Public Attitudes Towards the Effects of Land Use on Coldwater Ecosystems

by

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Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Master of Science

in

Fisheries and Wildlife Science

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August 1991

Blacksburg, Virginia

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(ABSTRACT)

This study looked at differences in public attitudes of the effects of land use on coldwater ecosystems. Two parts of the general public were studied-- landowners having trout waters on their land and trout anglers. In addition, coldwater fisheries professionals in the southern Appalachian Mountain area were studied. It was hypothesized that differences in attitudes would exist among the three groups based on education, prior knowledge, and past experiences. It was also hypothesized that differences would exist among fisheries professionals based on amount and type of experience and amount of professional responsibility.

A series of mail surveys was conducted using the Delphi Method. The Delphi Method is an efficient way to quantify judgement through systematic solicitation of group opinion. High survey response rates were achieved, and are attributed to the simple survey, the interest of the groups, and the rewards offered.

In general, all participants felt that any land use had at least some ill effects on nearby streams. Landowners responded that farming had the least detrimental effects, while all groups agreed that industries posed the biggest risk to aquatic resources.

Greatest disagreement among groups concerned the effects of land use on dissolved oxygen and large woody debris. This coincides with disagreement among researchers and an increase in research of these topics. Disagreement among groups also concerned the effects of farming on trout food supply, presumably because of the complex interactions associated with farming.

Disagreement among fisheries professionals concerned the effects of land use on large woody debris-- an artifact of a current research topic-- and the effects of urban development on stream parameters. This is probably because of the diverse nature of urban development. Disagreement

among professionals was found to be a function of amount and type of experience, but specific differences could rarely be isolated.

Overall, the Delphi Method was an efficient way to obtain a group opinion. It is an inexpensive, effective means of quantitatively describing public knowledge of the effects of land use on coldwater ecosystems.

Acknowledgements

Funding for this project was provided by the Coldwater Research Unit of the USDA-Forest Service, Southeastern Forest Experiment Station, Coldwater Fisheries Research Unit, Blacksburg, Virginia, for which I am grateful. I would like to thank the Forest Service personnel involved for the latitude to conduct this study. Also, I would like to thank the Virginia Department of Game and Inland Fisheries, the Virginia Cooperative Extension Service, and the Virginia Council of Trout Unlimited for their contributions to this project.

I greatly appreciate the time and effort put forth by my committee on this project. Thank you Drs. Larry Nielsen, John Ney, Patricia Flebbe, and Andy Dolloff. Special thanks go to Dr. Donley Hill of National Forests in North Carolina and Dr. Patricia Flebbe for their continued support with my endeavors and for expanding my career horizon.

Eternal thanks go to John Stanovick and Ron Kokel for their "expert advice" and lasting friendship, and to the other graduate students for many great memories. And finally, very special thanks go to those people without whom my education would not have been possible: my husband, Roger; my parents, Suzan and Dave Bryan; and my sister, Stephanie.

Hats off to all of you!

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Introduction

This study examines differences in attitudes among three important groups regarding the effects of land use on coldwater ecosystems. Because of recent increases in public awareness of natural resources, an integrated approach to resource management is becoming necessary. Understanding the attitudes of involved groups is an important part of effective fisheries management because their roles (i.e. use of the coldwater resources) in the condition of fisheries resources are fundamental parts of the system. Inevitably, land use and coldwater systems must coexist. Therefore, the first step in improving management is to identify public knowledge of the effects of land use on coldwater systems.

Human use and development of land along streams result in many changes within the system. Within a landscape, all land is part of a watershed; therefore all land use has the potential to affect aquatic resources. However, land along aquatic systems (the riparian zone) is especially prone to use because of the diversity of resources it supports. Riparian areas support recreational activities, such as fishing and hunting, and serve as the foundation for many land use activities. Timber harvest, road and dam construction, agriculture, urban development, and industry affect the quality of the aquatic resources supported by coldwater systems (Haugen 1985). For example, timber harvest and other land use practices can alter the size, amount, and distribution of woody debris within a stream (Bryant 1981, Bryant 1983). Riparian timber harvest selectively removes older trees

that would otherwise enter the stream. Trout use large debris for cover, while aquatic invertebrates use small debris for substrate and food. Harvest of trees near streams also changes the amount of terrestrial invertebrates entering the system (Wilzbach et al. 1986), which along with aquatic invertebrates, form the base of salmonid food chains. This sequence shows that land use affects parameters that in turn affect trout populations in many ways.

Land Use and the Trout Fishery of the Southern Appalachians

Because small coldwater streams store little water and are closely integrated with the terrestrial ecosystem, they are more likely to be impacted by land use practices than are larger streams (Nielsen and Lackey 1980). In many cases, land uses such as forestry and agriculture occur or historically occurred on headwater streams with fragile aquatic habitat. In the southern Appalachian Mountain region, these headwater streams support the major populations of native brook trout (*Salvelinus fontinalis*) in the southeastern United States (Neves and Pardue 1983). Many southeastern trout streams also contain viable populations of non-native rainbow (*Oncorhynchus mykiss*) and brown (*Salmo trutta*) trout.

Historically, productive trout habitat in Virginia included the entire region west of the coastal plain (Schuder 1975). However, Mohn and Bugas (1980) documented a rapid loss in suitable habitat, which is now confined to the area west of the eastern slope of the Blue Ridge Mountains. Changes in the land along these streams have been documented as far back as the early settlers, when land was cleared for subsistence agriculture and to develop communities. These changes were followed by the growth of the forest industry and increased development. Removal of shade trees along streams and deforestation of entire watersheds for agriculture essentially changed streams from cold to warmwater habitat (Schuder 1975).

Trout populations in the southeastern mountain states fluctuate drastically from season to season (Lennon 1961). Exploitation by anglers and environmental extremes contribute to the instability of fish populations. However, streams are imbedded within the landscape, also making them vulnerable to changes associated with land use (Flebbe et al. 1988). Effects of land use on resident trout populations have been observed by Lennon (1961) and Wilzbach et al. (1986), and supported by a regional model developed by Flebbe et al. (1988). In this model, trout density could be related to seven watershed characteristics: runoff, total cropland, human land uses, natural pine cover (ages 10-20 years and 21-50 years), and hardwood cover (ages 21-50 years and 50+ years). The model predicts that highest trout densities would be associated with age 50+ hardwood cover, and lowest densities with high human use and total cropland. Sedell and Swanson (1984) also found that in areas where human land use was high, conditions favorable for trout were low. Regional models have predicted that with future increases in human land use, high quality trout habitat will decline concomitant with increasing harvest of older hardwood acreages (Flebbe et al. 1988). Thus, careful watershed management is essential in the planning and management of southeastern trout fisheries.

Effects of Land Use on Salmonid Populations

Changes in stream systems brought about by land use are often critical to fish communities. Among the most significant affected stream factors are: 1) water temperature, 2) dissolved oxygen, 3) turbidity and sedimentation, 4) allochthonous organic input (including woody debris), and (5) streamflow (Hall and Lantz 1969, Tebo 1975, Lynch et al. 1977). These in turn affect biological parameters such as algal production and aquatic invertebrate diversity and abundance (Hall and Lantz 1969). Impacts associated with the above physical and biological parameters are both long- and short-term and must be understood by both the public and the managers if informed planning is to be achieved. Because of the interactions among physico-chemical parameters and interactions

between these parameters and biological characteristics, the factors addressed by the survey do not coincide exactly with the text, but are rather a combination of the above factors and related subjects. For example, since there is an inverse relationship between water temperature and dissolved oxygen, only one of the parameters was chosen for the survey. Dissolved oxygen was chosen because it is harder to understand than water temperature (i.e. changes in water temperature as a result of land use follow common sense, while changes in dissolved oxygen are not so apparent).

Water Temperature

Water temperature is perhaps the most important parameter to consider when evaluating the suitability of a stream for maintaining stable trout populations. Seasonal and annual temperature fluctuations in trout streams are greatly altered by land use changes. For example, average temperature increases of as much as 7°C have been reported following logging in eastern hardwood forests (Greene 1950, Eschner and Larmoyeux 1963). In North Carolina, a stream draining a logged watershed maintained water temperatures 4-5°C higher than streams draining adjacent unlogged areas (Greene 1950). Also, Burns (1972) observed an 11.1°C increase in average stream temperature during road construction by a small California stream. In these examples, changes in stream temperature have been attributed to the heating of the entire watershed (e.g. through heating of the water table), rather than to the insulating effects of riparian vegetation on exposed water surfaces (riparian vegetation helps regulate groundwater and stream temperatures through shading, etc.).

Dissolved Oxygen

There is an indirect relationship between water temperature and dissolved oxygen concentration (i.e. as temperature increases, dissolved oxygen concentration decreases). This relationship is of special concern in the southern Appalachian Mountains. Trout require high levels of dissolved oxygen to optimize metabolism and reproduction (Raleigh 1982). Because headwater streams characteristically have high gradients and fast flow, dissolved oxygen levels show little decline as a result of increased temperature. However, low dissolved oxygen levels may be lethal to salmonid eggs and alevins in pools and areas of low flow (Hall and Lantz 1969, Raleigh 1982).

An increase in the amount of sand and silt from runoff may also lead to reduced oxygen levels within the substrate. Silt deposition and reduction in surface water flow can cause a decreased rate of exchange between surface and intragravel oxygen. This decrease, along with an increasing demand for oxygen by decomposing debris and benthic invertebrates, can cause an oxygen deficit in redds severe enough to suffocate fry (Hall and Lantz 1969). This leads to lower fry densities, but increased growth and survival of young salmonids may compensate (at the population level) when fry densities are reduced and conditions remain favorable (Hartman et al. 1984). It has also been noted that decreased levels of intragravel oxygen negatively affect benthic invertebrate populations, which can result in lower food supplies for adult and juvenile trout (Raleigh 1982).

Turbidity and Sedimentation

Spawning habitat quality is of primary importance in the maintenance of healthy salmonid populations. Stream-dwelling salmonids begin their life as eggs buried in the streambed, where increased sedimentation caused by runoff and bank erosion can reduce egg and alevin survival (Allen 1969, Hartman et al. 1987). This leads to lower juvenile and adult production, and therefore a smaller spawning stock (Allen 1969, Hall and Lantz 1969). Increased turbidity is associated with

higher concentrations of dissolved minerals and heavy metals and damaging particles such as silt (Tebo 1975). Not only can these particles be toxic to trout, but also since trout are visual feeders, high turbidity can reduce effectivness of foraging (Allen 1969, Wilzbach et al. 1986).

Unless influenced by outside sources such as agricultural runoff, most trout streams are clear during periods of low to normal streamflow (Tebo 1975). However, the combination of land use and high runoff has been found to cause high turbidity levels (Tebo 1975). Tebo (1975) also found that continuous high levels of sediment input from point sources such as streamside clearcutting, road construction, and mining operations, are considerably more detrimental to the stream than are the effects of natural erosion and storm runoff.

Woody Debris

The amount and quality of woody debris entering a stream following land use depends largely on the degree of channel clearing that occurs (Webster et al. 1988). In unperturbed forest reaches, large woody debris in the stream acts as retention structures, creating breaks in the gradient through a stair-stepping effect, thereby reducing barriers to instream movement, and creating a diversity of microhabitats suitable for invertebrate substrate, fish cover, and overwintering habitat (Bryant 1981, Wilzbach et al. 1986, Bisson et al. 1987, Hartman et al. 1987).

Woody debris entering a stream increases immediately after logging; however, in years following, land use leads to a decrease in large woody debris and an increase in small woody debris in the channel (Hartman et al. 1987, Webster et al. 1988). For example, timber harvest in the riparian zone removes the larger, older trees that would otherwise enter the stream. Younger, sturdier fruits and dogwoods, which are smaller and break down faster, replace the hardwoods, providing less large organic input to the system (Webster and Waide 1982). The eventual recovery of the stream depends on the rate of recovery of the surrounding ecosystem (Gurtz et al. 1980).

Streamflow

Land use often alters streamflow, which can affect several stages of salmonid life history. Increases in streamflow of as much as 28% have been observed following logging in an Appalachian watershed and are especially pronounced in summer and autumn, when normal flows are reduced (Webster and Waide 1982). Increased streamflow is common after clearcutting, and may be attributed to decreased transpirational losses (Kovner 1956, Webster and Waide 1982, Swank 1988).

Agriculture may reduce instream flow through irrigation uses. Also, stream-side industry may affect streamflow if hydropower is used by introducing a fluctuating flow regime. Fluctuating flow is not as critical in regions where headwater streams provide salmonid habitat. Because of the small volume of water these streams store, they are rarely used for irrigation or hydropower. Increased flows can be detrimental in winter when flow is normally high, causing flooding and dislodging of eggs. However, an increase during summer low flows can be beneficial, raising the area of productive stream bottom and thus, usable habitat (Chapman 1962, Allen 1969). While summer flows (even at floodstage) rarely exceed winter high flows, prolonged precipitation can result in elevated flows through a large part of the summer.

Interaction among parameters affected by land use are complex: temperature and dissolved oxygen are closely integrated, instream debris affects turbidity, and so on. Hall and Lantz (1969) suggested that the salmonid species with the highest threshold temperature and the strongest cover-seeking reaction (i.e. brown trout) are perhaps best adapted to life in severe or changing habitats. They further suggested that the ultimate effects of land use on salmonid fisheries depend largely on the ability of the fish populations to adapt to changes in habitat, and that in most watersheds subject to streamside alterations, favorable conditions for fish production can be reestablished if adequate attention is given to stream protection and maintenance.

Attitudes of Three Watershed User Groups

The high value of trout streams for aesthetic, recreational, and economic purposes and their susceptibility to alteration by land use attract special attention from state, federal, and private agencies responsible for managing natural resources (Tebo 1975). These agencies are dedicated to the maintenance of fish and wildlife and their habitats for public enjoyment. To do this effectively, agencies must first identify what people know about and want from the resources. There is a substantial database concerning public knowledge and attitudes about fisheries and wildlife resources (Kellert and Berry 1979, Kellert and Berry 1980), but studies conducted about specific groups (e.g. anglers, landowners, recreationists) are lacking. Historically, socioeconomic research in the fields of fisheries and wildlife has focused on the "general public" as a single unit, rather than a diverse group representing many viewpoints and interests. Today, however, it is realized that no two individuals or interest groups have exactly the same opinions and ideas. In recent years, for example, the focus of public attitudes about wildlife has changed from being harvest-oriented to more nonconsumptive uses such as photography and catch-and-release fishing (Shaw 1974, Mattfield et al. 1984, USFWS 1988). These changes have lead to the formation of hundreds of groups concerned about wildlife and other natural resources (e.g. Ducks Unlimited, Bass Anglers Sportsman Society, Trout Unlimited). Differences among groups are largely a result of differences in the individuals' knowledge of the subject and personal priorities and of the group's point of view. Therefore, research is needed that recognizes and addresses this diversity in knowledge and attitude.

The appraisal of public knowledge and attitudes towards the effects of land use on coldwater fisheries contained in this study is an example of the diverse nature of the general public. Three user groups were identified from this public for analysis: landowners from western Virginia, trout anglers from the Commonwealth of Virginia, and coldwater fisheries professionals from the southern Appalachian Mountains. Rationale for selection of these three groups can be found in the methods section of this document. Results are used to better understand public interest and to introduce new management techniques that incorporate public opinion.

Landowners

Private landowners control access to 50% of the land suitable for outdoor recreation in Virginia (Bromley 1982). This proportion is somewhat smaller in the western part of the state where a majority of the coldwater habitat is located on government-owned land. Programs directed at decreasing habitat loss associated with agricultural and urban land use by educating landowners about the effects of land use on wildlife resources have been implemented in many states. To be successful, management programs on private land must consider agricultural economics and sound land management practices as well as landowner attitudes about wildlife on their property (Sheriff et al. 1981).

Numerous studies have evaluated landowner attitudes towards land use and terrestrial wildlife. For example, 83% of Missouri's landowners said that wildlife was at least slightly important in their farm management (Sheriff et al. 1981). Ruff and Isaac (1987) found that scenic enjoyment and wildlife habitat were the two most important factors considered by a majority of Wisconsin's woodland owners. Kellert and Berry (1979) showed that private landowners felt wildlife and associated habitat should be considered during land use, even at the expense of lumber and agricultural products. Wisconsin landowners considered wildlife to be important and wanted it on their property for aesthetic and recreational purposes, but only 13% asked for management advice (Ruff and Isaac 1987). It is assumed that ideals held by landowners about land use and terrestrial wildlife apply similarly to aquatic wildlife.

Great opportunity exists to improve wildlife management on private land through public education programs. However, landowners are often at odds with conservationists when it comes to the use of their land and its economic value. Most are concerned about natural resources and want to maintain an "ecological balance," but cannot afford to invest substantial effort or money into wildlife management (Stone 1981). In essence, people do not buy land expressly to provide wildlife habitat, but once purchased, habitat quality becomes an important reason for ownership (Ruff and Isaac 1987). Sharing ideas and management techniques is a critical element in promoting

understanding between wildlife professionals and landowners. Future wildlife management programs on private land must consider the economic value of the land as well as effective habitat manipulation in order to satisfy the majority of involved groups (Sheriff et al. 1981).

Anglers

Fisheries managers have historically assumed that harvest, and therefore production (biomass or number of fish), was the desirable measurement of angler satisfaction (Knopf et al. 1973, Helfrich et al. 1987). Today, however, other factors such as aesthetics, companionship, and motivation play a vital role in the degree of angler satisfaction (Hampton and Lackey 1975, Driver and Knopf 1976, Smith 1980, Dawson and Wilkins 1981, Hudgins 1984, Helfrich et al. 1987). The angling public is growing (USFWS 1988), and demanding more high quality recreational fisheries, while areas suitable for fishing are becoming limited by industrial and urban development and pollution (Duttweiler 1974).

Anglers often disagree with fisheries managers when it comes to the use and management of the system (e.g. harvest regulations, dam construction). Like landowners, most anglers are concerned about the resource and want to conserve it for future use; however, many do not understand the consequences associated with their use of the system (e.g. harvest rate, hooking mortality). On the other hand, fisheries professionals must know what the public seeks in a successful fishing experience, and then attempt to integrate these desires into the management program. Again, communication of ideas and management techniques is a critical element in effective management of aquatic resources. If future management programs are to be effective, the recreational value of the system must play a role in the decision making process.

Fisheries Professionals

Fisheries biologists and managers are professionals, educated and trained in the management of natural resources. They are responsible for maintaining and enhancing fisheries resources based on biological facts. This responsibility often puts fisheries professionals at odds with the public because of differing objectives. Although the goal is the same-- healthy fish populations-- the public often does not appreciate the means of achieving this goal (e.g. bait restrictions, creel and size limits). Differences in fisheries professionals' responsibilities due to agency programs must also be considered. For example, in North Carolina, the North Carolina Wildlife Resources Commission employs biologists who are primarily responsible for managing fish populations, while U.S. Forest Service biologists focus on habitat protection and enhancement. The U.S. Fish and Wildlife Service employs biologists interested in threatened and endangered species. Differences in responsibility are not often recognized by the public, resulting in misunderstanding and frustration.

If fish and wildlife resources are to remain an integral part of the landscape, research and management must make habitat maintenance and population assessment competitive with other land uses. This can be best achieved through public information and education programs that provide understandable information on economics and sociology as well as biological information pertaining to resource management.

Effective Communication

Effective communication and education are critical links between professionals and the public when dealing with the effects of land use on natural resources. Most people share a common desire to keep resources healthy and productive over time so that they contribute to the concept that the "optimum combination of goods and services provides the greatest good to the greatest number"

(Peterson 1983). However, because management preferences often differ among constituencies, a multiple satisfaction approach may be needed (Hendee 1974, Mattfield et al. 1984). A multiple satisfaction approach is defined as the state in which recreational resources offer people the opportunity for a range of experiences which, in turn, give rise to various human satisfactions.

In the last twenty years, the public has increasingly demanded more information and more input into the policy-making process (Rohrbaugh and Wehr 1978). In the face of decreasing coldwater resources in particular, and increasing concern for natural resources in general, this interest is beginning a promising trend in public participation in the management process. Increased interest indicates that the public is beginning to focus on the condition of their environment and wanting to do something about it. However, lack of understanding of watershed interactions (among physico-chemical parameters and between these parameters and biological characteristics as a result of a change in the watershed) has been identified by local conservation groups (e.g. Virginia Council of Trout Unlimited) to be present at all levels of involvement with watershed use-- from the resource manager to the individual citizen (Schuder 1975).

A logical first step in improving this situation is to facilitate effective communication among different user groups to increase the effectiveness of conservative management practices in areas of high or increasing land use. For this to work, the public first needs to be informed of the situation and then asked for its opinion (Jackson et al. 1981, Soden et al. 1988). This would not only increase public involvement in resource management, but also make management priorities visible to fisheries professionals. For example, farmers should understand the effects of agriculture on aquatic resources, while fisheries professionals need to recognize the problems of agricultural producers.

The Delphi Method

Public views are commonly solicited through the mail or by personal contacts with conservation officers. Public meetings and hearings also provide the public with an opportunity to

express themselves. These viewpoints, although valid, must not be considered as the final word because they are often biased. Dissatisfied groups tend to register complaints more often than satisfied people offer commendations (Lanford 1972). Also, the tendency of people to follow a strongly opinionated or vocal individual must not be overlooked. Other pitfalls of public hearings include overdramatization of specific positions on an issue and development of long debates over specific benefits or part of a policy (Rohrbaugh and Wehr 1978). Opinion polls increase communication, but are often limited in scope (i.e. leading responses in a particular direction, little or no room for comments or alternative answers) and treated without regard to ancillary factors such as demographic profile.

Methods of sampling that provide unbiased estimates of public opinion have become highly developed in the social sciences, and are now being adapted to problems in natural resource management (Williams et al. 1986, Helfrich et al. 1987). For example, estimates of public opinion have been obtained by mail questionnaire for wildlife issues (Decker et al. 1987) and for angler satisfaction (Williams et al. 1986, Helfrich et al. 1987). The key to effectively soliciting public opinion is found in the construction of the decision making tool.

The Delphi Method is one of several means directed at the systematic solicitation of group opinion through iterative mail surveys (Lanford 1972). It incorporates the input of each participant and results in a range of responses that converge on a common solution. The Delphi Method can be applied in a data-analysis situation (Zuboy 1981) and is an efficient way to quantify intuitive judgements (Lanford 1972). Since the Delphi Method was invented specifically to project the future, it is particularly appropriate for envisioning future research directions such as socioeconomic influences on fisheries management.

The Delphi process begins with a series of several broad questions. Responses to the first set of questions are compiled and analyzed and then a summary is sent back to the panel along with any new questions for the remaining rounds of the program. In subsequent rounds, participants are asked to look at the results from the previous round and make any comments they feel pertinent (e.g. a respondent may be asked to justify an answer if it falls outside the interquartile range). This response-reevaluation process continues until a consensus is reached among participants. Outlying

responses may be attributed to misunderstanding the questions or strongly opposing views, neither of which invalidate the results. The process of justifying extreme responses will often cause panelists without strong convictions to move closer to group opinion, while those with strong views will defend them. This inquiry-feedback process may stimulate panelists to consider factors they may have neglected or dismissed on first thought (Linstone and Turoff 1975).

The Delphi Method attempts to make effective use of intuitive judgement and is designed to systematically combine individual judgements to obtain a reasoned consensus. The Delphi Method is approximately twenty years old (Turoff 1971), and only in recent years has its use expanded into areas other than the ones for which it was developed (RAND Corporation). Therefore, it is only beginning to be recognized as an effective decision making tool (Lanford 1972, Turoff 1971). Today, the Delphi Method is being applied to a broad range of problems, including those in fisheries management to facilitate group judgement and aid in establishing new management techniques (Zuboy 1981, Crance 1987).

The Delphi Method has several advantages over typical group decision making techniques (e.g. nominal group techniques, panel discussions, and brainstorming activities). The Delphi Method replaces direct debate and eliminates committee activity by giving panel members anonymity through a written questioning process. Because the identities of the participants remain anonymous, influence of psychological factors inherent in group discussion are reduced (e.g. deliberate persuasion, unwillingness to abandon publicly expressed opinions, and the bandwagon effect of majority opinion (Lanford 1972, Linstone and Turoff 1975). Lanford (1972) also stated that group judgements carry more weight than do individual opinions and that reaching a consensus reflects group judgement; this provides a sound basis for long-range decision making.

As with any survey tool, the Delphi Method has several pitfalls. Negative aspects identified by Ludlow (1972) were related to the benefits a conference has over anonymous mailings, such as the Delphi Method does not allow 1) change and exchange of ideas; 2) expression of reasons for various opinions; 3) cross-fertilization of ideas; and 4) explanation of ambiguities in terms and questions. Linstone and Turoff (1975), leaders in the development and use of the Delphi Method, identified another disadvantage, stating "The Delphi designer who understands the philosophy of

his approach and the resulting boundaries of validity is engaged in the practice of a potent communication process. The designer who applies the technique without this insight or without clarifying these boundaries for his clients or observers is engaged in the practice of mythology."

Objectives and Hypotheses

Because of the complex nature of the effects of land use on coldwater resources and how these effects are perceived by the public, this project was developed with the following objectives and hypotheses.

1. To describe and compare attitudes of landowners, trout anglers, and coldwater fisheries professionals concerning the effects of land use on trout streams of the southern Appalachian Mountains.
    a. Survey responses will be different because of differences in the background and knowledge of the three groups. People owning land that supports coldwater resources will base their responses on the economic value of the land rather than on the aesthetic qualities of the resource. Trout anglers will base their responses on their personal objectives and past angling experiences. Coldwater fisheries professionals will base their decisions about land use on the biological consequences to fish and habitat. This hypothesis is based on attitudes and motives from the literature (see Introduction section titled "Attitudes of Three Watershed User Groups").

2. To describe and compare attitudes of fisheries professionals on the effects of land use on trout resources as a function of their professional experience with coldwater fisheries.
    a. Attitudes will differ among fisheries professionals with respect to the amount

(years) of coldwater research or management experience.

b. State professionals responsible for managing the fish will make different decisions than federal professionals responsible for managing land associated with trout resources.

c. Location and amount of coldwater habitat within a professional's responsibilities will also affect opinions.

3. To evaluate the efficiency of the Delphi Method to represent public opinion.

a. Knowledgeable populations and those in which coldwater systems are of high relative priority will reach a consensus sooner than those with less knowledge and lower relative priorities (i.e. fisheries professionals first, anglers second, and landowners third).

Methods

This study consisted of Delphi mail surveys of three human populations concerned with trout streams: private landowners with trout waters flowing through their land, specialized trout anglers, and coldwater fisheries experts. Participants in the survey were asked to evaluate the severity of the impacts associated with several land uses common throughout the southern Appalachian Mountains. The Delphi Method was selected for this study for several reasons in addition to the advantages discussed earlier: 1) the participants are from a wide geographic region and scheduling meetings would be difficult; 2) the type of feedback provided is better suited to interpretation by the sample populations (i.e. results from previous rounds consisted of percent response and were easy to interpret); and 3) this study provided an opportunity to expand the use of the Delphi Method in fisheries science by introducing it to socioeconomic research.

Identification and Selection of Study Populations

Landowners

Virginia landowners were chosen because of their ties with stream systems either through direct or indirect uses such as irrigation, cattle watering, recreation, and aesthetic value. Landowners having viable trout waters on their property were identified through a four-step process. First, fisheries biologists from the Virginia Department of Game and Inland Fisheries identified the most productive trout waters in the state. This resulted in a list of 42 trout streams located in 29 Virginia counties (Figure 1). Because of time constraints, 18 of 29 counties were randomly selected for further use. Second, landowners along these trout streams were identified from Virginia property tax maps located at the county courthouses. Third, up to 30 landowners were randomly selected from each county, depending on county size, stream length, and percent private ownership. This produced a total population of 240 landowners from 18 counties (Figure 1). Fourth, a letter was sent to each landowner explaining the study and asking their willingness to participate in the Delphi process. Return of the accompanying postcard indicated their willingness to participate. Seventy-two landowners (30%) returned the survey, distributed approximately in proportion to the population identified from the tax maps (Table 1, Figure 1). A brief demographic description of this population can be found in Appendix A.

Trout Anglers

Anglers specialized in trout fishing were selected because of their interest in coldwater systems. Specialized trout anglers were identified through a three-step process. First, the Virginia Council of Trout Unlimited (VCTU) provided a 1989 membership roster (Total VCTU members in 1989

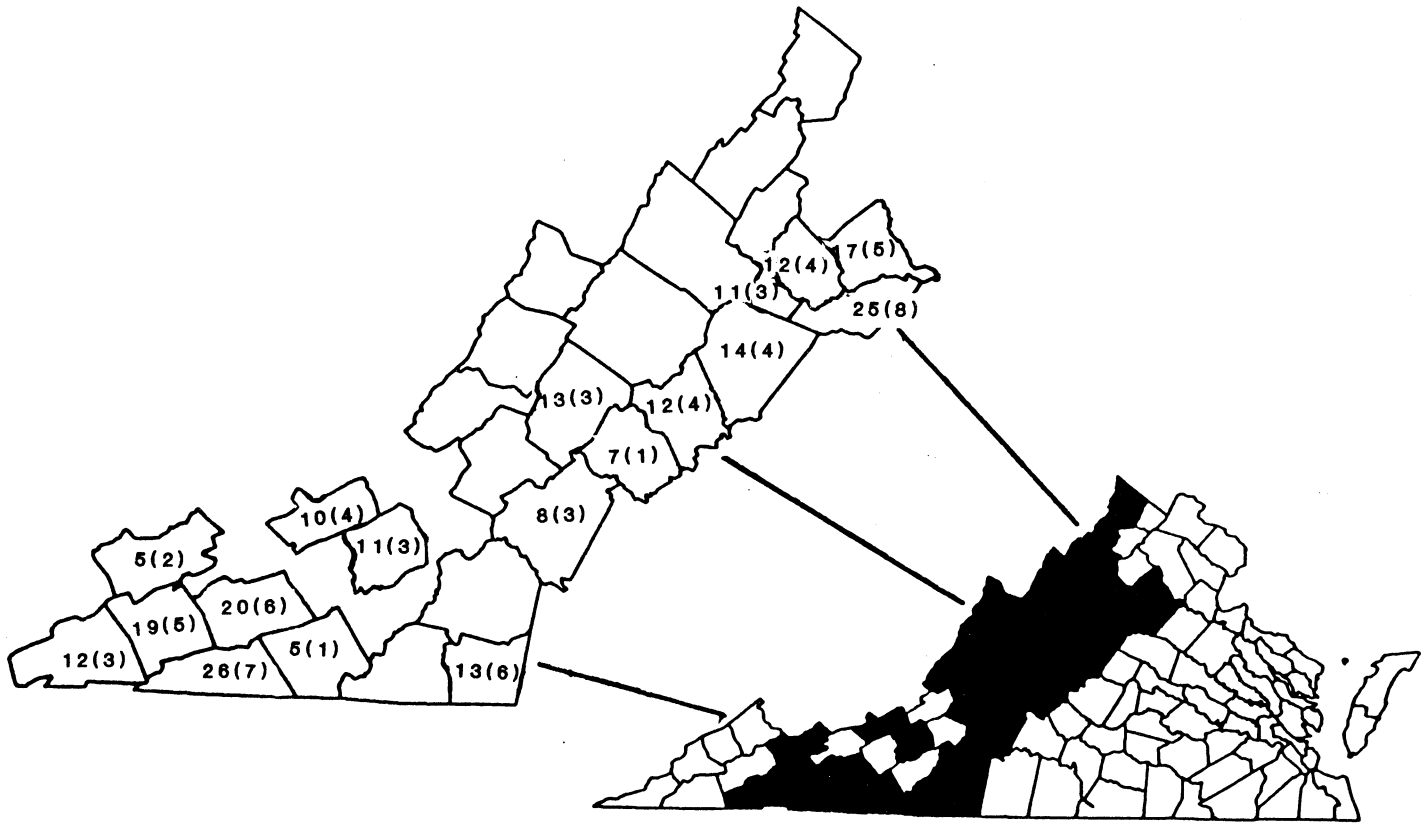


Figure 1. Virginia counties identified by Virginia Department of Game and Inland Fisheries biologists as having streams supporting healthy trout populations under at least 75% private ownership (shaded). Numbers represent number of landowners identified from randomly selected counties, numbers in parentheses represent number of landowners participating in study.

