, and only 36% of their fishing trips in the previous year were spent targeting trout. Thus, trout were only of secondary interest to most of these anglers. Group 1 anglers averaged 16 d of trout angling in the previous year and 12 years of trout fishing experience. Sixty percent had invested less than US\$200 in trout fishing equipment. Only 26% reported ever taking a vacation to fish for trout or salmon, and 44% had never traveled more than 80.47 km (i.e., 50 mi) to fish for trout. Many (55%) reported harvesting trout “often” or “always.” They had moderate to high scores for the six centrality questions, which indicated that fishing was an

important activity to them. Group 1 was labeled “occasional trout anglers.”

*Group 2.*—Anglers in group 2 were the least specialized at fishing, but they spent more time fishing for trout than did anglers in group 1. Most (83%) ranked trout as their preferred sport fish, and they averaged 22 d of trout fishing in the previous year out of only 30 d fishing for all species. Anglers in group 2 exhibited moderate harvesting practices and investment in trout fishing equipment. Only 16% of them had ever taken a vacation to fish for trout or salmon, and they had the lowest average scores on the six centrality questions. Group 2 was labeled “casual trout anglers.”

*Group 3.*—This group was the third most specialized. Forty-five percent of anglers in group 3 ranked trout as their preferred sport fish. They averaged 35 d of trout fishing in the previous year, which represented 58% of their fishing trips. Anglers in group 3 averaged 22 years of trout fishing experience, the most of any cluster, and they invested the second highest amount of money in trout fishing equipment. About half of group 3 anglers harvested trout “often” or “always.” Sixty-two percent of them had gone on a trout fishing vacation, and 36% of them had traveled up to 322 km (i.e., 200 mi) to fish for trout. They also had moderate to high average scores on the six centrality questions. Group 3 anglers were labeled “fishing generalists.”

*Group 4.*—This group was the second most specialized subgroup of anglers; 88% ranked trout as their most preferred sport fish. Anglers in group 4 averaged 42 d of trout fishing in the previous year, which represented 81% of their fishing trips. They averaged 19 years of trout fishing experience, and 50% had invested a modest amount (\$201–500) in trout fishing equipment. Group 4 was equally divided into those that had taken a trout fishing vacation and those that had not. Group 4 anglers averaged moderate to high scores on the six centrality questions. Anglers in group 4 were much more likely to harvest trout than anglers in group 5 (nonconsumptive specialists); thus, they were labeled “consumptive specialists.”

*Group 5.*—This group was the most specialized of the five subgroups. Ninety-eight percent ranked trout as their most preferred sport fish. These anglers averaged 48 d of trout angling in the previous year (89% of their fishing trips). They had pursued trout for an average of 21 years, and 61% had invested between \$1,001 and \$5,000 in trout fishing equipment, the most of any group. Anglers in group 5 rarely harvested trout; 42% responded that they never harvested trout, and 36% harvested trout only rarely. Trout angling was an important part of their lives: 76% claimed to have taken a vacation with the primary purpose of fishing for trout or salmon, and 49% reported traveling over 804.67 km

TABLE 3.—Mean (SE) or percentage values for 14 cluster analysis variables used to assign trout anglers to one of the five angler subgroups based on responses to a survey at eight Tennessee tailwaters, 2001–2002.

