FACTORS RELATED TO ANGLER COMPLIANCE IN A BLACK BASS FISHERY, JAMES RIVER, VIRGINIA

by

Ron W. Kokel

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APPROVED

Larry A. Nielsen, Co-Chair

Donald J. Orth, Co-Chair

Louis A. Helfrich

Louis A. Helfrich

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(ABSTRACT)

An on-site interview and mail survey questionnaire of anglers on the James River, Virginia, was conducted to compare the characteristics of anglers, estimate angler compliance and illegal harvest, and determine the factors related to angler compliance with a black bass slot length limit regulation of 280 to 356-mm (11 - 14 in) and a daily creel limit of five bass. Boat and bank anglers differed significantly in yearly tackle expenditures, travel distances, knowledge of existing regulations, and species preference. Angler compliance with the slot limit averaged nearly 85% for the entire river, while angler compliance with the creel limit was over 99%. The total illegal harvest of black bass averaged approximately 10% of the total bass harvested. Comparisons between known complying anglers and known non-complying anglers showed differences in daily bait expenditures and yearly tackle expenditures. Non-complying anglers had a yearly tackle expense that was one-half that of complying anglers, and a

daily bait expense that was more than twice that of complying anglers. All other characteristics were similar. Comparisons between anglers who knew the regulations and those who did not showed differences in species preference and yearly tackle expenditures. For fishery managers, understanding the factors related to an angler's probability of complying will be an important criteria when establishing or changing fishing regulations. By understanding those factors that cannot be manipulated by managers and serve only as predictors of compliance (i.e., angling methods), and those factors that can be modified (i.e., regulation knowledge), managers should better comprehend angler behavior.

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INTRODUCTION

The use of harvest regulations by fishery managers is a generally accepted technique to manage fish populations. Regulations may be altered or changed because of a shift in the fish population structure or a change in the desired management goals. While the effects of these regulation changes on the fish population have often been studied, the effects on the angler population have largely been neglected.

The management of anglers can generally be broken down into two types of management: indirect and direct management (Dawson and Wilkins 1981). Indirect management emphasizes influencing or modifying anglers' behavior so that an angler's freedom of choice is retained. Although indirect management offers less control over the fishery than direct management, it is usually less costly. Direct management is used to restrict the individual angler's choice and regulate an angler's behavior, thereby providing a higher degree of control. The associated costs are usually substantially higher than with indirect management strategies.

The two primary concepts of indirect management are information dissemination and angler eligibility requirements. Information dissemination consists of strategies such as

promoting fishery conservation education and the nonconsumptive aspects of sport fishing. Information dissemination includes angler educational programs such as catch-and-release fishing, fish ecology and population dynamics, and limiting competitive tournaments (Dawson and Wilkins 1981). Using angler eligibility requirements as a management tool consists of strategies to license either recreational fishermen or to license recreational fishing boats. All states currently use some licensing strategy.

Two concepts are commonly associated with direct management: (1) reducing or limiting the total catch, and (2) protecting a portion of the fish population (Dawson and Wilkins 1981).

A reduction or limit of the total catch can be achieved by all or one of three strategies. The first, reducing the efficiency of anglers, is accomplished by either gear type restrictions, season restrictions, or a combination of both. The second strategy, limiting catch, one of the most commonly used strategies, is accomplished by either establishing daily and/or seasonal harvest limits or prohibiting the sale of catch. The third, limiting fishing units, is accomplished by either limiting entry, limiting the amount of gear, or limiting the number of anglers per boat.

The second type of direct management, protecting a portion or segment of the fish population, consists of strategies to protect either large or small fish, certain age classes, or stocks during critical life stages or conditions. These strategies are usually accomplished by using either minimum or maximum size limits, slot limits, minimum gear sizes, or the closing of certain areas at certain times of the year.

To evaluate the utility and effectiveness of different fishery management regulations, several criteria can be used by managers: (1) the regulation's enforceability, (2) the regulation's acceptability to anglers and managers, (3) the probable change in catch, (4) the economic impacts, (5) the probable change in angler participation, (6) the preferences of anglers for various regulations, and (7) angler motivations for fishing (Dawson and Wilkins 1981). It is the regulation's acceptability to anglers that I will concentrate on in this study.

When faced with a regulation(s) change, anglers have few choices or responses. They can increase or decrease their effort, change their fishing style or method, or simply not comply with the new regulation(s). Because anglers are a

heterogeneous group (Bryan 1977; Chipman and Helfrich 1988), their responses will vary. The least desired response, from the fishery manager's standpoint, is a high degree of angler non-compliance.

Angler compliance with fishing regulations is an important but largely overlooked matter in the success of fisheries management. The degree of compliance with a regulation can be a major determinant of the efficacy of restrictive size limits (Paragamian 1984). A small percentage of non-compliance with a harvest regulation can significantly affect the desired management results (Redmond 1986). Without a high degree of voluntary compliance by anglers, a size limit probably will not succeed (Novinger 1984). By understanding the different responses of anglers to regulation changes, a fishery manager may predict the anglers' reaction to a proposed change. An optimum social and biological management policy can then be implemented.

Few investigations have dealt seriously with the issue of angler compliance (Paragamian 1982). Although a number of studies have estimated angler compliance with current fishing regulations, none have tried to either predict compliance with new regulations or to incorporate the compliance factor in management decisions.

I used the black bass Micropterus spp. fishery in the James River, Virginia, as a case study on angler compliance. The James River offered a good case study for several reasons. A 280 to 356-mm (11-14 inch) slot length limit and a creel limit of five per day for black bass was imposed January 1, 1987. A daily creel limit of eight bass per day and no minimum length limit were in effect before the change in regulations. The change was not highly publicized. In addition, the river flows though several distinct geographic regions and metropolitan areas in the central portion of Virginia, and easy access is possible from both the northern and southern parts of the state. This provided a good cross section of the different angler types or groups which used the river.

Most harvest models assume complete compliance, i.e., no fishing mortality in the protected size ranges (Clady 1975; Taylor 1981; Zagar and Orth 1986). This assumption is unrealistic according to published angler compliance studies (Mense 1981; Kauffman 1983; Glass and Maughan 1984; Paragamian 1984; Austen and Orth 1986; Novinger 1987). Understanding anglers' reactions to varying management schemes must be more completely evaluated to predict the impact of regulations on sport fish populations more effectively. The objectives of my

study were:

(1) describe angler characteristics on the James River, Virginia,

(2) estimate the compliance of anglers with current length-limit regulations on the James River, Virginia,

(3) identify the factors affecting angler compliance, and

(4) develop a predictive model of angler compliance with existing and novel length-limit and creel regulations.

LITERATURE REVIEW

Angler compliance with length-limit regulations and the proportion of illegal harvest have been estimated for a small number of fisheries and are quite variable. Paragamian (1984) found that only 85 to 87 percent of the anglers who actually caught sublegal fish complied with a 12.0-inch minimum-length limit for smallmouth bass M. dolomieui. Glass and Maughan (1984) found sublegal harvest to range over several years from 8 to 65 percent of all bass taken from Sooner Lake, Oklahoma. In five other Oklahoma reservoirs, illegal harvest of sublegal fish ranged from 0.0 to 42.8 percent of total harvest (Mense 1981). In Table Rock Lake, Missouri, Novinger (1987) found that only 1.8 percent of anglers possessed a sublegal fish, but this was equivalent to 15 percent of the estimated legal harvest of largemouth M. salmoides and spotted bass M. punctulatus. Similarly, at Watkin's Mill Lake, Missouri, the annual illegal harvest of largemouth bass was an estimated 26 percent of all protected bass in a slot-length limit of 12.0 to 14.9 inches (Eder 1984). In Virginia, sublegal harvest of smallmouth bass ranged from 6.8 to 17.9 percent of the total harvest on the Shenandoah River (Kauffman 1983) to 33 percent of total harvest on the New River, Virginia (Austen and Orth 1986). Meador and Green (1986) found sublegal harvest of spotted sea trout Cynoscion nebulosus in Texas to be

approximately 12 percent of the total harvest, and Iverson and Moffett (1962) found that 13 percent of the sportfish and commercial catch of spotted sea trout in Florida to be sublegal.

While the above studies point out that angler compliance rates can be quite variable between fisheries, very little account for this variability exists. Several reasons or factors have been cited for angler non-compliance with size-limit regulations, namely lack of regulation knowledge, poor understanding of regulation purpose, inadequate enforcement, and angler type or group. The first, and probably most obvious reason, is the angler's lack of knowledge of the regulation (Glass and Maughan 1984). Helfrich et al. (1987) found 26 to 70 percent of the anglers on the Shenandoah River, Virginia, did not know the correct size limit regulations for smallmouth bass after the establishment of three different regulated areas. Schramm and Dennis (1988) found that only 50 percent of all anglers on 18 municipal lakes in Lubbock, Texas, knew the correct largemouth bass regulations following a regulation change.

A second reason for angler non-compliance is a poor understanding of the purpose of the regulation (Glass and Maughan 1984). An important strategy for the future will be

to educate anglers on the value of harvest restrictions and to demonstrate success to them (Redmond 1986). Fishery managers must explain the basis of length-limit regulations to anglers (Paragamian 1982). A recent marine recreational fisheries action plan by the National Marine Fisheries Service (NMFS) stressed the need to educate and inform marine recreational anglers in order to achieve more effective public adherence to fishery regulations (NMFS 1989). Gabelhouse (1980) found that complying anglers believed that the length-limit regulations would benefit them.

Inadequate enforcement of length-limit regulations has also been found to be a contributing factor of angler compliance (Mense 1981, Coomer and Holder 1981, Glass and Maughan 1984). Rohrer (1986) attributed improved angler compliance in the second year of a new regulation with more enforcement, and Gabelhouse (1980) found that the threat of a ticket deterred anglers from the harvest of illegal fish.

A fourth factor of angler non-compliance relates to the angler type or group. Bass anglers are more likely to know the current regulations (Schramm and Dennis 1988) and comply with them (Glass and Maughan 1984) than non-bass anglers. Pelzman (1979) found organized bass fishing groups very supportive of minimum size limit regulations. These studies

support the idea that anglers are a heterogeneous assemblage and that to manage a sport fish stock effectively, the fishery manager must consider the different reactions of anglers to various management schemes.

One way to factor in the different responses or preferences of anglers is through angler specialization. Bryan (1977) was able to differentiate trout anglers into four different groups, occasionalists, generalists, technique specialists, and technique-setting specialists, based on differences in angling experience, commitment to fishing, preferences, and behavior. Based on Bryan's (1977) work, Chipman and Helfrich (1988) found six types of anglers on the New River, Virginia, and the Shenandoah River, Virginia, by partitioning across a continuum of specialization ranging from novice to specialist. Angler data in four areas were used to classify anglers: fishing preferences, orientation to the stream resource, history of interest in the sport, and relationship of fishing to other areas of life. Management scheme preferences differed among the six types, with the occasional or novice anglers preferring more liberal regulations, and the specialists preferring more conservative regulations.

McGurrin (1986) also found different angler types on a

put-and-take trout fishery in Maryland. Three specialty levels were provided for anglers to choose from in a self administered questionnaire and subsequently used for differentiation: occasionalists, generalists, and specialists. The three levels of anglers differed on fishing experience, trip frequency, and management preferences. Occasional anglers had the least experience, the lowest trip frequency, and generally favored increased creel limits. Specialists, on the opposite end of the specialty curve, had both the highest experience and trip frequency, while also favoring decreased creel limits and increased catch and release fishing. Using a classification system of this type, if a fishery manager knew the breakdown of angler types in his population, then a management policy could be tailored to both the angler and the fish stock. However, this could only be done if the different management preferences of the various angler types were known.

Other work on angler compliance has included studying the factors associated with fishing without a license. Smith and Smelzer (in press) found that an angler's age was the most significant factor in license violations on a public trout stream in Colorado. Younger anglers were more likely to non-comply than were older anglers. Nonresident violations were also slightly higher than resident violations, however,

less than five percent of all fishing trips taken were taken without a license.