Table 1. Number of people mailed initial postcard survey and number of postcards returned (number that agreed to participate in Delphi survey).

	Landowners	Anglers	Professionals
Population Size	---	1713	81
Number Contacted	240	214	81
Number Returned	72	108	52
Number Participated	72	108	36

= 1713). Second, 214 members were randomly selected, distributed in proportion to chapter membership (Figure 2). Third, anglers were contacted by letter explaining the study and asking their willingness to participate in the Delphi process. Return of the accompanying postcard indicated their willingness to participate. One hundred eight anglers (51%) returned the survey, distributed approximately the same as the original randomly-selected population (Table 1, Figure 2). A brief demographic description can be found in Appendix A.

Previous research suggested that limiting the angling population to fishing club members introduces bias into survey results (King et al. 1978, Williams et al. 1986). While it is true that fishing club members constitute only a part of the angling public, their objectives (e.g. species, size, habitat quality) are more suitable to this type of survey. For this study, anglers with intense interest in the resource were targeted to assure an adequate response rate. Also, results from King et al. (1978) contradict statements made about bias and indicate that knowledge of fishing club members on resource issues may not be different than that of anglers who are not members of an organized club, but rather that their personal objectives and goals are different.

Coldwater Fisheries Professionals

Coldwater fisheries professionals from the southern Appalachian region were selected because of their educational background and because of their importance to the maintenance of healthy ecosystems. Because of the limited number of coldwater fisheries professionals in Virginia, the survey was expanded to several southeastern states with similar coldwater fisheries. Coldwater fisheries professionals were identified for this study by three methods. First, personal recommendations were made by the fisheries faculty at Virginia Polytechnic Institute and State University, the Coldwater Fisheries Research Unit of the U.S. Forest Service Southeastern Forest Experiment Station, members of the American Fisheries Society Southern Division Trout Committee, and other known coldwater stream biologists. Second, state and federal agency directories were used to identify additional coldwater biologists, researchers, and managers. Third,

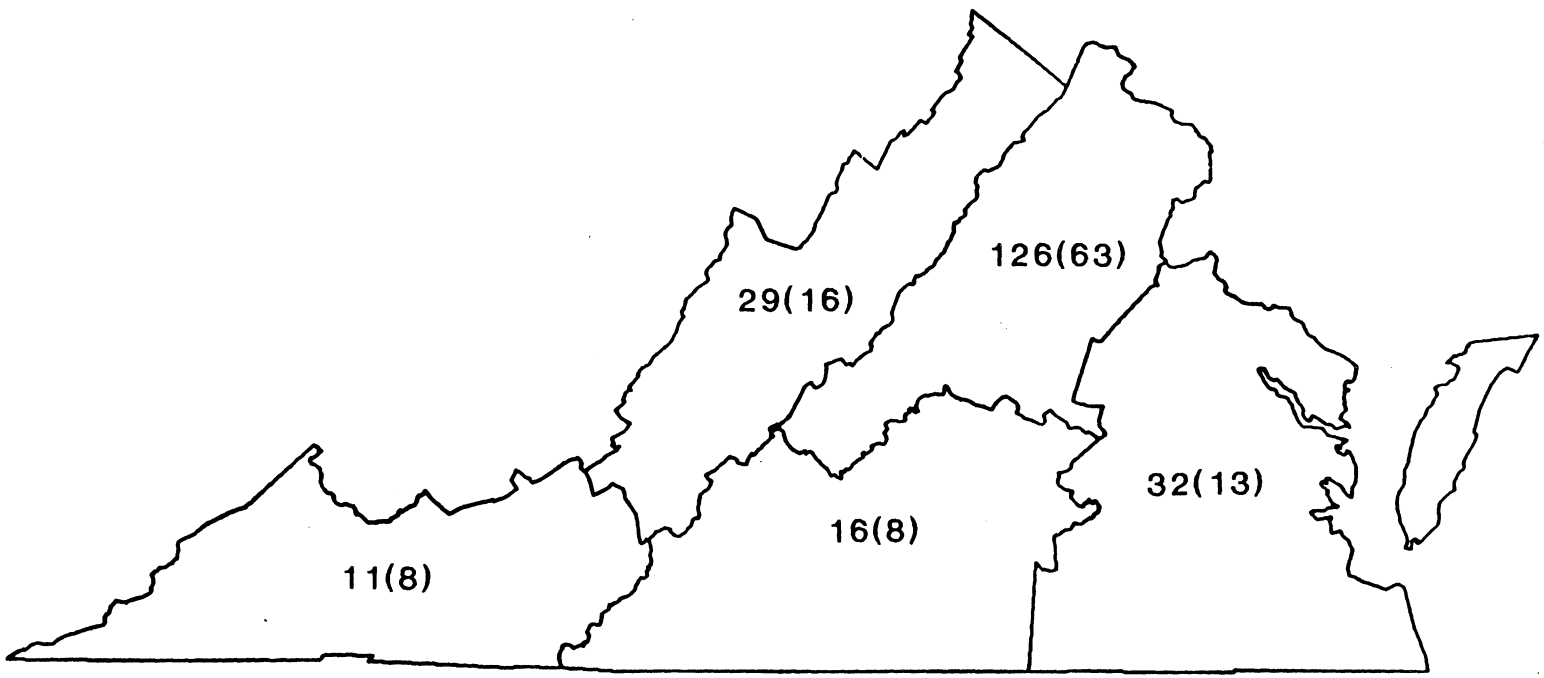


Figure 2. Number of trout anglers randomly selected from each of five regions of Virginia (based on Trout Unlimited chapter boundaries). Numbers in parentheses represent number of anglers participating in study.

individuals identified in the first two processes were invited to list other persons. This process produced a list of 81 coldwater professionals in the southern Appalachian Mountain region (Figure 3).

From the original list of coldwater fisheries professionals, the "expert" sample was identified through a two-step process. First, a brief survey (see Appendix B.1) was sent to all professionals asking them about the amount and relevancy of coldwater experience and about their willingness to participate in the Delphi process. Sixty-four percent of the coldwater fisheries professionals indicated their willingness to participate in the Delphi process (Table 1). Second, the responses were evaluated regarding the extent of the experience with coldwater fisheries and the relevance of that experience to the coldwater resources in the Southeast. Of the 52 usable surveys, 37 were characterized as "coldwater experts" and chosen to participate in this study (Figure 3). Characteristics of the 37 fisheries professionals selected can be found in the Results section of this document. Results from the screening survey were used to stratify the fisheries professionals into groups based on the amount and type of coldwater experience, as well as the amount of professional responsibility for analysis in objective 2.

Construction of the Delphi Survey

An eight-page mail survey was constructed according to the guidelines established by Dillman (1978). The survey consisted of a cover page containing a brief description of the project goals, six pages of objective questions (30 questions in all), and a back cover page containing space for comments (Appendix B.2). In a pilot test of the survey on the fisheries and wildlife graduate students at Virginia Polytechnic Institute and State University, estimated time of completion was fifteen minutes. This pre-test of the survey also allowed for comments on question construction and content. Corrections made upon completion of the pilot survey consisted of changes in the construction and grammar of the questions; no changes were made in survey content. All three

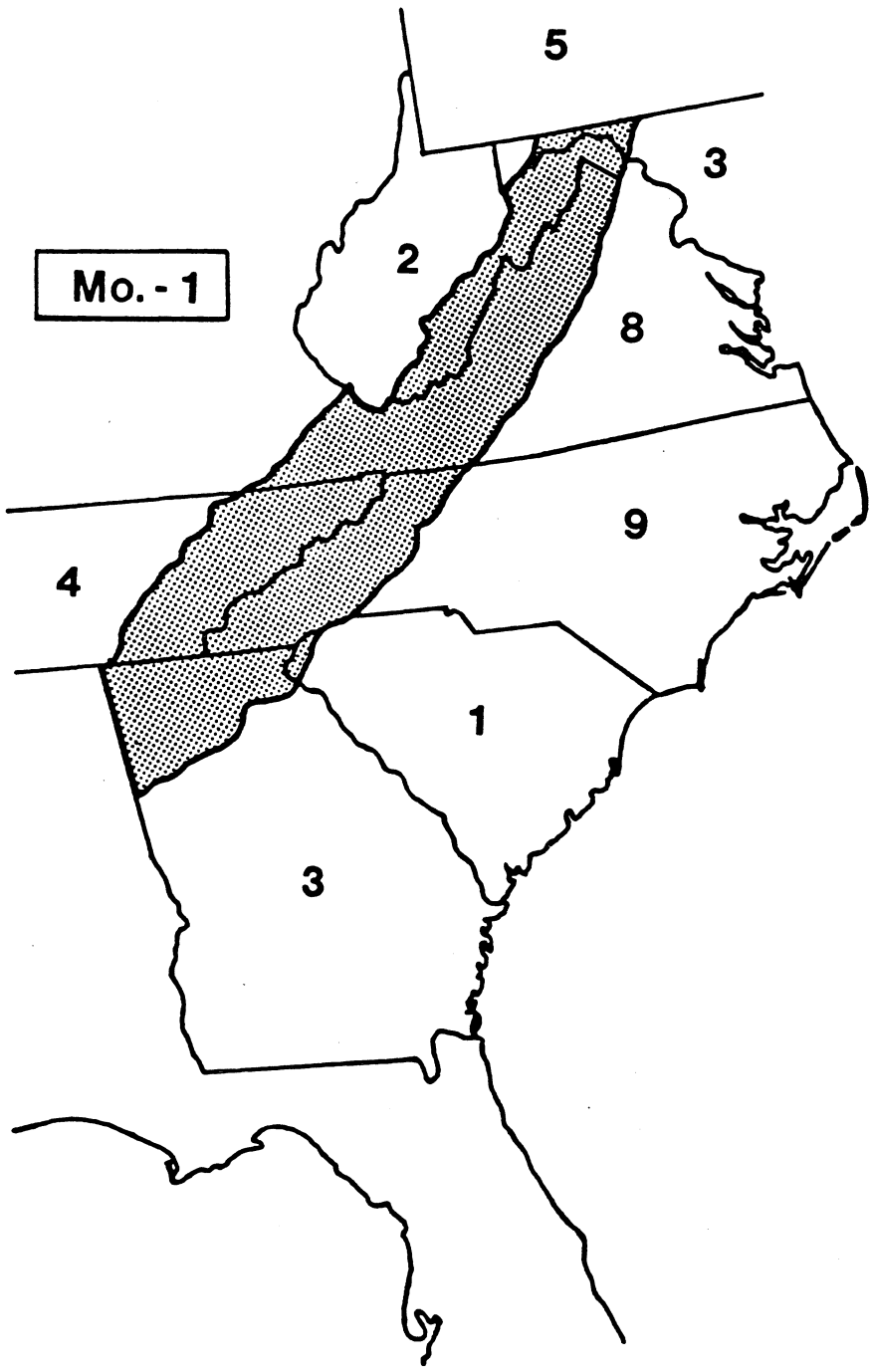


Figure 3. Number of coldwater fisheries professionals participating from eight states in the southern Appalachian Mountain region (Missouri biologist was included because a majority of his experience (> 10 years) was in southern Appalachians). Shaded area represents Southern Appalachian Mountain region.

survey groups (landowners, anglers, and coldwater fisheries professionals) were asked the same questions so that comparisons could be made among groups.

The first question asked the participants to evaluate the severity of five land uses popular in the southern Appalachians (roads and railroads, industries, urban development, farming, and forestry) on the following scale:

1 = HURTS STREAM A LOT

2 = HURTS STREAM A LITTLE

3 = DOES NOT HURT STREAM

4 = HELPS STREAM A LITTLE

5 = HELPS STREAM A LOT

An "I don't know" response was accidentally left off the survey form; however, some respondents commented that they did not know or left the question blank (presumably rather than guess at a response).

Questions two through six were focused on the assessment of five stream characteristics (dissolved oxygen, food supply, sedimentation, woody debris, and standing stock) associated with each land use. The parameters selected for use in the survey differed from those discussed in the introduction somewhat to facilitate survey design and ease of completion. Water temperature is closely related to dissolved oxygen; therefore questions about both would be redundant. Food supply was chosen because it is related to physico-chemical and biological characteristics of a coldwater stream and because most people recognize food as a basic biological need. Sedimentation was chosen because it is thought to be a critical parameter to healthy salmonid populations. Large woody debris was chosen because of the general lack of understanding of its purpose and use in coldwater systems. Streamflow was not chosen because it is altered too much by weather patterns. Besides these reasons, survey length was a major deciding factor in which questions were asked. The participants were asked to evaluate the impact of each land use on each of the five characteristics on the following scale:

1 = INCREASES (THE IMPACT)

2 = DOES NOT CHANGE (THE IMPACT)

3 = DECREASES (THE IMPACT)

4 = I DON'T KNOW

Comments were welcome at any point in the survey, and space was provided on the back cover and in the margins of all pages.

The Delphi Process

In round one, the participants were asked to answer the questions based on their current knowledge and return the survey in the enclosed stamped envelope. If they failed to return the survey within one week, a postcard reminder was mailed to them requesting their participation. If there was still no response after approximately two weeks, another copy of the same survey was mailed as a last attempt to increase overall response (Table 2).

Rounds two and three of the Delphi process used different survey instruments. In round two, the same survey form was used, with the results from round one added to the left margin (see Appendix B.3). Results added to the second-round form included the percentage of respondents giving each answer and the participant's response from round one. The participants were then asked to answer the questions again in light of the results from round one. If their response did not agree with the most popular group response, they were asked to explain their answers in a comment block provided in the right margin. As an incentive to respond, a copy of the Virginia Cooperative Extension Service's "Landowner's Guide to Managing Streams in the Eastern United States" was included in the mailing.

Round three consisted only of those questions for which a consensus had not been reached by the group (i.e. less than approximately 80% choosing the same answer; see Results). Therefore, the questions appearing on round three were not the same for each survey group (see Appendix B.4). Results from round two were presented in the same format as the previous round, and the participants were asked to answer the questions in light of the results from round two. If their

Table 2. Survey mailing dates for the initial postcard survey and three Delphi rounds.

Survey	Date Mailed
Initial Contact	
Professionals	11/17/88
Landowners	07/27/89
Anglers	08/28/89
Round 1	
Initial mailing	10/12/89
Postcard reminder	10/19/89
Follow-up mailing	11/10/89
Round 2	
Initial mailing	12/01/89
Postcard reminder	12/08/89
Follow-up mailing	01/09/90
Round 3	
Initial mailing	02/28/90
Postcard reminder	03/07/90
Follow-up mailing	Not needed

response did not agree with the most popular response, they were again asked to explain their answers. No analysis of non-response bias (i.e. characteristics of nonresponding population) was made because of the anonymity of the Delphi Method.

Statistical Analysis

Response rates of the three survey groups were compared using nonparametric analysis of variance (Friedman's Two-way Analysis) to determine if response rates for each of the Delphi rounds and each of the survey groups were statistically different (Hollander and Wolfe 1973).

Results from question one on the severity of land use on nearby streams were analyzed using simple descriptive statistics (mean, range) because of the skewed distribution of responses. Results from questions two through six were analyzed using Chi-square Contingency Tables for discrete data to determine if the distribution of responses for the three groups was statistically different (Hollander and Wolfe 1973). The results from objective one use p-values from a Chi-square Contingency Table unless otherwise noted.

For objective 2, comparisons were made among groups of fisheries professionals. Considerable disagreement among coldwater fisheries professionals occurred on five survey questions. Because of the small sample sizes involved, a modification of the Fisher's Exact Test was used to determine if the disagreement among professionals was a function of amount of experience, type of agency the professional was employed by, or amount of professional responsibility (Bedeian and Armenakis 1977, Ghent 1972, Hollander and Wolfe 1973). If a statistical difference was found, multiple comparisons between groups were performed using the modified Fisher's Exact Test. The modifications of Fisher's Exact Test, as reported by Bedeian and Armenakis (1977) and Ghent (1972), are useful when analysis of discrete data is limited by small sample sizes and contingency tables larger than 2x2 cannot be efficiently reduced for analysis by Fisher's Exact Test. Reported p-values for objective 2 are from a modified Fisher's Exact Test

unless otherwise noted and do not change with multiple comparisons as with other tests because the same test is used in the multiple comparisons on subsets of the original test data. A null hypothesis was tested that no difference in percent agreement existed between groups, while an alternative hypothesis posed that a difference in percent response did exist between groups each time the test was performed. An alpha level of .05 was used to determine significance despite small sample sizes because of the nature of Fisher's Exact Test. Failure to reject the null hypothesis (when p-value is greater than .05) indicates that no statistically significant difference exists between the groups as a function of the parameter being tested.

Results

Objective 1: Attitudes of Three Survey Populations

Survey Response Rates

Responses to individual survey rounds exceeded 70% in all cases (Table 3). Although responses for individual survey rounds ranged from 73.6% to 100.0%, no statistical differences were found either among survey rounds or populations (Friedman Two-way Analysis, $p = 0.361$). Cumulative response rates (response based on initial number of contacts) for the three rounds averaged 62%. However, if the first round is excluded under the premise that it served primarily to identify the interested population, then the cumulative response averaged 76% for the final two rounds. Although a screening survey was used prior to the first Delphi mailing, some participants may not have understood the demands of the Delphi process and agreed to participate until they received the first round survey. The cumulative response rate for rounds 2 and 3 meets expectations for surveys of interested populations (equalling or exceeding 75%) (Dillman 1978).

Table 3. Response rates for a three-round Delphi analysis for several watershed user groups. Response rates for subsequent rounds are calculated with the number of surveys returned from the previous round.

	Landowners (n = 72)	Anglers (n = 108)	Professionals (n = 37)	Overall (n = 217)
Round 1	73.6%	88.9%	75.7%	81.6%
Round 2	83.0%	80.2%	92.9%	83.1%
Round 3	86.4%	90.9%	100.0%	91.1%
Overall	81.0%	86.7%	89.5%	85.3%
Cumulative (Rounds 1, 2, and 3)	52.8%	64.8%	70.3%	61.8%
Cumulative (Rounds 2 and 3)	71.7%	72.9%	92.8%	75.7%

Survey Responses

Survey results from the final round of the Delphi Method (round 3) are reported here because they most accurately reflect the knowledge and attitudes of the three user groups. Participants were asked to evaluate the severity of impacts associated with five land uses (industry, urban development, roads and railroads, forestry, and farming). In general, all groups felt that each land use negatively affected trout streams (Table 4). For each land use, at least 84% of the responses were 1 (hurts stream a lot) or 2 (hurts stream a little) (Figs. 4a-e). Mean response for each of the five land uses was less than 1.67, with an overall mean of 1.40.

Differences in mean response among survey populations were minor. In general, anglers and coldwater fisheries professionals responded that land use had more severe impacts on than landowners. The range of responses among land uses for anglers and professionals was also lower than that for landowners (0.57, 0.50, and 1.08, respectively).

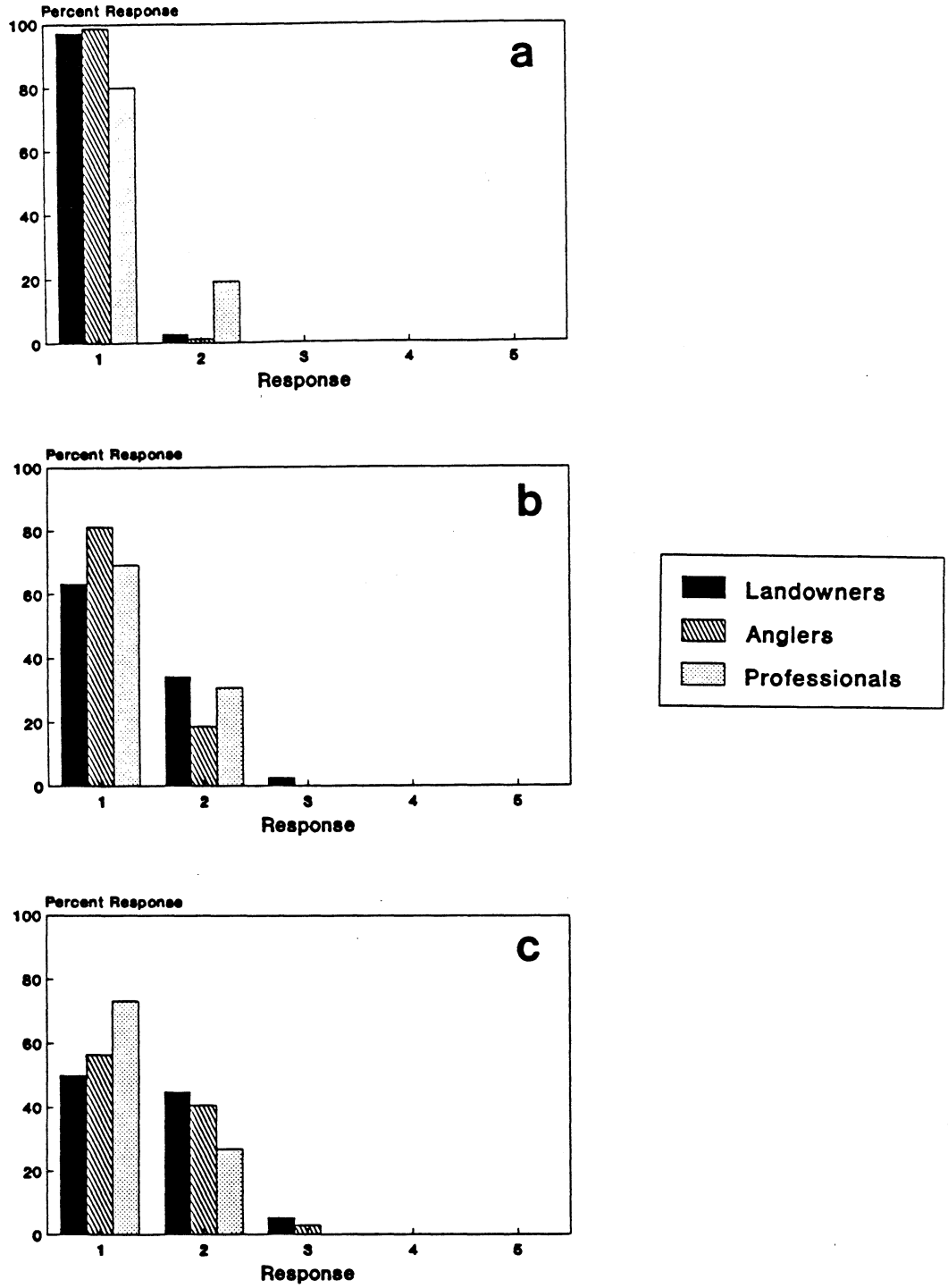
All three user groups responded that industries had the most severe effects on nearby trout streams (mean response = 1.05) and felt that farming had less detrimental effects (mean response = 1.67) than the other land uses. Landowners felt that urban development and roads and railroads had less severe impacts on nearby streams than forestry, while anglers felt that the impacts associated with roads and railroads and forestry were a bit more serious than those of the other land uses. Professionals felt that the severity of the impacts of urban development, roads and railroads, and farming were about equal, with a mean response of 1.28 (hurts stream somewhat) for these three land uses (Table 4).

Questions two through six asked the participants to evaluate the effects of the five land uses on five parameters of trout habitat and populations (dissolved oxygen, food supply, sedimentation, woody debris, and trout standing stock). They chose whether the land use increased (+), did not change (o), or decreased (-) the parameter based on their knowledge of the subject. They were also allowed to respond "I don't know" (?) to any question.

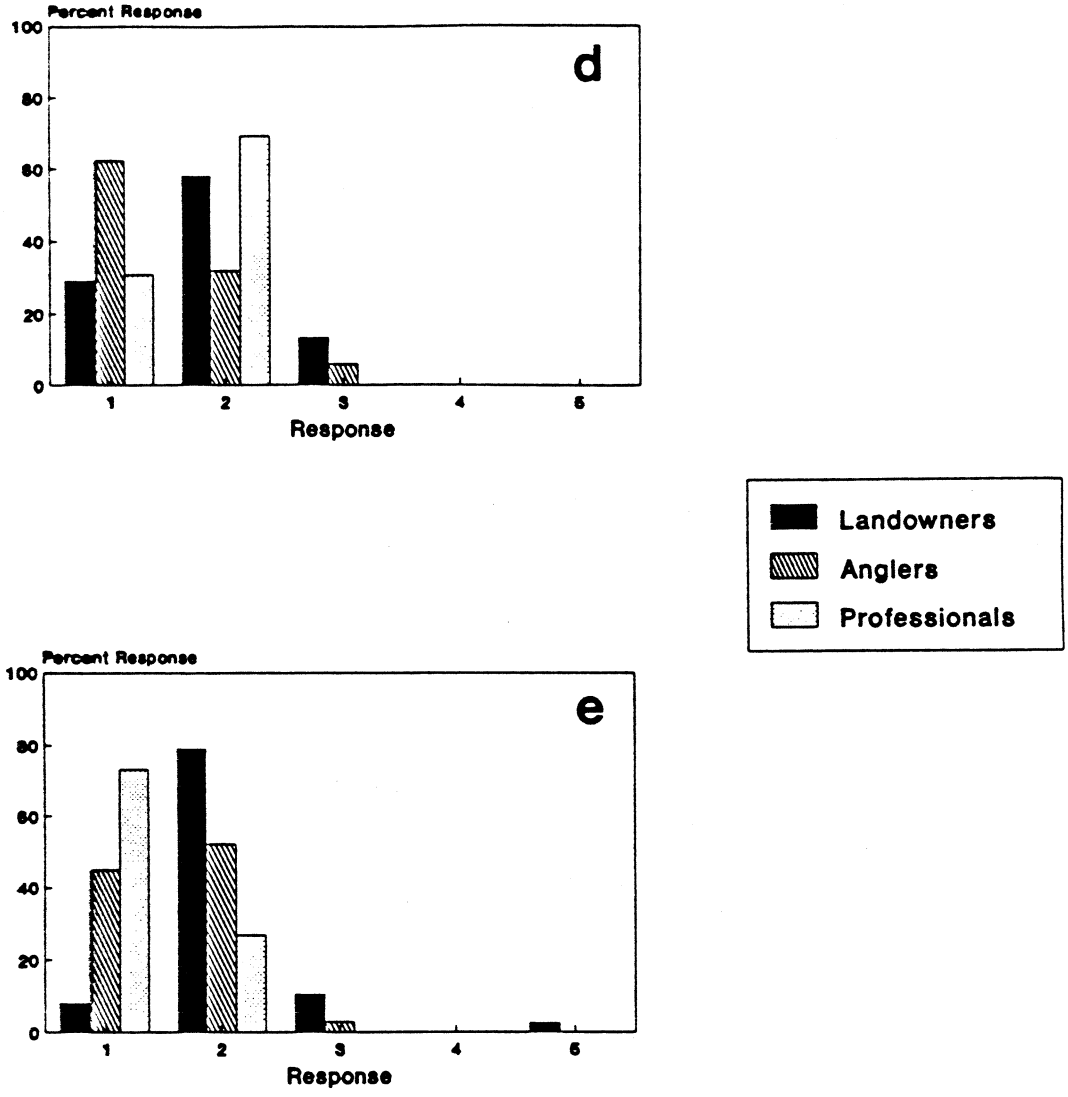
Table 4. Mean scores and ranks of responses to questions on the severity of the impacts of land use on nearby trout streams[a].

Land Use	Landowners (n = 38)		Anglers (n = 69)		Professionals (n = 26)		Overall (n = 133)	
	$\bar{x}$	Rank	$\bar{x}$	Rank	$\bar{x}$	Rank	$\bar{x}$	Rank
Industries	1.03	1	1.01	1	1.19	1	1.05	1
Urban Development	1.39	2	1.19	2	1.31	4	1.30	2
Roads & Railroads	1.55	3	1.46	4	1.27	2.5	1.44	3
Forestry	1.84	4	1.43	3	1.69	5	1.60	4
Farming	2.11	5	1.58	5	1.27	2.5	1.67	5
Mean	1.58	-	1.33	-	1.35	-	1.40	-

[a]Survey Responses:
1 = Hurts stream a lot
2 = Hurts stream a little
3 = Does not hurt stream
4 = Helps stream a little
5 = Helps stream a lot



Figures 4a-c. Frequency of response to questions on the severity of impacts associated with industry (4a), urban development (4b), and roads and railroads (4c) on coldwater resources. 1 = Hurts stream a lot, 2 = Hurts stream a little, 3 = Does not hurt stream, 4 = Helps stream a little, and 5 = Helps stream a lot.



Figures 4d-e. Frequency of response to questions on the severity of impacts associated with farming (4d) and forestry (4e) on coldwater resources. 1 = Hurts stream a lot, 2 = Hurts stream a little, 3 = Does not hurt stream, 4 = Helps stream a little, and 5 = Helps stream a lot.

The figures associated with this analysis require some explanation. In figures 6-10, each response is represented by an axis, scaled from 0 to 100 percent. The positive and negative responses fill the two vertical axes and the "no change" and "I don't know" responses fill the two horizontal axes. For each question, the percent of respondents giving each answer was marked on the appropriate axis, and the four points were connected, creating a quadrilateral representation of the response pattern for each question and survey group. From these representations, it is possible to effectively observe the amount of agreement or disagreement between and within the three user groups (examples in Fig. 5). Thus, a question on which everyone agrees (e.g. scores of 100, 0, 0, and 0, with +,-,o, and ? being represented respectively), would appear as a straight line along one axis. A question with a high level of disagreement and uncertainty (scores of 25, 25, 25, and 25) would appear as an equal-sided diamond. A question with an intermediate level of disagreement (scores of 50, 50, 0, and 0) could look like a straight line along two axes or like a right triangle (Fig. 5). In general, narrower quadrangles represent higher percent agreement. Whereas, wider quadrangles represent higher levels of disagreement and uncertainty.

Effects of Roads and Railroads

Eighty-four percent of landowners and 66% of anglers said that roads and railroads decreased the dissolved oxygen in the water, while 81% of professionals said that roads and railroads had no effect (Table 5, Fig. 6a). Statistical analysis revealed a significant difference in opinion among user groups ($p < 0.001$). Further analysis revealed that the professional responses differed from those of the landowners and anglers ($p < 0.001$ in both cases).

All three groups agreed that roads and railroads decreased food supply and standing stock of trout and increased sedimentation in nearby trout streams (Table 5, Figs. 6b, 6c, and 6e). In all cases, more than 79% agreed ($p > 0.10$).

