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Use of Random Response to Estimate Angler Noncompliance with Fishing Regulations

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Abstract.—We assessed noncompliance with angling regulations on three Idaho waters using random response, a technique designed to quantify embarrassing or criminal behavior. We searched for associations between positive random response answers and angler regulation awareness across a number of demographic variables. Illegal use of bait and creeling of westslope cutthroat trout *Oncorhynchus clarki lewisi* within two catch-and-release zones ranged from −0.4 to 3.0%. Creeling of illegal-sized cutthroat trout was a more common violation (5 to 8%) in two zones managed with a minimum size regulation. Estimated noncompliance with barbless hook regulations for the same zones was high (29%), but nearly 75% of these violations were accidental. Noncompliance with harvest restrictions was greatest on Henrys Lake where 9.5% of anglers violated the two-trout creel limit each day. We observed statistically significant associations between the types of regulations and angler ability to correctly recite them on a given stream. Several demographic variables including age, residence, and gear type used were also associated with regulation awareness. We conclude that random response is a viable method for estimating rates of angler noncompliance with regulations. Additional analyses are needed to evaluate potential biological effects of noncompliance on the trout populations.

Fishing regulations typically require various levels of restraint by the public. The Idaho statewide general creel limit of six trout requires little sacrifice for most harvest-oriented anglers because few anglers exceed such a limit in a typical angling day (Hunt 1970; Thurow 1990). Special regulations often require anglers to return most or all of their catch and restrict gear used (e.g., bait restrictions, barbless hooks). Although special regulations typically result in increased fish sizes, densities, and angler catch rates (Wydoski 1977; Anderson and Nehring 1984; Behnke 1987), individuals may or may not comply with such restrictions.

Perhaps because of the success associated with special regulation areas, angler noncompliance is often ignored when regulations for individual waters are developed. Noncompliance has not been considered or even mentioned in many modeling exercises that have dealt with regulation options (e.g., Clark 1985; LaBolle and Schill 1988; Espegren et al. 1990; Thurow 1990).

In fact, angler noncompliance with regulations could affect the success of special regulations. Paragamian (1984) concluded that angler noncompliance with special regulations in a smallmouth bass *Micropterus dolomieu* fishery could be the main factor blocking attainment of management objectives. Using simulations, Gigliotti and Taylor (1990) suggested that a relatively small amount of angler noncompliance could affect salmonid stock structures and densities in a typical catch-and-release fishery. Lewynsky (1986) concluded that angler noncompliance was a factor in the poor response to special regulations by the westslope cut-

throat trout *Oncorhynchus clarki lewisi* stock in the North Fork of the Coeur d'Alene River.

Even advanced attempts to manage exploited wildlife populations may be confounded without estimates of illegal harvest (Smith et al. 1989), but such data are difficult to obtain. Violators often successfully hide evidence of violations from enforcement personnel during contacts. Resultant estimates of noncompliance based on routine contacts can be misleading (Cowles et al. 1979). Several techniques including undercover contacts (Smith and Smeltzer 1991), clandestine observations (Lewynsky 1986; Rohrer 1991), and violation simulation (Stork and Walgenbach 1973) have been used on rare occasions to estimate noncompliance with fishery regulations. These techniques are logistically difficult and expensive to use. A less expensive alternative, random response, has been used several times (Lewynsky 1986; Smith 1989; Rohrer 1991), but the technique has received little attention despite promise as a method for estimating noncompliance.

Random response is a survey method for gathering unbiased data on sensitive issues that could embarrass or criminalize individuals. Warner (1965) pioneered the random response concept, and Greenberg et al. (1969) refined the initial model. Lewynsky (1986) and Rohrer (1991) used random response surveys in Idaho to estimate the incidence of regulation violations in waters with special regulations. Results from those studies suggested that noncompliance with special regulations on two waters consistently exceeded 10%. Schill and Kline (1994) noted mathematical errors in their methods and recalculated estimates for both waters. Although a number of the revised estimates indicated low noncompliance rates, several remained above 20%. Gigliotti and Taylor (1990) demonstrated that such levels of noncompliance could affect the population size structures and densities of salmonids.

The objective of this study was to evaluate the use of random response as a tool to estimate the frequency of special regulation violations. We quantified angler noncompliance rates for three Idaho waters and classified anglers demographically in terms of regulation awareness and propensity to violate restrictions.

Study Site

We conducted random response surveys on five study sections of three Idaho waters (Figure 1). Henrys Lake is a shallow, highly productive, 2,630-ha lake in eastern Idaho. It supports an extensive salmonid sport fishery for yellowstone cutthroat trout *Oncorhynchus clarki bouveri,* brook trout *Salvelinus fontinalis,* and cutthroat–rainbow trout hybrids *O. clarki bouveri* × *O. mykiss.* Annual effort on the lake has ranged from 125,000 to 365,000 angler-hours in the last decade (T. Herron, Idaho Fish and Game, unpublished data). The fishery is supported by both wild and hatchery trout. Anglers are restricted with a two-trout creel limit (any species) with no terminal gear restrictions.