In summary, the topic of angler compliance with fishing regulations has not been studied thoroughly enough to predict the reactions of anglers to changes in sport fish regulations. Most studies have not looked at angler reactions to proposed changes, only current compliance rates. The factors which have been related to non-compliance by anglers are both poorly studied and poorly understood. By understanding the angler reactions to regulation changes and the factors which affect these reactions better, an optimum management policy can be implemented that accommodates both the angler and the fish stock.

STUDY SITE

The James River is the longest river entirely in the state of Virginia (Figure 1). Formed by the confluence of the Jackson and Cowpasture Rivers in the Appalachian Mountains of western Virginia, the river flows easterly for more than 400 km to the city of Richmond where it becomes tidal. Above Richmond, the river basin is largely rural, but winds through several distinct geophysical regions and one major metropolitan area, Lynchburg.

Because of these differences, the river was divided into six major physical strata which represent different physical zones or have different use patterns (Figure 1) (Stanovick and Nielsen 1991). Area 1, the most upstream area, (96 km), west of the Blue Ridge Mountains, starts at the river confluence in Irongate downstream to Snowden Landing near the US Route 501 bridge and Snowden Dam. The river here is heavily used by both boat and bank anglers, as access to the river is well developed with six Virginia Department of Game and Inland Fisheries (VDGIF) landings and one commercial canoe livery, located in Buena Vista, in the section. The area has the highest river gradient as it passes through the Blue Ridge province. Area 2 (48 km) starts at Monocan Park above Lynchburg City running downstream to Bent Creek Landing at the

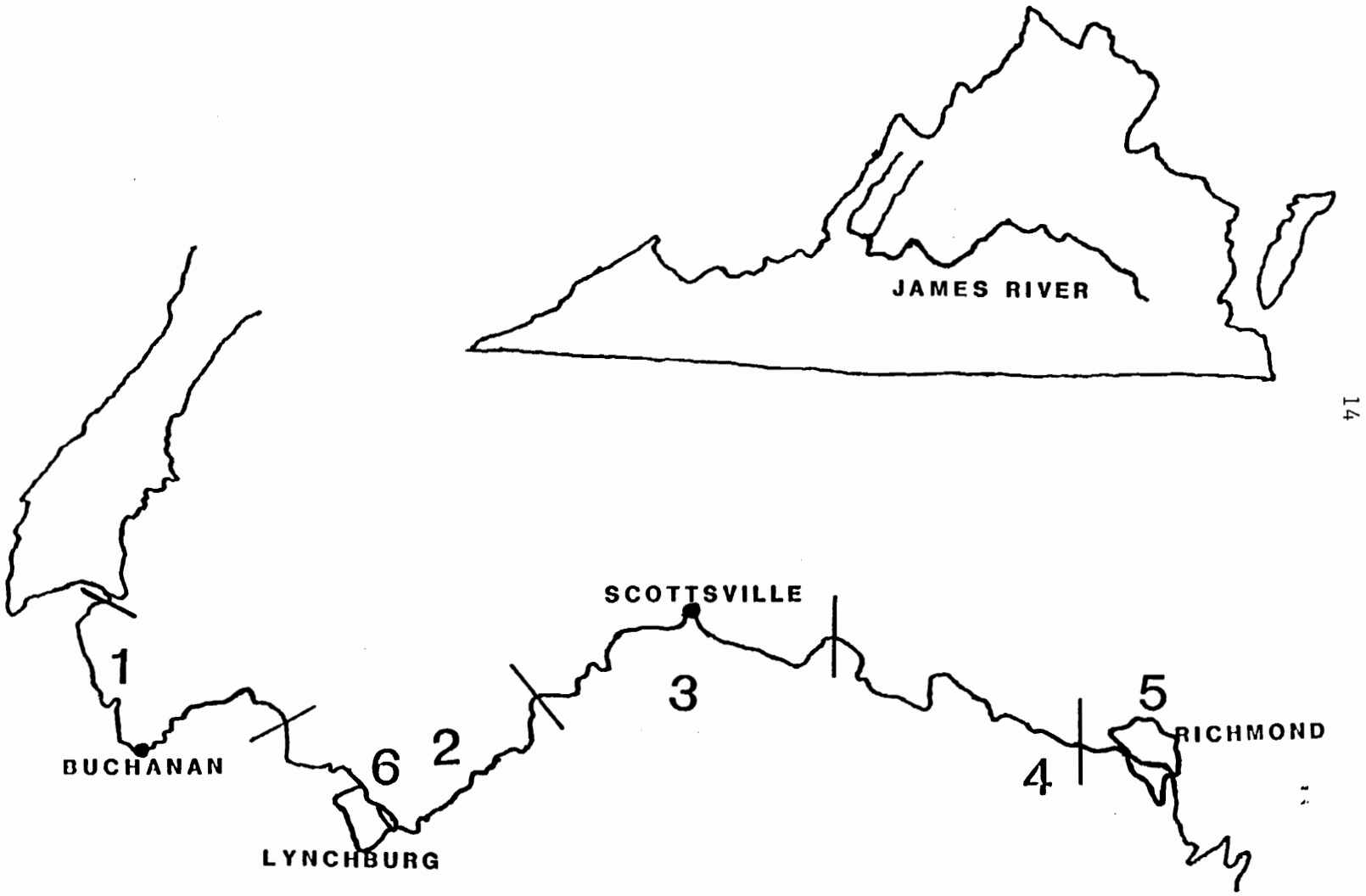

Figure 1. James River basin and study areas.

US Route 60 bridge below Lynchburg, but excluding a 5 km river section in the city of Lynchburg (see Area 6). Boat access in this area on the edge of the Piedmont Region is limited with large inaccessible stretches, however bank anglers have relatively easy access. One canoe livery at Galts Mill, below Lynchburg, serves this area. Area 3 (80 km) runs through the Piedmont Region of Virginia from Norwood to Bremo Bluff. The largely pastoral and forested area is characterized by five well developed VDGIF landings and two commercial canoe outfitters at Hatten and Scottsville. Area 4 begins at Columbia Landing running 64 km downstream to Watkin's Landing above Richmond. Access is very good with five equally spaced VDGIF landings and one canoe livery in Goochland. Use by both boat anglers and bank anglers (congregated at access points) is intense in this area. Area 5 consists of the city of Richmond from Boshers Dam above the city downstream 16 km to the I-95 bridge where the river becomes tidal. Access is nearly continual along the river with several city parks and landings. Angling use, however, is primarily bank/bridge fishing. Area 6 is the small, five kilometer section of river in the city of Lynchburg, from Scots Mill Dam to the Blackwater Creek park area. Bank angling is the predominant use in this area.

The primary sport fishery in the nontidal portion of the

James River is for smallmouth bass. Perhaps one of the best such fisheries in the country, the James River smallmouth bass fishery is one of the most valuable, yet until recently unstudied, fisheries in the state of Virginia. Anglers spent over 286,000 angling days on the James River in 1988. Boat angling accounted for approximately 55 percent of the trips, while bank angling accounted for the remaining 45 percent of the total trips (Garman et al. 1989).

METHODS

Because of the need to collect data of different types, several data collection procedures were used. First, various types of intercept surveys were used to obtain data from river anglers during their trips. Then, several months after the recreational season, a sub-group of anglers was asked to participate in a follow-up mail survey of their yearly activities.

Angler Intercept Surveys

James River anglers were interviewed on 162 days from March 1 through November 30, 1988. Sampling effort was distributed among the six spatial strata (areas) based on the subjective judgments of VDGIF fisheries managers and knowledgeable river users. Intensity of use values for river areas were assigned by fishery managers and combined with intensity scores assigned by the public to derive an overall index of use. Because Areas 5 and 6 were subsequently added in the course of the survey, sampling effort was made equal to Areas 4 and 2, respectively. Additionally, sampling effort was distributed among five seasonal strata. This also was based on the subjective judgments of the samplers. A detailed discussion of the calculations and methods used to assign sampling effort can be found in Stanovick and Nielsen (1991).

Sampling effort was further subdivided in the seasonal and spatial stratum into weekdays and weekend days. No fewer than two days within each stratum were sampled to allow the calculation of a variance estimate. The complete sampling effort is shown in Table 1.

In general, the survey consisted of a series of Robson-Jones surveys (Robson and Jones 1989), roving access-point surveys, roving shoreline surveys, and roving on-river surveys. Anglers interviewed included boat anglers and bank anglers.

The Robson-Jones survey method was used as the primary method in the four rural river sections (Areas 1-4). Designed for sampling large areas with limited access via specific access points, the method was ideally suited for the widely dispersed boat landings on the river. In summary, the surveyor traveled a specific route (consisting of an area), waited at an access point for a specified time, counted vehicles to determine effort, and interviewed arriving and departing anglers. The exact minute in the surveyor's day for beginning and ending each waiting period were defined. The starting point within each circular route and the direction of travel (upstream or downstream) within the eight-hour route

Table 1. Number of sampling days for angler survey on James River, Virginia, 1988.

Area	Day type	Season: Early spring (3/1-4/10)	Late spring (4/11-6/10)	Summer (6/11-9/5)	Early fall (9/6-10/16)	Late fall (10/17-11/30)	Total
1	Weekend	2	4	10	2	2	20
	Weekday	2	3	11	2	2	20
2 (+6)	Weekend	2	2	5	2	2	13
	Weekday	2	2	5	2	2	13
3	Weekend	2	2	7	2	2	15
	Weekday	2	2	7	2	2	15
4	Weekend	2	4	10	2	2	20
	Weekday	2	4	11	2	2	21
5	Weekend	-	-	8	2	2	12
	Weekday	-	-	9	2	2	13
Total	Weekend	8	12	40	10	10	80
	Weekday	8	11	43	10	10	82
Total		16	23	83	20	20	162

were randomly chosen.

The roving on-river survey method employed in the rural areas (Areas 1-4) was the standard roving creel survey. During an eight-hour day, a pair of surveyors floated downstream between two or more access points counting and interviewing all encountered anglers. The river portion sampled was chosen randomly from among those access points near the starting point for the Robson-Jones route driven the same day.

The roving access point survey was used to contact bank anglers at access points in rural areas (Area 1-4) and at specific points in Richmond City (Area 5). Since bank angling often occurred at predefined access points and the surveyor performing the Robson-Jones route was present at every access point within the route on every sampling day, roving access point surveys were employed to supplement bank angling information. Although both these data and the roving on-river survey data were based on incomplete trips, these methods were the only practical way to contact enough bank anglers.

The roving shoreline survey was used to survey the bank fishing population in Lynchburg City (Area 6). Because access was nearly continuous, bank angling was widely dispersed

within the city. Within the Robson-Jones survey route of Area 2, time was included for the surveyor to count and interview anglers while they were fishing. Again, these data were necessary based on incomplete trips.

Anglers were interviewed either before their trip, during their trip, or after their trip. Interviews were conducted as recommended by Malvestuto (1983). Anglers were approached and asked to participate, after which willing respondents were asked a standard set of questions. All interviews were completed in fewer than five minutes, and virtually all contacts were successful. Forty-six questions were asked relating to trip expenditures, yearly expenditures, trip frequency, regulation knowledge, trip itinerary, catch, species preference, and general comments (Appendix A).

A total of 1333 interviews was collected during the survey, composed of 867 boat anglers and 466 bank anglers.

Several statistical comparisons were used. Data for seasonal strata were pooled, as differences among the strata were insignificant. Mean values of expenditure estimates, distance traveled, and fishing trip frequencies were statistically tested by analysis-of-variance procedures on the Statistical Analysis System (SAS Institute Inc. 1988).

Knowledge of regulations among angler types was compared by chi-square analysis and standard errors of the mean percentages were calculated by treating the percentage as a binomial proportion as prescribed by Ott (1987).