The three populations differed statistically regarding the effects of roads and railroads on the amount of woody debris in nearby streams (Table 5, Fig. 6d). In general, anglers and coldwater

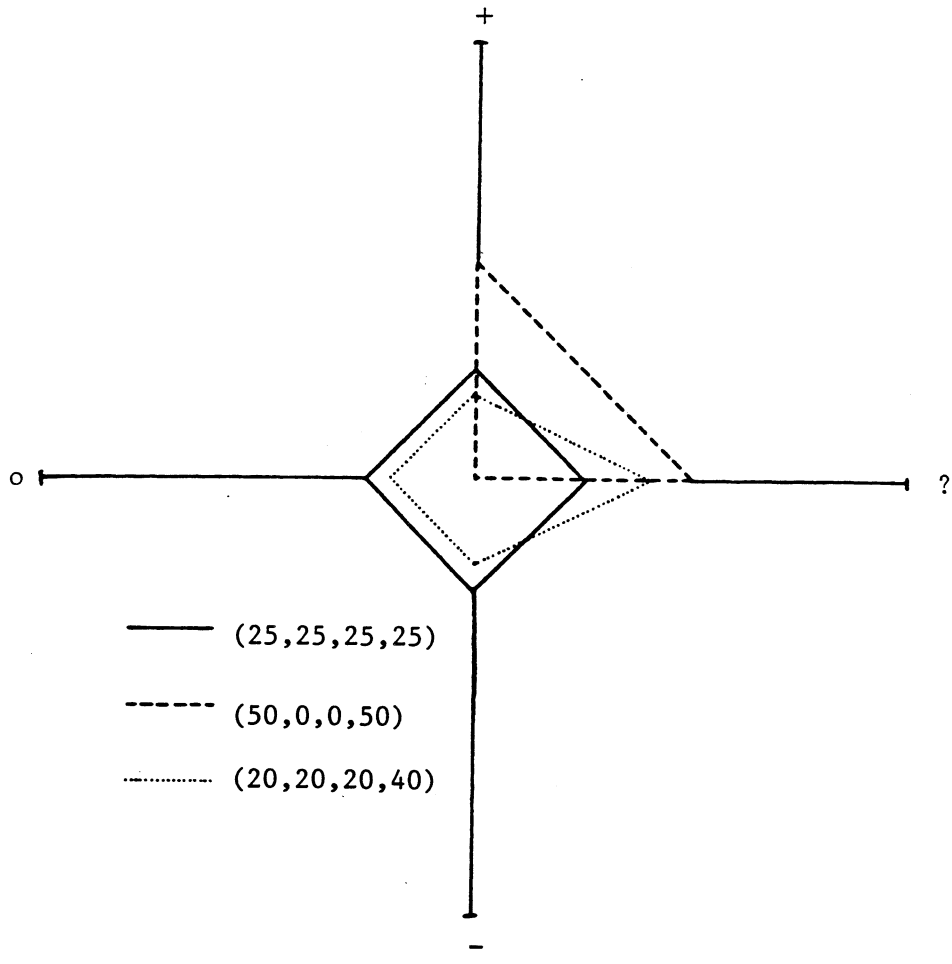
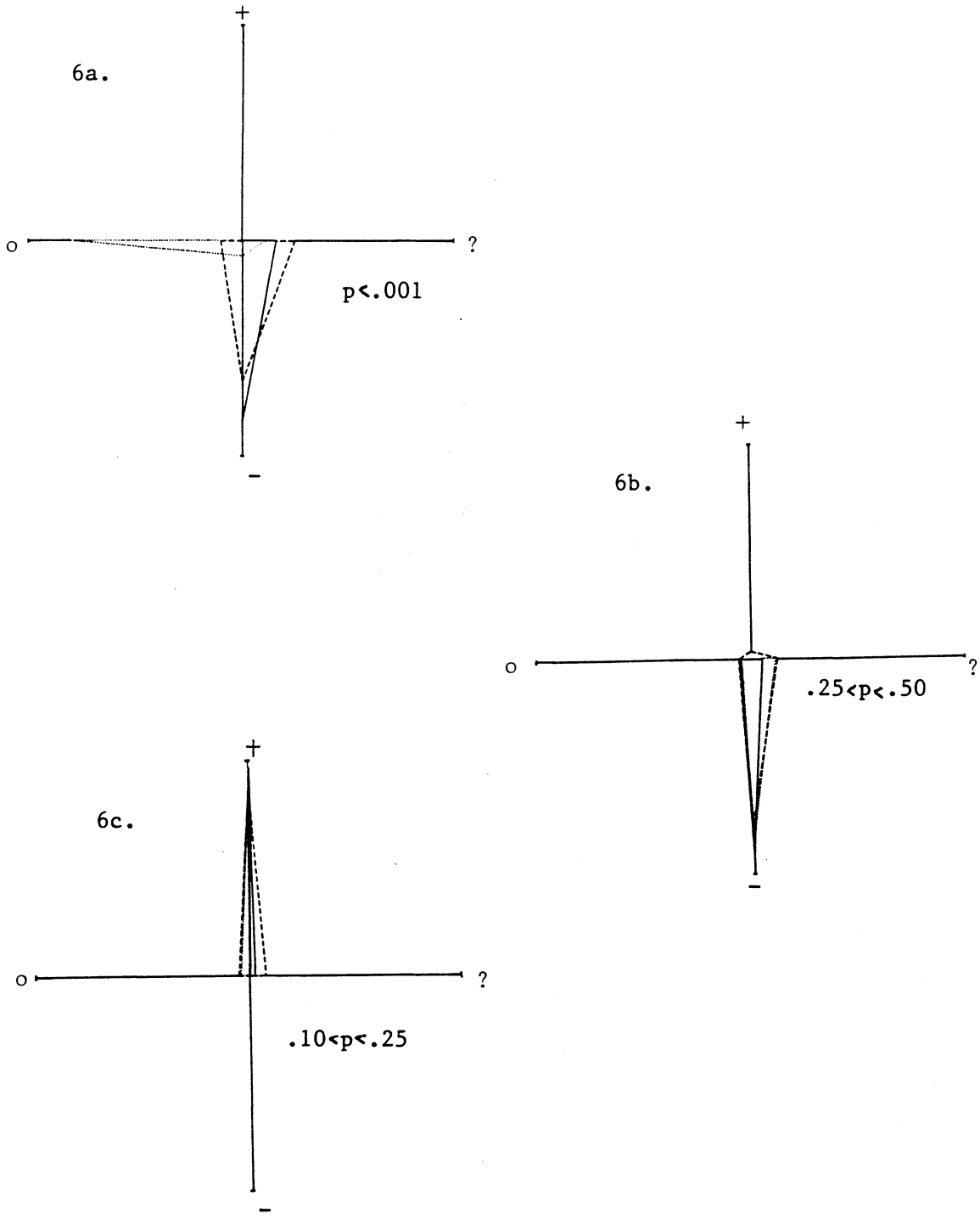


Figure 5. Examples of frequency graphs. Each axis is scaled from 0 (origin) to 100%; percent of each response is plotted on the appropriate axis, creating a quadrilateral representation of the responses.

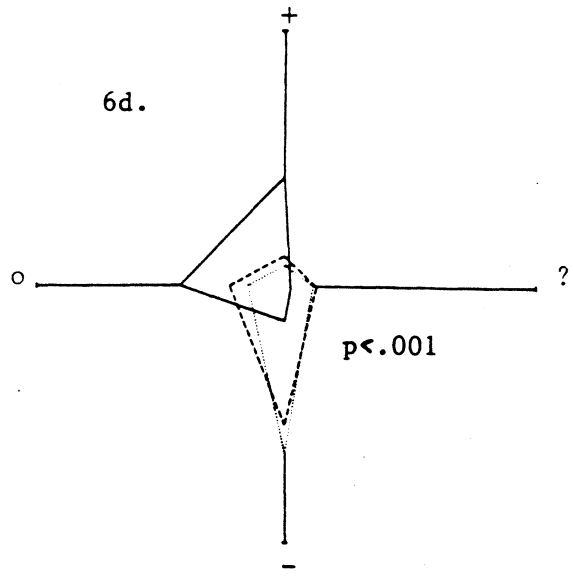
Table 5. Percent response from several survey groups on the effects of roads and railroads on nearby trout habitat and populations (+ = increase, o = no change, - = decrease, ? = don't know).

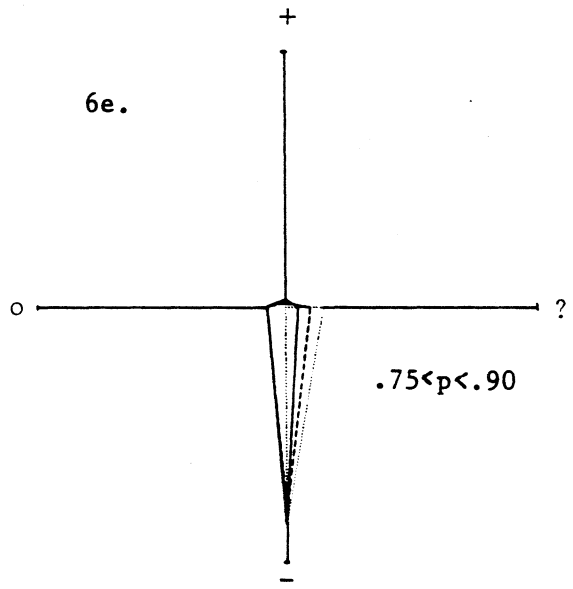
	Landowners				Anglers				Professionals			
Parameter	+	o	-	?	+	o	-	?	+	o	-	?
Dissolved Oxygen	00.0	00.0	84.2	15.8	00.0	10.0	65.7	24.3	00.0	80.8	07.7	11.4
Food Supply	00.0	05.3	89.5	05.3	02.9	05.7	78.6	12.9	00.0	03.8	84.6	11.5
Sedimentation[a]	97.4	00.0	00.0	02.6	88.6	04.3	00.0	07.1	96.2	03.8	00.0	00.0
Woody Debris	42.1	42.1	13.2	02.6	11.4	21.4	54.3	12.9	07.7	15.4	65.4	11.5
Standing Stock	02.6	07.9	84.2	05.3	01.4	07.2	81.2	10.1	00.0	00.0	84.6	15.4

[a]Unlike other parameters, an increase in sedimentation (+) has detrimental effects on trout habitat and populations.



Figures 6a-c Distribution of responses to questions on the effects of roads and railroads on dissolved oxygen (6a), food supply (6b), and sedimentation (6c). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.





Figures 6d-e Distribution of responses to questions on the effects of roads and railroads on woody debris (6d) and standing stock (6e). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.

professionals agreed that roads and railroads decreased the amount of woody debris ($p = 0.63$), but landowners had different opinions ($p < 0.001$ in both cases). Landowner response was evenly split between increased woody debris and no change.

Effects of Industries

More than 86% of each survey group responded that industries decrease dissolved oxygen (Table 6, Fig. 7a). However, because of 100% agreement among landowners, even the high agreement of anglers and professionals appeared statistically different from landowners ($p = 0.05$).

Also, because of high landowner agreement (97%), statistical analysis showed that the groups felt differently about the effects of industry on the food available to trout in nearby streams ($0.025 < p < 0.05$). However, anglers and professionals showed more than 80% agreement that industry hindered available food as well (Table 6, Fig. 7b). Statistical analysis revealed that the three user groups agreed that industry caused an increase in the sedimentation of nearby streams ($0.75 < p < 0.90$), with greater than 80% agreement in all cases (Table 6, Fig. 7c).

There was a general lack of agreement within the three groups on the effects of industry on the amount of woody debris in nearby streams ($0.10 < p < 0.25$) (Table 6, Fig. 7d). Despite this disagreement, at least 42% of landowners, anglers, and professionals responded that industry did not affect the amount of woody debris in nearby trout streams. Statistical analysis revealed that landowners, anglers, and professionals agreed that industry decreases the standing stock of trout in nearby streams ($0.10 < p < 0.25$) (Table 6, Fig. 7e), with at least 84% agreement.

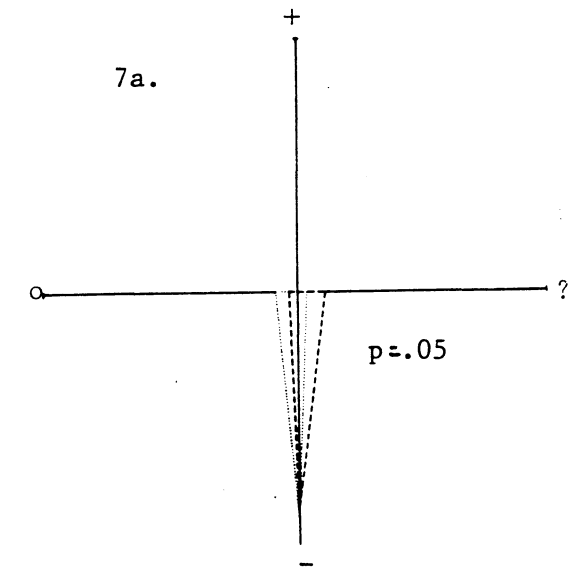
Effects of Urban Development

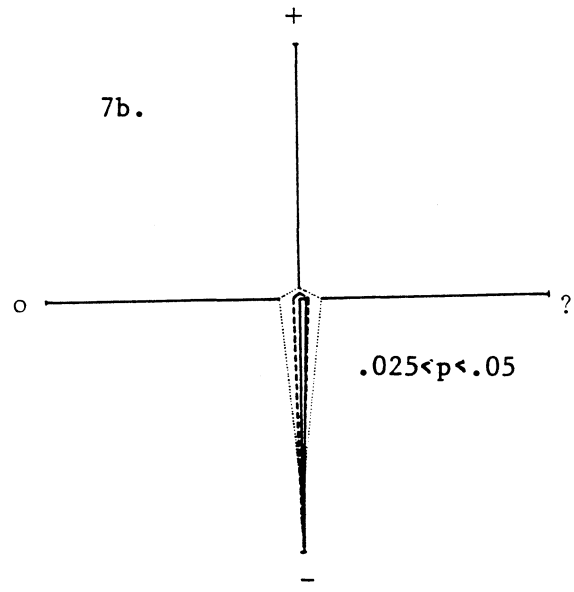
Statistical analysis supported differing opinions about the effects of urban development on dissolved oxygen concentration in nearby streams ($p < 0.001$). Ninety-five percent of landowners and 83% of anglers agreed that urban development decreased dissolved oxygen; 58% of

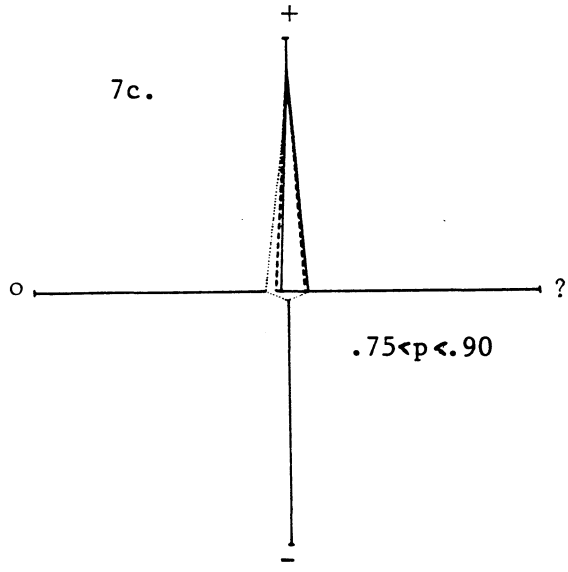
Table 6. Percent response of survey groups on the effects of industries on nearby trout habitat and populations (+ = increase, o = no change, - = decrease, ? = don't know).

	Landowners				Anglers				Professionals			
Parameter	+	o	-	?	+	o	-	?	+	o	-	?
Dissolved Oxygen	00.0	00.0	100.0	00.0	00.0	02.9	85.5	11.6	00.0	08.0	88.0	04.0
Food Supply	00.0	00.0	97.4	02.6	01.4	01.4	92.8	04.3	04.0	08.0	80.0	08.0
Sedimentation[a]	89.5	02.6	00.0	07.9	88.6	04.3	00.0	07.1	80.0	08.0	04.0	08.0
Woody Debris	13.2	52.6	10.5	23.7	04.3	62.9	12.9	20.0	03.8	42.3	30.8	23.1
Standing Stock	00.0	00.0	97.4	02.6	00.0	00.0	89.9	10.1	04.0	04.0	84.0	08.0

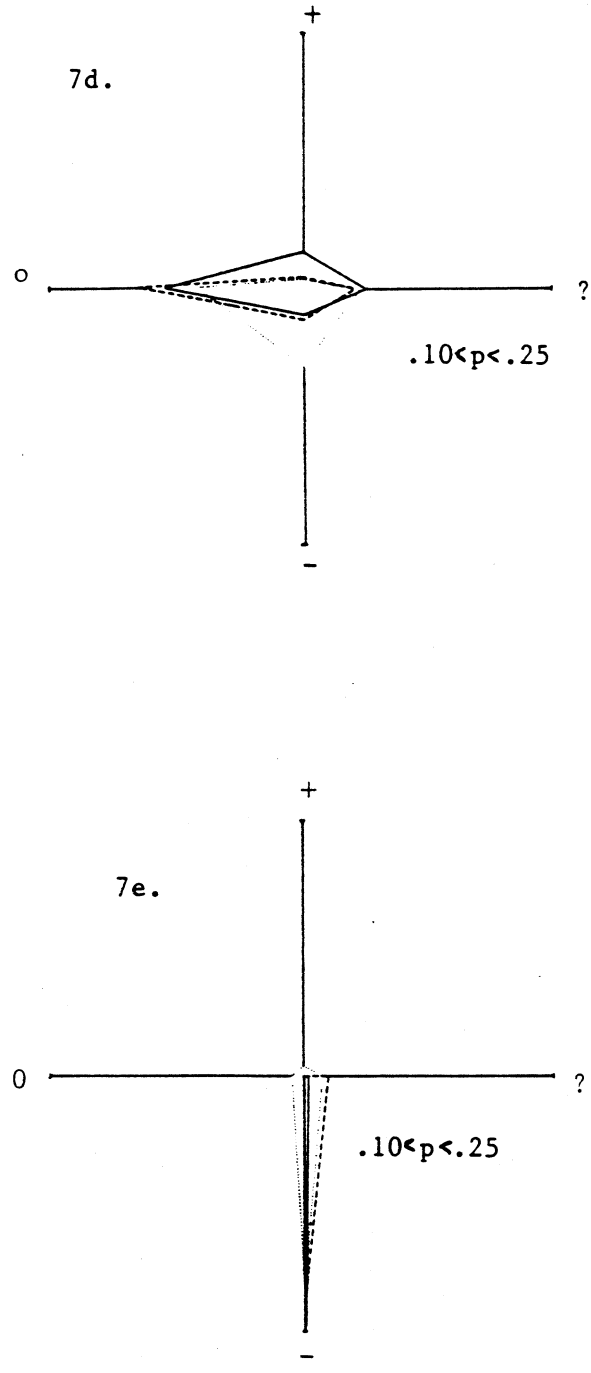
[a]Unlike other parameters, an increase in sedimentation (+) has detrimental effects on trout habitat and populations.







Figures 7a-c Distribution of responses to questions on the effects of industries on dissolved oxygen (7a), food supply (7b), and sedimentation (7c). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.



Figures 7d-e Distribution of responses to questions on the effects of industries on woody debris (7d) and standing stock (7e). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.

professionals agreed that urban development decreased dissolved oxygen, but 39% felt that it had no effect on the amount of oxygen in nearby streams (Table 7, Fig. 8a).

Statistical analysis also showed that the three groups agreed that urban development negatively affected the food supply for trout in nearby streams ($0.25 < p < 0.50$), that it increased sedimentation of nearby streams ($0.50 < p < 0.75$), and that urban development reduced the standing stock of trout in nearby streams ($0.25 < p < 0.50$). In all cases, at least 76% agreed (Table 7, Figs. 8b, 8c, and 8e).

The three survey groups did not agree on the effects of urban development on the amount of woody debris in nearby trout streams ($p < 0.001$). Among-group differences were matched by differences within groups. Landowners showed the highest disagreement, with 47% responding no change, 26% responding increase, and 21% responding decrease. Sixty-four percent of anglers and 81% of professionals agreed that urban development near streams decreased the amount of woody debris in the stream (Table 7, Fig. 8d).

Effects of Farming

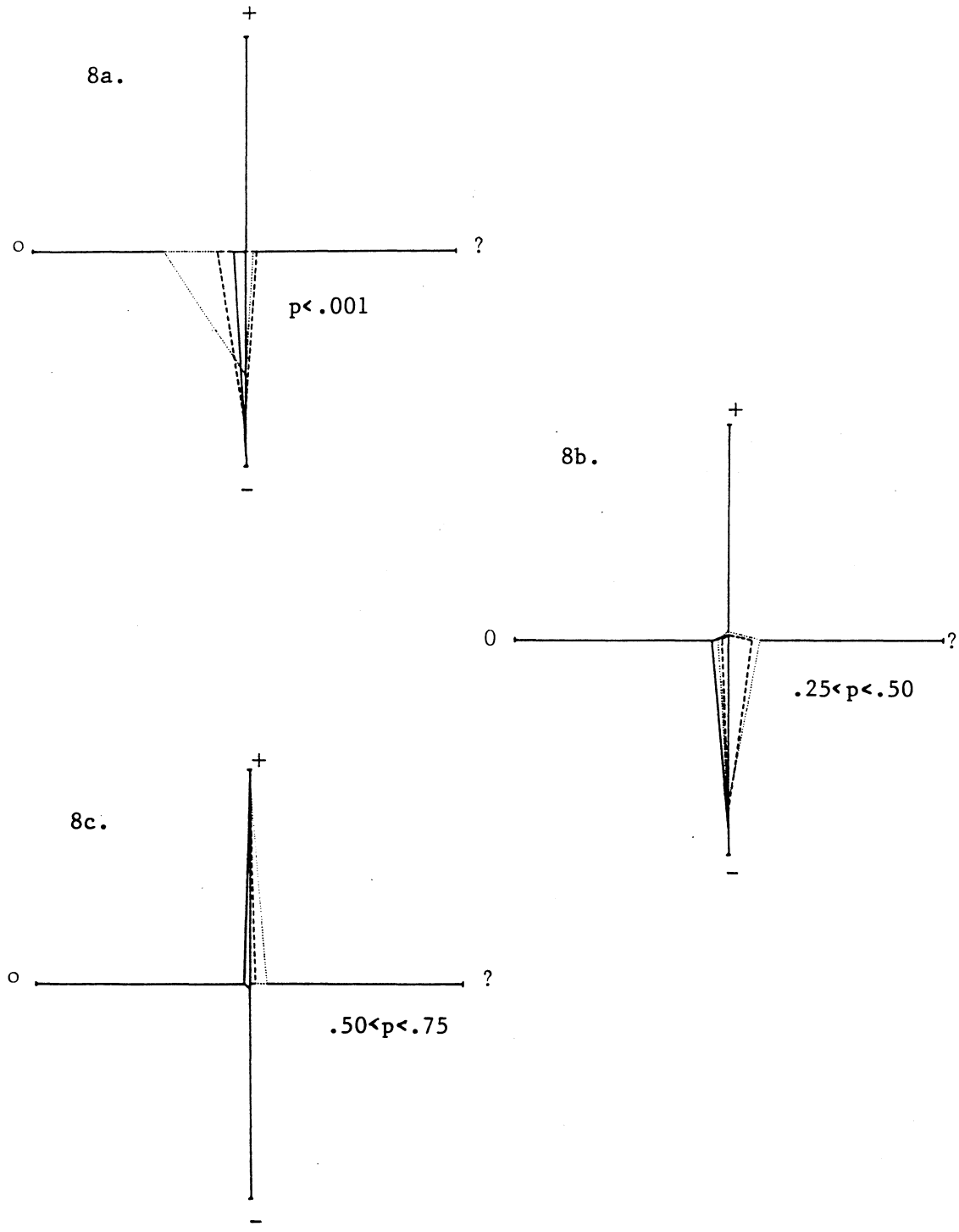
Statistical analysis revealed that the three groups did not agree on the effects of farming on dissolved oxygen ($0.025 < p < 0.05$). However, more than half of the respondents in each group agreed that farming near streams lead to decreased dissolved oxygen in the water, with landowners having the least agreement (63.2%) (Table 8, Fig. 9a).

There was considerable disagreement among the three user groups on the effects of farming on the food supply available to trout in nearby streams ($p < 0.001$). Sixty-one percent of landowners felt farming increased food supply, while 32% felt it decreased available food. Seventy-three percent of anglers and 64% of professionals agreed that farming decreased food supply, while 36% of professionals felt farming helped the food supply (Table 8, Fig. 9b).

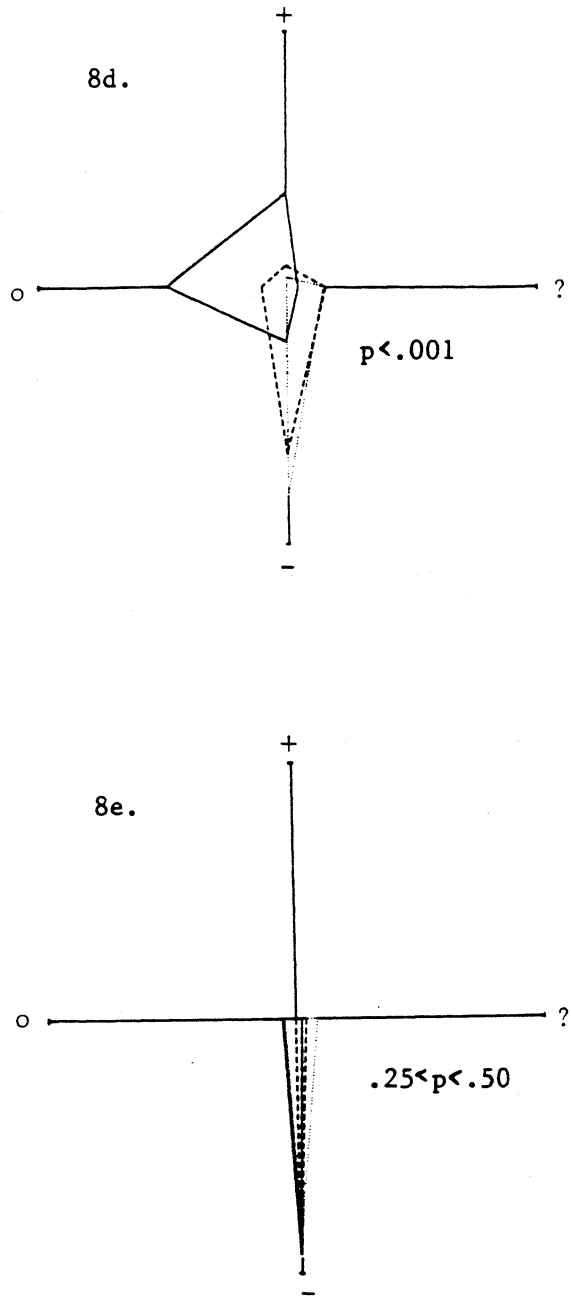
Table 7. Percent response of survey groups on the effects of urban development on nearby trout habitat and populations (+ = increase, o = no change, - = decrease, ? = don't know).

	Landowners				Anglers				Professionals			
Parameter	+	o	-	?	+	o	-	?	+	o	-	?
Dissolved Oxygen	00.0	05.3	94.7	00.0	00.0	11.4	82.9	05.7	00.0	38.5	57.7	03.8
Food Supply	02.6	07.9	89.5	00.0	02.9	02.9	82.9	11.4	04.0	04.0	76.0	16.0
Sedimentation*	94.7	02.6	02.6	00.0	97.1	00.0	00.0	02.9	92.3	00.0	00.0	07.7
Woody Debris	26.3	47.4	21.1	05.3	08.6	10.0	64.3	17.1	03.8	00.0	80.8	15.4
Standing Stock	00.0	05.3	92.1	02.6	00.0	00.0	95.7	04.3	00.0	04.4	88.0	08.0

*Unlike other parameters, an increase in sedimentation (+) has detrimental effects on trout habitat and populations.



Figures 8a-c Distribution of responses to questions on the effects of urban development on dissolved oxygen (8a), food supply (8b), and sedimentation (8c). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.

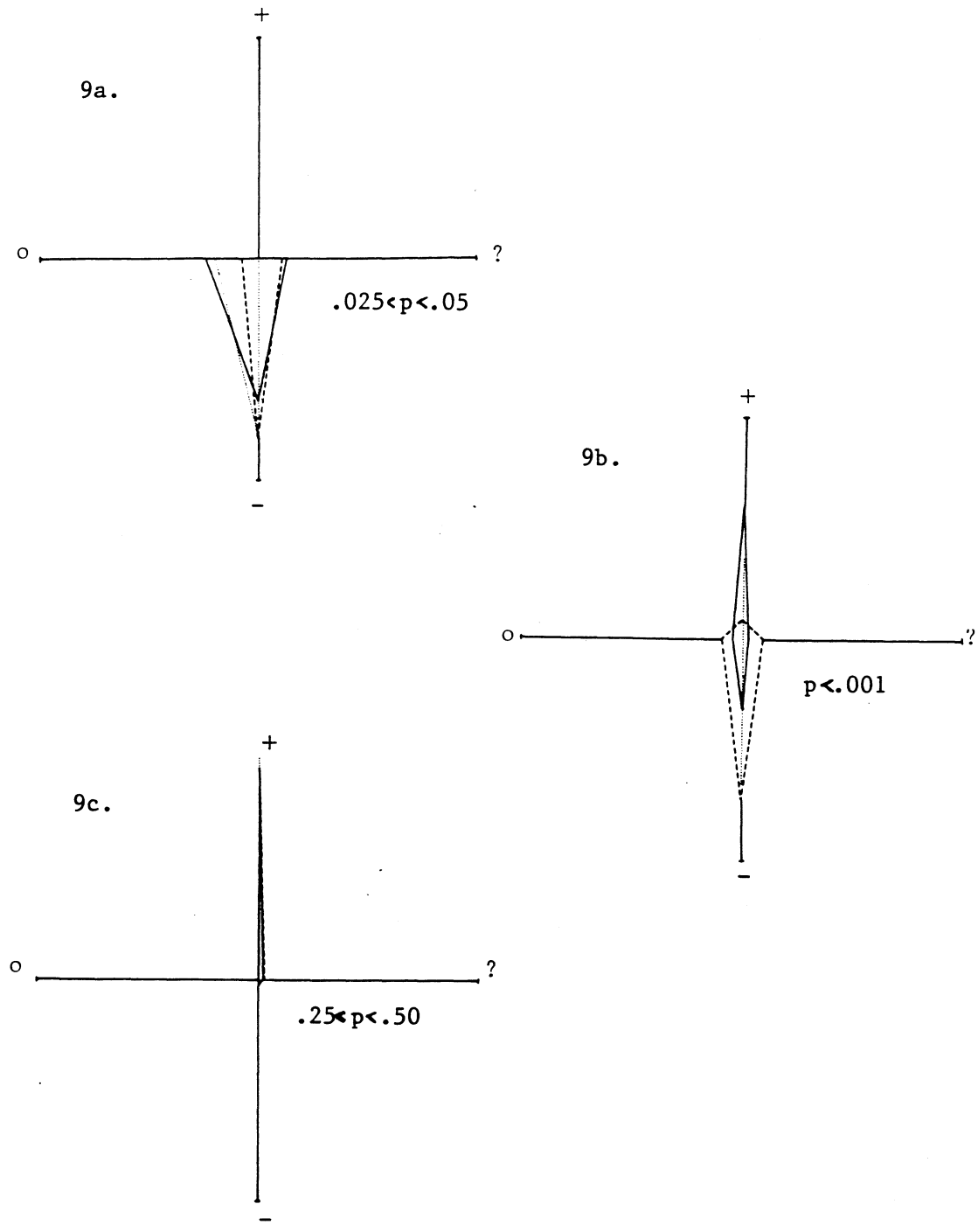


Figures 8d-e Distribution of responses to questions on the effects of urban development on woody debris (8d) and standing stock (8e). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.