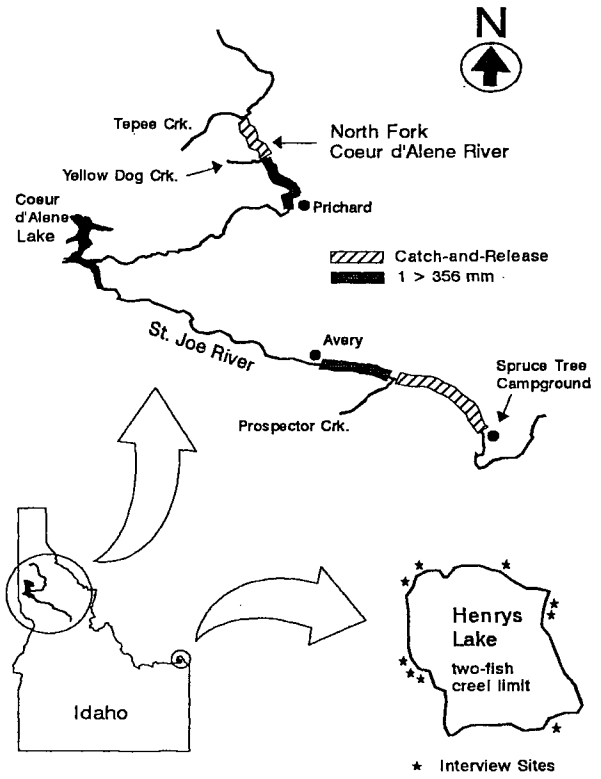

FIGURE 1.—Location of regulation zones evaluated in the 1993 random response study.

The St. Joe and North Fork Coeur d'Alene rivers originate near the Idaho–Montana border and flow westerly for 150 and 200 km, respectively, before entering Coeur d'Alene Lake. Westslope cutthroat trout and mountain whitefish *Prosopium williamsoni* are the predominant gamefish species. Since the mid 1970s, special regulations have been used to protect wild cutthroat trout from overexploitation on both streams. Regulations require barbless hooks and catch and release for cutthroat trout on upper segments of both drainages including tributaries. Cutthroat trout in lower segments of the two streams are managed with a one-trout creel limit and a 356-mm minimum length limit (1>356). Hatchery rainbow trout are planted in lower portions of both drainages and are managed under a six-trout statewide creel limit. Bait is not

excluded in the 1>356 zones but is prohibited within the catch-and-release zones.

Methods

Noncompliance Estimates

In 1993 we interviewed anglers on the two streams from 29 May to 28 August. We divided this period into 2-week intervals and randomly selected one weekday per interval to conduct interviews on each stream. We alternated weekend interviews systematically on the two streams and contacted anglers on Saturdays and Sundays. Thus, in each 2-week interval, anglers were contacted on 3 d. We contacted all anglers fishing in the catch-and-release and 1>356 zones between 0630 and 2100 hours.

We conducted angler interviews on Henrys Lake from 29 May to 5 September. We sought an interview schedule similar to that used on the two streams. However, because severe weather eliminated virtually all angling activities on a number of interview days, we had to modify our design. We rescheduled these days nonrandomly as dictated by personnel schedules. The size of Henrys Lake, coupled with intense angling effort, prohibited us from contacting all anglers on interview days. We interviewed anglers bank fishing at all publicly accessible sites and contacted boat anglers at all boat ramps and associated campgrounds. During busy periods at the boat ramp, we randomly selected one or two anglers from each group using a random number target (Reaser et al. 1975).

When first approaching anglers, we identified ourselves as Idaho Fish and Game biologists (not enforcement officers) and engaged respondents in casual conversation to relax them. We recorded the sex of each angler, asked their age, and placed them in six age categories ranging from 14 to 60+ years of age. Only anglers over 14 years old were included in the study.

To reduce the likelihood of anglers being untruthful, we sought data on their last fishing trip, not the present one. We asked anglers if they had fished this water before (between appropriate zone boundaries) and if they could remember details of the trip. If they responded yes to both questions, we continued the interview. If anglers had not fished the zone before, we terminated the interview.

We classified anglers by residence and the type of terminal gear they used. If anglers resided in the water body's Idaho Fish and game administrative region, we denoted them as local anglers. All remaining resident anglers were classified as Idaho anglers. Nonresident anglers were classified separately but because of their numeric importance, anglers from the eastern one-third of Washington were grouped separately for the northern Idaho stream fisheries.

Before asking the random response questions, we informed anglers that the remaining portion of the interview was unusual in that it involved a game of chance. We then explained the survey procedure to participants. On all waters we assured anglers that individual noncompliance was not of interest to us but that by sampling a large number of anglers, an overall rate could be derived.