Cluster variable	Angler group				
	1	2	3	4	5
<b>Resource use</b>					
Trout preference (%)					
First	13.8	82.6	44.9	88.1	97.7
Second	27.3	14.5	26.4	10.3	2.3
Third	25.7	1.4	6.2	0.0	0.0
Unranked	30.4	1.4	19.7	1.6	0.0
Harvest frequency <sup>a</sup>	3.8 (0.12)	3.0 (0.06)	3.3 (0.08)	3.1 (0.05)	1.8 (0.06)
Targeted effort <sup>b</sup>	36.3 (0.32)	78.3 (0.30)	58.0 (0.39)	81.1 (0.24)	89.0 (0.24)
<b>Experience</b>					
Days trout fishing	16 (0.33)	22 (0.30)	35 (0.43)	42 (0.36)	48 (0.41)
Years trout fishing	12 (0.21)	12 (0.20)	22 (0.28)	19 (0.20)	21 (0.24)
<b>Investment (%)</b>					
\$200 or less	59.7	59.6	0.0	9.5	0.0
\$201–500	36.8	36.5	0.0	50.4	0.0
\$501–1,000	2.0	3.2	34.8	39.8	17.8
\$1,001–5,000	0.0	0.0	51.7	0.0	60.6
\$5,001–15,000	0.0	0.0	10.7	0.0	16.6
\$15,000 or more	0.0	0.0	2.8	0.0	5.0
<b>Centrality</b>					
Fishing vacations (%)					
Never taken one	73.9	84.4	38.2	50.7	23.6
1–3 d	15.0	10.3	25.3	23.0	23.9
4–7 d	9.1	4.3	20.8	19.2	28.2
7–10 d	0.8	0.7	10.7	4.3	16.6
>10 d	1.2	0.0	3.9	2.4	6.6
Farthest distance traveled (%)					
0–50 mi	43.9	54.6	16.3	23.6	8.5
51–200 mi	38.3	36.2	35.4	44.7	22.4
201–500 mi	10.3	4.3	19.1	12.5	20.1
<b>Centrality statements<sup>c</sup></b>					
Fishing is my main form of outdoor recreation.	3.5 (0.07)	3.0 (0.06)	3.9 (0.08)	3.9 (0.05)	4.1 (0.06)
I find that a lot of my life is centered around fishing.	3.1 (0.07)	2.3 (0.06)	3.6 (0.08)	3.4 (0.05)	3.7 (0.07)
I have definite preferences about the types of water I like to fish.	3.7 (0.06)	3.2 (0.06)	4.2 (0.07)	4.2 (0.05)	4.3 (0.06)
I usually fish with people of about the same skill level as myself.	3.3 (0.06)	2.9 (0.06)	3.2 (0.08)	3.4 (0.05)	3.5 (0.06)
Most of my friends have the same interests in fishing as I do.	3.4 (0.06)	3.1 (0.06)	3.4 (0.08)	3.5 (0.05)	3.3 (0.07)

<sup>a</sup> Measured on a 5-point scale: 1 = never, 2 = rarely, 3 = occasionally, 4 = often, 5 = always.  
<sup>b</sup> Targeted effort = (days trout fishing in previous year) ÷ (total days fishing in previous year).  
<sup>c</sup> Measured on a 5-point scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

(i.e., 500 mi) to do so. Seventy-eight percent agreed that fishing was their main form of outdoor recreation. Group 5 also had the highest ranking on five of the six centrality statements. Group 5 was labeled “nonconsumptive specialists.”

*Demographic Characteristics*

The mean age of anglers in each group varied significantly ( $F = 4.19$ ;  $df = 4, 1,330$ ;  $P = 0.002$ ). Casual anglers (group 2) were significantly younger on average (42 years) than all other groups. There were significant differences among groups for education level ( $\chi^2 = 140.46$ ;  $df = 20$ ;  $P < 0.001$ ) and household income ( $\chi^2 = 123.06$ ;  $df = 20$ ;  $P < 0.001$ ). Nonconsumptive specialists (group 5) were by far the most educated and wealthiest group; 81% had

completed at least some college coursework, and 27% had annual household incomes over \$100,000. The percentage of individuals in the other groups with at least some college education ranged from 40% (occasional trout anglers; group 1) to 65% (fishing generalists; group 3). The percentage of anglers in the other groups with annual household incomes exceeding \$100,000 ranged from 5% (group 1) to 17% (group 3).

*Angling Methods*

The relative frequency with which anglers used certain fishing methods varied significantly with specialization. As angler specialization increased among angler groups, so did the use of fly fishing gear ( $\chi^2 = 320.34$ ;  $df = 16$ ;  $P < 0.001$ ). The exact opposite was the case with bait fishing, the use of

TABLE 4.—Mean responses (scale of 1–5) of five trout angler subgroups (Table 2) at eight Tennessee tailwaters to statements about motivations for trout fishing, attitudes towards catching trout, and opinions on trout fishing regulations. Within each statement or item, responses with the same lowercase letter were not significantly different ( $P = 0.05$ ).