Angler Mail Survey

The 1988 angler population, consisting of anglers contacted on the river, was surveyed via a mail questionnaire after the 1988 season. The questionnaire was designed, printed, and mailed according to the methods of Dillman (1978), with slight format modifications as described by Nielsen (1982). The 8-page survey included 19 structured questions and space for general comments (Appendix B). Up to three mailings were sent to 552 anglers randomly chosen from a nonstratified list of willing anglers interviewed during the on-river surveys (approximately 1200 anglers). The first mailing (April 7, 1989) included a cover letter (Appendix C), the questionnaire, and a stamped return envelope. One week later, a follow-up postcard (Appendix D), encouraging response, was mailed to everyone who received the first mailing. Two weeks later, a second copy of the questionnaire, a brief cover letter (Appendix E), and another stamped return envelope were mailed to all nonrespondents. Of the 552 questionnaires mailed to James River anglers, 24 were undeliverable. Of the remaining, 430 were returned, for an

81.4 percent response rate (Table 2).

Quantitative questions were structured so that respondents chose ranges rather than estimating actual values. At the sacrifice of some precision in actual estimates, this format was chosen to achieve a high return rate of completed questionnaires (Nielsen 1982; Nielsen and Orth 1988). For all such questions, the mid-point of each range was used as the average value for respondents choosing that range.

Data were compared statistically to the angler intercept survey data by transformation of the intercept data to the mail survey format. Since the intercept survey data were continuous and the mail survey data were categorical, the transformation was achieved by placing the angler intercept data in predetermined mail survey ranges as if on-river anglers had filled out the mail questionnaire themselves. For example, an on-river angler's yearly tackle expenditure estimate of $215 would be placed in the mail survey's format range of $200 to $500. Chi-square analyses were used to test for differences (Ott 1987). However, because of anonymity, on-river responses could not be compared to mail survey responses to determine a non-response bias.

Table 2. Mail survey response by James River anglers, 1989.

Results	Frequency N	(%)
Total sent	552	100.0
Undeliverable	24	4.3
Total deliverable	528	95.7
Returned	430	81.4

Angler Compliance Estimation

To estimate the probability of angler compliance with current length-limit regulations on the James River, Virginia, the previously described on-river roving survey design was used to contact anglers on the river. Harvested black bass were measured and counted to determine the legality of the catch. From the harvest data, the probability of angler compliance was calculated using the formula:

$$\text{Compliance Probability} = 1 - \frac{\text{\# of angler parties w/ illegal fish}}{\text{\# of angler parties who meet classification criteria}} \times 100$$

Classification criteria included all anglers who reported either catching more than five bass or catching one bass in the slot limit range. In other words, an angler could not meet classification criteria comply unless he/she had the opportunity to not comply with the regulations.

To measure the effect of angler non-compliance on the fishery, the illegal percent of the total harvest was calculated using the formula:

$$\text{Percent Illegal Harvest} = \frac{\text{\# of illegal fish}}{\text{\# of fish harvested}} \times 100$$

Data were separated into areas, as seasonal differences were insignificant, on the basis of the creel design in order to better describe the angler non-compliance. Additionally, compliance data were separated into slot limit and creel limit violations. By treating the data as a binomial proportion, confidence limits were set on all compliance estimates. Non-parametric statistics were done on both estimates of compliance to determine if significant differences existed among areas.

Factors Affecting Angler Compliance

Surveyed anglers were classified as either a complier or non-complier according to the legality of their catch. Anglers who possessed either a bass in the slot limit (280-mm to 356-mm) or a bass in excess of the creel limit (5 per day) were classified as non-compliers. Anglers who caught a bass in the slot limit and subsequently released it, or who caught more than five bass and kept no more than five were classified as known compliers. Field data were then analyzed concerning four alleged important compliance factors or areas:

A) Perceptions
   1) Knowledge of James River smallmouth bass slot length regulations
   2) Knowledge of James River smallmouth bass creel limit regulations

B) Resource use
   1) Species preference
   2) Amount spent on live bait
   3) Boat angler/ Bank angler
   4) Party size

C) Experience
   1) # of fishing trips/ month
   2) # of fishing trips/ month on James River

D) Investment
   1) Amount spent in last year on fishing equipment
   2) Distance traveled

A total of 217 anglers were classified as known compliers and 32 anglers as known non-compliers based on field interviews. Perception questions were not included in field interviews until late summer (August) of 1988, thus resulting in a lower sample size for this category than for the rest of the factors.

In the mail survey, known non-compliers (based on the

field interviews) were separated from the rest of the respondents. Because of the logistics and time associated with separating known compliers from the remaining interviews, all other mail survey recipients were assumed, for the purpose of the mail survey, to be compliers. Mail survey data were then collected on the same four alleged important compliance factors or areas:

A) Perceptions
    1) Knowledge of James River smallmouth bass slot regulations
    2) Knowledge of James River smallmouth bass creel regulations
B) Resource use
    1) Species preference
    2) Frequency of keeping fish
    3) Catching fish for food
C) Experience
    1) # of fishing trips/ month
    2) # of fishing trips/ month on the James River
D) Investment
    1) Amount spent last year on fishing tackle
    2) Amount of fishing tackle owned
    3) Belong to a fishing organization

Additionally, the number of times the angler was checked by a

VDGIF conservation officer while fishing on the James River was asked.

Data for field interviews were first analyzed using a t-test comparison between the two groups for continuous data. Categorical data were analyzed by chi-square analysis to test for differences between angler types (boat vs. bank, complier vs. non-complier) or river areas. To estimate confidence intervals, categorical data were treated as a binomial proportion and do not represent empirical confidence intervals. Mail survey data were also tested for differences between the two groups by chi-square analysis (Ott 1987). In all instances, the alpha level was 0.05.

To further characterize the factors affecting an angler's probability of compliance, intercept survey data were analyzed by the use of a logistic regression model (SAS Institute, Inc. 1988). The single binary dependent variable, in this case an angler's probability of compliance with "0" being non-compliance and "1" being compliance, was fitted using the four alleged compliance factors: regulation knowledge, live bait expenditures, fishing frequency, miles traveled, and fishing tackle investment. The alpha level was set at 0.05 in all instances.

Regulation knowledge should be an important factor in an angler's ability to obey fishing regulations. If an angler wishes to harvest fish, knowledge about the current regulations is an important asset. To guide natural resource information and education specialists in targeting their programs, an analysis of anglers in the mail survey that did not know the current regulations was conducted. Data were separated into those who knew the correct regulations concerning black bass and those who did not. Factors which could influence an angler's opportunity to learn the regulations were analyzed by chi-square procedures to determine if significant differences existed in the two angler groups. Factors analyzed included fishing frequency, club participation, species preference, frequency of keeping fish, game warden contact, consumption of fish, and yearly tackle expenditures.

Field data were also analyzed for regulation awareness factors by the previously mentioned logistic regression model. Angler knowledge served as the single binary dependent variable with the above angler compliance and knowledge factors serving as the independent variables.

Predictive Model of Angler Compliance

To provide a tool for future management actions, mail

survey recipients were presented with five different regulation scenarios. Scenarios consisted of a 14-in minimum length limit and five fish per day creel limit, a 14-in minimum length limit and two fish per day creel limit, an 11-in to 14-in slot length limit and five fish per day creel limit (present regulation), an 11-in to 14-in slot length limit and two fish per day creel limit, and a catch-and-release only regulation. Respondents were asked to rate their likelihood of complying with each scenario on a five-point scale of compliance ranging from "1", would always comply, to "5", would never comply, with "3" representing neutrality.

Data were first analyzed by chi-square analysis between known non-compliers and the remaining respondents. Because no significant differences existed between the two groups, all respondents were grouped together for further analysis. Angler profiles for each regulation scenario were then constructed of respondents who rated their likelihood of compliance as either "4" or "5", would never obey. Data were analyzed by chi-square procedures for each alleged compliance factor to determine if significant differences existed between anglers stating that they would not comply (4 or 5) with the presented scenario and remaining anglers who stated that they would obey (1 or 2). Additionally, data were analyzed by

chi-square procedures for each compliance factor to determine if significant differences existed within the angler groups opposed to the five different regulation scenarios. In all instances, the alpha level was 0.05.

RESULTS

Angler Characteristics

James River anglers interviewed on the river were generally active. They fished approximately six times per month with 50 percent of those times occurring on the James River (Table 3). They drove an average of 66.6 miles round-trip to reach the river. Anglers spent an average of $2.36 per day or approximately $181 per year (extrapolated) for the purchase of live bait, which was comparable to the amount they spent on yearly fishing tackle purchases ($214). In addition, anglers were not well aware of the current fishing regulations regarding black bass. Overall, only 38.5 percent of the anglers knew the slot-limit regulation and 36.2 percent knew the creel limit regulation.

James River boat anglers and bank anglers interviewed on the river gave statistically different responses to four use questions (Table 3). Boat anglers spent 75 percent more on yearly tackle expenditures than bank anglers. Boat anglers also traveled 30 percent farther than bank anglers to fish. In addition, the proportion of boat anglers who knew the current bass fishing regulations was nearly five times higher than bank anglers for knowledge of the slot-limit regulation and nearly twice as high for knowledge of the creel limit

Table 3. Mean value or percentage of responses given by anglers interviewed on James River, Virginia, 1988; asterisk denotes significant difference between boat and bank anglers ($P < 0.05$); SE denotes standard error.

Variable	All anglers Mean or %	SE	Boat anglers Mean or %	SE	Bank angler Mean or %	
Daily bait expense ($)	2.36 (n=1263)	0.12	2.30 (n=867)	0.16	2.45 (n=453	0
Distance traveled (mi) *	66.6 (n=1278)	4.3	72.8 (n=834)	4.0	55.0 (n=444	9
Yearly tackle expenditures ($) *	214.37 (n=1211)	10.65	252.47 (n=784)	14.24	144.42 (n=427	14
Days fished per month	6.4 (n=1265)	0.19	6.2 (n=813)	0.21	6.8 (n=452	0
Days fished per month on the James	3.7 (n=1287)	0.14	3.5 (n=836)	0.17	3.9 (n=451	0
Slot regulation knowledge (%) *	38.6 ± 7.0 (n=187)		48.6 ± 8.3 (n=138)		10.2 ± 8. (n=49)	
Creel limit regulation knowledge (%) *	36.2 ± 6.9 (n=188)		41.0 ± 8.1 (n=139)		22.4 ± 11 (n=49)	

regulation. The two angler types also differed significantly on the fish species targeted (Table 4), as boat anglers generally were after bass or panfish, while bank anglers were either generalists, targeting no specific species, or after catfish.

Boat anglers differed significantly by the area of river fished (Table 5). Anglers in Areas 1 and 3 traveled twice as far as anglers in Areas 2 and 4. Conversely, the same anglers in Areas 1 and 3 fished 50 percent less per month on the James River than anglers in Areas 2 and 4. In addition, boat anglers in Areas 1 spent less on yearly tackle expenditures than anglers in other sections, while anglers in Area 3 fished fewer days each month. Boat anglers also differed on the species of fish targeted (Table 6), as more anglers in Areas 1 and 2 were generalists, targeting no specific species.

Bank anglers interviewed also differed significantly among six river areas on four use questions (Table 7). Anglers in Area 1 spent 50 percent more than all other areas on bait expenditures and traveled 2.5 times farther than the other areas. Bank anglers in Area 5 fished nearly 30 percent more often per month than other anglers, while together with anglers in Area 6, both groups fished 35 percent more often per month on the James River than other bank anglers. Bank

Table 4. Species preference of angler types interviewed on James River, Virginia, 1988; asterisk denotes significant difference between boat and bank anglers based on chi-square tests ($P < 0.05$) ($N = 1293$ for all anglers, $N =$ for boat anglers, and $N = 467$ for bank anglers)[a].

	All anglers		Boat anglers		Bank angle	
Species	N	%	N	%	N	
Bass *	733	56.7	568	68.8	165	35
Panfish *	130	10.1	97	11.7	33	7
Catfish *	109	8.4	47	5.7	62	13
Other	69	5.3	50	6.1	19	4
Musky/Stripers	14	1.1	6	0.7	8	2
Roughfish[b] *	6	0.5	0	0.0	6	1
Any *	377	29.2	169	20.4	208	44

[a] Percentage exceeds 100.0 because multiple answers were allowed

[b] Gar, Carp, Suckers, Chubs

Table 5. Mean values or percentage of responses by boat anglers interviewed in four river areas in 1988 James River survey; superscripts denote significant differences (in row) based on Duncan multiple range ANOVA tests ($P < 0.05$); SE denotes standard error.