We used a six-sided die placed in a lidded coffee mug as the randomizing device and used known random response input parameters identical to those of Shotland and Yankowski (1982). There were two questions (sensitive and unrelated) printed on the side of the cup. The numbers one, two, three, four, and five were printed next to the sensitive question dealing with angling regulations. The number six was printed next to an unrelated question which did not apply to fishing regulations. Anglers were instructed to shake the cup, remove the lid and observe the number without informing the interviewer of the result. They were then asked to pair up the die number with the appropriate question on the side of the cup and answer "yes" or "no" without informing the interviewer which question they were answering. Interviewers did not maintain eye contact with anglers during this process. Anglers were then instructed to shake the cup to eliminate our ability to examine the number.

We repeated this procedure with different cups that pertained to different restrictions on the study waters. For example, we used three separate cups to ask anglers if they were complying with the zero-trout creel limit, bait, and barbless hook restrictions in the catch-and-release zones. Our question concerning barbless hooks asked whether anglers intentionally violated this regulation. During the first week of July, we added an additional survey question for the two catch-and-release zones that pertained to accidental use of barbless hooks (Table 1). We sought to determine how often anglers occasionally forgot to manually flatten hook barbs, use barbless hooks, or both, even though they knew and intended to comply with the regulation.

To expect honest responses from violators, anglers had to clearly understand how they were af-

TABLE 1.—Summary of random response questions used to interview anglers about their last fishing trip to five separate regulation zones in Idaho, May through August 1993.

Water body, regulation[a]	Question[b]	Sample size
St. Joe River		
Catch and release	Keep any cutthroat trout	297
Catch and release	Use bait	297
Catch and release	Use barbed hooks intentionally	297
Catch and release	Use barbed hook accidentally	154
St. Joe River		
1 > 356 mm	Keep more than one cutthroat trout	174
1 > 356 mm	Keep any cutthroat trout <356 mm	174
Coeur d'Alene River		
Catch and release	Keep any cutthroat trout	185
Catch and release	Use bait	185
Catch and release	Use barbed hooks intentionally	185
Catch and release	Use barbed hooks accidentally	93
Coeur d'Alene River		
1 > 356 mm	Keep more than one cutthroat trout	207
1 > 356 mm	Keep any cutthroat trout <356 mm	207
Henrys Lake		
Any two fish	Keep more than two trout	195

[a] 1 > 356 mm = creel limit of one cutthroat trout longer than 356 mm.
[b] For survey interviews 14 inches was used instead of 356 mm.

forded privacy. We stressed that the interviewer had no knowledge of the die roll outcome and that a yes answer did not identify them as a violator because of the way the "game" worked. For those who appeared confused, we conducted a practice run using a hypothetical example.

We reminded anglers several times during interviews that we were biologists (not enforcement personnel) and that the regulation questions pertained only to their last trip on this stream zone. After completing the random response interviews, we asked anglers if they could recite the regulations for the zone in question.

Use of the unrelated question model required an estimate of how many anglers would answer yes to a nonsensitive question. We used "Were you born in the month of April?" as the unrelated question in all cases. The proportion of statewide anglers born in the month of April (Π_Y) was obtained from the 1993 Idaho license database. We divided the total number of Idaho anglers born in April by the total number of anglers to approximate the proportion of anglers with the nonsensitive attribute (0.08). We then calculated noncompliance estimates for specific regulations using the formula of Greenberg et al. (1969) where the unrelated characteristic or non-sensitive attribute is known:

$$\Pi_A = \frac{\hat{\lambda} - (1 - P)\,\Pi_Y}{P}$$

with variance of

$$\frac{\lambda(1 - \lambda)}{nP^2};$$

Π_A = estimated proportion of anglers violating the regulation in question;
$\hat{\lambda}$ = proportion of yes answers in the survey;
p = probability of obtaining the regulation question from the die roll = 0.83;
Π_Y = the proportion of anglers with the nonsensitive attribute = 0.08;
$\lambda = p(\Pi_A) + (1 - p)\Pi_Y$ = probability of receiving a yes answer in the survey (Greenberg et al. 1969).

We approximated 95% confidence limits using the formula: $\Pi_A \pm 2\sqrt{\text{var}}$.

Model Validation

We used surreptitious observations (Lewynsky 1986) to validate the random response technique. During early June, we drove along the St. Joe catch-and-release zone and selected 37 possible sites where anglers could be discretely observed from concealed locations. We assigned each observation post a number. From 27 June to 27 August, project personnel, enforcement officers, and cooperating volunteers observed anglers fishing the stream near these sites. Personnel typically dressed in drab or camouflage clothing and used spotting scopes, binoculars, or both to facilitate observation. We spent a minimum of 6 h at each site.

Anglers observed fishing were classified according to their compliance with the bait restriction and zero-trout creel limit. We made no attempt to ascertain the frequency of barbed hook use. Personnel recorded both the number of minutes fished and the number of fish caught by each angler.

Sampling dates were not randomized. On days when personnel were available, a lottery-type drawing was conducted to determine the site location to be watched. This assignment was done without replacement to guarantee that all sites were included during the study.