Statement or item	Angler group					F	P
	1	2	3	4	5		
<b>Motivation<sup>a</sup></b>							
To be outdoors	4.4 z	4.3 z	4.5 zy	4.6 y	4.6 y	5.77	<0.001
For family recreation	3.8 z	3.6 zy	3.7 zy	3.8 z	3.4 y	5.13	<0.001
To experience new things	3.6 zy	3.4 z	3.6 zy	3.7 y	3.7 zy	2.48	0.042
For relaxation	4.5 zy	4.4 z	4.4 zy	4.6 y	4.6 zy	3.23	0.012
To obtain fish for eating	3.2 z	2.8 y	3.0 zy	3.0 zy	1.8 x	57.69	<0.001
For the experience of the catch	4.1 z	4.1 z	4.2 zy	4.5 y	4.3 y	9.61	<0.001
To be with friends	3.8 z	3.8 z	3.7 z	3.8 z	3.8 z	0.98	0.418
To develop my skills	3.5 z	3.6 z	3.7 zy	4.0 y	4.0 y	11.87	<0.001
To get away from the regular routine and other people	4.0 z	4.0 z	4.1 zy	4.3 y	4.2 zy	5.76	<0.001
To catch a trophy fish	3.3 zy	3.0 z	3.3 y	3.5 y	3.4 y	8.55	<0.001
For the challenge or sport	3.8 z	3.8 z	4.1 y	4.3 y	4.3 y	17.95	<0.001
To share my knowledge of fishing with others	3.1 zy	2.9 z	3.2 yx	3.4 x	3.4 x	11.72	<0.001
For physical exercise	3.2 z	3.0 z	3.2 zy	3.5 y	3.2 z	7.47	<0.001
<b>Attitude<sup>b</sup></b>							
The more trout I catch, the happier I am.	3.7 z	3.5 z	3.6 z	3.7 z	3.6 z	1.59	0.174
Keeping trout I catch is more enjoyable than releasing them.	2.7 z	2.3 yx	2.6 zy	2.3 x	1.4 w	50.65	<0.001
The bigger the trout I catch, the better the fishing trip.	3.9 z	3.6 z	3.8 z	3.8 z	3.7 z	2.40	0.049
A fishing trip can be a success even if I catch no trout.	3.6 z	3.7 z	3.7 z	3.8 z	3.8 z	1.83	0.121
Catching a trophy trout is the biggest reward for me.	3.0 zy	2.9 z	3.2 zy	3.3 y	3.3 y	6.57	<0.001
When I go fishing, I am not satisfied unless I catch something.	2.9 z	2.7 z	2.7 z	2.9 z	2.7 z	2.72	0.028
Bringing trout home to eat is an important outcome of fishing.	3.0 z	2.6 y	3.0 zy	2.8 y	1.6 x	60.20	<0.001
How I catch trout is as important to me as actually catching one.	3.1 z	3.1 z	3.6 y	3.8 y	4.2 x	56.63	<0.001
I am just as happy if I release the trout I catch.	3.7 z	3.9 zy	3.8 zy	4.1 y	4.7 x	37.06	<0.001
I like to fish where I have a chance to catch a trophy trout.	3.7 z	3.4 y	3.9 zx	3.9 zx	4.0 x	11.25	<0.001
It does not matter to me what type of trout I catch.	4.0 z	4.0 z	3.8 z	4.1 z	3.9 z	2.24	0.063
<b>Regulation support<sup>c</sup></b>							
Minimum size limit	3.7 z	3.7 z	3.7 z	3.9 z	4.5 y	22.83	<0.001
Maximum size limit	2.9 zy	2.8 z	3.1 zy	3.2 y	4.2 x	43.08	<0.001
Slot limit	3.1 z	2.9 z	3.2 z	3.1 z	3.7 y	11.84	<0.001
Reduced daily creel limits	2.6 z	2.7 z	2.8 zy	3.0 y	4.1 x	64.88	<0.001
Prohibiting the use of bait	1.7 z	1.8 zy	2.2 y	2.1 y	3.7 x	101.55	<0.001
Single-hook artificial lures only	2.1 z	2.2 z	2.5 zy	2.6 y	4.0 x	84.54	<0.001
Catch-and-release-only areas	2.7 z	2.8 z	3.1 zy	3.2 y	4.3 x	54.84	<0.001
Closed seasons	2.4 zy	2.2 z	2.2 zy	2.2 z	2.6 y	4.12	0.003
Spawning refuge areas	3.5 z	3.6 z	3.7 z	3.6 z	4.2 y	11.21	<0.001
<b>Management action<sup>d</sup></b>							
Habitat improvement	4.0 z	3.9 z	4.4 y	4.2 zy	4.5 x	8.6	<0.001
Water quality improvement	4.1 zx	4.0 zx	4.4 yx	4.3 x	4.6 y	9.48	<0.001
Increased access to rivers	3.6 z	3.5 z	3.5 z	3.6 z	3.4 z	0.68	0.624
Increased stocking of trout	4.1 z	4.1 z	4.2 z	4.1 z	4.0 z	2.24	0.063

<sup>a</sup> Motivation scale: 1 = very unimportant, 2 = unimportant, 3 = neutral, 4 = important, 5 = very important.