	Area							
	1[a]		2[b]		3[c]		4[d]	
Variable	Mean or %	SE	Mean or %	SE	Mean or %	SE	Mean or %	SE
Daily bait expense ($)	2.67	0.41	1.96	0.44	2.04	0.41	2.22	0.21
Distance traveled (mi)	100.5^{B}	9.1	36.0^{A}	5.9	114.2^{B}	16.4	52.5^{A}	2.3
Yearly tackle expense ($)	172.67^{A}	23.69	233.42^{AB}	34.85	241.61^{AB}	27.08	302.41^{B}	24.27
Days fished per month	6.0^{AB}	0.49	6.7^{A}	1.01	5.0^{B}	0.39	6.6^{AB}	0.31
Days fished on the James per month	2.6^{B}	0.29	5.0^{A}	0.90	2.6^{B}	0.29	3.92^{A}	0.24
Knowledge of slot limit (%)	52.4 ± 21.4		27.3 ± 26.3		64.3 ± 17.7		46.3 ± 11.9	
Knowledge of creel limit (%)	47.6 ± 21.4		9.1 ± 17.0		48.3 ± 18.5		43.3 ± 11.9	

[a] N = 158; for knowledge questions N=21
[b] N = 61; for knowledge questions N=11
[c] N = 166; for knowledge questions N=28
[d] N = 441; for knowledge questions N=67

Table 6. Species preference of boat anglers interviewed in four river areas in 1988 James River survey; aterisk denotes significant difference based on chi-square tests ($P < 0.05$); N = 158 for Area 1, N = 61 for Area 2, N = 166 for Area 3, and N = 441 for Area 4.[a]

	Area							
	1		2		3		4	
Species	N	(%)	N	(%)	N	(%)	N	(%)
Bass *	104	65.8	30	49.1	131	78.9	303	68.7
Panfish	28	17.8	6	9.7	16	9.6	49	11.0
Catfish	7	4.4	4	6.5	8	4.8	28	6.3
Other *	5	3.2	2	3.3	3	1.8	40	9.0
Musky *	5	3.3	0	0.0	1	0.6	0	0.0
Roughfish	0	0.0	0	0.0	0	0.0	0	0.0
Any *	42	26.6	22	36.1	26	15.7	79	17.9

[a] Percentage exceeds 100.0 because multiple answers were allowed.

Table 7. Mean values or percentage of responses by bank anglers interviewed in six river areas in 1988 James River survey; superscripts denote significant differences (in row) based on Duncan multiple range ANOVA tests ($P < 0.05$); standard error is in parenthesis.

	Area					
	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]
Variable	Mean or %	Mean or %	Mean or %	Mean or %	Mean or %	Mean or %
Daily bait expense ($)	4.13[A] (0.51)	1.79[B] (0.29)	1.67[B] (0.54)	1.67[B] (0.29)	2.02[B] (0.28)	2.71[B] (0.50)
Distance traveled (mi)	123.7[A] (38.0)	28.1[B] (4.7)	42.7[B] (6.9)	50.3[B] (10.2)	26.4[B] (5.3)	15.1[B] (3.4)
Yearly tackle expense ($)	179.21 (50.22)	127.07 (21.77)	88.77 (21.66)	125.10 (21.11)	152.67 (19.29)	178.22 (38.18)
Days fished per month	6.1[A] (0.65)	5.8[A] (0.54)	5.5[A] (0.86)	6.3[A] (1.08)	9.4[B] (0.93)	7.3[AB] (1.18)
Days fished on the James per month	2.8[B] (0.42)	4.1[AB] (0.47)	3.1[B] (0.71)	2.7[B] (0.52)	5.6[A] (0.73)	6.0[A] (1.15)
Knowledge of slot limit (%)	16.7	18.2	0.0	0.0	0.0	14.3
Knowledge of creel limit (%)	16.7	27.3	0.0	40.0	30.0	14.3

[a] N = 114; for knowledge questions N=12
[b] N = 97; for knowledge questions N=11
[c] N = 60; for knowledge questions N=4
[d] N = 61; for knowledge questions N=5
[e] N = 93; for knowledge questions N=10
[f] N = 42; for knowledge questions N=7

angler species preference among the six areas also differed significantly (Table 8). Anglers in Area 3 were predominantly generalists, while nearly one-half of all bank anglers in Areas 1 and 5 were targeting bass.

Most mail survey interviewed anglers (over 50 percent) fished at least once per week (Table 9). Almost 55 percent reported that they fished at least twice per month on the James River (Table 9).

Similar to on-river results (Table 4), black bass were the preferred species by most James River mail survey interviewed anglers (over 50 percent) (Table 10). Of those anglers who expressed a preference, almost one-third spent their entire fishing time pursuing that species (Table 11). However, over 50 percent responded that they practiced catch-and-release fishing, keeping almost no fish (Table 11).

James River anglers listed several reasons why they went fishing (Table 12). Enjoying the outdoors, relaxing, and spending time with fishing friends were reasons reported by more than half. Competing in a fishing tournament, catching fish for food, and catching large fish were reported by less than a quarter of anglers.

Table 8. Species preference of bank anglers interviewed in six river areas in 1988 James River survey; asterisk denotes significant difference based on chi-square tests ($P < 0.05$); N = 114 for Area 1, N = 97 for Area 2, N = 60 for Area 3, N = 61 for Area 4, N = 93 for Area 5, and N = 42 for Area 6.[a]

	Area											
	1		2		3		4		5		6	
Species	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Bass *	49	42.9	35	36.1	14	23.4	16	26.2	44	47.4	7	16.7
Panfish	7	6.1	7	7.2	1	1.7	7	11.4	7	7.6	4	9.6
Catfish *	10	8.7	17	17.6	5	8.4	17	27.9	5	5.4	8	19.1
Other	3	2.6	4	4.1	2	3.3	2	3.3	5	5.4	3	7.1
Musky/Striper	1	0.9	2	2.0	0	0.0	0	0.0	5	5.4	0	0.0
Roughfish[b]	0	0.0	2	2.0	2	3.3	0	0.0	1	1.1	1	2.4
Any	54	47.4	36	37.1	38	63.3	25	41.0	32	34.4	23	54.8

[a] Percentage exceeds 100.0 because multiple answers were allowed.
[b] Gar, carp, suckers, chubs

Table 9. Frequency of fishing in 1988 by James River anglers interviewed in mail survey.

	Total fishing frequency		Fishing on the James River	
Response	N	(%)	N	(%)
≥ 1 per week	216	50.6	103	24.5
2 per month	144	33.7	127	30.2
1 per month	39	9.1	98	23.3
< 1 per month	28	6.6	93	22.1
Total	427	100.0	421	100.0

Table 10. Species preference of 1988 James River anglers interviewed in mail survey.

Species	Preference N	Preference (%)
Black bass	221	51.6
Catfish	23	5.4
Trout	15	3.5
Striped bass	13	3.0
Crappie	9	2.1
Panfish	3	0.7
Other	3	0.7
Any kind	140	32.7
Total	428	100.0

Table 11. Percentage of time spent pursuing preferred fish species and percentage of time fish harvested by 1988 James River anglers interviewed in mail survey.

	Time spent pursuing preferred species		Harvest of fish	
Percent time	N	(%)	N	(%)
Almost none	29	7.2	215	50.6
One-fourth	53	13.1	83	19.5
One-half	84	20.7	57	13.4
Three-fourths	112	27.7	21	4.9
Almost all	127	31.4	49	11.5
Total	290[a]	100.0	425	100.0

[a] Number represents only those anglers that had a preferred species

Table 12. Reasons why 1988 James River anglers interviewed in mail survey went fishing (N = 430)[a].

Reasons	Frequency N	Frequency (%)
Enjoying the outdoors	322	75.4
Spending time with fishing friends	235	55.0
Relaxing	233	54.6
Catching many fish	167	39.1
Combining fishing with camping, boating, or picnicking	151	34.5
Catching large fish	88	20.6
Catching fish for food	48	11.2
Other	44	10.3
Competing in a fishing contest	26	6.1

[a] Percentage exceeds 100.0 because multiple answers were allowed.

Given choices among Virginia rivers, James River anglers generally chose the James River to fish. Over 40 percent of the mail surveyed anglers fished only on the James River (Table 13). More than one-third of anglers said that the James River was the most enjoyed. Only one river, the Chickahominy River, was the favorite of more than ten percent of the anglers. The Shenandoah River, the New River, the Rappahannock River, the Appomattox River, the York River, and the Potomac River were favored by less than five percent of anglers.

By the time of the mail survey (after the fishing season), James River anglers had increased their knowledge of black bass regulations. Nearly two-thirds of the anglers responded correctly to the size limit (Table 14), while more than half knew the correct creel limit of five fish per day (Table 15). However, most anglers did not know the primary reasons why these regulations were implemented (Table 16). Most anglers also had a multitude of opportunities to learn the current regulations since over 50 percent reported being checked at least once by a Virginia Department of Game and Inland Fisheries law enforcement officer while fishing on the river (Table 17).

Involvement in outdoor organizations was not widespread

Table 13. Rivers enjoyed more than the James River by 1988 James River anglers interviewed in mail survey (N = 430)[a].

Rivers	Frequency N	(%)
Only fished the James	180	43.2
James River	151	36.2
Other	51	12.2
Chickahominy River	43	10.3
Roanoke River	23	5.5
New River	19	4.6
Rappahannock River	17	4.1
Shenandoah River	12	2.9
Appomattox River	11	2.6
York River	12	2.4
Potomac River	7	1.7

[a] Percentage exceeds 100.0 because multiple answers were allowed.

Table 14. Angler mail survey response to the correct size limit for smallmouth bass on the James River by 1988 James River anglers.

Size	Frequency N	(%)
No size limit	22	5.4
12 inch minimum size	77	19.0
14 inch minimum size	10	2.5
11 inch - 14 inch slot[a]	263	64.8
12 inch - 15 inch slot	21	5.2
Other	13	3.2
Total	406	100.0

[a] Correct size limit

Table 15. Angler mail survey response to the correct creel limit for smallmouth bass on the James River by 1988 James River anglers.

Creel limit	Frequency N	(%)
Three per day	32	8.0
Five per day[a]	219	54.9
Eight per day	61	15.3
No limit	69	17.3
Other	18	4.5
Total	399	100.0

[a] Correct creel limit

Table 16. Angler reasons why current smallmouth bass regulations on the James River were implemented by VDGIF by 1988 James River anglers interviewed in mail survey (N = 430)[a].

Reasons	Frequency n	(%)
Protect breeding fish	377	89.5
Make fish grow faster	43	10.2
Protect bigger fish	40	9.5
Don't know	26	6.2
Other	26	6.2

[a] Percentage exceeds 100.0 because multiple answers were allowed.

Table 17. Number of times checked by a game warden while fishing on the James River in 1988 by James River anglers interviewed in mail survey.

Number	Frequency N	(%)
None	202	47.8
Once	97	22.9
Twice	66	15.6
Three times	21	5.0
Four times	19	4.5
> Four	18	4.3
Total	423	100.0

among James River anglers. More than two-thirds were not members of any organizations (Table 18). Nearly half (41%) of those who were members belonged to the Bass Anglers Sportsman Society (B.A.S.S.), and about 21 percent were members of a local fishing club.

Fishing tackle expenditures varied widely among anglers. Approximately 75 percent of James River anglers spent in excess of $100 annually on fishing tackle with slightly more than one-third spending in excess of $500 annually (Table 19). The amount of fishing tackle owned also varied widely with over 50 percent owning over $500 in fishing equipment (Table 19).

Comparisons of the mail survey and the on-river creel survey showed marked differences in all questions analyzed (Table 20). Mean estimates of frequency of fishing, both on the James River and in total, were nearly double for on-river interviews than for mail survey responses. Conversely, mail survey respondents reported a yearly tackle expenditure almost 20 percent higher than that of on-river interviews. In addition, the proportion of mail-survey respondents who knew the current fishing regulations was 50 percent higher than that of on-river interviews.

Table 18. Percentage of 1988 James River anglers interviewed in mail survey who are members of an outdoor organization (N = 430)[a].