In addition to the site-specific work just described, a local conservation officer spent 6 d patrolling the St. Joe catch-and-release zone and con-

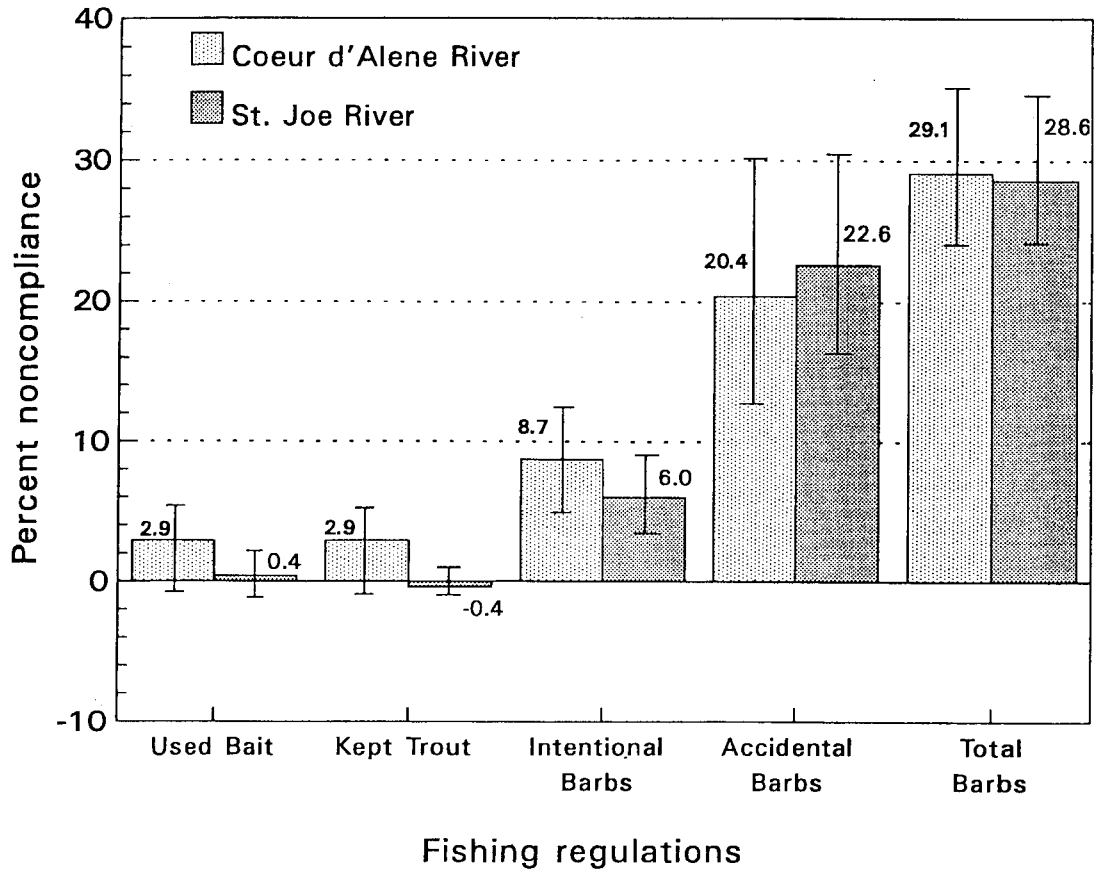

FIGURE 2.—Random response estimates of angler noncompliance in two Idaho stream zones managed under catch-and-release regulations, May–August 1993. Bars denote 95% confidence limits.

tacted 115 anglers. For comparison with our random response results for barbless hook use, the officer attempted to contact all anglers fishing in the catch-and-release zone on his patrol days. In some cases he drove up in full view of anglers, left the vehicle, and initiated contact. Whenever possible, however, he would observe the anglers covertly for up to 1 h before initiating contact. The officer recorded confirmed barbless hook violations. A number of anglers hastily changed or broke off flies as the officer approached. This behavior was so overt and hurried that these anglers were obviously violating the barbless hook regulation; thus, we included these cases in the data as barbless violations. We compared the estimate from these contacts to the frequency of barbless hook violations estimated by random response. We calculated 95% confidence limits around the validation estimates using the standard proportion formula with correction for continuity (Fleiss 1981).

Angler Demographics

We summarized angler responses to regulation questions by demographic categories. For each zone, we calculated the proportion of demographic groups (sex, residence, gear type, age, years of education, and time of week interviewed) that could recite the special regulation correctly and who answered yes to one or more random response questions for individual restrictions. We pooled data for the stream study sections (excluding Henrys Lake) and tested relations among demographic variables and responses to the regulation questions. We used a chi-square test of association to make statistical comparisons at the 0.05 significance level using Yates correction when necessary (Zar 1974).

Results

Noncompliance Estimates

Based on the 1,058 anglers interviewed with random response methods, there was a wide range of noncompliance with special regulations. Estimated daily noncompliance with individual restrictions on the five study sections ranged from −0.4 to 29.1% for each angler-day.