<sup>b</sup> Attitude scale: 1 = strongly disagree, 5 = strongly agree.

<sup>c</sup> Regulation support scale: 1 = strongly oppose, 5 = strongly support.

<sup>d</sup> Management action scale: 1 = very unimportant, 5 = very important.

which declined in relation to the increase of specialization within angler groups ( $\chi^2 = 278.01$ ;  $df = 16$ ;  $P < 0.001$ ). The use of artificial lures, excluding flies, was fairly constant among angler groups with the exception of the nonconsumptive specialists, who rarely used them ( $\chi^2 = 154.7$ ;  $df = 16$ ;  $P < 0.001$ ).

*Motivational Differences*

Large sample sizes yielded highly significant ( $P < 0.001$ ) differences among groups for most (10 of 13) of the motives examined (Table 4), although the differences between means were sometimes as little as 0.3 points on a 5-point scale. One motive that did not differ

among groups was “to be with friends” ( $F = 0.98$ ;  $df = 4, 654$ ;  $P = 0.42$ ). The most disparate mean ratings among angler groups were for the motive “obtaining fish to eat”, which nonconsumptive specialists ranked much lower than the other four groups ( $F = 57.69$ ;  $df = 4, 657$ ;  $P < 0.001$ ). This finding was not surprising because harvest frequency was one of the variables used in the cluster analysis. The two specialist groups (i.e., nonconsumptive and consumptive) tended to rate the remaining motives higher than did the other three angler groups. Surprisingly, those two specialist groups also had identical or nearly identical mean responses to several key motivations, including catching a trophy

TABLE 5.—Percentage distribution of five trout angler subgroups (Table 2) from eight Tennessee tailwater fisheries and statewide. The proportion in each subgroup varied significantly between tailwaters ( $\chi^2 = 77.4$ ,  $df = 28$ ,  $P = 0.001$ ).

River	Angler group				
	1	2	3	4	5
Caney Fork	21.1	22.3	9.5	26.9	20.2
Clinch	17.9	21.6	16.6	25.0	18.9
Duck	35.8	15.1	9.4	26.4	13.2
Elk	22.2	14.8	9.9	28.4	24.7
Hiwassee	18.7	20.6	15.9	21.5	23.4
Obey	29.9	22.4	16.7	24.1	6.9
South Fork Holston	9.4	19.9	12.2	35.4	23.2
Watauga	6.5	23.6	8.9	35.0	26.0
Statewide	18.9	21.0	13.3	27.5	19.3

fish, experiencing the catch, and developing fishing skills.

*Catch Preferences*

Mean ratings for eight of the eleven catch preference statements differed among the five angler groups (Table 4). Differences among angler groups were most apparent for statements regarding the harvest of trout, which was of little importance to the nonconsumptive specialists. When asked if they were just as happy to release the trout they caught, nonconsumptive specialists agreed much more strongly than did the other groups. Significant differences existed among groups for statements regarding the pursuit of trophy trout and the importance of using specific angling methods to catch trout. In both cases, the more highly specialized the group, the more it agreed with the statements. The three statements with similar ratings among groups described the importance to overall satisfaction of catching numbers of trout, catching something, and trout type caught.

*Regulations*

Angler support for fishing regulations varied substantially among angler groups; nonconsumptive specialists consistently showed greater support than did the other groups (Table 4). The disparity of support between angler groups was most apparent for regulations involving reductions in daily creel limit, establishment of catch-and-release areas, and prohibition of bait or multi-hook artificial lures. The only regulation that was unsupported by most anglers in all groups was fishing season closure. Most anglers in all groups supported the use of minimum length limits and spawning refuge areas, such as those on the South Fork Holston River.