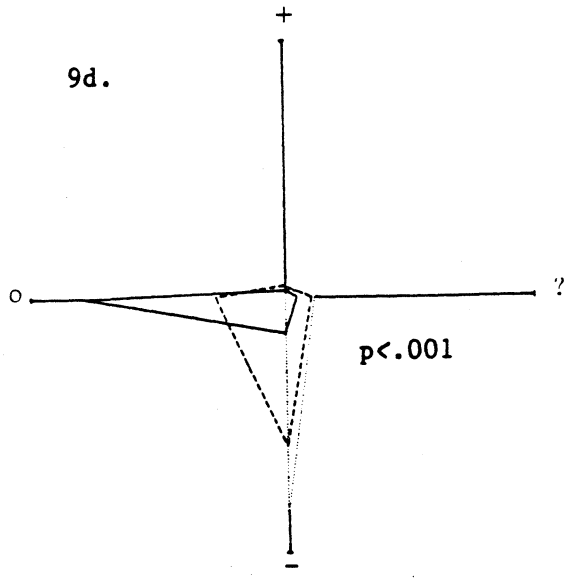
Table 8. Percent response of survey groups on the effects of farming on nearby trout habitat and populations (+ = increase, o = no change, - = decrease, ? = don't know).

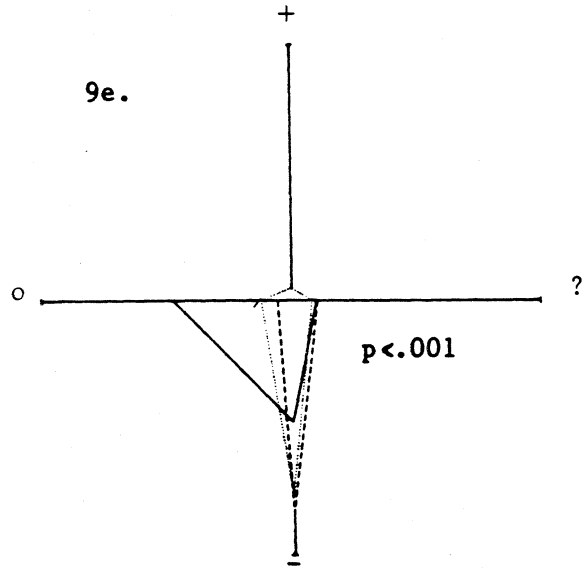
	Landowners				Anglers				Professionals			
Parameter	+	o	-	?	+	o	-	?	+	o	-	?
Dissolved Oxygen	00.0	23.7	63.2	13.2	00.0	07.1	81.4	11.4	00.0	20.0	80.0	00.0
Food Supply	60.5	05.3	31.6	02.6	08.6	10.0	72.9	08.6	36.0	00.0	64.0	00.0
Sedimentation*	94.7	00.0	02.6	02.6	95.7	00.0	01.4	02.9	100.0	00.0	00.0	00.0
Woody Debris	02.6	78.9	13.2	05.3	04.3	27.5	58.0	10.1	03.8	00.0	84.6	11.5
Standing Stock	00.0	44.7	44.7	10.5	00.0	05.8	82.6	11.6	04.0	12.0	76.0	08.0

*Unlike other parameters, an increase in sedimentation (+) has detrimental effects on trout habitat and populations.



Figures 9a-c Distribution of responses to questions on the effects of farming on dissolved oxygen (9a), food supply (9b), and sedimentation (9c). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.





Figures 9d-e Distribution of responses to questions on the effects of farming on woody debris (9d) and standing stock (9e). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.

There was agreement among the groups that farming increased sedimentation of nearby streams ($0.25 < p < 0.50$). In each group, at least 95% agreed that farming increased the sediment load (Table 8, Fig. 9c).

Statistical analysis showed that the three groups differed in their opinions on the effects of farming on the amount of woody debris in nearby streams ($p < 0.001$). This disagreement was both among and within user groups. Seventy-nine percent of landowners responded that farming did not change the amount of woody debris, while 85% of professionals said that it decreased the amount of woody debris. Anglers were split, with 58% saying farming decreased woody debris and 28% saying it did not change the amount of woody debris in nearby streams (Table 8, Fig. 9d).

The effects of farming on standing stock also provided much disagreement among groups ($p < 0.001$). At least 76% of anglers and professionals felt it decreased trout populations, while landowners were split, with 45% agreement for both no change in trout populations and decreases trout standing stock (Table 8, Fig. 9e).

Effects of Forestry

Statistical analysis revealed that professionals differed from landowners and anglers in their opinions about the effects of forestry on the dissolved oxygen in nearby trout streams ($p < 0.001$). Seventy-two percent of professionals responded that timber harvest did not alter dissolved oxygen concentrations, while 71% of landowners and 74% of anglers felt forestry decreased the oxygen available to trout (Table 9, Fig. 10a).

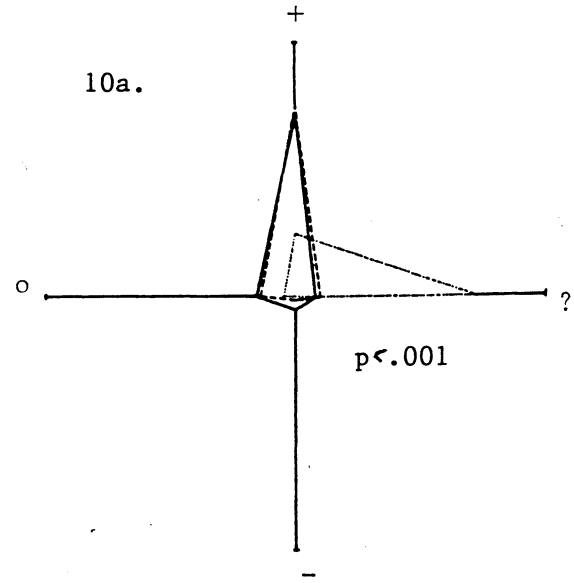
Statistical analysis revealed no differences among groups that forestry decreased food supply available to trout in nearby streams ($0.05 < p < 0.10$). At least 79% of landowners and anglers responded that forestry hurts the food supply. While 60% of professionals agreed with them, 24% said forestry helps increase the food supply available to trout (Table 9, Fig. 10b).

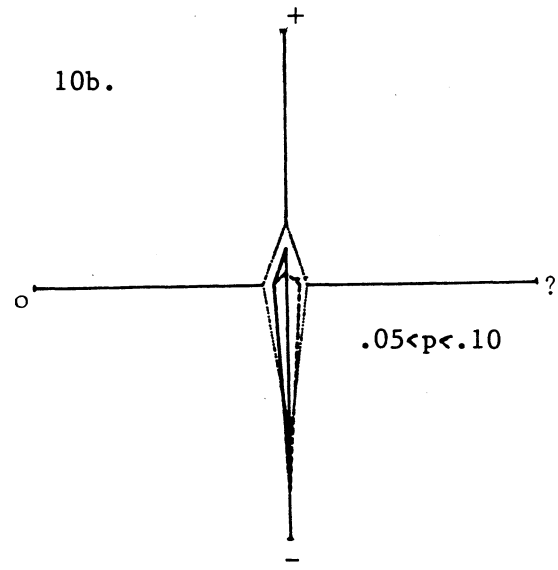
At least 92% of landowners, anglers, and professionals agreed that forestry increased sedimentation ($0.25 < p < 0.50$) (Table 9, Fig. 10c). Statistical analysis also revealed that the three

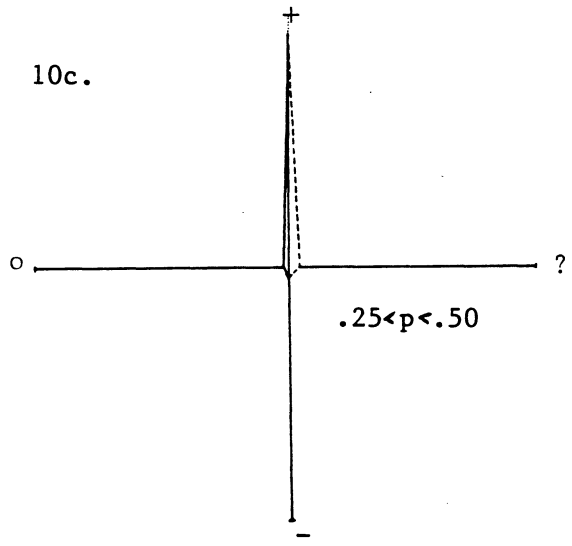
Table 9. Percent response of survey groups on the effects of forestry on nearby trout habitat and populations (+ = increase, o = no change, - = decrease, ? = don't know).

	Landowners				Anglers				Professionals			
Parameter	+	o	-	?	+	o	-	?	+	o	-	?
Dissolved Oxygen	05.3	07.9	71.1	15.8	01.4	10.0	74.3	14.3	00.0	72.0	24.0	04.0
Food Supply	15.8	05.3	78.9	00.0	05.9	05.9	82.4	05.9	24.0	08.0	60.0	08.0
Sedimentation[a]	92.1	02.6	05.3	00.0	92.9	00.0	02.9	04.3	100.0	00.0	00.0	00.0
Woody Debris	89.5	02.6	02.6	05.3	84.3	02.9	08.6	04.3	48.0	00.0	48.0	04.0
Standing Stock	05.3	07.9	78.9	07.9	00.0	07.1	85.7	07.1	00.0	12.0	76.0	12.0

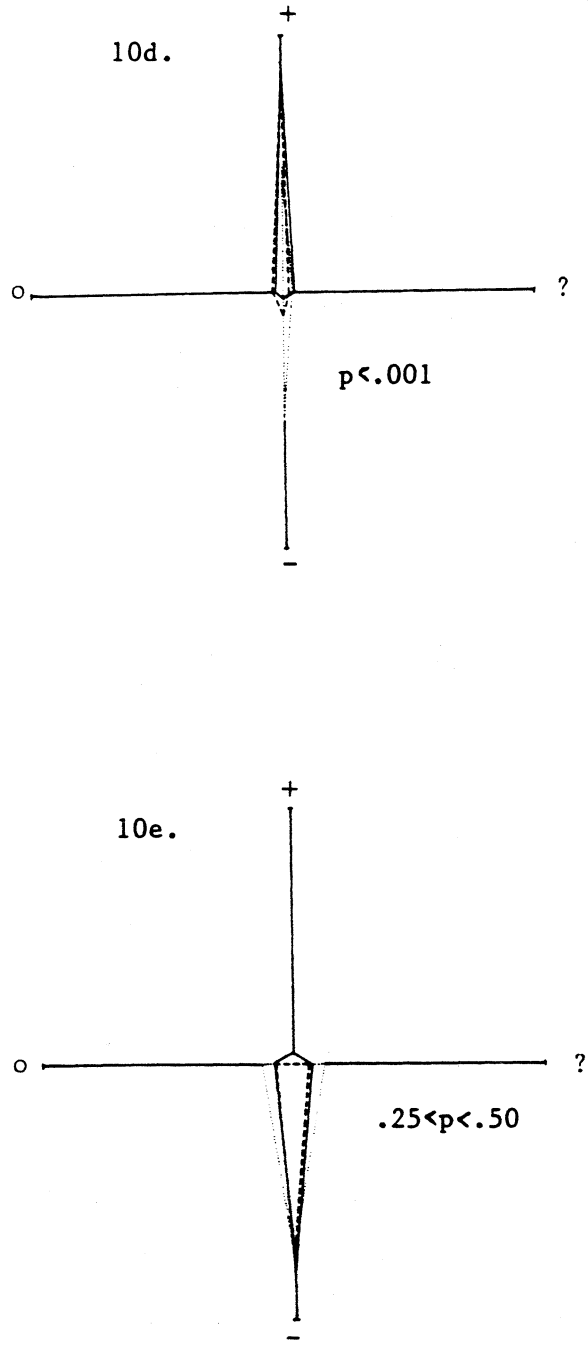
[a]Unlike other parameters, an increase in sedimentation (+) has detrimental effects on trout habitat and populations.







Figures 10a-c Distribution of responses to questions on the effects of forestry on dissolved oxygen (10a), food supply (10b), sedimentation (10c), woody debris (10d), and standing stock (10e). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.



Figures 10d-e Distribution of responses to questions on the effects of forestry on woody debris (10d) and standing stock (10e). Landowner responses are represented by solid lines, anglers by dashed lines, and fisheries professionals by dotted lines.

groups did not agree on the effects of forestry on woody debris ($p < 0.001$). Ninety percent of landowners and 84% of anglers agreed that forestry increased the amount of woody debris in nearby trout streams. Professionals were split; 48% responded that forestry increased the amount of woody debris and 48% responded that it decreased the amount of woody debris (Table 9, Fig. 10d).

Statistical analysis revealed that all three groups felt that forestry decreased the standing stock of trout in nearby streams ($0.25 < p < 0.50$). At least 76% of the landowners, anglers, and professionals agreed (Table 9, Fig. 10e).

In summary, Table 10 shows that landowners, anglers, and fisheries professionals disagreed the most on the effects of farming in general. This coincides with the differences in scores among the groups about farming in question 1. They also disagreed frequently on the effects of all land uses on dissolved oxygen and amount of woody debris present in nearby streams. Disagreement was minimal on the effects of all land uses on sedimentation and trout standing stock. Intermediate levels of agreement occurred on questions about the effects of roads and railroads, urban development, and forestry on nearby streams and on the effects of all land uses on available food supply. These results are also reflected in the responses to related parts of question 1.

Objective 2: Attitudes of Fisheries Professionals

Just as there were attitudinal differences among the three user groups in the study, coldwater fisheries professionals exhibited within-group differences on two general groups of questions. The first group of questions included the effects of roads and railroads, industries, and urban development on the amount of woody debris in nearby streams. The second group included the effects of urban development on the dissolved oxygen, food supply, and woody debris in nearby streams (Table 11).

Table 10. Questions where disagreement occurred among survey groups based on statistical significance.

	Stream Parameter				
Land Use	Dissolved Oxygen	Food Supply	Sedimentation	Woody Debris	Standing Stock
Urban Development	X			X	
Industry	X	X			
Roads & RR	X			X	
Farming	X	X		X	X
Forestry	X			X	

Table 11. Percent response of coldwater fisheries professionals to questions without consensus.

Effects of (land use) on woody debris	+	o	-	?
Roads & RR	7.7	15.4	65.4	11.5
Industry	3.8	42.3	30.8	23.1
Urban Development	3.8	0.0	80.8	15.4
Effects of urban dev. on (stream parameter)	**+**	**o**	**-**	**?**
Dissolved Oxygen	0.0	38.5	57.7	3.8
Food Supply	4.0	4.0	76.0	16.0
Woody Debris	3.8	0.0	80.8	15.4

Amount of Experience

Years of coldwater fisheries experience ranged from 3 to 50 years, with a mean of 15 (Figure 11). For this analysis, the 29 professionals were divided into four groups with approximately the same number in each group. Twenty-four percent of the professionals had from 3 to 8 years of experience, 28% from 9 to 14 years of experience, 31% from 15 to 20 years of experience, and 17% more than 20 years of coldwater experience. These groups were analyzed to see if the disagreement among the professionals was a function of amount of experience.

Statistical analysis revealed that the disagreement among coldwater fisheries professionals on the effects of roads and railroads, industry, and urban development on the amount of woody debris in nearby streams was a function of experience (Table 12). Professionals with fewer than 8 years of experience responded that roads and railroads and industries affected nearby streams in one of two ways: either did not alter or decreased the amount of woody debris in nearby streams. While professionals with between 9 and 14 years of experience agreed that roads and railroads decreased and industries did not change woody debris. This did not hold true for the effects of urban development on woody debris, where paired statistical analysis could not isolate specific differences in response as a function of years of experience (Table 12).

Statistical analysis showed that the disagreement among professionals on the effects of urban development on dissolved oxygen, food supply, and woody debris of nearby streams was a function of the years of experience (Table 13). However, further analysis could not isolate any pairs of groups that responded differently solely as a function of amount of experience.

Type of Experience

Of the twenty-nine coldwater fisheries professionals surveyed, about half worked for state fish and wildlife agencies in the Southeast, about one third worked for federal agencies (U.S. Forest

Figure 11. Amount of experience (years) of southeastern coldwater fisheries professionals participating in Delphi survey.

Table 12. P-values for questions lacking consensus and related multiple comparisons about the effects of several land uses on the amount of woody debris in nearby streams as a function of amount of coldwater experience using a modified Fisher's Exact Test.

			Pairwise Comparisons		
	Overall		Years of Experience		
Land Use	p-value	Yrs. Exp.	3-8	9-14	15-20
Roads and Railroads	.003	9-14	.04	-	-
		15-20	.16	.15	-
		21-50	.14	.29	.15
Industries	.0002	9-14	.03	-	-
		15-20	.17	.14	-
		21-50	.03	.12	.10
Urban Development	.007	9-14	.23	-	-
		15-20	.23	.44	-
		21-50	.42	.16	.16

Table 13. P-values for questions lacking consensus and related multiple comparisons about the effects of urban development on several stream parameters as a function of amount of coldwater experience using a modified Fisher's Exact Test.

			Pairwise Comparisons		
	Overall		Years of Experience		
Stream Parameter	p-value	Yrs. Exp.	3-8	9-14	15-20
Woody Debris	.007	9-14	.23	-	-
		15-20	.23	.44	-
		21-50	.42	.16	.16
Dissolved Oxygen	.01	9-14	.44	-	-
		15-20	.17	.13	-
		21-50	.45	.42	.23
Food Supply	.003	9-14	.27	-	-
		15-20	.37	.12	-
		21-50	.21	.11	.23

Service, National Park Service, Fish and Wildlife Service), and 7% worked for other types of agencies (Fig. 12). Only state and federal participants were examined for the five questions that lacked agreement since such a small percentage of the professionals were from other types of employment.

Disagreement among professionals on the effects of roads and railroads and industries on the amount of woody debris in nearby streams was found to be a function of the type of agency ($p = 0.04$ and 0.03, respectively). In these cases, state employees felt that roads and railroads have mixed effects on the amount of woody debris in nearby streams, while federal employees agreed that roads and railroads decreased the amount of woody debris in nearby streams. State employees felt that industries increased the woody debris in nearby streams, while federal employees felt that industries decreased the amount of woody debris. However, statistical analysis revealed that employees of different agencies agreed on the effects of urban development on the amount of woody debris in nearby streams ($p = 0.22$).

State and federal employees agreed about the ways urban development affected streams. They agreed that urban development decreased the food supply available to trout in nearby streams ($p = 0.08$), that it decreased or did not change the dissolved oxygen concentration ($p = 0.22$), and that it decreased the amount of woody debris in nearby streams ($p = 0.14$).

Amount and Type of Experience

Both amount and type of coldwater experience gave some indication of overall differences among fisheries professionals. These differences were inconsistent, however, suggesting that a relationship between agency employment and years of experience might exist. Therefore, amount and type of coldwater experience were combined, and the professionals were divided into four groups for analysis. Seven state employees had fewer than 15 years and nine had 15 or more years of coldwater experience. Six federal employees had fewer than 15 years and four had 15 or more

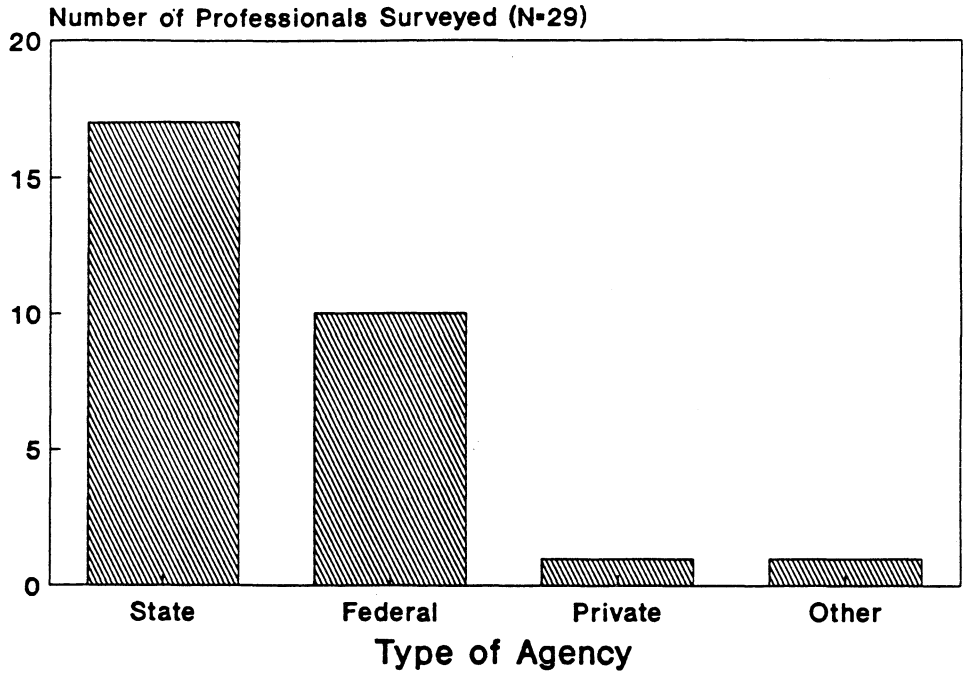


Figure 12. Type of experience (type of agency employeed by) of southeastern coldwater fisheries professionals participating in Delphi survey.

years of coldwater experience. Again, a modified Fisher's Exact Test was used to test responses because of small sample sizes.

Statistical analysis revealed that the disagreement among professionals on the effects of roads and railroads, industries, and urban development on the amount of woody debris in nearby streams was a function of both years of experience and type of agency ($p = 0.001$, 0.001, and 0.009, respectively). State employees with fewer than 15 years of coldwater experience felt that roads and railroads decreased the amount of woody debris in nearby streams, while state employees with 15 or more years of experience and federal employees generally had mixed feelings about the effects of roads and railroads on woody debris. State employees with fewer than 15 years of experience also felt that industry did not change the woody debris, while the other groups had mixed results. However, paired comparisons revealed, in general, that there were no differences in responses as a function of amount and type of experience (Table 14).

Statistical analysis also revealed that disagreement among professionals on the effects of urban development on the dissolved oxygen, food supply, and amount of woody debris in nearby streams was a function of amount and type of experience ($p = 0.006$, 0.004, and 0.009, respectively). However, once again, paired comparisons revealed that in general, the disagreement could not be isolated as a function of amount and type of experience (Table 15).

Amount of Professional Responsibility

Of the 27 coldwater fisheries professionals who worked for state and federal agencies, 11% had district responsibility within a region, 41% had regional responsibility within a state, 33% were responsible for an entire state, and 7% were responsible for more than one state. Fifteen percent worked in association with colleges or universities, without geographical boundaries on their responsibility (Fig. 13). For the following analysis, professionals with regional and state responsibility were compared.

Table 14. P-values for questions lacking consensus and multiple comparisons about the effects of several land uses on the amount of woody debris in nearby streams as a function of amount and type of experience using a modified Fisher's Exact Test (S = State Employee, F = Federal Employee).

Question	Overall p-value	Years/Type	Pairwise Comparisons Years & Type of Experience < 15/S	15+/S	< 15/F
Roads and Railroads	.001	15+/S	.07	-	-
		< 15/F	.22	.10	-
		15+/F	.17	.16	.33
Industries	.001	15+/S	.07	-	-
		< 15/F	.17	.05	-
		15+/F	.18	.08	.29
Urban Development	.009	15+/S	.07	-	-
		< 15/F	.46	.20	-
		15+/F	1.00	.18	.06

Table 15. P-values for questions lacking consensus and related multiple comparisons about the effects of urban development on several stream parameters as a function of amount and type of coldwater experience using a modified Fisher's Exact Test (S = State Employee, F = Federal Employee).

Overall Stream Parameter	p-value	Years/Type	Pairwise Comparisons Years & Type of Experience 15/S	15+/S	<15/F
Woody Debris	.009	15+/S	.07	-	-
		<15/F	.20	.24	-
		15+/F	1.00	.18	.06
Dissolved Oxygen	.006	15+/S	.09	-	-
		<15/F	.20	.24	-
		15+/F	.25	.31	.48
Food Supply	.004	15+/S	.15	-	-
		<15/F	.19	.13	-
		15+/F	.30	.38	.36

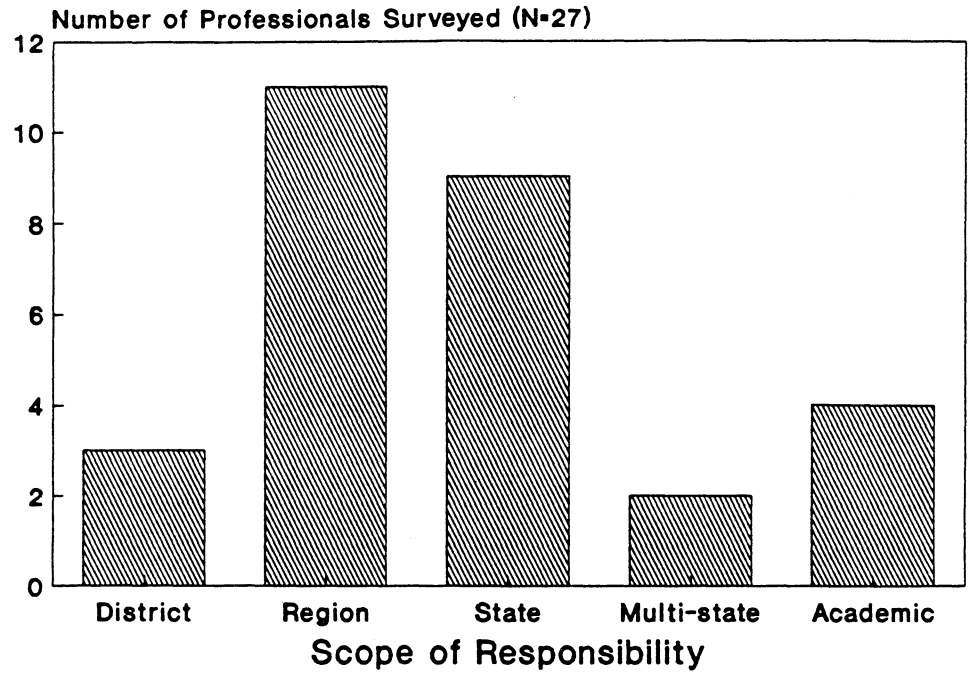


Figure 13. Scope of responsibility of southeastern coldwater fisheries professionals participating in Delphi survey.

Statistical analysis showed that professionals with regional and state responsibility agreed on the effects of roads and railroads, industry, and urban development on the amount of woody debris in nearby streams ($p = 0.11$, 0.07, and 0.26, respectively). They agreed that roads and railroads and urban development decreased woody debris, and that industries did not change the amount of woody debris in nearby streams.

Statistical analysis revealed no difference in response of coldwater fisheries professionals on the effects of urban development on the dissolved oxygen, food supply, and woody debris of nearby streams as a function of amount of responsibility ($p = 0.30$, 0.15, and 0.26, respectively).

Objective 3: Evaluation of the Efficiency of the Delphi Method

The following analysis describes the efficiency of the Delphi Method at reaching a group opinion (consensus) in each of the three user groups: landowners, anglers, and coldwater fisheries professionals.

Defining a Consensus

A consensus is an opinion held by all or most (Berube et al. 1982). Therefore, the quantitative definition of a consensus is arbitrary. I attempted to visualize consensus by ordering each question used in this study (a total of 90 questions, 30 from each of 3 groups) from highest to lowest percent agreement, and then plotting them in this order (Figure 14). Figure 14 appears to contain two distinct slopes (fitted by eye), one flat and one steep. If the point of intersection of these lines represents the largest break in percent agreement, the percent response at that point

can be defined as an opinion held by all or most, or a consensus. Overall, these lines intersect at 78.9% agreement, the point chosen to represent consensus for the combined survey populations. This same analysis for each of the three survey groups (30 questions each) revealed virtually identical consensus points of 78.9%, 81.2%, and 80.0% for the landowners, anglers, and professionals, respectively (Figs. 15a-c). Visual estimation of the consensus point was used rather than arbitrary selection so that the data would support the decision.

Strength of Consensus

After three rounds, all groups had reached consensus on more than half of the 30 questions. Landowners had reached consensus on 20 questions (67%), anglers on 19 questions (63%), and professionals on 16 questions (53%) (Fig. 16).

The rate of reaching consensus was different among groups. After round 1, landowners had reached consensus on only three questions, while anglers had reached consensus on nine questions and professionals on ten questions (Fig. 17). After round 2, landowners had increased the number of questions at consensus by 78.6%, anglers by 52.6%, and coldwater fisheries professionals by 41.2%. After round 3, landowners had increased the number of questions at consensus by 30.0% from round 2, for an overall increase of 85.0%. Anglers had the same number of questions at consensus after round 3, for an overall increase of 52.6%, and professionals had 6.3% (i.e. one question) fewer questions at consensus after round 3 for an overall increase of 37.5%.

After three rounds, questions lacking consensus in all three groups concerned the severity of the effects of land use on nearby streams (questions 1a-e), the effects of land use on the amount of woody debris (questions 2-6, part d) , or the effects of farming (questions 5a-e). Anglers also lacked consensus on several questions concerning the effects of roads and railroads (questions 2a, b, & d). Professionals lacked consensus on several questions dealing with the effects of urban development (questions 4a & b) and on 4 of 5 aspects of the effects of forestry (questions 6a, b, d, & e).