Organization	Frequency N	(%)
None	286	67.9
B.A.S.S.	59	14.0
Other	58	13.8
Local fishing club	30	7.1
Smallmouth, Inc.	16	3.8
Trout Unlimited	8	1.9
Izaak Walton League	8	1.9
VA Federation of Anglers	6	1.4
Float Fishermen of VA	5	1.2

[a] Percentage exceeds 100.0 because multiple answers were allowed.

Table 19. Annual tackle expenditures for 1988 and the total value of tackle owned for 1988 James River anglers interviewed in mail survey.

	Tackle expenditure		Value of tackle owned	
Amount	N	(%)	N	(%)
< $50	28	6.5	11	2.6
$50 - $99	83	19.3	21	4.9
$100 - $199	89	20.7	46	10.7
$200 - $499	82	19.1	106	24.7
$500 - $999	69	16.1	81	18.8
$1000 - $4999	62	14.4	128	29.8
$5000 - $9999	9	2.1	18	4.2
$10000 - $19999	7	1.6	11	2.6
> $19999	0	0.0	8	1.9
Total	429	100.0	430	100.0

Table 20. Mean values of responses given by anglers and by mail-survey respondents, James River, Virginia, 1988. All differences were significant based on chi-square tests ($P < 0.05$).

		Number of respondents	
Question	Categories	Intercept Survey	Mail Survey
Days fished per month	>3.99	724	216
	2.0-3.99	295	144
	1.0-1.99	128	39
	< 1.0	118	26
	Mean	6.4	3.2
Days fished on the James River per month	>3.99	420	103
	2.0-3.99	325	127
	1.0-1.99	206	98
	< 1.0	336	93
	Mean	3.7	2.3
Yearly tackle expenditures ($)	< 50	345	28
	50-99	178	83
	100-199	219	89
	200-499	245	82
	500-999	128	69
	1000-2499	130	34
	2500-4999	43	28
	5000-7499	16	8
	7500-9999	4	1
	> 9999	26	7
	Mean	757.60	918.36
Slot regulation knowledge (%)	correct	72	263
	incorrect	115	143
	% correct	38.5	64.8
Creel limit knowledge (%)	correct	68	219
	incorrect	120	180
	% correct	36.2	54.9

Angler Compliance

The probability of an angler complying with James River black bass slot limit regulations was generally high, averaging nearly 85 percent for all river sections (Table 21). Of the 203 angler parties that meet the classification criteria of catching one bass in the slot limit range, 84.2 percent complied with the regulations at the time of interview. Differences in the distribution of compliers vs. non-compliers among areas were not significant ($X^2_{(3)}$= 3.29).

The probability of an angler complying with the creel limit was higher than that observed for the slot limit (Table 21). Over 99 percent of the interviewed anglers, who had an opportunity to non-comply, complied with the five bass per day limit. The only non-complier was found in Area 2.

The total illegal harvest of black bass varied between sections (Table 22). Area 1 anglers took the largest percentage of illegal fish, almost 17 percent of the total harvest for that area. For the James River as a whole, illegal harvest averaged approximately 10 percent of the total black bass harvested.

Factors Affecting Angler Compliance

Univariate comparisons (t-tests) between field interviews of anglers classified as either complying or non-complying

Table 21. Angler compliance rates and 95% C.I. by area for anglers meeting classification criteria at the time of interview in 1988 James River survey.

Area	Slot Limit			Creel Limit		
	Number of possible non-compliers[a]	Number of compliers	Compliance (%)	Number of possible non-compliers[b]	Number of compliers	Compliance (%)
1	49	37	75.5 ± 12.0	50	50	100.0
2	8	7	87.5 ± 2.3	8	7	87.5 ± 2.3
3	51	43	84.3 ± 9.9	24	24	100.0
4	82	71	86.6 ± 7.4	42	42	100.0
5	13	13	100.0	2	2	100.0
6	0	0	-	0	0	-
Total	203	171	84.2 ± 5.0	126	125	99.2 ± 1.5

[a] Anglers who meet classification criteria (caught 1 fish in the slot).
[b] Anglers who meet classification criteria (caught more than 5 fish).

Table 22. Illegal percentage of total black bassharvest by area, James River, 1988.

Area	Percentage of total harvest - illegal (%)
1	16.8
2	4.8
3	1.7
4	10.1
5	0.0

showed differences on two factors (Table 23). Non-complying anglers had a daily bait expense that was more than twice that of known compliers. Conversely, complying anglers had a yearly tackle expenditure that was over two times more than non-compliers. Differences in regulation knowledge were large, but the sample size was too small to show statistical significance. However, differences in regulation knowledge were significant for both slot limit knowledge and creel limit knowledge between the two groups in 1989 where sample sizes were larger. In both instances, complying anglers had a significantly higher awareness of the regulations than non-complying anglers (Garman et al. 1990). Species preferences were similar as more than two-thirds of both angler types preferred bass (Table 24).

Inaccurate angler length measurements appeared not to be a significant factor in angler non-compliance. Only 30 percent of all illegally harvested black bass were within 5 mm of the extreme slot ranges, 280 mm and 355 mm (Figure 2). The mean illegal harvest size for all sections ranged between 297 mm and 320 mm, well within the slot limit range.

Mail survey responses were less informative in characterizing the differences between complying and known non-complying anglers as only one question was statistically

Table 23. Mean value or percentage of responses given by anglers identified as either compliers or non-compliers on the James River, Virginia, 1988; asterisk denotes significant difference ($P < 0.05$); SE denotes standard error.

	Compliers (n=217)		Non-Compliers (n=32)	
Variable	Mean or %	SE	Mean or %	SE
Daily bait expense ($) *	2.00	0.31	4.38	1.45
Distance traveled (mi)	82.7	6.0	105.3	20.6
Yearly tackle expenditures ($) *	306.12	31.39	132.93	20.75
Days fished per month	6.8	0.45	6.0	0.93
Days fished per month on the James	3.6	0.31	2.8	0.61
Boat anglers (%)	87.9 ± 4.3		76.7 ± 15.1	
Bank anglers (%)	12.1 ± 4.3		23.3 ± 15.1	
Slot regulation knowledge (% correct)	56.8 ± 16.0 (n=37)		20.0 ± 35.1 (n=5)	
Creel limit regulation knowledge (% correct)	54.1 ± 16.1 (n=37)		20.0 ± 35.1 (n=5)	
Party size	2.8	0.16	2.5	0.20

Table 24. Species preference of 1988 James River anglers classified as either compliers or non-compliers interviewed in James River survey (N = 217 for compliers and N = 32 for non-compliers)[a].

Species	Compliers (%)	Non-compliers (%)
Bass	79.7	65.6
Panfish	11.1	3.1
Catfish	3.2	9.4
Musky	0.5	0.0
Other	0.0	0.0
Any kind	15.7	28.1

[a] Percentage exceeds 100.0 because multiple answers were allowed.

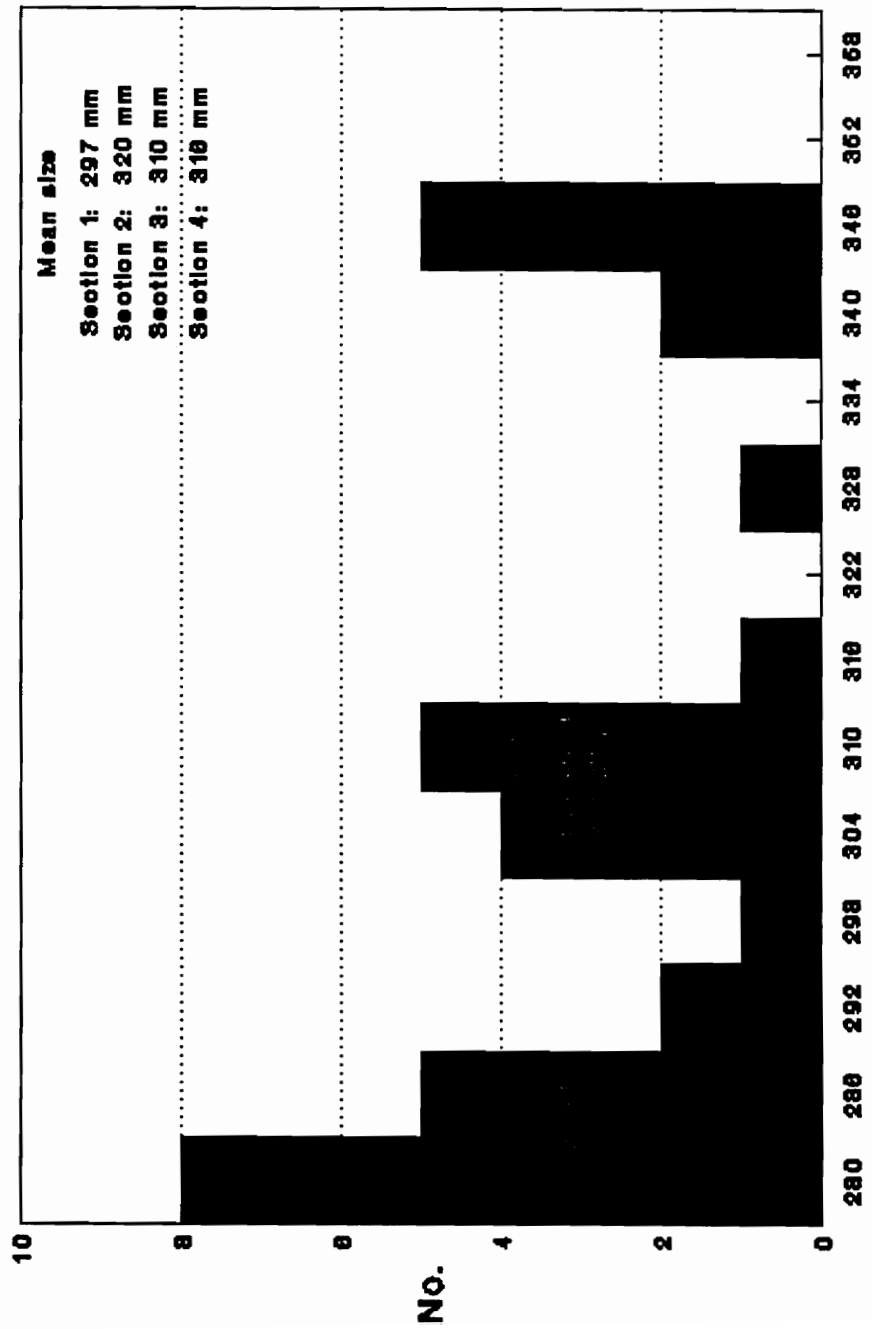

Figure 2. Distribution and mean size of illegally harvested black bass, James River, VA, 1988.

different between the two angler types. Directly opposite of the expected outcome, non-complying anglers were more knowledgeable of the slot limit regulation than complying anglers (Table 25). Differences among species preferences were also insignificant (Table 26).

Supporting the univariate comparisons of the field data (Table 23), results of the logistic regression procedure on intercept data showed that daily bait expense and yearly tackle expenditures were significantly correlated with an angler's probability of complying with the current black bass regulations. Daily bait expense was found to negatively influence (R = -0.165) an angler's probability of complying, while yearly tackle expenditures positively influenced (R = 0.131) an angler's probability of complying. The resulting logistic regression equation for an angler's probability of complying was:

Probability that

$$Y = 1 \text{ (i.e., complier)} = 1/(1 + \exp(-1.63305 + 0.0902(\text{bait}) - 0.00312(\text{tackle})))$$

where: bait ($) SE = 0.0352, P = 0.105

tackle ($) SE = 0.0014, P = 0.0272

Table 25. Mean value of mail survey responses given by anglers identified as either complier or non-complier on the James River, Virginia, 1988; asterisk denotes significant difference based on chi-square tests ($P < 0.05$).