*Tailwater Comparisons*

The proportion of anglers in each subgroup varied between tailwaters (Table 5;  $\chi^2 = 77.4$ ;  $df = 28$ ;  $P =$

0.001). Consumptive specialists (group 4) were the single largest angler group at five of the eight rivers surveyed (Caney Fork River: 27% of all anglers; Clinch River: 25%; Elk River: 28%; South Fork Holston River: 35%; Watauga River: 35%). On the Duck, Hiwassee, and Obey rivers, consumptive specialists were the second largest group. On the Duck and Obey rivers, the largest angler group was occasional trout anglers (group 1). The largest group on the Hiwassee River was nonconsumptive specialists (group 5). Fishing generalist anglers (group 3) were the smallest or second smallest group on each river.

**Discussion**

The trout anglers targeted in this study were a diverse group of individuals that spanned the socio-economic spectrum and had a wide range of attitudes and desires pertaining to the resource. The cluster analysis revealed five groups of trout anglers that shared some similarities to one another yet possessed differences relevant to the management of the resource. Our results mirror those of previous studies elsewhere (Graefe 1980; Chipman and Helfrich 1988; Ditton et al. 1992; Fisher 1997; Romberg 1999), which identified several angler subgroups that ranged from the low to the high end of the specialization continuum outlined by Bryan (1977). These studies typically identified one or two highly specialized angler subgroups that placed greater emphasis on the catch-related attributes of the angling experience, showing specific interest in catching large or trophy fish and less interest in harvesting fish. Those studies also identified several subgroups of lesser specialization that emphasized the non-catch-related motives of relaxation and family recreation as being primary reasons for angling while being likely to harvest the fish they catch. The results of this study tended to follow the same pattern.

Primary sources of motivation differed significantly among the five trout angler subgroups outlined in this study. All anglers tended to rate the non-activity-

specific or non-catch-related motives fairly equally. However, the anglers in the less-specialized subgroups (occasional and casual trout anglers) tended to consider non-catch-related motives more important than catch-related motives. Anglers in the two more specialized groups (consumptive and nonconsumptive specialists) tended to place greater emphasis on catch-related or activity-specific motives for angling. Specialized anglers identified were more interested in pursuing trophy trout and being challenged by the sport than their less-specialized counterparts, and this is consistent with the findings of previous studies (Graefe 1980; Chipman and Helfrich 1988; Ditton et al. 1992; Fisher 1997). Connelly et al. (2001) identified two similar angler subgroups in a study of anglers in New York. They identified a subgroup of anglers that were skilled, coldwater fish consumers like the consumptive specialists in our study. They also identified a subgroup of skilled, remote-area, catch-and-release, coldwater stream anglers that exhibited the same preferences as our group 5.

Not surprisingly, an area of particular contention between angler subgroups in our study was whether to harvest trout. The five subgroups differed significantly for all motive and catch preference questions related to the importance of harvesting or releasing trout. Bryan (1977) observed that as an angler's level of specialization increased, so did their interest in preserving the resource, which led to the adoption of catch-and-release practices. This finding has been supported by studies of other angler populations (Chipman and Helfrich 1988; Romberg 1999); however, an interesting exception to this rule was exhibited in our findings.

The two specialized subgroups of trout anglers identified in this study, the consumptive (group 4) and nonconsumptive (group 5) specialists, exhibited significant differences in harvest rates and opinions on regulations. Group 5 exhibited high levels of specialization for all variables measured in the survey and was therefore ranked the most specialized subgroup. Group 4 exhibited high levels of specialization for most of the variables mentioned, but their low levels of investment, frequent harvest of trout, and opposition to restrictive harvest regulations were more characteristic of unspecialized anglers. The differences between the two specialized subgroups can be explained by differences in their demographic profiles. Anglers in group 5 had significantly higher incomes and were significantly more likely to have attended college than anglers in group 4. Kuentzel and McDonald (1992) found that low socioeconomic status could serve as an impediment to reaching greater levels of specialization. Low income easily explains the low investment in fishing equipment by group 4; however, given this group's

high levels of participation, there is no obvious explanation for the apparent lack of a preservationist ethic. There is a definite need for additional research expanding on Kuentzel and McDonald's (1992) initial exploration of the factors that impede the progress of some individuals along the specialization continuum.