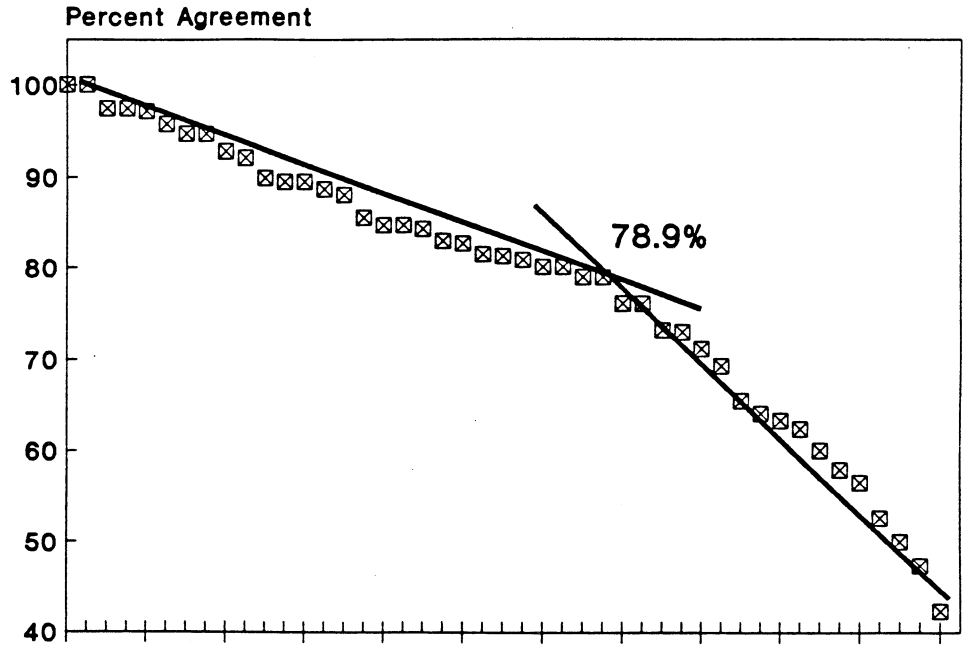
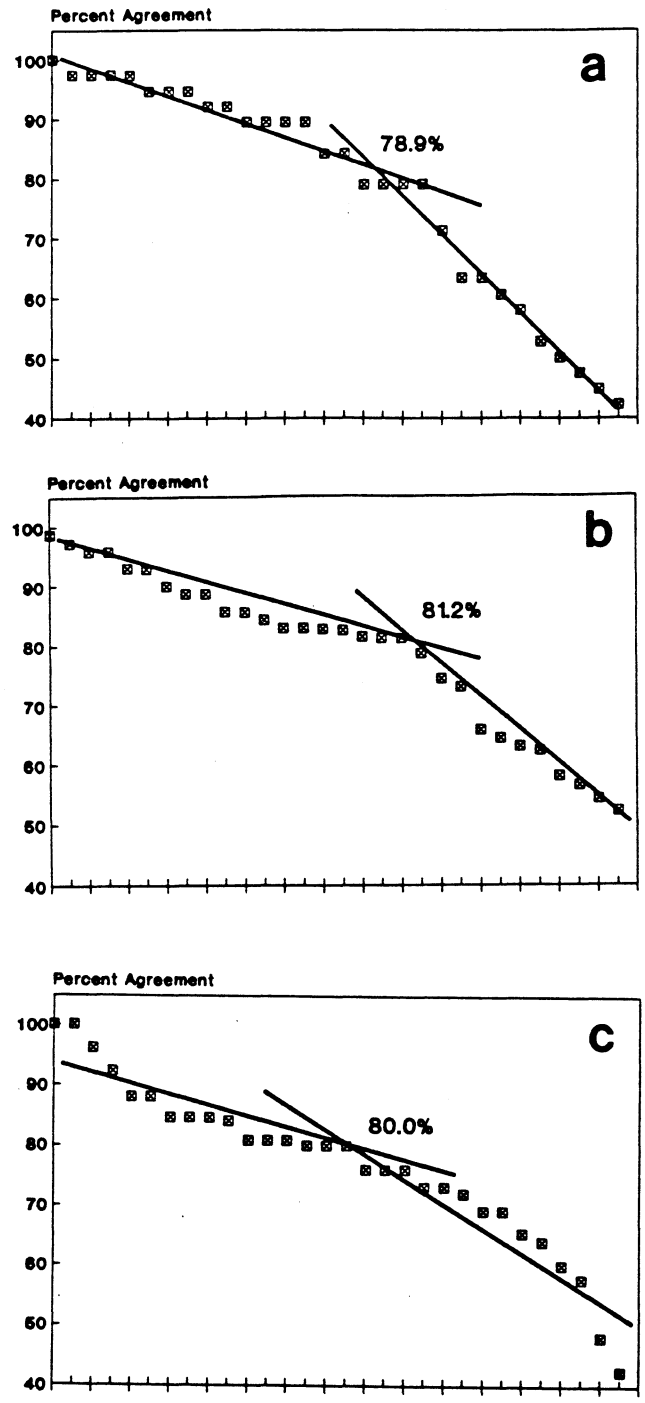


Figure 14. Consensus curve for landowner, angler, and fisheries professional responses. Percent agreement is ordered from highest to lowest for all questions; consensus is the point where the slope changes (78.9%).



Figures 15a-c. Consensus curves for landowners (15a), anglers (15b), and fisheries professionals (15c). Percent agreement is ordered from highest to lowest for all questions; consensus is the point where the slope changes (landowners 78.9%, anglers 81.2%, and fisheries professionals 80.0%

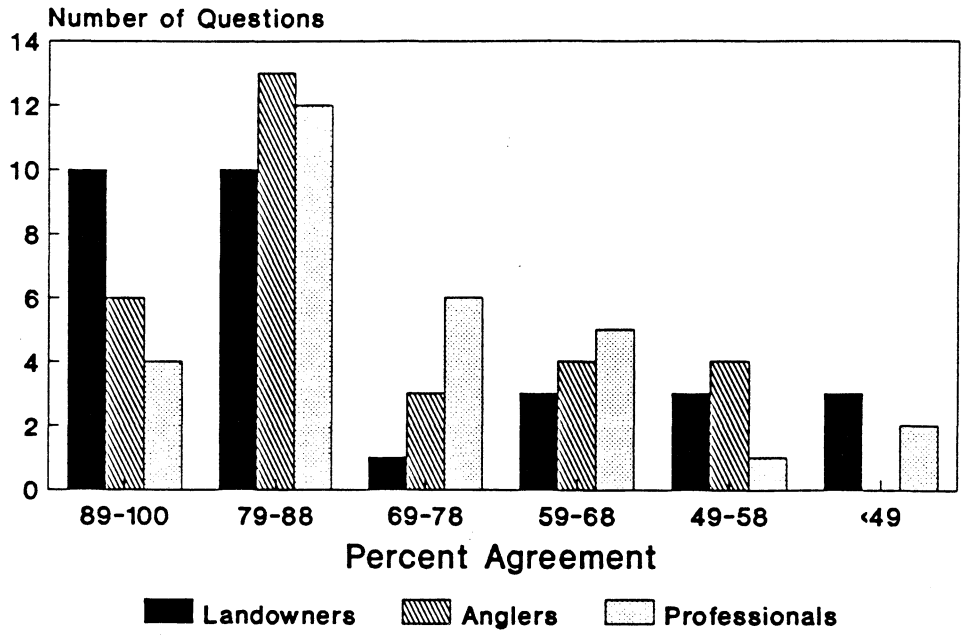


Figure 16. Strength of consensus (number of questions versus percent agreement).

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Discussion

Survey Response Rates

The Dillman Total Design Method (Dillman 1978) is a highly successful survey method, which increases response through postcard reminders and remailings. Overall, response to this survey was similar to other surveys (Dillman 1978). This success can be attributed to several factors. First, the survey was easy to complete. One critical element in achieving high response success is attaining the right information from the respondents without making the survey tool too costly in terms of completion time and effort. Thibaut and Kelly (1959) pointed out that cost is high when great physical or mental effort is required and when embarrassment or anxiety accompany the action. This was not a problem in this study because the survey was concise and anonymity was assured. The survey used for this study consisted of 30 multiple choice questions, contained in eight pages. Dillman (1978) stated that a respondent acts on the basis of anticipated costs, as well as costs already incurred. A questionnaire that appears formidable may be rejected simply because it looks like it will take a long time to complete. Conversely, a questionnaire that seems short may encourage a respondent to continue. Until the second and third rounds, when the participants were asked to elaborate on a response if they did not agree with the majority of

responses from the previous round, little was demanded of the participants except to choose an answer from a list. Even then, time and effort involved was minimal because respondents were familiar with the survey and presumably wanted to continue to participate.

Second, higher than average response rates may be an artifact of the vested interest each survey group had in the subject. For example, landowners may have been eager to find out if their land practices were having any ill effects on nearby streams. Although landowners rarely purchased their land for wildlife related activities, 83% of Missouri's landowners said that wildlife and related activities were important components in their land management (Sheriff et al. 1981). Angler interest and motivation is also shifting from biomass or number of fish caught to other factors such as aesthetics and companionship (Hampton and Lackey 1975, Driver and Knopf 1976, Smith 1980, Dawson and Wilkins 1981, Hudgins 1984, Helfrich et al. 1987). This shift in angler objectives may increase interest in the health and condition of the stream system as a whole, thus increasing interest in a survey like this one. The interest of coldwater fisheries professionals is self-explanatory. Presumably, area professionals were eager to learn the attitudes of their colleagues and to see if they matched their own.

Rewards offered to the respondents may also have contributed to response success. Introducing the survey with statements like "this survey is an effort to incorporate public opinions into the management process" and explaining that the respondents are part of a carefully selected panel expresses positive regard for participants and encourages them to reply (Dillman 1978). Also, the publication mailed with the second round was designed as an incentive to respond. Perhaps also encouraging the participants to respond to such a survey was the rise in popularity of environmentally-oriented projects. The survey provided them with a chance to participate in such an activity.

Objective 1: Attitudes of Survey Populations

Several factors may influence attitudes. Before I began this study, I hypothesized that the groups would differ because: 1) the public (i.e. landowners and anglers) rely more on the visible impacts associated with a land use, rather than on the biological information used by coldwater fisheries professionals; 2) that factors such as economic value, aesthetics, and media attention play a vital role in shaping landowner attitudes (Sheriff et al. 1981); 3) that anglers base their opinions on past angling experiences (Williams et al. 1986); and 4) that fisheries professionals base their decisions on past education and work experience (Peyton and Langenau 1985). The study results reveal that, for the most part, the hypothesis was untrue (i.e. more agreement was found than expected). However, when disagreement occurred among groups, the responses appeared to support the notion that background and prior knowledge appeared to influence response. The data obtained from this project do not directly support the hypothesis; but when combined with evidence from past research, the direction of response supports conclusions such as the ones presented in this document.

Attitudes Towards the Severity of Land Use Practices

Several characteristics were associated with the groups, although differences in mean response to questions on the severity of impacts associated with land use among survey populations were minor. Overall, mean responses to the questions were low and differences among land uses were small, indicating that all respondents felt that land use generally had some ill effect on nearby streams. Anglers and professionals used the lower end of the scale more often than landowners in their evaluation of the severity of impacts associated with a particular land use. Landowners also used a larger portion of the scale in their evaluations than anglers and professionals. Range of response is perhaps a function of the diverse nature of the landowner population, persons who may

or may not know or care about the streams, while objectives of the anglers and professionals are more uniform. This also may be an artifact of the process used to identify each survey group. Fisheries professionals were chosen by vocation, anglers by avocation, and landowners by location. Because landowners lacked a common interest, they were more likely to represent an array of views.

The tendency for anglers and professionals to score land use impacts lower than landowners (i.e. impacts are more severe) is presumably a function of their knowledge of stream systems. Studies conducted by Kellert and Berry (1980) revealed that anglers were more knowledgeable about wildlife and natural resources than those who did not fish. Because it is the responsibility of the fisheries professionals to manage the stream systems, it can be assumed that they are educated in such areas. While it is not fair to assume that landowners are oblivious to the severity of impacts resulting from careless land use, their interests do not necessarily lie with the aquatic resources, but rather with the products of the land use. In the southern Appalachian Mountains, many landowners with trout waters flowing through their property use the land heavily for crops, livestock, and private forestry. Because they are actively involved in some of the land uses being evaluated, they may have been cautious when responding to the survey questions. In future research, establishment of a relationship between landowners' use of their land and knowledge of the effects of land use on aquatic systems would be useful; however, the Delphi Method would have to be further modified or another survey instrument used since retaining anonymity would be difficult in such a specific survey.

All three groups felt that industries exerted the most severe impacts on nearby stream systems. Presumably, this can be attributed to the nature of the impacts associated with industry. Industry near streams often results in impacts that are highly visible and easily noticed. For example, chemical effluents from industry often result in visible fish kills and water discoloration. This supports the premise that visible impact equals bad impact and that in general, people do not like industry.

Rankings of the severity of impacts associated with land use by landowners and anglers are readily understandable. Landowners felt that farming and forestry had the least detrimental effects on nearby streams. This can be largely attributed to the fact that landowners rely on farming and

forestry for their livelihood. Anglers considered the impacts associated with urban development, roads and railroads, and forestry to be more serious than farming. Urban development along streams detracts from the aesthetic experience of fishing for trout in the mountains by filling a once wooded landscape with houses, yards, parking lots, etc. Roads and railroads increase angler access (angler and public) to many trout streams, which can lead to higher fishing pressure and therefore harvest mortality, as well as problems such as increased traffic, erosion and sedimentation, and trash. Most trout streams in the southern Appalachians are located in areas where timber harvest occurs (either state, federal, or private); therefore, forestry is the land use anglers come in contact with most often on their fishing trips. Areas of recent timber harvest are not very pleasing to the eye; debris left behind may find its way into a stream, making it appear "messy". Coldwater fisheries professionals felt that forestry had the least harmful impacts on nearby streams. This attitude can be attributed to the professionals' educational background and their experience with the effects of land use. Furthermore, because some respondents work for agencies that manage land for forest products, they may believe that forest practices are under control by prescribing and enforcing Best Management Practices.

The remainder of the discussion of Objective 1 will focus on those questions where the strongest disagreement among the three groups existed. These questions included the effects of land use on dissolved oxygen concentrations and amount of woody debris in nearby streams and the effects of farming on stream parameters.

Effects of Land Use on Dissolved Oxygen

Considerable disagreement among the three survey groups existed on the effects of land use on the dissolved oxygen content of nearby streams. This disagreement can be attributed to the lack of public knowledge of the importance and role of dissolved oxygen in aquatic systems. This hypothesis is supported by the high percentage of landowners and anglers responding "I don't know" to questions concerning dissolved oxygen, while professionals seldom reported "I don't

know". In the case of each land use (roads and railroads, urban development, industry, farming, and forestry), most of the remaining landowners and anglers responded that the land use decreased dissolved oxygen in nearby streams. Dissolved oxygen is an invisible part of stream dynamics. Therefore, unless educated on the subject, landowners and anglers had no reason to know the effects of land use on dissolved oxygen concentration.

Effects of Land Use on Woody Debris

Considerable disagreement also existed among the three survey groups on the effects of land use on the amount of woody debris in nearby streams. This is understandable because presently, researchers and biologists also disagree on the role and dynamics of large woody debris in southern Appalachian Mountain streams.

In this survey, anglers and professionals agreed that roads and railroads, urban development, and farming decreased the amount of woody debris in nearby streams. Anglers probably based their decisions on past angling experiences, while professionals relied on their education and past professional experiences. For each of these three land uses, land is cleared of trees before land use occurs, eliminating the major contributors of large woody debris to nearby streams (Bryant 1981, 1983). Since woody debris in a stream looks "messy", it is usually cleared from streams where aesthetics are important (e.g. along roads, yards). Anglers who fish streams along roads and developed property may notice the relative lack of woody debris compared to forest streams, which may also be reflected in their catch. Landowners responded that the land uses mentioned above increased or did not change the amount of woody debris in nearby streams. These responses are presumably because 1) preliminary land clearing results in woody debris entering a stream, 2) landowners may not understand the value of large woody debris as instream cover and invertebrate substrate, and 3) landowners may not want to admit that their land use may be affecting a nearby stream.

Effects of Farming on Food Supply and Trout Standing Stock

Questions on the effects of farming on trout food supply and standing stock elicited different responses from the three survey groups. Landowners and some fisheries professionals responded that farming increases the food available to trout in nearby streams. Some professionals also responded that farming decreases the food supply, as did anglers. Most anglers and professionals responded that farming decreases trout populations, but landowners were split between no change and decreased standing stock.

Because of the nutrient input associated with fertilizer runoff, landowners and professionals presumably responded that trout food supply is increased near farms. However, professionals also presumably understand that farming decreases food supply if too much fertilizer or toxic pesticides enter the stream. Anglers responded that farming decreased food supply probably because they experienced lower catches from streams near farms. They also may have noticed lower aquatic invertebrate densities in streams near farms. For the most part, survey response agreed with the literature that land uses such as farming increase stream productivity (Greene 1950, Gurtz et al. 1980). Because trout standing stock is largely dependent on food supply, it was not surprising that responses to questions on the effects of farming on trout standing stock were similar to those on the effects on food supply.

In summary, responses of the three groups were similar. However, several differences in opinion were noted. The greatest differences in opinion occurred between landowners and professionals, perhaps because of the indirect relationship between landowners and aquatic systems (i.e. they use the systems for uses other than aquatic products and management). Also, the greatest differences in opinion occurred in areas where less research has been conducted or the issues presented were less familiar (e.g. woody debris, dissolved oxygen). Also, these factors may be more variable in effect than the survey allows (i.e. effects of land use could be different in different situations). Therefore, if management is to consider public opinion in the future, an improved information exchange between researchers, managers, and the public is needed.

Objective 2: Attitudes of Coldwater Fisheries Professionals

Differences in attitudes among coldwater fisheries professionals of the southern Appalachian Mountains were found to be at least partly a function of amount and type of professional experience. Differences could also be attributed to an interaction between type and amount of experience. The following discussion addresses these differences in two parts, corresponding with the two groups of questions about which professional response disagreed most: the effects of roads and railroads, industries, and urban development on the amount of woody debris in nearby streams and the effects of urban development on dissolved oxygen, food supply, and woody debris in nearby streams.

Effects of Land Use on Woody Debris

Professionals with fewer than eight years of coldwater fisheries experience responded differently than professionals with more experience to questions on the effects of roads and railroads and industries on the amount of woody debris in nearby streams. Professionals with less experience felt that these two land uses either decreased or did not change woody debris content, while a higher proportion of professionals with more experience agreed that the land uses did not change the amount of woody debris. Disparity among the responses as a function of amount of experience can be attributed to the change in perspective among researchers about the effects of land use on woody debris input into streams. For both land uses, a substantial portion of the survey population responded that they did not know the effects of roads, railroads, and industry on the woody debris of nearby streams. So much variability exists in land use practices themselves, that evaluating effects on woody debris input becomes extremely difficult, especially for young professionals. However, as professionals gain experience, their views of the effects become more general, and hence the frequency of the "does not change" response increased. The fact that once initial clearing

occurs and the system stabilizes, roads, railroads, and industry do little to further manipulate streamside vegetation may have also played a part in the responses of professionals with more experience. Also, the subject of woody debris is a recent idea in stream management, so older professionals may have little experience with it.

Disagreement also occurred as a function of type of experience. State employees responded that roads and railroads had mixed effects on woody debris, while federal employees agreed that woody debris decreased. An explanation of this disagreement stems from the difference in responsibility of the two types of agencies. State agencies are primarily responsible for managing the fish populations through angling regulations and population research. Federal agencies, such as the U.S. Forest Service, are charged with habitat assessment and management. Presumably, therefore, federal professionals have more exposure to current thinking about the sources of woody debris in streams.

The combination of amount and type of experience also affected coldwater fisheries professional responses. State employees with fewer than fifteen years of experience generally felt that roads and railroads decreased and that industry did not change woody debris, while state employees with more experience and all federal employees expressed mixed opinions. Although no statistical difference was noted among the groups for this analysis, differences in response can be attributed to several characteristics of young fisheries professionals. First, young state professionals may have a broader charge. Second, they may have less specific training. And third, they have less experience, so they are basing management decisions on generalities learned in school (e.g. woody debris is good, development is bad). Older state professionals and federal employees have had to confront the woody debris issue at varying levels, may or may not know anything about it, or may havebeen educated when large woody debris was considered "bad".

Effects of Urban Development on Stream Parameters

Although disagreement among fisheries professionals on the effects of urban development on the dissolved oxygen, food supply, and woody debris was a function of amount of experience, further analysis could not isolate the differences. Overall, fisheries professionals agreed that urban development either did not change or decreased dissolved oxygen, decreased food supply, and decreased woody debris. However, a significant portion of "I don't know" responses and variance in response produced results that were statistically different but not distributionally different. Basically, few differences existed among fisheries professionals on the effects of urban development. Where differences did exist, they could not be associated with a specific group of professionals. It is likely that whatever differences did occur are because of varying degrees of urbanization and the amount of exposure to different types of development.

In summary, few differences existed in knowledge of coldwater fisheries professionals as a function of amount and type of experience. Where differences did exist, they were associated with areas of current research (e.g. woody debris, habitat management), where professional knowledge may have not yet expanded. From this study, it is concluded that continuing education of fisheries professionals will enhance the effectiveness of future management.

Objective 3: Efficiency of the Delphi Method

The Delphi Method was originally developed as a forecasting tool to achieve a goal that was unattainable through ordinary means. For example, habitat suitability curves for fish species have been constructed using Delphi surveys on fisheries experts in the absence of data and time to conduct a field study (Crance 1987). This study further extends the Delphi Method into fisheries science by testing it as a tool for determining public opinion without conducting public meetings.

Through a series of written questionnaires, three populations reached a consensus about the effects of land use on coldwater streams. Although percentage agreement at which a consensus occurs could be defined differently among populations, it was found to be approximately the same for the landowner, angler, and professional populations used in this study (78.9%). Also, each group reached a consensus on at least half of the 30 survey questions. Since consensus was defined in this study by high percentage agreement, the accuracy and reliability with which the responses represent actual group opinion is assumed to be high.

The rate of reaching consensus differed among the groups, indicating that different factors were influencing the decision making process of the survey populations. Coldwater fisheries professionals reached consensus on more questions than anglers and landowners after round 1. Professionals reached initial consensus on more questions probably because of their common education and work experience, in-service training and continuing education, and exchange of ideas at professional meetings. They also often make decisions on these issues while performing their job. Anglers also reached consensus on a large number of questions initially. This is likely due to the time anglers spend in aquatic environments, observing their surroundings. Also, King et al. (1978) found that anglers use angling and sports-related magazines as an information transfer system. Landowners, however, achieved consensus in later rounds at a faster rate than anglers and professionals. The higher rate may have been a result of several things. First, the initial low level of consensus provided greater opportunity for improvement in rounds 2 and 3. Second, landowner views may not have been as strong as those of the anglers and professionals, and they were easily swayed by the most popular opinion. Third, the landowners may have learned after the first round of the Delphi survey, allowing more common opinions in later rounds.

Overall, the Delphi Method was successful with all three populations. This is supported by similar final consensus levels, and overall response rates. Also, the Delphi process gave evidence of places where real differences in attitude exist within the public. If the survey had been terminated after round 1, many superficial differences would have been included. The Delphi Method helped to focus attention on areas where important differences exist. As a result of this study, it is concluded that differences in knowledge within the public exist in the areas of the effects of land

use on large woody debris and dissolved oxygen concentrations. This is largely a result of a relative lack of research in these areas. However, current research and management programs are focusing more and more on these elements.

General Conclusions

In general, the Delphi Method was a successful, inexpensive way of determining public knowledge of the effects of land use on coldwater ecosystems. Not only did it solicit public knowledge, but it also served as an educational tool.

Overall, less disagreement than expected was discovered. When it comes to knowledge of the effects of land use on coldwater ecosystems, perhaps the public is not as diverse as hypothesized (i.e. that the reasons given for differences in knowledge do not apply in all situations). When differences were detected, distribution and direction of response appeared to support the characteristics hypothesized as being the foundation for differing knowledge (e.g. landowners felt that farming harmed nearby aquatic systems least probably because most of them farmed their land). Collection and use of demographic information would have better defined the hypothesized relationships.

Another general conclusion that can be made is that the format and questions used in this survey are not suitable for gathering the specific data needed to isolate differences in knowledge. However, this survey did identify areas where further research is needed, such as the effects of land use on large woody debris and dissolved oxygen and the effects of farming on trout food supply and socioeconomic aspects of these topics.

Management Recommendations

For future uses of the Delphi Method in fisheries research, I recommend that the procedures in this study be followed. However, determination of the number of rounds necessary to achieve consensus, sample size, and survey design should be done on a case-by-case basis to insure that project objectives will be met. The Delphi Method would also be a useful tool in planning and budget activities in that as a forecasting tool it would identify research and management priorities, which would facilitate effective use of constrained budgets. I suggest that in future uses of the Delphi Method, or any mail survey technique, that demographic information be collected and used to form stronger relationships with survey responses.

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Appendix A. Description of Landowner and Angler Populations

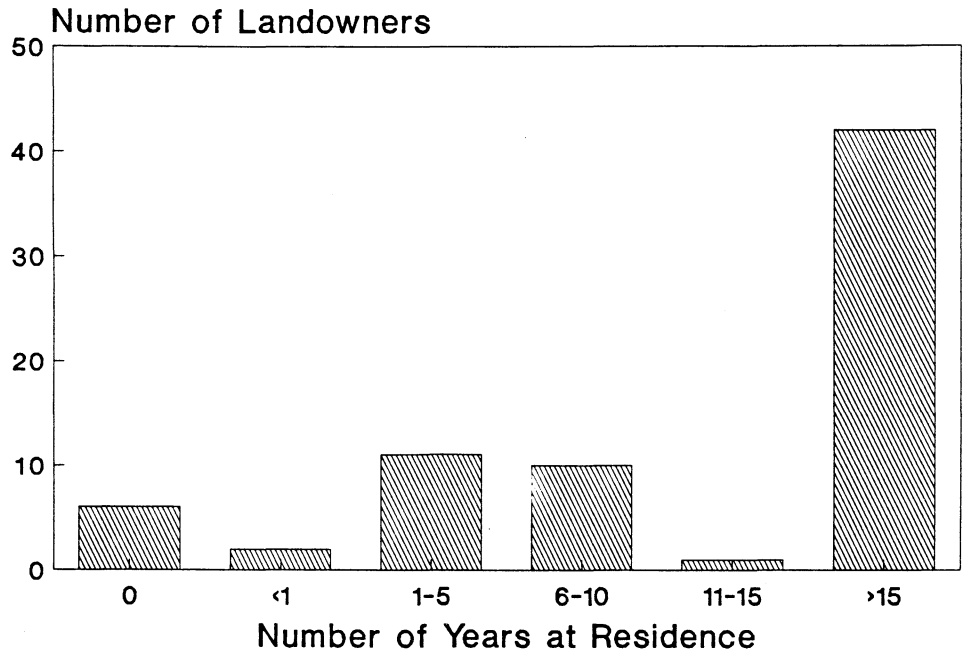


Figure 1. Number of years landowners have been at residence. 0 = Landowner does not live at residence (i.e. land is leased or rented).

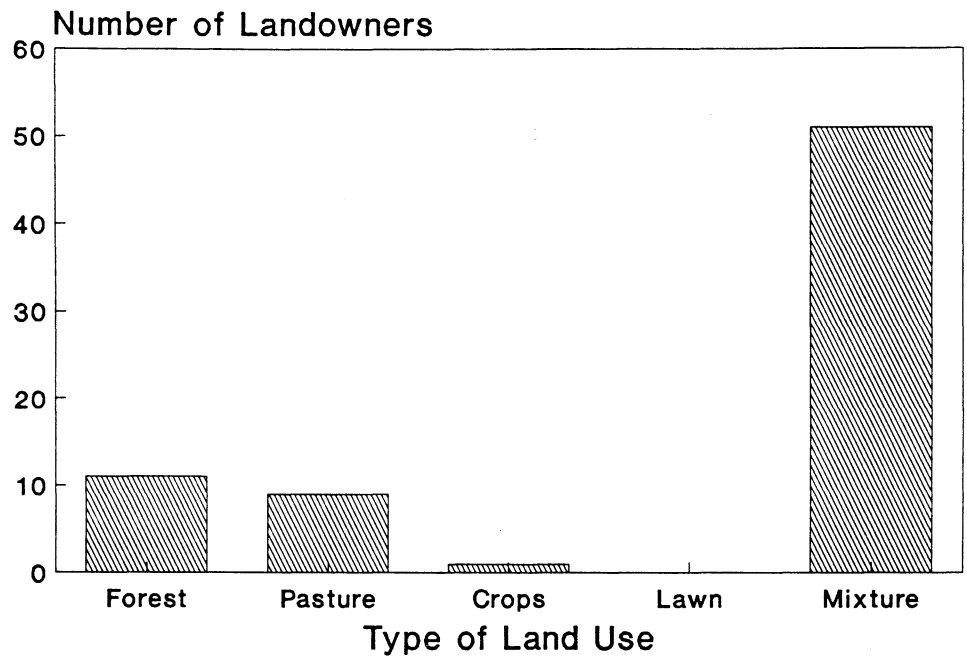


Figure 2. Type of land use occurring on landowners' property. Mixture equals more than one of the other land uses.

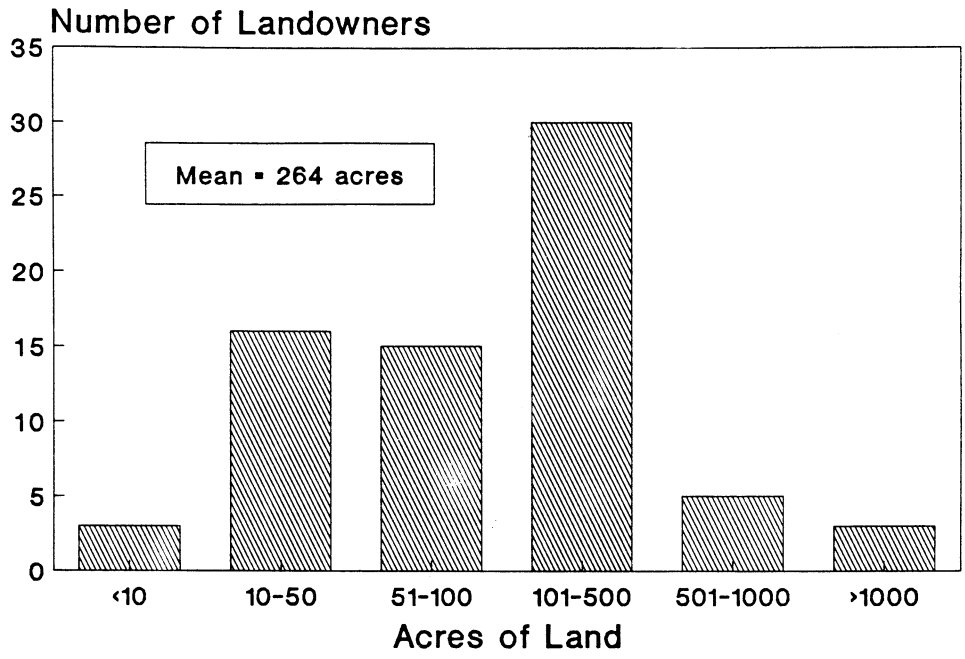


Figure 3. Acres of land owned by survey participants with trout waters flowing along or through property.

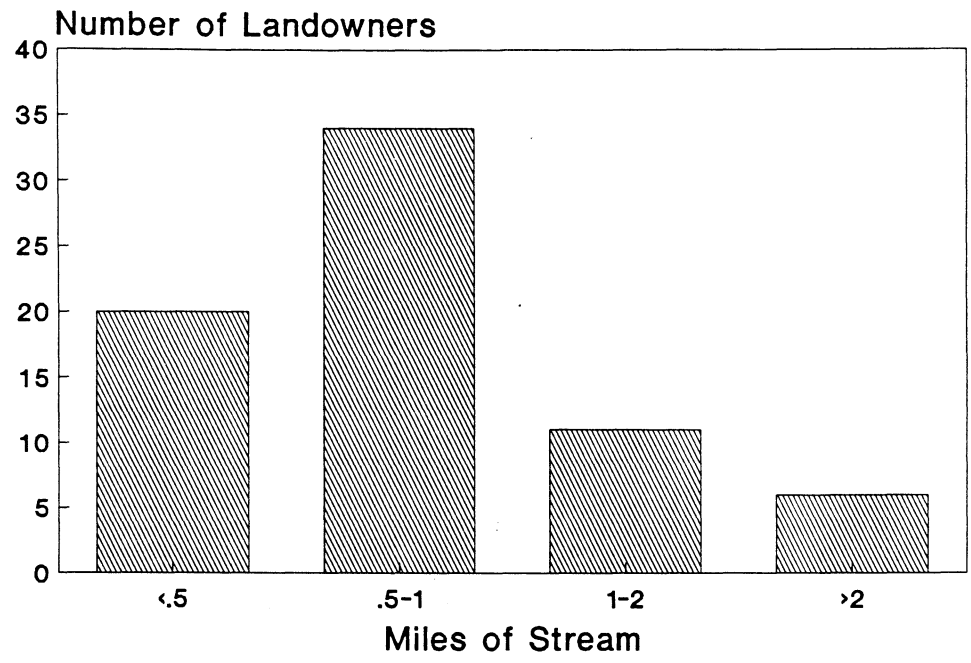


Figure 4. Miles of coldwater stream flowing along or through landowners' property.