Variable	Compliers (n=406) Mean	Non-Compliers (n=24) Mean	X^2
Yearly tackle expenditures ($)	945.06	651.04	4.24
Fishing equipment owned	1963.42	2215.63	7.29
Days fished per month	2.8	2.5	4.68
Days fished per month on the James	1.9	1.5	3.43
Slot regulation knowledge (%) *	63.4	87.5	4.98
Creel limit regulation knowledge (%)	55.7	41.7	1.60
Frequency of keeping fish (%)	30.4	36.5	5.36
Belong to a fishing organization (%)	32.8	18.1	1.99
Number of times checked by a warden in 1988 (%)	1.0	1.0	3.38
Fish for food (%)	6.5	12.5	0.72

Table 26. Species preference of 1988 James River anglers classified as either compliers or noncompliers on-river, interviewed in mail survey.

	Compliers		Non-compliers	
Species	N	(%)	N	(%)
Bass	206	51.0	15	62.5
Catfish	23	5.7	0	0.0
Trout	14	3.5	1	4.2
Striped bass	13	3.2	0	0.0
Crappie	9	2.2	0	0.0
Other	4	1.0	0	0.0
Sunfish	3	0.7	0	0.0
Any kind	132	32.7	8	33.3
Total	404	100.0	24	100.0

All other alleged compliance areas were found to be insignificant.

The overall ability of the model to predict whether an angler was a complier or non-complier was not reliable. Although the overall percent correctly predicted was 84.2 percent, only one known non-complier was correctly identified as a non-complier.

Comparisons between anglers that knew the slot-limit regulations and those who did not further supported angler specialization precepts mentioned earlier. Two factors, species preference and yearly tackle expenditures (Table 27), were found to significantly differ between the two angler groups. Anglers who knew the regulations were primarily bass anglers that had higher yearly tackle expenditures than anglers that did not know the regulations. Unknowledgable anglers were either more generalistic anglers than those who knew the regulations or targeted other fish species.

Because of the small sample size, the logistic regression procedure performed on the same field data variables that were used in the compliance probabilty model, but using angler knowledge as the single binary dependent variable showed little support of the mail survey results. In the procedure

Table 27. Comparison of responses given by two angler knowledge groups in mail survey, James River, Virginia, 1988. Asterisk denotes significant differences based on chi-square tests ($P < 0.05$).

Question	Categories	Number of respondents: Did not Know Regulations	Number of respondents: Knew Regulations
Days fished per month	>3.99	64	151
	2.0-3.99	55	89
	1.0-1.99	12	27
	< 1.0	10	16
Days fished on the James River per month	>3.99	28	75
	2.0-3.99	40	87
	1.0-1.99	34	64
	< 1.0	38	55
Yearly tackle expenditures ($) *	< 50	9	19
	50-99	32	51
	100-199	40	49
	200-499	20	62
	500-999	24	45
	1000-2499	11	23
	2500-4999	5	23
	> 5000	2	14
Club Participation	None	95	191
	One or more	41	94
Species Preference *	Any	52	88
	Bass	58	163
	Catfish	11	12
	Trout	6	9
	Other	15	14
Frequency of keeping fish	None	67	148
	One-fourth	27	56
	Half	19	38
	Three-fourths	9	12
	All	19	30
Checked by game warden	None	74	128
	At least once	69	152

performed on the creel limit knowledge data, the number of days fished per month was positively correlated (R = 0.193) with an angler's knowledge of the creel limit. However, all other variables were not significant. The resulting logistic equation for an angler's probability of knowing the creel limit was:

Probability that

Y = 1 = 1/(1 + exp(-1.1495- 0.10856(days fished))

(i.e., knew the

regulations)

where: days fished/mo SE = 0.03696, P = 0.033

The predictive abilty of the equation, however, was somewhat more dependable. Over 70 percent of those anglers who did not know the regulations were correctly predicted, and over 66 percent of those anglers who did know the creel limit regulations were correctly predicted.

The results of the logistic procedure performed on the slot limit knowledge data were similar to that shown in the creel limit procedure. Only an angler's daily bait expense was found to significantly contribute to the predictive ability of the model. Daily bait expense was found to negatively influence an angler's knowledge of the slot length

limit. The resulting logistic equation for an angler's probability of knowing the slot length limit was:

Probability that

Y = 1 (i.e., knew the regulations) = $1/(1 + \exp(0.977 - 0.3408(\text{bait}))$

where: bait ($) SE = 0.147 P = 0.0068

The model correctly predicted over 50 percent of the anglers who did not know the regulations and over 85 percent of the anglers who did know the regulations.

Predictive Model of Angler Compliance with Novel Regulations

Comparisons of constructed non-complier angler profiles for each of the five regulation scenarios showed little difference between the angler groups, with one noteable exception. Fishing frequency, species preference, club participation, yearly tackle expenditures, and the smallest size bass enjoyed catching were all non-significant factors (all $P > 0.1$) for differentiating the different non-complier angler profiles from either other non-complier profiles or complying angler profiles (Appendix F).

One factor, however, did show significance (Table 28).

Table 28. Percentage of time fish harvested by anglers who were identified as against four regulation scenarios in 1988 James River mail survey.

			Regulation scenarios							
			14 in minimum				Slot length limit			
	All		5/day		2/day		5/day		2/day	
Percent time	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Almost none	215	50.6	2	10.5	22	33.3	2	18.2	22	31.9
One-fourth	83	19.5	6	31.6	14	21.2	4	36.4	12	17.4
One-half	57	13.4	6	31.6	12	18.2	3	27.3	15	21.7
Three-fourths	21	4.9	1	5.3	7	10.6	0	-	8	11.6
Almost all	49	11.5	4	21.1	11	16.7	2	18.2	12	17.4
Total	356	100.0	19	100.0	66	100.0	11	100.0	69	100.0

Anglers who identified themselves as against, or would not comply with, more conservative regulations (i.e., a 14 in minimum length limit, a 2 fish per day creel limit, or a catch-and-release regulation) said they more frequently kept their fish catch than anglers who said that they would always comply.

Angler perceptions and acceptability of potential regulation scenarios are an important part of the success of new regulations. To provide James River managers with a measure of angler acceptability, mean responses of each regulation scenario were computed (Table 29). No statistical differences were found between compliers and non-compliers. All anglers were more likely to obey liberal creel limits (5), than either restrictive creel limits (2) or catch-and-release regulations. Angler acceptability increased as creel limits increased from 2 fish per day to 5 fish per day, regardless of changes in the size limit. Subsequently, the catch-and-release scenario scored the lowest acceptability with a mean of 2.7, near neutrality.

Table 29. Mean response (on compliance scale of 1 to 5) and rank (in parenthesis) to five regulation scenarios by two angler types in 1988 James River mail survey.

Scenario	All	Complier (n=404)	Non-complier (n=24)
14" minimum length 5 fish/day	1.38 (2)	1.37 (2)	1.59 (4)
14" minimum length 2 fish/day	2.02 (4)	2.00 (4)	1.38 (2.5)
11"-14" slot length 5 fish/day	1.28 (1)	1.27 (1)	1.36 (1)
11"-14" slot length 2 fish/day	2.00 (3)	1.98 (3)	1.38 (2.5)
Catch-and-release only	2.72 (5)	2.72 (5)	2.70 (5)

Note:
1 = Would always comply
5 = Would never comply

DISCUSSION

Angler Characteristics

Differences among boat anglers and bank anglers can probably be attributed to both inherent differences in basic angling philosophies and differences in angler specialization. Boat anglers, by making an additional large investment in fishing with the purchase of a boat, are usually more specialized and involved in the sport of angling than the typical bank angler. The purchase of more fishing equipment per year than bank anglers, a longer travel distance (Table 3), and a narrower, less generalized species preference (Table 4), all indicate, or are attributes of, a higher angling specialization (Bryan 1977). Additionally, since most boat anglers (68.8%) were bass anglers (Table 4), and the regulations on the river concerned only bass, boat anglers expectedly exhibited a higher knowledge of the current bass regulations, rather than bank anglers who were mainly generalists.

The apparent lack of overall regulation knowledge among anglers interviewed on-river can probably be tied to several important factors. Only recently implemented (January 1, 1987), the current black bass regulations were not highly publicized by the VDGIF. Posted signs, stating the

regulations, were absent from all areas except Area 5, where the City of Richmond Park Service posted regulations in selected river park access areas. The Shenandoah River, a similar black bass fishery in Virginia, showed comparable results after the implementation of new regulations in three sections of the river. Helfrich et al. (1987) found 26 to 70 percent of the anglers did not know the correct size limit regulation for smallmouth bass in the section they were fishing in at the time of interview. This large range can probably be attributed to the regulation's similarities or differences to the old regulation.

On-river acquired data also showed that differences did occur among the various river areas, thus supporting the intuitive preliminary classification system used to section the river in the study (Stanovick and Nielsen 1991). Area 1 was characterized by boat anglers who traveled greater distances to fish (mainly for bass) than most other sections, and yet who spent the least amount on fishing tackle of all other anglers (Table 5). Bank anglers in Area 1 also traveled longer distances to fish than anglers in other areas and spent more on live bait than all other anglers (Table 7). The longer travel distances in this area, as in Area 3, can probably be attributed to the area's rural location in the state away from most larger metropolitan areas. Area 2 was

characterized by boat anglers who traveled shorter distances to fish (Table 5). This trend is probably attributable to this area's close proximity to metropolitan Lynchburg. Area 3, because of its rural location in central Virginia, was characterized by boat anglers who were very similar to boat anglers in Area 1 (Table 5). Conversely, bank anglers in Area 3 were more similar to anglers in Areas 2 and 4 than to anglers in Area 1 perhaps due to the geographic proximity of the areas (Table 7). Area 4 anglers, except for the large amount of money spent yearly on fishing tackle by boat anglers (Table 5), were characteristically similar to most other anglers in the downstream areas of the river (Areas 2 and 3). This trend may be attributable to the inclusion of larger and more expensive fishing boats that are able to be employed by anglers on the river in this area. Area 5, the City of Richmond, and Area 6, the City of Lynchburg, were similar in angler characteristics. Because of their urban locations, both areas had travel distances that were much shorter and fishing frequencies that were much higher than other river areas.

Comparisons between mail survey responses and on-river interviews showed several discrepancies among answers (Table 20). On-river fishing frequencies were much higher than mail survey estimates, while, conversely, yearly tackle

expenditures were much lower than mail survey estimates. Sampling biases in the mail survey could account for its significantly higher estimate of yearly tackle expenditures. Kokel et al. (in press) found that mail survey populations consisting of anglers who volunteer their names, may not accurately represent the true angling population. Anglers who reported smaller tackle purchases during the on-river survey (possibly less specialized or less involved anglers) may have refused to volunteer for the mail survey, or they may have failed to return the questionnaire, resulting in an inflated yearly tackle expenditure.

Higher angler awareness of current fishing regulations by mail survey respondents (Table 20) probably can be attributed to their repeated opportunities to learn. All anglers interviewed on the river were told the current regulations immediately after the interview; thus, each mail survey respondent had been personally informed. Additionally, many anglers fished throughout the season after the interview, so they had substantial opportunity to learn the regulations. Over one-half of the interviewed anglers reported being checked by VDGIF conservation officers at least once for yet another learning experience (Table 17) although this factor did not seem to have a direct effect on angler knowledge (Table 27). Mail-survey recipients also could have looked up

up the regulations while completing the questionnaire. Beyond these reasons, however, as with the expenditure data, those anglers who were less committed to fishing may have refused to participate in the mail survey or to return the survey form.

Angler Compliance

While James River estimated illegal harvest compared similarly to estimates on the black bass fishery in the Shenandoah River, Virginia (Kauffman 1983) and on smallmouth streams in Iowa (Paragamian 1984), they were lower than estimates on the New River, Virginia (Austen and Orth 1986) and Watkin's Mill Lake, Missouri (Eder 1984). Two possible reasons exist. First, the practice of catch-and-release fishing was prevalent on the James River. Over 50 percent of anglers in the mail survey almost always released fish (Table 11), while intercept survey results show that only 4 percent of all bass caught were harvested (Garman et al. 1989). This may either be a phenomenon unique to the James River or it may represent a recently developed angling ethic. If the later, many potential non-complying anglers who may have kept a marginally legal, or possibly illegal, fish in the past, presently may not have done so. Second, the slot limit (11 - 14 in) was not a highly conflicting harvest regulation to most anglers. Angler "acceptibility" of the regulations were

high (Table 29), and anglers seemed more concerned with more restrictive creel limits than with more restrictive length limits. Reynard and Hilborn (1986) found that seasonal closures and daily bag limits were generally not acceptable to anglers when given a preference choice among other regulations.