In the two catch-and-release zones, angler non-

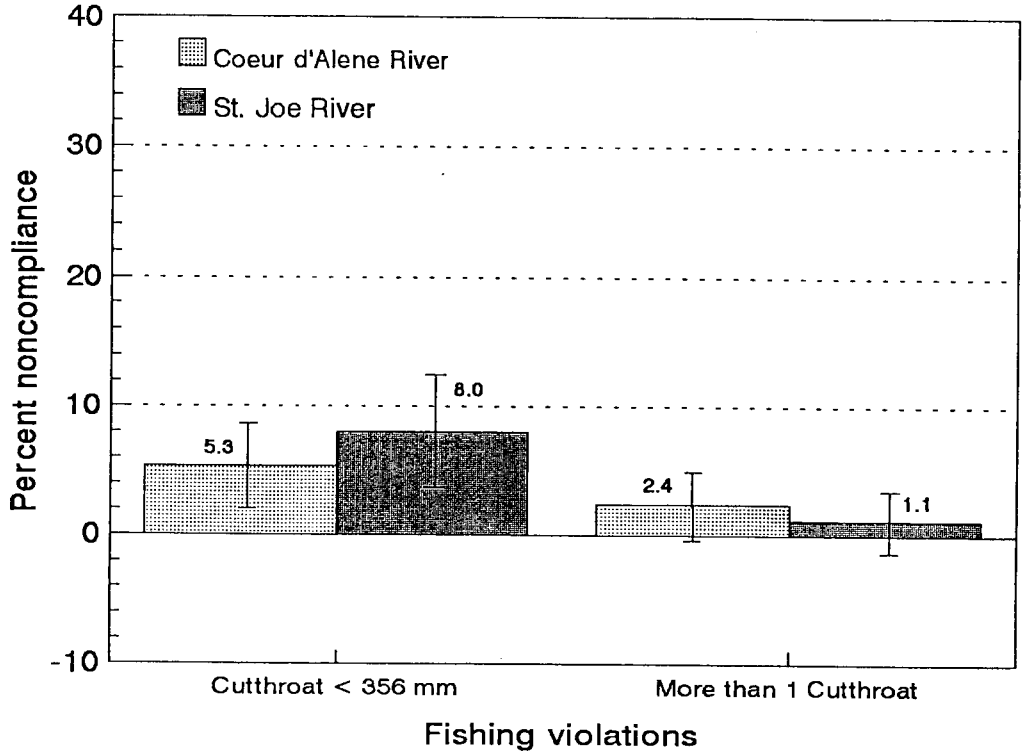

FIGURE 3.—Random response estimates of angler noncompliance in two Idaho stream zones managed with a one-trout bag limit and a 356-mm minimum size limit, May–August 1993. Bars denote 95% confidence limits.

compliance with restrictions that directly limited harvest was rare. We estimated the incidence of bait use and creeling of cutthroat trout at 2.9% of angler-days on the Coeur d'Alene River. Less than 1% of anglers in the St. Joe River catch-and-release zone violated the bait restriction (Figure 2). Our estimate for anglers creeling trout on the St. Joe river was −0.4%; the upper confidence bound was 1%.

Angler noncompliance with the barbless hook restrictions in both catch-and-release zones was common, with 28.6 and 29.1% of anglers violating this restriction daily. About 75% of these violations were accidental (Figure 2).

Compliance in the two 1>356 zones varied by individual restriction. Coeur d'Alene River anglers were about twice as likely as St. Joe River anglers to creel more than the legal limit, but both rates were low (Figure 3). Of the St. Joe River anglers we interviewed, 8% harvested cutthroat trout smaller than the legal length limit on their last day fishing, compared to 5.3% on the Coeur d'Alene River.

Noncompliance with a restriction that directly affected or limited harvest was greatest on Henrys Lake. We estimated that 9.5% of anglers violated the two-trout creel limit during the interview period. Much of this illegal activity may have resulted from party fishing (giving creeled fish to others in party). Several anglers volunteered this openly after replying yes in the random response interview.

Model Validation

Project personnel surreptitiously observed 107 anglers on the St. Joe River during the study. Anglers fished an average of 39 min. Only 30 anglers caught cutthroat trout during this period and had an opportunity to violate the zero-trout creel limit.

Estimates of noncompliance derived from surreptitious observations were nearly identical to random response results. We observed only one angler (0.9%) violating the bait restriction while fishing the catch-and-release zone. This individual was not using bait himself but was observed placing a worm on a child's hook. Both random response and surreptitious estimates of noncompliance with the bait restriction were less than 1.0%, and 95% confidence limits overlapped (Figure 4).

Estimates for illegal creeling of cutthroat trout were low, regardless of the methodology used. The surreptitious and random response methods yielded estimates of 0.0 and −0.4%, respectively.