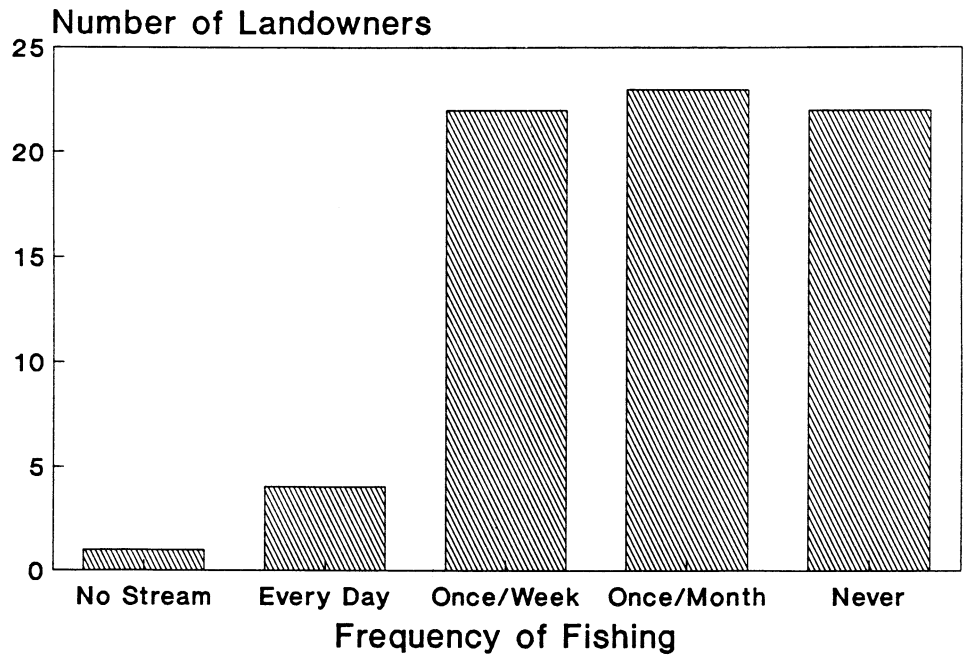


Figure 5. Frequency of angling on private stream by landowner, family, or friends.

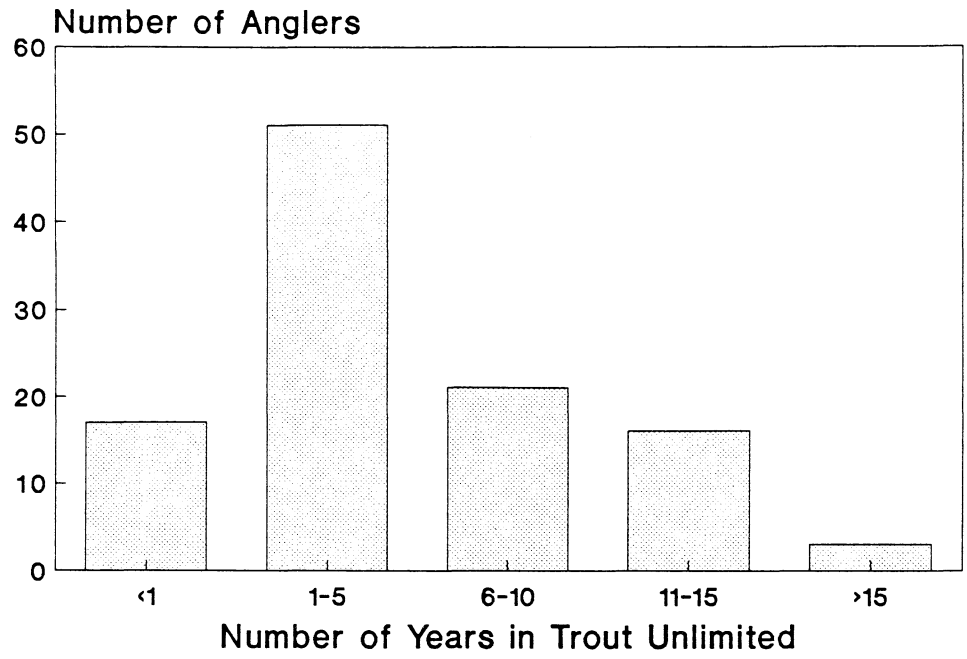


Figure 6. Number of years of membership in Trout Unlimited of anglers selected for Delphi survey.

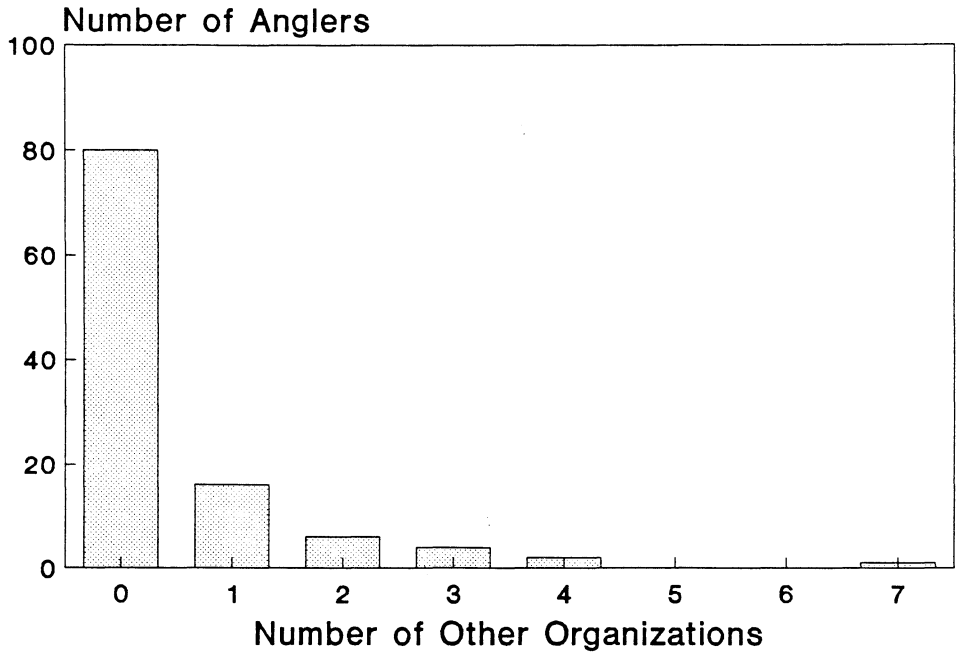


Figure 7. Number of fishing clubs and organizations other than Trout Unlimited of which selected anglers were members.

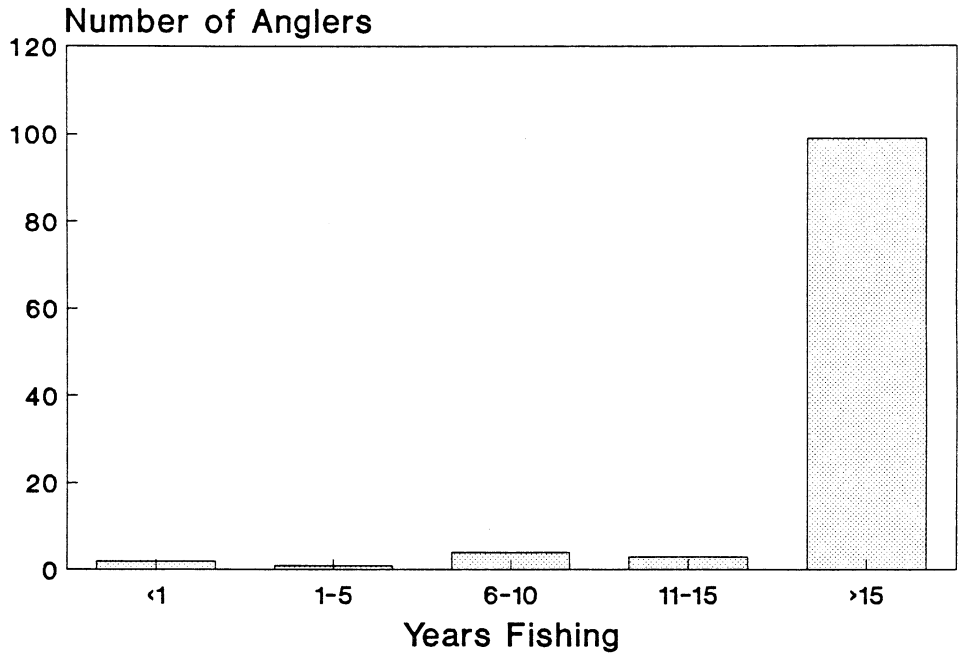


Figure 8. Years of coldwater fishing experience of selected trout anglers.

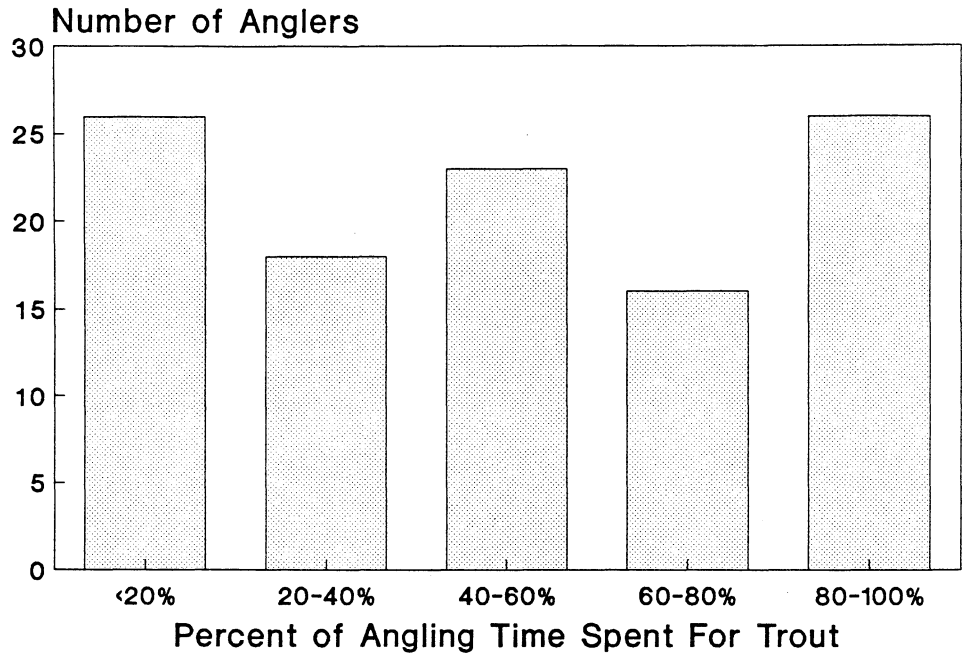


Figure 9. Percent of angling time spent angling for trout in small coldwater streams.

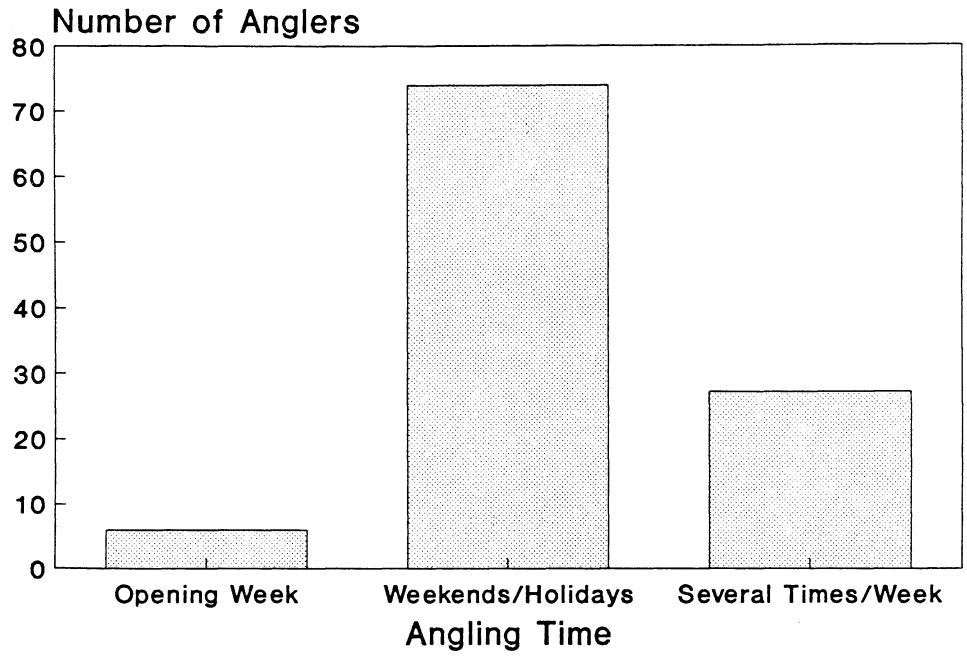


Figure 10. Time selected anglers were most likely to fish for trout.

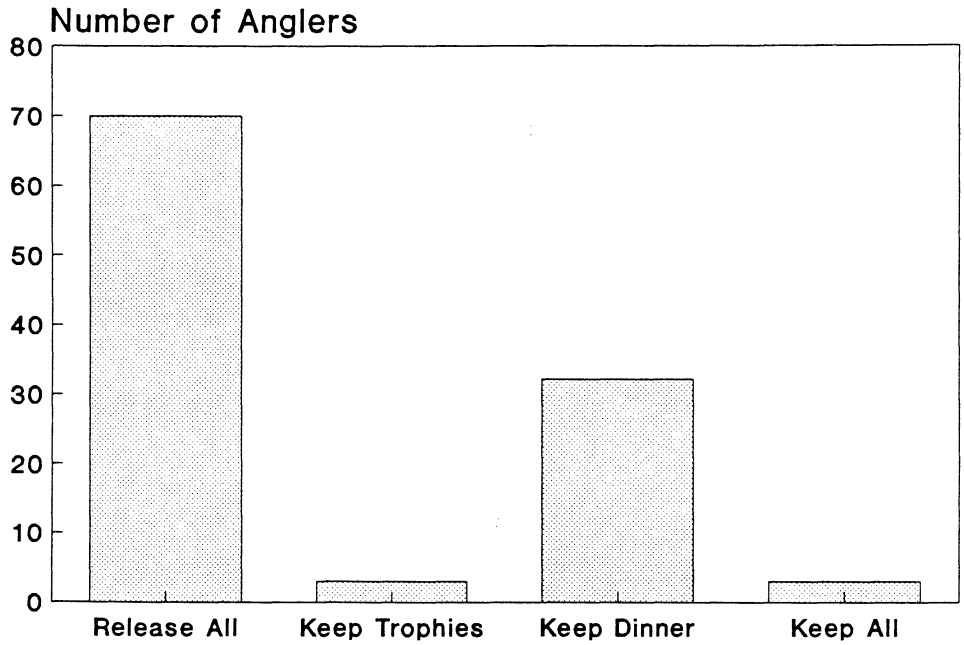


Figure 11. Catch tendencies of selected anglers.

Appendix B. Survey Tools Used in Delphi Process

Appendix B.1. Scoping Survey Sent to Coldwater Fisheries Professionals

Coldwater Fisheries Expert - Information Survey

Name _____ Title _____

Agency _____

Address _____

_____

_____

_____

Telephone Number _____

Years of experience with coldwater fisheries _____

Please describe your current research and other areas of interest. If you are an agency biologist, please describe your background in coldwater fisheries:

Please list any researchers/managers who are not on the enclosed list you feel are coldwater experts:

Please return this form to:

Sheryl A. Bryan
Department of Fisheries and Wildlife
113 Cheatham Hall, Virginia Tech
Blacksburg, VA 24061

Thanks for your help!

Appendix B.2. First Round of Delphi Survey Process.

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

July 27, 1989

Dear Virginia Landowner:

Congratulations! You have been selected from the Virginia landowner records to help improve the trout resources of Virginia. Dr. Larry Nielsen and I are conducting a study, sponsored by the United States Forest Service, to improve the management of Southeastern trout streams. As a landowner, you probably value Virginia's mountain streams as highly as we do for their beauty, sparkling water, and fish populations. I hope that you will accept this invitation to become a part of our study.

We will be identifying the attitudes and ideas of several groups about the effects of land use on Virginia's trout streams. Landowners represent one of the groups we want to learn about because we feel that owners such as yourself have personal knowledge of land use practices, and are aware of the changes, both good and bad, associated with the practices.

We are asking that you complete a series of short written questionnaires about land use and trout streams. If you agree to participate, we will send you a survey form once a month for three or four months this fall. Each survey will take 15 to 30 minutes to complete. The first mailing will include some additional details about the survey technique we will be using. Don't worry if you are not an expert on these topics-- we are interested in the views of people like yourself, who care about our natural resources but aren't fisheries professionals.

The information you share will help guide fisheries managers and scientists in their efforts to improve our mountain streams. As a concerned citizen, you can join their efforts by participating in our study. If you are willing to participate, please complete the enclosed postcard and return it to us. Thanks for your time and effort on behalf of Virginia's outstanding natural resources. We look forward to hearing from you.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

October 12,1989

Dear Virginia Landowner:

Thank you for showing concern about the quality of Virginia's trout resources by returning our preliminary survey and by volunteering to participate in our study.

As mentioned before, we will be identifying the attitudes and ideas of several groups about the effects of land use on Virginia's trout streams. Landowners represent one of the groups we want to learn about because we feel that owners such as yourself have personal knowledge of the land use practices and the changes in nearby streams, both good and bad, associated with the practices.

We are asking that you complete a series of short written questionnaires about land use and trout streams. The first of the series is enclosed, and will take 15 to 30 minutes to complete. Don't worry if you are not an expert on these topics-- we are interested in the views of people like yourself, who care about our natural resources but aren't fisheries professionals.

Attached is a brief description of the survey technique we are using and directions for completing the enclosed survey. The information you share will help guide fisheries managers and scientists in their efforts to improve our mountain streams. As a concerned citizen, you can join their efforts by participating in our study. We value your input because we feel that landowners such as yourself have much to offer coldwater fisheries management in the southeast.

It is important to mention that your responses will not be associated with your name and that I will be the only one that sees the responses before they are integrated with others. Please use this anonymity to respond fully and honestly. Again, I thank you for your time and effort on behalf of Virginia's outstanding natural resources. We look forward to hearing from you.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

November 10, 1989

Dear Virginia Landowner:

About three weeks ago I wrote you seeking information about land use and trout streams in the Southern Appalachian Mountains. As of today I have not received your completed questionnaire.

I have undertaken this study at the request of the United States Forest Service because we believe the experience and knowledge of landowners like yourself is valuable information in managing the trout resources of the southeast.

I am writing to you again because of the value of each completed questionnaire. In order for the results of this survey to be representative of all landowners, it is essential that each person returns their completed questionnaire.

In case your questionnaire has been misplaced, I have enclosed a replacement. Please complete the survey and return it in the enclosed stamped envelope.

Your cooperation is greatly appreciated.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

August 28, 1989

Dear Trout Angler:

Congratulations! You have been selected from the Virginia Council of Trout Unlimited to help improve the trout resources of Virginia. Dr. Larry Nielsen and I are conducting a study, sponsored by the United States Forest Service, to improve the management of Southeastern trout streams. As a trout angler, you probably value Virginia's mountain streams as highly as we do for their beauty, sparkling water, and fish populations. I hope that you will accept this invitation to become a part of our study.

We will be identifying the attitudes and ideas of several groups about the effects of land use on Virginia's trout streams. Trout anglers represent one of the groups we want to learn about because we feel that anglers such as yourself have personal knowledge of the stream environment, and are aware of land use practices and the changes, both good and bad, associated with the practices.

We are asking that you complete a series of short written questionnaires about land use and trout streams. If you agree to participate, we will send you a survey form once a month for three or four months this fall. Each survey will take 15 to 30 minutes to complete. The first mailing will include some additional details about the survey technique we will be using. Don't worry if you are not an expert on these topics-- we are interested in the views of people like yourself, who care about our natural resources but aren't fisheries professionals.

The information you share will help guide fisheries managers and scientists in their efforts to improve our mountain streams. As a concerned citizen, you can join their efforts by participating in our study. If you are willing to participate, please complete the enclosed postcard and return it to us. Thanks for your time and effort on behalf of Virginia's outstanding natural resources. Happy fishing!

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

October 12,1989

Dear Trout Angler:

Thank you for showing concern about the quality of Virginia's trout resources by returning our preliminary survey and by volunteering to participate in our study.

As mentioned before, we will be identifying the attitudes and ideas of several groups about the effects of land use on Virginia's trout streams. Trout anglers represent one of the groups we want to learn about because we feel that anglers such as yourself have personal knowledge of the stream environment and are aware of land use practices and the changes in nearby streams, both good and bad, associated with the practices.

We are asking that you complete a series of short written questionnaires about land use and trout streams. The first of the series is enclosed, and will take 15 to 30 minutes to complete. Don't worry if you are not an expert on these topics-- we are interested in the views of people like yourself, who care about our natural resources but aren't fisheries professionals.

Attached is a brief description of the survey technique we are using and directions for completing the enclosed survey. The information you share will help guide fisheries managers and scientists in their efforts to improve our mountain streams. As a concerned citizen, you can join their efforts by participating in our study. We value your input because we feel that anglers such as yourself have much to offer coldwater fisheries management in the southeast.

It is important to mention that your responses will not be associated with your name and that I will be the only one that sees the responses before they are integrated with others. Please use this anonymity to respond fully and honestly. Again, I thank you for your time and effort on behalf of Virginia's outstanding natural resources. We look forward to hearing from you.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

November 10, 1989

Dear Trout Angler:

About three weeks ago I wrote you seeking information about land use and trout streams in the Southern Appalachian Mountains. As of today I have not received your completed questionnaire.

I have undertaken this study at the request of the United States Forest Service because we believe the experience and knowledge of trout anglers like yourself is valuable information in managing the trout resources of the southeast.

I am writing to you again because of the value of each completed questionnaire. In order for the results of this survey to be representative of all trout anglers, it is essential that each person returns their completed questionnaire.

In case your questionnaire has been misplaced, I have enclosed a replacement. Please complete the survey and return it in the enclosed stamped envelope.

Your cooperation is greatly appreciated.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

November 17, 1988

Richard Standage
George Washington National Forest
P.O. Box 233
Harrisonburg, Virginia 22801

Dear Mr. Standage:

We are conducting a study to identify and rank data gaps regarding knowledge about coldwater systems of the Appalachian Mountains. The project, funded by the United States Forest Service, eventually will create an accurate assessment of all topics which lack useful data and those topics for which sufficient data exists. A segment of the project involves working with coldwater experts who can both contribute to and benefit from the project results.

You were identified, either through our literature search or by another individual, as a "coldwater stream fisheries expert". We hope that you will take a few minutes to complete the enclosed one-page questionnaire so that we can better define your expertise and interests. If so, please complete the survey and return it in the enclosed envelope by December 1. If you do not feel qualified to respond, please recommend someone in your agency who is qualified. Your effort in helping us to identify coldwater experts is greatly appreciated.

We have enclosed a brief summary of the project. We are very excited about the beneficial results this project will produce. With your help, we believe that this study can greatly improve research and management efforts on coldwater fisheries in the Appalachian Mountains.

If there are any questions concerning the questionnaire or the project, please call us at 703-961-6959. Again, thank you for your help and cooperation.

Sincerely,

Sheryl A. Bryan
Research Assistant

Larry A. Nielsen
Professor

Enclosures

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

12 October, 1989

Dear Fisheries Professional:

The Coldwater Data Gap Project has been down and out, but we aren't lost! I hope that you are still willing to participate in our study of the coldwater research data gaps. I am confident that the favor asked of you will return a substantial benefit for the improved research and management of southeastern coldwater resources.

To help refresh your memory, Dr. Larry Nielsen and I, in conjunction with the USDA Forest Service, are conducting a study to identify and rank existing data gaps regarding knowledge about the coldwater systems of the Appalachian Mountains. A segment of the project involves working with coldwater experts who can both contribute to and benefit from the project results. I have included a brief summary of the project to bring you up to date.

We are asking you to complete the enclosed matrices involving land use and the effects of such practices on stream habitat and salmonid populations and behavior. Please consider each cell carefully. Directions for ranking the data gaps are found in the upper left of the matrix form. The basis of this procedure is to create an accurate assessment of the areas in coldwater research that need management attention. Let me also remind you that this is part of a Delphi study, and you will be asked to re-evaluate your responses in light of the results from the first mailing. Repeating the evaluations serves to confirm group opinion on research needs.

Also enclosed is a copy of a survey that we are using to evaluate the attitudes and ideas of several watershed user groups on the effects of land use practices near trout streams. After completing the data gap matrices, please take a few minutes to complete the survey and return it with your data gap forms. Feel free to comment in the margins; all comments will be read and taken into consideration.

We are very excited about the results these projects will produce. With your help, we believe that projects can greatly improve research and management efforts on coldwater fisheries in the Appalachian Mountains. If there are any questions concerning the questionnaire or the project, please call me at (703)231-6959. Again, thank you for your help and cooperation.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

November 10, 1989

Dear Fisheries Expert:

About three weeks ago I wrote you seeking information about land use and trout streams in the Southern Appalachian Mountains. As of today I have not received your completed questionnaire.

I have undertaken this study at the request of the United States Forest Service because we believe the experience and knowledge of professionals like yourself is valuable information in managing the trout resources of the southeast successfully.

I am writing to you again because of the value of each completed questionnaire. In order for the results of this survey to be representative of all fisheries professionals, it is essential that each person returns their completed questionnaire.

In case your questionnaire has been misplaced, I have enclosed a replacement. Please complete the survey and return it in the enclosed stamped envelope.

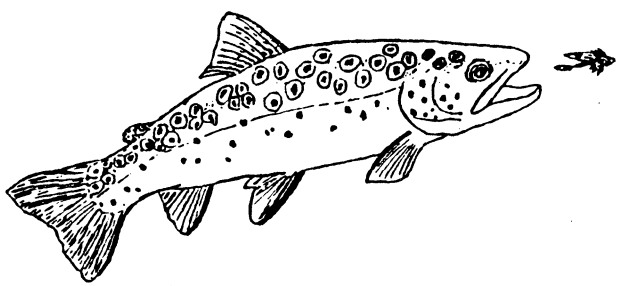
Your cooperation is greatly appreciated.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

EFFECTS OF LAND USE ON TROUT STREAMS

OF THE SOUTHERN APPALACHIAN MOUNTAINS



This survey is part of a study to assess the knowledge of several watershed user groups about the effects of land use on Southern Appalachian trout streams. It is an effort to let everyone be heard and influence the management of southeastern trout resources. Please answer all questions. If you wish to comment on any questions, please feel free to write in the margins. Your comments will be read and taken into consideration.

Thank you for your help.

Return this survey to:

Sheryl A. Bryan
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Knowing the way people feel about how land use affects trout streams is important for good stream management. The first question asks for your opinions about how different land uses affect streams. Please base your answers on your personal knowledge and experiences.

1. In your opinion, to what extent does each of the following land uses affect a nearby trout stream? (Circle the number of the response that best fits your answer for each of the five land uses.)

	HURTS STREAM A LOT	HURTS STREAM A LITTLE	DOES NOT HURT STREAM	HELPS STREAM A LITTLE	HELPS STREAM A LOT
ROADS & RAILROADS (CONSTRUCTION, USE & MAINTAINENCE)	1	2	3	4	5
INDUSTRIES (MINES, FACTORIES, WATER TREATMENT PLANTS)	1	2	3	4	5
HOUSING DEVELOPMENT (HOUSES, TRAILER PARKS, LAWNS)	1	2	3	4	5
FARMING (CROPS, PASTURES)	1	2	3	4	5
FORESTRY (TREE HARVEST, THINNING, LOGGING)	1	2	3	4	5

3

The following questions ask how you think roads and railroads (construction, use, and maintainence) near streams affect trout habitat and populations. Please base your answers on your personal knowledge and experiences.

2a. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

1. INCREASES THE AMOUNT OF OXYGEN
2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
3. DECREASES THE AMOUNT OF OXYGEN
4. I DON'T KNOW

2b. How do roads and railroads affect the food supply (insects, algae) available to trout? (Circle one.)

1. INCREASES THE FOOD SUPPLY
2. DOES NOT AFFECT THE FOOD SUPPLY
3. DECREASES THE FOOD SUPPLY
4. I DON'T KNOW

2c. How do roads and railroads affect the amount of sedimentation present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF SEDIMENTATION
2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
3. DECREASES THE AMOUNT OF SEDIMENTATION
4. I DON'T KNOW

2d. How do roads and railroads affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF WOODY DEBRIS
2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
3. DECREASES THE AMOUNT OF WOODY DEBRIS
4. I DON'T KNOW

2e. In addition to any habitat changes, how do roads and railroads directly affect the number of trout in the stream? (Circle one.)

1. INCREASES THE NUMBER OF TROUT
2. DOES NOT CHANGE THE NUMBER OF TROUT
3. DECREASES THE NUMBER OF TROUT
4. I DON'T KNOW

2f. Are there any other problems or benefits that roads and railroads cause for trout streams? (Comment below.)

4

The following questions ask how you think industries (mines, factories, water treatment plants) near streams affect trout habitat and populations. Please base your answers on your personal knowledge and experiences.

3a. How do industries affect the amount of oxygen in the water available to trout? (Circle one.)

1. INCREASES THE AMOUNT OF OXYGEN
2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
3. DECREASES THE AMOUNT OF OXYGEN
4. I DON'T KNOW

3b. How do industries affect the food supply (insects, algae) available to trout? (Circle one.)

1. INCREASES THE FOOD SUPPLY
2. DOES NOT AFFECT THE FOOD SUPPLY
3. DECREASES THE FOOD SUPPLY
4. I DON'T KNOW

3c. How do industries affect the amount of sedimentation present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF SEDIMENTATION
2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
3. DECREASES THE AMOUNT OF SEDIMENTATION
4. I DON'T KNOW

3d. How do industries affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF WOODY DEBRIS
2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
3. DECREASES THE AMOUNT OF WOODY DEBRIS
4. I DON'T KNOW

3e. In addition to any habitat changes, how do industries directly affect the number of trout in the stream? (Circle one.)

1. INCREASES THE NUMBER OF TROUT
2. DOES NOT CHANGE THE NUMBER OF TROUT
3. DECREASES THE NUMBER OF TROUT
4. I DON'T KNOW

3f. Are there any other problems or benefits that industries cause for trout streams? (Comment below.)

The following questions ask how you think housing developments (houses, trailer parks, lawns) near streams affect trout habitat and populations. Please base your answers on your personal knowledge and experiences.

4a. How do housing developments affect the amount of oxygen in the water available to trout? (Circle one.)

1. INCREASES THE AMOUNT OF OXYGEN
2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
3. DECREASES THE AMOUNT OF OXYGEN
4. I DON'T KNOW

4b. How do housing developments affect the food supply (insects, algae) available to trout? (Circle one.)

1. INCREASES THE FOOD SUPPLY
2. DOES NOT AFFECT THE FOOD SUPPLY
3. DECREASES THE FOOD SUPPLY
4. I DON'T KNOW

4c. How do housing developments affect the amount of sedimentation present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF SEDIMENTATION
2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
3. DECREASES THE AMOUNT OF SEDIMENTATION
4. I DON'T KNOW

4d. How do housing developments affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF WOODY DEBRIS
2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
3. DECREASES THE AMOUNT OF WOODY DEBRIS
4. I DON'T KNOW

4e. In addition to any habitat changes, how do housing developments directly affect the number of trout in the stream? (Circle one.)

1. INCREASES THE NUMBER OF TROUT
2. DOES NOT CHANGE THE NUMBER OF TROUT
3. DECREASES THE NUMBER OF TROUT
4. I DON'T KNOW

4f. Are there any other problems or benefits that housing developments cause for trout streams? (Comment below.)