Very little conflict was seen between anglers and the creel limit. Again, this may relate to the practice of catch-and-release fishing. Most anglers harvested fewer than one fish per trip significantly lessening the likelihood of conflicts with the creel limit. Additionally, Wagner and Orth (1991) found that the frequency distributions of daily catch in smallmouth bass fisheries closely resemble a negative binomial distribution, where most anglers catch few fish and the likelihood of an angler catching a limit is a rare occurrence. This factor may have further lessened creel limit conflicts.

Factors Affecting Angler Compliance

Univariate comparisons and logistic regression results of known non-compliers' and compliers' river interviews help support earlier assumptions about angler compliance rates. The two factors, higher daily bait expenditures and lower yearly tackle expenditures for non-complying anglers,

contributed to distinguishing non-compliers from compliers.

Other factors such as fishing frequency and distance traveled, surrogates of fishing involvement, and species preference, did not play significant roles in distinguishing compliers from non-compliers. Perhaps, these other factors are not directly related to an angler's probability of complying, but instead an angler's decision as to whether he/she will comply or not comply is a function of complex social and behavioral factors.

Glass and Maughan (1984) stated that the most obvious reason for an angler's noncompliance was lack of regulation knowledge. Although knowledge of the current black bass regulations on the James River was not high, there were no statistical differences in compliance rates among those who knew the regulations and those who did not. However, data obtained in 1989 did show significant differences in the two angler types.

Inadequate enforcement and angler mistaken length measurements also have been mentioned as possible reasons for angler non-compliance (Mense 1981, Coomer and Holden 1981, Glass and Maughan 1984). However, the mean size of illegally harvested bass in all river sections was well within the slot

limit range (Figure 2), and over 50 percent of mail survey anglers were contacted by a VDGIF conservation officer while fishing on the James River. This contact, however, may not have been an educational or enforcement opportunity for most anglers.

The final factor, an angler's type or group, is probably the least understood of the factors contributing to angler non-compliance. Given the premise that anglers are a heterogeneous assemblage, different angler types will behave differently given the same set of circumstances, or, in this case, regulations. If this basic premise can be carried over to an angler's probability of complying with a regulation, then distinguishing factors should separate complying anglers from non-complying anglers.

On the James River, daily bait expense and yearly tackle expenditures appear to be factors related to angler non-compliance. Daily bait expense is directly related to angling method. Bryan (1977) characterized trout anglers who fish with live bait as generally less specialized. In the case of black bass fishing, as well as other warm water fisheries, however, angling methods and live bait fishing have not been thoroughly studied regarding angler specialization. Chipman and Helfrich (1988) found that an angler's preference

for live or artificial bait helped distinguish an angler's overall specialization score. More specialized anglers favored artificial bait, thus lowering or eliminating daily bait expense. Usually associated with live bait fishing is a lower fishing tackle investment. This lower investment should translate into lower yearly tackle expenditures. If these factors are linked together, the combination of lower yearly tackle purchases and higher daily bait expenditures should correlate with a higher probability of angler non-compliance. Logistic regression procedures support this hypothesis by positively correlating yearly tackle expenditures and negatively correlating daily bait expense with an angler's probability of complying.

The question, however, remains as to why these two factors are related to an angler's probability of non-compliance. Factors tied to an angler's knowledge of the current regulations may help explain. Anglers who knew the regulations were primarily bass anglers with high (relative to other anglers) yearly tackle purchases. Anglers who did not know the current regulations were more general in their species preference and had significantly lower yearly tackle expenditures. By relating regulation knowledge to the opportunity to non-comply, then the angler who has low yearly tackle purchases, probably uses live bait more often than

other anglers, and is more general in species preference becomes the probable non-complier. All of these factors were discovered in one or more of the analysis performed.

Implications and Management Recommendations

There are several important management implications regarding angler compliance that fishery managers should consider when debating changes in regulations. First, a substantial lack of knowledge by anglers appears to exist following changes in fisheries regulations. The lack of angler knowledge exhibited in this study, along with that discovered by Helfrich et al. (1987) and Schramm and Dennis (1988), indicate that managers will have to consider this factor when evaluating the effectiveness of new regulation scenarios.

Second, determining the factors responsible for illegal behavior is a difficult and complex task. Many factors appear to contribute to an angler's behavior and whether or not he/she will comply with a given set of regulations. It is highly probable that like most other biological and social dilemmas, there is no absolute, simple solution or model for determining an angler's reaction to potential lawbreaking situations.

Third, on-site determination of angler compliance remains the best, and unfortunately the most expensive, method for distinguishing non-complying anglers. In this way, "malignant" non-compliers (those anglers who knowingly and willingly break the regulations) can be caught, and "benign" non-compliers (those anglers who unknowingly break the regulations) can be educated. Although only the angler knows his true classification, the non-complier contact and discovery is still a success. In the case of the James River, as with other fisheries where the regulations have been recently changed, it may have been that most non-compliers were benign. Certainly, this could be the case in fisheries where the regulations are not highly publicized, and the angling population consists of non-local anglers.

Fourth, because compliance was high, illegal harvest may not be a major concern for James River managers. Given the high catch-and-release rate (92%) and the relative difficulty of enforcing regulations on widely dispersed river fisheries, fisheries managers and budgeters could probably make better use of limited funds by concentrating on educational programs and fish stock manipulations on the James River.

Lastly, for information and education specialists, as well as for fishery managers and conservation officers, the

lack of knowledge factor must be eliminated in order to accurately and effectively determine the factors affecting angler non-compliance. If managers are to deter, target, and educate, these factors must be determined. Ideally, signs stating the current regulations should be posted at every established boat ramp, canoe take-out, and bank angling access point. Additionally, bait stores along the river should be targeted as potential sites for cooperative information displays that not only state the current regulations, but identify fish species, and educate anglers as to the scientific reasoning behind the different regulations. Only through cooperative efforts can anglers be educated, angling ethics be changed, and management recommendations whole-heartedly followed by anglers.

It can be further stated that the factors affecting angler compliance can be categorized into two groups: (1) those factors that cannot be manipulated by managers and serve only as predictors of compliance (i.e., angling methods), and (2) those factors that can be modified (i.e., knowledge of regulations). Based on the findings of this and other studies, potential predictors could include an angler's investment and fishing method, the percentage of non-local anglers, the practice of catch-and-release fishing, and the potential conflict with proposed regulations. Factors that

can be modified include regulation knowledge, regulation understanding, and angler ethics. By concentrating effort on modifiable areas, potential benign non-compliers can be educated before taking to the field.

Although much research remains, future studies should help fishery managers better understand the many factors that affect an angler's behavior. Suggested research topics include:

1. The effects of different types of educational media on angler compliance;
2. Enforcement versus education - which tool is best?
3. The economics versus the effectiveness of regulation enforcement;
4. Practical and efficient ways to develop angler profiles before regulation implementation;
5. The role of social and economic factors in an angler's decision to comply.

In conclusion, establishing a framework and obtaining a better understanding of the factors that determine an angler's probability of complying with both established and proposed regulations should provide a valuable tool for fishery

management decisions. To maximize the social, biological, and economic aspects of angling, fishery managers must implement cooperative programs with their constituents. Only through these types of programs can the benefits from fishery resources be fully attained.

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APPENDIX A - INTERVIEW FORM

(10-25-88) James River Study - Interview Form

Date_____Area_____Section/Access_____Initials_____
Type: DC DR OR RC Interview no._____Start time_____ Arriv/During/Depart

---

Use: bank-fish boat-fish canoe boat-rec swim other_____
Number in party_____Interviewed today: Y N (if yes, stop interview)
Age: 0-9____10-19____20-29____30-39____40-49____50-59____60-69____70-up____

"Hello. I'm doing a survey for the Department of Game and Inland Fisheries. Do you mind if I ask you some questions about your trip on the river today? First, I want you to know that all of your answers will be anonymous."

Where did you start your trip_____Where do you plan to stop_____
When did you start your trip_____When do you plan to stop_____
How many vehicles do you have parked at access points_____

Slot_____Creel_____Purpose_____(enter response)
What kind of fish are you after: any SMB LMB RED ROC MUS CAT ___ ___
How many have you caught today: ___ ___ ___ ___ ___ ___ ___ ___ ___
How many have you released: ___ ___ ___ ___ ___ ___ ___ ___ ___
How many bass have you caught today: under 11 ____ 11-14 ____ over 14 ____
How many bass have you released today: under 11 ___ 11-14 ____ over 14 ____
How many times have you fished in the last month: _____ On the James:_____

"Now we'd like to ask you some questions about how much money you've spent for your fishing/boating/swimming trip."

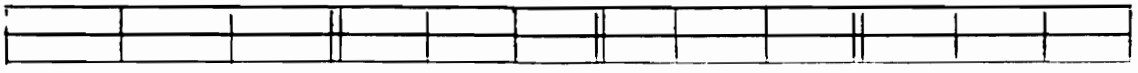
How many days is your trip: 1 2 3 over 3 _____
Is your primary purpose of this trip to use the river? Yes____ No____
How many miles will you drive round-trip:_____
How much did you spend for bait:_____ food:_____ gas:_____
Did you stay in a motel: Y N How many nights_____
How much have you spent this year on:
Fishing tackle: 0 0-19 20-39 40-59 60-79 80-99 100-up(_____)
Recreat. equip: 0 0-19 20-39 40-59 60-79 80-99 100-up(_____)
Boats _____ Motors _____ Trailer _____ Other _____
Where do you live: Town_____County/City_____State_____

"In general, how much money is a recreational trip on the James River worth to you, over and above the money you have already spent on gas, food, bait, and lodging?"_____
why?
How successful was your day today: Excellent Good Fair Poor
Why_____

Is there anything you would like us to tell the Game Department about the condition of the river or their management?

"This fall, we will be asking anglers their ideas about fishing on the river. Would you be willing to participate in a mail survey?" Thank you.

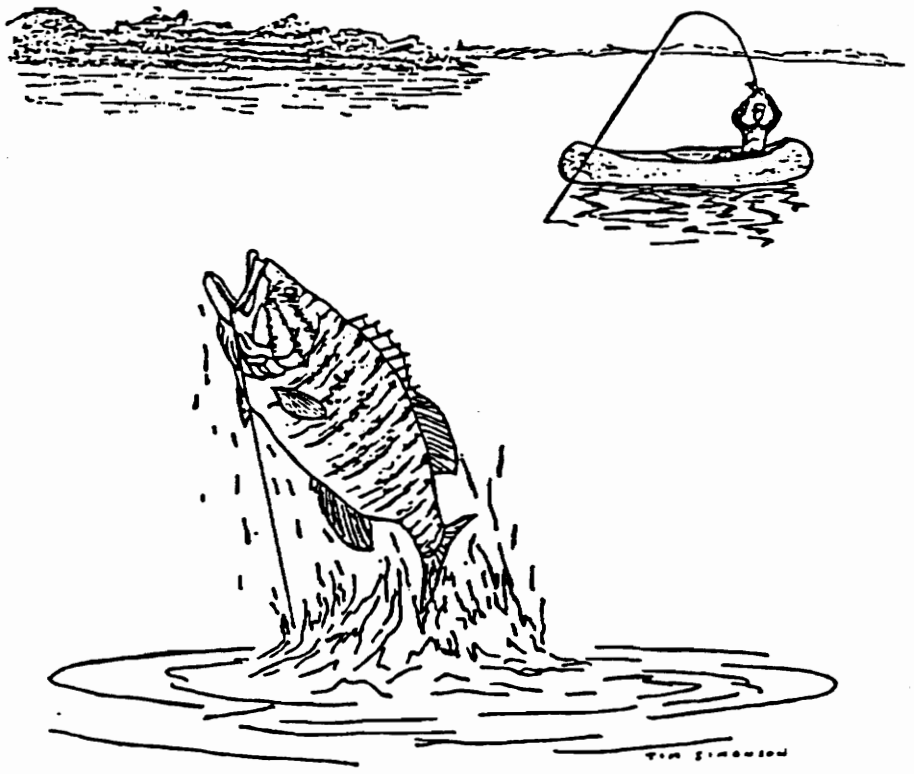
"Do you mind if we weigh and measure the fish you have kept today?"