The incidence of barbed hook use estimated via random response exceeded that recorded by the officer on patrol. Based on random response, we estimated that 28.6% of St. Joe River anglers fish-

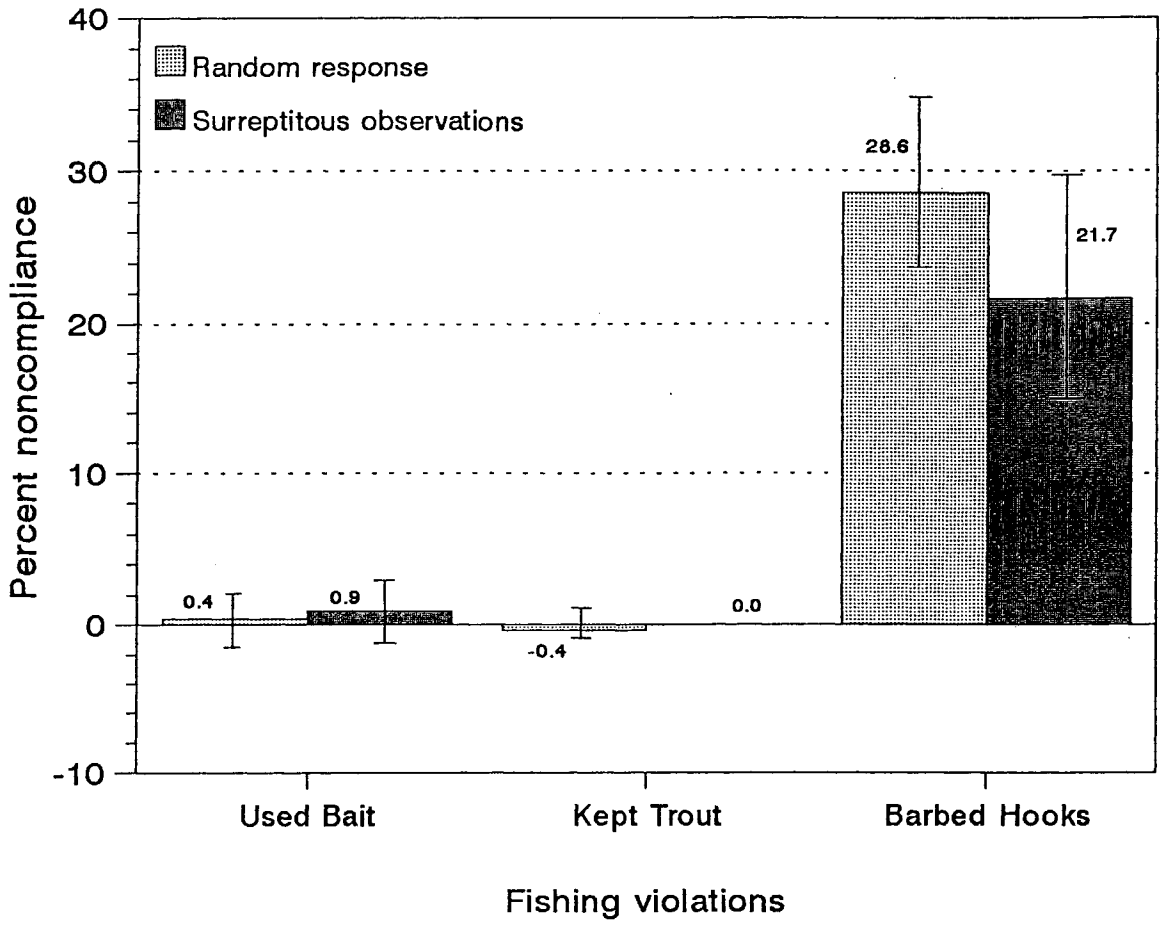

FIGURE 4.—Comparison of noncompliance estimates for the St. Joe River catch-and-release zone from random response interviews and surreptitious observations, May–August 1993. Bars denote 95% confidence limits.

ing the catch-and-release zone violated the barbless regulation each day. The enforcement officer observed that 9.6% of the anglers (11 cases) committed a barbless hook violation. If we include all individuals who quickly cut off their terminal gear as the officer approached, the estimate increases to 21.7%.

TABLE 2.—Regulation awareness for anglers fishing two Idaho special regulation waters, May–August 1993.

Water body regulation	Aware of regulation (%)	Sample size	χ^2 value	P
Coeur d'Alene River				
1 > 356 mm[a]	68	156	24.5	<0.001
Catch and release	91	164		
St. Joe River				
1 > 356 mm[a]	72	148	49.2	<0.001
Catch and release	96	280		

[a] 1 > 356 mm = creel limit of one cutthroat trout longer than 356 mm.

Angler Demographics

Angler awareness of regulations was higher in the catch-and-release zones than in 1>356 zones on both northern Idaho streams. An average of 94% of anglers interviewed in both catch-and-release zones could recite the regulations; 70% could do so in the 1>356 zones. Within both streams, these differences were highly significant (Table 2).

We also observed statistically significant associations between regulation awareness and several demographic categories. Young anglers (<30 years) were less likely to recite the regulations correctly ($\chi^2 = 29.3$, $P < 0.001$). Bait and lure anglers gave fewer correct responses than fly fishermen ($\chi^2 = 6.0$, $P < 0.05$). Weekend anglers were less informed than weekday anglers ($\chi^2 = 5.2$, $P < 0.024$). Local and eastern Washington anglers were not as aware of regulations as other Idaho residents and nonresidents ($\chi^2 = 7.7$, $P < 0.05$). Only the sex and education variables were not associated with regulation awareness (Table 3).