The following questions ask how you think farming (crops, pastures) near streams affects trout habitat and populations. Please base your answers on your personal knowledge and experiences.

5a. How does farming affect the amount of oxygen in the water available to trout? (Circle one.)

1. INCREASES THE AMOUNT OF OXYGEN
2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
3. DECREASES THE AMOUNT OF OXYGEN
4. I DON'T KNOW

5b. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

1. INCREASES THE FOOD SUPPLY
2. DOES NOT AFFECT THE FOOD SUPPLY
3. DECREASES THE FOOD SUPPLY
4. I DON'T KNOW

5c. How does farming affect the amount of sedimentation present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF SEDIMENTATION
2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
3. DECREASES THE AMOUNT OF SEDIMENTATION
4. I DON'T KNOW

5d. How does farming affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF WOODY DEBRIS
2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
3. DECREASES THE AMOUNT OF WOODY DEBRIS
4. I DON'T KNOW

5e. In addition to any habitat changes, how does farming directly affect the number of trout in the stream? (Circle one.)

1. INCREASES THE NUMBER OF TROUT
2. DOES NOT CHANGE THE NUMBER OF TROUT
3. DECREASES THE NUMBER OF TROUT
4. I DON'T KNOW

5f. Are there any other problems or benefits that farming causes for trout streams? (Comment below.)

The following questions ask how you think forestry (tree harvest, thinning, logging) near streams affects trout habitat and populations. Please base your answers on your personal knowledge and experiences.

6a. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

1. INCREASES THE AMOUNT OF OXYGEN
2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
3. DECREASES THE AMOUNT OF OXYGEN
4. I DON'T KNOW

6b. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

1. INCREASES THE FOOD SUPPLY
2. DOES NOT AFFECT THE FOOD SUPPLY
3. DECREASES THE FOOD SUPPLY
4. I DON'T KNOW

6c. How does forestry affect the amount of sedimentation present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF SEDIMENTATION
2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
3. DECREASES THE AMOUNT OF SEDIMENTATION
4. I DON'T KNOW

6d. How does forestry affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

1. INCREASES THE AMOUNT OF WOODY DEBRIS
2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
3. DECREASES THE AMOUNT OF WOODY DEBRIS
4. I DON'T KNOW

6e. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

1. INCREASES THE NUMBER OF TROUT
2. DOES NOT CHANGE THE NUMBER OF TROUT
3. DECREASES THE NUMBER OF TROUT
4. I DON'T KNOW

6f. Are there any other problems or benefits that forestry causes for trout streams? (Comment below.)

Is there anything else you would like to tell me about the effects of land use on trout streams in the Southern Appalachian Mountains? If so, please use this space.

Thank you for your cooperation. Please do not write your name on this form. If requested, a copy of the results will be provided at the end of the study.

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

December 01, 1989

Dear Virginia Landowner:

Thank you for showing concern about the quality of Virginia's trout resources by returning our survey. We achieved an initial response rate of 81 percent and are very excited about the results this project will produce. As always, this letter asks a favor of you, but first I'd like to fill you in on what's happening and why you've been getting so much mail from me.

Dr. Larry Nielsen and I are attempting to assess public attitudes towards land use and trout streams by using a modification of the Delphi Method. This process will get at how the public thinks and feels through a series of written questionnaires like the one you've already seen. As a reward for your participation thus far and for your cooperation in the future, we have enclosed some information that you may be interested in.

And now for the purpose of this letter. Enclosed you will find another copy of the survey which includes your last response and a summary of the responses from the landowners. Please complete the survey again in light of the new information presented. If you change your mind, that's OK. If your response does not agree with the most popular responses, please explain why you answered the way you did. I am sure that by now you can begin to see how a group opinion is formed by this process. The response-reevaluation cycle continues until most of the responses agree, usually until 3 or 4 rounds are completed.

I would like to remind you that your responses are confidential, so please answer honestly, basing your responses on your personal knowledge and experience. Again, I would like to express my sincerest thanks for your time and effort. Since we are surveying only a few landowners, your response is valuable-- please complete the survey and return it in the enclosed stamped envelope promptly. If there are any questions concerning the questionnaire or the project, please call me at (703)231-5573.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

December 01, 1989

Dear Virginia Landowner:

Thank you for showing concern about the quality of Virginia's trout resources by returning our survey. We achieved an initial response rate of 77 percent and are very excited about the results this project will produce. As always, this letter asks a favor of you, but first I'd like to fill you in on what's happening and why you've been getting so much mail from me.

Dr. Larry Nielsen and I are attempting to assess public attitudes towards land use and trout streams by using a modification of the Delphi Method. This process will get at how the public thinks and feels through a series of written questionnaires like the one you've already seen. As a reward for your participation thus far and for your cooperation in the future, we have enclosed some information that you may be interested in.

And now for the purpose of this letter. Enclosed you will find another copy of the survey which includes your last response and a summary of the responses from the landowners. Please complete the survey again in light of the new information presented. If you change your mind, that's OK. If your response does not agree with the most popular responses, please explain why you answered the way you did. I am sure that by now you can begin to see how a group opinion is formed by this process. The response-reevaluation cycle continues until most of the responses agree, usually until 3 or 4 rounds are completed.

I would like to remind you that your responses are confidential, so please answer honestly, basing your responses on your personal knowledge and experience. Again, I would like to express my sincerest thanks for your time and effort. Since we are surveying only a few landowners, your response is valuable-- please complete the survey and return it in the enclosed stamped envelope promptly. If there are any questions concerning the questionnaire or the project, please call me at (703)231-5573.

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Graduate Research Assistant

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Blacksburg, Virginia 24061-0321

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

January 09, 1990

Dear Virginia Landowner:

About three weeks ago I wrote you seeking information about land use and trout streams in the Southern Appalachian Mountains. As of today I have not received your completed questionnaire.

I am writing to you again because of the value of each completed questionnaire. In order for the results of this survey to be representative of all landowners, it is essential that each person returns their completed questionnaire. In case your questionnaire has been lost or misplaced, I have enclosed another copy. Please complete the survey and return it promptly in the enclosed stamped envelope.

This time the process is a little different. This copy of the survey includes your last response and a summary of the responses of all the landowners. Please answer the questions again in light of the new information presented. If you change your mind, that's OK. If your response does not agree with the most popular responses, please explain why you answered the way you did. If you have any questions about this process, please call me at (703)231-5573.

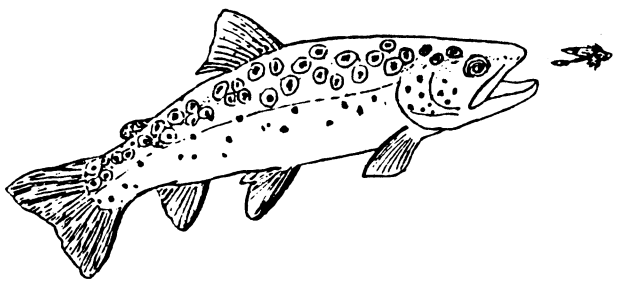
Your cooperation is greatly appreciated.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

EFFECTS OF LAND USE ON TROUT STREAMS

OF THE SOUTHERN APPALACHIAN MOUNTAINS



This survey is part of a study to assess the knowledge of several watershed user groups about the effects of land use on Southern Appalachian trout streams. It is an effort to let everyone be heard and influence the management of southeastern trout resources. Please answer all questions. If you wish to comment on any questions, please feel free to write in the margins. Your comments will be read and taken into consideration.

Thank you for your help.

Return this survey to:

Sheryl A. Bryan
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Knowing the way people feel about how land use affects trout streams is important for good stream management. The first question asks for your opinions about how different land uses affect streams. Beneath each question is your response from the first mailing and a summary of the group response. Please base your answers on your personal knowledge and experiences in light of the information presented. If you change your mind, that's OK; however, if your response does not agree with the most popular responses from the group results, please explain why you answered the way you did in the comment space provided on the right.

1. In your opinion, to what extent does each of the following land uses affect a nearby trout stream? (Circle the number of the response that best fits your answer for each of the five land uses.)

	HURTS STREAM A LOT	HURTS STREAM A LITTLE	DOES NOT HURT STREAM	HELPS STREAM A LITTLE	HELPS STREAM A LOT
ROADS & RAILROADS (CONSTRUCTION, USE & MAINTAINENCE)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	32%	56%	12%	0%	0%
INDUSTRIES (MINES, FACTORIES, WATER TREATMENT PLANTS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	92%	8%	0%	0%	0%
HOUSING DEVELOPMENT (HOUSES, TRAILER PARKS, LAWNS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	54%	25%	21%	0%	0%
FARMING (CROPS, PASTURES)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	8%	48%	32%	8%	4%
FORESTRY (TREE HARVEST, THINNING, LOGGING)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	32%	36%	28%	4%	0%

3

The following questions ask how you think roads and railroads (construction, use, and maintainence) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

2a. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
15%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
41%		3. DECREASES THE AMOUNT OF OXYGEN
44%		4. I DON'T KNOW

2b. How do roads and railroads affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE FOOD SUPPLY
15%		2. DOES NOT CHANGE THE FOOD SUPPLY
48%		3. DECREASES THE FOOD SUPPLY
33%		4. I DON'T KNOW

2c. How do roads and railroads affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
67%		1. INCREASES THE AMOUNT OF SEDIMENTATION
11%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
11%		3. DECREASES THE AMOUNT OF SEDIMENTATION
11%		4. I DON'T KNOW

2d. How do roads and railroads affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
33%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
37%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
7%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
23%		4. I DON'T KNOW

2e. In addition to any habitat changes, how do roads and railroads directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
11%		2. DOES NOT CHANGE THE NUMBER OF TROUT
48%		3. DECREASES THE NUMBER OF TROUT
41%		4. I DON'T KNOW

4

The following questions ask how you think industries (mines, factories, water treatment plants) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

3a. How do industries affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
4%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
78%		3. DECREASES THE AMOUNT OF OXYGEN
18%		4. I DON'T KNOW

3b. How do industries affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE FOOD SUPPLY
0%		2. DOES NOT CHANGE THE FOOD SUPPLY
88%		3. DECREASES THE FOOD SUPPLY
8%		4. I DON'T KNOW

3c. How do industries affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
67%		1. INCREASES THE AMOUNT OF SEDIMENTATION
7%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
4%		3. DECREASES THE AMOUNT OF SEDIMENTATION
22%		4. I DON'T KNOW

3d. How do industries affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
19%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
30%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
11%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
40%		4. I DON'T KNOW

3e. In addition to any habitat changes, how do industries directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
0%		2. DOES NOT CHANGE THE NUMBER OF TROUT
73%		3. DECREASES THE NUMBER OF TROUT
27%		4. I DON'T KNOW

5

The following questions ask how you think housing developments (houses, trailer parks, lawns) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

4a. How do housing developments affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE AMOUNT OF OXYGEN
22%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
44%		3. DECREASES THE AMOUNT OF OXYGEN
30%		4. I DON'T KNOW

4b. How do housing developments affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
7%		1. INCREASES THE FOOD SUPPLY
11%		2. DOES NOT CHANGE THE FOOD SUPPLY
56%		3. DECREASES THE FOOD SUPPLY
26%		4. I DON'T KNOW

4c. How do housing developments affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
56%		1. INCREASES THE AMOUNT OF SEDIMENTATION
15%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
70%		3. DECREASES THE AMOUNT OF SEDIMENTATION
22%		4. I DON'T KNOW

4d. How do housing developments affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
19%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
26%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
18%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
37%		4. I DON'T KNOW

4e. In addition to any habitat changes, how do housing developments directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
11%		2. DOES NOT CHANGE THE NUMBER OF TROUT
67%		3. DECREASES THE NUMBER OF TROUT
22%		4. I DON'T KNOW

6

The following questions ask how you think farming (crops, pastures) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

5a. How does farming affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
11%		1. INCREASES THE AMOUNT OF OXYGEN
27%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
27%		3. DECREASES THE AMOUNT OF OXYGEN
35%		4. I DON'T KNOW

5b. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
46%		1. INCREASES THE FOOD SUPPLY
8%		2. DOES NOT CHANGE THE FOOD SUPPLY
23%		3. DECREASES THE FOOD SUPPLY
23%		4. I DON'T KNOW

5c. How does farming affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
64%		1. INCREASES THE AMOUNT OF SEDIMENTATION
16%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
4%		3. DECREASES THE AMOUNT OF SEDIMENTATION
16%		4. I DON'T KNOW

5d. How does farming affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
22%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
41%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
15%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
22%		4. I DON'T KNOW

5e. In addition to any habitat changes, how does farming directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
10%		1. INCREASES THE NUMBER OF TROUT
30%		2. DOES NOT CHANGE THE NUMBER OF TROUT
30%		3. DECREASES THE NUMBER OF TROUT
30%		4. I DON'T KNOW

The following questions ask how you think forestry (tree harvest, thinning, logging) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

6a. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
30%		1. INCREASES THE AMOUNT OF OXYGEN
7%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
30%		3. DECREASES THE AMOUNT OF OXYGEN
33%		4. I DON'T KNOW

6b. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
30%		1. INCREASES THE FOOD SUPPLY
11%		2. DOES NOT CHANGE THE FOOD SUPPLY
44%		3. DECREASES THE FOOD SUPPLY
15%		4. I DON'T KNOW

6c. How does forestry affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
54%		1. INCREASES THE AMOUNT OF SEDIMENTATION
8%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
15%		3. DECREASES THE AMOUNT OF SEDIMENTATION
23%		4. I DON'T KNOW

6d. How does forestry affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
70%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
0%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
15%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
15%		4. I DON'T KNOW

6e. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

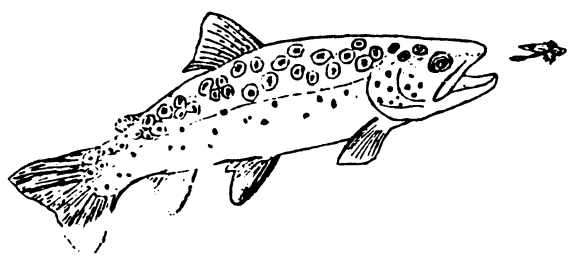
GROUP	YOURS	
19%		1. INCREASES THE NUMBER OF TROUT
11%		2. DOES NOT CHANGE THE NUMBER OF TROUT
35%		3. DECREASES THE NUMBER OF TROUT
35%		4. I DON'T KNOW

Please use this space for any comments you may have about the effects of land use on trout streams in the Southern Appalachian Mountains or this project.

Thank you for your cooperation. Please do not write your name on this form. If requested, a copy of the results will be provided at the end of the study.

EFFECTS OF LAND USE ON TROUT STREAMS

OF THE SOUTHERN APPALACHIAN MOUNTAINS



This survey is part of a study to assess the knowledge of several interested user groups about the effects of land use on Southern Appalachian trout streams. It is an effort to let everyone be heard and influence the management of southeastern trout resources. Please answer all questions. If you wish to comment on any questions, please feel free to write in the margins. Your comments will be read and taken into consideration.

Thank you for your help.

Return this survey to:

Sheryl A. Bryan
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Knowing the way people feel about how land use affects trout streams is important for good stream management. The first question asks for your opinions about how different land uses affect streams. Beneath each question is your response from the first mailing and a summary of the group response. Please base your answers on your personal knowledge and experiences in light of the information presented. If you change your mind, that's OK; however, if your response does not agree with the most popular responses from the group results, please explain why you answered the way you did in the comment space provided on the right.

1. In your opinion, to what extent does each of the following land uses affect a nearby trout stream? (Circle the number of the response that best fits your answer for each of the five land uses.)

	HURTS STREAM A LOT	HURTS STREAM A LITTLE	DOES NOT HURT STREAM	HELPS STREAM A LITTLE	HELPS STREAM A LOT
ROADS & RAILROADS (CONSTRUCTION, USE & MAINTAINENCE)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	40%	36%	24%	0%	0%
INDUSTRIES (MINES, FACTORIES, WATER TREATMENT PLANTS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	80%	20%	0%	0%	0%
HOUSING DEVELOPMENT (HOUSES, TRAILER PARKS, LAWNS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	42%	46%	8%	4%	0%
FARMING (CROPS, PASTURES)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	4%	60%	20%	8%	8%
FORESTRY (TREE HARVEST, THINNING, LOGGING)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	25%	42%	21%	8%	4%

3

The following questions ask how you think roads and railroads (construction, use, and maintainence) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

2a. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
20%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
56%		3. DECREASES THE AMOUNT OF OXYGEN
24%		4. I DON'T KNOW

2b. How do roads and railroads affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE FOOD SUPPLY
28%		2. DOES NOT CHANGE THE FOOD SUPPLY
56%		3. DECREASES THE FOOD SUPPLY
12%		4. I DON'T KNOW

2c. How do roads and railroads affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
84%		1. INCREASES THE AMOUNT OF SEDIMENTATION
4%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
12%		4. I DON'T KNOW

2d. How do roads and railroads affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
44%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
24%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
28%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
4%		4. I DON'T KNOW

2e. In addition to any habitat changes, how do roads and railroads directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE NUMBER OF TROUT
17%		2. DOES NOT CHANGE THE NUMBER OF TROUT
67%		3. DECREASES THE NUMBER OF TROUT
12%		4. I DON'T KNOW

4

The following questions ask how you think industries (mines, factories, water treatment plants) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

3a. How do industries affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
8%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
84%		3. DECREASES THE AMOUNT OF OXYGEN
8%		4. I DON'T KNOW

3b. How do industries affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE FOOD SUPPLY
4%		2. DOES NOT CHANGE THE FOOD SUPPLY
84%		3. DECREASES THE FOOD SUPPLY
8%		4. I DON'T KNOW

3c. How do industries affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
81%		1. INCREASES THE AMOUNT OF SEDIMENTATION
4%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
4%		3. DECREASES THE AMOUNT OF SEDIMENTATION
11%		4. I DON'T KNOW

3d. How do industries affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
19%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
42%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
27%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
12%		4. I DON'T KNOW

3e. In addition to any habitat changes, how do industries directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
8%		2. DOES NOT CHANGE THE NUMBER OF TROUT
77%		3. DECREASES THE NUMBER OF TROUT
15%		4. I DON'T KNOW

5

The following questions ask how you think housing developments (houses, trailer parks, lawns) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

4a. How do housing developments affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
23%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
69%		3. DECREASES THE AMOUNT OF OXYGEN
8%		4. I DON'T KNOW

4b. How do housing developments affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
15%		1. INCREASES THE FOOD SUPPLY
15%		2. DOES NOT CHANGE THE FOOD SUPPLY
62%		3. DECREASES THE FOOD SUPPLY
8%		4. I DON'T KNOW

4c. How do housing developments affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
81%		1. INCREASES THE AMOUNT OF SEDIMENTATION
11%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
8%		4. I DON'T KNOW

4d. How do housing developments affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
35%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
27%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
38%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
0%		4. I DON'T KNOW

4e. In addition to any habitat changes, how do housing developments directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE NUMBER OF TROUT
19%		2. DOES NOT CHANGE THE NUMBER OF TROUT
73%		3. DECREASES THE NUMBER OF TROUT
4%		4. I DON'T KNOW

6

The following questions ask how you think farming (crops, pastures) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

5a. How does farming affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
15%		1. INCREASES THE AMOUNT OF OXYGEN
35%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
35%		3. DECREASES THE AMOUNT OF OXYGEN
15%		4. I DON'T KNOW

5b. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
48%		1. INCREASES THE FOOD SUPPLY
16%		2. DOES NOT CHANGE THE FOOD SUPPLY
32%		3. DECREASES THE FOOD SUPPLY
4%		4. I DON'T KNOW

5c. How does farming affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
80%		1. INCREASES THE AMOUNT OF SEDIMENTATION
16%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
4%		4. I DON'T KNOW

5d. How does farming affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
8%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
60%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
32%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
0%		4. I DON'T KNOW

5e. In addition to any habitat changes, how does farming directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
8%		1. INCREASES THE NUMBER OF TROUT
46%		2. DOES NOT CHANGE THE NUMBER OF TROUT
35%		3. DECREASES THE NUMBER OF TROUT
11%		4. I DON'T KNOW

The following questions ask how you think forestry (tree harvest, thinning, logging) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

6a. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
15%		1. INCREASES THE AMOUNT OF OXYGEN
23%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
54%		3. DECREASES THE AMOUNT OF OXYGEN
8%		4. I DON'T KNOW

6b. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
31%		1. INCREASES THE FOOD SUPPLY
15%		2. DOES NOT CHANGE THE FOOD SUPPLY
54%		3. DECREASES THE FOOD SUPPLY
0%		4. I DON'T KNOW

6c. How does forestry affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
73%		1. INCREASES THE AMOUNT OF SEDIMENTATION
8%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
15%		3. DECREASES THE AMOUNT OF SEDIMENTATION
4%		4. I DON'T KNOW

6d. How does forestry affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
76%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
4%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
20%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
0%		4. I DON'T KNOW

6e. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
15%		1. INCREASES THE NUMBER OF TROUT
27%		2. DOES NOT CHANGE THE NUMBER OF TROUT
42%		3. DECREASES THE NUMBER OF TROUT
16%		4. I DON'T KNOW

Please use this space for any comments you may have about the effects of land use on trout streams in the Southern Appalachian Mountains or this project.

Thank you for your cooperation. Please do not write your name on this form. If requested, a copy of the results will be provided at the end of the study.

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

December 01, 1989

Dear Trout Angler:

Thank you for showing concern about the quality of Virginia's trout resources by returning our survey. We achieved an initial response rate of 91 percent and are very excited about the results this project will produce. As always, this letter asks a favor of you, but first I'd like to fill you in on what's happening and why you've been getting so much mail from me.

Dr. Larry Nielsen and I are attempting to assess public attitudes towards land use and trout streams by using a modification of the Delphi Method. This process will get at how the public thinks and feels through a series of written questionnaires like the one you've already seen. As a reward for your participation thus far and for your cooperation in the future, we have enclosed some information that you may be interested in.

And now for the purpose of this letter. Enclosed you will find another copy of the survey which includes your last response and a summary of the responses from the trout anglers. Please complete the survey again in light of the new information presented. If you change your mind, that's OK. If your response does not agree with the most popular responses, please explain why you answered the way you did. I am sure that by now you can begin to see how a group opinion is formed by this process. The response-reevaluation cycle continues until most of the responses agree, usually until 3 or 4 rounds are completed.

I would like to remind you that your responses are confidential, so please answer honestly, basing your responses on your personal knowledge and experience. Again, I would like to express my sincerest thanks for your time and effort. Since we are surveying only a few trout anglers, your response is valuable--please complete the survey and return it in the enclosed stamped envelope promptly. If there are any questions concerning the questionnaire or the project, please call me at (703)231-5573.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

January 09, 1990

Dear Trout Angler:

About three weeks ago I wrote you seeking information about land use and trout streams in the Southern Appalachian Mountains. As of today I have not received your completed questionnaire.

I am writing to you again because of the value of each completed questionnaire. In order for the results of this survey to be representative of all trout anglers, it is essential that each person returns their completed questionnaire. In case your questionnaire has been lost or misplaced, I have enclosed another copy. Please complete the survey and return it promptly in the enclosed stamped envelope.

This time the process is a little different. The copy of the survey includes your last response and a summary of the responses of all the trout anglers. Please answer the questions again in light of the new information presented. If you change your mind, that's OK. If your response does not agree with the most popular responses, please explain why you answered the way you did. If you have any questions about this process, please call me at (703)231-5573.

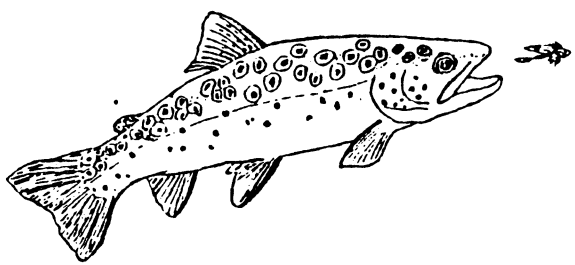
Your cooperation is greatly appreciated.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

EFFECTS OF LAND USE ON TROUT STREAMS

OF THE SOUTHERN APPALACHIAN MOUNTAINS



This survey is part of a study to assess the knowledge of several watershed user groups about the effects of land use on Southern Appalachian trout streams. It is an effort to let everyone be heard and influence the management of southeastern trout resources. Please answer all questions. If you wish to comment on any questions, please feel free to write in the margins. Your comments will be read and taken into consideration.

Thank you for your help.

Return this survey to:

Sheryl A. Bryan
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Knowing the way people feel about how land use affects trout streams is important for good stream management. The first question asks for your opinions about how different land uses affect streams. Beneath each question is your response from the first mailing and a summary of the group response. Please base your answers on your personal knowledge and experiences in light of the information presented. If you change your mind, that's OK; however, if your response does not agree with the most popular responses from the group results, please explain why you answered the way you did in the comment space provided on the right.

1. In your opinion, to what extent does each of the following land uses affect a nearby trout stream? (Circle the number of the response that best fits your answer for each of the five land uses.)

	HURTS STREAM A LOT	HURTS STREAM A LITTLE	DOES NOT HURT STREAM	HELPS STREAM A LITTLE	HELPS STREAM A LOT
ROADS & RAILROADS (CONSTRUCTION, USE & MAINTAINENCE)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	49%	40%	9%	0%	2%
INDUSTRIES (MINES, FACTORIES, WATER TREATMENT PLANTS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	94%	6%	0%	0%	0%
HOUSING DEVELOPMENT (HOUSES, TRAILER PARKS, LAWNS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	66%	34%	0%	0%	0%
FARMING (CROPS, PASTURES)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	39%	52%	4%	2%	2%
FORESTRY (TREE HARVEST, THINNING, LOGGING)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	40%	49%	11%	0%	0%

The following questions ask how you think roads and railroads (construction, use, and maintainence) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

2a. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
25%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
44%		3. DECREASES THE AMOUNT OF OXYGEN
31%		4. I DON'T KNOW

2b. How do roads and railroads affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
13%		1. INCREASES THE FOOD SUPPLY
15%		2. DOES NOT CHANGE THE FOOD SUPPLY
56%		3. DECREASES THE FOOD SUPPLY
16%		4. I DON'T KNOW

2c. How do roads and railroads affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
88%		1. INCREASES THE AMOUNT OF SEDIMENTATION
8%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
4%		4. I DON'T KNOW

2d. How do roads and railroads affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
27%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
33%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
33%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
7%		4. I DON'T KNOW

2e. In addition to any habitat changes, how do roads and railroads directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE NUMBER OF TROUT
15%		2. DOES NOT CHANGE THE NUMBER OF TROUT
72%		3. DECREASES THE NUMBER OF TROUT
9%		4. I DON'T KNOW

The following questions ask how you think industries (mines, factories, water treatment plants) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

3a. How do industries affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE AMOUNT OF OXYGEN
4%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
79%		3. DECREASES THE AMOUNT OF OXYGEN
15%		4. I DON'T KNOW

3b. How do industries affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE FOOD SUPPLY
2%		2. DOES NOT CHANGE THE FOOD SUPPLY
87%		3. DECREASES THE FOOD SUPPLY
9%		4. I DON'T KNOW

3c. How do industries affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
72%		1. INCREASES THE AMOUNT OF SEDIMENTATION
17%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
11%		4. I DON'T KNOW

3d. How do industries affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
12%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
44%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
17%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
27%		4. I DON'T KNOW

3e. In addition to any habitat changes, how do industries directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE NUMBER OF TROUT
0%		2. DOES NOT CHANGE THE NUMBER OF TROUT
85%		3. DECREASES THE NUMBER OF TROUT
13%		4. I DON'T KNOW

The following questions ask how you think housing developments (houses, trailer parks, lawns) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

4a. How do housing developments affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE AMOUNT OF OXYGEN
14%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
67%		3. DECREASES THE AMOUNT OF OXYGEN
17%		4. I DON'T KNOW

4b. How do housing developments affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
9%		1. INCREASES THE FOOD SUPPLY
6%		2. DOES NOT CHANGE THE FOOD SUPPLY
77%		3. DECREASES THE FOOD SUPPLY
8%		4. I DON'T KNOW

4c. How do housing developments affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
98%		1. INCREASES THE AMOUNT OF SEDIMENTATION
2%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
0%		4. I DON'T KNOW

4d. How do housing developments affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
23%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
25%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
35%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
17%		4. I DON'T KNOW

4e. In addition to any habitat changes, how do housing developments directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
6%		2. DOES NOT CHANGE THE NUMBER OF TROUT
92%		3. DECREASES THE NUMBER OF TROUT
2%		4. I DON'T KNOW

The following questions ask how you think farming (crops, pastures) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

5a. How does farming affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
6%		1. INCREASES THE AMOUNT OF OXYGEN
10%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
67%		3. DECREASES THE AMOUNT OF OXYGEN
17%		4. I DON'T KNOW

5b. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
25%		1. INCREASES THE FOOD SUPPLY
15%		2. DOES NOT CHANGE THE FOOD SUPPLY
44%		3. DECREASES THE FOOD SUPPLY
17%		4. I DON'T KNOW

5c. How does farming affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
92%		1. INCREASES THE AMOUNT OF SEDIMENTATION
6%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
2%		4. I DON'T KNOW

5d. How does farming affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
19%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
33%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
31%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
17%		4. I DON'T KNOW

5e. In addition to any habitat changes, how does farming directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE NUMBER OF TROUT
11%		2. DOES NOT CHANGE THE NUMBER OF TROUT
74%		3. DECREASES THE NUMBER OF TROUT
13%		4. I DON'T KNOW

The following questions ask how you think forestry (tree harvest, thinning, logging) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

6a. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE AMOUNT OF OXYGEN
17%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
67%		3. DECREASES THE AMOUNT OF OXYGEN
14%		4. I DON'T KNOW

6b. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
13%		1. INCREASES THE FOOD SUPPLY
10%		2. DOES NOT CHANGE THE FOOD SUPPLY
64%		3. DECREASES THE FOOD SUPPLY
13%		4. I DON'T KNOW

6c. How does forestry affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
94%		1. INCREASES THE AMOUNT OF SEDIMENTATION
4%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
2%		4. I DON'T KNOW

6d. How does forestry affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
73%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
4%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
19%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
4%		4. I DON'T KNOW

6e. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

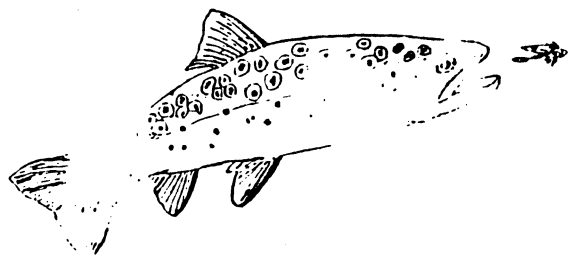
GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
11%		2. DOES NOT CHANGE THE NUMBER OF TROUT
85%		3. DECREASES THE NUMBER OF TROUT
4%		4. I DON'T KNOW

Please use this space for any comments you may have about the effects of land use on trout streams in the Southern Appalachian Mountains or this project.

Thank you for your cooperation. Please do not sign your name on this form. If requested, a copy of the results will be provided at the end of the study.

EFFECTS OF LAND USE ON TROUT STREAMS

OF THE SOUTHERN APPALACHIAN MOUNTAINS



This survey is [illegible] of study to assess the knowledge of several watershed user groups about the effects of land use on Appalachian trout streams. It is an effort to let [illegible] be heard and influence the management of southeastern trout resources. Please answer all questions. If you wish to comment on any questions, please feel free to write in the margins. Your comments will be read and taken into consideration.