APPENDIX B - MAIL SURVEY QUESTIONNAIRE

(Questions 9, 15, and 19 are not a part of this study)

JAMES RIVER ANGLER SURVEY



This survey is part of a study to better understand and manage the James River fishery. Please answer all of the questions. If you wish to comment on any of the questions or explain your answers, please feel free to write in the margins. Your comments will be read and taken into account.

Thank you for your help.

A project of

Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

Sponsored by the

VIRGINIA DEPARTMENT OF GAME

AND INLAND FISHERIES

First we'd like to ask you a few questions about your fishing activities during 1988.

1) About how often did you go fishing last year? (circle one)

0 At least once per week
1 Twice per month
2 Once per month
3 Less than once per month

2) About how often did you go fishing on the James River last year? (circle one)

0 At least once per week
1 Twice per month
2 Once per month
3 Less than once per month

3) What kind of fish do you like to catch most? (circle one)

0 Any kind
1 Bass
2 Catfish
3 Trout
4 Sunfish
5 Muskellunge
6 Striped Bass
7 Crappie
8 Shad
9 Other (which one? _____)

4) If you do have a favorite fish, about how much of your fishing time do you spend specifically fishing for it? (circle one)

0 Almost none
1 One-fourth
2 One-half
3 Three-fourths
4 Almost all

5) On about how many of your 1988 fishing trips did you keep the fish you caught? (circle one)

0 Almost none
1 One-fourth
2 One-half
3 Three-fourths
4 Almost all

Next we'd like to get your opinions about the quality of fishing on the James River. Please answer these questions on the basis of your experiences in 1988.

6) What were the major reasons why you went fishing on the James River in 1988? (circle as many as you wish)

0 Catching many fish
1 Catching large fish
2 Catching fish for food
3 Competing in a fishing contest
4 Enjoying the outdoors
5 Spending time with fishing friends
6 Combining fishing with camping, boating, or picnicking
7 Relaxing
8 Other (which ones?_____)

7) If you fished on other rivers in 1988, which rivers did you enjoy more than the James? (circle as many as you wish)

0 Only fished the James River
1 James River was the best
2 Shenandoah River
3 New River
4 Rappahannock River
5 Chickahominy River
6 Potomac River
7 Appomattox River
8 York River
9 Roanoke(Staunton) River
10 Other (which ones?_____)

8) What is the smallest size smallmouth bass that you enjoy catching? (circle one)

1 Size does not matter
2 10 inches
3 12 inches
4 14 inches
5 16 inches

9) This question lists ways that anglers on the river have suggested to improve the James River. Please indicate how strongly you agree or disagree with each suggestion by checking one box in each row across.

	strongly disagree	disagree	no opinion	agree	strongly agree
Enforce laws better	( )	( )	( )	( )	( )
Require canoe registration	( )	( )	( )	( )	( )
Encourage canoe-rental businesses	( )	( )	( )	( )	( )
Control water pollution	( )	( )	( )	( )	( )
Forbid new dams	( )	( )	( )	( )	( )
Remove existing dams (to allow fish migration)	( )	( )	( )	( )	( )
Clean up trash better	( )	( )	( )	( )	( )
Build more access points	( )	( )	( )	( )	( )
Improve existing access points	( )	( )	( )	( )	( )
Provide better parking	( )	( )	( )	( )	( )
Provide more river information	( )	( )	( )	( )	( )
Continue musky stocking	( )	( )	( )	( )	( )
Eliminate "citation" program	( )	( )	( )	( )	( )

Fishing regulations have changed recently on the James River -- and other changes are always possible! A popular regulation these days is a "slot" limit. The "slot" is a size range (like 11"-13") within which fish cannot be kept. We'd like to ask you a few questions about your reaction to certain fishing regulations.

10) What was the size limit for smallmouth bass on the James River in 1988? (circle one)

0 No size limit
1 12" minimum size
2 14" minimum size
3 11"-14" slot limit
4 12"-15" slot limit

11) What was the daily limit for smallmouth bass on the James River in 1988? (circle one)

0 Three per day
1 Five per day
2 Eight per day
3 No limit

12) Why do you think these regulations are used for smallmouth bass in the James River? (circle all that apply)

0 Don't know
1 Protect bigger fish
2 Protect breeding fish
3 Make fish grow faster
4 Other _____

13) About how many times were you checked by a game warden while fishing on the James River in 1988? (circle one)

0 None
1 Once
2 Twice
3 Three times
4 Four times
5 More than four times (how many times?_____)

14) This question lists several possible combinations of size limits and catch limits. Please indicate how likely you would obey with each set of regulations by checking one number for each (1= always obey to 5= never obey).

	would always obey 1	2	3	4	would never obey 5
14" minimum length and 5 fish/day	( )	( )	( )	( )	( )
14" minimum length and 2 fish/day	( )	( )	( )	( )	( )
11"-14" slot limit and 5 fish/day	( )	( )	( )	( )	( )
11"-14" slot limit and 2 fish/day	( )	( )	( )	( )	( )
All fish must be released	( )	( )	( )	( )	( )

Now we'd like to ask you a few questions about you and your overall interest in fishing and in the James River.

15) Which county or city do you live in? _____

16) What outdoor organizations are you a member of? (circle all that apply)

0 None
1 B.A.S.S.
2 Muskies Inc.
3 Smallmouth
4 Trout Unlimited
5 Float Fishermen of Va.
6 Va. Federation of Anglers
7 Izaak Walton League
8 Local fishing club
9 Other (which ones?_____)

17) About how much money did you spend last year on fishing tackle and equipment (including boats, motors and trailers)? (circle one)

0 Less than $50
1 $50 - 100
2 $100 - 200
3 $200 - 500
4 $500 - 1000
5 Over $1000 (about how much? _____)

18) About how much fishing tackle and equipment do you own? (circle one)

0 Less than $50
1 $50 - 100
2 $100 - 200
3 $200 - 500
4 $500 - 1000
5 $1000 - 2000
6 $2000 - 5000
7 Over $5000 (about how much?_____)

Finally, we would like to ask a question about how valuable James River fishing is to you. This value is important for comparing fishing to other uses of the James. To help you think about this value, we have made up an imaginary situation (this could never happen in real life):

19) Suppose you could sell your right to fish on the James River for one year. And suppose that if you did sell, you could not fish on the James for that entire year. What is the smallest amount of money you would sell for? _____

Please write any additional comments in this space.

Thank you for completing this survey. The few minutes you have spent will help greatly in the future management of the James River.

Please return this survey to:

Dr. Larry A. Nielsen
James River Project
Dept. of Fisheries and Wildlife Sciences
Virginia Tech
Blacksburg, Virginia 24061-0321

APPENDIX C - MAIL SURVEY COVER LETTER

Last week I sent you a questionnaire about James River fishing. Thanks for agreeing to participate.

If you have completed and returned the questionnaire, please accept my sincere thanks. If not, please do so today. Because we are surveying only a few James River anglers, your responses are very important.

If you did not receive the questionnaire or misplaced it, please call me collect (703-231-6959) and I will mail you another today.

Sincerely,

Larry A. Nielsen, Project Director

APPENDIX D - POSTCARD REMINDER

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061-0321

SCHOOL OF FORESTRY AND WILDLIFE RESOURCES—DEPARTMENT OF FISHERIES AND WILDLIFE SCIENCES

April 7, 1989

Dear James River angler:

The James River is one of Virginia's most popular fishing spots. The Virginia Department of Game and Inland Fisheries (VDGIF) is now studying the river in order to improve its value for fishing and other uses. As part of that study, the VDGIF has asked me to survey anglers regarding their use of the river.

Last year while fishing on the James, you agreed to participate in this mail survey. I appreciate your willingness to complete and return the enclosed questionnaire. You are one of only a few anglers who are receiving this questionnaire. Your responses are very important, so that we can get an accurate picture of the James River fishery.

Please complete the questionnaire as soon as possible and return it in the enclosed envelope. Your answers will be treated with strict confidentiality, and your name will never be associated with your answers. An identification number is printed on the return envelope so that we may check your name off our mailing list and not bother you with follow-up letters. The envelope is separated from your questionnaire when it arrives to assure anonymity.

The results of this research will be reported to the VDGIF for use in their management of the James River. Thus, the results will be important for improving fishing and environmental quality on the James for years to come. If you would like a copy of our report, please write "copy of results requested" and your name and address on the back of the return envelope.

Thank you for your time and for contributing to the future of the James River. And good fishing this season!

Sincerely,

Larry A. Nielsen
Project Director

APPENDIX E - FOLLOW-UP MAIL SURVEY COVER LETTER

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061-0321

SCHOOL OF FORESTRY AND WILDLIFE RESOURCES—DEPARTMENT OF FISHERIES AND WILDLIFE SCIENCES

April 21, 1989

Dear James River angler:

About three weeks ago, I sent you a questionnaire regarding your use of the James River. As of today, I have not received your completed questionnaire.

The Virginia Department of Game and Inland Fisheries (VDGIF) is sponsoring this study in order to improve the value of the James River for fishing and other recreational uses.

I am writing to you again because of the significance each questionnaire has to the usefulness of this study. You are one of only a few James River anglers who are receiving this questionnaire. Responses are very important if the study is to produce an accurate picture of the James River fishery.

In the event that your questionnaire has been misplaced, a replacement is enclosed.

Thank you for your time and for contributing to the future of the James River.

Sincerely,

Larry A. Nielsen
Project Director

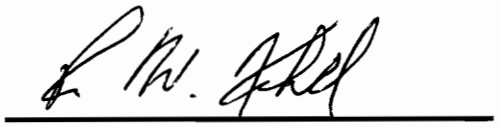
APPENDIX F - ANGLER PROFILES

Comparison of responses given by four angler non-complier groups in mail survey, James River, Virginia, 1988.

Question	Categories	Regulation scenarios: 14 in minimum 5/day	14 in minimum 2/day	Slot length limit 5/day	Slot length limit 2/day
Days fished per month	>3.99	7	35	5	35
	2.0-3.99	7	23	3	27
	1.0-1.99	3	5	2	5
	< 1.0	2	3	1	2
Days fished on the James River per month	>3.99	2	13	2	18
	2.0-3.99	8	27	3	25
	1.0-1.99	3	16	4	17
	< 1.0	6	11	2	10
Yearly tackle expenditures ($)	< 50	4	6	1	6
	50-99	3	11	3	13
	100-199	3	12	2	15
	200-499	3	11	2	11
	500-999	4	13	1	13
	1000-2499	1	3	0	3
	2500-4999	1	8	0	7
	> 5000	0	3	0	3
Club Participation	None	16	43	10	50
	One or more	2	22	0	18
Species Preference	Any	8	23	2	24
	Bass	6	35	6	32
	Catfish	3	7	2	7
	Trout	1	2	1	4
	Other	1	2	0	4
Smallest size Smallmouth enjoyed catching	None	11	42	3	39
	10"	3	8	2	8
	12"	3	6	1	10
	14"	1	4	1	5
	16"	0	6	2	6

Vita

Ron W. Kokel was born September 9, 1964, in Waco, Texas, and graduated from McKinney High School, McKinney, Texas in May 1983. He earned a B.S. in Wildlife and Fisheries Sciences (Fisheries Ecology) from Texas A & M University in May, 1987. After a short stint as a foreign fisheries observer in Alaska with the National Marine Fisheries Service, he entered the Virginia Polytechnic Institute and State University graduate program, and is currently a candidate for Master of Science in Fisheries and Wildlife Sciences (Fisheries Option). From December, 1989, to December, 1990, Mr. Kokel took a leave of absence from VPI & SU to receive a one-year internship as a policy intern at the Sport Fishing Institute in Washington, D.C. Mr. Kokel is a member of the American Fisheries Society, Gamma Sigma Delta, and Sigma Xi.



Ron W. Kokel