TABLE 3.—Pooled summary of regulation knowledge (percent able to recite current special regulations) and frequency of individual anglers responding yes to any random response question in four northern Idaho study sections, May through August 1993. Sample size is in parentheses. Only the sex and education variables showed no statistically significant association with awareness of regulations. Responses to random response questions did not differ significantly across demographic groups.

Measurement	Sex		Age (years)						Education[a]			Time of week[b]	
	M	F	14–20	21–30	31–40	41–50	51–60	>60	<13	13–16	>16	WE	WD
Able to recite regulation													
Percent	82	88	75	80	90	88	96	92	85	87	90	85	91
N	(813)	(108)	(80)	(172)	(229)	(251)	(99)	(104)	(335)	(431)	(167)	(668)	(276)
Replying yes to any random response question													
Percent	10	9	8	13	9	9	6	12	10	9	10	10	8
N	(817)	(109)	(98)	(197)	(264)	(272)	(110)	(108)	(384)	(485)	(178)	(768)	(290)

[a] Years of education achieved for those anglers more than 20 years old.
[b] WE = weekends; WD = weekdays.
[c] LOC = local anglers; ID = all other Idaho residents; EWA = anglers from the eastern one-third of Washington; Other = all other nonresidents.

We could not categorize likely violators by demographic groups. Within individual zones, no significant differences resulted when responses to random response questions were compared across demographic groups. In addition, none of the pooled data were significantly different (Table 3).

Discussion

A benefit of inquiring about sensitive topics with random response surveys is a reduction in refusals (Goodstadt and Gruson 1975). Three anglers in 1,061 (0.3%) refused to participate in the random response portion of the interview. Two of these refusals were in the North Fork Coeur d'Alene catch-and-release zone and one on Henrys Lake. The Henrys Lake angler was in obvious violation at the time of the refusal. If we assumed that all anglers refusing to participate were violators, recalculation of noncompliance estimates would have virtually no effect on our results.

Our results for accidental versus intentional violation of barbless hook regulations may have implications for fishery management agencies. Seventy-five percent of the reported barbless hook violations were accidental. Many anglers indicated they typically complied with regulations but sometimes forget to flatten barbs on individual flies and lures for short periods. Despite the recent paper of Taylor and White (1992), most past authors have concluded that hooking mortality does not differ between barbed and barbless hooks (Hunsaker et al. 1970; Falk et al. 1974; Wydoski 1977; Dotson 1982; Mongillo 1984; Titus and Vanicek 1988). If 75% of barbless hook citations are written to anglers attempting to comply with the law and the regulation violated has little or no demonstrated biological value, maintenance of such restrictions may be self-defeating for regulatory agencies. The animosity generated by issuing such citations to largely compliant anglers seems counterproductive.

An important limitation of our validation design is that anglers were observed for only a portion of their angling-day. We could not account for any night angling activity. In addition, only 28% of the anglers ($N = 30$) caught a cutthroat trout during observation periods. Thus, many anglers we observed did not have the opportunity to violate the creel limit. Additional creel violations possibly occurred if unsuccessful anglers moved to other areas on the stream and caught cutthroat trout. Despite the small sample size, none of the successful anglers were observed keeping a trout. This result agrees with our low random response estimate.

Anglers might violate the bait restriction elsewhere during their angler-day and not at the observation site, but this possibility seems remote. Anglers violating regulations because of a lack of awareness would do so all the time. We surreptitiously observed anglers for an average of 39 min and believe anglers intentionally violating bait restrictions would likely do so during that time.

There are several other limitations to our random response methods. We assumed anglers could accurately remember whether they committed violations on their last angling trip. Recall is often not 100% accurate in recreation studies (Hiett and Worrall 1977; Chase and Harada 1984). Accurate recall of barbless hook violations, particularly accidental ones, may be questionable and may be more of an estimate. However, we believe anglers violating the bait, bag, or size restrictions would accurately remember the violations.

TABLE 3.—Extended.

Measurement	Residence[c]				Gear		
	LOC	ID	EWA	Other	Bait	Lure	Fly
Able to recite regulation							
Percent	96	100	96	98	84	82	89
N	(386)	(47)	(156)	(119)	(152)	(116)	(612)
Replying yes to any random response question							
Percent	10	14	7	9	11	14	9
N	(470)	(102)	(188)	(198)	(153)	(117)	(615)

We obtained a negative estimate of noncompliance with the zero-trout creel limit in the St. Joe River catch-and-release zone, suggesting questionable random response model performance. It is possible that we obtained a negative estimate simply by chance based on the die rolls. It is also possible, however, that the negative estimate reflects individuals unwilling to be truthful. Biologists may simply be unable to convince violators to answer truthfully. Enforcing fish and game laws is one of the most visible activities of wildlife agencies, and assuring some violators that researchers are not interested in individual responses may be difficult. The fear that somehow their responses could result in a citation despite privacy protection mechanisms could be very hard to overcome. Wright (1980) suggested that random response surveys should not be done by fish and wildlife personnel for this reason.