Thank you for your help.

Return this survey to:

Sheryl A. Bryan
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

The following questions ask how you think industries (mines, factories, water treatment plants) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

3a. How do industries affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
6%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
83%		3. DECREASES THE AMOUNT OF OXYGEN
11%		4. I DON'T KNOW

3b. How do industries affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE FOOD SUPPLY
4%		2. DOES NOT CHANGE THE FOOD SUPPLY
83%		3. DECREASES THE FOOD SUPPLY
11%		4. I DON'T KNOW

3c. How do industries affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
71%		1. INCREASES THE AMOUNT OF SEDIMENTATION
17%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
2%		3. DECREASES THE AMOUNT OF SEDIMENTATION
10%		4. I DON'T KNOW

3d. How do industries affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
11%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
36%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
32%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
21%		4. I DON'T KNOW

3e. In addition to any habitat changes, how do industries directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
2%		2. DOES NOT CHANGE THE NUMBER OF TROUT
87%		3. DECREASES THE NUMBER OF TROUT
11%		4. I DON'T KNOW

Knowing the way people feel about how land use affects trout streams is important for good stream management. The first question asks for your opinions about how different land uses affect streams. Beneath each question is your response from the first mailing and a summary of the group response. Please base your answers on your personal knowledge and experiences in light of the information presented. If you change your mind, that's OK; however, if your response does not agree with the most popular responses from the group results, please explain why you answered the way you did in the comment space provided on the right.

1. In your opinion, to what extent does each of the following land uses affect a nearby trout stream? (Circle the number of the response that best fits your answer for each of the five land uses.)

	HURTS STREAM A LOT	HURTS STREAM A LITTLE	DOES NOT HURT STREAM	HELPS STREAM A LITTLE	HELPS STREAM A LOT
ROADS & RAILROADS (CONSTRUCTION, USE & MAINTAINENCE)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	43%	52%	5%	0%	0%
INDUSTRIES (MINES, FACTORIES, WATER TREATMENT PLANTS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	96%	2%	2%	0%	0%
HOUSING DEVELOPMENT (HOUSES, TRAILER PARKS, LAWNS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	59%	39%	2%	0%	0%
FARMING (CROPS, PASTURES)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	38%	51%	11%	0%	0%
FORESTRY (TREE HARVEST, THINNING, LOGGING)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	51%	33%	13%	2%	0%

The following questions ask how you think roads and railroads (construction, use, and maintainence) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

2a. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
26%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
47%		3. DECREASES THE AMOUNT OF OXYGEN
27%		4. I DON'T KNOW

2b. How do roads and railroads affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE FOOD SUPPLY
32%		2. DOES NOT CHANGE THE FOOD SUPPLY
51%		3. DECREASES THE FOOD SUPPLY
13%		4. I DON'T KNOW

2c. How do roads and railroads affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
89%		1. INCREASES THE AMOUNT OF SEDIMENTATION
4%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
7%		4. I DON'T KNOW

2d. How do roads and railroads affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
20%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
26%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
37%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
17%		4. I DON'T KNOW

2e. In addition to any habitat changes, how do roads and railroads directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
15%		2. DOES NOT CHANGE THE NUMBER OF TROUT
77%		3. DECREASES THE NUMBER OF TROUT
8%		4. I DON'T KNOW

The following questions ask how you think housing developments (houses, trailer parks, lawns) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

4a. How do housing developments affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS'	
0%		1. INCREASES THE AMOUNT OF OXYGEN
27%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
56%		3. DECREASES THE AMOUNT OF OXYGEN
17%		4. I DON'T KNOW

4b. How do housing developments affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE FOOD SUPPLY
15%		2. DOES NOT CHANGE THE FOOD SUPPLY
62%		3. DECREASES THE FOOD SUPPLY
21%		4. I DON'T KNOW

4c. How do housing developments affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
87%		1. INCREASES THE AMOUNT OF SEDIMENTATION
4%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
2%		3. DECREASES THE AMOUNT OF SEDIMENTATION
7%		4. I DON'T KNOW

4d. How do housing developments affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
19%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
11%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
49%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
21%		4. I DON'T KNOW

4e. In addition to any habitat changes, how do housing developments directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
9%		2. DOES NOT CHANGE THE NUMBER OF TROUT
81%		3. DECREASES THE NUMBER OF TROUT
10%		4. I DON'T KNOW

The following questions ask how you think farming (crops, pastures) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

5a. How does farming affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE AMOUNT OF OXYGEN
20%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
61%		3. DECREASES THE AMOUNT OF OXYGEN
17%		4. I DON'T KNOW

5b. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
17%		1. INCREASES THE FOOD SUPPLY
21%		2. DOES NOT CHANGE THE FOOD SUPPLY
43%		3. DECREASES THE FOOD SUPPLY
19%		4. I DON'T KNOW

5c. How does farming affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
9%		1. INCREASES THE AMOUNT OF SEDIMENTATION
2%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
7%		3. DECREASES THE AMOUNT OF SEDIMENTATION
[illegible]		4. I DON'T KNOW

5d. How does farming affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
15%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
24%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
44%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
17%		4. I DON'T KNOW

5e. In addition to any habitat changes, how does farming directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
15%		2. DOES NOT CHANGE THE NUMBER OF TROUT
70%		3. DECREASES THE NUMBER OF TROUT
15%		4. I DON'T KNOW

The following questions ask how you think forestry (tree harvest, thinning, logging) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

6a. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
30%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
45%		3. DECREASES THE AMOUNT OF OXYGEN
25%		4. I DON'T KNOW

6b. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
13%		1. INCREASES THE FOOD SUPPLY
20%		2. DOES NOT CHANGE THE FOOD SUPPLY
61%		3. DECREASES THE FOOD SUPPLY
6%		4. I DON'T KNOW

6c. How does forestry affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
90%		1. INCREASES THE AMOUNT OF SEDIMENTATION
2%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
4%		3. DECREASES THE AMOUNT OF SEDIMENTATION
4%		4. I DON'T KNOW

6d. How does forestry affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
63%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
9%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
17%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
11%		4. I DON'T KNOW

6e. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
11%		2. DOES NOT CHANGE THE NUMBER OF TROUT
66%		3. DECREASES THE NUMBER OF TROUT
21%		4. I DON'T KNOW

Please use the space for any comments you may have about the effects of land use on trout streams in the Southern Appalachian Mountains or this project.

Thank you for your cooperation. Please do not write your name on this form. If requested, a copy of the results will be sent to you at the end of the project.

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

December 01, 1989

Dear Fisheries Professional:

Thank you for showing concern about the quality of Virginia's trout resources by returning our survey. We achieved an initial response rate of 78 percent and are very excited about the results this project will produce. As always, this letter asks a favor of you, but first I'd like to fill you in on what's happening and why you've been getting so much mail from me.

Dr. Larry Nielsen and I are attempting to assess public attitudes towards land use and trout streams by using a modification of the Delphi Method. This process will get at how the public (i.e. landowners and anglers) thinks and feels through a series of written questionnaires like the one you've already seen. We hope to use the professional response as the baseline for our comparisons and evaluation of the public responses.

And now for the purpose of this letter. Enclosed you will find another copy of the survey which includes your last response and a summary of the responses from the fisheries professionals. Please complete the survey again in light of the new information presented. If you change your mind, that's OK. If your response does not agree with the most popular responses, please explain why you answered the way you did. I am sure that by now you can begin to see how a group opinion is formed by this process. The response-reevaluation cycle continues until most of the responses agree, usually until 3 or 4 rounds are completed.

I would like to remind you that your responses are confidential, so please answer honestly, basing your responses on your personal knowledge and experience. Again, I would like to express my sincerest thanks for your time and effort. Since we are surveying only a few fisheries professionals, your response is valuable-- please complete the survey and return it in the enclosed stamped envelope promptly. If there are any questions concerning the questionnaire or the project, please call me at (703)231-5573.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

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

January 09, 1990

Dear Fisheries Professional:

About three weeks ago I wrote you seeking information about land use and trout streams in the Southern Appalachian Mountains. As of today I have not received your completed questionnaire.

I am writing to you again because of the value of each completed questionnaire. In order for the results of this survey to be representative of all fisheries professionals, it is essential that each person returns their completed questionnaire. In case your questionnaire has been lost or misplaced, I have enclosed another copy. Please complete the survey and return it promptly in the enclosed stamped envelope.

This time the process is a little different. The copy of the survey includes your last response and a summary of the responses of all the fisheries professionals. Please answer the questions again in light of the new information presented. If you change your mind, That's OK. If your response does not agree with the most popular responses, please explain why you answered the way you did. If you have any questions about this process, please call me at (703)231-5573.

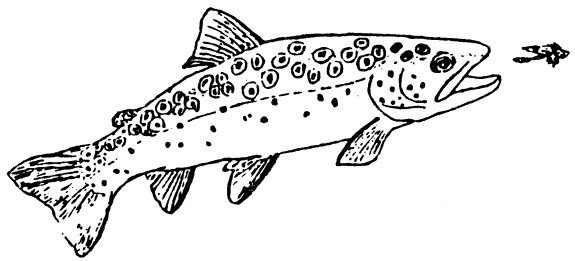
Your cooperation is greatly appreciated.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

EFFECTS OF LAND USE ON TROUT STREAMS

OF THE SOUTHERN APPALACHIAN MOUNTAINS



This survey is part of a study to assess the knowledge of several watershed user groups about the effects of land use on Southern Appalachian trout streams. It is an effort to let everyone be heard and influence the management of southeastern trout resources. Please answer all questions. If you wish to comment on any questions, please feel free to write in the margins. Your comments will be read and taken into consideration.

Thank you for your help.

Return this survey to:

Sheryl A. Bryan
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Knowing the way people feel about how land use affects trout streams is important for good stream management. The first question asks for your opinions about how different land uses affect streams. Beneath each question is your response from the first mailing and a summary of the group response. Please base your answers on your personal knowledge and experiences in light of the information presented. If you change your mind, that's OK; however, if your response does not agree with the most popular responses from the group results, please explain why you answered the way you did in the comment space provided on the right.

1. In your opinion, to what extent does each of the following land uses affect a nearby trout stream? (Circle the number of the response that best fits your answer for each of the five land uses.)

	HURTS STREAM A LOT	HURTS STREAM A LITTLE	DOES NOT HURT STREAM	HELPS STREAM A LITTLE	HELPS STREAM A LOT
ROADS & RAILROADS (CONSTRUCTION, USE & MAINTAINENCE)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	68%	29%	4%	0%	0%
INDUSTRIES (MINES, FACTORIES, WATER TREATMENT PLANTS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	68%	32%	0%	0%	0%
HOUSING DEVELOPMENT (HOUSES, TRAILER PARKS, LAWNS)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	54%	39%	7%	0%	0%
FARMING (CROPS, PASTURES)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	54%	46%	0%	0%	0%
FORESTRY (TREE HARVEST, THINNING, LOGGING)	1	2	3	4	5
YOUR RESPONSE					
GROUP RESPONSE	32%	61%	3%	4%	0%

3

The following questions ask how you think roads and railroads (construction, use, and maintainence) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

2a. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
69%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
21%		3. DECREASES THE AMOUNT OF OXYGEN
10%		4. I DON'T KNOW

2b. How do roads and railroads affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
3%		1. INCREASES THE FOOD SUPPLY
7%		2. DOES NOT CHANGE THE FOOD SUPPLY
83%		3. DECREASES THE FOOD SUPPLY
7%		4. I DON'T KNOW

2c. How do roads and railroads affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
100%		1. INCREASES THE AMOUNT OF SEDIMENTATION
0%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
0%		4. I DON'T KNOW

2d. How do roads and railroads affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
7%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
24%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
55%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
24%		4. I DON'T KNOW

2e. In addition to any habitat changes, how do roads and railroads directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
7%		2. DOES NOT CHANGE THE NUMBER OF TROUT
83%		3. DECREASES THE NUMBER OF TROUT
10%		4. I DON'T KNOW

4

The following questions ask how you think industries (mines, factories, water treatment plants) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

3a. How do industries affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
7%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
86%		3. DECREASES THE AMOUNT OF OXYGEN
7%		4. I DON'T KNOW

3b. How do industries affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
8%		1. INCREASES THE FOOD SUPPLY
4%		2. DOES NOT CHANGE THE FOOD SUPPLY
61%		3. DECREASES THE FOOD SUPPLY
27%		4. I DON'T KNOW

3c. How do industries affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
68%		1. INCREASES THE AMOUNT OF SEDIMENTATION
18%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
14%		4. I DON'T KNOW

3d. How do industries affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
38%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
34%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
28%		4. I DON'T KNOW

3e. In addition to any habitat changes, how do industries directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
3%		2. DOES NOT CHANGE THE NUMBER OF TROUT
86%		3. DECREASES THE NUMBER OF TROUT
11%		4. I DON'T KNOW

The following questions ask how you think housing developments (houses, trailer parks, lawns) near streams affect trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

4a. How do housing developments affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
48%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
45%		3. DECREASES THE AMOUNT OF OXYGEN
7%		4. I DON'T KNOW

4b. How do housing developments affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
8%		1. INCREASES THE FOOD SUPPLY
11%		2. DOES NOT CHANGE THE FOOD SUPPLY
69%		3. DECREASES THE FOOD SUPPLY
12%		4. I DON'T KNOW

4c. How do housing developments affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
93%		1. INCREASES THE AMOUNT OF SEDIMENTATION
4%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
3%		4. I DON'T KNOW

4d. How do housing developments affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
11%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
11%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
60%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
18%		4. I DON'T KNOW

4e. In addition to any habitat changes, how do housing developments directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
0%		2. DOES NOT CHANGE THE NUMBER OF TROUT
93%		3. DECREASES THE NUMBER OF TROUT
7%		4. I DON'T KNOW

The following questions ask how you think farming (crops, pastures) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

5a. How does farming affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
30%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
70%		3. DECREASES THE AMOUNT OF OXYGEN
0%		4. I DON'T KNOW

5b. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
32%		1. INCREASES THE FOOD SUPPLY
0%		2. DOES NOT CHANGE THE FOOD SUPPLY
60%		3. DECREASES THE FOOD SUPPLY
8%		4. I DON'T KNOW

5c. How does farming affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
100%		1. INCREASES THE AMOUNT OF SEDIMENTATION
0%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
0%		4. I DON'T KNOW

5d. How does farming affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
7%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
74%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
15%		4. I DON'T KNOW

5e. In addition to any habitat changes, how does farming directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE NUMBER OF TROUT
8%		2. DOES NOT CHANGE THE NUMBER OF TROUT
84%		3. DECREASES THE NUMBER OF TROUT
4%		4. I DON'T KNOW

The following questions ask how you think forestry (tree harvest, thinning, logging) near streams affects trout habitat and populations. To the left of each question are your last response and a summary of the group response from the first mailing. Please answer each question by circling one choice, based on your personal knowledge and experience in light of the information presented. It is OK to change your mind; however, if your response does not agree with the most popular responses from group results, please explain why you answered the way you did in the space provided on the right.

6a. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
63%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
33%		3. DECREASES THE AMOUNT OF OXYGEN
4%		4. I DON'T KNOW

6b. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
19%		1. INCREASES THE FOOD SUPPLY
8%		2. DOES NOT CHANGE THE FOOD SUPPLY
58%		3. DECREASES THE FOOD SUPPLY
15%		4. I DON'T KNOW

6c. How does forestry affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
100%		1. INCREASES THE AMOUNT OF SEDIMENTATION
0%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
0%		3. DECREASES THE AMOUNT OF SEDIMENTATION
0%		4. I DON'T KNOW

6d. How does forestry affect the amount of woody debris (fallen trees and limbs) in the stream? (Circle one.)

GROUP	YOURS	
50%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
0%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
39%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
11%		4. I DON'T KNOW

6e. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
19%		2. DOES NOT CHANGE THE NUMBER OF TROUT
66%		3. DECREASES THE NUMBER OF TROUT
15%		4. I DON'T KNOW

Please use this space for any comments you may have about the effects of land use on trout streams in the Southern Appalachian Mountains or this project.

Thank you for your cooperation. Please do not write your name on this form. If requested, a copy of the results will be provided at the end of the study.

Attention Patron:

Page 143 is missing
from all copies

Appendix B.4. Third Round of Delphi Survey Process.

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

February 28, 1990

Dear Virginia Landowner:

The third and final round is here. Thus far, the results are encouraging-- the response rate has been high and we are receiving tremendous amounts of valuable input from you. I would like to sincerely thank you for your time, effort, and enthusiasm. Your responses will be incorporated into a new management plan for Virginia's trout resources. A plan that we hope will improve trout resources near you in the future.

So, what now? This is the last time you'll see these questions— I promise! We are having trouble with the data analysis for several questions, so we are trying to salvage the information by asking for your responses to these questions once again.

The directions are simple. Re-evaluate each of the questions in light of the information presented. If you wish to keep the same response, just re-mark that answer. If you have changed your mind, that's OK, just mark the new answer. In any case, if your response does not agree with the most popular answers, please explain why you answered the way you did to the right of each question. Then return the survey as soon as possible in the enclosed stamped envelope.

Again, let me remind you that I am the only one that sees your responses, so use this to answer honestly and to the best of your knowledge. If you would like a copy of the final report and proposed management plan, please make a note on the survey form or on the envelope. DO NOT write your name on the form.

Thank you once again for your concern about Virginia's natural resources.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

Please answer the following questions on various land uses and the effects they have on coldwater streams. Base your answers on your personal knowledge and experience in light of the information presented. If you do not agree with the most popular responses, please explain why in the space at the right of each question. Thank you for your time and cooperation.

1. In your opinion, to what extent do roads and railroads (construction, use, and maintainance) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
32%		1. HURTS STREAM A LOT
68%		2. HURTS STREAM A LITTLE
0%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

2. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
9%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
50%		3. DECREASES THE AMOUNT OF OXYGEN
41%		4. I DON'T KNOW

3. How do roads and railroads affect the amount of woody debris (fallen trees and limbs present in the stream? (Circle one.)

GROUP	YOURS	
30%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
61%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
0%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
9%		4. I DON'T KNOW

4. How do industries (mines, factories, water treatment plants) affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
22%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
39%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
0%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
39%		4. I DON'T KNOW

5. In your opinion, to what extent do housing developments (houses, trailer parks, lawns) affect a nearby trout stream? (Circle the response that best fits your answer.)

GROUP	YOURS	
73%		1. HURTS STREAM A LOT
27%		2. HURTS STREAM A LITTLE
0%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

(OVER)

6. How do housing developments affect the amount of sedimentation present in the stream (Circle one.)

GROUP	YOURS	
87%		1. INCREASES THE AMOUNT OF SEDIMENTATION
4%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
9%		3. DECREASES THE AMOUNT OF SEDIMENTATION
0%		4. I DON'T KNOW

7. How do housing developments affect the amount of woody debris (fallen trees and limb present in the stream? (Circle one.)

GROUP	YOURS	
26%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
44%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
9%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
21%		4. I DON'T KNOW

8. In your opinion, to what extent does farming (crops and pastures) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
5%		1. HURTS STREAM A LOT
77%		2. HURTS STREAM A LITTLE
14%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
4%		5. HELPS STREAM A LOT

9. How does farming affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE AMOUNT OF OXYGEN
30%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
35%		3. DECREASES THE AMOUNT OF OXYGEN
31%		4. I DON'T KNOW

10. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
52%		1. INCREASES THE FOOD SUPPLY
4%		2. DOES NOT CHANGE THE FOOD SUPPLY
31%		3. DECREASES THE FOOD SUPPLY
13%		4. I DON'T KNOW

11. How does farming affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
17%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
61%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
13%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
9%		4. I DON'T KNOW

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12. In addition to any habitat changes, how does farming directly affect the number of trout in a stream? (Circle one.)

GROUP	YOURS	
4%		1. INCREASES THE NUMBER OF TROUT
35%		2. DOES NOT CHANGE THE NUMBER OF TROUT
44%		3. DECREASES THE NUMBER OF TROUT
17%		4. I DON'T KNOW

13. In your opinion, to what extent does forestry (tree harvest, thinning, logging) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
36%		1. HURTS STREAM A LOT
46%		2. HURTS STREAM A LITTLE
9%		3. DOES NOT HURT STREAM
4%		4. HELPS STREAM A LITTLE
5%		5. HELPS STREAM A LOT

14. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
26%		1. INCREASES THE AMOUNT OF OXYGEN
0%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
48%		3. DECREASES THE AMOUNT OF OXYGEN
26%		4. I DON'T KNOW

15. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
26%		1. INCREASES THE FOOD SUPPLY
4%		2. DOES NOT CHANGE THE FOOD SUPPLY
70%		3. DECREASES THE FOOD SUPPLY
0%		4. I DON'T KNOW

16. How does forestry affect the amount of sedimentation present in the stream? (Circle one.)

GROUP	YOURS	
87%		1. INCREASES THE AMOUNT OF SEDIMENTATION
5%		2. DOES NOT CHANGE THE AMOUNT OF SEDIMENTATION
4%		3. DECREASES THE AMOUNT OF SEDIMENTATION
4%		4. I DON'T KNOW

17. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
14%		1. INCREASES THE NUMBER OF TROUT
5%		2. DOES NOT CHANGE THE NUMBER OF TROUT
63%		3. DECCREASES THE NUMBER OF TROUT
18%		4. I DON'T KNOW

Do you think the Delphi Method has been an effective way to identify and quantify public attitudes towards land use on Virginia's trout streams? (Please comment below.)

12. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
57%		1. INCREASES THE FOOD SUPPLY
14%		2. DOES NOT CHANGE THE FOOD SUPPLY
29%		3. DECREASES THE FOOD SUPPLY
0%		4. I DON'T KNOW

13. How does farming affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
5%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
71%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
19%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
5%		4. I DON'T KNOW

14. In addition to any habitat changes, how does farming directly affect the number of trout in a stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE NUMBER OF TROUT
62%		2. DOES NOT CHANGE THE NUMBER OF TROUT
33%		3. DECCREASES THE NUMBER OF TROUT
5%		4. I DON'T KNOW

15. In your opinion, to what extent does forestry (tree harvest, thinning, logging) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
14%		1. HURTS STREAM A LOT
67%		2. HURTS STREAM A LITTLE
14%		3. DOES NOT HURT STREAM
5%		4. HELPS STREAM A LITTLE
		5. HELPS STREAM A LOT

16. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
5%		1. INCREASES THE AMOUNT OF OXYGEN
14%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
76%		3. DECREASES THE AMOUNT OF OXYGEN
5%		4. I DON'T KNOW

17. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
5%		1. INCREASES THE NUMBER OF TROUT
14%		2. DOES NOT CHANGE THE NUMBER OF TROUT
71%		3. DECCREASES THE NUMBER OF TROUT
10%		4. I DON'T KNOW

Do you think the Delphi Method has been an effective way to identify and quantify public attitudes towards land use on Virginia's trout streams? (Please comment below.)

Please answer the following questions on various land uses and the effects they have on coldwater streams. Base your answers on your personal knowledge and experience in light of the information presented. If you do not agree with the most popular responses, please explain why in the space at the right of each question. Thank you for your time and cooperation.

1. In your opinion, to what extent do roads and railroads (construction, use, and maintainance) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
61%		1. HURTS STREAM A LOT
30%		2. HURTS STREAM A LITTLE
9%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
		5. HELPS STREAM A LOT

2. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
14%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
56%		3. DECREASES THE AMOUNT OF OXYGEN
30%		4. I DON'T KNOW

3. How do roads and railroads affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
6%		1. INCREASES THE FOOD SUPPLY
9%		2. DOES NOT CHANGE THE FOOD SUPPLY
70%		3. DECREASES THE FOOD SUPPLY
15%		4. I DON'T KNOW

4. How do roads and railroads affect the amount of woody debris (fallen trees and limbs present in the stream? (Circle one.)

GROUP	YOURS	
15%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
38%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
47%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
0%		4. I DON'T KNOW

5. How do industries (mines, factories, water treatment plants) affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
6%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
62%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
9%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
23%		4. I DON'T KNOW

(OVER)

6. How do housing developments (houses, trailer parks, lawns) affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
17%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
24%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
47%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
12%		4. I DON'T KNOW

7. In your opinion, to what extent does farming (crops and pastures) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
48%		1. HURTS STREAM A LOT
49%		2. HURTS STREAM A LITTLE
0%		3. DOES NOT HURT STREAM
3%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

8. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
15%		1. INCREASES THE FOOD SUPPLY
3%		2. DOES NOT CHANGE THE FOOD SUPPLY
68%		3. DECREASES THE FOOD SUPPLY
14%		4. I DON'T KNOW

9. How does farming affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
9%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
47%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
32%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
12%		4. I DON'T KNOW

10. In your opinion, to what extent does forestry (tree harvest, thinning, logging) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
42%		1. HURTS STREAM A LOT
46%		2. HURTS STREAM A LITTLE
12%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

11. How does forestry affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
79%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
3%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
15%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
3%		4. I DON'T KNOW

Do you think the Delphi Method has been an effective way to identify and quantify public attitudes towards land use on Virginia's trout streams? (Please comment below.)

Please answer the following questions on various land uses and the effects they have on coldwater streams. Base your answers on your personal knowledge and experience in light of the information presented. If you do not agree with the most popular responses, please explain why in the space at the right of each question. Thank you for your time and cooperation.

1. In your opinion, to what extent do roads and railroads (construction, use, and maintainance) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
41%		1. HURTS STREAM A LOT
57%		2. HURTS STREAM A LITTLE
2%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

2. How do roads and railroads affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
9%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
63%		3. DECREASES THE AMOUNT OF OXYGEN
28%		4. I DON'T KNOW

3. How do roads and railroads affect the amount of woody debris (fallen trees and limbs present in the stream? (Circle one.)

GROUP	YOURS	
16%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
19%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
42%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
23%		4. I DON'T KNOW

4. How do industries (mines, factories, water treatment plants) affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
7%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
50%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
19%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
24%		4. I DON'T KNOW

5. How do housing developments (houses, trailer parks, lawns) affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
12%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
7%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
57%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
24%		4. I DON'T KNOW

(OVER)

6. In your opinion, to what extent does farming (crops and pastures) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
42%		1. HURTS STREAM A LOT
56%		2. HURTS STREAM A LITTLE
2%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

7. How does farming affect the food supply (insects, algae) available.to trout? (Circle one.)

GROUP	YOURS	
12%		1. INCREASES THE FOOD SUPPLY
16%		2. DOES NOT CHANGE THE FOOD SUPPLY
60%		3. DECREASES THE FOOD SUPPLY
12%		4. I DON'T KNOW

8. How does farming affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
7%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
14%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
62%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
17%		4. I DON'T KNOW

9. In your opinion, to what extent does forestry (tree harvest, thinning, logging) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
72%		1. HURTS STREAM A LOT
19%		2. HURTS STREAM A LITTLE
9%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

10. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE AMOUNT OF OXYGEN
12%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
70%		3. DECREASES THE AMOUNT OF OXYGEN
16%		4. I DON'T KNOW

11. In addition to any habitat changes, how does forestry directly affect the number of trout in the stream? (Circle one.)

GROUP	YOURS	
2%		1. INCREASES THE NUMBER OF TROUT
10%		2. DOES NOT CHANGE THE NUMBER OF TROUT
72%		3. DECREASES THE NUMBER OF TROUT
16%		4. I DON'T KNOW

Do you think the Delphi Method has been an effective way to identify and quantify public attitudes towards land use on Virginia's trout streams? (Please comment below.)

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

February 28, 1990

Dear Fisheries Professional:

The third and final round is here. Thus far, the results are encouraging-- the response rate has been high and we are receiving tremendous amounts of valuable input from you. I would like to sincerely thank you for your time, effort, and enthusiasm. Your responses will serve as a baseline for comparison with the public's ideas and attitudes. Also, your responses will be incorporated into a new management plan for Virginia's trout resources. A plan that we hope will benefit your agency in the future.

So, what now? This is the last time you'll see these questions-- I promise! We are having trouble with the data analysis for several questions, so we are trying to salvage the information by asking for your responses to these questions once again.

The directions are simple. Re-evaluate each of the questions in light of the information presented. If you wish to keep the same response, just re-mark that answer. If you have changed your mind, that's OK, just mark the new answer. In any case, if your response does not agree with the most popular answers, please explain why you answered the way you did to the right of each question. Then return the survey as soon as possible in the enclosed stamped envelope.

Again, let me remind you that I am the only one that sees your responses, so use this to answer honestly and to the best of your knowledge. If you would like a copy of the final report and proposed management plan, please make a note on the survey form or on the envelope. DO NOT write your name on the form.

Thank you once again for your concern about Virginia's natural resources.

Sincerely,

Sheryl A. Bryan
Graduate Research Assistant

Please answer the following questions on various land uses and the effects they have on coldwater streams. Base your answers on your personal knowledge and experience in light of the information presented. If you do not agree with the most popular responses, please explain why in the space at the right of each question. Thank you for your time and cooperation.

1. How do roads and railroads affect the amount of woody debris (fallen trees and limbs present in the stream? (Circle one.)

GROUP	YOURS	
8%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
15%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
62%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
15%		4. I DON'T KNOW

2. How do industries (mines, factories, water treatment plants) affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
42%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
39%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
19%		4. I DON'T KNOW

3. In your opinion, to what extent do housing developments (houses, trailer parks, lawns) affect a nearby trout stream? (Circle the response that best fits your answer.)

GROUP	YOURS	
62%		1. HURTS STREAM A LOT
38%		2. HURTS STREAM A LITTLE
0%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

4. How do housing developments affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
46%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
50%		3. DECREASES THE AMOUNT OF OXYGEN
4%		4. I DON'T KNOW

5. In your opinion, to what extent does farming (crops and pastures) affect nearby trout streams? (Circle the response that best fits your answer.)

GROUP	YOURS	
58%		1. HURTS STREAM A LOT
42%		2. HURTS STREAM A LITTLE
0%		3. DOES NOT HURT STREAM
0%		4. HELPS STREAM A LITTLE
0%		5. HELPS STREAM A LOT

(OVER)

6. How does farming affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
36%		1. INCREASES THE FOOD SUPPLY
0%		2. DOES NOT CHANGE THE FOOD SUPPLY
60%		3. DECREASES THE FOOD SUPPLY
4%		4. I DON'T KNOW

7. How does forestry affect the amount of oxygen in the water available to trout? (Circle one.)

GROUP	YOURS	
0%		1. INCREASES THE AMOUNT OF OXYGEN
64%		2. DOES NOT CHANGE THE AMOUNT OF OXYGEN
32%		3. DECREASES THE AMOUNT OF OXYGEN
4%		4. I DON'T KNOW

8. How does forestry affect the food supply (insects, algae) available to trout? (Circle one.)

GROUP	YOURS	
[illegible]		1. INCREASES THE FOOD SUPPLY
4%		2. DOES NOT CHANGE THE FOOD SUPPLY
56%		3. DECREASES THE FOOD SUPPLY
16%		4. I DON'T KNOW

9. How does forestry affect the amount of woody debris (fallen trees and limbs) present in the stream? (Circle one.)

GROUP	YOURS	
48%		1. INCREASES THE AMOUNT OF WOODY DEBRIS
0%		2. DOES NOT CHANGE THE AMOUNT OF WOODY DEBRIS
48%		3. DECREASES THE AMOUNT OF WOODY DEBRIS
4%		4. I DON'T KNOW

Do you think the Delphi Method has been an effective way to identify and quantify public attitudes towards land use on Virginia's trout streams? (Please comment below.)

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