The significant differences in harvest orientation and support for regulations between the consumptive (group 4) and nonconsumptive (group 5) specialists, despite both groups' high levels of participation in trout angling, gives further support to Fisher's (1997) assertion that the use of angling frequency as a univariate measure of specialization is oversimplified. If we had used angling frequency as a univariate measure of specialization instead of a multivariate approach, groups 4 and 5 would probably have been merged into a single group, preventing identification of the two subgroups that were most likely to conflict over management decisions. Failure to distinguish between groups 4 and 5 would have reduced the value of our findings for fisheries managers charged with overseeing the trout fisheries in Tennessee's tailwaters. In the future, researchers should be cautious of using univariate measures of specialization when attempting to identify recreational subgroups that may conflict with each other over resource management.

Tennessee trout angler subgroups with high levels of specialization showed greater support for management regulations than subgroups with low specialization, supporting the results of previous research (Chipman and Helfrich 1988; Romberg 1999). This is not surprising given the differences in motives, catch and harvest preferences, and angling techniques between anglers with low versus high levels of specialization. Less-specialized anglers tended to harvest trout more frequently, fished with bait, and placed little emphasis on catching trophy trout. As such, it is not surprising that less-specialized anglers opposed trophy trout regulations that limited their harvest and restricted them from using preferred angling methods. Conversely, this study also found that more specialized anglers did not oppose trophy trout regulations that limited trout harvest or fishing with bait, two things they were less likely to do anyway. This finding illustrates the point that angler opinions on how fisheries should be managed are not decided arbitrarily but are a logical extension of angler fishing preferences and behaviors. These observations explain the key differences in the management opinions of the five angler subgroups and the anglers using eight tailwaters across the state.

#### *Management Implications*

Differences in the attitudes and opinions of the five trout angler subgroups can and have led to conflict

between the various groups over how a given trout fishery should be managed. Dealing with these conflicts can be difficult. One approach is to seek a compromise that appeals to the desires of different angler groups. The use of slot limits on the South Fork Holston River is a good example. Slot limits protect larger trout to increase the number of trophy fish while still allowing the harvest of more numerous, smaller trout. Ideally, this should provide a good compromise between anglers that wish to harvest trout and those that want to increase the chance of catching a trophy. However, such compromises do not always work. When a compromise cannot be reached, managers may find themselves in the difficult position of having to make a unilateral decision.

Fisheries managers can best allocate resources by reviewing the motives and preferences of the five angler subgroups and knowing which subgroups dominate the angler constituency in each river. The Caney Fork, Clinch, and Hiwassee rivers had the most uniform distributions of anglers among the five subgroups, and thus the potential for conflicts over management decisions will be relatively high. The TWRA considered such information when it held public meetings in 2004 and overcame some initial opposition to enact a minimum size limit (457 mm TL) and creel limit (2 fish/d) for brown trout on the Caney Fork River (F. Fiss, TWRA, personal communication). On the Clinch River, the site of well-publicized conflicts in the 1990s, managers have decided to maintain the status quo for now. The diverse clientele of the Hiwassee River was in evidence when TWRA biologists successfully lobbied in 2004 to apply QTF regulations to the entire river (albeit only for brown trout) only to have that regulation rescinded a year later due to opposition by some anglers and landowners. Currently, QTF regulations for brown trout apply to about 25% of the Hiwassee River. The Duck and Obey River fisheries were dominated by less-specialized subgroups (occasional and casual trout anglers and fishing generalists); thus, the current put-and-take management strategy on those two systems is probably meeting their needs. Finally, the fisheries on the Elk, South Fork Holston, and Watauga rivers were dominated by the most specialized subgroups (consumptive and nonconsumptive specialists), suggesting that more specialized regulations would be or are accepted by the majority of anglers. The Watauga River already has special regulations in the form of a QTF reach. On the South Fork Holston River, a slot limit of 406–559 mm TL is still in effect, as are two spawning refuges. Anglers on these two rivers expressed greater support for most of the nine

regulations listed in the mail survey than did anglers on the other six tailwaters.

When there are several management alternatives and when the resource is protected regardless of which alternative is chosen, it is best to bring interest groups together in a format that allows them to share in the decision-making process with biologists serving as information providers. Advisory committees consisting of biologists and representatives of interested angler groups can work together to develop management plans that take into account the needs of all those involved while reducing excessive conflict over management decisions (McMullin 1996).

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