We believe that respondents' fears can be mitigated by judicious selection of interview personnel, proper training, and minimal use of uniforms. Individual interview personnel have demonstrated that they can influence survey responses and ultimately study results (Frey 1980). This would seem particularly true of random response surveys. The selection and training of people who can interact easily with the public and can honestly assure respondents of their lack of interest in individual answers should reduce the incidence of dishonest responses. Prospective interview personnel with a strong interest in enforcement activities should be avoided. We did not wear uniforms on Henry's Lake but found we needed to use uniform shirts on the two stream surveys to get anglers to stop fishing and wade to shore to participate in the survey.

Another reason actual violators might not want to answer truthfully is the fear that high stream-wide violation rates could result in stepped-up law enforcement efforts in general. Results from other applications of random response surveys suggest that members of a sensitive group (e.g., drug users or exam cheaters) will in fact cooperate despite this possibility. One would expect that fear of stepped-up enforcement activities would inhibit truthful response to sensitive questions, but random response has been used successfully in these and other instances (Goodstadt and Gruson 1975; Horvitz et al. 1976; Fiddler and Kleinknecht 1977; Lamb and Stem 1978; Shotland and Yankowski 1982).

Despite possible limitations of the study, our validation efforts in the St. Joe River catch-and-release zone agreed well with random response estimates. The similarity of the random response and validation estimates of noncompliance was quite striking, and confidence limits overlapped in all instances (Figure 4). We believe these results provide a reasonable validation of the method.

In addition to studies in Idaho (Lewynsky 1986; Rohrer 1991; Schill and Kline 1994), we found only two other wildlife-related studies that used random response. Smith (1989) used random response to estimate frequency of fishing without a license in Colorado. An estimated 22% of respondents had fished without one at least once during the past year. Wright (1980) estimated the numbers of deer poached illegally by Iowa farmers alone was equal to the legal harvest for the entire state.

Random response has received little attention from fish and wildlife agencies. The methodology is confusing for the average person (Smith 1989), and explaining it to survey respondents is sometimes difficult. However, survey respondents need not understand how the technique works. Anglers must only believe that their privacy is protected in order for random response to work (Smith 1989). Much of the random response literature is in statistical journals replete with complex mathematical formulas and discussions of variance efficiencies, optimal allocation of sample size, and other statistical jargon (Greenberg et al. 1969; Moors 1971; Folsom et al. 1973). These factors probably deter biologists from using the method.

Traditional methods of gauging compliance with regulations may not be useful in assessing biological effects of poaching on populations. In Idaho, the simple ratio of violations to field checks by enforcement personnel is often used to quantify compliance rates, but officers tend to seek and patrol areas where the most violations occur. Such estimates are likely biased. Field checks must be collected more randomly if they are to be used as an indicator of violation rates for biological pur-

poses (Cowles et al. 1979). Also, violators often successfully hide evidence of violations during routine contacts (Cowles et al. 1979), negatively biasing such estimates. Perhaps the best way to accurately estimate angler noncompliance is with surreptitious observations, but such work is difficult logistically and manpower-intensive, especially if sites are randomized. Random response appears to be a viable and relatively inexpensive way to estimate angling law violations.

Our estimates of noncompliance rates do not allow a final assessment of poaching effects on populations in the study waters. As discussed by Cowles et al. (1979), we have no idea how many violations each individual commits per day in the field, only that a certain proportion of anglers commit them. A quantitative variation of the traditional random response model (Greenberg et al. 1971; Horvitz et al. 1976; Fox and Tracy 1986) should facilitate such estimates. In any case, estimates of trout killed illegally must be considered with other data, including growth and natural mortality, before a final conclusion on the importance of noncompliance to the study waters can be reached.

Guidelines for random response model design are available from several sources. We followed the detailed guidelines from the original paper (Greenberg et al. 1969) in our study and selected $P = 0.83$ and $\Pi_Y = 0.08$. However, several recent authors have pointed out limitations to this approach. Folsom et al. (1973) suggested using a coin toss as the randomizing device, which would result in the sensitive question (P) being asked in 50% of the interviews. Fox and Tracy (1986) agreed with this approach and also encouraged the selection of an unrelated question with a higher probability of a positive response (e.g., in our study, we could have asked, "Were you born in the months of April, May, or June?" as our unrelated question). Such changes would decrease precision but would increase the perception of privacy protection for individuals skeptical of the technique. We recommend using this approach in future studies.

Our study identified substantial differences in regulation awareness among regulation zones. Angler awareness of the simple two-trout creel limit at Henrys Lake was high. On streams, anglers fishing catch-and-release zones were much more likely to know the regulations than those fishing 1>356 zones. Although there were no gear restrictions on the 1>356 zones, fishing regulations there were more complex because there was a different bag restriction for rainbow trout. Many anglers may not have the ability or interest to understand complex special regulations such as those for the 1>356 zones.

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